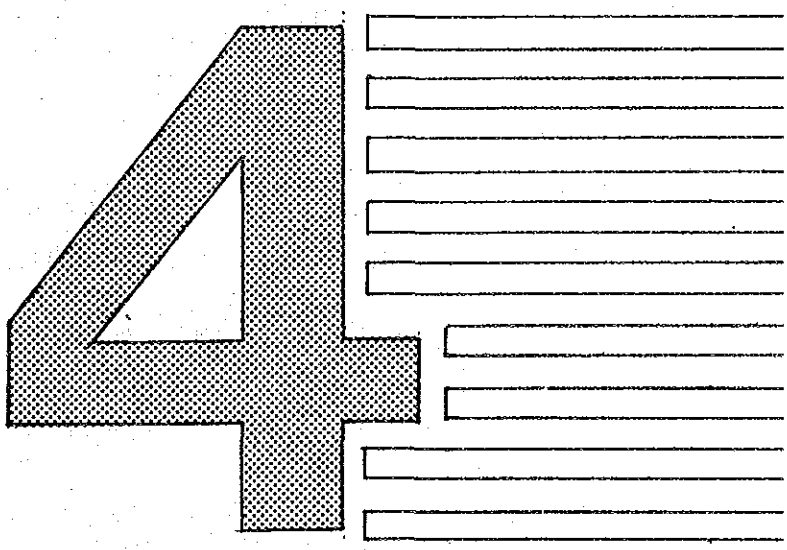
CHAPTER



4.0 IDENTIFICATION OF PROBLEMS AND ISSUES ON TRAFFIC MANAGEMENT

4.1 Identification of Problems

4.1.1 Problems on North-South Expressway

1) High Accident Rate on Expressway

According to the expressway accident data which could only be obtained for the section between Kuala Lumpur and Seremban, the average accident rate was 110.9 accidents per 100 million vehicle km while the injury and fatality rate was 76.2 accidents per 100 million vehicle km in 1986. These rates are exceptionally high compared to that of other countries. Taking this expressway section as an illustration, the Malaysian accident rate per 100 million vehicle km on expressway is twice that of Japan whereas the injury and fatality rate is more than eight times that of Japan.

2) Unsatisfactory Road Conditions

a) Unsatisfactory Geometric Designs

Road pavements along the expressway is generally in good condition since the construction was just recently completed. However, on geometric design, inadequate radius of curvatures can be found on a few sections of the expressways. The design of horizontal curvature is essential to traffic safety as traffic accident rate has found to be closely related to the horizontal radius.

It is pointed out that accident trend shows a profound increase for radius of curvature less than 400 meters. Related to this viewpoint, in particular, the design of horizontal curve at 129 km on the Changkat Jering-Ipoh section is a potential cause of accident.

b) Unavailability of Road Shoulder Pavement for Motorcyclist

The high volume of motorcycle traffic is one of the typical traffic characteristics in Malaysia, be it on ordinary roads or expressway. Despite of this, the safety measures for motorcycles are not adequately considered in the road design stage. For example, on the Kuala Lumpur-Seremban section, the road shoulder is unpaved, thus motorcyclist can be found riding on the soft-shoulder.

c) Insufficient Acceleration Lane

The acceleration and deceleration lanes must be of sufficient length to ensure traffic safety. It is observed that these lanes are insufficiently provided on approaches to petrol stations and vista points on the stretch of expressway between Kuala Lumpur and Seremban. Acceleration and deceleration lanes on approaches to vista point are also found to be inadequately provided on the section between Seremban and Ayer Keroh.

3) Shortcoming of Safety Facility

a) Different Standard of Road Marking

Various dimensions are found to have been used for the same type of road marking element. For instance, 100 mm and 150 mm are used for thickness of the lane lines on different expressway sections.

Road markings are not clearly visible on the section between Kuala Lumpur and Seremban (old standard). At places where bridge shoulder encroaches onto lane, road marking of insufficient length are observed on stretches between Changkat Jering and Ipoh as well as Kuala Lumpur and Seremban.

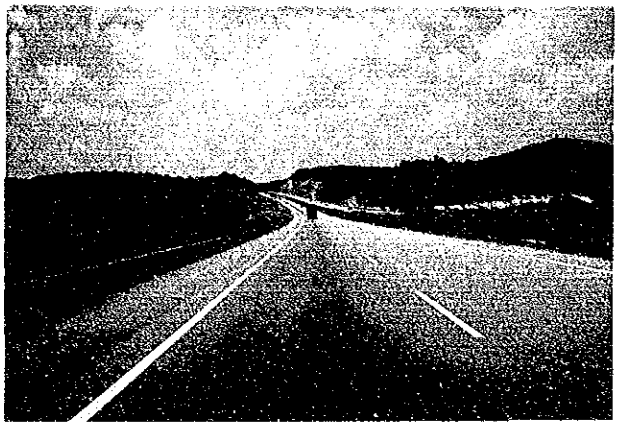
b) Lack of Uniformity in Guide Signs

The use of guide signs vary from sections to sections on the North-South Expressways as follows:-

i) different number of interchange guide sign;
ii) no standardization of legend for instance, on the interchange guide signs, the distance to interchange is written as '1 km', '1 kilometer' or '1000 m';
iii) different size of lettering;
iv) different placement of arrows, for example left-turn exit direction arrows are placed on the right side of the destination name on some locations and on the left side of the destination name on other sections of the expressway;
v) different type of guide signs for the same purpose, i.e. either post mounted guide signs or overhead type.

This lack of uniformity complicates the task of expressway users to properly recognize and understand the signs, hence causes misinterpretation.

Photo Sheet C



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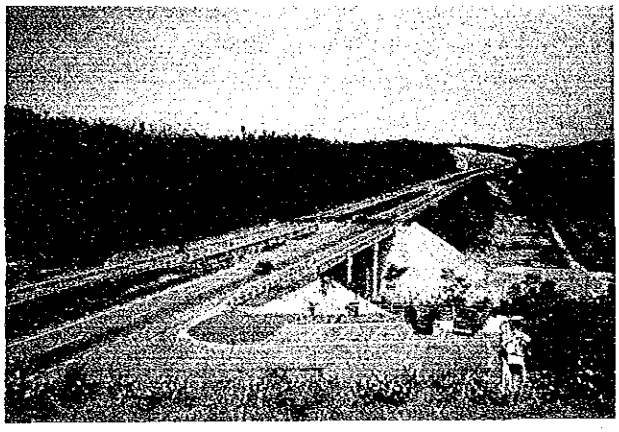
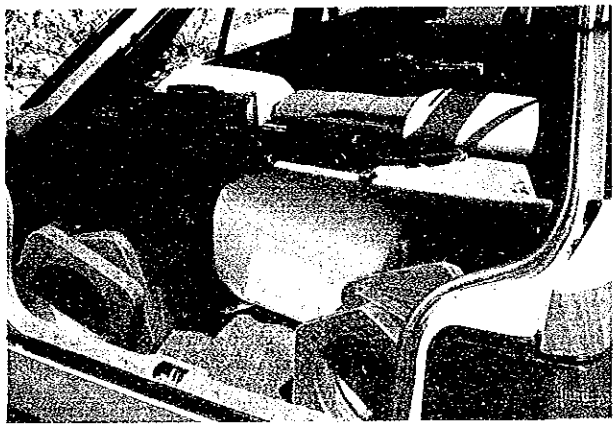
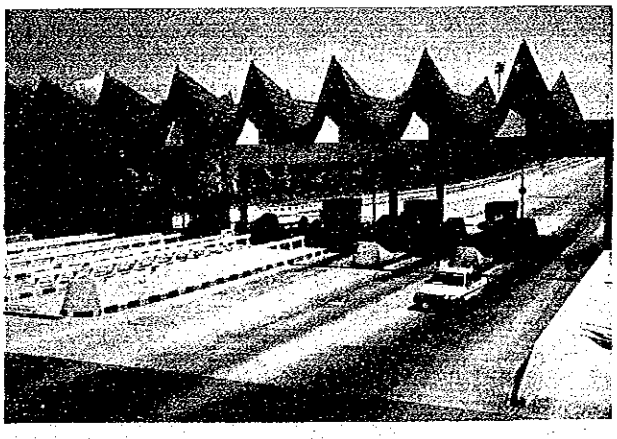
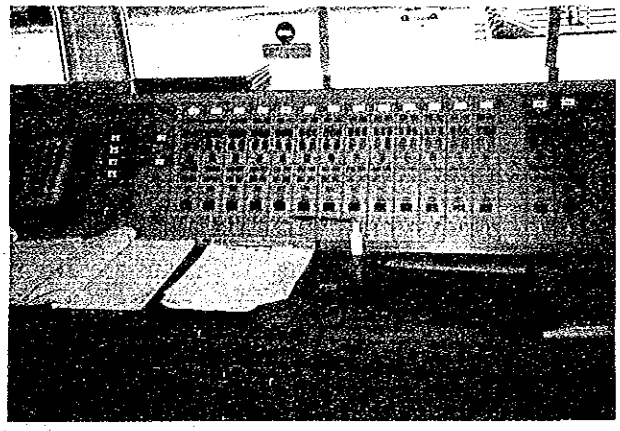
1. A view of the Seremban-Ayer Keroh Section of the North-South Expressway which has a higher design standard than the KL-Seremban Expressway. Notice the paved shoulder and wider lane width.
2. An example of a poorly design parking area. The proximity to a bridge make it difficult to provide a longer taper and hence safety is sacrificed.
3. One of the emergency telephones provided at 2 km apart along the Seremban-Ayer Keroh Section. The telephones are not lighted at night.
4. An overall view of a typical toll gate at Ayer Keroh Interchange.
5. The traffic patrol car belonging to the Concession Company PLUS.
6. Equipment carried in the patrol car. The use of a sedan car limits the number of items that can be carried in the patrol car.
7. A toll gate control panel at one of the toll gate office.









c) Lack of Optical Guidance

Optical guidance for drivers is hardly provided at the median on the stretch of expressway from Kuala Lumpur to Ayer Keroh.

d) Absence of Warning Signs/Devices for Strong Wind

Drivers travelling at high speed on several expressway sections along the stretches of Seremban-Ayer Keroh Expressway are prone to strong cross-winds. The strong winds, blowing at right angles to the direction of travel causes a vehicle to loose traction, giving the driver an eerie floating sensation. In the worse case, they can sweep a moving vehicle off its course.

The strong wind sections are identified as follows:-

* 79.4 km - 79.9 km
* 110.5 km - 111.0 km
* 112.1 km - 112.8 km
* 113.1 km - 113.9 km
* 123.2 km - 123.6 km
* 127.0 km - 127.4 km

However, there is insufficient warning signs or devices to warn drivers about this potentially fatal hazard.

4) Frequent Occurrence of Vehicular Breakdown

It is found that many vehicles breakdown on the North-South Expressway. According to records on the usage of emergency telephone on Seremban-Ayer Keroh Expressway, vehicular breakdown is frequent.

In 1987, a total of 136 vehicular breakdown were reported and this increased to 267 cases in 1988. It is observed that mechanical problems and punctured tyres are major causes of vehicle breakdown. In terms of vehicle type, car forms the major vehicle type that suffers breakdown, followed by motorcycle.

On the other hand, many unattended vehicles especially those with malfunctioned tail lamps are often seen on the expressway.

Under the present system in Malaysia, regular inspection is only required for commercial vehicles. In view of the situations, vehicle inspection and maintenance should be imposed on private cars and motorcycles in the near future.

5) Problems on Traffic Operation

a) Inadequate Emergency Telephone Service

Emergency telephone is one of the essential communication facilities in case of accidents on the expressway as there is no other means of communication for help.

At present, only a few portions of the North- South Expressways which have been completed and opened to traffic are provided with emergency telephone. The other large portions of the expressway, however, are not yet equipped with this facility.

b) Low Frequency of Patrol

Besides emergency telephone, patrol cars are another primary source of information on expressways. However, only a few expressway sections are patrolled daily while the rest is patrolled once or twice a month. The present frequency of patrolling on the expressway is too low for efficient traffic control purposes.

c) Inadequate Traffic Control Measure In Case of Accidents

Although some traffic control measures in case of accident have recently been set up, these involved only the establishment of communication network amongst patrol cars, toll plazas, police, hospitals, fire brigades, towing company, etc. These measures have yet to be evolved into a comprehensive system that covers all expressway sections.

d) Absence of Efficient Communication Means

At present, the communication means amongst the related agencies is only via public telephone line, which is in essence, insufficient for proper and prompt management of expressways.

6) Bad Driving Habits

a) Dangerous Driving

High speed driving, short headway, dangerous overtaking, changing lane without signals and driving in improper lane (motorcycle) are common scenes on the expressways.

In addition, car or motorcycle chasing/ racing on the expressways create dangerous situations to the driver themselves as well as to other road users.

b) Lack of Information and Knowledge of Safe Driving

It is commonly seen that a lot of vehicles park at the shoulder side of the expressway, partly due to vehicular breakdown or drivers and passengers taking a rest. Thus, it seems that many drivers do not have any information about the facility on the expressways and worst still, they are ignorant about traffic safety on expressways.

7) Intrusion onto Expressway by Animals

The intrusion by animals onto expressway and parking areas pose a hazard to traffic safety on the expressway. Most often than not, this intrusion causes accidents especially on the Seremban-Ayer Keroh and Jitra-Gurun sections.

Photo Sheet D

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1. Steep cut slopes and overloaded trucks are common features of Karak Highway.
2. Entrance to the one-bore Genting Tunnel at Karak Highway. Poor ventilation has aggravated the problem of dimness in the tunnel.
3. An example of the several at-grade intersections along the Senai-Johor Bahru Highway.
4. Another view of the Senai-Johor Bahru Highway that has no access control.
5. The Genting Sempah tunnel maintenance office.
6. Lack of periodic cleaning of tunnel wall and ceiling has resulted in the poor visibility in the tunnel. The dirt coated emergency telephone sign shown here can hardly be seen by passing motorists.
7. Slope slip is a common problem along Karak Highway.

4.1.2 Problems on Toll Highways

1) Karak Highway

a) High Accident Number on Karak Highway

According to the accident data obtained from Bentong Police Station which is responsible for part of Karak Highway, i.e. eastward from Genting Sempah Tunnel; the accident number is 157 in 1987 and 176 in 1988 on the section of 40 km-48 km. As such, the number of accident per kilometer is 22 on the highway in 1988. Out of the 176 accident cases in 1988, 14 people died and 61 people suffered injury within the stretch of just 8 km length.

b) Deficiency in Road Conditions

i) Poor Geometric Design

On Karak Highway, the steepest vertical curves slope at 8% while the sharpest horizontal curves are designed with radius of 130 meters. These design characteristics are found to be closely related not only to causes of heavy traffic jams but also to occurrence of accident.

ii) Poor Road Pavement

The poor road pavement on Karak Highway is reflected in the presence of many huge cracks and rutting on the road surface especially on climbing lanes. In addition, the road shoulder is not wide enough and to make matters worse, unpaved.

c) Shortcoming of Safety Facility

Generally, the safety facilities on Karak Highway are in poor condition. Lighting is only provided at toll booths and in the tunnels. Besides, lane markings are not well painted and too narrow whereas pavement edge markings are only poorly painted on some sections. Emergency telephones are not provided along the highway except in the tunnel even though public telephones are provided at rest areas. Other safety facilities such as traffic signs, delineators, glare screens are also not provided on the highway.

d) Occurrence of Vehicular Breakdown

Many vehicular breakdown, especially lorries, can be observed on the road shoulder of the highway.

e) Conspicuous Traffic Characteristics

i) Large Differences in Vehicular Speed Gap

The speed survey conducted recently reveals that the average speed of lorry and passenger cars is 52.3 km/h and 85.6 km/h on Karak Highway respectively. As such, the average differences in the vehicular speed is more than 30 km/h. However, the differences are much higher on slope section where the average differences easily exceed 50 to 60 km/h between passenger cars and lorries.

ii) Overloading of Lorry

One of the unique traffic characteristics on Karak Highway is the large traffic volumes of heavy lorry which are mostly overloaded. This overloading feature further lengthens the large speeding gaps between them and other vehicles. Besides, it causes heavy damage to road pavement especially that of climbing lanes.

f) Dangerous Overtaking

The common unsafe behaviour of drivers is the high speed driving and unsafe overtaking activities on Karak Highway. In particular, frequent overtaking by passenger cars over slow moving heavy lorry often results in serious accidents.

An illustration of the dangerous overtaking using opposite lane on down slope is given in Figure 4.1.1.

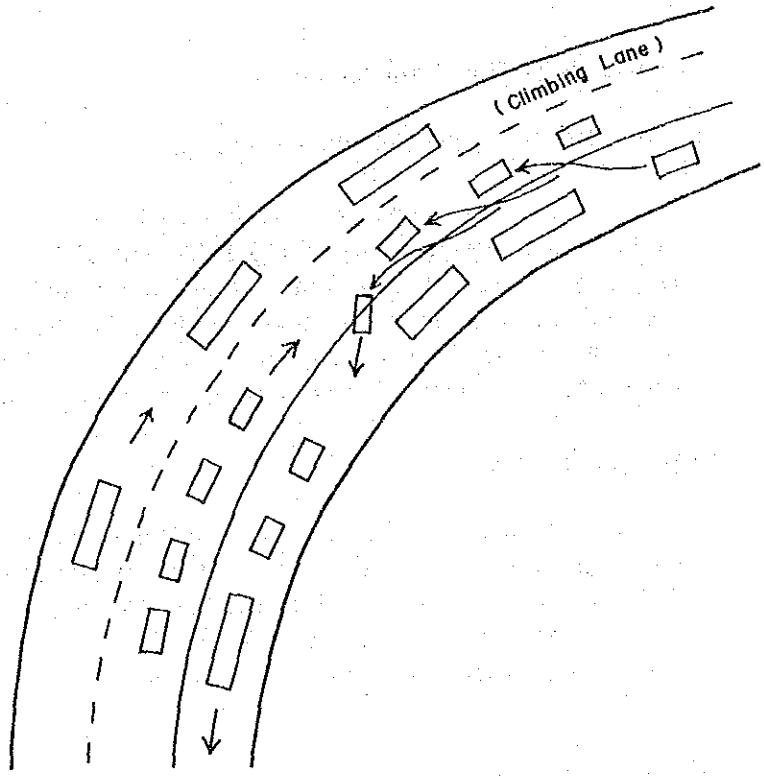


Figure 4.1.1: Dangerous Overtaking Using Opposite Lane on Down Slope

g) Absence of Proper Traffic Control Measures in Case of Accident

At present, there is no proper traffic control measures in case of incident on the Karak Highway. However, it should be stated here that effort is being made to draw out similar traffic control measures based on that established for the North-South Expressways. As pointed out earlier, the traffic control measure set up for the expressways are still insufficient and not comprehensively enough for traffic management.

h) Absence of Proper Communication Means

Similar to the North-South Expressway, the present communication tool amongst the related agencies involving in the Karak Highway is via the public telephone line. This is inadequate considering the peculiar situation on this isolated highway.

i) Unsatisfactory Tunnel Condition

Various unsatisfactory conditions can be found in the Genting Sempah Tunnel on Karak Highway.

Foremost, dirt on the ceiling, wall and lighting system diminished the luminance within the tunnel. This poor visibility results in unclear picture of the CCTV camera. Besides, the location indicator signs of the emergency telephone are too dirty for drivers to be aware of them.

2) Federal Highway (Federal Route 2)

a) Unsatisfactory Road Condition

i) Narrow Traffic Lane

The traffic lanes which do not conform to highway standard are just too narrow for the passage of high speed traffic of 90 km/h.

ii) Absence of Clearance between Side Marking and Median

The clearance between side marking and median is conspicuously absent from some sections of the Federal Highway. This situation creates an oppressing feeling among the drivers.

iii) Unpaved Road Shoulder

The soft shoulder and the resultant different level with the pavement bring about unsafe riding of motorcyclists.

b) Mixed Traffic

i) High Volume of Motorcycle

As the Federal Highway is an inter-urban highway, the motorcycle traffic contributes large share of the total traffic. The traffic composition aggravates the usage of Federal Highway since the shoulder is unpaved for the use of motorcycle.

ii) Improper Riding Habit of Motorcyclists

Improper riding habits of motorcyclists is observed on the highway. For example, frequent overtaking by motorcycle over slow moving motorcycles or cars often manifests in serious accident. Moreover, these activities also endanger other traffic.

c) Recurrent Traffic Congestion

Comparing the section of Federal Highway between Kuala Lumpur and Subang Jaya, the Study route from Subang Jaya to Klang is a 4-lane highway which under the present traffic condition, is highly deficient in capacity for its function. The section between Shah Alam and Petaling Jaya is carrying an average of 123,000 pcu/day with a v/c ratio of 2.6 in 1988.

