

**ATTACHED REPORT 2**  
**TRAFFIC MANAGEMENT PLAN**

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## **Part 2: Traffic Management Plan**

The preceding part discusses the various problems related to traffic control and management in Phnom Penh identified in this Study. Part 2 presents the basic traffic management plans to be effectively and promptly applied in order to improve or prevent the further deterioration of traffic environment including traffic accident in the city.

### **2.1 Planning Concept**

The final objective of formulating a traffic management plan is to realize a safe, smooth and comfortable traffic environment. In achieving a smooth traffic flow, the byproducts are in fact safe and comfortable traffic. In other words, to ensure safety and ability to travel in comfort, the traffic has to have the chief characteristic of being able to flow smoothly.

As a common traffic management planning approach, the 3E method is usually interpreted as 'Engineering', 'Education' and 'Enforcement'. However, with the increasing concerns over the degradation and need to protect the environment, many professionals are now stressing the 3E as 'Environment', 'Enforcement' and 'Education'. The previous engineering component is now embedded into the 'Environment' component. This chapter discusses according to the 3E method

#### **2.1.1 Problems on Traffic Management**

Problems on traffic management with regard to 3E(Engineering, Education, Enforcement) in Phnom Penh are described below:

(1) From Traffic Engineering and Technical perspective:

- Frequent occurrence of traffic congestion
- Increase of traffic accidents
- Disorderly traffic flow due to the mixed traffic
- Traffic congestion and accidents along road sections
- Traffic congestion and accidents at intersections
- Inadequate traffic signal control
- Difficulty of traffic control at the irregular intersections and roundabouts
- Inadequate traffic regulation
- Problems of on-street parking
- Inadequate pedestrian sidewalk facility.

(2) From Traffic Safety Education perspective:

At present, most residents are not aware of the danger of traffic accidents, except those who had unfortunately and personally experienced the horrors of accidents in the past. The awareness of traffic safety is considerably poor.

- Traffic safety education to children, students and general public does not spread at all.
- There are neither opportunities nor institutions for motor cyclist to learn traffic rules and safety.
- Written test and skill test for 4 wheelers are carried out during the application for drivers licenses. However the actual driving behavior on the road is far from that learned at the training course.
- There are neither opportunities nor institutions for cyclos and motor-remoks drivers to learn traffic rules and safety.
- There are no adequate educational materials on traffic rules and traffic safety.

(3) From Traffic Enforcement and Driving Instruction Perspective:

- There is no intensive enforcement against behaviors which may cause traffic congestion and dangerous driving.

- Penalties for violating traffic rules exist. However it is important to ensure consistency and penalize all offenders without any discrimination or favors and to make sure that the penalty collection system is clear and transparent.

(4) Institutional Issues

- No cooperative efforts from other traffic management related agencies
- Lack of standard of Uniform Traffic Control Devices
- No accumulation and storage system of basic data system on traffic management
- No rescue system

### 2.1.2 Tasks for Traffic Management

The followings are the major tasks for formulating the traffic management plan in order to solve or alleviate problems in Phnom Penh city.

(1) Reduction of traffic congestion

- Increase of traffic capacity
  - Upgrade the level of maintenance of roads and their auxiliary facilities
  - Implement adequate traffic operation measures
  - Strengthen the traffic enforcement
  - Reduce traffic accidents
- Restraint of traffic demand
  - disperse concentrated demand from certain locations and areas

(2) Reduction in traffic accidents

- Install various traffic control devices
- Strengthen traffic safety education
- Strengthen traffic enforcement
- Regulate the use and ownership of specific vehicles

(3) Prevention from further deterioration of environment

- Reduction of traffic congestion
- Reduction of noxious gases, noise and vibration,
- Saving fuel consumption.

### 2.1.3 Policy of Traffic Management Plan

(1) Scope of Traffic Management Plan

The scope of traffic management plan generally comprises not only traffic control, traffic regulation, traffic enforcement, but also measures on reducing traffic demand with the introduction of new systems such as staggered time commuting or bus system improvement. However, new construction or renovation of basic infrastructure is excluded. Thus the measure for traffic management has the following specific features compared with long term plan.

- It is possible to implement them in the short term
- It is possible to implement them at low cost
- It is easy to ensure that they are compatible with variable traffic conditions

(2) Policy of Formulating the Traffic Management Plan

1) Examine the effective use of existing roads and facilities

It is difficult to build a new road or widen the road space within the build-up area. Even if it's possible, it takes a long time to complete. Thus the effective use of existing road must be well considered in this plan.

2) Formulate an effective improvement plan

High priority improvement plan needs to be taken because there are many basic measures to be taken in the present situation. For example, improvement of sidewalk and pedestrian crossing is necessary in almost all areas in the city, however, priority and urgent considerations must be given to places around schools and markets.

3) Introduce new method and technology

Several new methods have been introduced in various cities with favorable outcomes. Among them, the methods suited for Phnom Penh City will be discussed. Traffic management from the following two perspectives can be considered: One is TSM (Transportation System Management), and the other is TDM (Traffic Demand Management).

4) Encourage the shift from private modes like cars to public transportation.

There are too many motor cyclist in Phnom Penh city and this causes the increase of traffic accidents greatly. In order to solve such problems the shift from private modes like cars and especially motor cycles to public transportation must be considered.

5) Implement interim measures until accomplishment of the long term plan

(3) Policy on Formulating the Traffic Safety Plans

Traffic safety plan comprises traffic safety education and enforcement against offenders.

1) Traffic safety education

- a. Traffic safety education should be for all citizens.
- b. It is especially important to give proper traffic safety education to children and students. Thus the conduct of regular traffic education in schools should be considered.
- c. Observation of traffic rules as well as improvement of driving skill are necessary for drivers. Driving instruction and police trap are some of the most important and effective ways for it. However, they must be well coordinated to achieve effective traffic enforcement.

2) Traffic enforcement

- a. In the present situation, selective enforcement should be considered. As a first step, common risky acts and behaviors among drivers must be revealed based on traffic accident analysis data. Then, as the second step, driving instructions and police trap on the incident prone spots should be considered
- b. Facilities and equipment for enforcement should be introduced in order to improve the effectiveness of these efforts.

## 2.2 Improvement of Roads and Traffic Operations

In this chapter, remedial measures which are possible for implementation in the short term with low cost are discussed in order to prevent further deterioration of traffic condition in Phnom Penh City. Especially, the most effective way to improve traffic processing capacity under the present road facility condition is forecasted. In addition, traffic remedial measures which can contribute to improve traffic safety are also discussed, and presenting the issues between the road section and intersections.

### 2.2.1 Road Section Improvement

In general, most of the congestion occurs at intersections compared with congestion at road sections. At intersections, most of the congestion is in the urban areas. (This applies to traffic accidents as well). However, the congestion can still be observed at road sections in Phnom Penh City. Thus, if obstructive factors at road sections are eliminated or reduced, a smoother traffic flow, increase of traffic capacity and decrease of traffic accidents can be expected.

#### (1) Obstructive Factors at Road Sections

Table 2.2.1 shows the main causes which obstruct smooth traffic flow and general remedial measures to improve them. They are divided into two categories, that is measures by improving roads or installing facilities and by better traffic operation.

#### (2) Poor and Water Logged Road Surfaces

The fundamental problem of traffic operation is poor and water logged road surfaces. This problem has a top priority in planning a traffic management plan. However, it is impossible to devise a remedial measure against road surfaces in the whole city at the same time. It is more workable to begin such remedial measures with the higher priority roads. Table 2.2.2 and Figure 2.2.1 show the priority roads identified from the perspective of traffic management.

