PART III

URBAN TRANSPORT PLAN

CHAPTER 12

TRANSPORT POLICY
AND
TARGET

CHAPTER 12

TRANSPORT POLICY AND TARGET

12.1 APPROACH

The Phnom Penh Metropolitan Area (the Study Area) consists of the seven (7) districts of the Municipality of Phnom Penh and a portion of Kandal Province with a total area of 439 km². The urban activities, such as public services, commercial, light-industry and tourism, are mostly concentrated in the limited zone surrounded by the inner dike - the Inner Ring Road. The area has been heavily urbanized.

The area outside the Inner Ring Road is still the suburban type. Population has been developed only along the arterial roads. The locations of residences, factories and roads were restricted by the existence of many ponds and rivers causing the frequent flood on the lands with low elevation. This area is still under random development.

In the two areas; the urbanized area and suburban area, the present transport issues are quite different because of the degree of development and land characteristics. The policies on transport planning are discussed separately for these two areas as described in Section 12.2.

Figure 12.1-1 shows the flow of procedure of transport master plan formulation. Important points in the actual process of master plan formulation are briefly described below:

(1) **Present and future transport** issues are examined through observation of the present situation, listing foreseen future issues and traffic demand analysis.
(2) In establishing **future socioeconomic frame**, there are no authorized nor fixed future land use plans available. Consequently, the Study Team had extensive discussion with the Cambodian side and drew up future land use plans which were used in the Study.
(3) **Transport planning policy and strategy** is drawn up based on (1) and (2) above and through extensive discussion with the Cambodian side with due attention on the future plan and opinion of the Cambodian side. Consequently, this transport planning policy and strategy includes urban development plans as the basic factors and, at the same time, includes anticipated transport developments and policy for the transport plan, derived from the development plans, that are considered as the main goal.
(4) **Objectives and target of transport master plan** were prepared based on, and by technically examining, "the transport planning and strategy" described in (3) above. Technical and concrete policies to the "Transport Master Plan" were set at this stage.
(5) Then, concrete policies and applicable measures for each sector were studied in line with the policy set out in (4) above. After this, several alternatives of the master plan were assumed with different combinations of the measures for the sectors.
(6) The alternatives thus prepared were comparatively evaluated with regard to such factors as engineering aspects, economic aspects and social acceptance, and the optimum plan was selected.
(7) In **evaluation of optimum alternatives**, the selected optimum plan is examined on its appropriateness in further detail considering the stage implementation and optimum implementation timing.
(8) In **transport sector plan**, further concrete plans for the components of each sector for the optimum alternative are prepared and implementation plans are drawn up.
(9) In **environmental assessment**, environmental aspects of the proposed projects and measures are evaluated, and mitigation methods are proposed if there are negative impacts.
(10) In **institution and financial plan**, institution and funds needed for implementation of the proposed projects and measures are studied.
(11) **Overall implementation plan** is prepared by comprehending the above process and sets out the practicable implementation scheme which can be actually carried out.

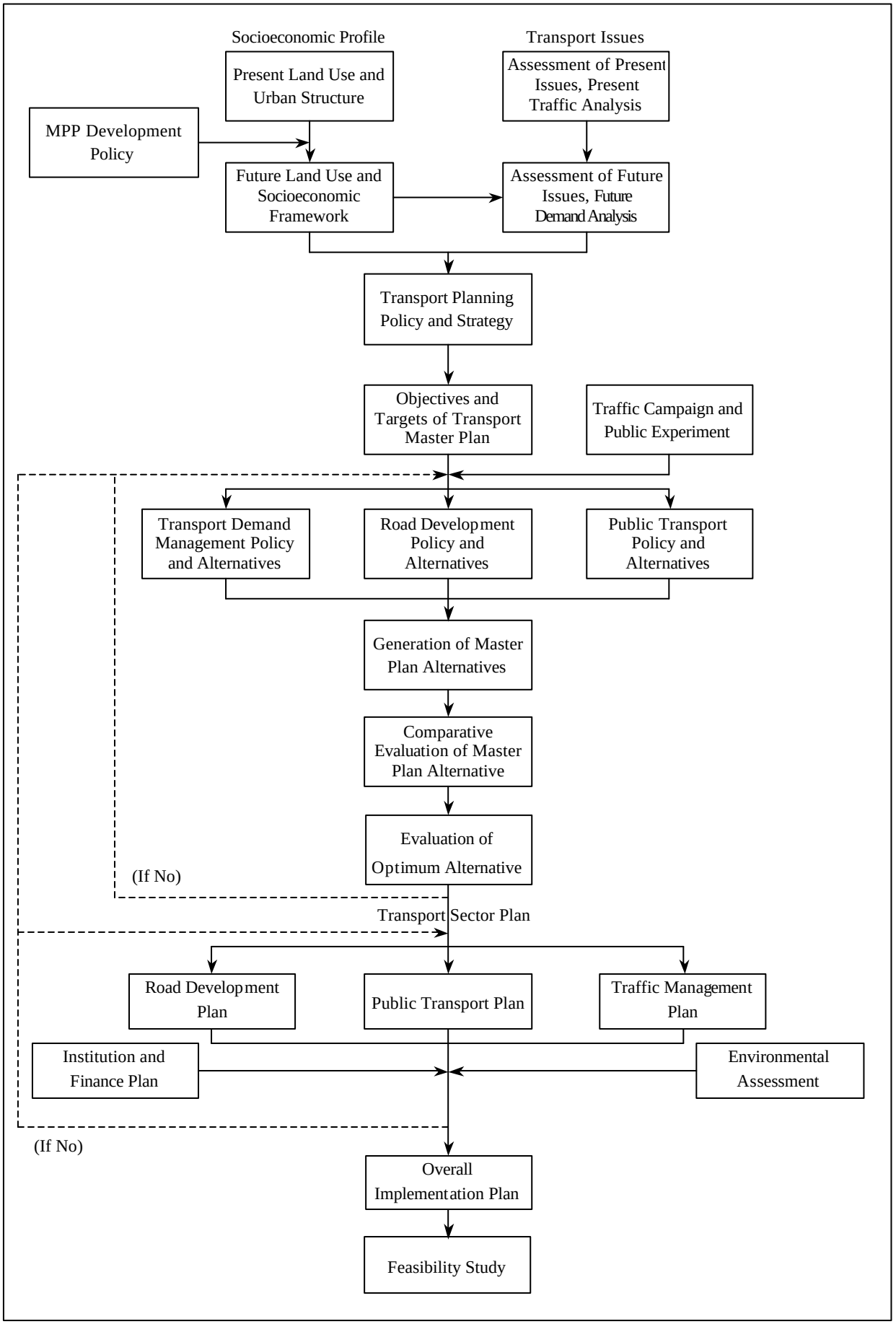

Figure 12.1-1 Procedure of Transport Master Plan Formulation

12.2 PRESENT TRANSPORT ISSUES

The present traffic conditions were assessed and transport issues were identified in PART I of the Report, and are summarized in Table 12.2-1 and Figure 12.2-1 for the urbanized area and suburban area.

Table 12.2-1 Present Transport Issues

Urbanized Area
Road Network • Well-developed road network, but poor and deteriorated pavement of collector and local streets, with many potholes, and inundation during rainy seasons. • Excess concentration of traffic on arterial streets because of poor pavement condition of collector and local streets. Public Transport • Lack of public transport system except para -transit so that urban transport capacity isvery low at present, and may not be responsive to future traffic demand. • Lack of public transport facilities Traffic Management • Lack of effective traffic management system • Disordered and mixed traffic flow due to high share of para-transit (84%) and their driving manner. • Decrease in traffic capacity due to on-street parking • Increase in traffic accidents and pollution due to increase of traffic volume and violation of traffic regulations. • Insufficient traffic signals and inadequate at-grade intersections
Suburban Area
Road Network • Incomplete road network, even arterial road system is not completed • Traffic congestion on arterial roads due to lack of alternative or collector roads. • Lack of access to strategic development areas so that land development may not be able to be achieved. Public Transport • Lack of efficient public transport system with only a few inter-city bus services.

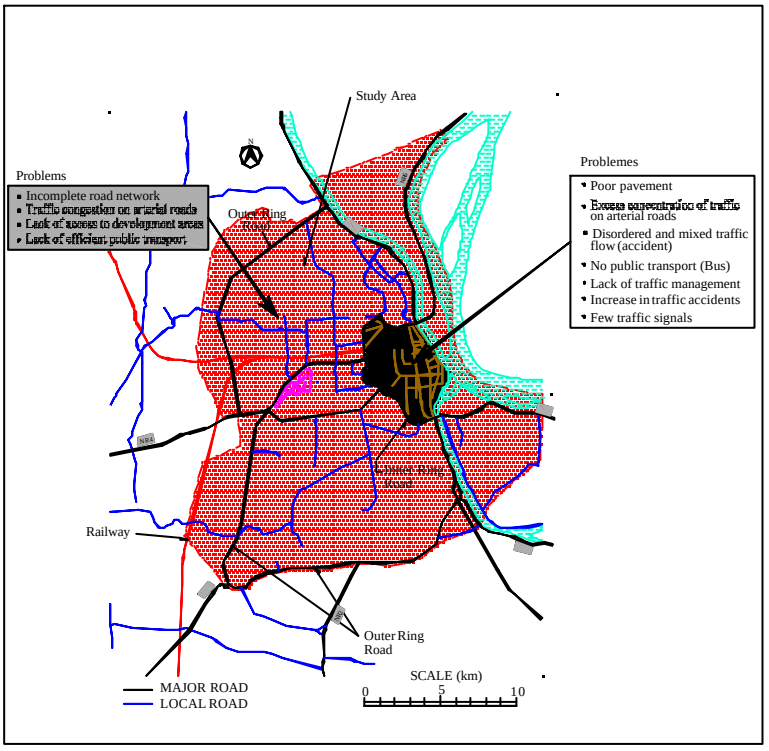

Figure 12.2-1 Typical Transport Issues in Urbanized and Suburban Area

Aside from the present transport issues, problems related to transport planning, particularly those of the urban characteristics and administration, were observed and are summarized in Table 12.2-2.

Table 12.2-2 Urban Characteristics and Administration Issues

Urban Characteristics

Urbanized Area

- Densely populated area, in which future development shall be restricted.
- Historic city with urban scenery, which shall be preserved.
- Commercial, business and residential land use, which shall be controlled.
- Flat terrain enclosed by Inner Ring Road that serves as a dike.

Suburban Area

- Scarcely populated area, which shall be developed in accordance with the land use plan.
- Random development along arterial roads, which shall be implemented under control
- Mainly agricultural land used, which shall be developed in accordance with the land use plan.
- Flat terrain, but existence of many ponds, sires and flood areas, enclosed by Outer Ring Road. Some section of this road serves as a dike.

Administration

- Weak and non-systematic organization
- Lack of human resource
- Traffic law and legislation system not enforced or enacted
- Limit of available funds

12.3 URBAN TRANSPORT PLANNING POLICY

At present, there is no authorized master development plan, such as national development plan, development plan for the metropolitan area and urban development plan for the metropolitan area, which can be used as the base for the Study. Therefore, planning policy and strategy were prepared based on the discussion between MPP and the Study Team.

12.3.1 Planning Policy

Based on the assessment of present transport issues, the following planning policies were established through discussions with the Municipality of Phnom Penh.

(1) Policies on Urbanized and Suburban Areas

1) Spatial Distribution of Urban Activity

The existing urbanized area has a limited capacity, so that a further concentration of socio-economic activities toward this area will critically hamper the function of this area and shall be avoided. The implementation of the following policies will be considered:

- The population growth shall be controlled and restricted by the regulation of building construction and land development, the allowable population growth in the urbanized area shall be 1.3 times of the present in the year 2015
- The expanded population shall be induced to the planned residential areas in the suburban area. The estimated population growth in the suburban area will be 1.9 times of the present in the year 2015
- Development of self-sustainable new communities in the planned development areas
- Formulation of arterial network to facilitate the development of such new communities

2) Transport System Responsive to Future Traffic Demand

The transport system, especially affordable means for public movement, shall be proposed to respond to the future traffic demand, and to be composed of appropriate transport modes including bus service, para-transit, non-motorized vehicle, in harmony with their respective roles complementing each other.

- Clear sharing of bus transport and para-transit roles
- Introduction and encouragement of bus transport system
- Harmonized and effective system between these transport modes

(2) Special Policy on Urbanized Area

1) Historic City with Urban Environment and Tourism Heritage

The plan shall be intended to preserve the historic heritage and urban scenery, and to ensure the urban environment and amenity.

- Preservation of environmental strategic areas such as green belts and water areas
- Provision of serviceable road facilities and well-designed access to attractive spots
- Education and enforcement on disciplined traffic manner and secured traffic safety

(3) Special Policy on Suburban Area

1) Modern City with Urban Structure and Development Potentiality

The plan shall be instrumental to build the modern Phnom Penh Metropolitan Area with harmonization of urban environment and structures. Construction of a city with modern urban function is imperative to attract foreign investment and attain economic growth.

- Advanced traffic facilities and management with international standards in terms of system and quality.
- Functional access to new development areas such as industry, export processing zone, freight zone etc.
- Comfortable access to residential areas with amenity and prestige (to prevent undesirable form of urban sprawl)

12.3.2 Development Strategy

The following strategies for the urbanized and suburban areas are established to support and realize the policy and target.

1) Strategic Approach to Urbanized Area

In the existing urbanized area, due consideration shall be given to the preservation of historic heritage and urban scenery with deliberate urban development control. The principle approach for the urbanized area, therefore, shall be strengthening of the public transport service, full utilization of existing facilities with minimum new construction and effective traffic management system involving education and enforcement.

- Effective traffic management system
- Introduction of public transport service
- Improvement of streets pavement
- Full utilization of existing facilities
- Implementation of off-street parking system
- Minimum / selected implementation of new construction

2) Strategic Approach to Suburban Area

The existing urbanized area has limited urban capacity, so that further concentration of so-

socio-economic activities in this area will critically hamper the functioning of the city. Therefore, future population growth shall be induced into the suburban areas. The fundamental approach to this area, therefore, shall be to formulate a systematic and functional transport network to be integrated with the proposed land use plan, to improve the congested national roads and to provide serviceable access to new development areas.

- Integrated transport system with the authorized land use plan
- Implementation of functional road hierarchy
- Strengthening of public transport services
- Improvement of congested roads
- Access to planned development area (EPZ, Transit Station, etc.)
- Reconstruction of existing bridges

The intended role and interrelationship of such strategies to realize the established policies are conceptually summarized in Table 12.3-1.

Table 12.3-1 Development Strategies to Realize Policy

Policy and Target / Strategies	Spatial Distribution of Urban Activity	Historic City with Urban Environment and Tourism Heritage	Modern City with Urban Structure and Development Potentiality	Transport System Responsive to Future Traffic Demand
Urbanized Area				
1) Effective Traffic Management System	○	◎		◎
2) Introduction of Public Transport System	○	◎		◎
3) Improvement of Streets' Pavement	○	◎		○
4) Full Utilization of Existing Facilities	◎	◎		○
5) Implementation of Off-Street Parking System	◎	○		◎
6) Minimum/Selected Implementation of New Construction	◎	◎		○
Suburban Area				
1) Integrated Transport System with Land Use Plan	◎		◎	◎
2) Implementation of Functional Road Hierarchy	◎		○	◎
3) Strengthening of Public Transport	◎		○	○
4) Improvement of Congested Roads	○		○	◎
5) Access to Planned Development Area (EPZ, Transit Station, etc.)	◎		◎	○
6) Reconstruction of Existing Bridges	○		○	◎

Note: ◎ Very closely inter-connected
○ Closely inter-connected

12.4 STRATEGIES AND TARGETS OF TRANSPORT PLAN

At present, there is no authorized master development plan or urban development plan which can be used as the base for the Study. Accordingly, the planning policy and strategy described in this section has been prepared based on extensive discussions between MPP and the Study Team.

The following targets are set in line with the Planning Policy and Strategy described in the previous Chapter.

Strategy 1: Establishment of Transport Network in Accordance with the Land Use Development Plan

Establishment of a transport network to support the development plans is indispensable for the desired socioeconomic development. Accordingly, improvement/construction of access to these planned developments is essential, and the Cambodian Government is giving high priority to them.

- Access to the planned residential areas
- Access to the planned Light Industry Zones
- Access to the planned Export Processing Zone

In the present suburban area, the basic road network is in very poor condition and construction/ improvement of the following components are the minimum requirement for establishing the basic road network.

- Construction of Northern New Trunk Road
- Construction of Southern New Trunk Road
- Connection of the above two traffic axes
- Improvement of collector and major local roads

Strategy 2: Provision of Efficient, Comfortable and Safe Transport System

Establishment of a functional transport network is one of the basic requirements to solve the present and future transport issues. The following items are major components:

- Road structure and road network endurable to inundation
- Reconstruction of deteriorated bridges
- Elimination of traffic congestion at the bottlenecks on the National Roads

Functional transport network is evaluated by the following items:

- Degree of congestion: Average v/c ratio of free flow (0.33)
  Degree of congestion on a road section is usually expressed in terms of the ratio of traffic volume against the capacity of the road.
- Average travel time: Degree of improvement from the present situation
- Average travel speed: Average travel speed of free flow (43 km/hr)
- Average trip length: Degree of improvement from the present situation

Strategy 3: Improvement of Urban and Traffic Environment

To cater for future traffic demand, minimizing unfavorable influences on the urban environment, such as noise, vibration and air pollution, forming desirable urban communities and maintaining a good living environment, it is necessary to implement the following:

- Improvement of pavement of the urban streets including local streets
- Improvement of pavement of major suburban roads
- Introduction of public transport which favorably affects the urban environment

Strategy 4: Introduction of Modern Public Transport System

As the population and economy grow, the public transport system will have to shift from para-transit-dominant system to a comprehensive public transport system to cope with the increasing demand. Introduction of an efficient and safe public transport system is also necessary to reduce traffic congestion and accidents. The requirements for the new public transport system are as listed below:

- New system responsive to future traffic demand
- Transport system which is appropriate and suitable for Phnom Penh as the capital of Cambodia
- Transport system which can coexist and mutually complement the present para-transit system such as the motodop.
- Transport system which does not need a large amount of investment and can flexibly respond to the future increase in demand.