During morning peak hours, acute congestion caused by heavy inbound traffic flowing on the through lanes occurs at Shah Alam, Subang Jaya as well as Petaling Jaya. For this reason, traffic queues occur frequently both at on/off-ramp and on through lanes.

On the other hand, during evening peak hours, exiting traffic from the highway to interchanges result in traffic queues not only on off-ramp lane but also on through lane. Traffic queues are usually seen along off-ramp at interchanges in Shah Alam and Petaling Jaya.

Such congestion or queue on through lane would have a significant adverse effect upon the traffic flow on these segments of the Federal Highway thus rendering the highway inefficient and unsafe.

However, the above-mentioned section will be increased to a 6-lane highway by 1992. As such, the existing traffic congestion may ease up considerably for a smooth flow from 1992 onwards.

d) Lack of First Aid Countermeasure

According to "Feasibility Study of Transportation Facilities Projects in Klang Valley", three accidents are observed on every two days on the highway in the Klang Valley. This high accident occurrence needs immediate first aid countermeasure from the viewpoint of humanity as well as ensuring efficiency of highway operation. However, there is a lack of first aid countermeasure on the existing highway network.

3) Penang Bridge

The unique traffic characteristics on Penang Bridge is the large volume of motorcycles.

The frequent parking offenders on the mid-span of the bridge despite of no parking signs and enforcement of regulations endanger the safety on the bridge.

Apart from this, the large joint gap between the bridge and embankment is a potential cause of accidents.

Another major condition affecting safety on the bridge is the vehicular breakdown. In 1987, the number of vehicular breakdown was 333 which then decreased to 257 in 1988. The large portions of this breakdown involve car and motorcycle. As to the type of breakdown, mechanical problems and burst or punctured tyres are often cited as causes of breakdown.

Even though mobile radio system is being planned to be introduced on the Penang Bridge, more comprehensive coordinated communication systems are needed.

4) Senai-Johor Bharu Highway

The Senai-Johor Bharu Highway is connected to local access roads by at-grade intersections. Functionally, the highway acts as a distributor road with many parked vehicles for loading and unloading activities and significant volume of pedestrian crossing. Moreover, the speed limit is fixed at 90 km/h, 70 km/h and 50 km/h depending on the relevant sections. Besides, the safety facilities such as guide signs, regulation signs, delineators are insufficiently provided.

4.1.3 Problems on Both Expressway and Toll Highway

1) Adverse Weather Conditions

Unusual weather conditions obstruct traffic in the following manner:-

i) Insufficient sight distance and skid resistance on road surface caused by heavy rain;
ii) Disaster such as landslide and landslip;
iii) Crosswind.

Precipitation records in the whole study area show that precipitation tends to be concentrated in a small area with high density of rainfall and sometimes thunderstorm.

Under such high intensity of rain, drivers often than not are unable to recognize the vehicles ahead of them or avoid unexpected obstacles. Moreover, the loss of skid resistant of road surface caused by heavy rain sometimes hinders safe driving even though the vehicle is running at the design speed.

Concentrated rainfall is the major cause of landslide or landslip at slope especially at cut slope. Since opened to traffic, landslide have occurred on the stretch between Ipoh and Changkat Jering and more profoundly on the Kuala Lumpur-Karak Highway while in many cut or embankment slopes, small scale landslips have also happened.

At present, the relationship between rainfall and landslide/landslips cannot be analyzed due to absence of meteorological data at these places as well as unavailability of disaster record.

Crosswinds sometimes affects safe driving especially those running in high speed. On the North-South Expressway, few sections are identified as cross-winds prone areas, i.e. the few sections located in valleys along the stretch between Seremban and Ayer Keroh. As such, in mountainous area, crosswinds should be taken into consideration during daily inspection or patrol.

2) Shortcoming in Accident Analysis

According to the accident statistical report by Royal Malaysian Police in 1986, accidents involving motorcycles make up about 50% of the total accident deaths in Malaysia. It is an alarming situation when compared to the rate of foreign countries. Rightfully, the first priority of traffic safety in Malaysia is to reduce the number of accidents involving motorcycles. This priority

treatment is further justified by the fact that around 40% of the total accidents involve young people in the age group of 16 to 25 years old. Hence, prevention of accident involving motorcycles and reduction of accident rate among young drivers must be seriously considered and pursued in today's Malaysia.

The accident data on expressways and highways are unfortunately not classified separately even though accident data and analysis has been done in general in Malaysia.

Even at the Headquarters of Royal Malaysian Police, it is not able to extract accident data on highways. The main reason is that the accident data on expressways is not classified and categorized which in turn illustrates an inadequate information system. However, the present situation is not totally unexpected since the expressways and highways were just opened to traffic not too long ago.

In fact, a computerized information system using a new form of accident data sheet which includes accidents on expressways and highways has been introduced from January 1989 by the Royal Malaysian Police. After careful examination of the accident data sheet, it is doubtful that it can provide a sound data base for comprehensive analysis of accident on expressways and highways and thereby proposing appropriate plans and countermeasures against accidents on expressways. As such, it is recommended that additional items be put on the accident data sheet.

3) Inadequacy in Maintenance

A proper maintenance manual is essential for maintenance works on expressway or highway. However, the MHA and PLUS are still in the process of agreeing on a common manual for use by both parties. Rightfully, the manual should establish a comprehensive maintenance system encompassing organization set-up, identification of inspection item and its frequency, establishment of inspection record formats and their analysis method as well as preparation of inspection manual.

The existing traffic and road conditions/problems on North-South Expressway and toll highways are illustrated in Table 4.1.1.

Table 4.1.1: Existing Traffic and Road Conditions/Problems on North-South Expressways and Toll Highways

Sections \ Factors	Road Condition	Traffic Volume/ Speed	Traffic safety Facilities	Driver's Movement
North-South Expressway Bukit Kayu Hitam to Jitra (24 km)	. Guardrail at Median . 4 lanes . Mostly straight . Connect to local road . At-grade intersection	. About 1,500 veh/day . Low percentage of truck traffic . 80-100 km/h (Ave) . High volume of motorcycle . Speed limit of 90 km/h	. Narrow edge marking . Lack of warning signs at at-grade intersection . No guard facilities at nose of diverging end	. High speed driving (over 100 km/h) . High speed passing at at-grade intersection . (crossing pedestrian at at-grade intersection)
Jitra to Gurun (56 km)	. 4 lanes . Guardrail at Median . Concrete pavement on some section . Poor pavement joints . Poor pavement condition	. About 3,000-4,500 veh/day . Low percentage of truck traffic . Speed limit of 110 km/h	. Wider lane marking . Vandalized guard fences . No emergency telephone . Median opening (2 km intervals) . Presence of warning sign for flood . No guard facilities at nose of diverging end	. Motorcyclist drive in opposite direction . (crossing pedestrian)

Table 4.1.1 (cont'd): Existing Traffic and Road Conditions/Problems on North-South Expressways and Toll Highways

Meru-Menora Tunnel (830m South-bound, 880m North-bound)	. Dual bore tunnels . Each tunnel has 2 lanes . About 1.5% slope . Lining walls	. About 8,500 veh/day . Heavy volume of lorry traffic . Speed limit of 65 km/h	. Sodium lighting at Entrance and Exit areas . Flourescent lighting at central section . km post sign erected near the fire extinguisher . Move km post sign from fire extinguisher . Poor legibility of extinguisher manual . Change the manual of Extinguisher (from words to design marking) . High lux at night . Check the lux at night time (Too bright at Entrance and Exit areas for driving comfort) . Emergency telephone at 200m intervals . Jet fan installed (7 locations) . Carbon monoxide, smoke detector installed . No guard facilities at nose of diverging end

Table 4.1.1 (cont'd): Existing Traffic and Road Conditions/Problems on North-South Expressways and Toll Highways

Changkat Jering to Ipoh (56 km)	. 4 lanes . Mountainous area . Steep cut/ embankment slopes . New Jersey type barrier at median . No side shoulder at bridge . Bridge shoulder encroaches on lane . Long stretch of straight road (3 km) (93.0kp-96.4kp) . Small radius of curvature (126-129kp) . Evidence of tyre marks at median . Provision of climbing lane	. About 8,500 veh/day . Strong cross wind (104 kp) . Speed limit of 110 km/h except 80 km/h at curve section . Overheated vehicle	. Short approach marking to bridge . Poor Warning Sign at Curve section . Broken Glare Screen (100-102 kp) . Untotalized units of distance (m and km) of Guide Sign . No emergency telephone . Lack of down grade sign . No guard facilities at nose of diverging end	. Poor driving habit when overtaking . Changing lane without signal . High speed driving

Table 4.1.1 (cont'd): Existing Traffic and Road Conditions/Problems on North-South Expressways and Toll Highways

Kuala Lumpur to Seremban (53 km)	. 4 lanes . Narrow lane width . Unpaved road shoulder (soft-shoulder) . Guardrail at median . Tall trees at median . Insufficient length of acceleration/ deceleration lanes to Petrol Station, R.A.	. About 30,000-54,000 veh/day . Mixed traffic . High volume of motorcycle traffic . Speed limit of 110 km/h	. Visibility obstructed by tall trees at median on some sections . Insufficient number of speed limit signs . No emergency telephone . No warning signs for strong cross wind . Some section without guardrail . No guard facilities at nose of diverging end . No warning sign for merging . Smaller size of guide signs . Poor legibility of Town Guide Signs . Long stretch of straight road (3 km) (110 km post)	. High speed driving (over 110 km/h) . Much lane changing by motorcycle riders . Lane changing without signals . Short headway . Poor driving habit when overtaking . Unsafe running situation by two-seater motorcycle . Sudden lane changing by motorcyclists . Driving in wrong lane by motorcyclist/bicyclist . Motorcycle use one lane because no space is provided
Seremban to Ayer Keroh (68 km)	. 4 lanes . Good pavement condition . Well paved shoulder . Deep though at median . No guardrail at median (some section)	. Speed limit of 110 km/h . About 8,000-13,000 veh/day . High volume of motorcycle traffic	. Emergency telephone at 2 km intervals . Emergency telephone sign at 250 m ahead . No warning sign for strong cross wind section . Poor warning signs and regulatory signs . Good marking condition . Domestic and wild animals at median and side-shoulder . High speed driving (over 120 km/h) . Driving through lane marking . Lighting system provided	. Dangerous animals crossing . High speed driving . Dangerous way of goods loading

Table 4.1.1 (cont'd): Existing Traffic and Road Conditions/Problems on North-South Expressways and Toll Highways

Kuala Lumpur-Karak Highway (68 km)	. Single carriageway . 2 lanes . Climbing lane provided . Slope 8% (maximum) . Sharp curves (R=130) . Mountainous road . Poor road pavement . Soft shoulder . Poor road maintenance (huge cracks, ruttings) . Narrow shoulder	. About 16,500 veh/day . Speed limit of 80km/h (40 km/h in tunnel) (50 km/h at toll plaza) . Mixed traffic . High volume of large goods vehicle . Large differences in vehicular speed . Overheated vehicles . Small engine displacement of motorcycle (80-90 cc) . Overloading lorry	. Lighting provided at toll booth and in the tunnel . Center line marking too narrow (100 mm width, 3 m length, 5 m space) . Low visibility of emergency sign in tunnel . No emergency telephone except in tunnel . Poor visibility in tunnel . Short sight distance (23 kp) . No speed limit sign of 40 km/h in tunnel . Poor visibility of edge marking . Inadequate safety facilities for night time driving	. Short headway . Dangerous overtaking . Changing lane without signals . High speed driving (120 - 130 km/h at some section) . Use opposite climbing lane for overtaking on down slope . Poor driving habit when overtaking . Unsafe driving situation by two-seater motorcyclist . Sudden lane changing by motorcycle . Driving in wrong lane by motorcycle
Penang Bridge (14 km)	. Dual carriageway . 4 lanes . New Jersey type barrier at median . Many cars park on bridge	. About 27,500 veh/day . High volume of motorcycle (about 30%) . Speed limit of 80km/h . Traffic peak at 19:00 -20:00	. Emergency telephones provided (7 west - bound 5 east - bound) . Emergency parking niches provided . Full lighting provided	
Senai-Johor Bharu Highway (28 km)	. Dual carriageway . 4-lanes . At-grade intersection and pedestrian crossing . Urbanization	. Speed limit of 110 km/h . About 32,000 veh/day	. 4 at-grade intersection . Lighting system provided . Narrow longitudinal lane marking	. High speed driving . High speed passing at at-grade intersection
Federal Highway (15 km)	. Dual carriageway . 4 lanes . Waving vertical alignment . Unpaved shoulder . Large mount-up median . Urbanized area	. High Traffic Volume (45,000-124,000 veh/day) . Traffic congestion . High volume of large goods vehicles . Speed limit of 90km/h	. Lighting provided at interchanges . U-turn lane	. High speed driving . Short headway . Dangerous overtaking

4.2 Issues on Traffic Control and Management on Expressways and Highways in Malaysia

The following issues on traffic control and management are identified:

1) Insufficient traffic control and management measures at present for constituting a well-coordinated and comprehensive traffic control and management system needed for the efficient operation of expressways and highways,

2) Inadequate provision of safety facilities on the expressways and highways, and the lack of standardization on the design, installation of such devices or facilities as guide signs, lane markings, accelerating and decelerating lanes,

3) Poor road conditions on certain sections of the expressways and highways due to poor design elements and damages caused by overloaded vehicles,

4) High traffic accident rate and vehicle breakdown incidents on the expressways and highways and yet there is an acute lack of traffic accident data and analyses while the present first-aid measures are not sufficient,

5) Insufficient maintenance activities and frequency that have resulted in the less than satisfactory conditions of the expressway, highways and tunnels,

6) Undesirable driving habits of expressway and highway users and their lack of knowledge on safe driving and behaviour on expressways,

7) Inadequate data collection and analyses on adverse weather conditions and incidents caused by such phenomena on the expressways and highways.

4.3 Necessity for Traffic Control and Management System on the Expressways and Highways

As a means to alleviate if not eliminate the various problems and issues identified in section 4.1 and 4.2, the introduction of a comprehensive traffic control and management system on the Malaysian expressways and highways is recommended.

1) Necessity for the Introduction of a Traffic Control and Management System

It is widely recognized that early detection of incident and confirmation of its magnitudes and nature are basic essential for the provision of prompt and appropriate first-aid measures in saving human lives on the expressways and highways. Inaccurate information and slow responses to incidents can lead to loss of lives as well as creating heavy traffic congestion on expressway, which in turn generates potential danger in secondary incidents. Moreover, due to the fact that a diversity of persons from different agencies are involved from the point where information on site is gathered, transmitted and appropriate actions are taken, a well coordinated system of traffic management is vital.

Given the fact that traffic volumes are high and increasing rapidly in and around Kuala Lumpur, early detection of traffic congestion and provision of countermeasures can improve traffic mobility and reduce traffic accident. The expressways and highways also pass through areas with concentrated heavy rainfall which can cause landslides that pose potential hazards to drivers. There is a need to provide prompt warnings to drivers on the potential dangers of landslide, strong cross winds, steep up-slope and down-slope as well as slow moving vehicles.

2) Necessity of Organization Set-up and Strengthening Manpower, Mobility and Equipment in Compatibility with the Traffic Control and Management System

The traffic control and management system to be introduced shall be equipped with the following functions on traffic operation:-

a) Communication among centers, maintenance offices, patrol units of the system, agencies involved in traffic operation and roadside traffic control equipment or devices,

b) Traffic surveillance,

c) Decision making on countermeasures to be taken when incidents or emergencies occur,

d) Coordination among the various executing bodies on traffic operation.

Given the many agencies involved and their interlocking responsibilities and functions, it is necessary to establish an organization capable of efficiently manage the system. The organization should also be strengthened in its manpower, mobility and equipment to facilitate system operation and execution of activities in meeting the social needs and demands.

3) Necessity of Establishing A Traffic Engineering Study Section

It is widely understood that full understanding on what happens, is happening and will happen on expressways and highways is essential for traffic management.

This understanding or knowledge can be required only through accident and traffic volume analyses and also by such activity as careful examination of drivers behaviour and accident rates changes before and after the modification of geometric design and improvement of traffic control devices are made.

This acquired knowledge will contribute much to the improvement of the planning of improvement works, geometric design and traffic safety measures and devices.

Therefore, it is necessary to establish a traffic engineering study section within the organization to deal mainly with:-

* accident data filing and analyses
* traffic volume data filing and analyses
* minor improvement designing for traffic safety.

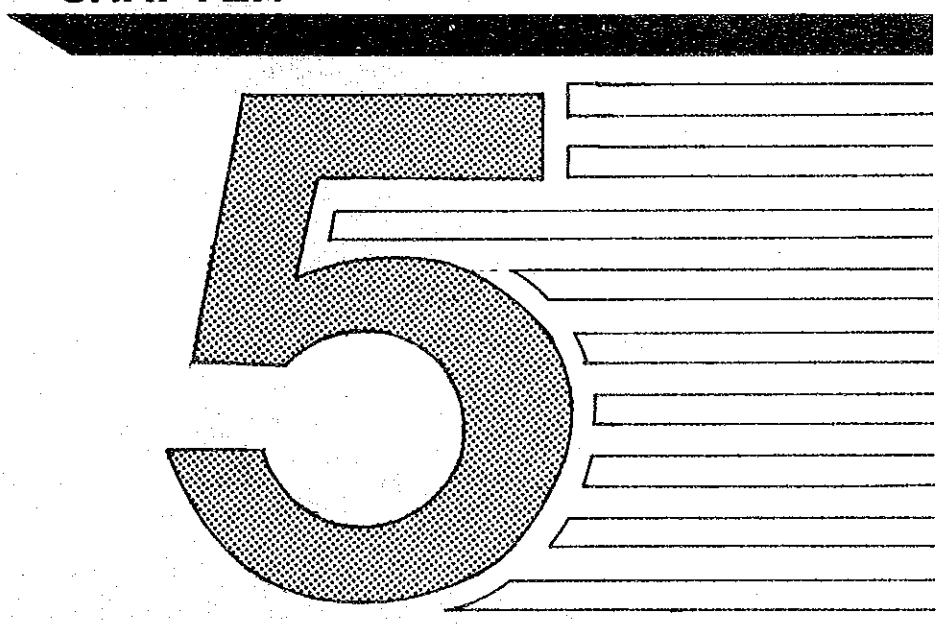
4) Necessity of Enhancing Consciousness of Traffic Safety to Expressway Users

Illegal or improper driving habits would lead to accident, vehicle breakdown and obstruction to smooth flow of traffic. These are problems presently affecting the safety level of the expressways and highways. Thus, it is necessary to enhance traffic safety consciousness among the public in general and expressway users in particular; through:

a) traffic safety campaign on safe expressway driving through public media in close coordination with nation-wide traffic safety campaign initiated by the National Road Safety Council;

b) wide publicity on traffic safety information by giving leaflets or pamphlets to expressways users in bringing to their awareness of the safety facilities provided along the expressways and highways; guidance to offenders in close coordination with Police when they carry out enforcement on overloaded vehicles, poorly maintained vehicles and overspeeding.

CHAPTER



5.0 TRAFFIC CONTROL AND MANAGEMENT MASTER PLAN

5.1 Introduction

This chapter presents the proposed master plan for Traffic Control and Management to be adopted on Malaysian expressway and toll highways.

The concept of traffic control and management is first defined in terms of its two basic system functions. The various components that constitute these functions are identified. Lastly the tasks that are performed under these components are briefly discussed.

The proposed organization set-up is presented with the recommended organization hierarchy structure and tasks at each respective level, including those tasks and responsibilities to be shared between MHA and PLUS. In order that the proposed traffic control and management system for the North-South Expressway can be effectively implemented, a three-division plan is recommended. The organization setup of such a plan and the tasks to be performed by the traffic control center which plays a key role in traffic control and management are discussed in this chapter.

In Section 5.4 of this chapter, three levels of traffic management standards are defined in terms of parameters such as traffic volume and traffic flow characteristics. These three levels of traffic management are then applied to each of the sections of the three functional classification of highways under study, namely motorway, expressway and highway.

An outline of the proposed traffic control and management system is presented in Section 5.5. The proposed system contains five (5) traffic control centers and nine (9) sub-centers. The installation standards of the various types of roadside equipment are given. The proposed system is consequently presented by a schematic diagram.