Table 2.2.2 High Priority Roads to be Improved

---

1.	Blvd. Charles De Gaulle - Blvd. S. Monired (217)	
		between Blvd. Monivong and Digue De L'Hopital Russf (271)
2.	No. 139	between No. 166 and Rue Kampuchea Krom (if possible, this improvement will be included in that of Blvd. Charles De Gaulle )
3.	Rue Tep Phan	between Blvd. Monivong and No. 271(or Blvd. Mao Tse Toung )
4.	Blvd. J. Nerhu	between Blvd. S.Monired and Blvd. URSS
5.	No. 271 (Inner Ring Road)	between Rue Kampuchea Krom and Blvd. Monivong
6.	Rue Samdech Pann(214)-Rue Joseph Broz Tito(214)-No. 161	
		between Blvd. Norodom and Rue Tep Phan
7.	No. 161-No.163	between Rue J. B. Tito(214) and No. 271(or Blvd. Mao Tse Toung )

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Remark: Improving road surface is discussed in details in chapter 13, "Road Development Plan"

#### (3) Pavement markings and Traffic Signs

##### 1) Pavement markings

Pavement markings are also important transportation facility in addition to road surface for the smooth flow of traffic. Marking a yellow center line can prevent disorderly traffic; otherwise drivers can not recognize which lane to drive and may cause opposite lane driving. At present, there is no rule to regulate opposite lane driving and this can cause traffic accidents or congestion. White broken line contributes to segregate four-wheel vehicles from the two-wheelers and hence to smoother traffic flows. Stop lines and intersection markings contribute to protect pedestrians from danger and to reduce conflicts between other vehicles.



Table 2.2.1: Main Causes of Interrupting Traffic Flow along Road Sections

Main Causes of interrupting flow	Measures by improvement or installation of facilities	Measures by traffic operation
1 Poor Road Surface	Improvement of road surface	
2 Waterlogging Road Surface	Improvement of drainage	
3 Travelling against the Designated Traffic Flow	Installation of center lane markings Installation of center divider on multi-lane roads	Strengthen traffic enforcement
4 Disorderly moving by Mixed Traffics	Installation of lane markings on multi-lane roads	Operation of exclusive lane on multi-lane roads
5 Access Vehicles to/from Small Road or Driveway	Installation of lane markings on multi-lane roads	Operation of Odd-number of lanes Prohibition of left turn
6 Using Vehicle Road by Pedestrians	Improvement of foot path Replacement of obstacle materials	
7 Random Crossing by Pedestrians	Installation/improvement of pedestrian crossing facilities	
8 Illegally parked Vehicles		Strengthen traffic enforcement
9 Parking Maneuvers		Prohibition of curb parking on streets
10 Street Vendors	Replacement of obstacle materials	Strengthen traffic enforcement
11 Traffic Accidents		Reduce of traffic accidents
12 Road Maintenance Works		Avoid construction in peak hours
13 Building Construction Works		
14 Illegally Storage of Building Materials	Replacement of obstacle materials	Strengthen Traffic Enforcement,
15 Machinery On Road Pavements	Replacement of obstacle materials	Strengthen Traffic Enforcement,

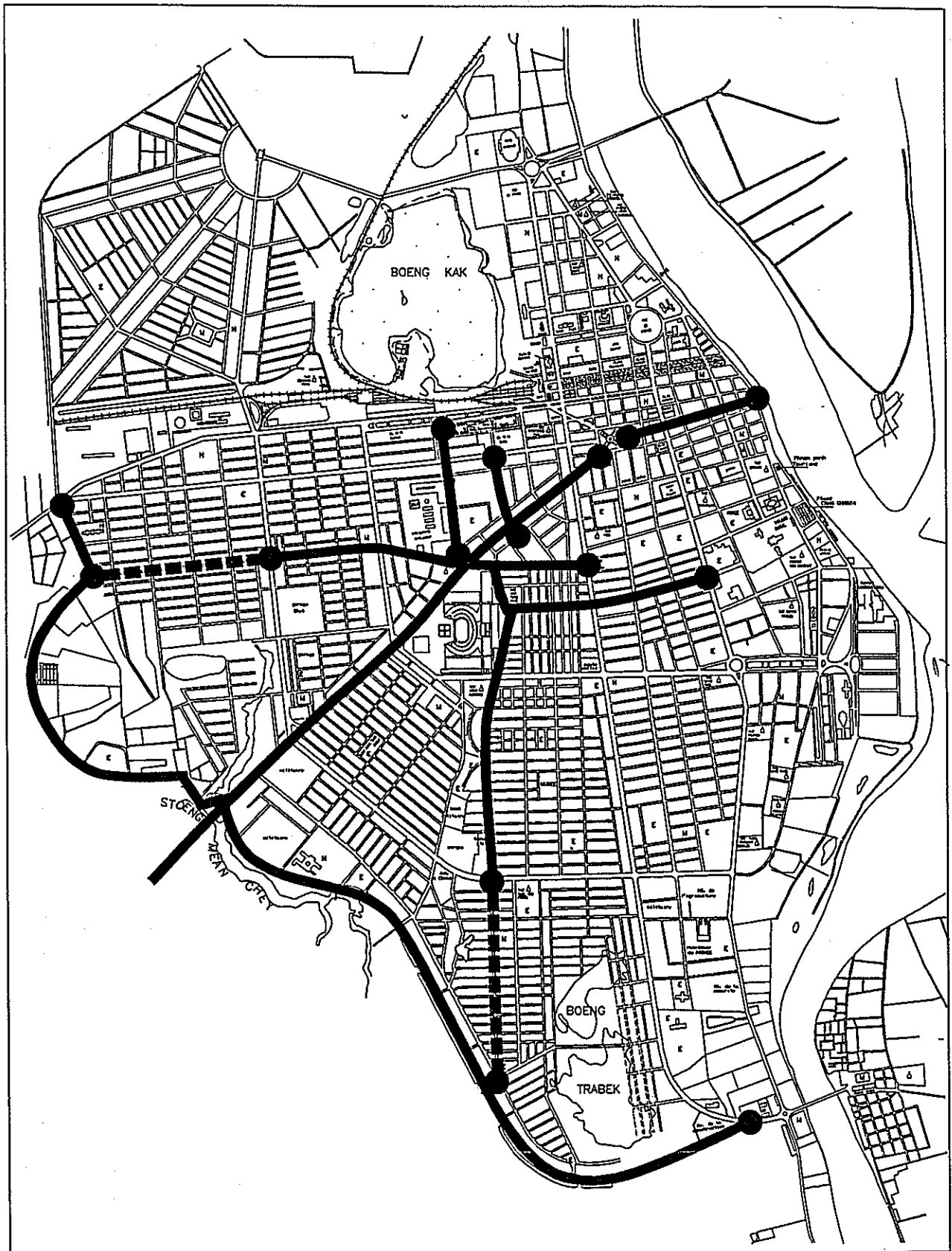


Figure 2.2.1: High Priority Roads to be Improved

After the road surfaces were improved, pavement markings have to be introduced to the main arterial streets in the city. However, estimated usable period of the markings is short and even if plastic material is used for marking, regular remaking is necessary as they would have deteriorated and can not be seen any more in about 6~ 12 months later. Maintenance is required in order to keep pavement markings in good condition all the time.

Targeted routes at present are as follows.

- All main arterial streets in the city
- From No.1 to No. 6 of the National routes.

The pavement marking on national route No.2 especially should be kept in a good condition since the route is characterized as one of the highest accident frequency points.

## 2) Traffic Signs

As for installing traffic signs, the following two conditions of existing signs must be improved.

- Heights of existing signs are lower than the average height of pedestrians and these signs obstruct pedestrians' way. The height of these signs should be raised.
- Regulatory signs such as "NO THOROUGHFARE" or "NO PARKING" are installed, however, the regulated area is not indicated clearly. Additional signs are necessary to make them clear.