Strategy 5: Establishment of Traffic Operation

Disorderly traffic flow due to undisciplined driving behavior of cars and motorcycles is one of the major causes of traffic congestion and accidents. Also other undisciplined behavior of vehicles, such as illegal parking, is amplifying the degree of congestion and the number of accidents. Appropriate traffic operation is essential to the following:

- Reduction of traffic accidents
- Alleviation of traffic congestion

CHAPTER 13

TRANSPORT MASTER PLAN ALTERNATIVES

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TRANSPORT MASTER PLAN ALTERNATIVES

13.1 GENERATION OF MASTER PLAN ALTERNATIVES

To achieve the objectives and targets set out in the Transport Master Plan described in the previous chapter, alternatives of the Master Plan consisting of the following factors are generated:

- Transport demand management (TDM)
- Road development
- Public transport
- Traffic control management (TCM)
- Transport legislation

Policy and alternatives of these fields are described in the following sections.

13.1.1 Transport Demand Management Policy and Alternatives

Common measures of transport demand management are as listed in Table 13.2-1. This policy, if requiring measures of reduction or adjustment of traffic volume, may hamper urban development and/or socioeconomic activities. Thus, this policy may not always be of direct benefit to the general public.

The Study Area is just now at the starting point of progress and, therefore, enhancement of the economic development is very urgent and necessary. Thus, the policy given below is adopted in the Study. Adjustment of vehicle ownership and vehicle usage are described in Chapter 17.

(1) Adjustment of traffic demand
- Encourage spontaneous adjustment induced by planned land use
- Adjustment with planned building regulation

These measures are basic preconditions of the Master Plan, and, therefore, no alternatives can be assumed.

(2) Introduction of bus services

Bus services are generally considered as one of the best measures for improvement of transport facilities when compared with other modes of road-surface-type public transport and/or rail-type public transport.

In the Study, the introduction of bus services is strongly desired for the reason described in Section 13.1-1, and formulating a policy on introduction of bus services is one of the key issues. Accordingly, the introduction of bus services is regarded as one of the main measures and the following policies are adopted as alternatives exploring the impact on private cars.

Policy 1: Vehicle Priority Policy

Usage of 4-wheel vehicles (passenger cars) is encouraged through measures in favor of cars such as reduction in fuel tax and vehicle registration fee. The share of 4-wheel vehicles among transport modes in the future is assumed to increase.

Policy 2: Bus Priority Policy

Buses services are operated on all the major urban arterial streets. Facilities such as bus terminals and bus stops are improved. Traffic operation in favor of bus, such as regulation of motorcycles on bus routes and bus-priority signal control is implemented.

Policy 3: Bus-favored policy

Bus services are operated on the limited routes with high demand. Passage of motorcycles on major arterial streets of bus route is regulated. Coexistence of bus and motorcycles is pursued.

Table 13.1.1 Measures of Urban Transport Master Plan ◎: Adopted in the Study

	Category	Item	Examples of Measures
Measures of Rectification of Traffic Demand	Traffic demand control	Traffic demand control	◎ Guiding desired land use ◎ Guiding desired urban structure/function ◎ Building regulation - Establishment of efficient logistic system - Realization of "office close to home" - Color coding - Road pricing - Park and ride
		Adjustment of peak-hour demand	- Differentiated commuting hours, flex time - Adjustment of off-work days
	Rectification of vehicle traffic (including motorcycles)	Management of vehicle ownership	◎ Improvement of vehicle tax system ◎ Improvement of drivers' license system ◎ Establishment of vehicle inspection system - Improvement of import tax system
		Control of vehicle usage	◎ Improvement of fuel tax system - Introduction of road-user tax system - Adjustment of parking facilities and fares
		Improvement of efficiency of vehicle usage	- Introduction of share-ride system - Introduction of HOV lane
	Rectification of public transport (including motorcycles)	Adjustment of traffic demand	- Introduction of appropriate fare system - Promotion of transfer between different modes of public transport (promote coexistence)
		Adjustment of peak-hour demand	- Differentiated commuting time - Adjustment of off-work days
Measures for Improving Transport Facilities	Improvement of road facilities	Improvement of existing roads	◎ Improvement of pavement ◎ Improvement of drainage facilities ◎ Improvement of intersections - Grade-separation of intersections ◎ Reconstruction of deteriorated bridges
		Establishment of road network	◎ Completion of the missing links ◎ Establishment of basic road network ◎ Provision of accesses to the planned development areas ◎ Provision of accesses to the planned development project sites
		Construction of expressway/ high-standard road	- Construction of intra-/inter-city expressway - Construction of high-standard road
		Introduction of road traffic management system	◎ Introduction of traffic control/signal system ◎ Introduction of traffic management system ◎ Introduction of regulation on on-street parking - Effective usage of road space
	Improvement of public transport system	Improvement of existing public transport system	- Improvement of existing public transport modes ◎ Improvement of operation of existing public transport modes
		Introduction of road-surface-type public transport system	◎ Introduction of bus services - Introduction of high-speed bus system - Introduction of trolley bus system - Introduction of demand bus system
		Introduction of rail-type public transport system	- Introduction of medium scale transit system - Introduction of mass transit system
	Construction of bicycle/ pedestrian facilities	Construction of bicycle lanes/roads	- Construction of bicycle roads - Construction of bicycle lanes
		Construction of pedestrian facilities	- Improvement/ construction of sidewalks - Construction of pedestrian bridges
	Construction of other transport facilities	Improvement of mode interchange area	Improvement/ construction of bus terminal Improvement of the area around railway station
		Construction of parking facilities	Construction of on-street parking facilities Construction of off-street parking facilities
		Construction of transport facilities	Construction of truck terminal Construction of facilities of other modes of transport

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Measures for Improvement of Environment and Safety	Improvement of environment	Measures for emission source	- Improvement of vehicle mechanism - Introduction of low-emission vehicles ◎ Introduction of road-surface-type public transport system - Introduction of rail-type public transport system
		Measures for traffic flow	◎ Create orderly traffic flow ◎ Guiding vehicles to functional class of road suitable to the type of vehicle - Regulation on operation of trucks in designated zone
		Improvement of road facilities	◎ Improvement of road facilities - Installation of guard rails - Installation of environmental buffer zone - Installation of noise barrier
		Measures for roadside area/ building	- Promotion of appropriate use of roadside land - Regulation on roadside buildings
	Traffic safety measures	Improvement of traffic safety facilities	◎ Segregation of pedestrians, motorcycles and cars - Construction/ improvement of bicycle lane/ road and sidewalks - Improvement of traffic safety facilities
		Implementation of traffic safety education	◎ Continuous implementation of traffic safety education ◎ Implementation of traffic education campaign - Implementation of "Traffic Safety Week"
		Strengthening of traffic enforcement	◎ Improvement of traffic enforcement methodology ◎ Strengthening of institutional organization for traffic enforcement
	Measures for disaster prevention	Improvement of endurance against natural disasters	◎ Construction of road structure endurable against inundation - Construction of road network endurable against natural disasters
		Securing sufficient road space	- Securing sufficient road space as fire-shutting zone - Securing sufficient road space as multi-purpose space in densely populated area

13.1.2 Road Development Policy and Alternatives

Commonly adopted measures on transport facilities are as listed in Table 13.1-1. Among them, improvement of existing roads and establishment of road network require a large amount of investment. Alleviation of urban transport problems should be pursued with a good balance between traffic demand management, traffic control management and improvement/development of road facilities.

The condition of roads in the Study Area is as described in Section 12.2. The following development policy and alternatives are identified considering the present road condition of the Study Area.

(1) Urbanized Area

Existing condition

- Well-developed road network, but poor and deteriorated pavement of collector and local streets with many pot holes, especially during rainy seasons.
- Excess concentration of traffic on the arterial streets because of poor pavement condition of collector and local streets.

Policy and alternatives

- Rehabilitation of collector and local streets is necessary not only for traffic improvement but also for environmental reasons.
- Traffic congestion on the arterial streets are planned to be reduced by traffic control management including improvement of traffic signals. Physical improvement of streets as a measure to reduce traffic congestion is not adopted considering its influence on urban scenery.

Because of the situation stated above, no alternatives are proposed for the road development plan of the suburban area.

(2) Suburban Area

Existing Condition

- Incomplete road network, even the arterial road system is not complete
- Traffic congestion on arterial roads due to lack of alternatives or collector roads
- Lack of access to strategic development areas so that land development may not be achievable.

Basic Road Network

To generate different alternatives for the most appropriate road network in the suburban area, a basic road network was first developed based on the future land development plan as well as the conceptual road network development plan. In developing this basic network, due considerations were given to the previously planned, committed and on-going transport projects, requirements of transport modes especially the public transport system, requirements of network functional hierarchy and both the social and the natural environment. Figure 13.1-1 shows the developed basic road network, which is composed mainly of the following components:

- Seven (7) National Roads, namely; NR1, NR2, NR3, NR4, NR5, NR6 and NR21, which form the existing national transport system in the capital region and function as radial roads.
- Three (3) ring roads, namely the Inner Ring Road, Intermediate Ring Road and Outer Ring Road which are formed to handle the transit traffic of the National Roads outside of the urbanized area.
- Two (2) east-west trunk roads, Namely the Northern New Trunk Road and Southern New Trunk Road, which will strengthen the access to western areas where new development projects are planned.

Policy and Alternatives

This basic road network was prepared through discussion with the Cambodian side. This network consists of arterial, collector and major local roads, and is evaluated as the minimum requirement to support the development plans to be achieved by the Target Year 2015.

Conditions of "minimum requirement" include not only aspects of traffic characteristics but also that it is acceptable from the economic viewpoint. This economic evaluation of the road network is described in Section 13.2.2.

13.1.3 Public Transport Demand Policy and Alternatives

Public transport systems are categorized into "road-surface-type" and rail-type" as shown in Table 13.1-1. The introduction of a public transport system as a means of improving transport facilities requires a large amount of investment, and a suitable mode of public transport needs to be selected based on careful examination of each type of mode.

The main factors for this analysis are as listed below:

- Scale of population
- Level of economic situation
- Level of social activities
- Traffic characteristics (trip purpose, trip length, trip time, trip frequency)
- Degree of population concentration
- Physical size of activity area
- Topographical condition of area

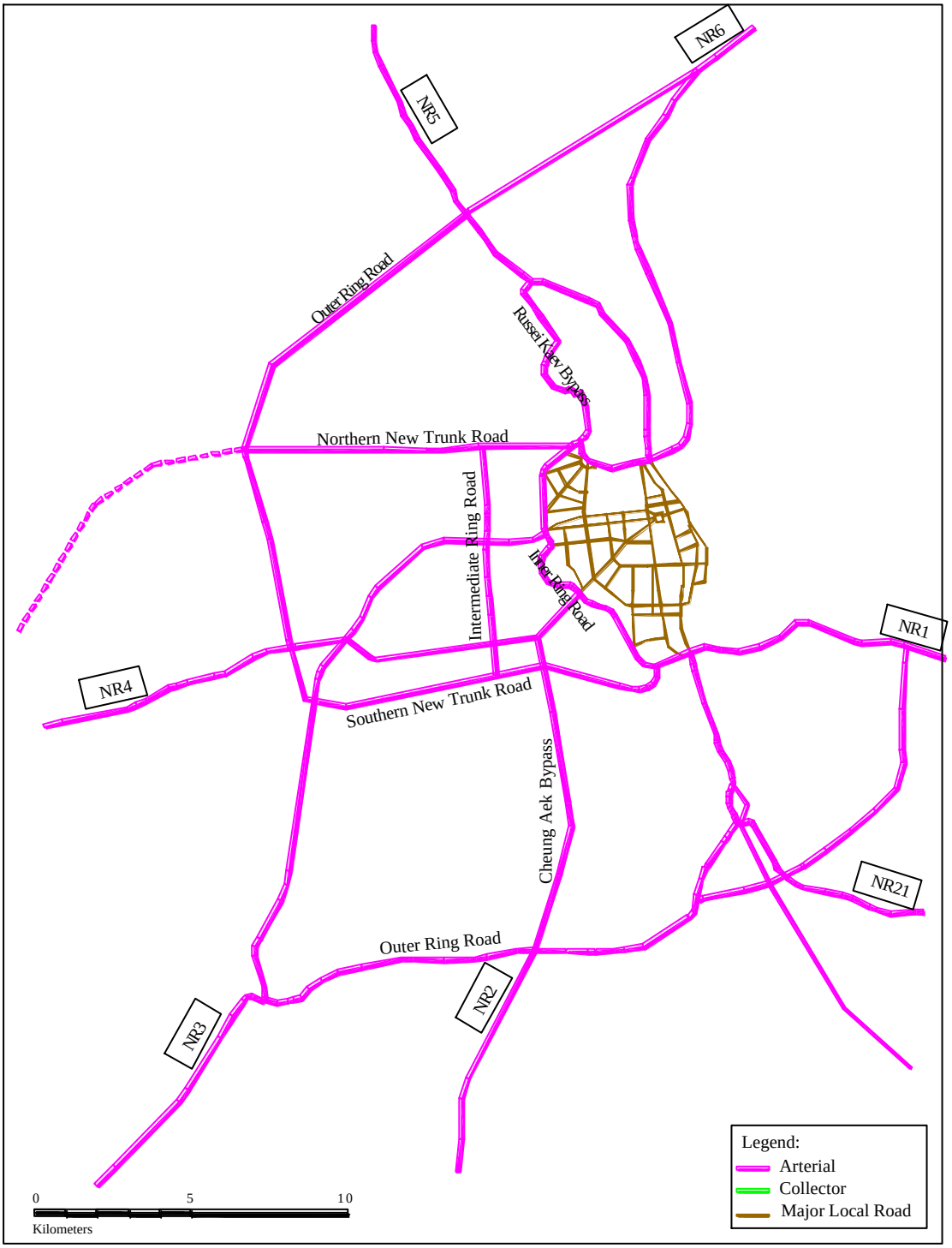


Figure 13.1-1 Future Basic Road Network

The present situation in the Study Area is as follows:

Existing Condition

At present, the most dominant transport mode in the city is the motorcycle (MC) (private and public) sharing 83.3 percent of the total person-trip excluding walk trips. The public MC, known as the motodop, is the only means of public transport (para-transit mode) in the city. Buses and taxi-buses provide inter-city services. The para-transit operation, including the driving manner of motodops, was assessed as one of the influential causes of traffic problems in the Study Area.

- Lack of a public transport system other than para-transit gives an urban transport capacity that is very low at present, and may not be responsive to future traffic demand.
- Lack of public transport facilities
- Lack of an efficient public transport system with only a few inter-city bus services

Policy and Alternatives

- Introduction of bus services is proposed considering the characteristics of the Study Area, investment scale, transport efficiency and traffic nuisance etc.

In the near future when the socioeconomic activities are developed in hand with the economic development and the population increase, the traffic condition will be aggravated due to increase in the number of vehicles even with full utilization of existing facilities. The great demand towards public transport will increase requiring the shift from para-transit oriented public transport system (motodop) to a comprehensive public transport system (bus). A bus system is considered as the most appropriate public transport mode based on the size of urban area, scale of population, magnitude of demand and present pattern of transport network.

Proposed bus routes are shown in Figure 13.1-2.

- Two alternatives are considered here:

  Alternative 1: Present public transport system (motodop)
  Alternative 2: Introduction of new public transport system (bus)

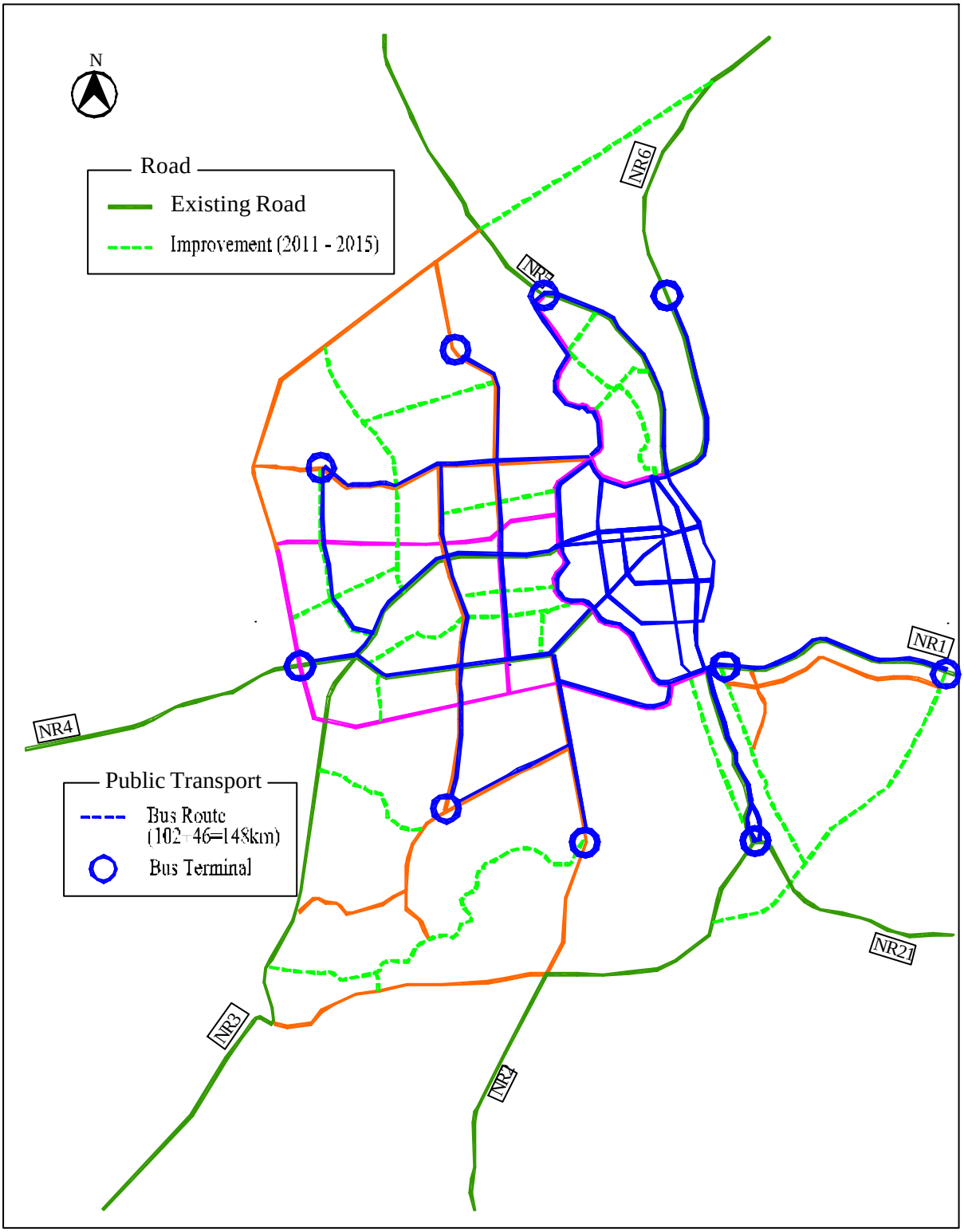


Figure 13.1-2 Proposed Bus Route

13.1.4 Traffic Control Management

Traffic control management is considered as the required measure for environmental improvement and traffic safety. Examples of measures of traffic control management are listed in Table 13.1-1.