Highway maintenance is discussed in section 5.6 of this chapter. Highway maintenance works which can be broadly classified into five categories are explained. An example of the type of traffic regulation to be implemented during a typical highway maintenance work on the expressway is also presented.

Lastly, various steps that have to be taken to enhance and ensure traffic safety on the expressways and toll highways are discussed in section 5.7.

5.2 Concept of Highway Traffic Control and Management

Highway traffic control and management has three goals, namely ensuring traffic safety, smooth traffic flow and users comfort on the expressways and highways. Such a system, as depicted in Figure 5.2.1, has two basic system functions, namely traffic operation and maintenance. Each of these functions has several components and tasks which are briefly described below.

1) Traffic Operation Function

The traffic operation function has four components. They are:

a) Traffic Control,
b) Traffic Surveillance,
c) Toll Collection, and
d) Traffic Regulation.

The traffic control component here includes not only the general traffic control on the expressways under normal conditions as carried out by the highway or police patrol units along the expressways everyday; but also those emergency measures taken for the purpose of controlling traffic under unusual conditions. Such unusual conditions may include traffic accident, adverse weather phenomena (torrential rain, heavy thunderstorm concentrated at small area; strong wind, fog, etc.) and conditions generated as a result of improvement works to the expressway like widening of carriageway, construction of additional ramp, pavement repairs, etc.

The traffic control component also performs a very important task, that of information dissemination. Road and traffic conditions or weather information gathered at the traffic control centers or sub-centers at the maintenance offices are conveyed to other offices, patrol units as well as the drivers via such media as wireless, highway radio, changeable message signs, and broadcasting.

The second component under traffic operation is traffic surveillance. Traffic surveillance is aimed at collecting information on road and traffic conditions using such equipment as vehicle detectors, closed-circuit television cameras, helicopters (aerial surveillance), emergency telephones and other means as cooperative motorists, mobile telephones, patrol vehicles, etc. Some of these will yield quantitative data while others will provide incident information or level of service. Traffic information collected and processed are interpreted - by traffic engineers and pass on to the police or patrol personnel for traffic control.

Toll collection constitutes another component under the traffic operation function.

The task here is simple and straightforward, i.e. the collection of toll from vehicles using the expressway at toll gates or plazas erected at the exit points of the expressway (in the case of closed system) or at toll barriers (in the case of an open system). At toll collection plazas or gates, equipment are also installed for the collection of traffic data. Toll ticketing itself will provide fundamental data such as traffic volume and traffic composition.

Lastly, traffic regulation which is the jurisdiction of the police in most countries, legitimates the various traffic control measures as provided by the governing traffic laws and regulations; such as maximum speed limit control, temporary closure of a lane or even a section of the highway during an emergency.

2) Maintenance Function

The other major system function in an expressway and highway traffic control and management is highway maintenance. The highway maintenance function of an expressway or highway can be distinctively divided into three components; these are:

a) Routine maintenance,
b) Periodical maintenance, and
c) Incidental maintenance.

Routine maintenance tasks include daily inspection on the conditions of roads, structures and other related facilities. Object of inspection covers pavement, embankment, bridge, fence, guardrail, signboard, etc. This daily inspection is hence aimed at early detection of any defects, damages, wear and tear of structures and facilities on the expressways and highways. The results of inspection are reported back for followed up maintenance work if necessary.

Periodical maintenance is the task of detailed inspection, checking and testing the conditions of various facilities at certain fixed time intervals. As the name suggests, maintenance is performed by fixed time cycles such as yearly or half-yearly, monthly or weekly, depending on the type of facilities and maintenance items. Defects or damages if detected are promptly reported for repairs or remedies. Periodical maintenance also covers the tasks of cleaning the pavement, signboards, guardrails and other facilities; upkeep of vegetation along the expressways and highways; and painting of structures.

Incidental maintenance are basically work carried out to restore the expressways and highways and related facilities to their normal functioning conditions after they have been damaged during road accidents or natural disasters (such as landslide, avalanche, etc).

Courtesy of Japan Highway Public Corporation

Traffic Regulation at Accident site

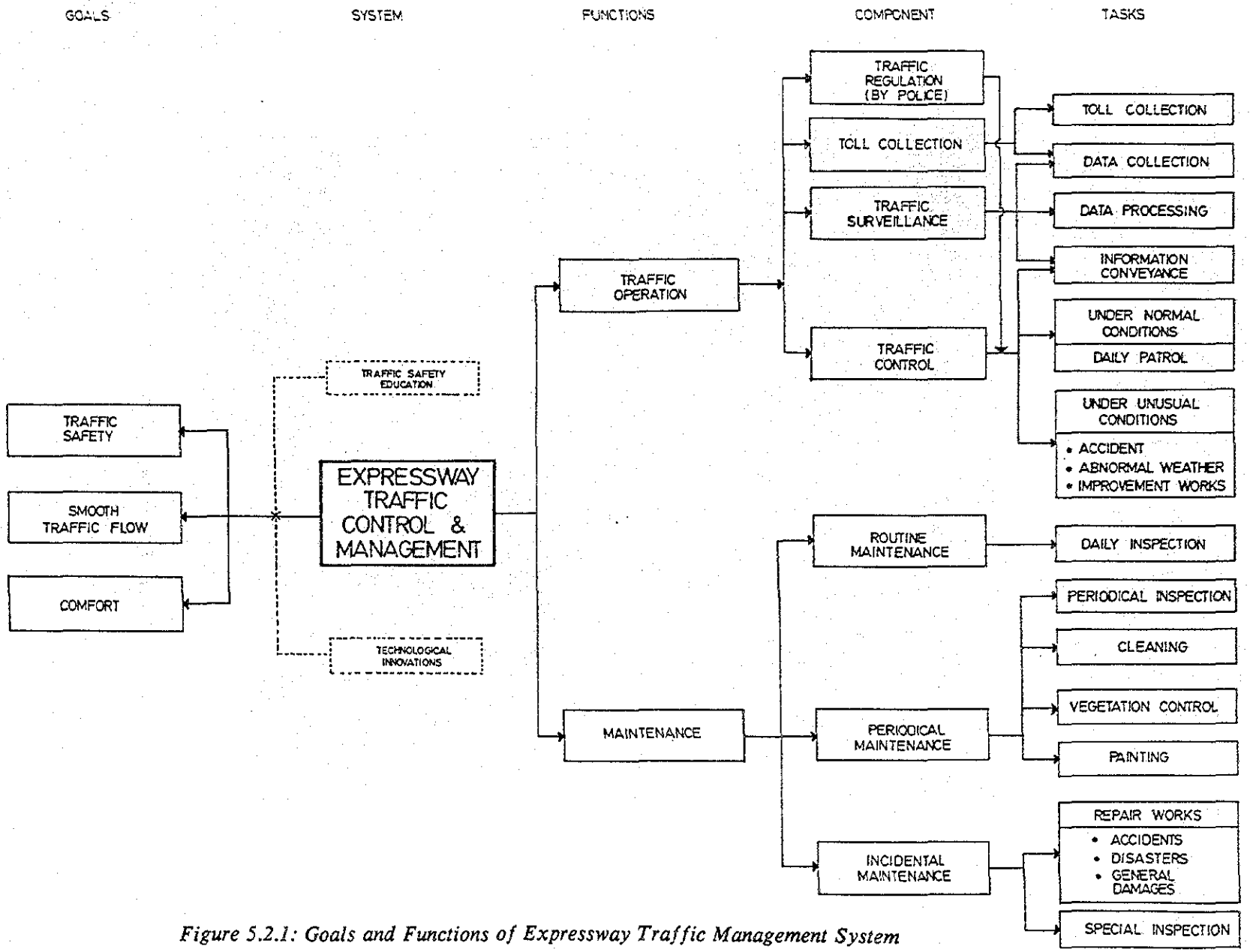
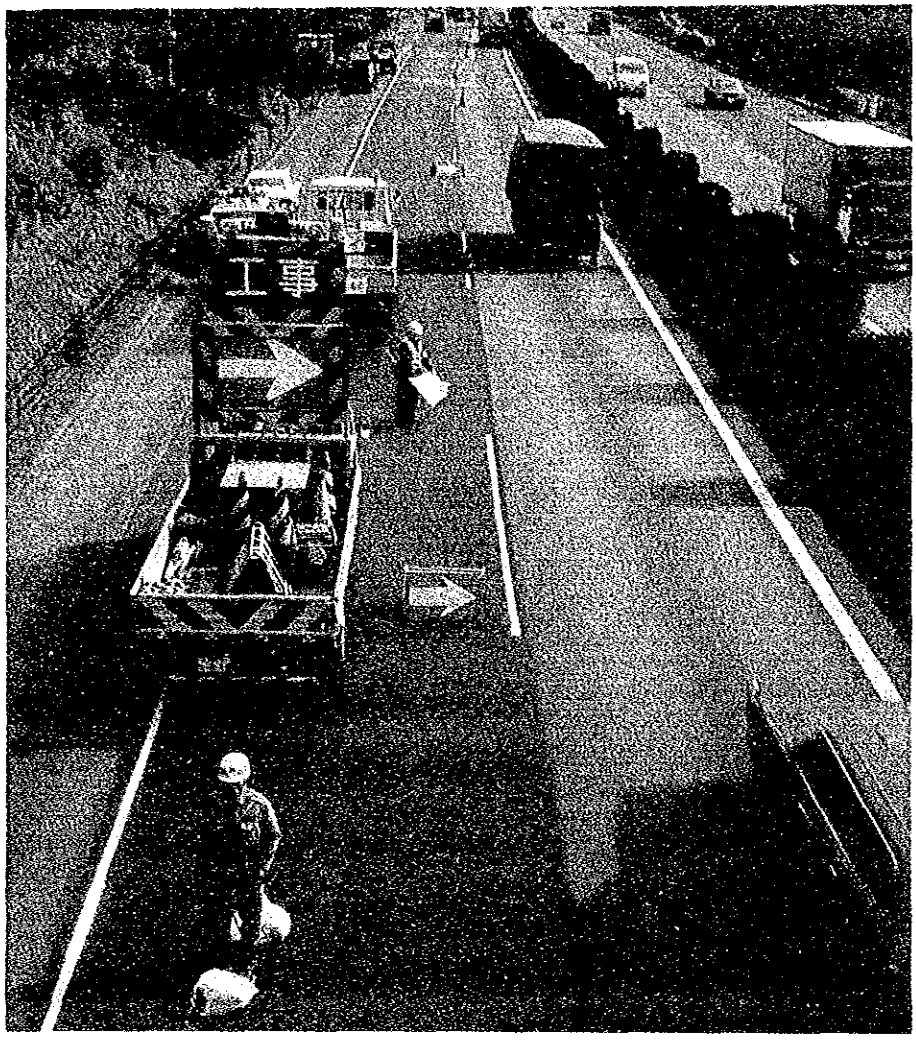


Figure 5.2.1: Goals and Functions of Expressway Traffic Management System



Courtesy of Japan Highway Public Corporation

Traffic Control During Road Maintenance

Courtesy of Japan Highway Public Corporation

Road Side Assistance

5.3 Organization Set-up and its Role in Traffic Management

5.3.1 Introduction

This section discusses the recommended organization set-up and its role in managing expressway traffic when the proposed traffic control and management system is introduced.

There are currently three bodies which are directly involved in traffic management, that is Malaysian Highway Authority (MHA), PLUS and police, while the local police, fire brigade, hospital, and towing company are indirectly involved as their services are requested when needs arise.

The concession company, PLUS, is appointed by the government to undertake the design, construction, management and operation of the North-South Expressway including Senai-Johor Bharu Highway, New Klang Valley Expressway, and Federal Highway (Subang-Klang section). In this master plan, basic guidelines for proposing an appropriate organization set-up are to take into account the status of the concession company, the privatization agreement provisions; as well as the organization set-up as planned by PLUS for undertaking their responsibilities under the Concession Agreement.

5.3.2 Main Tasks and Responsibilities of Management Offices

To facilitate efficient traffic management on the expressways and toll highways, an organization with a three-tier hierarchial setup, comprising of a headquarters, several regional offices and maintenance office with their respective roles and responsibilities as well as coordination among them is essential.

The main tasks involved in traffic management can be divided into five items, namely:

a) Planning and programming,
b) Traffic engineering,
c) Traffic operation,
d) Maintenance, and
e) Coordination with related agencies and public relation.

The headquarters is responsible for planning, development and formulation of standards particularly those on traffic engineering. In addition, it is entrusted to draw up policy, future expressway development plans, work contracts, financial plan for new constructions or improvement works and oversee all works contracted to private companies.

The regional office is responsible for managing the operation and activities of all maintenance and toll offices within its jurisdiction. It is also responsible for the planning and scheduling of maintenance and improvement works and conducting traffic engineering studies for enhancing the efficiency and quality of traffic operation and maintenance. The regional office will also manage the traffic control center to facilitate traffic operation.

The maintenance office is mainly devoted to carrying out field activities such as patrolling, routine maintenance works, first-aid activities, law enforcement (by the police who are stationed at the maintenance office) and accident investigation.

The proposed main tasks and responsibilities of traffic control and management system for each of the three tier management offices are shown in Table 5.3.1 while its details of their activities are illustrated in Table 5.3.2.

Table 5.3.1: Main Tasks of Traffic Control and Management System and Its Responsible Office

Main Task	Headquarters	Regional Office	Maintenance Office
1. Planning and Programming	Planning	Basic Design	
2. Traffic Engineering and Safety	Development, Standard and Planning	Survey and Data Processing	
3. Traffic Operation	Policy and Planning	Management	Execution
4. Maintenance	Planning and Consultation	Supervision	Execution
5. Coordination and Public Relation	National Level	Local Level	

Table 5.3.2: Details of Main Tasks of Traffic Control and Management System and its Responsible Office

Main Tasks	Contents	Responsible Office		
		Headquarters	Regional Office	Maintenance Office
1. Planning and Programming	a. Planning	o		
	b. Road construction, planning, design and execution of maintenance work	o	o	
	c. Location setting and basic design of interchange, bus stop, service and parking areas	o		
	d. Implementation plan of traffic control and management system	o		
	e. Administration and redemption survey and planning	o		
2. Traffic Engineering and Safety	a. Setting of standards and management level	o		
	b. Road and traffic engineering development and research	o		
	c. Future traffic volume forecasting	o		
	d. Execution of traffic survey	o planning	o execution	
	e. Statistical data processing	o processing	o collection	
3. Traffic Operation	a. Basic planning	o	o	
	b. Traffic operation		o management	o execution
4. Maintenance	a. Setting of standards, supervision and consultation works,	o	o	
	b. Maintenance management			o execution
5. Coordination and Public Relation	a. Coordination with relevant agencies	o national	o local	
	b. Response activity	o national	o local	

As mentioned earlier, privatization has been introduced on the construction and management of toll roads in this country. Among the study routes, North-South Expressway, New Klang Valley Expressway, Federal Highway (Subang-Klang section) and Senai-Johor Bharu Highway are privatized.

Under the Concession Agreement between the government and concession company, the company is responsible for the execution of construction, maintenance and operation while MHA is vested with the following responsibilities:

a) protecting the interests of the Government by ensuring that construction works are carried out according to the approved design and geometric standards;

b) ensuring that the progress of construction works is satisfactory at all times;

c) ensuring that the expressway and related facilities are maintained in good condition;

d) auditing the actual traffic volume figures as provided for in the concession agreement;

e) ensuring that the concession company complies with user safety and comfort requirements.

Under the above provisions, MHA has an important role to play in ensuring that the five tasks of traffic management outlined above are effectively carried out. For the tasks of planning, traffic engineering and inter-agency coordination, MHA has a greater role than the tasks of maintenance and traffic operation which will be largely undertaken by PLUS.

The detailed responsibilities of MHA and the concession company for the five main tasks are shown in Table 5.3.3 below.

Table 5.3.3: Details of Responsibility of MHA and PLUS

Main tasks of Traffic Control and Management System		MHA	PLUS
1. Planning and Programming	a. Planning	o	
	b. Road construction, planning, design and maintenance work	o	o design, execution
	c. Location setting and basic design of interchange, bus stop, service and parking areas	o	o design
	d. Implementation plan of traffic control and management system	o	o
	e. Administration and redemption survey and planning	o	o
	f. Checking and approval of above-mentioned tasks	o	
2. Traffic Engineering	a. Setting of standards and management level	o	
	b. Road and traffic engineering development and research	o	o
	c. Future traffic volume forecasting	o	
	d. Execution of traffic survey	o	o
	e. Statistical data processing	o	o
	f. Checking and approval of above-mentioned tasks	o	
3. Traffic Operation	a. Basic planning	o	o
	b. Traffic operation		o
	c. Checking and approval of above-mentioned tasks	o	
4. Maintenance	a. Setting of standard, supervision and consultation	o	
	b. Maintenance management		o
5. Coordination and public relation	a. Coordination of relevant agencies	o	o
	b. Response activity	o	o

5.3.3 Proposed Management Office Location and Their Coverage

For the North-South Expressway, two alternative regional division plans could be considered from the practical viewpoint, as follows:

a) Two Division Plan

Northern Region	..	Bukit Kayu Hitam to Kuala Lumpur
Southern Region	..	Kuala Lumpur to Johor Bharu

b) Three Division Plan

Northern Region	..	Bukit Kayu Hitam to Rawang
Central Region	..	Rawang to Bangi
Southern Region	..	Bangi to Johor Bharu

In examining the traffic and regional growth trend, the Central Region with Kuala Lumpur as the focus, has been displaying and will continue to display a distinctive different travel behaviour from the northern and southern regions. Travel within the Klang Valley Region are largely intra-urban in nature while travel in the north and south regions are more of the inter-urban travel. Traffic volume in the Klang Valley Region is also substantially larger than the northern or southern region. The central region also contains urban expressways that are interlinked between them as well as with urban arterials in Kuala Lumpur and Petaling Jaya.

To facilitate effective traffic control and management, it is therefore more desirable to have a central regional office to manage the peculiar central region as explained above. Hence the three (3) division plan is recommended.

The Central Regional Office therefore should ideally control expressway routes that are within the economic and commuting sphere of the Klang Valley Region. Geographically, therefore, the Central Region should encompass the New Klang Valley Expressway, Federal Highway, the sections of N-S Expressway from Rawang to Bukit Lanjan, Sungei Besi to Bangi and the planned connecting link (called N-S Link) between New Klang Valley Expressway and KL-Seremban Expressway.

At the time of this reporting, the planned N-S Link has been committed but only for the section between New Klang Valley Expressway and Shah Alam Highway. Thus, the linkage from the northern section of the North-South Expressway to the southern section is still incomplete and North-South traffic has to pass through Kuala Lumpur city by using the city ring roads or arterials. The section from Sungei Besi to Bangi therefore bears little relation to the northern sections in terms of facilities and traffic operation. It is impractical for management personnel stationed at Subang to have to travel through urban streets to reach the section between Sungei Besi and Bangi. This section will therefore be provisionally included into the Southern Region to facilitate system installation, traffic operation and management. In future, when the N-S Link is fully constructed and thus completing the North-South Expressway Network, then the section from Sungei Besi to Bangi can be incorporated into the Central Region. As a matter of fact, the urban sphere of Klang Valley could have extended to Nilai in the south by then and this must be deliberated in the future.

The proposed three-division plan therefore comprises of :

1) Northern Region

Route Coverage:	*North-South Expressway (Bukit Kayu Hitam to Rawang)
Distance:	442 km
Regional Office:	To be located near Ipoh IC

2) Central Region

Route Coverage:	*North-South E'way (Rawang to Bukit Lanjan-17 km) *New Klang Valley Expressway (37 km) *Federal Highway (Klang to Subang) (15 km)
Distance:	69 km
Regional Office:	To be located near Subang International Airport

3) Southern Region

Route Coverage:	*North-South E'way (Sungei Besi to Kota Tinggi-316km) *Senai-Johor Bharu Highway (28 km)
Distance:	344 km
Regional Office:	To be located near Ayer Keroh

Location of the regional offices are arrived at considering the ease of personnel commuting to the office and the maintenance offices under its supervision, and stage construction of the system.

The location of regional office does not have much influence on construction cost and traffic operation efficiency because a regional office is basically a center of communication and not a center of execution in traffic operation and management. Communication line installation cost does not differ much as long as a trunk communication line is installed along the expressway.

Maintenance offices are usually located near or at interchanges because of the need for easy access to the expressway. The interval or route coverage by each maintenance office is determined by such factors as:

1) Traffic volume and its composition on the section;
2) Required frequencies of patrolling by police and maintenance squadrons;
3) Time required to travel to incident sites immediately after receiving the emergency call;
4) Topographical and geological conditions.