## 3) Navigating at danger points

Road geometric rectification and maintaining continuity in design contribute to improve traffic safety and to enhance traffic processing capacity of roads. This is particularly important when there are obstructions on the road or sharp curves. To avoid vehicles following too close to each other, pavement markings and warning signs should be given in advance to warn drivers of such possible dangers. A detailed research on dangerous points should be carried out since such potential dangerous points can be commonly observed in the suburbs. An appropriate measure should be prepared.

## (4) Sidewalk and Crossing walk

### 1) Sidewalk

Although sidewalks are equipped in Phnom Penh City in principle, maintenance is hardly carried out. Almost all the arterial streets have sidewalks but pedestrians have to walk on roadway because they are not continuous and pedestrians can not walk comfortably.

The obstructive factors are as follows.

- Insufficient maintenance of side walks
  - Undeveloped sidewalk
  - Steps on sidewalk
  - No cover on manhole or hand hole
  - Lack of care for wayside trees
  - Others
- Parking on sidewalks
- Business activities on sidewalks
- Illegally storage of commercial goods

Thus improving sidewalk and eliminating the above factors are recommended. However it is impossible to put them into practice all at once because of time and economic restrictions. A gradual or step-by-step approach is recommended. High priority places under the present circumstances are as follows.

- Sidewalks around schools
- Sidewalks along main arterial street in the urban area
- Sidewalks around tourist spots

In addition, protecting pedestrians by speed zone regulation should be taken into consideration as they face potential danger from speeding vehicles.

## 2) Crosswalks at road sections

Zebra marking are used for crosswalks in road sections at the moment. However, if there are only road surface marking it is inadequate for national roads in suburbs.

The following facilities are required.

- Crosswalk signs at and in front of intersections.
- Road surface markings to clearly indicate the stop lines.
- Lighting for nighttime
- Lighting signs for nighttime

In addition, pedestrian-only signals are required depending on the number of pedestrians or traffic volume. Figure 2.2.2. shows the typical facilities of crosswalks at road sections.

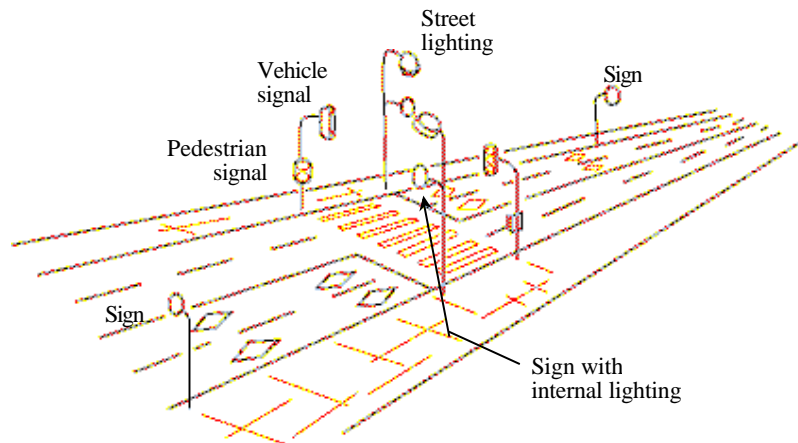


Figure 2.2.2: Typical Facilities of Crosswalks at Road Sections

## (5) Traffic Control in Road Sections

There are various control methods applied to road sections in many cities. The following describes main control methods which will be useful for Phnom Penh.

### 1) One-way

One-way streets can reduce congestion and increase capacity by:

- eliminating the friction between opposing directions,
- simplifying intersection operation,
- utilizing intersection approach width more efficiently.

However, potential disadvantages of one-way operation include:

- longer trip distances and, as a result, higher fuel consumption,
- more turns and concentration of turns at certain intersections, especially, at terminal intersections of one-way operation,
- business owners may oppose one-way operation.

#### *Consideration in Phnom Penh streets*

*It may be impossible or difficult to construct other major arterial streets in the existing road network of the urban area. Thus, by means of applying one-way operation on the local streets, these must function as arterial or collector streets. The suggested streets are shown in Figure 2.2.3.*

- *Pair streets of Rue Pasteur (57) and Rue Trasak Paem(63)*
- *Pair streets of No.113-103 and No.143*
- *Pair streets of No.199 and No.193*
- *Pair streets of Rue Keo Chea (184) and Rue Sokum Meanbon (178)*

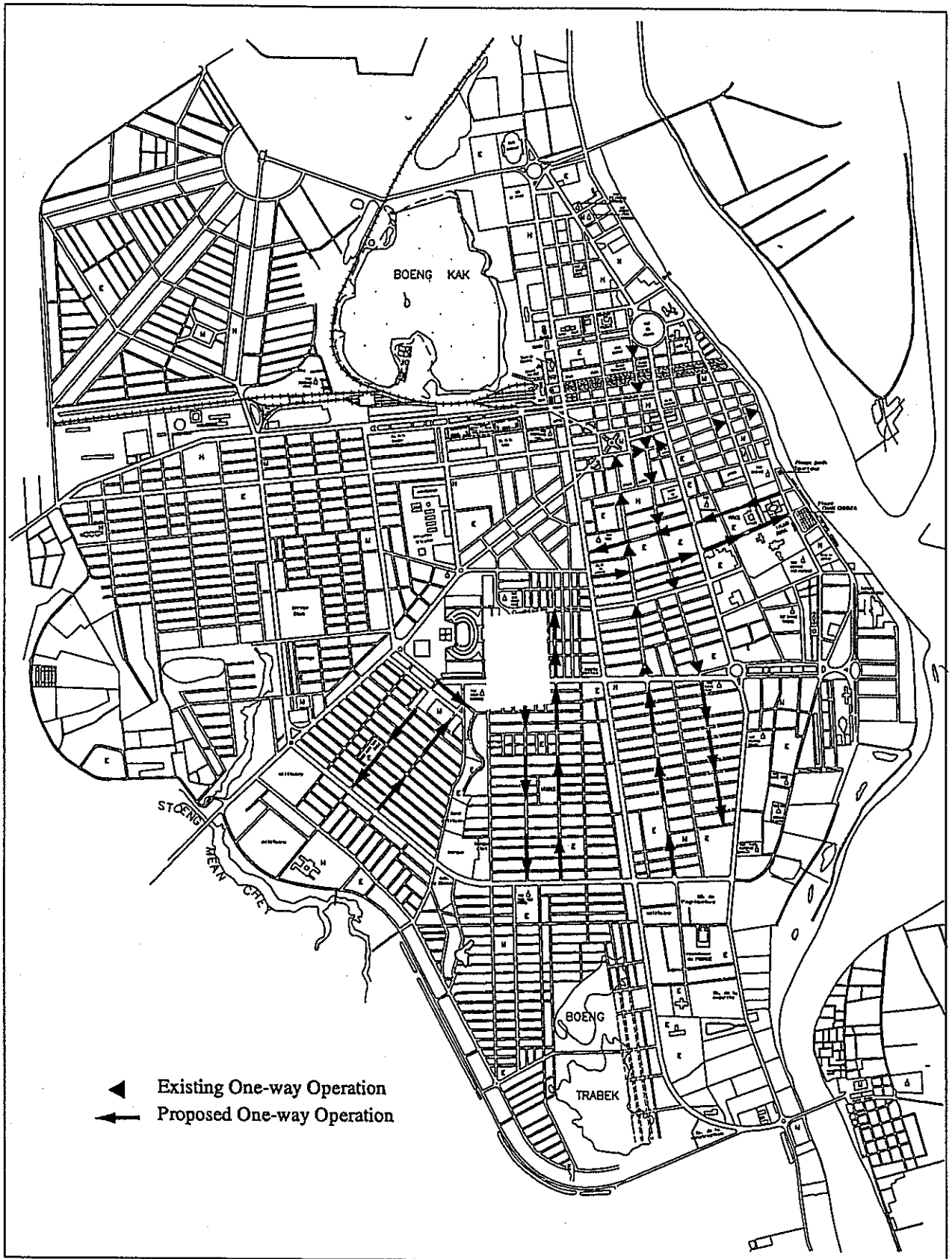


Figure 2.2.3: Proposed Roads to be Operated under Own-way Control

## 2) Reversible lane

Reversible lane control provides one or more lanes, which operate in one direction during part of the day, and in the opposite direction during another part of the day.