The present status of the traffic control in the Study Area is in a very early stage as described below. No sophisticated measures however are necessary even in the Target Year 2015 and basic measures should be applied.

- Lack of effective traffic management system
- Disordered and mixed traffic flow due to high share of para-transit modes (84%) and their undisciplined driving manner
- Decrease in traffic capacity due to on-street parking
- Increase in traffic accidents and pollution due to increase of traffic volume and violation of traffic rules
- Insufficient number of traffic signals and inadequate configuration of at-grade intersections

Policy and Alternative Measures

The required measures are as listed below; implementation of these measures are an absolutely necessary precondition.

- Rehabilitation of road pavement
- Rectification of disorderly traffic flow
- Sustained implementation of traffic safety education and campaign
- Improvement of traffic enforcement, including improvement of "Accident Analysis System"
- Strengthening of institutional organization for traffic enforcement
- Road network endurable against inundation
- Introduction of traffic signal system, including improvement of facilities
- Regulation of on-street parking (not for the entire road network, but for necessary sections)

Among these measures, rehabilitation of road pavement and traffic signals are being enthusiastically implemented by the Cambodian Government. Further promotion of these measures is considered to be the "objective" of the Master Plan.

13.1.5 Transport Legislation

Legislations relevant to transport are shown in Table 13.1-1 and listed below:

- Vehicle tax system
- Driving license system
- Vehicle inspection system
- Fuel tax system

In Cambodia, these basic legislations are in the process of preparation. Implementation of these legislations as measures of adjustment of traffic demand is judged to be too early, in lieu of the present situation of administration and social welfare, and may hamper urban development and/or socioeconomic activities.

13.1.6 Generation of Master Plan Alternatives

The policy and alternatives as described in the previous section are combined as shown in Table 13.1-2.

Table 13.1-2 Combinations of Policy and Alternatives

	Transport Demand Management				Road Development		Public Transport		Traffic Control Management	Transport Legislation
	Policy 1	Policy 2	Policy 3	Policy 4	Existing Network	Basic Network	Present	Bus		
Do-Nothing					○		○			
Alternative 1 Present Pattern	○					○	○		○	○
Alternative 2 Vehicle Priority		○				○	○		○	○
Alternative 3 Bus Priority			○			○		○	○	○
Alternative 4 Bus Favored				○		○		○	○	○

The alternatives of the Master Plan can be summarized as the following:

Do-Nothing : Present Road Condition and Present Traffic Pattern
This case is assumed to be used as the base for evaluating the selected Optimum Alternative as described in 13.2.4. In this case, both the road condition and traffic pattern are assumed to be the same as present ones and only future increase in traffic demand is considered.

Alternative 1: Present Pattern (Continuation of present pattern)
This alternative assumes that no specific measures nor regulation is taken, except ordinary traffic management measures and road improvement. Modal share of future is assumed to remain almost same to that of present, except the change due to the growth in income level and/or variation in the choice by the individuals.

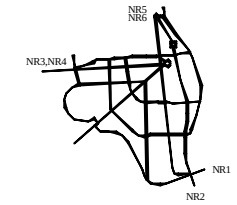
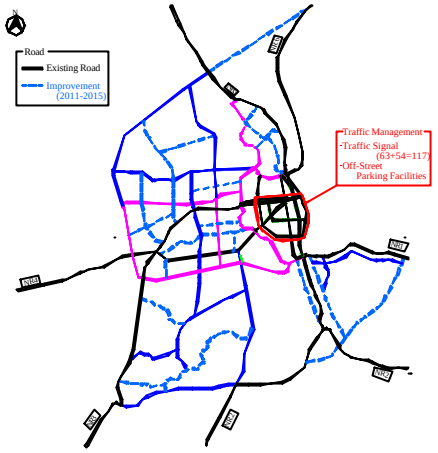
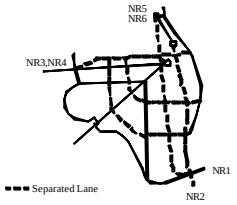
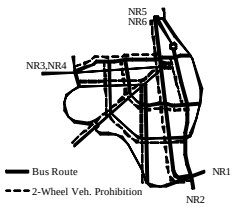
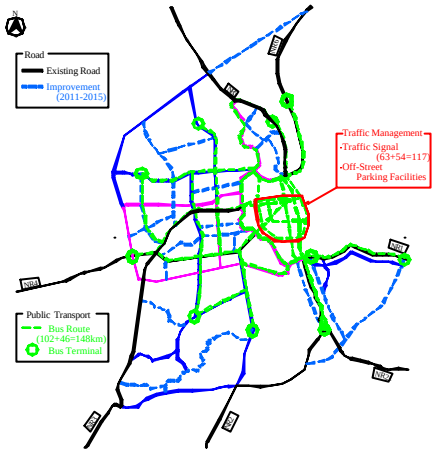
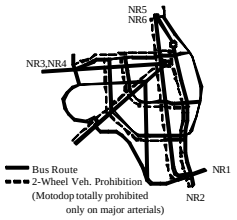
Alternative 2: Vehicle Priority Policy (Encourage 4-whel vehicles)
This alternative assumes encouraging usage of 4wheel vehicles (passenger cars) through such measures as acceleration of road improvement and introduction of vehicle tax system in favor of cars. The share of 4wheel vehicle is assumed to increase in future.

Alternative 3: Bus Priority Policy (Suppress 2-wheel vehicles)
This alternative assumes introduction of bus services on all the urban arterial streets. Operation of motorcycles on the bus routes is regulated. Operation of motodops is totally prohibited.

Alternative 4: Bus Favored: Para-transit Co-existing Policy (Encourage bus operation with coexistence of bus and 2-wheel vehicles)
This alternative assumes introduction of bus services only along the high-demand routes. Operation of motodops are allowed but controlled. Operation of motorcycles on bus routes is regulated.

Outlines of these alternatives are summarized in Table 13.1-3.

Table 13.1-3 Transport System Alternatives

Alternatives	Urbanized Area	Suburban Area
Alternative 1: Present Pattern - Present pattern is assumed to be continued in the future without transport regulation. - Modal share of future transport is assumed to be remained the same as present except the change due to the economic growth.		
Alternative 2: Vehicle Priority Policy - Vehicle are assumed to be increased by encouraring usage of 4-wheel vehicles. - Policy in favor of 4-wheel vehicles is enforced.		
Alternative 3: Bus Priority Policy - Bus services are assumed to be operated on arterials by implementation of bus priority policy. - Operating of 2-wheel vehicles is regulated on arterials, thus suppressing 2-wheel vehicles.		
Alternative 4: Bus Favored (Para-Transit Coexistence) Policy - Bus operation with co-existence of 2-wheel vehicles are assumed to be encouraged by bus promotion policy. - Paasage of 2-wheel vehicles is regulated on principal arterials.		

13.2 EVALUATION OF MASTER PLAN ALTERNATIVES

13.2.1 Evaluation Method

(1) Assumption of Modal Share

The total number of person-trips excluding walk trips is 2.38 million in 2000 and 3.95 in 2015, which are split into the modal shares as shown in Table 13.2-1. The assumption adopted in splitting modal share is made based on the person trip survey and estimation of future socioeconomic framework.

Table 13.2-1 Assumed Modal Share of Person Trip (Unit: Percent)

		Car	Private Motorcycle	Motodop	Bus	Others
Year 2000		10.9	69.4	18.9	0.0	0.8
Year 2015	Alternative 1	17.5	63.0	18.7	0.0	0.8
	Alternative 2	25.0	62.5	11.7	0.0	0.8
	Alternative 3	17.2	62.1	0.0	20.0	0.7
	Alternative 4	17.2	62.3	11.4	8.4	0.7

Alternative 1: Present Pattern

The share ratio of car is assumed to be the increased by 6.6% from Year 2000 to Year 2015 shifting from private motorcycle (MC) in accordance with economic growth in the future.

Alternative 2: Vehicle Priority Policy

The car ratio is assumed to significantly increase by 14.1% from Year 2000 to Year 2015 shifting from private MC and motodop because of the proposed vehicle priority policy. Car ratio of Alternative 2 is higher by 7.5% than that of Alternative 1.

Alternative 3: Bus Priority Policy

The bus ratio is assumed to drastically increase by 20.0%, reducing the private MC share by 7.3%, and suppressing the motodop. The car ratio remains almost the same as Alternative 1.

Alternative 4: Bus Favored: Para-transit Co-existing Policy

The bus ratio is assumed to reasonably increase by 8.4%, which is determined based on the bus passenger demand analysis discussed in Chapter 13, with a reduction of private MC by 7.1% and motodop by 7.5%. The car ratio remains almost the same as Alternative 1.

(2) Evaluation Indicator

The four (4) alternatives are comparatively evaluated using four (4) factors as explained below:

(i) Traffic condition

- Average travel speed; should be higher than speed of Level of Service B defined in the Highway Capacity Manual (HCM) (30 km/hr); Higher is better
- Average VCR; should be smaller than volume-capacity ratio (VCR) for Level of Service B as defined in HCM (0.383); Smaller is better

(ii) System efficiency
- Travel length; figures of the alternatives are compared with each other
- Travel time; same as above
- Travel cost; same as above

(iii) Environmental impact
- Traffic nuisance; estimated degree of nuisance for the alternatives are compared with each other.
- Traffic accidents; degrees of impact on increase/decrease of traffic accidents are compared with each other.
- Relocation of people; degrees of impact is compared among the alternatives.

(iv) Social acceptance
- Public acceptance; degree of acceptance of impact, such as impact on the daily life of the citizens are compared.
- Impact with the existing para-transit system; impact is qualitatively evaluated compared with each other

13.2.2 Comparative Evaluation of Transport System Alternatives

(1) Traffic Assignment Analysis

Traffic assignment analysis of the four (4) alternatives was made on the proposed road network in Year 2015. The results are shown in Figure 13.2-2 for the urbanized area and Figure 13.2-3 for the suburban area. The figures generally demonstrate VCR on each link. On the network of Alternative 1 (Present Pattern) and Alternative 2, there exist some links with VCR more than 1.5, which means that traffic conditions are worse than unstable flow.

(2) Comparative Analysis of Traffic Parameters

Table 13.2-2 summarizes the comparison of traffic parameters for the urbanized area, suburban area and whole area, and Figure 13.2-1 graphically shows the comparison.

Table 13.2-2 Comparisons of Traffic Parameters

	Travel Length (pcu-km)	Travel Time (pcu-hr)	Ave. VCR	Ave. Speed (km/hr)	Traffic Cost (US$)
Urbanized Area					
Alternative 1:Present Pattern	3,165,550	108,176	0.53	29.3	196,106
Alternative 2:Vehicle Priority Policy	3,227,641	110,590	0.54	29.2	200,236
Alternative 3:Bus Priority Policy	2,852,988	93,492	0.48	30.5	177,953
Alternative 4:Bus Favored Policy	3,037,549	102,029	0.51	29.8	182,653
Suburban Area					
Alternative 1:Present Pattern	4,019,691	104,018	0.26	38.6	227,748
Alternative 2:Vehicle Priority Policy	3,931,364	101,140	0.26	38.9	221,519
Alternative 3:Bus Priority Policy	4,027,491	104,242	0.26	38.6	224,491
Alternative 4:Bus Favored Policy	4,001,427	103,560	0.26	38.6	225,945
Whole Area					
Alternative 1:Present Pattern	7,185,241	212,194	0.34	33.9	423,854
Alternative 2:Vehicle Priority Policy	7,159,005	211,730	0.34	33.8	421,755
Alternative 3:Bus Priority Policy	6,880,479	197,734	0.32	34.8	402,444
Alternative 4:Bus Favored Policy	7,038,976	205,589	0.33	34.2	408,598

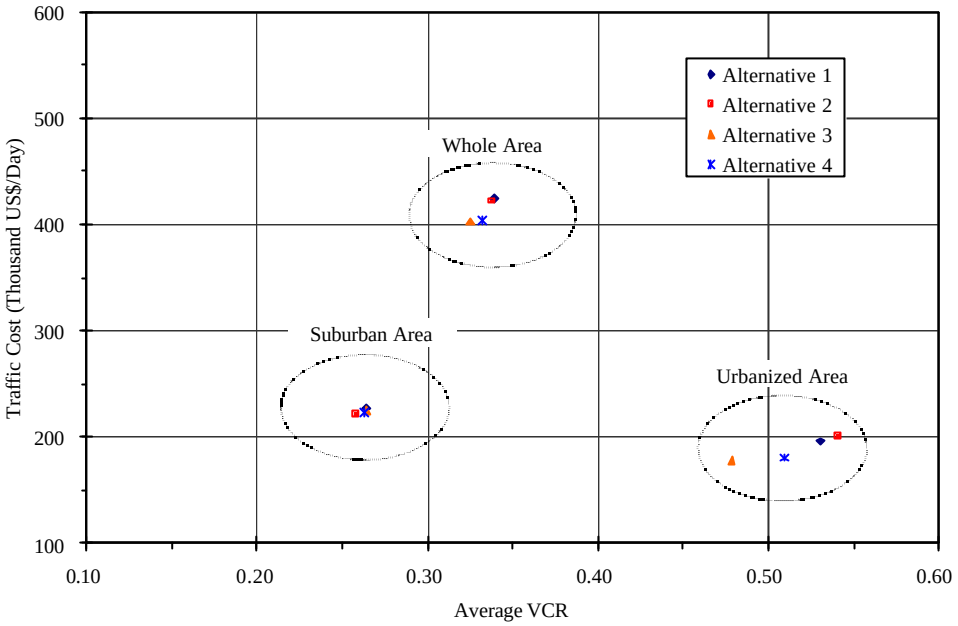


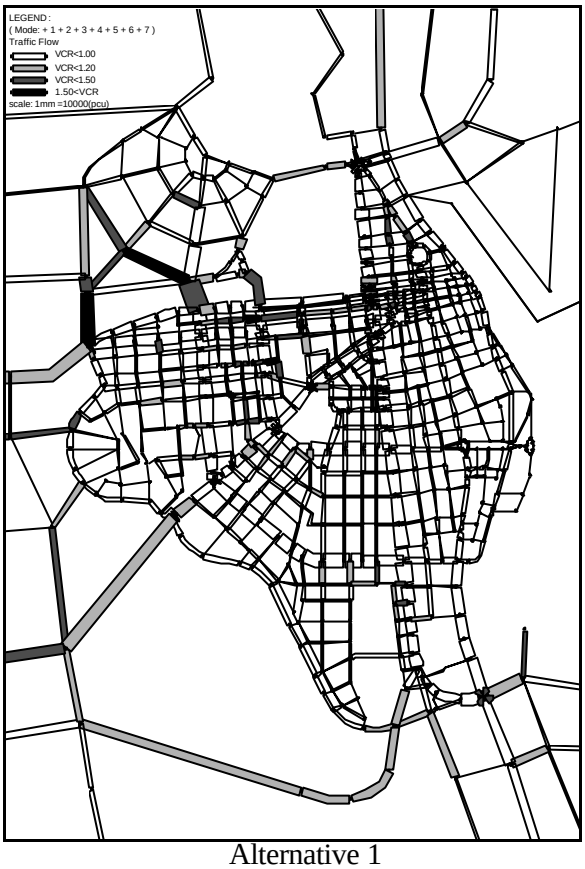
Figure 13.2-1 Comparisons of Traffic System Alternatives

Alternative 3 (Bus Priority Policy) shows the most favorable figures in all parameters, such as gross travel length (pcu-km), gross travel time (pcu-hr), traffic condition (average speed, average VCR (volume-capacity ratio)) and gross traffic cost.

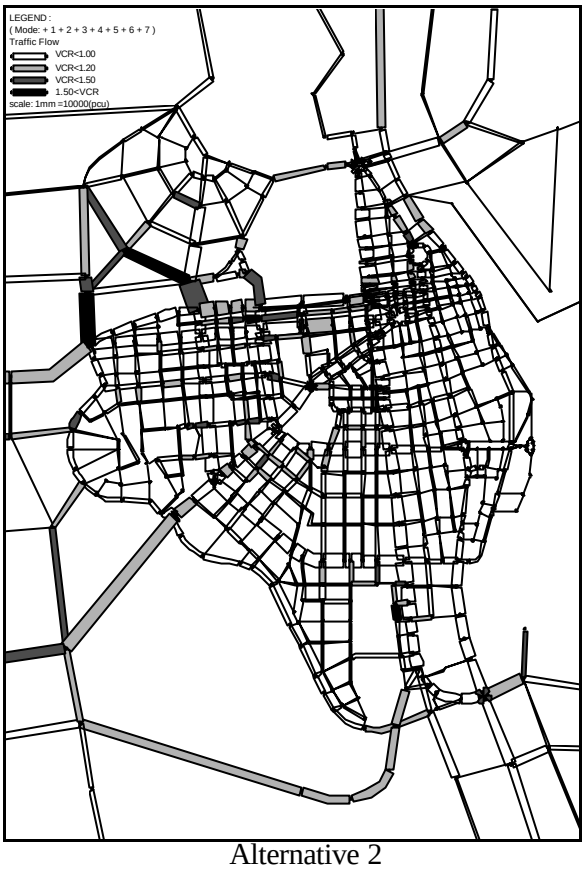
Alternative 4 (Bus Favored Policy) has the second favorable figures followed by Alternative 2 (Vehicle Priority Policy) and Alternative 1 (Present Pattern). Alternative 4, however, shows a very marginal difference in travel length and in traffic cost compared with Alternative 3. Alternative 2 shows a smaller traffic cost than that of Alternative 1 in the suburban area.