Based on the Japanese experience, a length of 50 km to 70 km along a fairly flat terrain is the most appropriate length to be maintained by one maintenance office. For the North-South Expressway therefore, a coverage of 70 km to 90 km is considered to be appropriate as the expressway passes through relatively gentle terrain.

MHA still manages Karak Highway and Penang Bridge. MHA shall therefore retain its two regional offices at Ipoh and Ayer Keroh and its maintenance offices at Penang and Genting.

The proposed three division regional and maintenance offices is schematically represented in Figure 5.3.1. The route coverage of each of these proposed offices is presented in Table 5.3.4. while their geographical locations are shown in Figure 5.3.2.

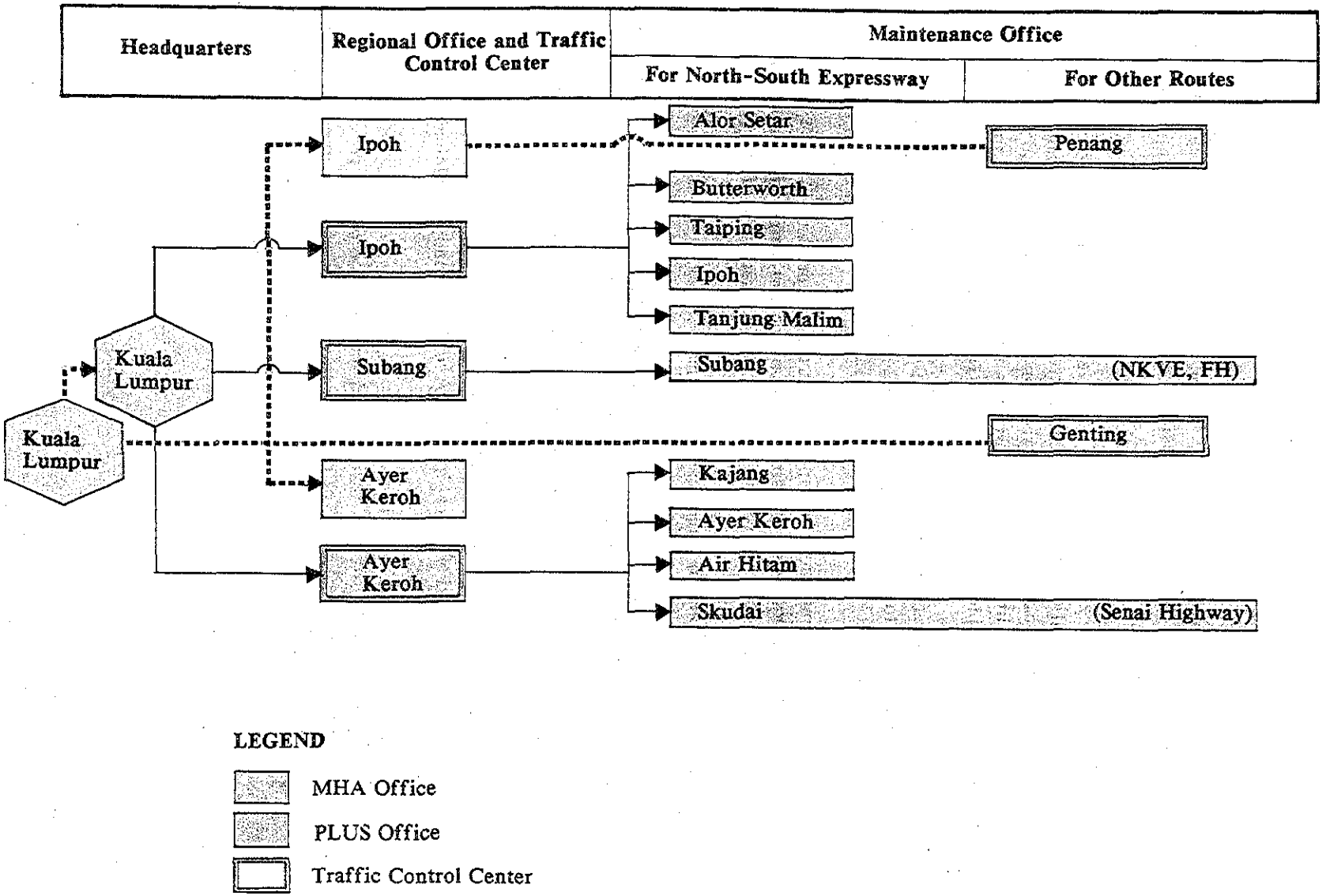


Figure 5.3.1: Management Office Locations

Table 5.3.4: Management Office Locations and Their Coverage

Headquarters	Regional Office Location	Management Body	Maintenance Office Location	Management Routes and Sections				
				Type	Name	Section	Length (km)	
Kuala Lumpur	Ipoh	PLUS	Alor Setar	Expressway	N-S Expressway	* Bukit Kayu Hitam (BKH) - Jitra (JIT)	24.0	24.0
				Motorway	N-S Expressway	* Jitra (JIT) - Gurun (GRN)	56.6	
				Motorway	N-S Expressway	* Gurun (GRN) - Sungei Petani Utara (SPU)	16.1	72.7
			Butterworth	Motorway	N-S Expressway	* Sungei Petani Utara (SPU) - Bandar Baru (BBR)	76.4	76.4
			Taiping	Motorway	N-S Expressway	* Bandar Baru (BBR) - Jelapang (JLP)	91.4	91.4
			Ipoh	Motorway	N-S Expressway	* Jelapang (JLP) - Sungkai (SGK)	87.6	87.6
			Tanjung Malim	Motorway	N-S Expressway	* Sungkai (SGK) - Rawang (RAW)	90.3	90.3
		MHA	Penang	Motorway	Penang Bridge	* J. Prai - Penang Island	14.0	14.0
	Subang	PLUS	Subang Airport	Motorway	N-S Expressway	* Rawang (RAW) - Bukit Lanjan (BKL)	16.6	
				Motorway	New Klang Valley Exp.	* Bukit Raja (BKR) - Jalan Duta (JDT)	37.0	
				Expressway	Fed. Highway	* North Klang Straits Bypass - Subang Airport	15.0	68.6
	Ayer Keroh	PLUS	Kajang	Motorway	N-S Expressway	* Sungei Besi (SBI) - Pedas/Linggi (PLI)	75.9	75.9
			Ayer Keroh	Motorway	N-S Expressway	* Pedas/Linggi (PLI) - Pagoh (PGH)	97.3	97.3
			Air Hitam	Motorway	N-S Expressway	* Pagoh (PGH) - Simpang Renggam (SRG)	83.5	83.5
			Skudai	Motorway	N-S Expressway	* Simpang Renggam (SRG) - Kota Tinggi (KTG)	59.1	
				Expressway	Senai-Johor Bharu Expressway	* Senai - Johor Bharu	28.0	87.1
		MHA	Genting	Highway	Karak Highway	* Kuala Lumpur - Bentong	68.0	68.0
Total								936.8

Note: For type of road, see Section 5.4.3.

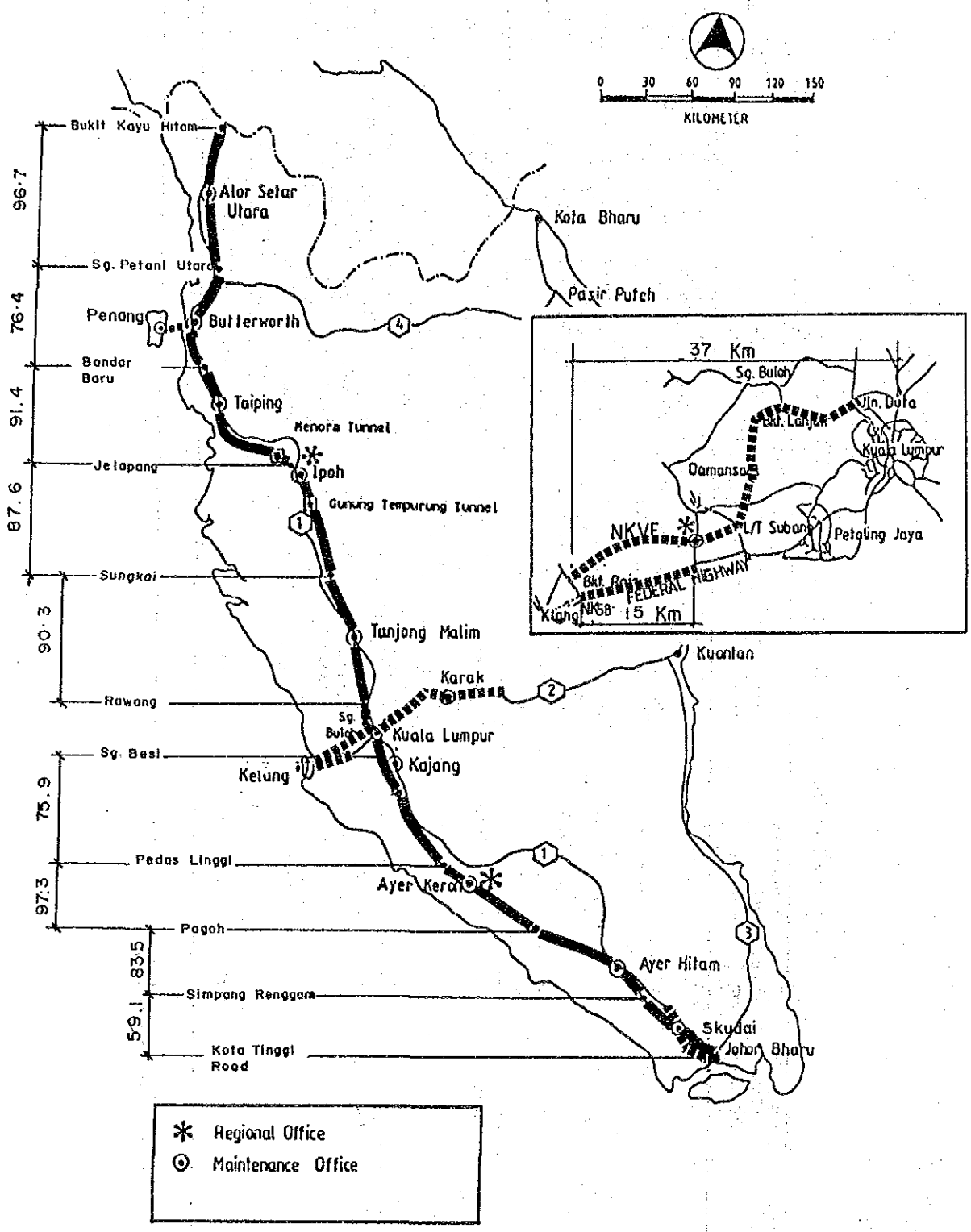


Figure 5.3.2: Management Office Location and Their Coverage

5.3.4 Traffic Control Center

1) Tasks and Functions

Traffic control centers are located in the regional offices along the North-South Expressway. It is 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 becomes the nucleus where information is received from site while instructions are given in return of what to do. The control center is the important "base" where requests for ambulance, fire engine, local police are carried out by exclusive telephone lines.

Traffic control centers for Penang Bridge and Karak Highway under the management of MHA are provided in the maintenance offices as their traffic operation are independent from that of North-South Expressway.

The proposed specific tasks and responsibilities in the traffic control center are listed in Table 5.3.5.

Table 5.3.5: Proposed Tasks and Responsibilities of Traffic Control and Management Center

1. COMMUNICATION WITH PATROL CARS ON DUTY
2. RECEPTION OF EMERGENCY TELEPHONE CALL
3. COMMUNICATION WITH OTHER ORGANIZATIONS FOR HELP OR COOPERATION
4. OPERATION OF GRAPHIC PANEL OR CRT DISPLAYS
5. OPERATION OF ROADSIDE TRAFFIC CONTROL EQUIPMENT
6. PROVISION OF ROAD AND TRAFFIC INFORMATION TO ROAD USERS
7. SURVEILLANCE OF TRAFFIC SITUATIONS AND COMPILATION OF TRAFFIC AND INCIDENT DATA
8. MONITORING OF PROGRESS OF ACCIDENT DISPOSAL OR OTHER ACTIVITIES
9. DIRECTION TO EXECUTION SQUADRONS

2) Information Flow at the Center

a) Traffic Control Centers at PLUS's Regional Offices

Each of the traffic control centers at the regional offices along the North-South Expressway, New Klang Valley Expressway and Federal Highway is to be staffed by PLUS personnel. However, since it is under the jurisdiction of the regional office, the head of the control center is required to obtain consensus/ instructions and report to MHA's regional director as well as PLUS's regional manager.

A police traffic control officer will also be stationed at the traffic control center and through the MHA's regional director or the head of control center, the cooperation of the police, particularly for matters involving law enforcement, accidents, emergencies will be sought. Figure 5.3.3 shows the flow and exchange of information within the traffic control center and with other departments.

b) Traffic Control Center at MHA's Maintenance Office

The traffic control center at Penang Bridge and Karak Highway are fully staffed by MHA's personnel. As shown in Figure 5.3.4, cooperation from the police is obtained by consultation via the head of the maintenance office or head of traffic control center.

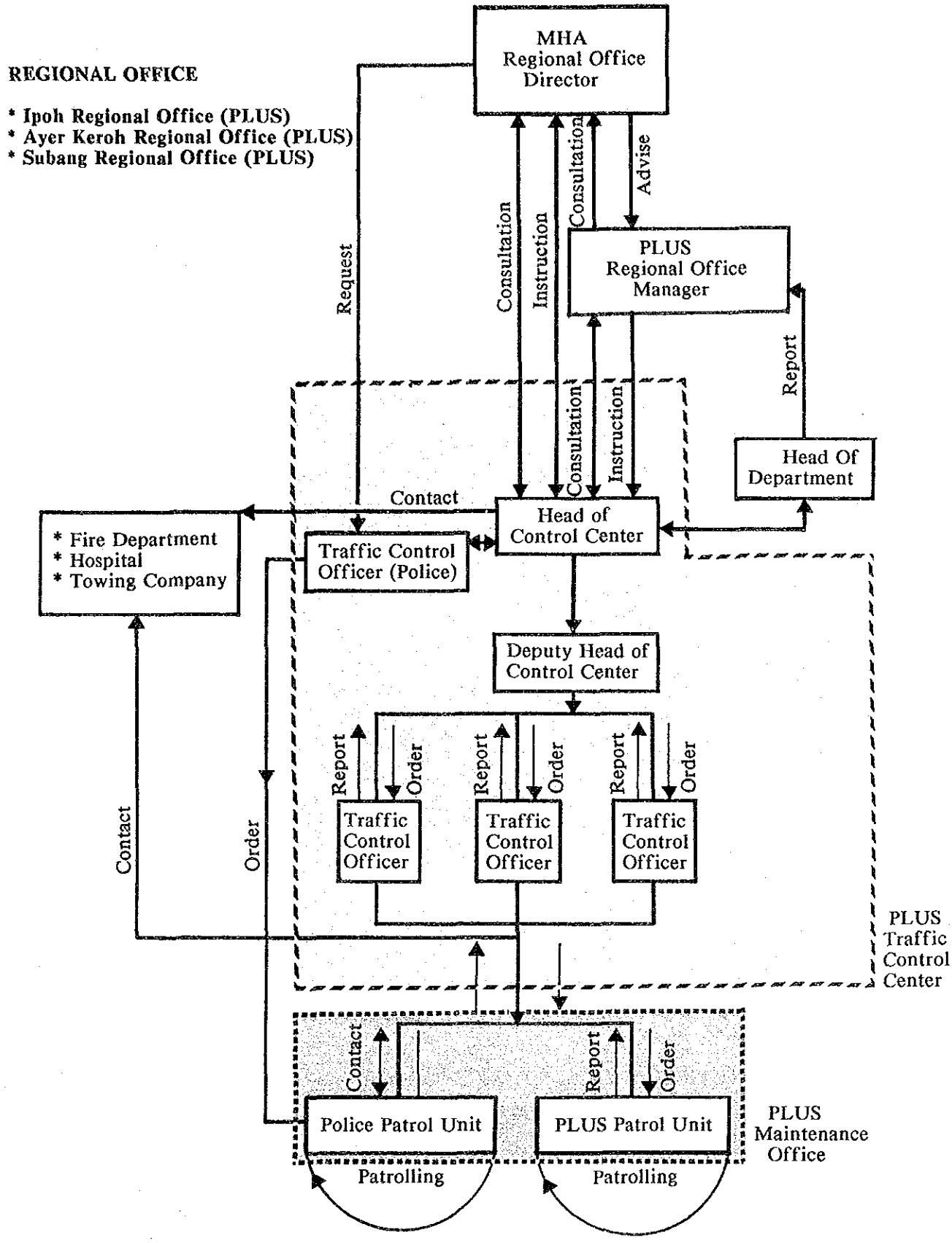
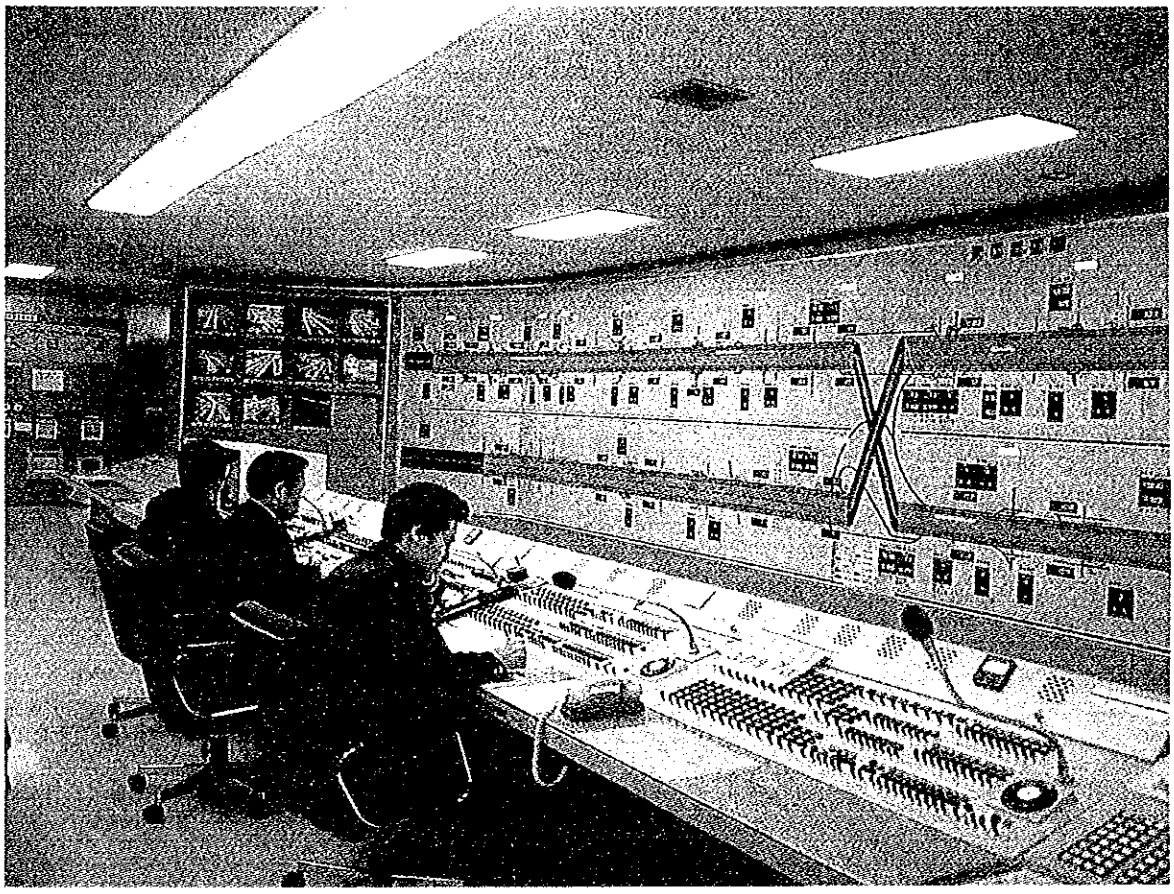


Figure 5.3.3: Personnel Interaction at the Traffic Control Center at PLUS Regional Office