The control is applied to balance the street capacity with the directional distribution of traffic during different peak hours.

In general, the operation is adapted to:

- one-way streets on which the flow is reversed at different period of the day,
- two-way streets on which traffic flow is reversed in the center lane(s),
- two-way streets, which become one-way during peak hours.

An importance point for successful operation is to inform road users of the current condition of operation. Methods of control include:

- distinctive pavement markings (double broken yellow lines) delineated the dividing lines,
- fixed signs indicating lanes and direction of lane flow,
- lane control signals indicating lane usage,
- Physical separation by movable barriers.

## 3) Turn movement control

Turn movement control may be used to reduce congestion and accident related to turning traffic, especially left turns. It is preferable to make a plan for satisfying users' turn needs, rather than restricting them.

The control may include providing:

- left or right-turn lanes,
- double turn lanes,
- two way-left-turn lane,
- left turn phasing of signal, or
- turn restriction.

As an example of left-turn control, Figure 2.2.4 shows typical marking for a two-way left-turn configuration.

(From Manual on Uniform Traffic control Devices)

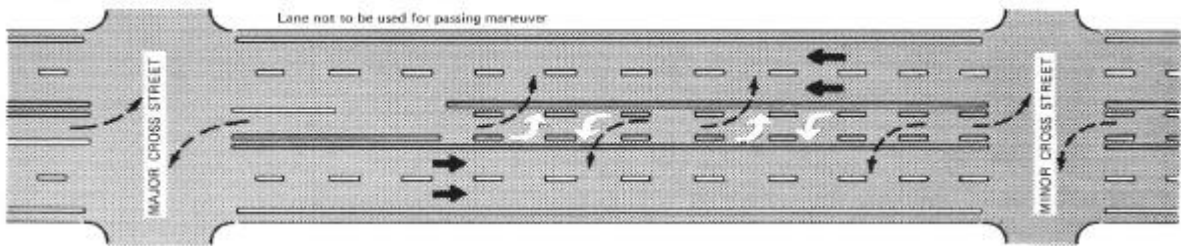


Figure 2.2.4: Typical Marking for a Two-Way Left-Turn Configuration.

Left turn vehicle must have the following behaviors for left turn:

Case 1: Vehicles turning left from an arterial to a minor street or drive-way take the following two steps:

- diverting course to the turning lane,
- crossing the traffic stream in the opposite direction for left turn,

Case 2: Vehicles turning left to a minor street or drive-way from an arterial take the following two steps:

- turning left into the turning lane,
- merging into the traffic stream.

The main benefits of the control are:

- to reduce delay in traffic,
- to reduce rear-end collisions,
- to accommodate left-turn needs

*Consideration in Phnom Penh streets*

*Under the current drivers' poor driving manner, it is impossible to apply the operation of two-way left-turn lane to the Phnom Penh streets, but the operation may provide benefits for the city when the driving manner become good in the near future.*

*The existing candidate routes are:*

- *The north part of Blvd. Monivong*
- *National Rout No. 2*

4) Raised medians

Raised medians provide a higher level of traffic safety and improve operations for through vehicles on multi-lane street.

The benefits of the medians are:

- separating opposing traffic physically,
- restricting access to/from the arterial,
- providing pedestrian refuge areas.

*Consideration in Phnom Penh streets*

*The raised medians along multi-lane arterial streets are greatly useful in this city, because it is possible to restrict driving on opposing road and left-turning to/from a minor road or drive-way.*

*However, when driving manners improve, the median may not be needed because existing arterial streets have insufficient width and considering the need to make more effective use of existing streets.*

5) Curb lane and parking management

Arterial streets should serve the function of traffic movement primarily. On-street parking often conflicts with this function, and the friction reduces the effective width of the street if the friction are caused by vehicles entering and leaving parking spaces and cars keeping their doors open.

Before adopting parking restriction to arterial and collector streets, the following consideration in the use of the curb lane must be made:

- Movement of traffic is the first priority for use of the curb lane in order to increase road capacity,
- Mass transit vehicles (public bus), especially bus stops, is the second priority.
- Limited time parking should be provided as the third priority, Parking meters are useful for encouraging short-term parking,
- Long-term parking should be permitted only if the three preceding priorities are satisfied. In general, long-term parking are not permitted on arterial streets.
- Parking may be prohibited for only the peak hours in the direction of the capacity restraint.

Parking regulation should be indicated using proper signs at the beginning and ending points of the regulation, and at intermediate locations as well.

When on-street parking can not be controlled, enforcement should be made to remove parking in and near intersections.

It is essential that parking regulations be enforced in order to keep streets effective width for traffic movement as well as to enhance drivers' manner.

6) Access management

Access management is an important issue for serving through-traffic movement on the arterial.

Main methods of traffic access controls are as follows:

- Controlling access to/from arterial by limiting locations, alleyways and driveways,
- Designing alleyways and driveways to control certain movements, especially left-turn, through channelization,
- Providing raised median to prohibit access,
- Providing two-way, left-turn lane
- Controlling traffic to concentrate access points through local circulation off the arterial.

*Consideration in Phnom Penh streets*

*There are many local streets, alleys and driveways crossing or connecting to major arterial streets in the urban area of the city. The access traffic is a main factor interrupting the through-traffic on the arterial. It is recommended to control or limit the access to/from the local streets, alleys and driveway along the arterial, and to concentrate the access traffic on certain key intersections.*

7) Restriction of designated type of vehicles

Designated types of vehicles, especially large trucks, large buses etc., may be prohibited to pass through certain streets or area in an urban area. As for large trucks, Phnom Penh City has already applied such regulation during day-time period.

The regulation must be continued in the future, if the urban road network is not developed.

8) Exclusive lanes or streets for designated type of vehicles

In general, exclusive lane for public buses is provided along major arterial streets in major cities of the world in order to accommodate larger number of persons effectively.

*Consideration in Phnom Penh streets*

*It is preferable in Phnom Penh to introduce exclusive lanes or streets for segregation of 4 wheel vehicles, motorcycles and others, in order to maintain a higher level of traffic safety and smoother traffic streams.*



### 2.2.2 Intersection Improvement

Given the present state of traffic control at intersections, it is predicted that much traffic congestion will occur in view of the increasing traffic demand in the near future, which may further lead to increase in traffic accidents. Table 2.2.3 shows the main factors which obstruct smooth traffic flow at the intersections. General countermeasures for them are also described under two categories, that is, measures by improvement or installation facilities and by traffic operation.

#### (1) Regulation on Traffic Operation Method by Type of Vehicles

At present, the traffic operation is rather confusing to drivers. All kinds of vehicles operate in the same way, with remarkable problems when making left turns. The followings are suggested to improve the current condition.

##### 1) Segregating slow speed from high speed vehicles.

For left turn operation at intersections (both signalized intersections and non-signalized ones), the slow speed vehicles (bicycles, Cyclo and so forth) should be completely segregated at the least from the other vehicles. This means that these slow speed vehicles should cross the intersection in two stages or steps just like the pedestrians' way as shown the below. It will become somewhat inconvenient for drivers of such vehicles but it will bring the much needed safety. Figure 2.2.5 shows a preferable left turn movement for slow seed vehicles.