In the urbanized area, the range of VCR is between 0.48 and 0.54, among which Alternative 3 is the lowest of 0.48 followed by Alternative 4 of 0.51. Alternative 4 shows a very marginal difference in traffic cost of 4,700 US$ per day or 102.6% comparing with Alternative 3. In the suburban area, the range of VCR is very small, 0.258~0.265, and Alternative 2 is the lowest. On traffic cost, Alternative 4 again shows a negligible difference of 1,404 US$ per day or 100.6% compared with Alternative 3.

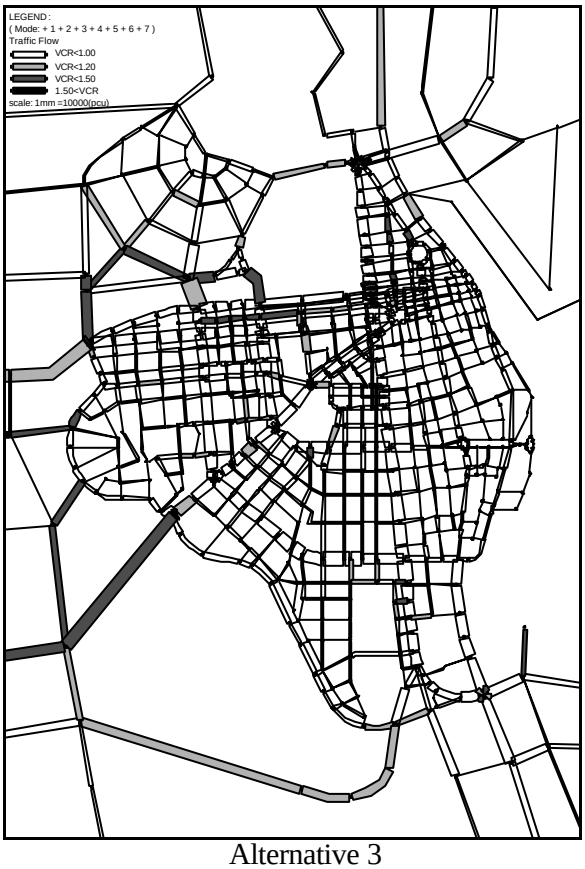
As to the whole area, VCR ranges between 0.32 and 0.34, of which 0.32 is indicated by Alternative 3, followed by Alternative 4 of 0.33. The traffic cost of Alternative 4 has a negligible difference of 6,154 US$ per day or 101.5% in comparison with that of Alternative 3. It shall be noted that in estimation of gross travel length and travel time in Table 13.2-2, only those of vehicles are considered and person walking distances from their houses to bus stops are excluded.



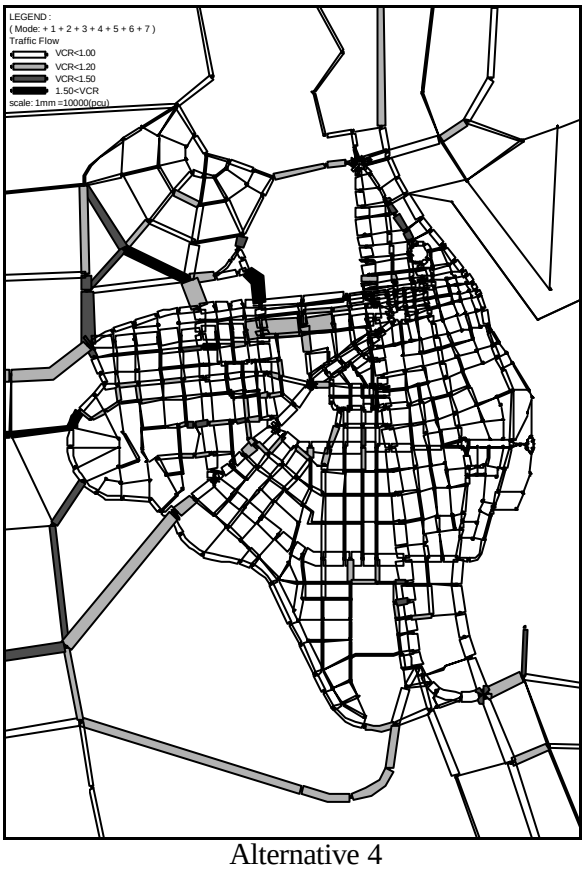
Alternative 1



Alternative 2

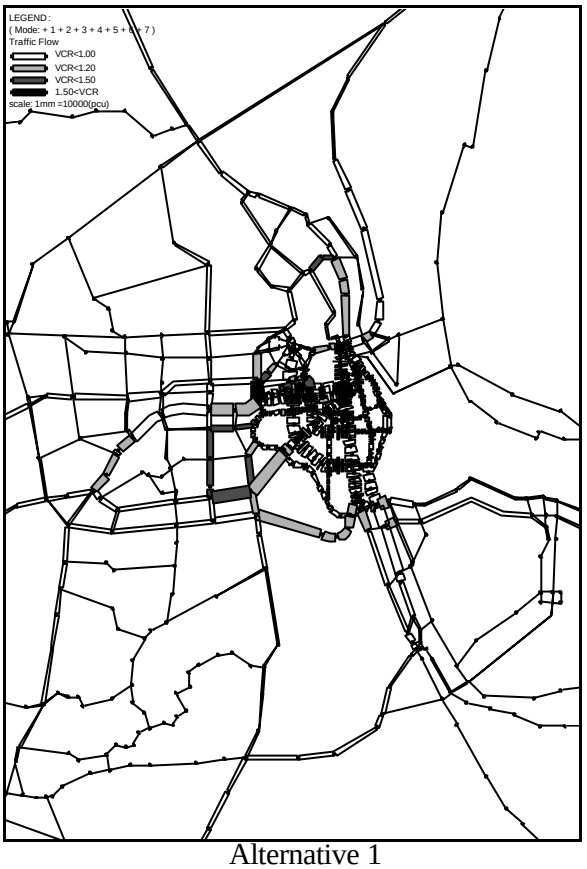


Alternative 3

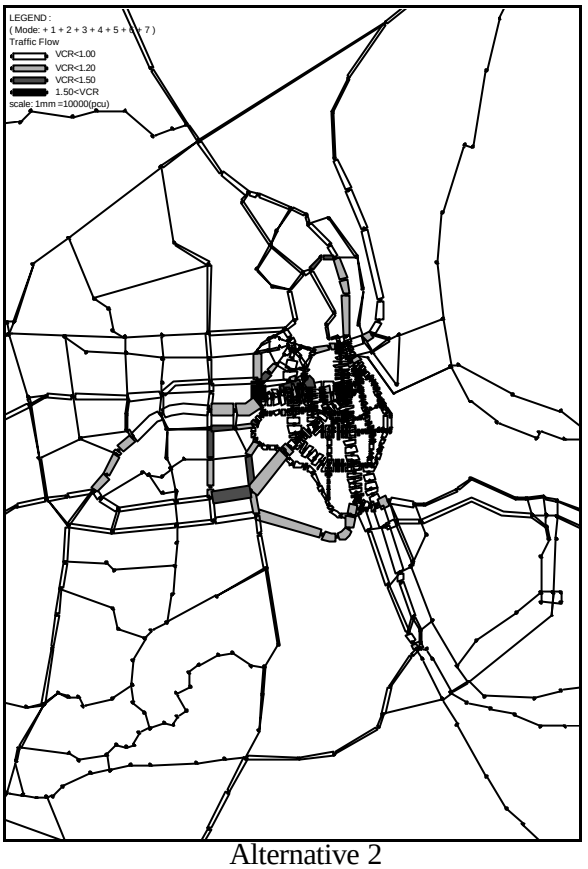


Alternative 4

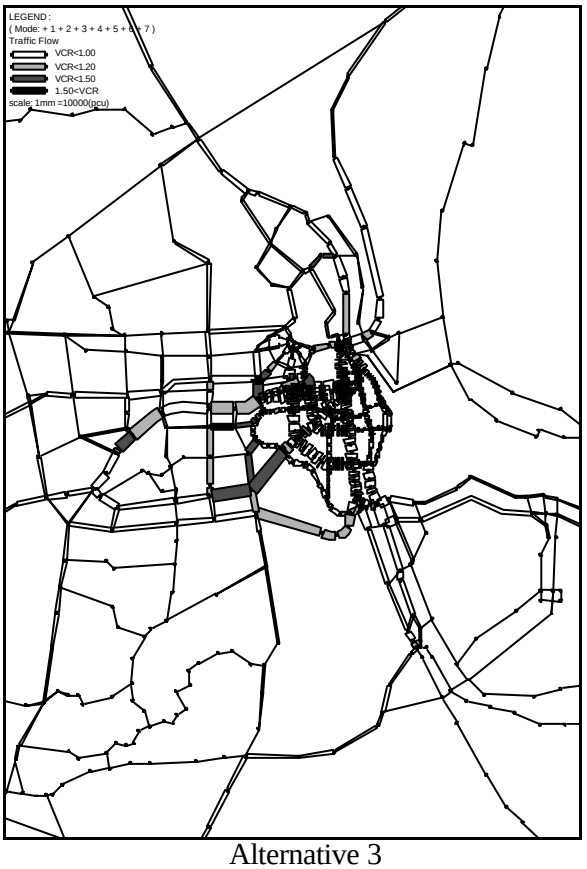
Figure 13.2-2 Traffic Assignments in Urbanized Area, Year 2015



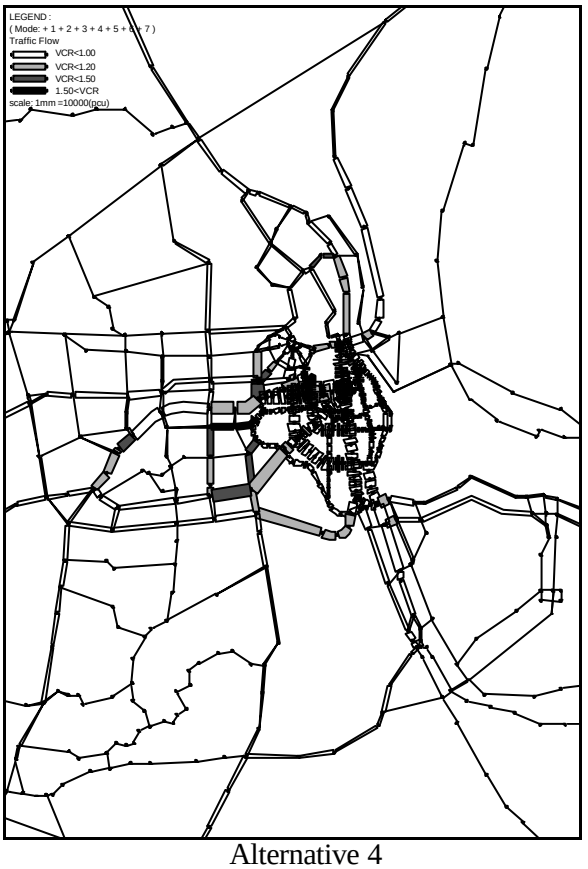
Alternative 1



Alternative 2



Alternative 3



Alternative 4

Figure 13.2-3 Traffic Assignments in Suburban Area, Year 2015

(3) Economic Analysis

Economic analysis was carried out on the four (4) alternatives. The assumptions of the analysis, such as vehicle operation cost, are described in Section 13.3.2.

The results of the analysis are summarized in Table 13.2.3.

Table 13.2-3 Comparison of Economic Indicators

	B/C	EIRR (%)	NPV (US$mil)
Alternative 1	1.59	16.07	104.73
Alternative 2	1.64	16.29	111.69
Alternative 3	1.73	24.82	146.86
Alternative 4	1.73	24.64	126.17

While Alternative 3 (Bus Priority Policy) yields the highest NPV followed by Alternative 4 (Bus Favored Policy), in terms of B/C ratio and EIRR, Alternatives 3 and 4 gives almost same figures. Therefore, Alternatives 3 and 4 can be evaluated to yield similar economic effects.

(4) Environmental Comparison

The air pollution components of HC, CO and NOx produced by each scenario are estimated as presented in Table 13.2-4. For comparison purposes, the difference between each scenario with the Do-nothing case show that the last two scenarios give less air pollution when compared with the first two scenarios.

Table 13.2-4 Environmental Evaluation – 2020 (kg/year)

Scenario	HC	Difference between Do-nothing and Scenario	CO	Difference between Do-nothing and Scenario	NOx	Difference between Do-nothing and Scenario
Do-nothing	20,825	0	131,123	0	6,479	0
Scenario 1	19,387	-1,438	122,067	-111,736	6,032	12,908
Scenario 2	19,321	-1,505	121,649	-111,802	6,011	12,842
Scenario 3	18,570	-2,255	116,923	-112,553	5,777	12,091
Scenario 4	18,997	-1,828	119,610	-112,126	5,910	12,518

Note: Discharge rates are assumed as follows: HC 2.70 g/km
CO 17.0 g/km
NOx 0.84 g/km

(5) Comparative Evaluation of Master Plan Alternatives

Table 13.2-5 presents the evaluation of four (4) system alternatives. The table includes evaluation on environmental impact and social acceptance.

Alternative 1 gets a scarcely acceptable score in the evaluation on traffic condition aspects, but shows unacceptable results in all other items.

Alternative 2 shows almost the same result to Alternative 1.

Alternative 3 is evaluated as most effective in terms of traffic condition and system efficiency, but shows uncertainly in social acceptance of regulation/prohibition policy of motodop.

Alternative 4 gets a slightly lower score in system efficiency and gets the highest score in social acceptance. Actually, Alternative 4 is evaluated as the only alternative which is socially acceptable given the smaller impact on the motodop service.

These evaluations are summarized in Table 13.2-5.

Table 13.2-5 Overall Evaluation of Transport Master Plan Alternatives

	Traffic Condition	System Efficiency	Environmental Impact	Social Acceptance	Economic Evaluation	Overall Evaluation
Alternative 1	△	X	X	X	B/C= 1.59 EIRR = 16.1%	4
Alternative 2	△	X	X	X	B/C= 1.64 EIRR = 16.3%	3
Alternative 3	◎	◎	○	XX	B/C= 1.73 EIRR = 24.8%	2
Alternative 4	◎	○	○	◎	B/C= 1.73 EIRR = 24.6%	1

13.2.3 Selection of Optimum Master Plan

Based on the comparative evaluation as described in Section 13.2.4 above Alternative 4 is selected as the Optimum Master Plan.

13.2.4 Evaluation of Optimum Master Plan

As described in the previous sections, Alternative 4 is selected as the Optimum Master Plan. In this section, the selected Optimum Master Plan is further evaluated in detail to verify its effectiveness as well as to examine the appropriate timing of implementation for the proposed projects and measures. The time frame for the implementation of the projects and measures are set at Years 2005, 2010 and 2015.

In addition, it is also verified that the selected Optimum Master Plan is reasonable and acceptable with regard to investment timing.

(1) Traffic Analysis

Traffic Assignment Analysis

The traffic assignment analysis was carried out on the present road network "Do Nothing Case" and the proposed future transport networks of the "Master Plan Case" for the target years of 2005, 2010 and 2015. Figures 13.2-4 to 13.2-9 show the assigned traffic demand and V/C ratio in the target years for the urbanized area and suburban area separately.

In the assignment process, virtual road network models covering the Study Area and its adjacent area are formulated into the JICA STRADA program files in accordance with the road network improvement plans in the target years of 2005, 2010, and 2015 independently. Therefore the staged construction of new roads and/or improvements of existing road conditions are reflected in these road network models. In other words, traffic capacity and free flow speed setting of each of the links in these models reflects these road improvements stage by stage.

During the course of several trial runs of the traffic assignment models, the modification of link settings for several series of road networks are also made in line with the possibility of alternative routes and/or grade improvement arrangements in both urbanized area and suburban area. Therefore, level of improvements of proposed and/or existing road networks, such as Inner Ring Road, Outer Ring Road, and New Trunk Roads, are also reflected in these results of model feedbacks.