Courtesy of Japan Highway Public Corporation

Three-men Team of Traffic Control Officers at the Traffic Control Center

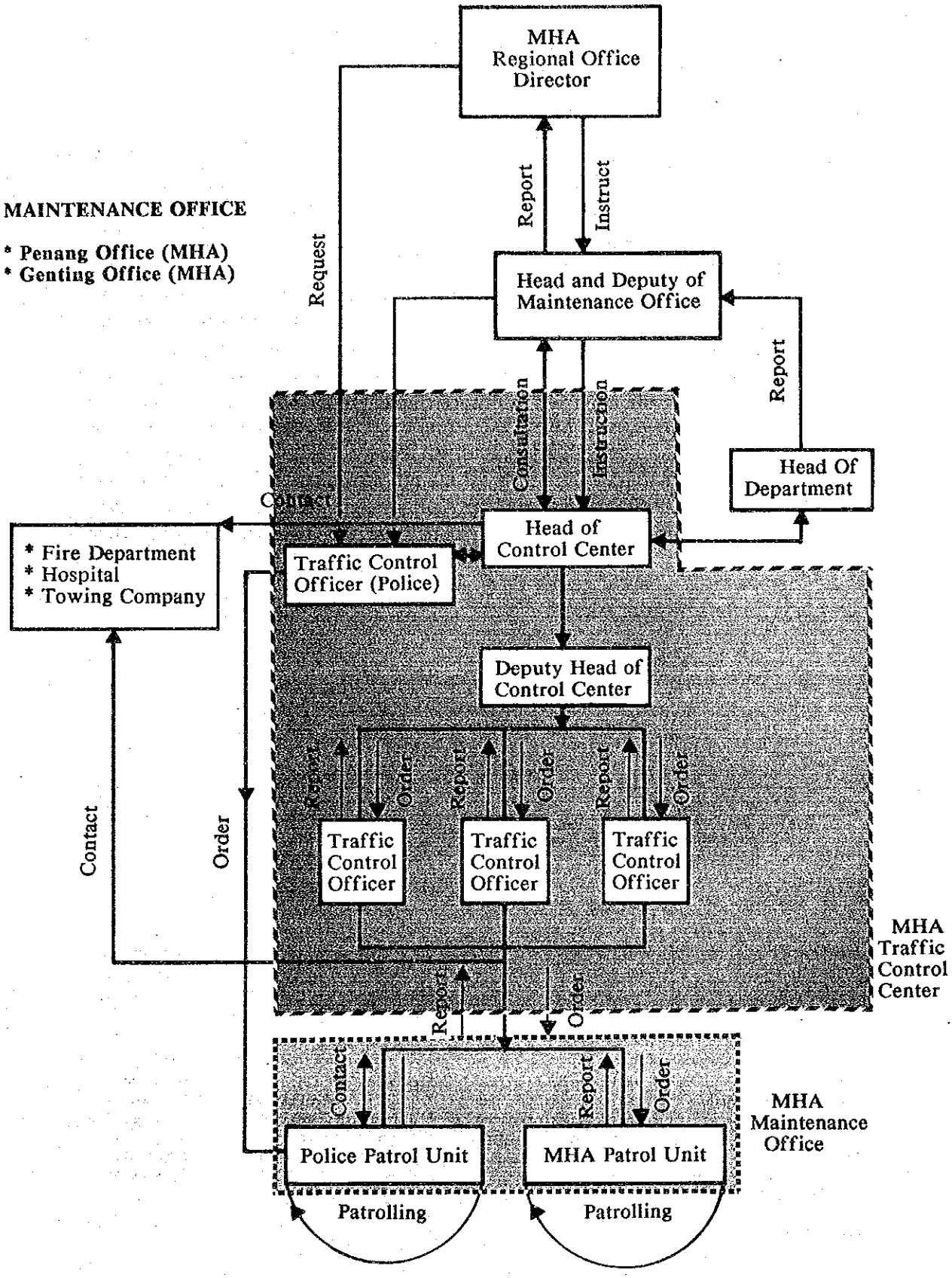


Figure 5.3.4: Personnel Interaction at the Traffic Control Center at MHA's Maintenance Office

5.4 Traffic Management Standard

5.4.1 Basic Concept on Setting of Management Level

Traffic management means to maintain safety and convenience of expressway and highway through the activities of the management body and other agencies concerned, and through the operation of various facilities installed on the expressway and highway. The former represents the software aspect of traffic management while the latter is a hardware component. The various facilities on expressway and highway can be divided into two groups. One group consists of permanent facilities such as lighting, sign, service area, etc. whose function is fixed regardless of road and traffic conditions. The other group is concerned with traffic surveillance and control equipment to deal with changing road, traffic and weather conditions. Figure 5.4.1 shows the components which constitute the traffic management.

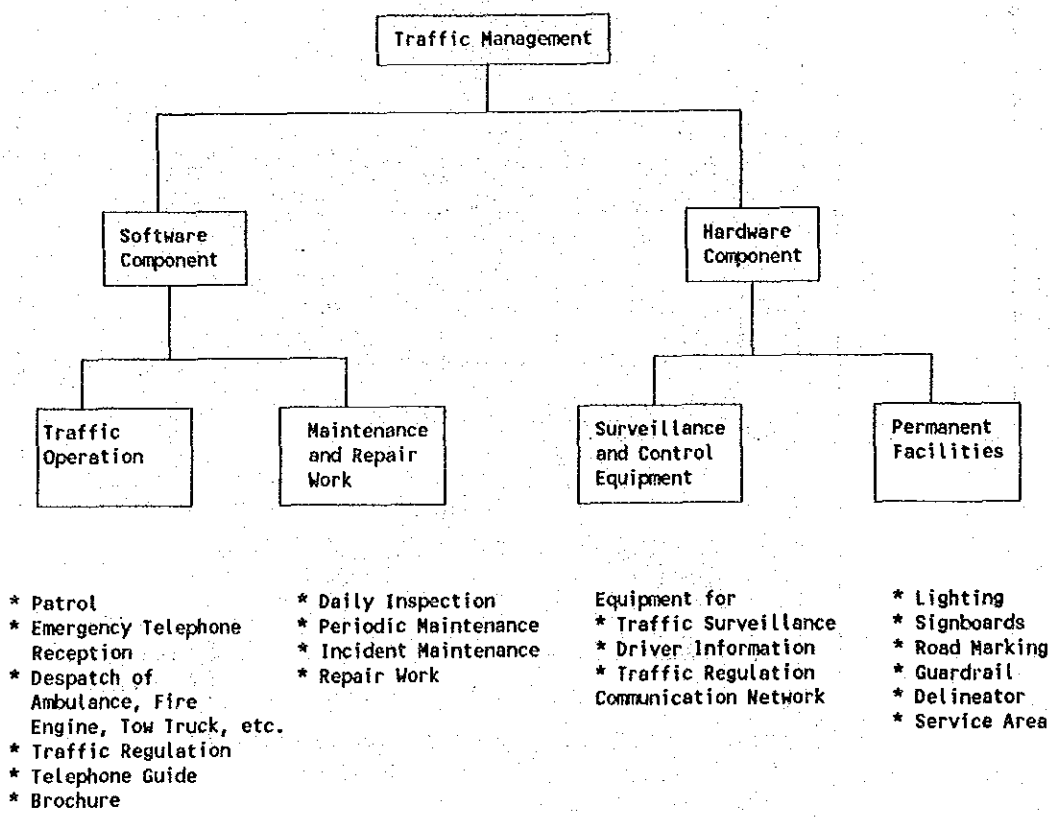


Figure 5.4.1: Components for Traffic Management

Traffic management standard is therefore dictated by the two factors mentioned above, i.e. organizational activity and facility utilization in relation to the existing problems and issues, future traffic demand, social needs and economic aspect.

The resolution of existing problems and issues is obviously the top priority. For instance, if the expressway has no direct communication system, the responses to traffic incidents are greatly delayed. Then the installation of emergency telephones and the strengthening of expressway patrol units must be given priority thoughts.

Traffic management standard is also dependant on social needs involving the extent of effects caused by traffic congestion, accidents and road closures on the expressways. If the expressway in a particular region forms the backbone of its transportation system, then any incident irrespective of its scale can greatly effect its socio-economic activities. In such a case, the introduction of various facilities to alleviate these problems is to be given high urgency.

In addition, if traffic accidents and its resultant loss in human life and properties are a prime social concern, then effective facilities irrespective of their cost have to be installed to reduce the traffic accidents.

The introduction of a highly sophisticated and comprehensive traffic management system however, would involve a large capital investment. Consideration must therefore be given to the economic aspects of the system. For example, the more changeable signs are installed on the expressways, the faster will the traffic information be conveyed to the road users, but the wide use of such sophisticated equipment would involve high capital and operation costs.

Bearing the above discussion in mind, traffic management standard on an expressway may in fact be made up of several management levels. Each of these levels is applied to a particular section of the expressway in response to its sectional characteristics or conditions. Moreover, for a particular section, its management level is to be upgraded gradually in response to changing environment and demands. In this way, the upgrading of management levels by section according to their changing needs can help to relieve the financial burden on the implementation body.

5.4.2 Setting of Traffic Management Level

Three levels of traffic management standards are defined here to meet the different requirements of different type and section of study roads.

Traffic Management Level 1

Level 1 forms the basic requirements for a traffic control and management system. Basic information collection, information processing, information dissemination, and traffic control equipment are installed and frame of incident detection and disposal organization is set up at Level 1.

Level 1 has the following objectives:-

* Provide road users with means of communication for incident reporting or requesting assistance;

* Provide road users with elementary road and traffic information;

* Establish communication network among related agencies and facilities.

Level 1 applies to sections having low traffic volume (daily traffic volume lower than 30,000 veh/day on a 4-lane highway) where free flow of traffic is possible and consequence of an incident including dangers of secondary incidents is almost none. For the North-South Expressway at the present conditions, this traffic management Level 1 may be applied to all sections except the section near to Kuala Lumpur (Kuala Lumpur to Kajang section).

Facilities introduced at Level 1 will be emergency telephone, vehicle detector, weather observatory equipment, changeable message sign, changeable speed limit sign and communication network.

Traffic Management Level 2

At Level 2, equipment installed at Level 1 will be reinforced or supplemented by adding more units at new locations, and activity and coordination of the agencies involved in the incident detection and disposal organization will be strengthened.

Additional objectives to be achieved by Traffic Management Level 2 are:-

* Upgrade the traffic flow monitoring function;
* Upgrade the information dissemination function to road users.

As daily traffic volume increases above 30,000 veh/day, free flow of traffic is easily hindered by any delays in incident handling whereby there is a potential danger for secondary accidents to occur. Sections with such traffic conditions require Traffic Management Level 2.

In addition to those equipment provided at Level 1, facilities introduced at Level 2 will be CCTV system and radio broadcasting.

Traffic Management Level 3

With further growth in traffic demand, increased dependence on expressway and highway system, and social demands or awareness for higher level of traffic safety, convenience and comfort; additional and new types of traffic surveillance and information dissemination facilities have to be installed to meet such needs and service level will be upgraded at Traffic Management Level 3. Response time to an incident will be improved and various means of information conveyance are provided to cope with versatile requirements of road users.

Additional objective at Traffic Management Level 3 is:-

* Strengthen the function of traffic surveillance, incident detection and information dissemination.

This level will be necessary for sections facing daily traffic congestions, where danger of secondary incidents are high even if a minor incident occurs and quick and prompt countermeasures are demanded against any incidents as they would cause severe congestion and other adverse effects.

Traffic volume on these sections would have reached 50,000 veh/day and beyond on a 4-lane road. This level is particularly applicable to expressway sections around Kuala Lumpur beyond 1995.

In addition to the equipment to be installed at Levels 1 and 2, facilities introduced at Level 3 will be highway radio.

The proposed traffic management levels as described above are further illustrated in Figure 5.4.2 and Table 5.4.1.

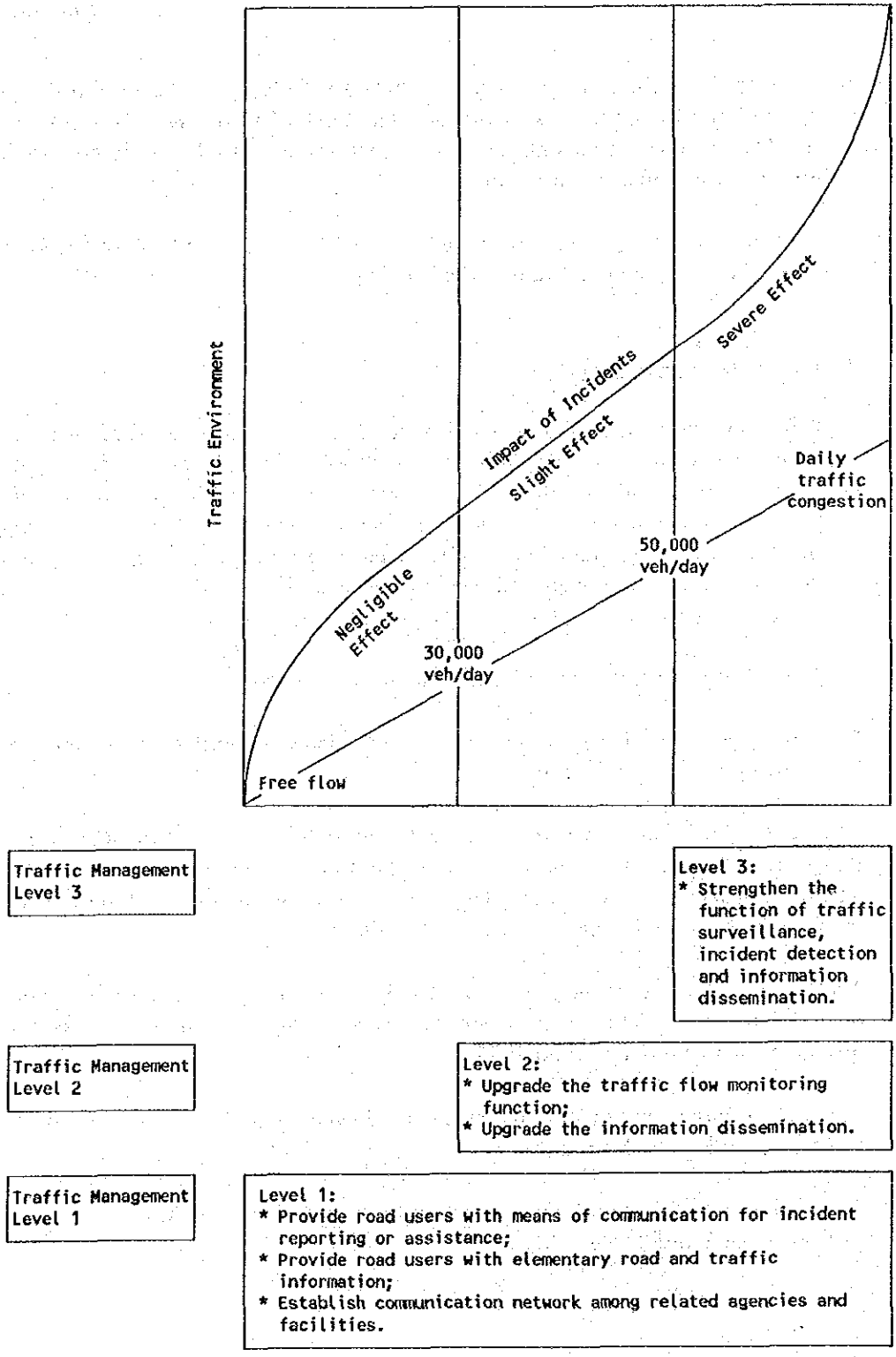


Figure 5.4.2: Traffic Management Level

Table 5.4.1: Traffic Management Level and Equipment

Level	Objectives	Facility/Equipment	Sections Applied
Level 1	1. Provide road users with means of communication for incident reporting or assistance 2. Provide road users with elementary road and traffic information 3. Establish communication network among related agencies and facilities	* Emergency Telephone * Exclusive Telephone * Wireless System * Vehicle Detector * Weather Observatory Equipment * Changeable Message Sign * Changeable Speed Limit Sign	* Applicable to sections having free-flow traffic with a daily traffic volume of below 30,000 veh/day for a 4-lane section.
Level 2	In addition to 1 through 3 above:- 4. Upgrade the traffic flow monitoring function: 5. Upgrade the information dissemination function to road users	In addition to the facilities and equipment above:- * CCTV System * Radio Broadcasting	* Applicable to sections having more than 30,000-50,000 veh/day (4-lane)
Level 3	In addition to 1 through 5 above:- 6. Strengthen functions of traffic surveillance, incident detection and information dissemination.	In addition to the facilities and equipment at Levels 1 and 2 above:- * Highway Radio	* Applicable to sections having more than 50,000 veh/day (4-lane)

Note: It should be emphasized here that the daily traffic volume of 30,000 veh/day or 50,000 veh/day is not absolute as factors such as road condition, weather condition, etc. may warrant its deviations.

5.4.3 Road Classification, Target Year and Traffic Management Level

1) Road Classification

MHA has recently adopted the classification of expressways and highways into the following functional categories:-

	Category	Routes/Sections
a)	Motorway	.. North-South Expressway (except Bukit Kayu Hitam-Jitra Section)
		.. New Klang Valley Expressway
		.. Penang Bridge
b)	Expressway	.. Bukit Kayu Hitam-Jitra Section on the North-South Expressway
		.. Federal Highway (Subang Airport-Berkeley Roundabout)
		.. Senai-Johor Bharu Highway
c)	Highway	.. Karak Highway

Roads categorized as motorways are national trunk roads with full access control and certain sections of which form the urban expressway network. Depending on the needs of particular section of these motorways, the proposed three traffic management levels may be applied.

Roads categorized as expressways form part of the national trunk road network with certain sections having full access control as those in the motorways. Expressways are therefore closely related to motorways and therefore from the general perspective of traffic management, similar standards apply.

However, due to the peculiar nature of some expressways, the facilities used to achieve a certain function for each of the management level may not be similar to those on the motorways. For instance, on expressways which have no access control (eg. Johor Bharu-Senai Highway) the road users can therefore easily report any incident on these expressways without any emergency telephones. For such expressway sections, therefore, the installation of emergency telephones is not necessary, lest they will be vandalized. Different installation standard may therefore be used on expressways to achieve the objectives or functions for each management level parallel to those on the motorways.

Even though Karak Highway has been categorized as highway, its special characteristics warrant it to be treated as a special case. Traffic management on highways (such as federal highway, state highway) can be sufficiently met if the basics, namely the organization with the necessary facilities for maintaining communication between patrol cars and related agencies in providing emergency countermeasures, are provided. For Karak Highway, however, additional considerations are needed, because access to it is limited and it is the only trunk road linking Kuala Lumpur and the east coast crossing over the mountainous region of Peninsular Malaysia.

There are large number of lorries laden with primary products on Karak Highway. On weekends, there are substantial recreational traffic. The present daily traffic volume has also exceeded its capacity. Lastly, Karak Highway faces the problems of frequent slope slips due to adverse weather conditions.

Karak Highway thus demands a higher traffic management standard than the ordinary federal or state highways.

For highways, similar equipment for each management level as those for motorways are required but the installation standards will vary according to their structural characteristics.

2) Target Year

The Study covers expressways and highways of different design standards, geographic conditions and traffic demands. Some sections of them are already opened to traffic while others are being constructed or planned as shown in Table 5.4.2. Entire stretch of North-South Expressway is scheduled to be completed in 1995. New Klang Valley Expressway will be completed in 1992 and widening of Federal Highway will be completed in 1992.

Table 5.4.2: Construction Program

Route	Section	Completion
N-S Expressway	Bukit Kayu Hitam-Gurun	Open
	Gurun-Butterworth	1992
	Butterworth-Changkat Jering	1995
	Changkat Jering-Ipoh	Open
	Ipoh-Tanjung Malim	1995
	Tanjung Malim-Kuala Lumpur	1992
	Kuala Lumpur-Ayer Keroh	Open
	Ayer Keroh-Pagoh	Open
	Pagoh-Ayer Hitam	1992
	Ayer Hitam-Johor Bharu	1994
New Klang Valley Expressway		1992
Penang Bridge		Open
Kuala Lumpur-Karak Highway		Open
Federal Highway	Subang Airport-Berkeley Roundabout	1992
Senai-Johor Bharu Highway		Open

In line with the construction program, implementation of the traffic management system is divided into three stages; those measures to be taken for the existing routes (short term plan), those to be implemented by 1995 (medium term plan), and those to be adopted by 2005 (long term plan). Short term plan is prepared to alleviate the problems and issues on the existing route and can be implemented immediately. Medium term plan applies to the route to be constructed and coincides with the construction program. Long term plan will be implemented after 1995 up to 2005 in conjunction with the increase in traffic demand and change in expressway environments.