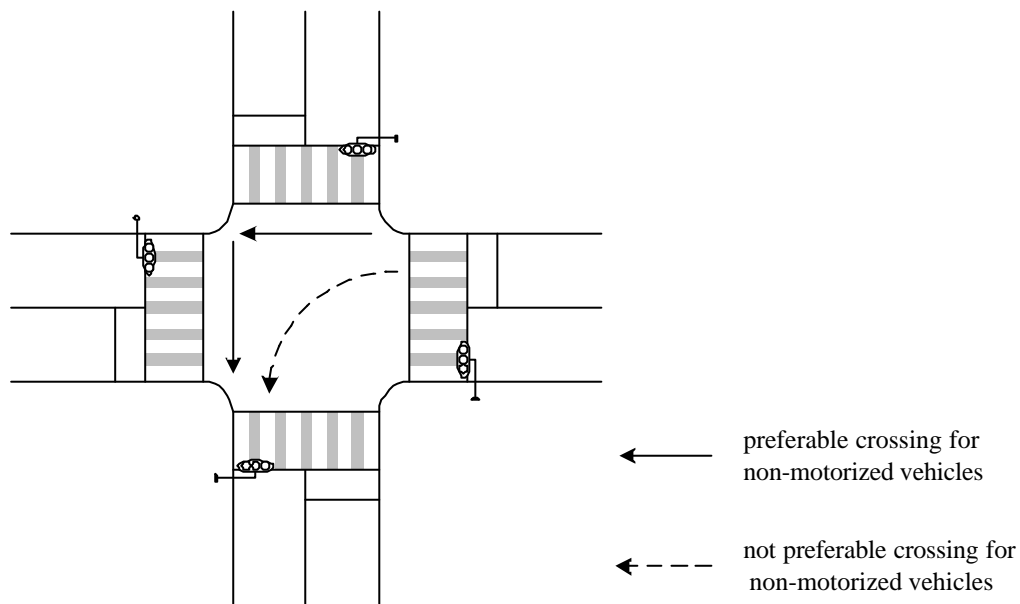


Figure 2.2.5: Segregation of Slow Speed Vehicles from High Speed Vehicles

##### 2) Prohibition of right-turn-on-red at crowded signal intersections.

It is recommended that right-turn-on-red at crowded signaled intersections be prohibited at all time. Traffic warning signs shall be used to accomplish this objective. Right turning vehicles tend to ignore the stop line and turn from the centerline in spite of the red signal. This disrupts the order of the other waiting vehicles at the intersection. Such condition obstructs smooth traffic flow. Various data and field surveys should be conducted before the necessary measure is determined as each method has both advantages and disadvantages.

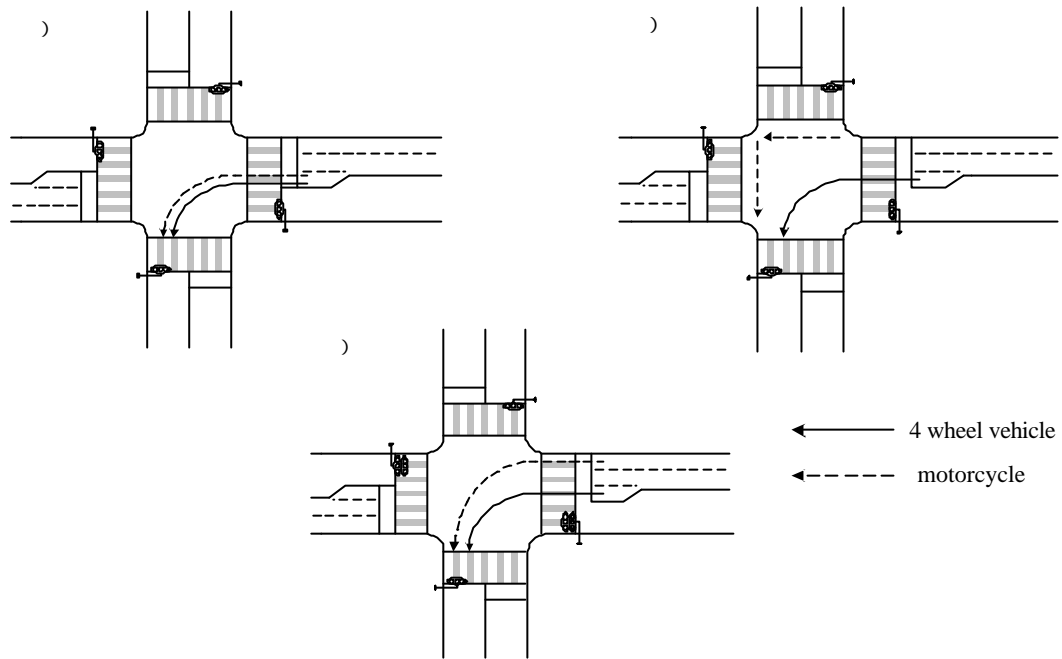
##### 3) Left-turn motorcycles

In this section, the possibility of adopting the measure for left-turn motorcycles in the future is discussed considering the current traffic conditions;

Table 2.2.3: Main Causes of Interrupting Traffic Flow at Intersections and Possible Countermeasures

Main Causes of interrupting flow	Measures by improvement or installation of facilities	Measures by traffic operation
1 No special rule on traffic movement by type of vehicles at intersection		Decision on traffic rule based on experiment or survey data
2 Disorderly movement by Mixed Traffic	Installation of markings and signs according to traffic rule	Application on the type of signal control
3 No proper channelization for each traffic movement	Installation of pavement marking, signs, island etc.	
4 Lack of traffic control and safety facilities (pavement markings, traffic signs and so on)	Installation of center divider on multi-lane approaches Installation of center line, lane, stop line, crosswalk markings Installation of proper signs regarding traffic regulation	Physically restricting driving on opposing road  Indicating priority of approach using signs
5 No exclusive left-turning lane despite heavy left-turn traffic	Installation of exclusive left-turning lane on approaches	Controlling by signals with exclusive left-turn phase Prohibiting left-turn movement
6 Inadequate pedestrian crossing	Installation of pedestrian crossing using markings Installation of islands for pedestrian refuge	Controlling by exclusive signals for pedestrian
7 Complex movements at irregular intersection and roundabout	Improvement of geometric design of intersection	Closure of certain leg of intersection to traffic One-way operation on a leg of intersection Change roundabout to cross intersection with signal control
8 Inadequacy and insufficiency of traffic signals		Signal control at intersection with heavy traffic Introducing high level of signal control
9 Illegally parked Vehicles on approaches / exits of intersection	Installation of traffic signs of no stopping/parking	Strengthen traffic enforcement

- i) If this measure is put into practice under the present situation.  
The major fault is that motorcycles have to cross any four-wheel vehicle lane in order to go into an exclusive turn left lane before making the turning. This action is very risky.
- ii) Two step crossing is necessary for motorcycle when making the turn left.  
However it is doubtful that drivers may observe such a process considering the present behavior of drivers. Moreover, it is doubtful that sufficient space at the intersection can be secured for waiting the second crossing. Thus it is difficult to accomplish this measure at the moment.
- iii) In the case that the mentioned measure is introduced.  
It can not be denied that the maximized volume of traffic able to cross the intersection (traffic capacity) by lanes will become smaller because four-wheel vehicles and motor cycles have to turn left from their own designated lanes at the intersections.



Thus, it is recommended that measure i) be adopted to general intersections and measure ii) to specific signalized intersections on the assumption that drivers' manner is better.