Table 13.2-6 Comparative Evaluation of Transport System Alternatives

	Traffic Condition (Ave. Speed, Ave. VCR)	System Efficiency (Travel Length, Cost)	Environmental Impact (Traffic Pollution, Nuisance)	Social Acceptance (Legislation, Regulation)
Alternative 1 Present Pattern (Do-Nothing)	•Average speed = 33.9 km/h •Average VCR = 0.34 LoS is between C (free flow) and D (stable flow) but speed starts to decline. •Proposed network in 2015 is acceptable △	•Travel Length = 7,185,000 pcu-km •Travel time =212,200 pcu-hr •Traffic Cost = 424,000 US$ •System efficiency is fair ×	•Due to non-control increase of para-transit system, the traffic pollution; nuisance and accidents will be more than tolerable. •Environmental impact will hamper the image of tourism heritage and modern city. ×	•No specific legislative measure and regulation will be employed. •However, people may ask to implement some control and regulation, not accepting bad traffic situation ×
Alternative 2 Vehicle Priority Policy (Encourage 4-wheel Vehicles)	•Average Speed = 33.8 km/h •Average VCR= 0.34 •LoS is the same as Alternative 1 •Proposed network in 2015 is acceptable △	•Travel Length = 7,159,000 pcu-km •Travel Time 211,700 pcu-hr •Traffic Cost = 422,000 US$ •System efficiency is fair ×	•An intentional encouragement of 4-wheel will increase traffic pollution and accidents •Necessary road improvement will require the acquisition of road right of way and relocation of people. ×	•Increase of vehicle volume will requires the huge investment for road improvement. •Policy in favor of 4-wheel such as taxation may be accepted by people, but not acceptable by the government side because tax shall be used as road improvement fund. ×
Alternative 3 Bus Priority Policy (Suppress 2-wheel Vehicles)	•Average Speed = 34.8 km/h •Average VCR = 0.32 •LoS is C (free flow). ◎	•Travel Length = 6,880,000 pcu-km •Travel Time 197,700 pcu-hr •Traffic Cost = 402,000 US$ •System efficiency is better ◎	•Most preferable in terms of traffic pollution, nuisance and accidents •Suppressing/prohibition of motodop may be preferable in urban viewpoint, but very inconvenient in local traffic service. ○	•Suppressing/prohibition of motodop operation will not be accepted. •Transport service on feeder roads is lacking, thus not accepted. ×
Alternative 4 Bus Favored Policy (Encourage Bus Operation with Coexistence of Bus and 2-wheel Vehicles)	•Average speed = 34.2 km/h •Average VCR = 0.33 LoS is the same as Alternative 3 •Proposed network in 2015 is favorably acceptable ◎	•Travel Length = 7,039,000 pcu-km •Travel Time = 205,600 pcu-hr •Traffic Cost = 404,000 US$ •System efficiency is good ○	•Acceptable level of traffic pollution, nuisance and accidents. •Coexistence of bus and motodop provides a favorable urban structures because of sufficient local traffic service. ○	•Coexistence of bus and motodop operation can form the functional modal share of transport, thus welcome by people. •Transport on feeder roads can supplement bus service on arterial roads ◎

Note : ◎ Highly recommendable
○ Recommendable
△ Acceptable
× Not Recommendable

Figures 13.2-4, 14.3-6, and 14.2-8 graphically show the traffic demand and VCR on all links in the Study Area including the suburban. As demonstrated in these figures comparing "Master Plan Case" with "Do Nothing Case", it is clearly seen that the proposed transport network provides an efficient traffic system given that no links exist with VCR over the critical level of 1.5. While, in the "Do Nothing Case" of the year 2015, as shown in Figure 13.2-8, many links are identified with congested traffic flow of VCR over 1.5, such as the extensions of Samdach Moninet Boulevard, National Road No.4 near the intersection with Outer Ring Road, Tumpum Dike Road, Boeng Krop Road, etc. On the "Master Plan Case" those congested links disappear.

Figures 13.2-5, 13.2-6 and 13.2-9 show the traffic demand and VCR in the urbanized area. In the "Do Nothing Case" for year 2015, as shown in Figure 13.2-9, congested links with VCR over 1.5 are Kim Il Song Blvd, Monivong Bridge, the extension of Inner Ring Road, and certain collector streets. Several sections of arterials including Confederation de la Russie Boulevard, Monivong Boulevard, Norodom Boulevard, Sihanouk Boulevard, Mao Tse Toung Boulevard, are almost in critical condition showing VCR between 1.0 and 1.5. Congested traffic situations are seen even on some sections of collectors and local streets.

Comparison of Traffic Parameters

The traffic system performance of the Transport Master Plan is assessed with analysis of traffic parameters such as gross travel length (pcu-km), gross travel time (pcu-hr), traffic condition (average speed), VCR and gross traffic cost.

Table 13.2-7 summarizes the results of the analysis for the "Master Plan Case" compared with the "Do Nothing Case". As clearly shown in the table, all traffic parameters of the "Master Plan Case" indicate a remarkable improvement in the traffic efficiency in comparison with the "Do Nothing Case".

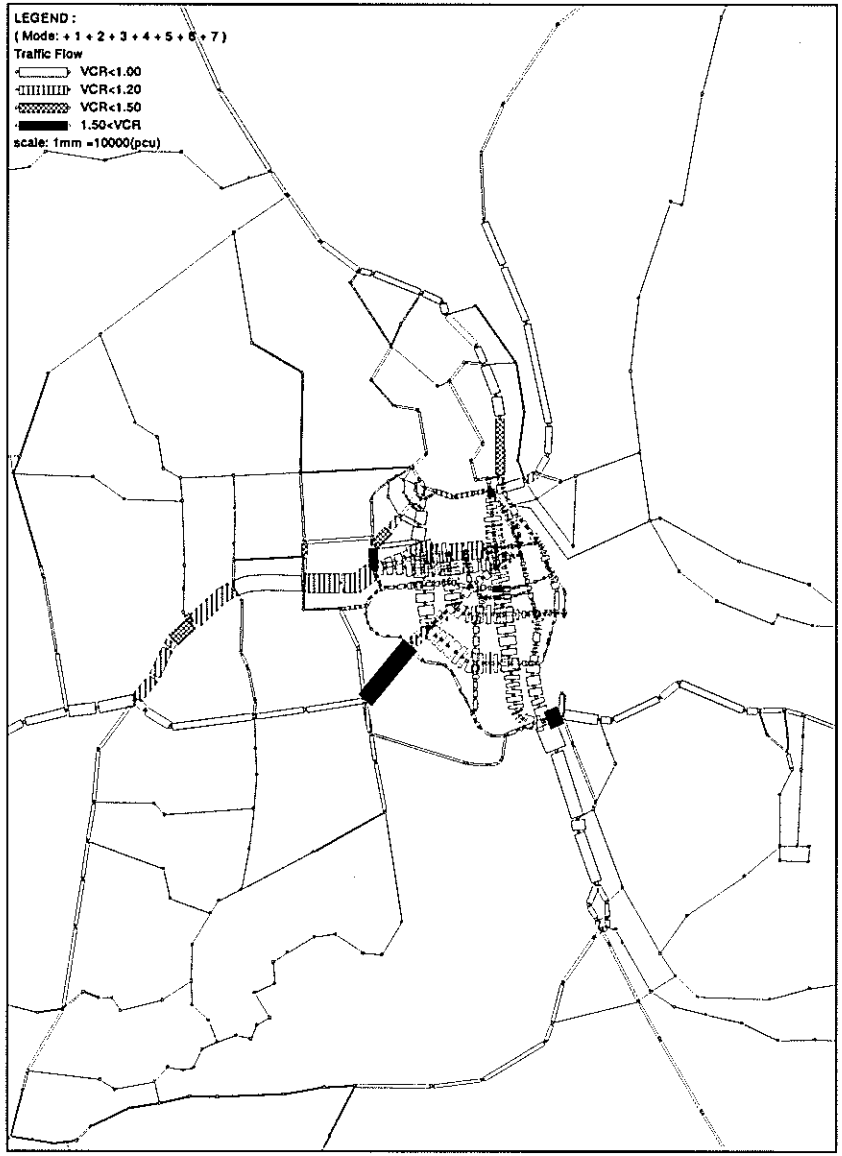
Table 13.2-7 Comparison of Traffic Parameters – Traffic Cost

Unit in US$1,000

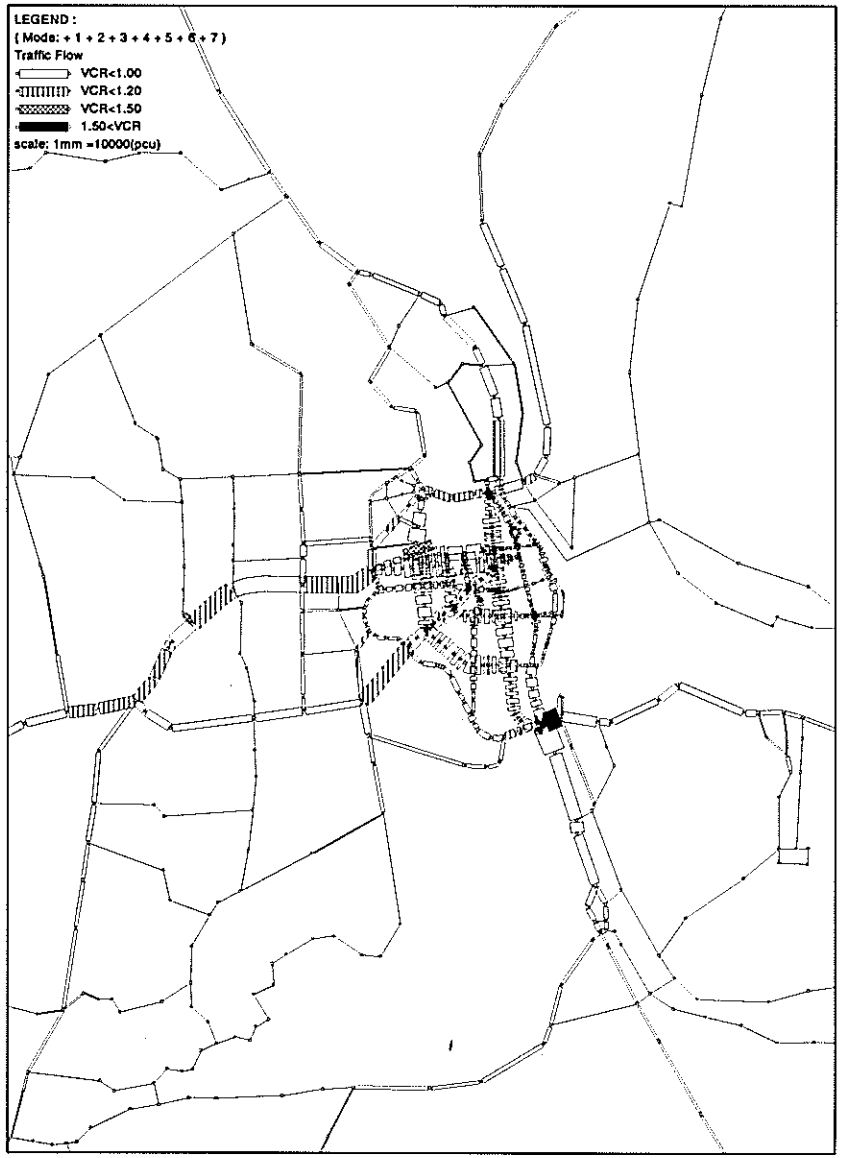
Year		PCU-km	PCU-hr	Ave. speed (km/h)	Ave. VCR	Traffic Cost
2005	Do-nothing	5,009,461	170,944	29.3	0.35	347,930
	With Master plan	4,792,779	145,017	33.0	0.32	265,414
	Difference	216,682	25,927	3.7	0.03	82,516
2010	Do-nothing	6,155,914	232,126	26.5	0.43	443,283
	With Master plan	5,710,082	168,806	33.8	0.31	323,129
	Difference	445,832	63,320	7.3	0.12	120,154
2015	Do-nothing	7,713,110	335,683	23.0	0.54	579,908
	With Master plan	7,038,976	205,589	34.2	0.33	403,878
	Difference	677,216	128,012	10.9	0.21	176,030

Table 13.2-8 indicates the comparative ratios between the "Master Plan Case" and "Do Nothing Case". The gross travel length of the "Master Plan Case" is decreased to 95.7% of "Do Nothing Case" in year 2005, 92.8% in year 2010 and 91.3% in year 2015. The average speed is remarkably increased to 1.13 times in year 2005, 1.28 in year 2010, and 1.49 in year 2015 respectively.

The gross traffic cost also demonstrates the noticeable improvement, decreasing to 76.3% in year 2005, 72.8% in year 2010, and 69.6% in year 2015 respectively. With these traffic parameters, the traffic performance of the Transport Master Plan is justified.

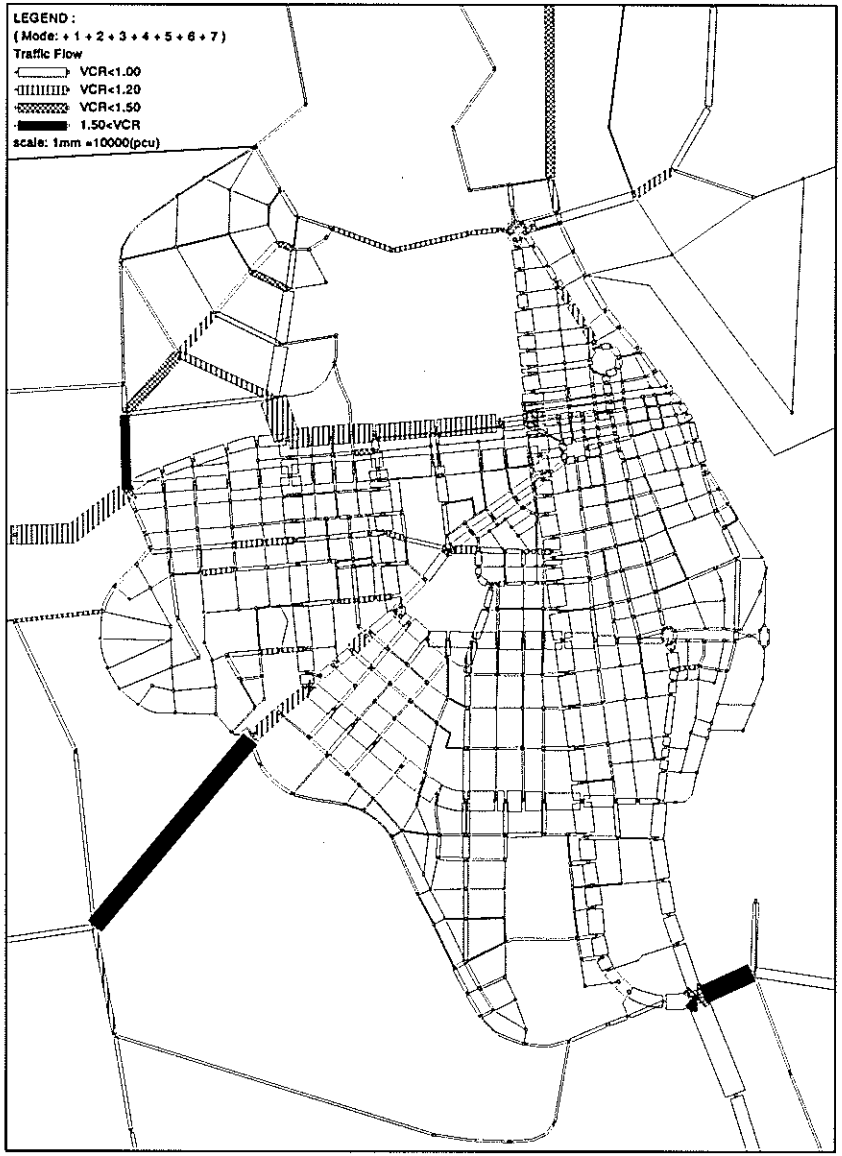


"Do Nothing Case"

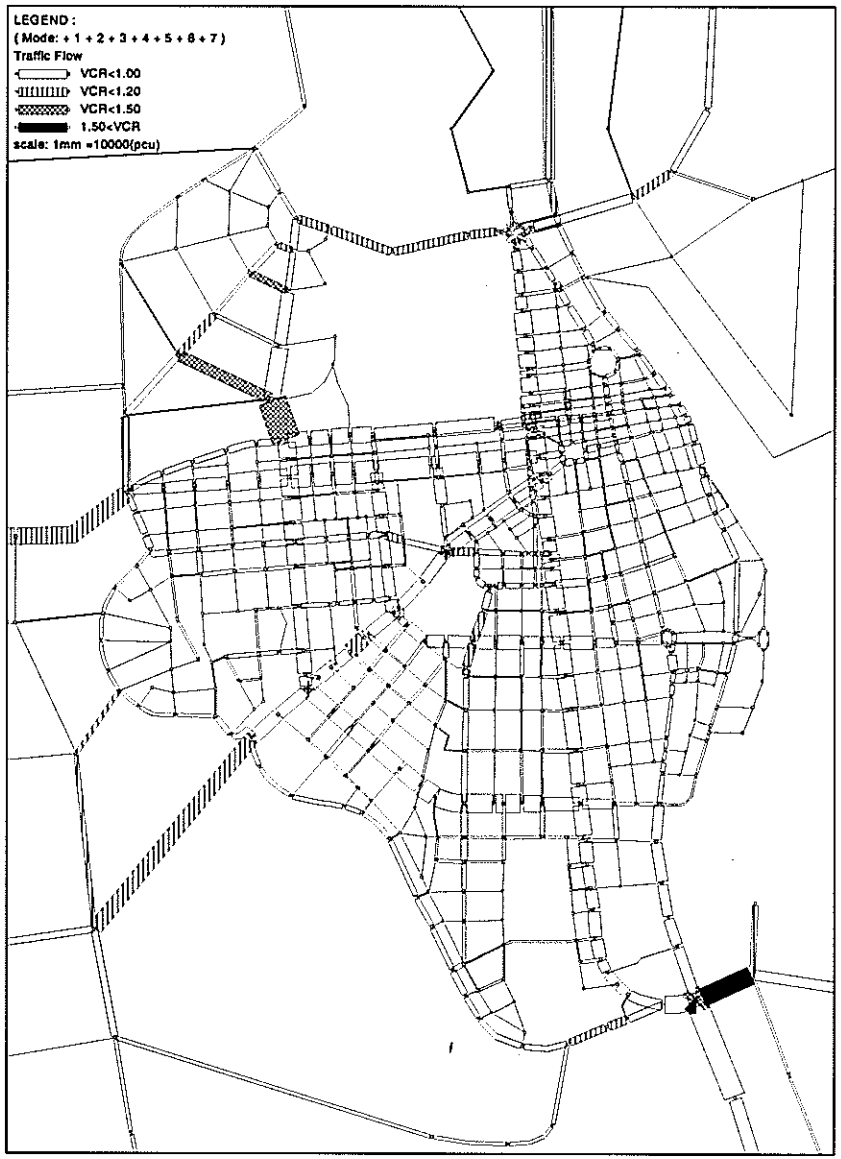


"With Master Plan Case"