3) Traffic Management Level for Each Section

Table 5.4.3 shows the proposed traffic management level at each stage for each section of the motorway, expressway and highway. Brief description of the staged implementation for each section of these roads is given below.

Table 5.4.3: Traffic Management Level by Stage

Category	Route	Section	Stage 1 (Immediate)	Stage 2 (1995)	Stage 3 (2005)
Motorway	N-S Expressway	Jitra-Gurun	1	1	1
		Gurun-Butterworth	-	1	2
		Butterworth-Changkat Jering	-	1	2
		Changkat Jering-Ipoh	1	1	1
		Ipoh-Tanjung Malim	-	1	2
		Tanjung Malim-Kuala Lumpur	-	1	2
		Kuala Lumpur-Seremban	1	2	3
		Seremban-Ayer Keroh	1	1	1
		Ayer Keroh-Pagoh	1	1	1
		Pagoh-Air Hitam	-	1	1
		Air Hitam-Johor Bharu	-	1	2
	New Klang Valley Expressway		-	2	3
	Penang Bridge		1	2	3
Expres-sway	N-S Expressway	Bukit Kayu Hitam-Jitra	1	1	1
	Federal Highway	Subang Airport-Berkeley Roundabout	-	1	2
	Senai-Johor Bharu Highway		1	1	1
Highway	Kuala Lumpur-Karak Highway		2	3	3

In Stage 1, Level 1 standards are applied to all sections of North-South Expressway already opened to traffic. Penang Bridge is already equipped with the roadside facilities of Level 1 but operation organization including rescue and assistance service must be established. Level 2 standards are applied to only Karak Highway in which traffic demand has already exceeded the capacity.

In Stage 2, newly opened sections of North-South Expressway will be provided with Level 1 facilities and sections between Kuala Lumpur and Seremban will be upgraded to Level 2. Level 2 standards will be applied to New Klang Valley Expressway when it is opened in 1992 as the traffic forecast warrants it. Penang Bridge and Karak Highway will be upgraded to Level 2 and Level 3 respectively.

In Stage 3, Kuala Lumpur-Seremban section will be upgraded to Level 3 together with New Klang Valley Expressway and Penang Bridge while some sections of North-South Expressway, namely Gurun-Changkat Jering, Ipoh-Kuala Lumpur and Ayer Hitam-Johor Bharu are to be upgraded to Level 2.

Figure 5.4.3 depicts the traffic management level by each expressway section in year 2005.

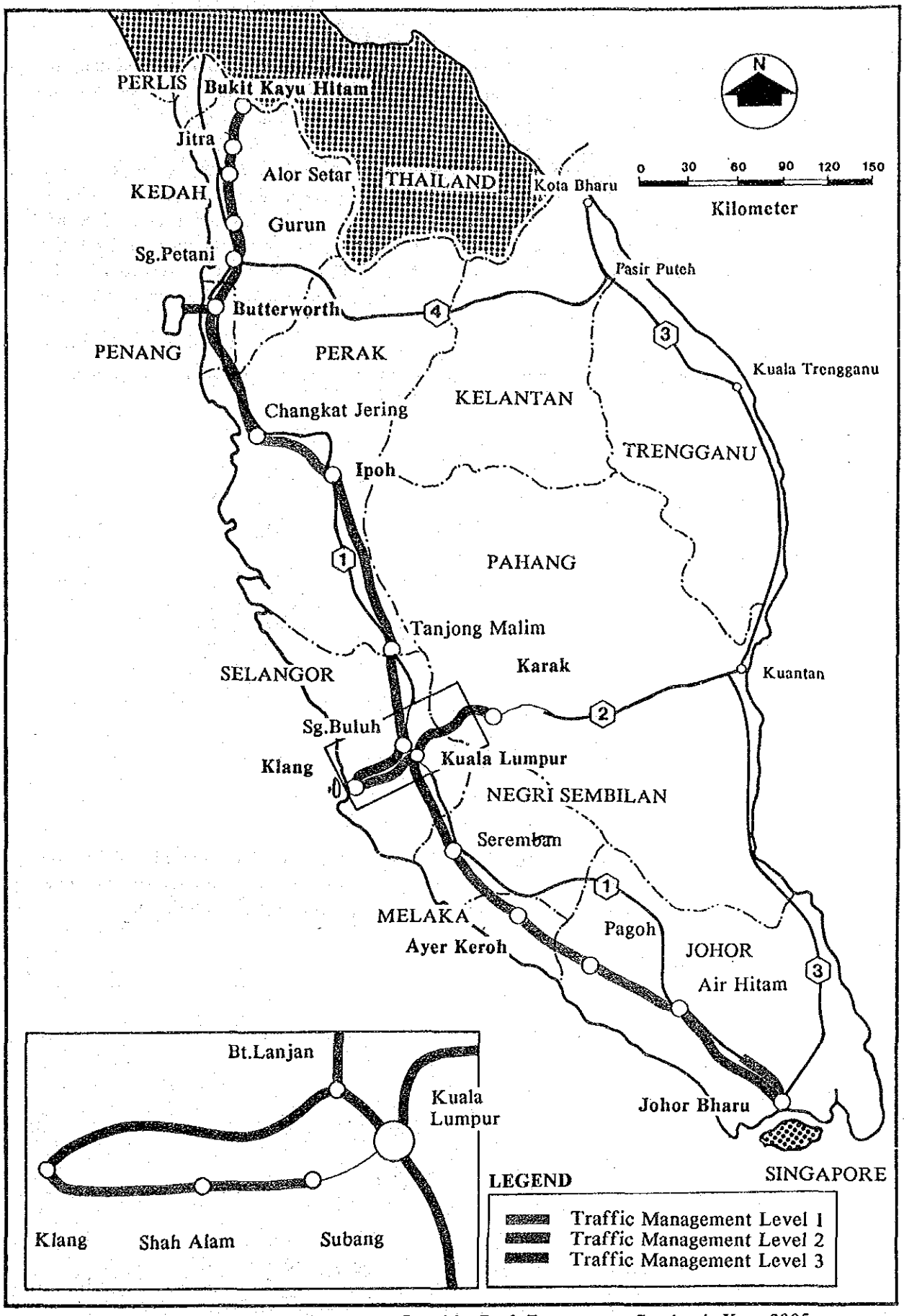


Figure 5.4.3: Traffic Management Level by Each Expressway Section in Year 2005

5.4.4 Route Numbering System

A system in numbering the expressway routes will assist the users in travelling on the expressway network without much confusion. The route numbering system for all the Federal Routes has recently been launched by the Public Works Department. For the toll expressway, however, a system has yet to be introduced.

The number assigned to the expressway should bear some relation to those already in use for the Federal Routes, so as to provide easier recognition and transfer to the motorists. To distinguish the expressway numbering from Federal Route numbering, the expressway logo and the Alphabet E will precede the route number for expressway, for example, E1 . The color green is to be used for the background of the route number markers to be consistent with signs used for the expressways and toll highways.

The proposed route numbering for the study routes are as shown in Figure 5.4.4.

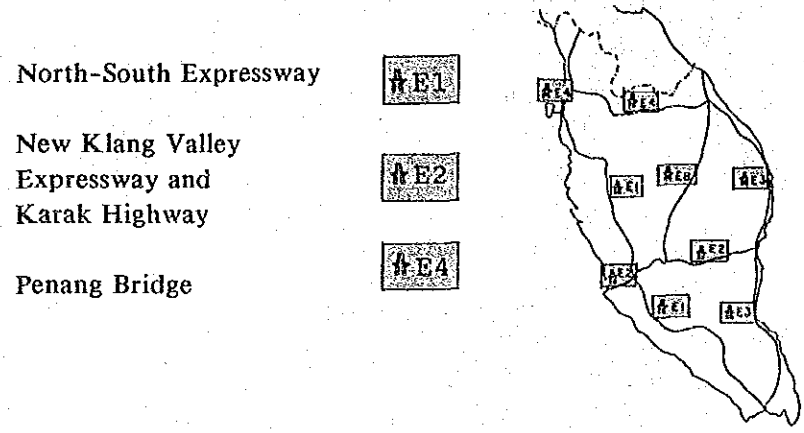


Figure 5.4.4: Basic Concept of Toll Expressway Numbering System

In addition, a branch route from the main route will be numbered based on the main route numbers, for example, as shown in Figure 5.4.5, a branch route number consists of the main route number hyphenated with the branch number.

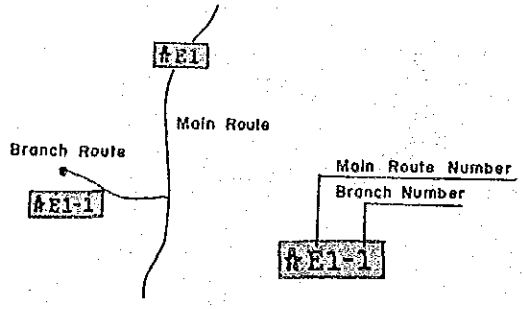
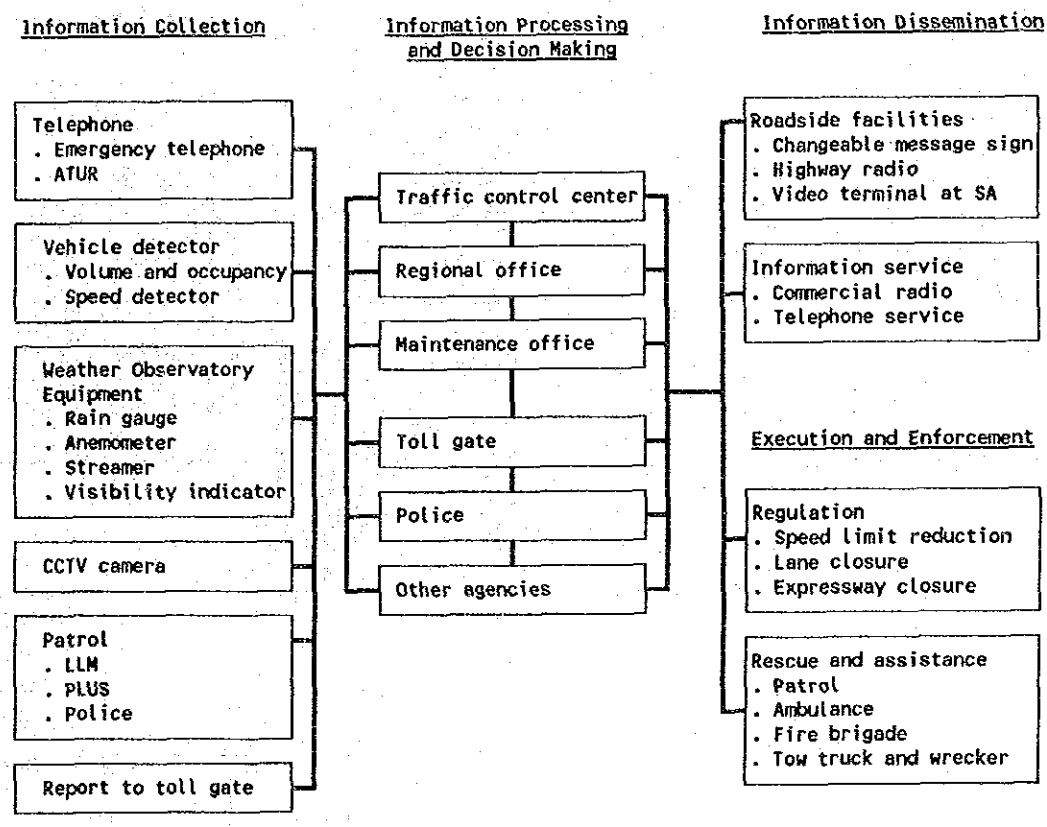


Figure 5.4.5: Branch Route Numbering System

5.5 Traffic Control and Management System

5.5.1 Outline of Traffic Control and Management System

In order to manage an expressway efficiently and in an organized manner, a traffic control and management system must 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. Figure 5.5.1 illustrates the structure of traffic management system and Figure 5.5.2 depicts the concept of traffic control and management system.



CCTV: Closed circuit television
ATUR: Automobile telephone using radio
SA: Service area

Figure 5.5.1: Traffic Management System Structure

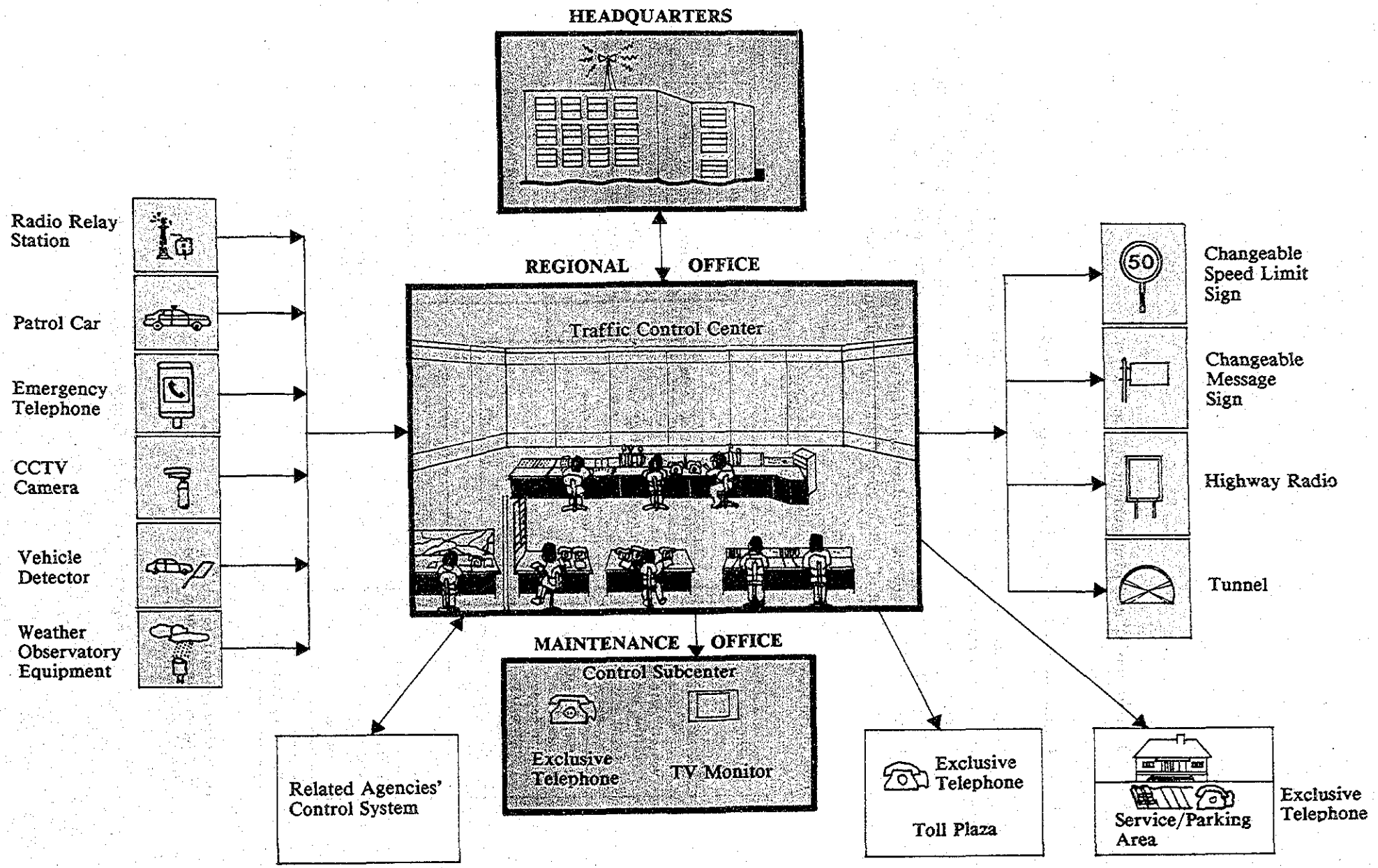


Figure 5.5.2: Concept of Traffic Control and Management System

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 car. CCTV system is also an essential tool for traffic surveillance as it furnishes system operator with the visual image of traffic situation.

Information processing and decision making

Traffic control and management center is a kernel of the traffic control and management 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.

Information dissemination

Roadside information dissemination devices such as changeable message sign, highway 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 are also provided through video terminal installed at service area 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.

Execution and enforcement

Should an incident occur on the expressway and highway, countermeasure must be taken swiftly. There are variety of traffic control measures such as speed limit reduction in case of adverse weather condition, closure of shoulder, closure of one lane, and closure of a section of expressway and highway. The traffic control must be executed in a coordinated manner by both expressway management body and police and traffic control and management center is a core for overseeing such activities.

5.5.2 Traffic Control Center and Sub-center

Traffic control center is established at regional office as a core of the traffic control and management system. It accommodates a computer system and other associated equipment as well as staff for operation of the system and planning of countermeasures against incidents.

Sub-center is installed at each maintenance 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 sub-center and center.

a) Construction

Traffic control center comprises a control room where staff 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 comprises a control room where monitoring or control desk are installed and a carrier terminal station where computer, peripherals and data transmission system are located.

b) Location

Traffic control center is recommended to be set up at regional offices and certain maintenance offices. Besides, sub-center is also recommended to be established at the rest of the maintenance offices in order to monitor certain information required for management activities such as patrolling, maintenance works and first-aid activities.

As shown in Figure 5.5.3, five traffic control centers and nine sub-centers are proposed for the traffic control and management system. Most of these control centers and sub-centers are established in Stage 2 when the entire stretch of the North-South Expressway will be opened to traffic.