## (2) Traffic Channelization

Pedestrian and vehicle lanes need to be divided or regulated by means of pavement markings, refuge islands, traffic signs and so forth at grade intersections in order that pedestrians and drivers shall move safely and orderly, and that any conflicting traffic stream be led to a regulated line. Traffic Channelization facilities are necessary at intersections in Phnom Penh City.

### 1) Objective of traffic channelization

The objectives of traffic channelization are as follows

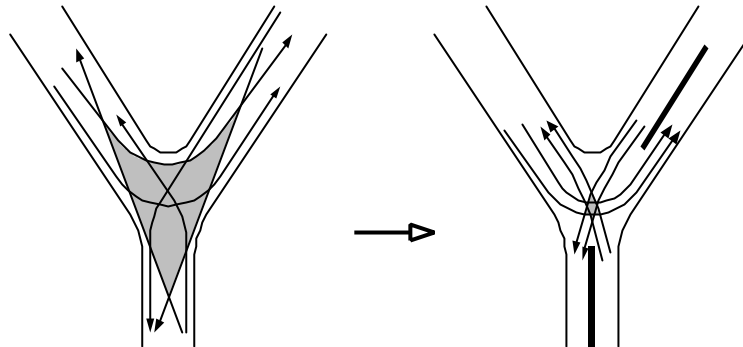
- a. Segregating conflicting traffic streams,
- b. Curbing collision angles
- c. Reducing extremely wide paved roads
- d. Regulating traffic flow, and inducing an appropriate way of intersection use
- e. Giving priority to the major turning traffic
- f. Protecting pedestrians
- g. Protecting turning and crossing vehicles
- h. Providing places to erect traffic control facilities
- i. Provide a target point for indicating "Object of driving "
- j. Intercepting traffic going in the prohibited direction
- k. Speed control

2) Principles in designing Channelization facilities

Principles for designing traffic channelization are as follows.

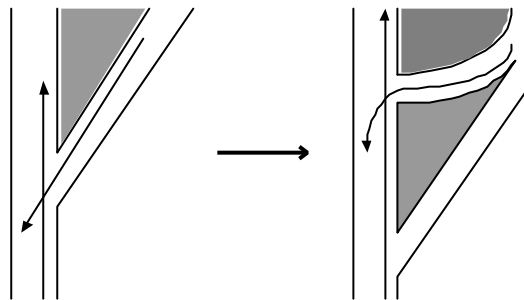
a. Traffic weaving area is designed to be small

If a pavement area is too large, it is dangerous for vehicles and pedestrians to weave among them.

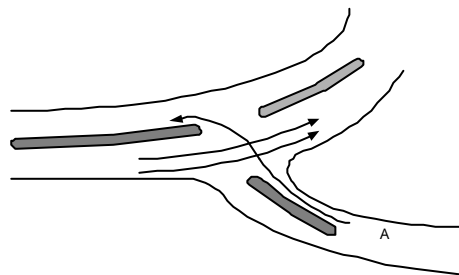


b. Crossing should be designed at right angle or nearly right angle for cases that traffic intersects or interweaves. The reasons are,

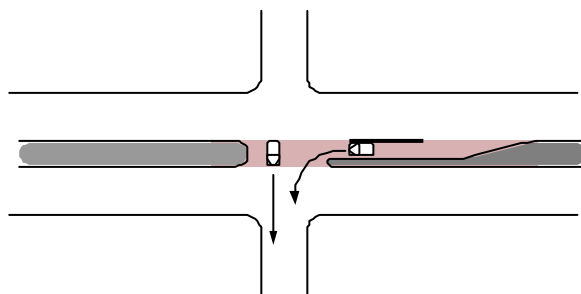
- to reduce the potential area at which crash may happen.
- to reduce the time period of intersecting between traffic flows .
- to give an appropriate condition for drivers to judge their relative positions and speed against the other vehicles.



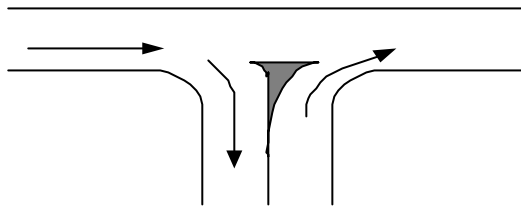
c. Speed of vehicles turning into the intersection is reduced, thus avoiding disruption to the main traffic flow. .



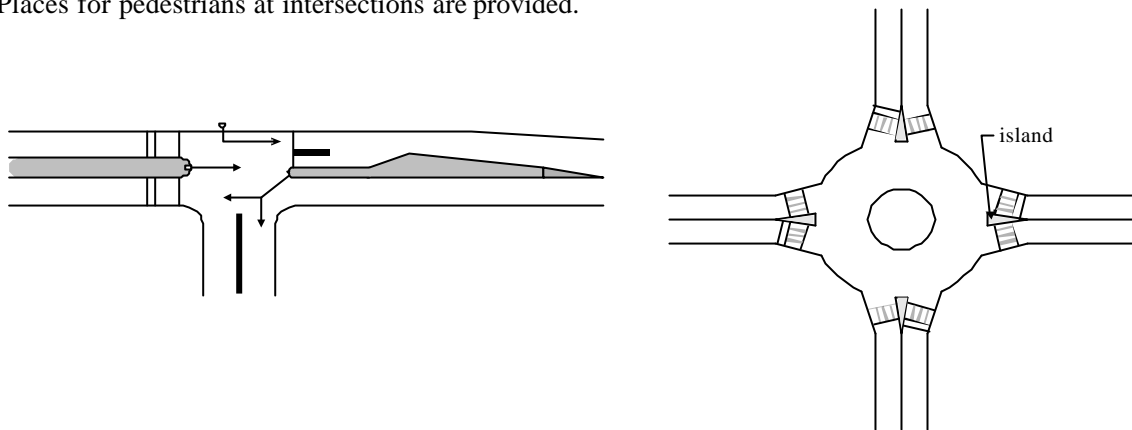
d. It should taken into consideration the need to separate traffic flow, and to protect vehicles which are turning or crossing.



e. Drivers should observe traffic rules (regulated turning) by the form and place of a guiding island.



f. Places for pedestrians at intersections are provided.



### 3) Channelization in Phnom Penh City

The structures and forms of intersections are already fixed in the urban area in Phnom Penh City and any significant changes proposed on them are impossible. However, it is possible to implement channelization in the suburbs based on the mentioned principles, as there are many intersections requiring improvements to their structures.

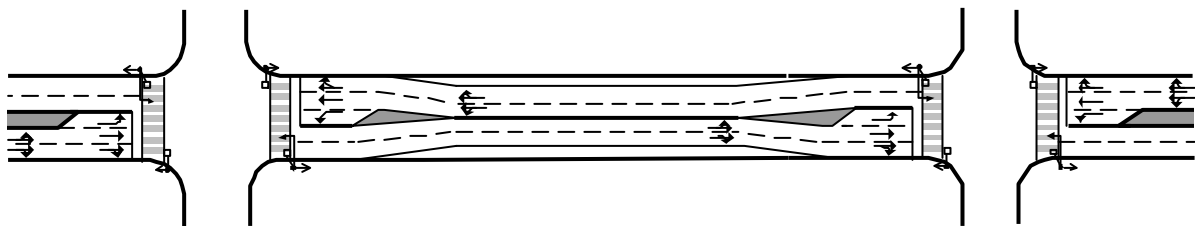
In the urban area, intersections with channelization cannot be observed except at signalized intersections. Channelization by pavement markings is at least required at all intersections.