Figure 13.2-4 Traffic Assignments in Suburban Area - 2005 -

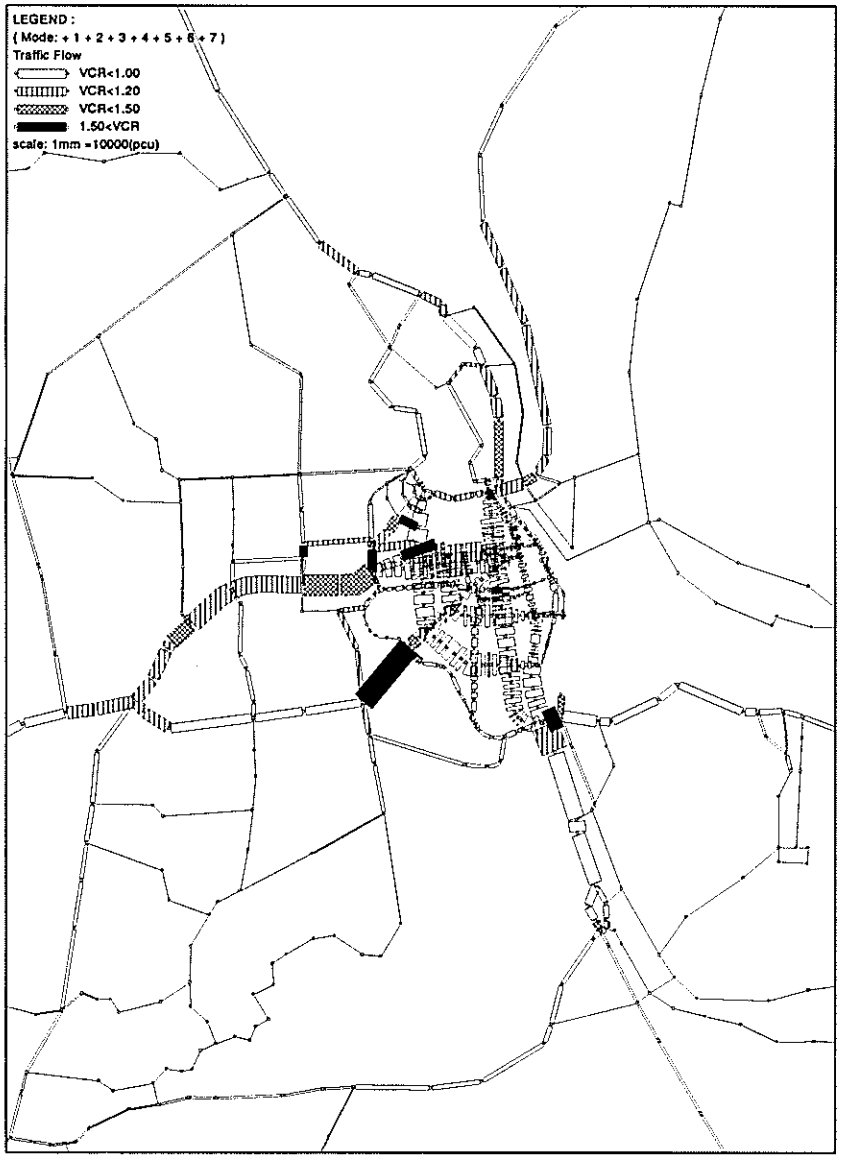


"Do Nothing Case"

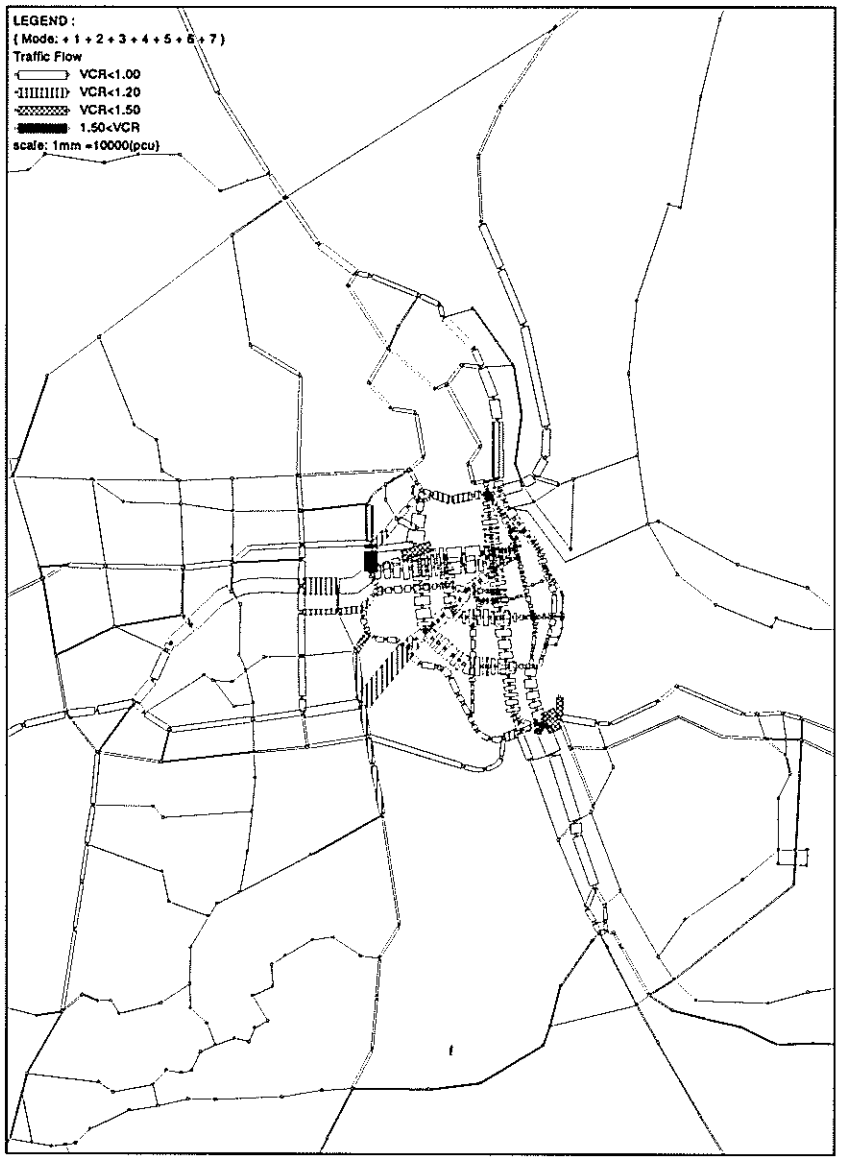


"With Master Plan Case"

Figure 13.2-5 Traffic Assignments in Urban Area - 2005 -

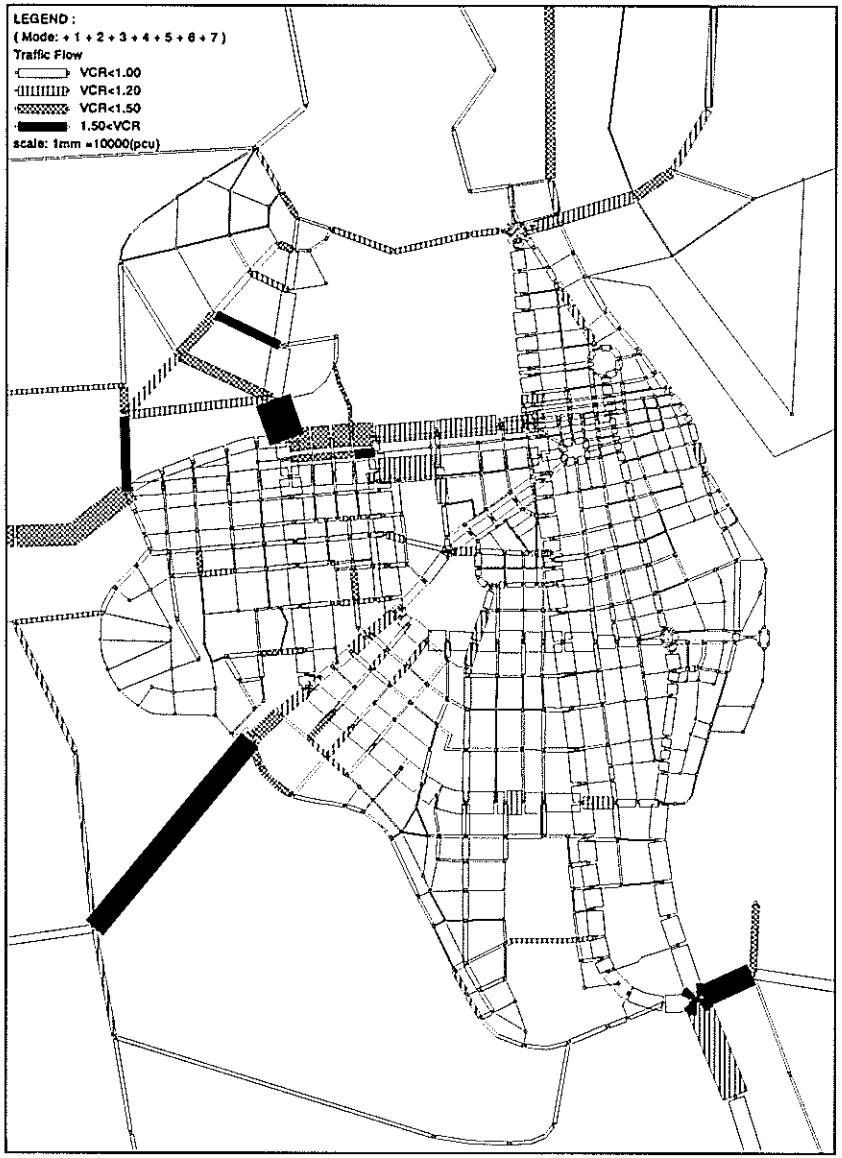


"Do Nothing Case"

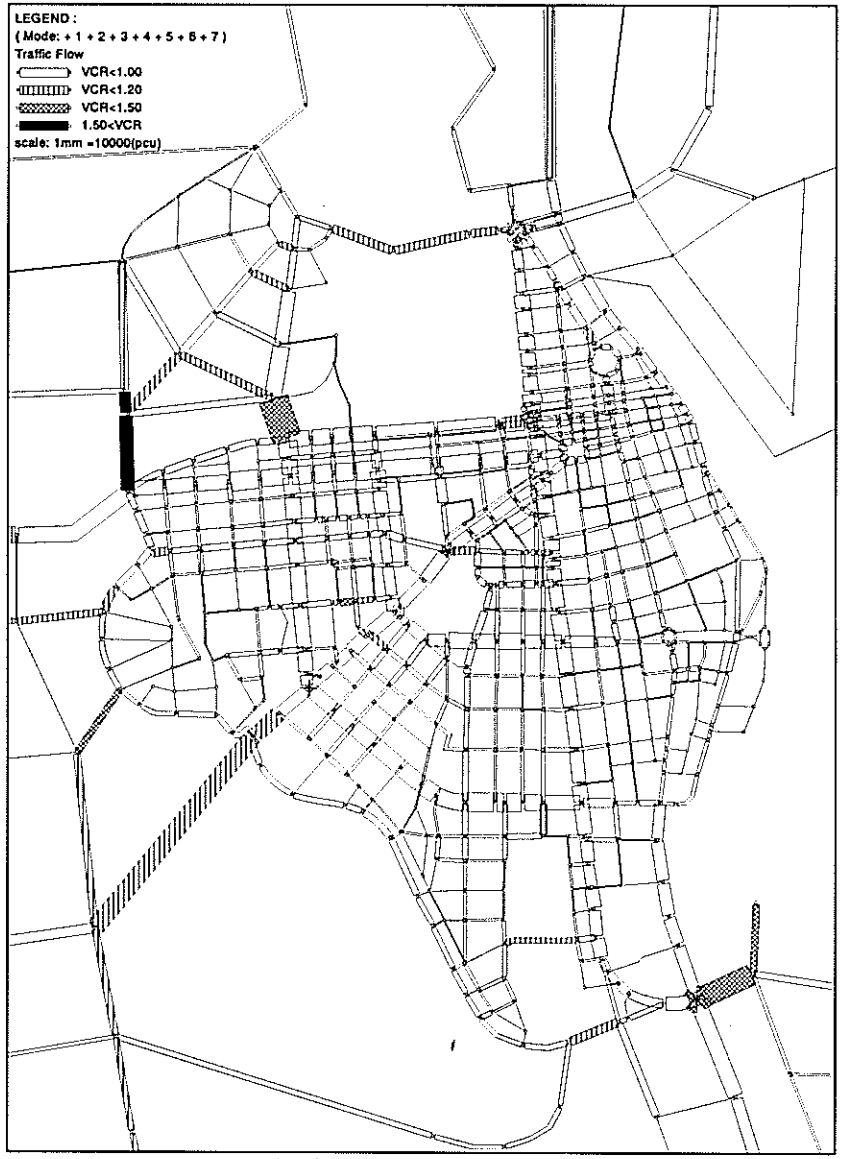


"With Master Plan Case"

Figure 13.2-6 Traffic Assignments in Suburban Area - 2010 -

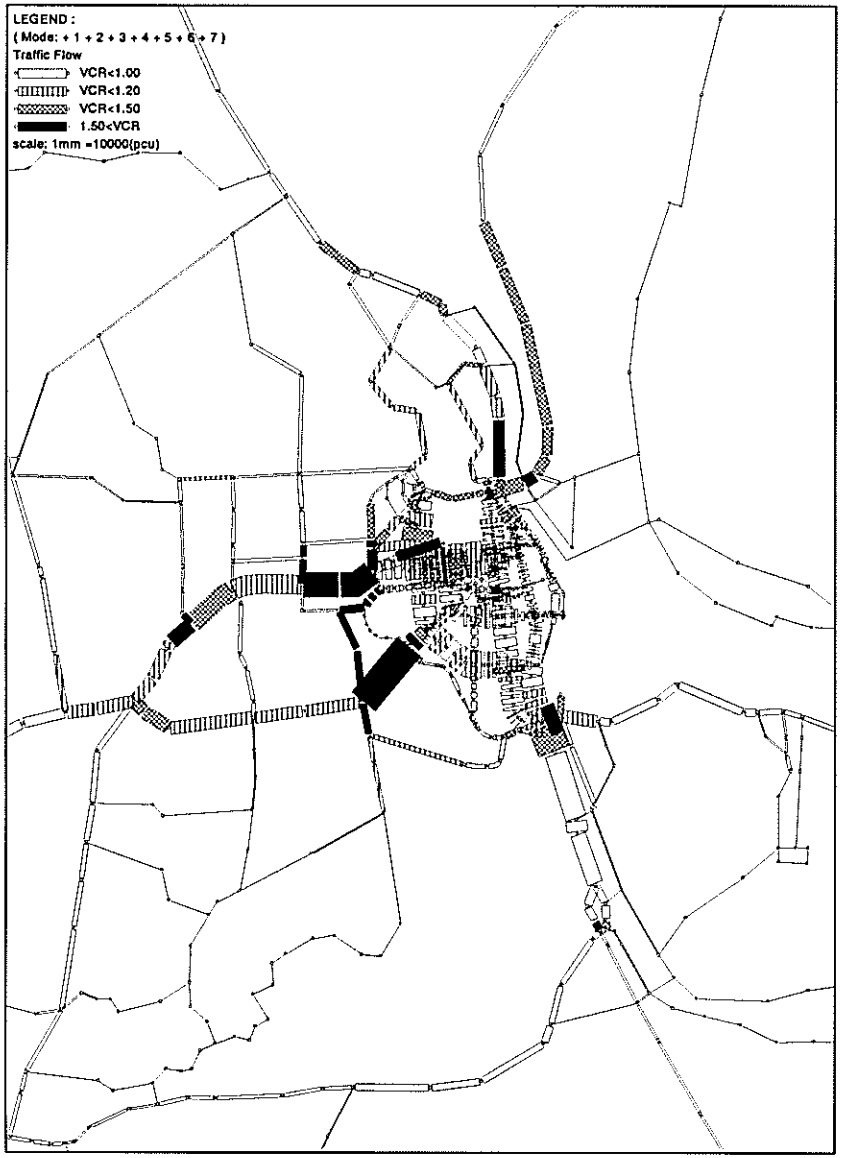


"Do Nothing Case"



"With Master Plan Case"