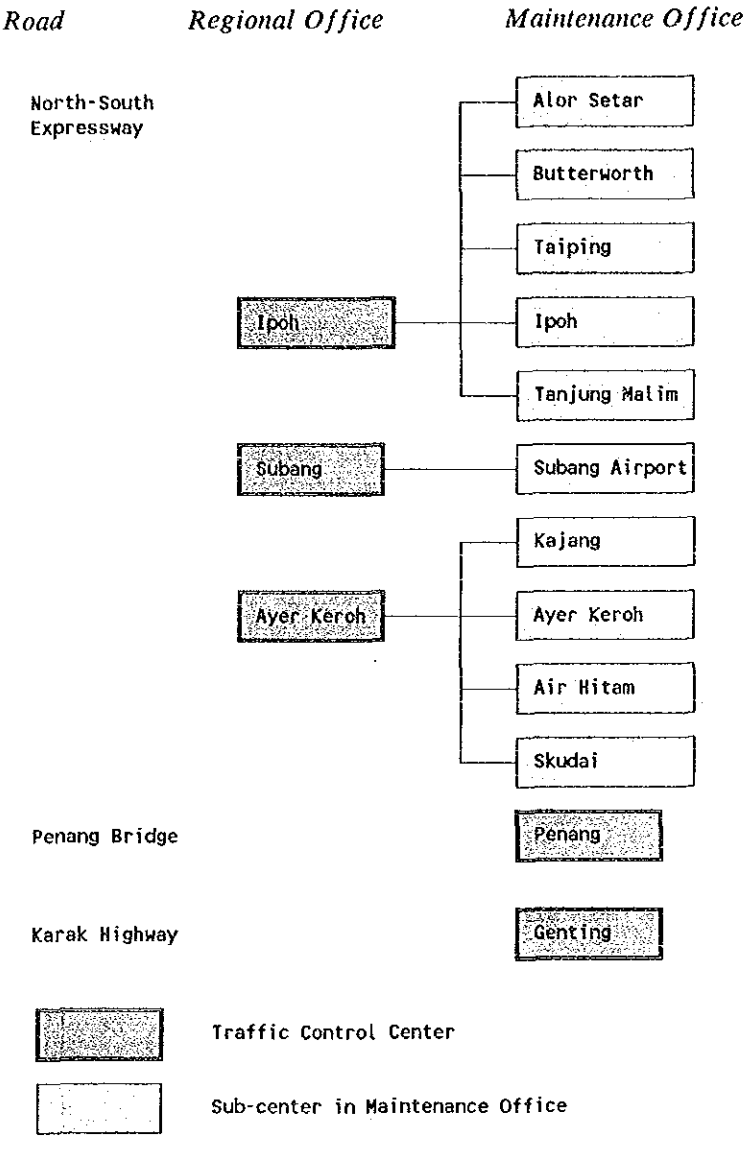
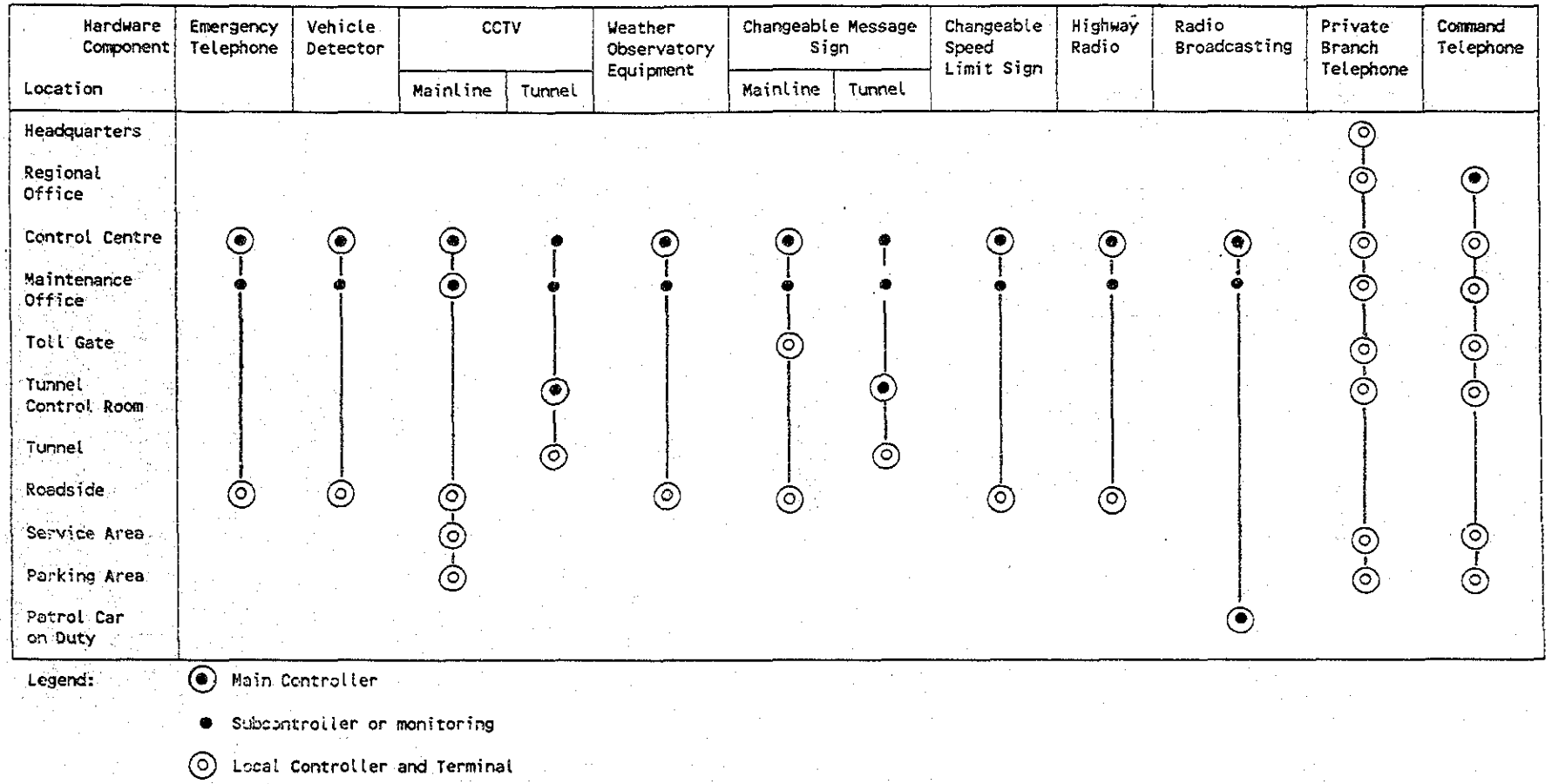


Figure 5.5.3: Location of Control Center and Sub-center

c) Connection of roadside equipment

Roadside equipment are installed at various locations along the highway as described in the following section, and they are controlled either by maintenance office or by control center. Communication network is established among the offices and between offices and roadside equipment. Figure 5.5.4 illustrates the location of the roadside equipment and how these equipment are connected and operated.

Figure 5.5.4: Connection of Roadside Equipment



5.5.3 Installation Standards

As mentioned earlier, a traffic control and management system consists of various equipment on roadside and at various locations within the expressway management organization as well as a communication network.

These equipment are installed differently on motorway, expressway or highway so as to reflect the traffic management level of each road classification. Table 5.5.1 illustrates the general guideline of installation standards for various equipment for motorway, expressway and Karak Highway at each level, while Table 5.5.2 summarizes the equipment to be installed at each level for three types of road.

Table 5.5.1: Installation Standards

Level	Objective/Function	Facilities	Installation Locations		
			Motorway	Expressway	Karak Highway
1	1. Provide road users with means to report incidents 2. Provide road users with elementary road and traffic information 3. Establish communication network among related agencies and facilities	Emergency Telephone	*1km interval on both sides	None	*1km interval on one side
		Exclusive Telephone, Wireless for Patrol Car	Exclusive telecommunication circuit between center and stations; wireless communication between patrol car with stations and center		
		Vehicle Detector	*1 location between major cities	*1 location between major cities	
		Weather Observatory Equipment	*One representative location in high rainfall areas		*One location in the disaster prone areas
		Changeable Message Sign	*Toll booth *Tunnel entrance *Upstream of off-ramp located in major cities	*Toll booth	*Toll booth *Tunnel entrance
		Changeable Speed Limit Sign	*High rainfall areas		
2	In addition to 1 through 3 above, 4. Upgrade the traffic flow monitoring function 5. Upgrade the information dissemination function to road users	Vehicle Detector	*1 location between ICs *On and off-ramp of major ICs	*1 location between major ICs	*1 location between toll gate and tunnel
		Changeable Message Sign	*Upstream of off-ramp at major ICs	*Upstream of off-ramp at major ICs	
		CCTV Camera	*Major ICs and toll plaza	*Major ICs and toll plaza	*Incident/accident prone areas
		Radio Broadcasting	*All areas by broadcasting stations with information in respective areas		
3	In addition to 1 through 5 above, 6. Strengthen functions of incident detection, traffic surveillance and information conveyance	Vehicle Detector	*Recurrent congestion areas	*Recurrent congestion areas	*Recurrent congestion areas
		Changeable Message Sign	*Major access roads	*Major access roads	
		CCTV Camera	*Recurrent congestion areas	*Recurrent congestion areas	
		Highway Radio	*Recurrent congestion areas	*Recurrent congestion areas	

Table 5.5.2: Summary of Equipment Installation

Equipment	Level			Motorway			Expressway			Karak Highway		
				Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Information Collection	Exclusive Telephone and Wireless for Patrol Car			o	o	o	o	o	o	o	o	o
	Emergency Telephone			o	o	o	o	o	o	o	o	o
	Vehicle Detector	Mainline		o	oo	ooo	o	oo	oo		o	oo
		On & Off-ramp			o	o						
	Weather Observatory Equipment (Rain gauge, anemometer)			o	o	o				o	o	o
	CCTV Camera	Mainline			o	oo		o	oo		o	o
		Tunnel								o	o	o
Information Dissemination	Radio Broadcasting				o	o		o	o		o	o
	Changeable Message Sign	Mainline	Upstream of Off-ramp	o	oo	oo						
			Upstream of Tunnel	o	o	o				o	o	o
		Access Road				o						
		Toll Booth		o	o	o	o	o	o	o	o	o
	Changeable Speed Limit Sign			o	o	o						
	Highway Radio					o						
	Information Counter at Service Area					o						

In Level 1, the provision of the very basic facilities namely emergency telephones along the route and laying of communication cable network are carried out. In addition to these, basic equipment that provide the element of safety on the highway are also installed. This include vehicle detector on the mainline between major urban centers, weather observatory devices at maintenance offices and changeable speed limit sign located in adverse weather prone areas, and changeable message signs at toll booth, tunnel entrance and upstream of off-ramp at major cities. In principle, all roadside facilities are operated at the maintenance office at this level.

At Level 2, functions of equipment installed at Level 1 are to be enhanced by either increasing the unit of installations or adding new devices. The installation of vehicle detectors, for example, is increased to one for every section between interchanges as well as at on- and off-ramps at major interchanges. With these increased number of detectors, more traffic data including access and egress traffic volume at major interchanges can be accurately compiled. Changeable message signs are also increased and installed upstream of off-ramp at major interchanges. Visual information gathering is made possible by introducing CCTV system at Level 2 and cameras are installed at major interchanges and toll plaza on mainline. Basic information dissemination by means of radio broadcasting is also introduced.

If traffic control and management system is introduced to two or more adjacent sections, a traffic control center must be set up to effect more efficient traffic control and management between maintenance offices.

Level 3 is to achieve a further sophistication from Level 2 where all the necessary data collection devices are installed to gather detail and accurate traffic data, in particular congestion data. Information dissemination function is further expanded by installing changeable message sign at major access roads to the highway and the use of highway radio and information counter at all service areas.

5.5.4 Proposed Traffic Control and Management System Plan

Based on the preceding discussion on the traffic control and management system, system plans at their final stage in year 2005 has been prepared for the study routes. Figure 5.5.5 illustrates the proposed traffic control and management system plan.

Five traffic control centers will be set up at Penang, Ipoh, Subang, Genting, and Ayer Keroh to cover the entire stretch of Penang Bride, North-South Expressway, Karak Highway, New Klang Valley Expressway, Federal Highway, and Senai Highway. A total of nine sub-centers will be placed under them. Communication network using optical fiber cable and carrier transmission will be established between these offices and roadside facilities. Various types of roadside equipment are installed as shown in the diagram.

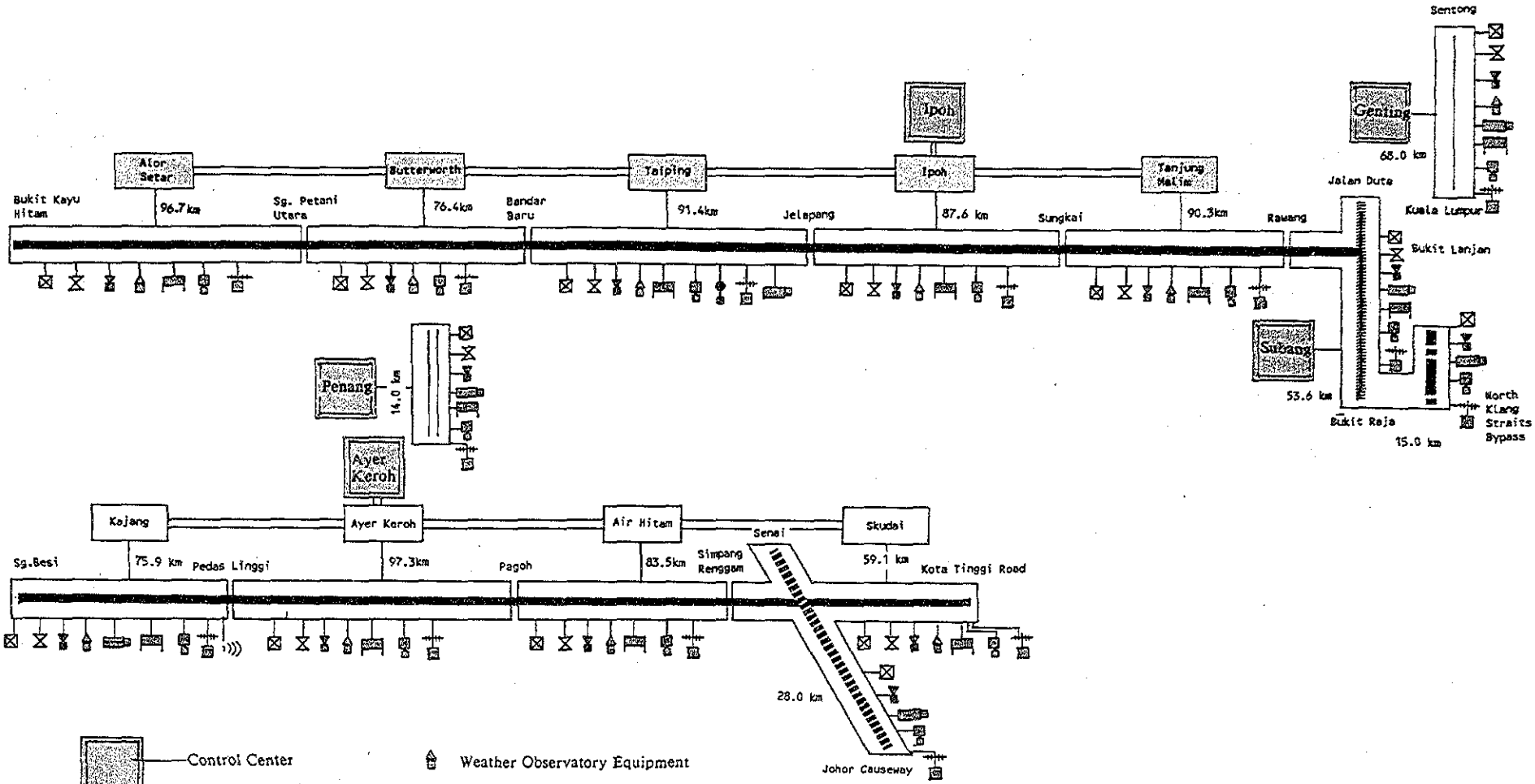
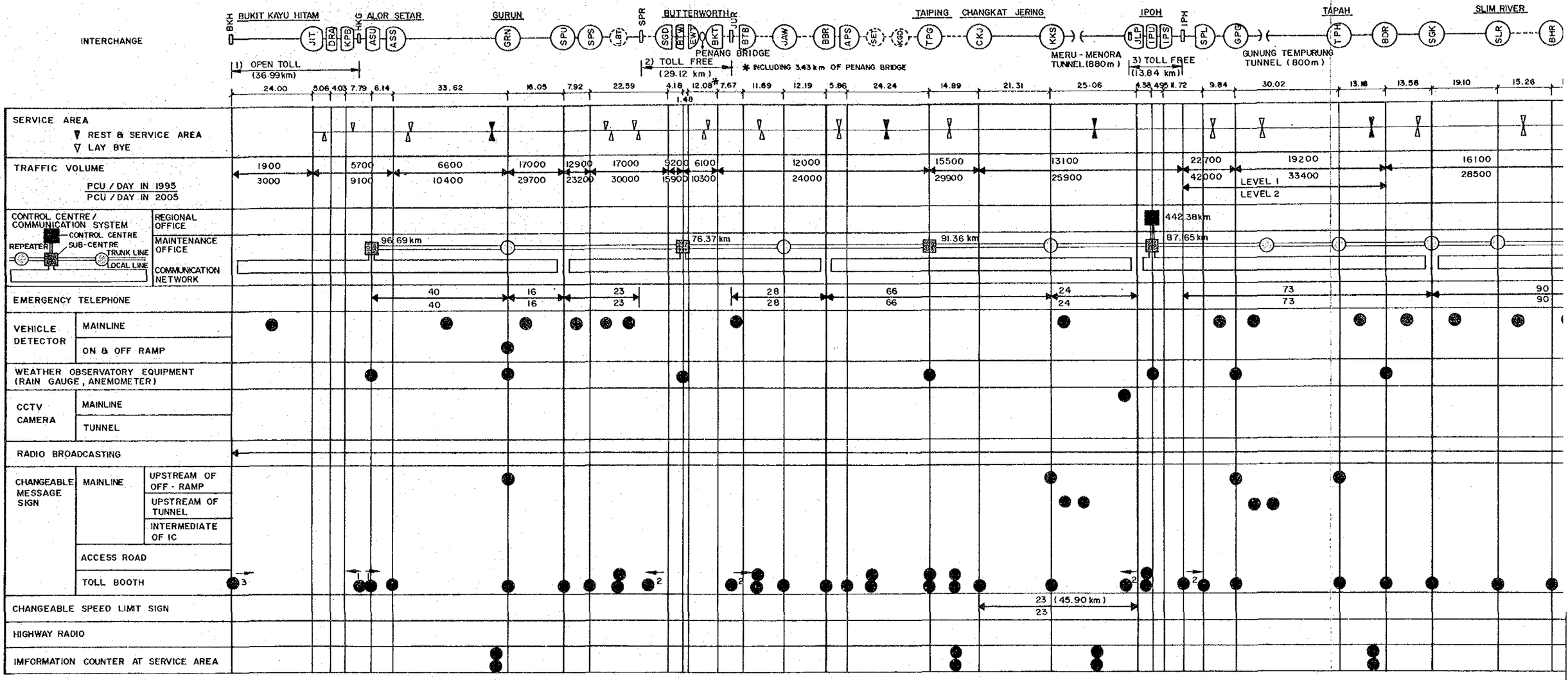


Figure 5.5.5: Proposed Traffic Control and Management System Plan

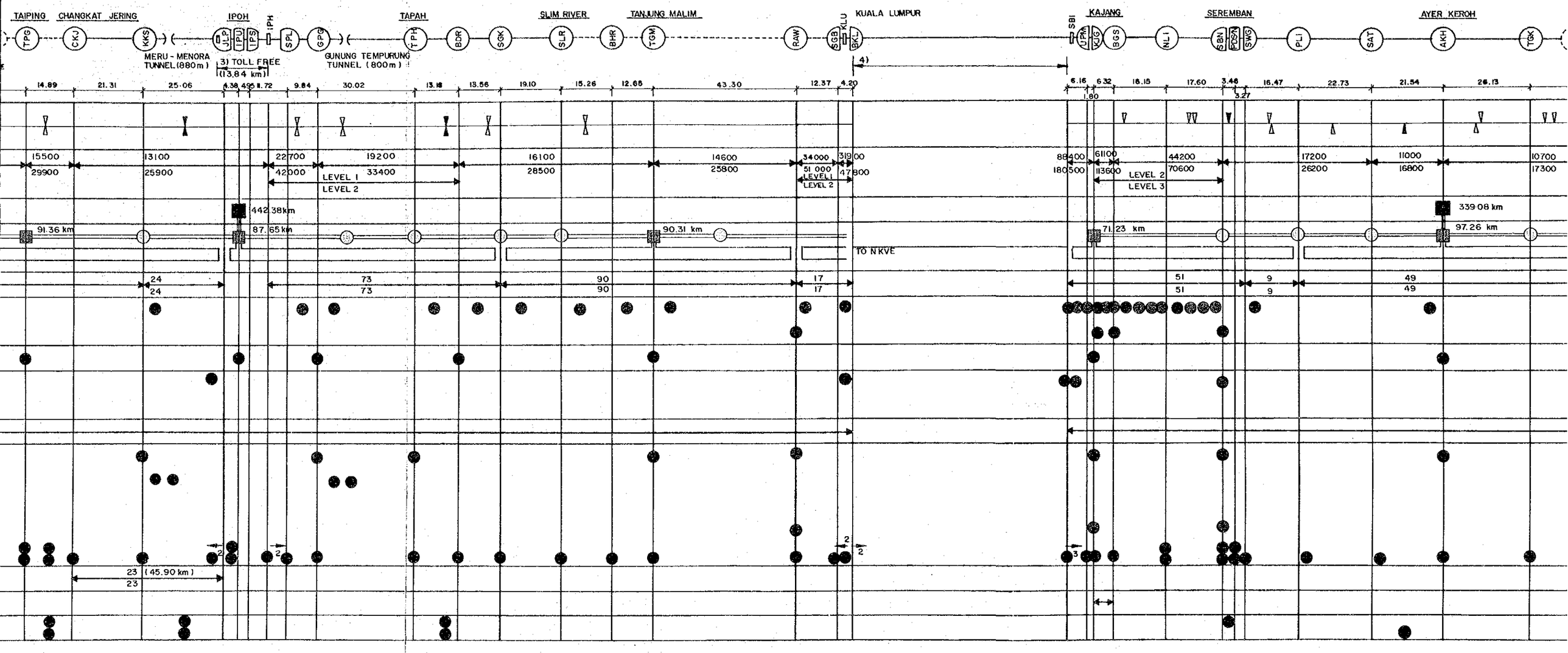
The final proposed traffic control and management system installation plans on the North-South Expressway, New Klang Valley Expressway, Federal Highway 2, Senai-Johor Bahru Highway, Penang Bridge and Karak Highway are shown in Figures 5.5.6 through 5.5.11. All the proposed roadside equipment are shown on the figures at their respective location schematically. For the emergency telephones, the number of units to be installed along each section of the route is shown instead. The installation of these equipment are also shown by the proposed stages of construction.

Figure 5.5.6: Proposed Traffic Cont.