#### (3) Establishing Exclusive Left-turn Lane

Exclusive left-turn lanes need to be established depending on the demand of left turning vehicles. With an exclusive left turn lane, the traffic processing capacity and safety are expected to be improved unless the vehicles waiting for turning left are too many that they obstruct the through traffic.

It is suggested that left turn vehicles be controlled by the exclusive lane and use the left turn phase at major intersections before left turn is prohibited. Even if congestion occur under such control, left turn prohibition is required.

Exclusive left-turn lane should be introduced to two-lane roads, too, although it is often only considered for multilane roads. The approach capacity even on the narrow leg may be increased by installation of a left or right turn exclusive lane.



#### (4) Transformed (Modified) Intersections and Roundabouts

There are 10 Roundabouts and some transformed intersections in Phnom Penh City. The geometric structures of some of them need to be modified. The followings are effective alterations for some intersections.

##### 1) Compound (Multiple) intersection

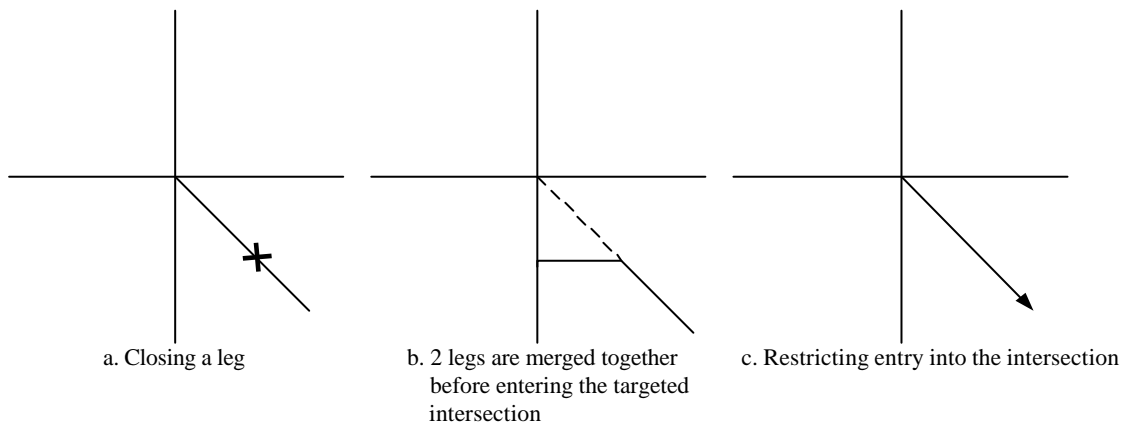
Any major intersection with five-legged or more approaches is not recommended in principle. This is because the number of locations where traffic streams cross, merge and diverge increases rapidly with the number of legs at an intersection. This means that much attention or judgement is demanded of drivers and, as the result, the degree of danger increases (Table 2.2.4). In addition, in the case of signal processing, its processing ability decreases rapidly because of signal aspect increases and the period of green in each aspect decreases.

Table 2.2.4 Number of locations of crossing, merging and diverging

No. of Legs	Crossing	Merging	Diverging	Total
3 legs	3	3	3	9
4 legs	16	8	8	32
5 legs	49	15	15	79

Compound intersections, where congestion occurred frequently and traffic accidents happened continuously, need to be reduced in such a way that intersection legs are reduced up to resemble a near simple cross road. The following figures show possible methods for such alterations.

- a. Closing a leg
- b. 2 legs are merged together before entering the targeted intersection
- c. Restricting entry into the intersection ( e.g., one way )

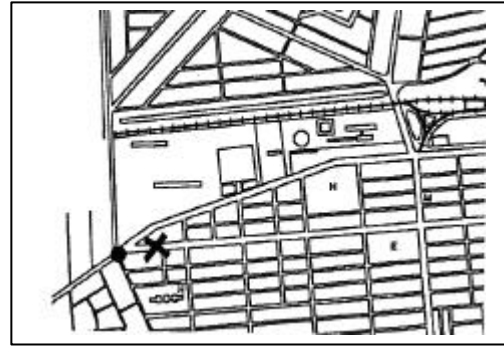
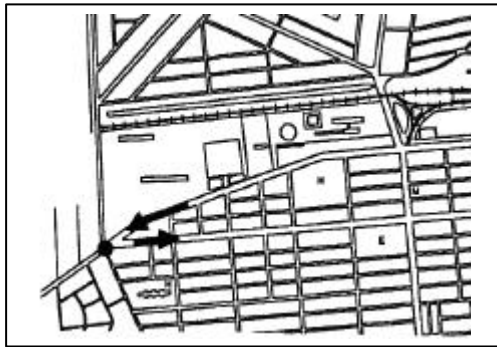


##### Example – Intersection of Blvd. URSS /Ru Ka,mpuchea Krom /No. 271

This 5-legged intersection is an example where congestion happens during the peak periods and traffic accident occurs frequently. Thus an improvement is surely needed.

An appropriate measure is to put signal control into operation. In such a case, traffic flows from all the 5 approach roads to the intersection is not preferable. On the contrary, traffic flow from a 4-legged one is considered as shown below.

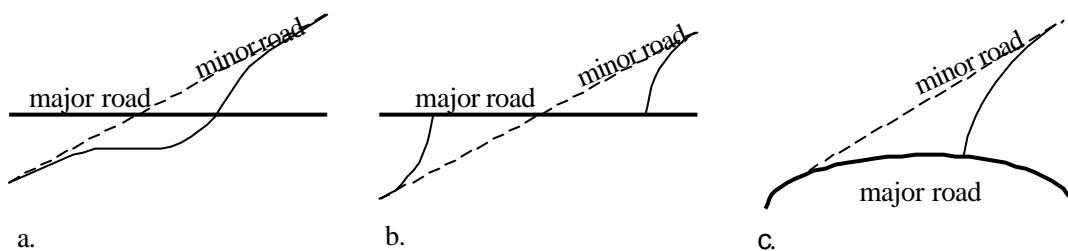
- One-way operation on the roads adjoining Blvd. URSS and Ru Ka,mpuchea Krom
- Closure of Ru Kampuchea Krom



Intersection of Blvd. URSS /Ru Ka,mpuchea Krom /No. 271

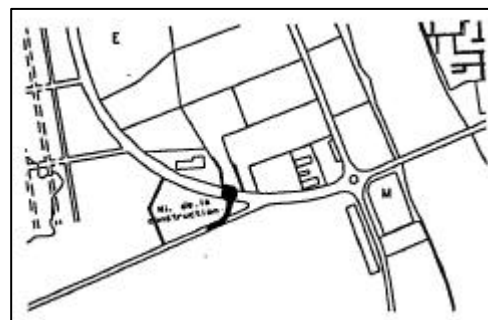
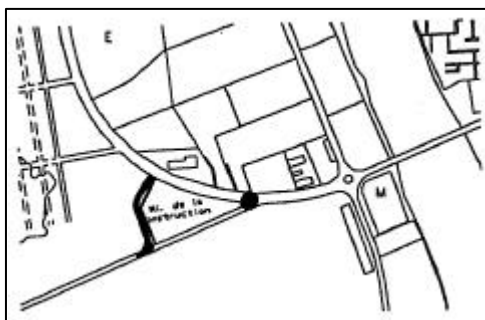
2) Intersecting angles at a major intersection.

Intersecting traffic streams should cross at a right angle or near to a right angle. This contributes to the shortest length of crossing road and a smallest traffic weaving area. In addition, traffic safety and intersection processing capacity will be improved since drivers can see the road clearly and make an appropriate judgement. The following measure can be suggested confidently. It is further suggested that when modifying the intersection angle, focuses should be given to the minor road in principle. In addition, straight alignment must always be reserved for the priority traffic stream.