Figure 13.2-7 Traffic Assignments in Urban Area - 2010 -



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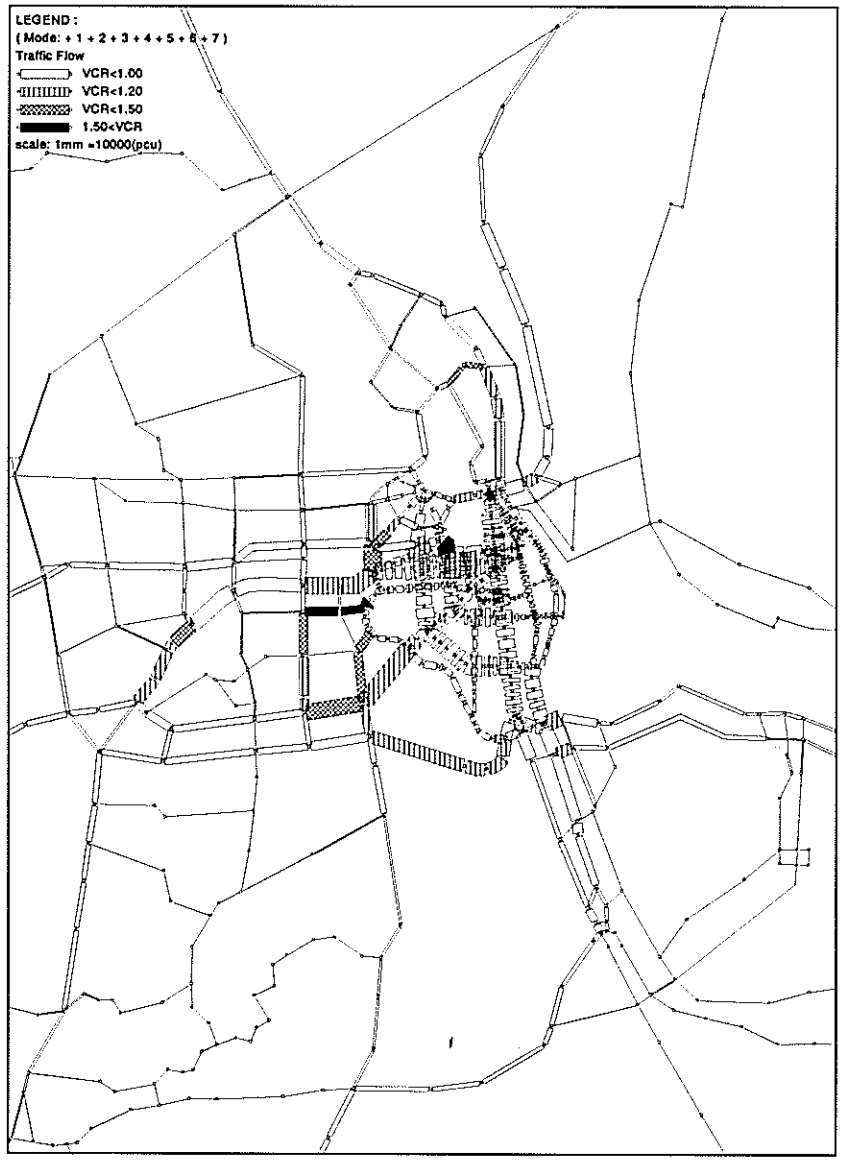
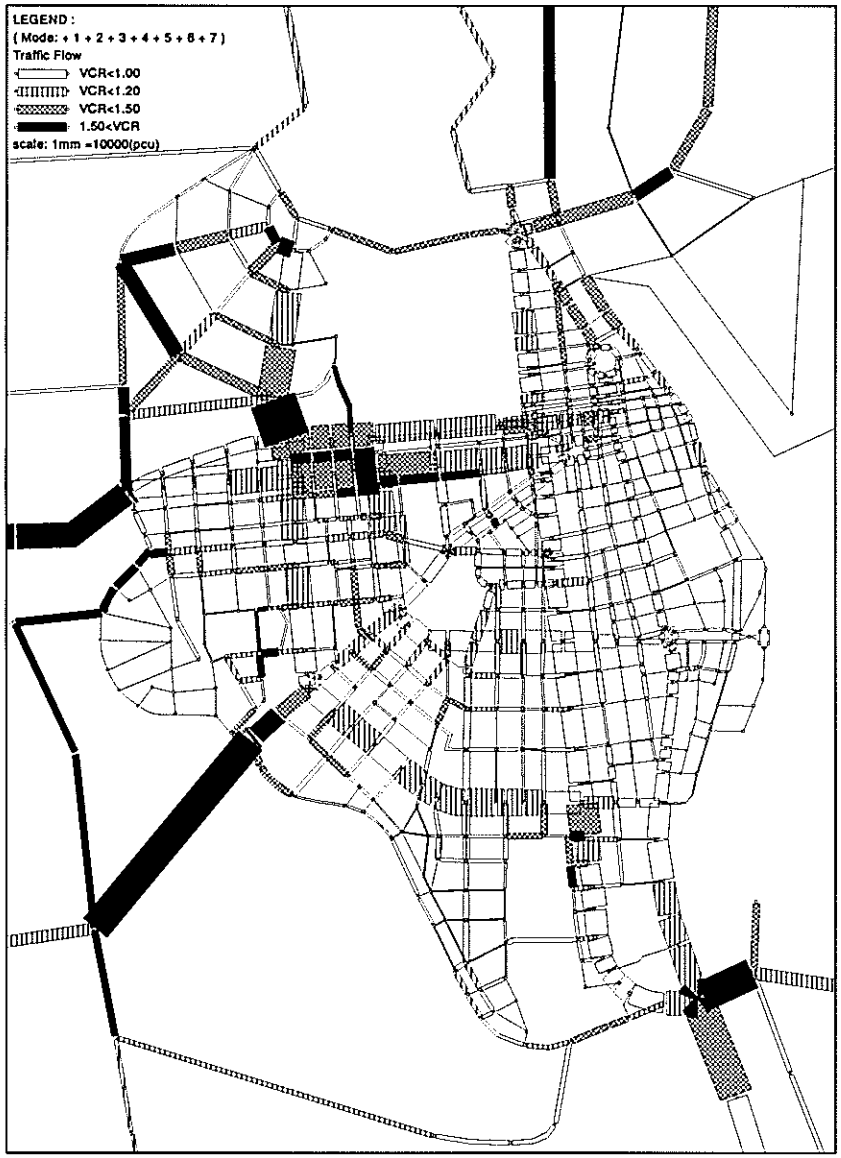


"With Master Plan Case"

Figure 13.2-8 Traffic Assignments in Suburban Area - 2015 -



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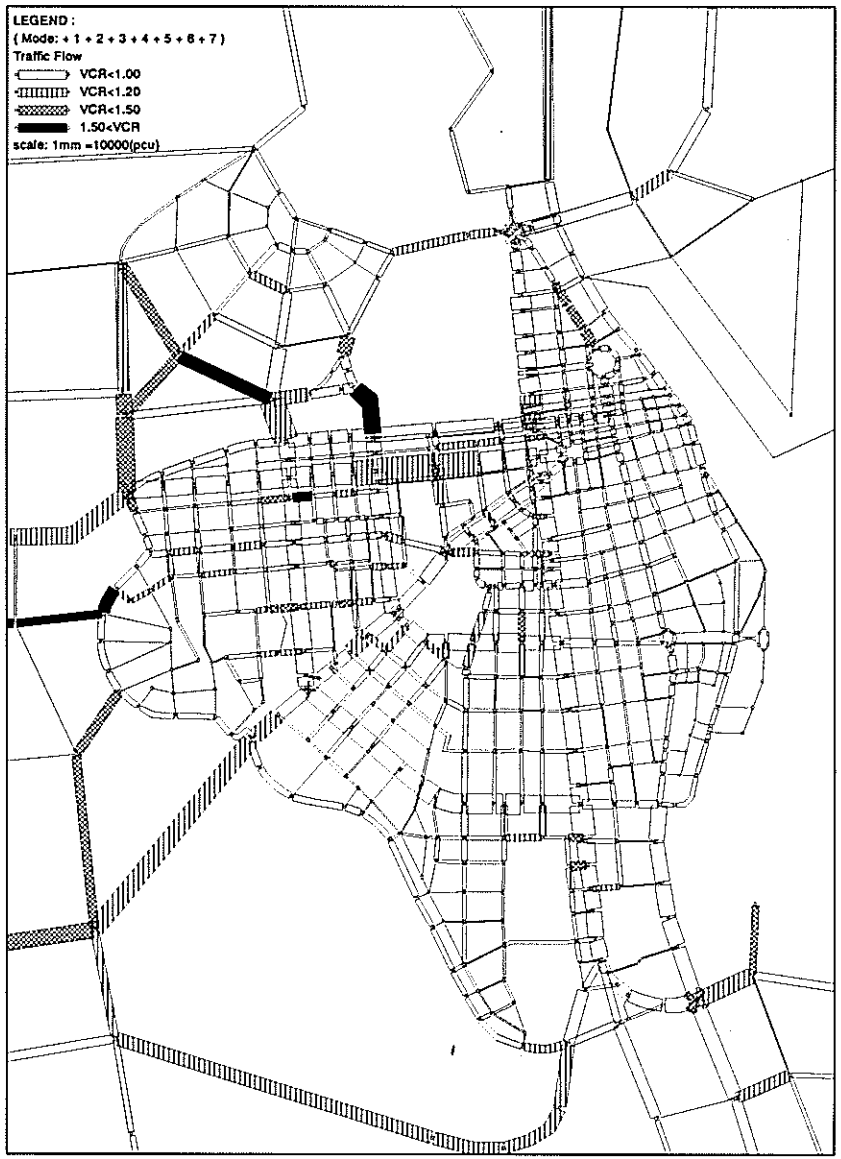

"With Master Plan Case"

Figure 13.2-9 Traffic Assignments in Urban Area - 2015 -

Table 13.2-8 Comparison of "Master Plan Case " and "Do Nothing Case"

Year	Decrease in PCU-Km (%)	Increasing Rate in Average Speed	Decrease in Traffic Cost (%)
2005	95.7	1.13	76.3
2010	92.8	1.28	72.8
2015	91.2	1.47	69.6

The analysis results demonstrate the necessity of implementing the Master Plan to avoid further concentration of traffic flow in the urbanized area and to encourage an efficient public transport system such as bus service operation.

(2) Economic Analysis

Procedure

The total economic impact of the Master Plan project is analyzed taking into account that each project element will be implemented as scheduled. The implementation schedule developed in Chapter 21 is preconditioned to identify each term for project investment. The benefits generated by the Master Plan are calculated as savings in Vehicle Operating Cost (VOC) and Travel Time Cost (TTC) when analyzing the two cases of “Master Plan Case” and “Do Nothing Case” for each year.

Project Economic Cost

The economic cost for road sector projects consists of the total costs of construction of road improvement works and bridge reconstruction, land acquisition, engineering and maintenance. Public transport system cost consists of purchasing of buses, construction of bus terminal, depot and other necessary facilities. Traffic management cost consists of installing intersection signalization systems and on street parking. The economic cost for each term in the Master Plan project is shown in Table 13.2-9.

Table 13.2-9 Economic Cost for Master Plan Projects Unit in US$1,000

Sector	Short Term	Medium Term	Long Term	Total
Road Sector				
Urbanized Area	27,940	49,543	3,165	80,648
Suburban Area	47,365	44,997	68,134	160,496
Bridge Reconstruction	4,741	16,489	53,621	74,851
Public Transport System				
Bus System	14,294	12,900	14,880	42,074
Traffic Management & Regulation				
Intersection Signalization	6,422	3,148	7,802	17,372
Total	100,762	127,077	147,602	375,441

Economic Benefit

(a) Vehicle Operating Cost (VOC)

This is one of the main economic benefits in implementing a transport development project. The VOC is composed of the savings in cost of the following items;

- Saving in running cost: This cost of vehicle operation depends on traveled distance in vehicle-km and consists of costs for fuel, lubricant, tire, maintenance and repairs.
- Saving in fixed cost: This cost of vehicle operation depends on traveled time of vehicle in vehicle-hour and consists of costs for capital, crew, overhead and depreciation.

The following sections present a description for the items of the savings in VOC in this study.

(i) Vehicle Cost and Relevant Taxes

Vehicles cost and related taxes are shown in Table 13.2-10. The most dominant types of vehicles used in the country are classified into five main categories, which are motorcycle (MC), passenger car (PC), light truck (LT), heavy truck (HT) and bus (BS).

Table 13.2-10 Vehicle Cost and Taxes (US$)

Code	Model	CIF	Import Tax		Spec. Tax		VAT		Financial Cost	Remarks
MC	Honda C100	600	20%	120	0%	0	10%	72	792	NEW
	Honda C100	250	20%	50	0%	0	10%	30	330	'93
	Suzuki C200	800	20%	160	0%	0	10%	96	1,056	'98
PC	Pajero 2800	31,000	90%	27,900	30%	17,670	10%	7,657	84,227	NEW
	Lancer 1300	15,000	40%	6,000	20%	4,200	10%	2,520	27,720	NEW
	Camri 1800	3,700	40%	1,480	20%	1,036	10%	622	6,838	'89
LT	Pick UP	20,000	15%	3,000	10%	2,300	10%	2,5308	27,720	NEW
	Pick UP	6,500	15%	975	10%	748	10%	22	9,045	'91
HT	Hino	10,000	15%	1,500	10%	1,150	10%	1,265	13,915	'93
BS	ROSA 29	48,000	15%	7,200	10%	5,520	10%	6,072	66,792	New
	Hundia	6,115	15%	917	10%	703	10%	774	8,509	'91

Source: Law on Taxation 1997

(ii) Fuel Cost and Lubricant Cost

Prices of fuel and lubricant are shown in Table 13.2-11.

Table 13.2-11 Fuel Cost (US$/LT)

Item	Regular	Diesel	Lubricant
Financial Cost	0.54	0.38	3.00
Tax (IT,SP,VAT)	0.18	0.07	0.20
Economic Cost	0.36	0.31	2.80

Note : IT, (Import Tax), SP.T, (Specific Tax)

(iii) Repair and Maintenance Cost

Travel distance varies depending on such factors as vehicle type and road surface condition. Table 13.2-12 shows the repair and maintenance cost.

Table 13.2-12 Repair and Maintenance Cost (US$/km)

Item	MC	PC	LT	HT	BS
Frequency (km)	15,000	45,000	45,000	30,000	15,000
Spare Parts	0.0003	0.0011	0.0011	0.0033	0.01
Labor Cost	0.0003	0.0002	0.0002	0.0009	0.0019
Maintenance Cost	0.0006	0.0013	0.0013	0.0042	0.0119

Source : Car Dealer, Bus Operation Company

(iv) Tire Cost

Prices of different types of tires are shown in Table 13.2-13. Passenger car tires are subject to high rate (50 percent) of import tax.

Table 13.2-13 Tire Cost (US$)

Code	Economic Cost (1Set)	Import Tax		VAT		Profit Tax		Financial Cost	No. of Tire
		%	Amount	%	Amount	%	Amount		
MC	16.00	15	2.40	10	1.84	1	0.20	20.44	2
PC	156.00	50	78.00	10	23.40	1	2.57	25	4
LT	204.00	15	30.60	10	23.46	1	2.58	26	4
HT	940.00	15	141.00	10	108.10	1	11.89	1,200	10
BS	402.00	15	60.30	10	46.23	1	5.09	51	6

Source : Study Team survey

(v) Depreciation Cost

No established formula for depreciation of motor vehicles is available in Cambodia. In this study, depreciation is calculated as the quotient of difference between the price of a vehicle at the time of first sale in Cambodia and the residual value, or resale price, after a certain period of use divided by number of years of the said use.

Table 13.2-14 Depreciation Cost

Item	Unit	MC	PC	LT	HT	BS
Economic Vehicle Cost	US$	600	15,000	20,000	70,000	48,000
Residual Value	US$	250	3,700	6,500	10,000	6,115
Vehicle Life	Year	7	10	7	5	10
Depreciation Rate	%p.a	8.3	7.5	9.6	17.1	8.7
Depreciation Amount	US$	50	1,125	1,920	11,970	4,176
Average Running p.a	Km	7,142	20,000	28,600	60,000	30,000
Depreciation Cost	US$/km	0.007	0.056	0.067	0.20	0.14

Source : Car Dealer, Bus Operation Company
Thus, depreciation rate is $Dp = \{(Vi - Vr) / Yu\} / Vi$
Dp : Depreciation Rate, Vi : First sale price(CIF),
Vr : Residual value, Yu : Vehicle life

(b) Saving in Travel Time Cost (TTC)

Table 13.2-15 presents the time value estimated for the household of Car owner, Motorcycle owner and Non Vehicle owner based on the average GNP/Capita and the household average income. The unit traffic cost by vehicle type is estimated as shown in Table 13.2-16. Values of VOC and TTC savings of the years 2005, 2010 and 2015 are summarized in Table 13.2-17.

4) Economic Analysis Results

Costs and benefits for the project elements were allocated to each year from 2001 to 2025. The cost beyond year 2015 is that for maintenance and operation while benefit was assumed to have the same growth rate as in year 2014/2015 and the residual value was calculated assuming a project life of 50 years. Table 13.2-18 presents the economic cash flow of the Master Plan project. The economic analysis is carried out for the master plan period of 15 years and for a period of 25 years, as benefits of projects implemented by the end of the master plan period will be generated in the years beyond 2015.

Net Present Value (NPV) and Benefit-Cost Ratio (B/C) with a discount rate of 12% were calculated at about M.US$47.3 and 1.32 respectively for the 15 year period, and at M.US$114.4 and 1.62 respectively for the 25 year period. The corresponding values of the Economic Internal Rate of Return (EIRR) were calculated at 19.50 and 22.02 for the two periods.

Table 13.2-15 Travel Time Cost

Item	Car Owner	Motorcycle Owner	Non-veh. Owner	Note
Household Income	306	115	70	US$/month
Number of Persons	4	4	4	Person/household
Monthly Working Hours	192	192	192	Hours/person
Hourly Income	0.40	0.15	0.09	US$/hour/person
Time Value				
Business Trip	0.40	0.15	0.09	
Other Trip	0.10	0.04	0.02	
Trip Composition				
Business Trip	23.5%			
Other Trip	76.5%			
Travel Time Value				
Person Base	0.17	0.06	0.04	US$/hour/person
Vehicle Base				
Motorcycle	0.09			Occupancy = 1.8
Passenger Car	0.25			Occupancy = 3.0
Light Truck	0.29			Occupancy = 7.5
Heavy Truck	-			Occupancy = 3.0
Bus	0.78			Occupancy =20.0

(Prices at year 2000)

Table 13.2-16 Unit Traffic Cost by Vehicle Type (US$)

Vehicle Type	Running Cost	Fixed Cost	Travel Time Cost
Motorcycle	0.018	0.0104	0.091
Passenger Car	0.053	0.2501	0.248
Light Truck	0.037	0.3838	0.291
Heavy Truck	0.175	2.3546	0.117
Bus	0.068	3.4630	0.78

(Prices at year 2000)

Table 13.2-17 Future VOC and TTC Savings of year 2005, 2010 and 2015 (US$1,000)

Year	Case	VOC km	VOC hr	TTC	Total	Savings
2005	Do Nothing	104,623	10,545	11,825	126,993	
	Master Plan	76,409	10,226	10,241	96,876	30,117
2010	Do Nothing	130,087	15,869	15,843	161,799	
	Master Plan	91,804	14,393	11,745	117,942	43,857
2015	Do Nothing	164,153	24,912	22,602	211,667	
	Master Plan	114,619	18,551	14,245	147,415	64,252

Table 13.2-18 Economic Cash Flow of Master Plan (US$1,000)

Year		Costs	Benefit	B-C	Discounted Values		
					Cost	Benefit	B-C
1	2001	2,111	0	- 2,111	2,111	0	-2,111
2	2002	25,362	0	-25,362	22,645	0	- 22,645
3	2003	51,828	0	-51,828	41,317	0	- 41,317
4	2004	21,603	27,371	5,768	15,377	19,482	4,105
5	2005	12,497	30,117	17,620	7,942	19,141	11,199
6	2006	26,156	32,866	6,710	14,842	18,649	3,807
7	2007	26,067	35,613	9,546	13,206	18,043	4,837
8	2008	24,873	38,361	13,488	11,251	17,353	6,101
9	2009	24,953	41,108	16,155	10,078	16,603	6,525
10	2010	25,028	43,857	18,829	9,025	15,815	6,790
11	2011	30,872	47,935	17,063	9,940	15,434	5,494
12	2012	31,343	52,014	20,671	9,010	14,953	5,943
13	2013	28,728	56,093	27,365	7,374	14,398	7,024
14	2014	28,371	60,172	31,801	6,502	13,790	7,288
15	2015	28,288	64,252	35,964	5,788	13,147	7,359
16	2016	22,056	68,606	46,550	4,030	12,534	8,504
17	2017	6,429	73,257	66,828	1,049	11,950	10,901
18	2018	6,141	78,223	72,082	894	11,393	10,499
19	2019	5,477	83,526	78,049	712	10,862	10,150
20	2020	1,572	89,190	87,618	183	10,356	10,173
21	2021	18,309	95,239	76,930	1,898	9,873	7,975
22	2022	2,772	101,701	98,929	257	9,413	9,156
23	2023	4,540	108,603	104,063	375	8,975	8,600
24	2024	3,837	115,977	112,140	283	8,558	8,275
25	2025	- 176,631	123,854	300,485	-11,637	8,160	19,797
							NPV=114,427
							B/C=1.62
							EIRR=22.02

13.3 MASTER PLAN COMPONENTS

13.3.1 Selected Transport Master Plan

The selected transport system of "Alternative 4" is based on the bus-favored policy to cover existing deficiencies and requirements of the transport infrastructure in the Study Area. Under this alternative, bus services are operated first only on limited high-demand routes and are to be expanded in the future based on the growth in demand and improvements in the road network. Regulating the movement of two-wheelers on bus routes will be applied with the improvement in parallel side streets to accommodate the high demand of two-wheelers' traffic. Figure 13.3-1 shows a conceptual plan for the components of the Master Plan in the year 2015. Basically, the planning components are as follows:

- Road Network Development
- Traffic Management Measures
- Public Transport System
- Traffic Regulating Measures

In the planning process of each component, policies and strategies are established in order to provide directions for a comprehensive planning concept with optimum implementation scheme that incorporates the staging plans of each component. Under this process, considerations are given to

the planning requirements for the urbanized area and the suburban area separately based on the characteristics of land-use, transport system, road network in each area.