COLOR LEGEND
- STAGE 1
- STAGE 2
- STAGE 3

Figure 5.5.6: Proposed Traffic Control and Management System Installation Plan for North-South Expressway - 775 km



m Installation Plan for North-South Expressway - 775 km

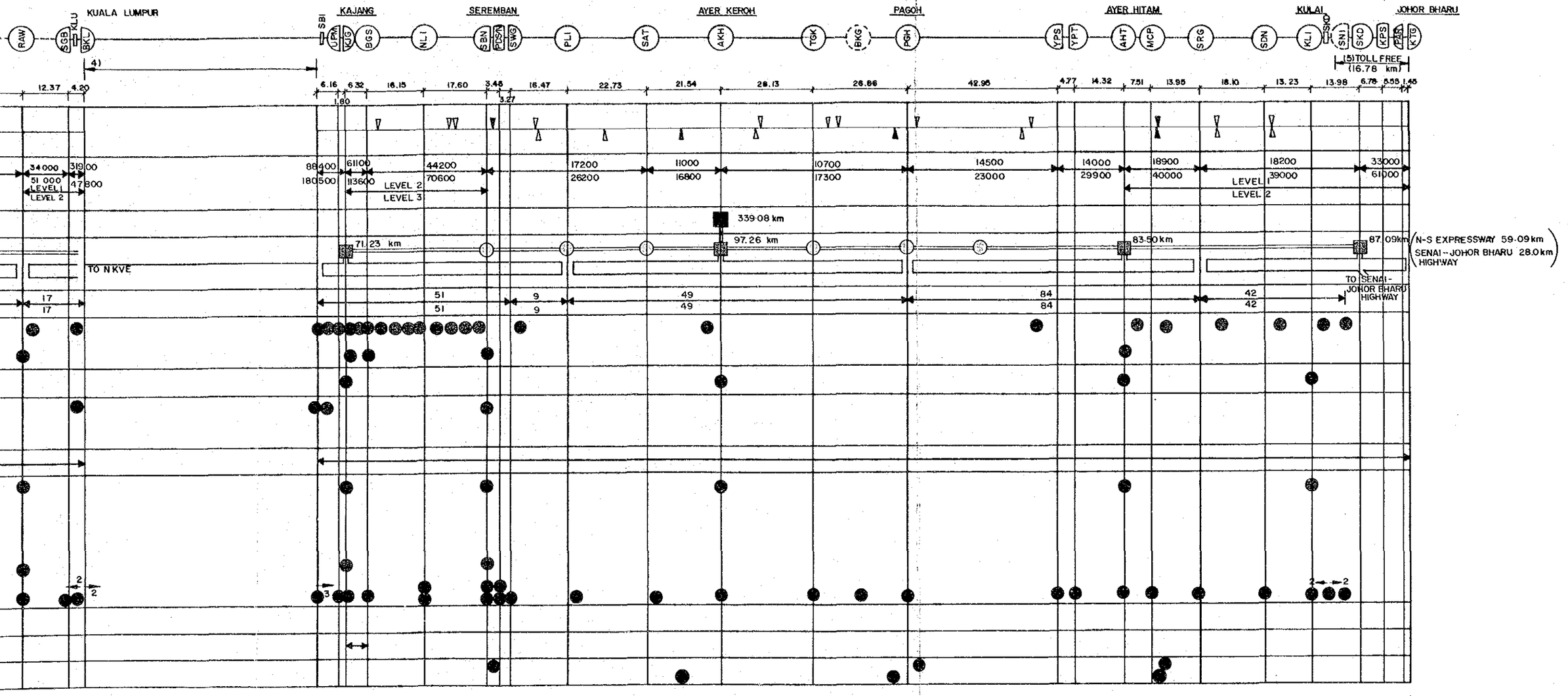


Figure 5.5.7 : Proposed Traffic Control and Management System Installation Plan for New Klang Valley Expressway - 37.0 km

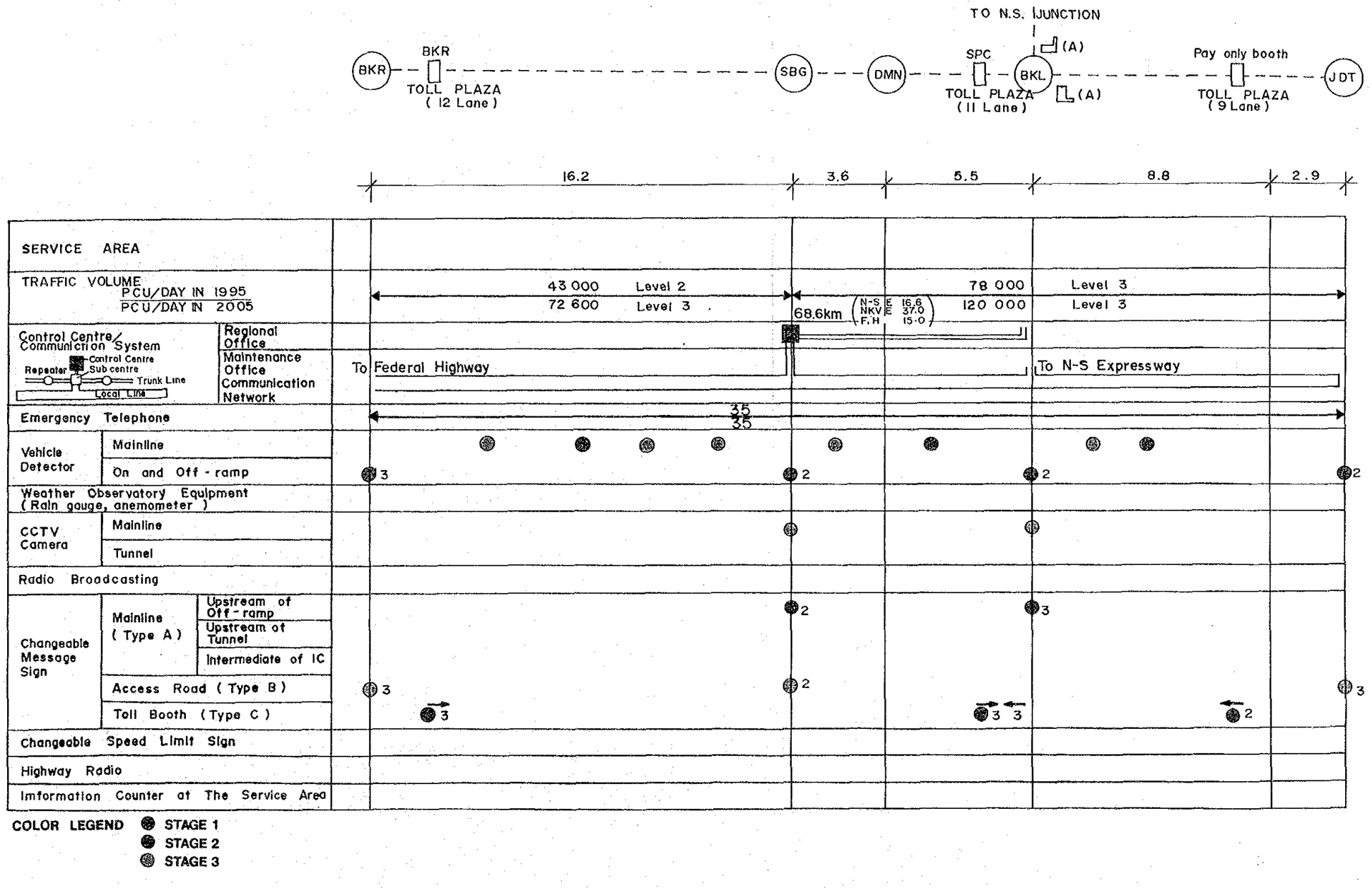
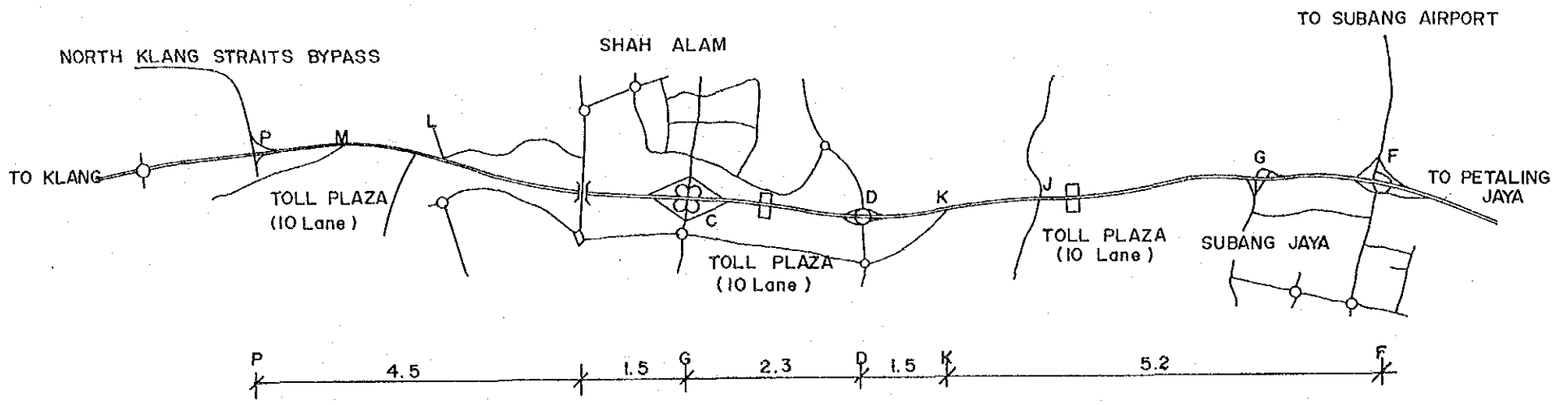


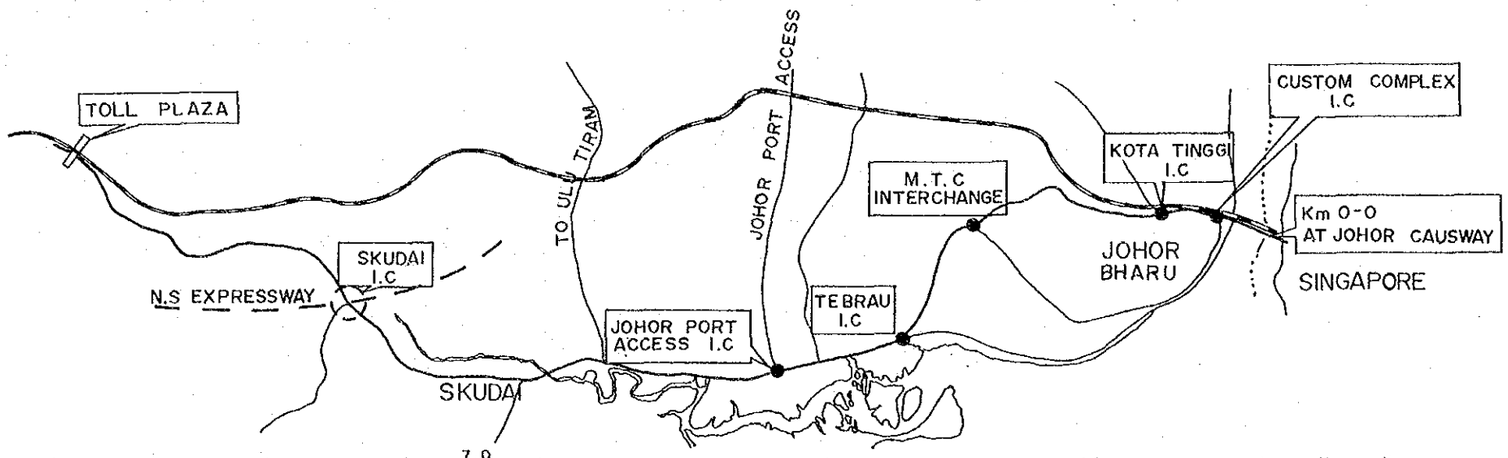
Figure 5.5.8 : Proposed Traffic Control and Management System Installation Plan for Federal Highway 2 - 15.0 km



SERVICE AREA											
TRAFFIC VOLUME PCU/DAY IN 1995 PCU/DAY IN 2005			46 000 Level 1 70 600 Level 2			143 000 Level 1 190 000 Level 2					
Control Centre Communication System (Control Centre, Repeater, Sub centre, Trunk Line, Local Line)	Regional Office Maintenance Office Communication Network		To New Klang Valley Expressway								
Emergency Telephone											
Vehicle Detector	Mainline		●	●					●	●	
	On and Off - ramp										
Weather Observatory Equipment (Rain gauge, anemometer)											
CCTV Camera	Mainline										●
	Tunnel										
Radio Broadcasting											
Changeable Message Sign	Mainline (Type A)	Upstream of Off - ramp									
		Upstream of Tunnel									
		Intermediate of IC									
	Access Road (Type B)										
	Toll Booth (Type C)		● 3 3						● 3 3		
Changeable Speed Limit Sign											
Highway Radio											
Information Counter at The Service Area											

COLOR LEGEND ● STAGE 1
● STAGE 2
● STAGE 3

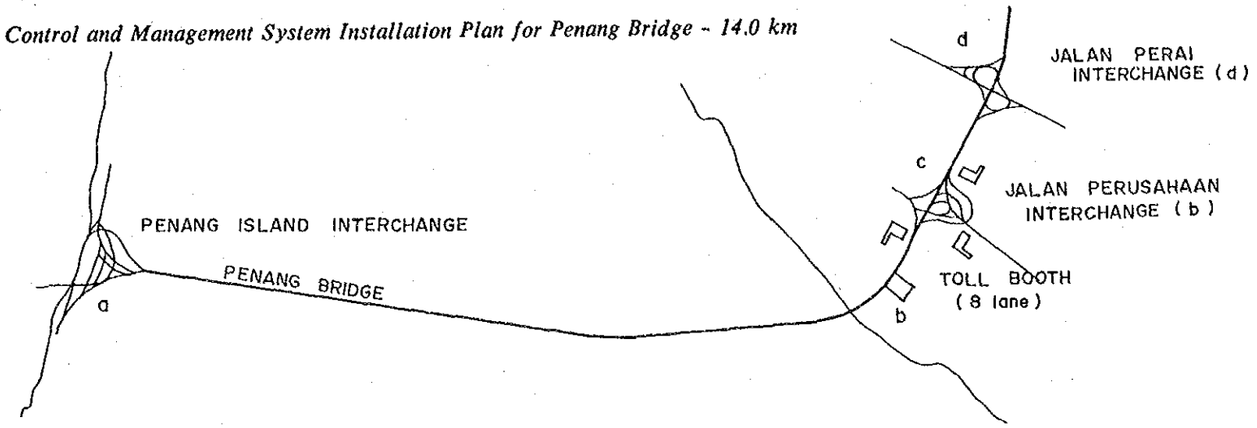
Figure 5.5.9 : Proposed Traffic Control and Management System Installation Plan for Senai-Johor Bharu Highway - 28.0 km



SERVICE AREA										
TRAFFIC VOLUME PCU/DAY IN 1995 PCU/DAY IN 2005				25200 40700	Level I Level I					
Control Centre/ Communication System Repeater, Control Centre, Sub centre, Trunk Line, Local Line	Regional Office									
	Maintenance Office Communication Network									
Emergency Telephone				To N-S Expressway						
Vehicle Detector	Mainline			●						
	On and Off - ramp									
Weather Observatory Equipment (Rain gauge, anemometer)										
CCTV Camera	Mainline									◉
	Tunnel									
Radio Broadcasting										
Changeable Message Sign	Mainline	Upstream of Off - ramp								
		Upstream of Tunnel								
		Intermediate of IC								
	Access Road									
	Toll Booth (Type C)		● 2							◉ 3
Changeable Speed Limit Sign										
Highway Radio										
Information Counter at The Service Area										

COLOR LEGEND ● STAGE 1
● STAGE 2
◉ STAGE 3

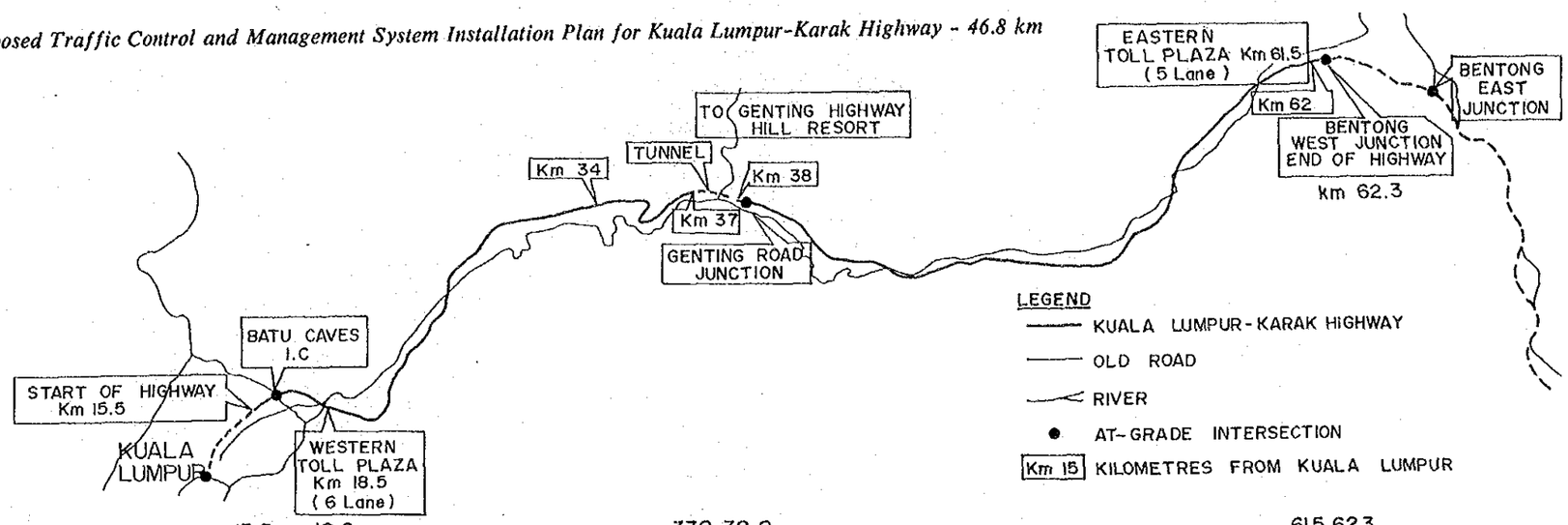
Figure 5.5.10 : Proposed Traffic Control and Management System Installation Plan for Penang Bridge - 14.0 km



SERVICE AREA			
TRAFFIC VOLUME PCU/DAY IN 1995 / PCU/DAY IN 2005			35900 Level 2 / 58500 Level 3
Control Centre/ Communication System (Control Centre, Sub centre, Repeater, Trunk Line, Local Line)	Regional Office		
	Maintenance Office Communication Network		14 km
Emergency Telephone			(EXISTING)
Vehicle Detector	Mainline		
	On and Off - ramp	2	4, 3
Weather Observatory Equipment (Rain gauge, anemometer)			
CCTV Camera	Mainline		
	Tunnel		
Radio Broadcasting			
Changeable Message Sign	Mainline (Type A)	Upstream of Off - ramp	x 3
		Upstream of Tunnel	
		Intermediate of IC	
	Access Road (Type B)	2	
	Toll Booth (Type C)		4
Changeable Speed Limit Sign			
Highway Radio			
Imformation Counter at The Service Area			

COLOR LEGEND
- STAGE 1
- STAGE 2
- STAGE 3

Figure 5.5.11 : Proposed Traffic Control and Management System Installation Plan for Kuala Lumpur-Karak Highway - 46.8 km



			15.5 18.0	37.0 38.0	61.5 62.3
SERVICE AREA					
TRAFFIC VOLUME PCU/DAY IN 1995 / PCU/DAY IN 2005			22 800 / 36 300	Level 3 / Level 3	
Control Centre/ Communication System (Control Centre, Repeater, Sub centre, Trunk Line, Local Line)		Regional Office			
		Maintenance Office Communication Network		46.8 km	
Emergency Telephone			21	4	24
Vehicle Detector	Mainline		● ● ●	●	
	On and Off-ramp				
Weather Observatory Equipment (Rain gauge, anemometer)				●	
CCTV Camera	Mainline		● ●2		
	Tunnel			(O)(O)	
Radio Broadcasting					
Changeable Message Sign	Mainline (Type A)	Upstream of Off-ramp		●	●
		Upstream of Tunnel			
		Intermediate of IC			
	Access Road (Type B)				
	Toll Booth (Type C)		●2		●2
Changeable Speed Limit Sign					
Highway Radio					
Information Counter at The Service Area					

COLOR LEGEND
- STAGE 1
- STAGE 2
- STAGE 3