*Example (1) – Intersection of Blvd. Monivong /No. 271 (Inner Ring Road)*

*This intersection has the characteristic of a major arterial street being intersected with each other and both crossing angles are acute angles. An appropriate measure is to alter the acute angle to a right angle or near right angle, and signal control introduced.*

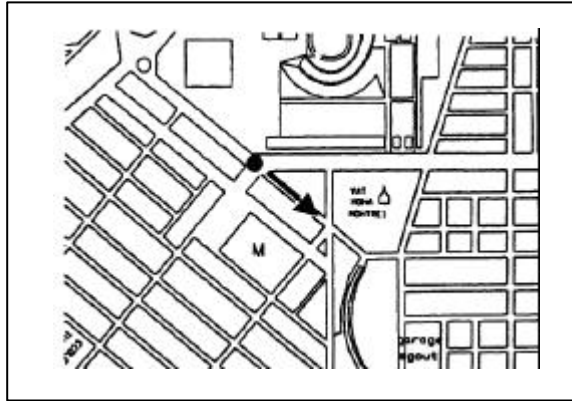


Intersection of Blvd. Monivong /No. 271 (Inner Ring Road)

*Example (2) – Intersection of Blvd. S. P. Sihanouk /No. 199 /No. 264 (near the Olympic Market)*

*Although this intersection is a 4-legged one, the intersecting angle of Blvd. S. P. Sihanouk and Route No. 264 is acute and congestion happens frequently at peak hours.*

*An adequate measure is that the acute angled Route No. 264 be changed to a one way operation, prohibiting any outflow traffic stream. In such a case, traffic operation will be devised in such a way that traffic on Route No.264 can be complemented with that on Route No. 199. In addition, it is preferable to introduce signal control at this intersection.*



Intersection of Blvd. S. P. Sihanouk /No. 199 /No. 264 (near the Olympic Market)

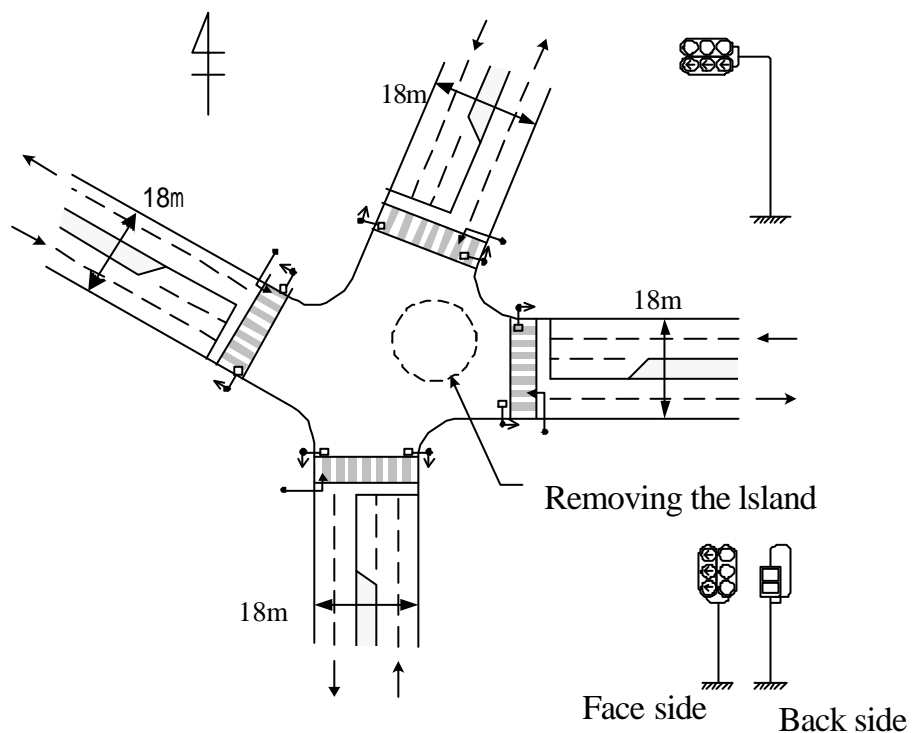
### 3) Treatment at Roundabouts

Data analysis carried out on roundabouts in the inner city has made it obvious that radius of rotary island is small and traffic processing capacity of such facility is smaller than signal control capacity. In addition, it is very difficult for pedestrians to cross the roundabouts. Thus, signal control is suggested to be introduced to 4-legged roundabouts, whenever possible.

There are two roundabouts where the central islands should be taken away and signal control be introduced in Phnom Penh Coty.

- Roundabout of Blvd. S. Monired / Blvd. Mao Tse Tonog
- Roundabout of Blvd. C. de Gaulle – Blvd. S. Monired / Blvd. Neruk / Blvd. S. P. Sihanouk

*Example (1): Changing the roundabout to a cross intersection with appropriate signal control at*



Roundabout of Blvd. C. de Gaulle – Blvd. S. Monired / Blvd. Neruk / Blvd. S. P. Sihanouk



There is another roundabout where signal control should be introduced but without removing the central island.

*Example (2):*

*Roundabout of Blvd. Monivong – NR No. 1 / Blvd. Norodom – NR No. 2*

*In the case of this roundabout, it is impossible to take away the central island because of the presence of a monument. However if signal control is introduced at peak hours, it is possible to prevent the congestion and to reduce traffic accidents in the roundabout under the current geometric structure. This measure is regarded as an interim procedure to implement NR No.2 road network plan in the future.*

#### (5) Installing Crossing Facilities

Pedestrians would jay walk at any part of the intersections in Phnom Penh City. Risk of danger is high and it also affects the processing capacity of intersections for vehicular traffic. This is caused by a lack or inadequacy of pedestrian crossing facilities and insufficient traffic safety education to pedestrians. Thus, the current condition needs to be analyzed based on traffic engineering method and adequate facilities be installed. After which, safety education for pedestrians should be provided.

Major facilities to be introduced are as follows.

- Installing pavement markings on crossings at intersections
- Maintaining pedestrian-only roads around intersections
- Fences to prohibit crossing
- Installing refuge islands on wide roads
- Installing crossings between two far distant intersections.

#### (6) Prohibition of Parking in and near to Intersections

Parking in/around intersections are abated by law. According to the prevailing traffic law, it is prohibited to park within 5 m from the end of an intersection in an urban road, and 10 m in rural roads. Even if there are no designations around intersections, drivers should never park in such areas in any case from a legal point of view. Therefore, efforts should be made to remove such illegal parking by enforcing the traffic regulation and provide traffic safety education for drivers. Parking in/around intersections causes not only a decrease of traffic volumes at an intersection but also causes traffic accidents.

#### (7) Installing Traffic Signals

Installing traffic signals are discussed in the next chapter.

#### (8) Notes in Intersection Remedial Designing

- Traffic control method and geometric structure designing should take into account all considerations together and maintaining their interrelationship at all time.
- Either one of these measures must be introduced, traffic signal control or stop sign control without signal control.
- In the case of signal control, an appropriate method should take into account the consideration of promoting smooth traffic flows and safety. The order, combination and timings of signal aspects with regard to movements of pedestrians and vehicles must be carefully decided.
- In the case of stop sign control, a distinction between priority lane and non-priority lane should be made clear. And the intersection should be designed so that drivers can not but stop naturally as a habit by inventive road conditions (alignment, width of road, intersection angle, structure and so forth) even if the driver has not noticed the stop sign
- Such regulation controls as one way, prohibition except designated direction (e.g., No Left-turn), should be avoided as far as possible.
- If such regulations are not avoided, the introduction must be carried out with the greatest care because, in general, this makes the average trip distance longer, resulting in an increase of turning traffic at the intersection.
- Even if congestion and accident decrease at an intersection, inconspicuous but extensive adverse effects may be observed around other intersections or roads.