In the urbanized area, where the road network does not require new roads, planning is concentrated on providing efficient public transport system and applying management measures. For the suburban area, which will accommodate future development projects, an efficient road network is required to connect developed areas together and to strengthen connections with the national road network. In addition, another main planning task is to provide a public transport system that can handle the future demand and provide strong links with the urbanized area.

(1) Traffic Legislation Measures

The present traffic conditions on the streets of the Study Area reflect the urgent need to apply restricted regulation measures in order to provide the minimum requirements of safe and smooth traffic. With the existence of many unqualified drivers without licenses and unregistered vehicles without number plates, it is impossible to develop the transport system in the city. In general, the development process and components of required traffic regulating measures are based on the following:

- Introducing an effective vehicle registration system
- Establishment comprehensive driver license system
- Developing human resource capacities.

(2) Road Network Development

The present road network in the Study Area has different characteristics for the urbanized area and the suburban area. Roads in the urbanized area require mainly to be paved and to be provided with management measures in order to provide smooth and safe traffic movement. The Inner Ring Road, which is currently under construction, surrounds this built-up area. Additional ring roads in the suburban area are required to cope with the expansion in future land-use activities. In general, the road network development process and components are based on the followings:

- Previously planned, committed and on-going projects
- Future land-use planning and socioeconomic activities
- Population growth and distribution
- Trip pattern and characteristics
- Future traffic demand and assigned volumes
- Requirements of transport modes, especially the public transport
- Requirements of network functional hierarchy
- Social and physical environment considerations
- Technical and economic viability
- Budget allocation and investment resources
- Interaction with the national transport system

(3) Public Transport System

The present public transport provision in the Study Area is inefficient due to the lack of a mass public transport system. People depend mainly on the motodop as the main public transport mode for door-to-door trips. Despite its popularity, this service is inefficient and poses a danger to passengers and drivers as well. In addition, it is a primary contributor to traffic problems. Considering the population and size of the urbanized area, an efficient public transport system, based on bus-service operation, that can handle the future demand and provide accessibility to developed areas, is required to improve the transport conditions and city environment. In the future, the transport pattern will be changed from the motodop mode to another pattern of: “walking from house to bus stop – bus service – walking from bus stop to destination”. In general, the development process and components of the required public transport system are based on the following:

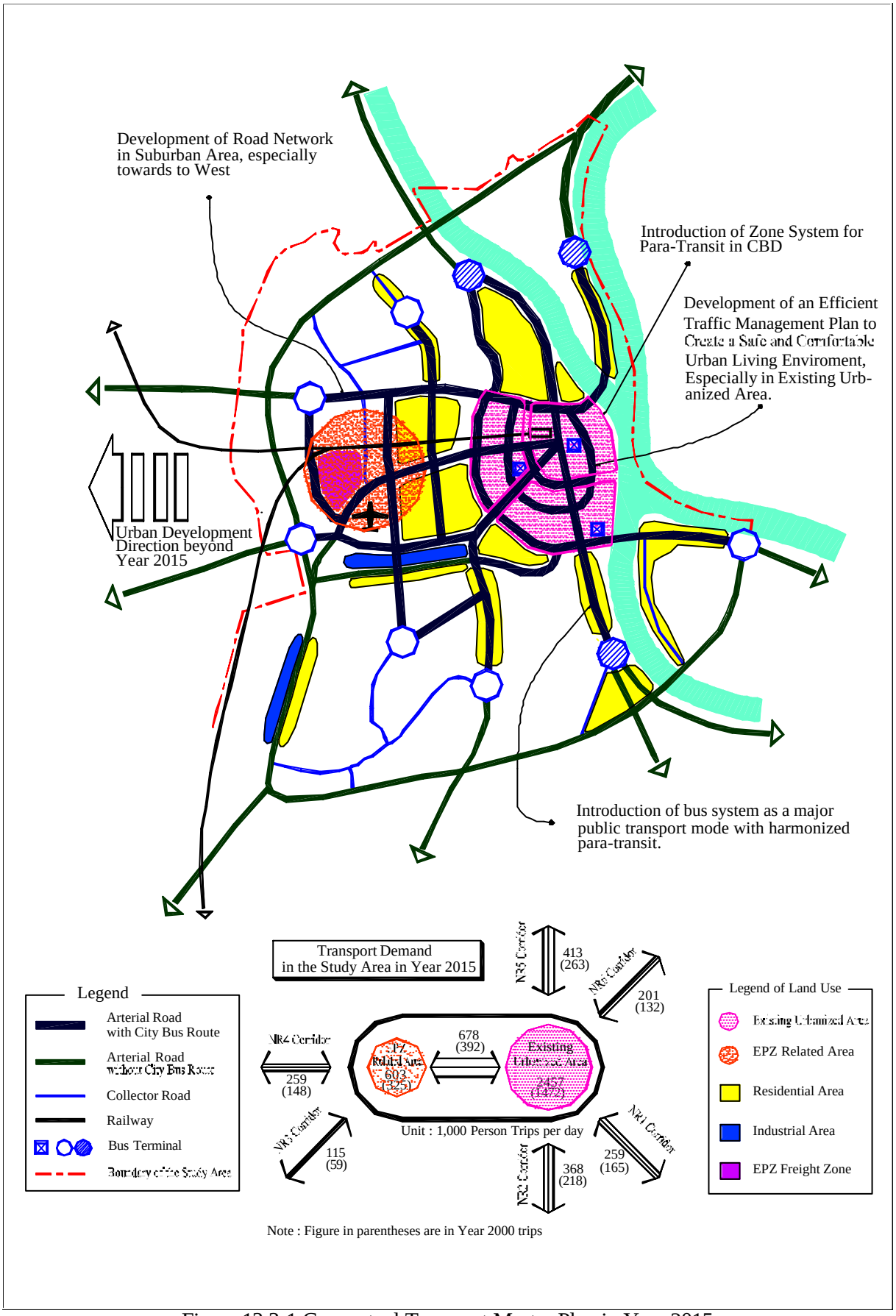

Figure 13.3-1 Conceptual Transport Master Plan in Year 2015

- Future population and urban size
- Future socio-economic activities
- Public transport demand
- Income level
- Optimum routing to cover high demand generating zones
- Optimum use of existing transport facilities
- Staging of other transport Master Plan components

(4) Traffic Management Measures

Problems with traffic management in the Study Area impose themselves as a major issue that should be solved in the Master Plan. Traffic congestion, accidents, disordered flow and inadequate regulation and control are dominant features of the traffic pattern especially in the urbanized area. In general, the development process and components of the required traffic management measures are based on the following:

- Optimum use of existing facilities
- Introducing applicable methods and techniques
- Encouraging the shift from private to public modes
- Promoting safety education for each target group of road-users
- Strengthening traffic enforcement personnel and facilities
- Interim measures and long-term measures
- Providing traffic control and safety devices

13.3.2 Master Plan Component

The Transport Master Plan is composed of all components of road, public transport and traffic management including traffic regulation measures. Various projects are proposed with staging implementation plans as summarized in Table 13.3-1.

Figure 13.3-2 graphically shows the location of proposed projects of the Transport Master Plan for each implementation stage of 2001-2005, 2006-2010 and 2011-2015.

Table 13.3-1 Proposed Major Projects of Transport Master Plan

Area	Sector	Major Project	Short Term (2001-2005)	Medium Term (2006-2010)	Long Term (2011-2015)	Total
Urbanized Area	Road	- Pavement Improvement	67.7 km	217.4 km	-	285.1 km
	Public Transport	- Bus Operation	44.7 km	9.5 Km	-	54.2 km
	Traffic Management	- Traffic Signals	13 Intersections	33 Intersections	51 Intersections	97 Intersections
Suburban Area	Road	- Improvement - New Construction	65.3 km	69.9 km	95.9 km	231.1 km
	Public Transport	- Bus Operation	26.3 km	21.5 km	46.0 km	93.8 km
	Traffic Management	- Safety Measures	- Education - Enforcement	-	-	-
Transport Legislation		- Vehicle Registration System	- Computerized System	-	-	-
		- Driver License System	- Computerized System - Education	-	-	-
		- Human Resource Capacity	- Training	-	-	-
		- Institution and Organization Development	- Personnel and Office	-	-	-

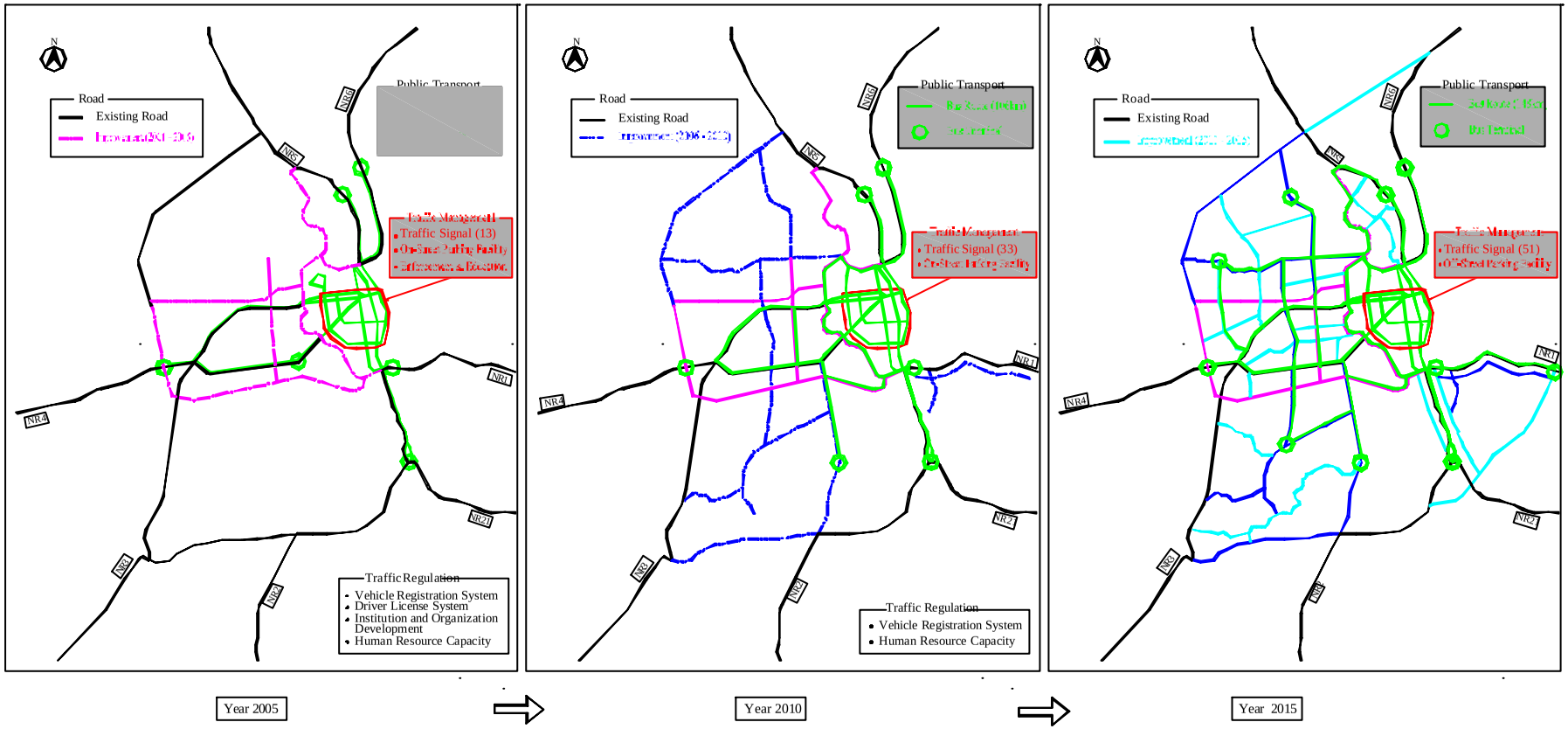

Figure 13.3-2 Proposed Projects and Measures of Transportation Master Plan

13.3.3 Effects of the Master Plan

The proposed Master Plan is designed to provide a reliable and economical means for the movement of people and commodity transport, and is evaluated to be economically viable. It is, therefore, concluded that the Master Plan should be implemented on schedule.

The effects of the Transport Master Plan are summarized from the viewpoints of target realization, transport system efficiency, economic benefits and indirect effects as follows.

(1) Target Realization

- Spatial Distribution of Urban Activity:
  This target is achieved by allocating future population in accordance with the proposed land use plan and providing road networks based on the traffic demands generated by each activity.
- Historic City with Urban Environment and Tourism Heritage:
  This is realized through alleviation of traffic congestion by introducing public transport system (coexistence of bus with para-transit by sharing their functional roles), implementing effective traffic management system including the installation of traffic signals and improving pavement of urban streets.
- Modern City with Urban Structure and Development Potentiality
  Providing access to planned development areas, formulating functional road network and introducing effective public transport system, attains this target.
- Transport System Responsive to Future Traffic Demand
  This is the direct goal of the Transport Master Plan, which is realized by implementing the proposed projects and measures in accordance with the established implementation schedule.

(2) Traffic Efficiency Improvement

As indicated by such parameters as the gross Vehicle-kilometer (pcu-km), gross Travel Time (pcu-hr) and average Volume/Capacity ratio (VCR) and average Travel Speed, the proposed Master Plan satisfactorily caters for the future traffic demand and maintains a desirable traffic efficiency in the Study Area, when compared with the "Do Nothing case".

- Decrease in PCU-km; 91.3 % in Year 2015
- Increase in Average Travel Speed; 1.49 times
- Decrease in Traffic Cost; 69.6 %

(3) Economic Benefits

In addition, The Master Plan projects and measures are planned to mitigate the existing traffic congestion on the urban roads as well as the national roads.

As described in Section 16.3, the Proposed Master Plan yields the economic benefit in ten (10) years after its completion as follows.

- NPV = US$ 114.4 million
- B/C = 1.62
- EIRR = 22.02

(4) Indirect Benefits

(i) Promotion of Basic Infrastructure for Future Development
As the economy is developed and population is increased, a need for infrastructure is also

increased; particularly the demand for a reliable and efficient transport system becomes great. The proper timing to start the provision of such a transportation system for the Municipality of Phnom Penh is assessed to be on time now. Therefore, the Master Plan proposes the start of development of such transport system at the earliest time.

(ii) Sound Development of Urban Area

Since the existing urbanized area has a limited capacity in terms of transportation, the concentration of urban activities and population shall be avoided. Therefore, the Master Plan intends to properly distribute such concentration to the existing urbanized area and suburban area to be developed.

(iii) Promotion of Tourism Industry

The city intends to preserve the historic heritage and urban scenery not only for the urban environment but also for the promotion of tourism. The Master Plan is designed in accordance with this policy by offering an efficient public transport system.

(iv) Improving traffic safety level

A traffic safety campaign was carried out under the Study and its successful impact is highly recognized. The Master Plan includes measures to improve the safety level through education programs for road-users and enforcement measures. In addition, the improvement works of the road network include safety facilities such as traffic signs and road markings at populated areas. These measures will decrease the potential of road accidents.

(v) Improving living environment

When traffic flow becomes smooth, acceleration and deceleration of vehicles decrease. As a result, exhaust gas and noise emitted by the vehicles are reduced, improving the living environment. Also, improvement of the pavement will substantially decrease the dust in the air, which is the main component of the PM (particle material) of the air in the Study Area.

(vi) Promotion of desirable form of development

The proposed Master Plan is designed to provide access to the planned development areas. This improved access is expected to promote the development of the planned areas and increase the commercial value of the land in these areas. As a result, uncontrolled sprawl of the urbanized area is prevented and a desirable form of development is promoted. At the same time, the areas which are developed in desirable form are expected to attract people and businesses, and to mitigate the undesirable increase of population in the present urbanized area.

(vii) Promotion of economic/industrial activities

Smooth traffic reduces the time and cost of both persons and cargo transportation. With less transportation cost, products services become competitive. As a result, growth of the economy/industry will be accelerated.

(viii) Fulfilling basic human needs

The Master Plan provides access to the remote villages where presently access by 4 wheel vehicles is not possible. With access by 4 wheel vehicles, the people in these villages can enjoy such benefits as urgent transportation of patients with serious illness or injury, and better transportation to/from school.

(ix) Promotion of poverty reduction

The proposed Master Plan is designed to provide safe transportation with reasonable price. This will allow the people in the remote villages to have improved access to the markets and improved journeys to/from the jobs.