CHAPTER 5 : PILOT PROJECT ROAD

The pilot project was carried out to understand natural and traffic conditions in and around the Maputo city respectively, and to plan the optimum road structures, to plan drainage facility structures, to plan traffic control facilities, to collect technical data on material and traffic characteristics, to confirm the material and equipment procurement situation, construction conditions and so on.

Rua S o Pedro was selected by reason of high priority factors regarding adequate right of way, easy drainage installation. Other factors were almost same as other candidate roads. The location of pilot project roads is shown in Figure 5.1.1. Furthermore, The evaluation result of pilot project road is presented in Chapter 17 Basic Design Standard.



Figure 5.1.1 Location of Pilot Project Road

CHAPTER 6 : TRAFFIC SURVEYS

6.1 TRAFFIC SURVEY ITEMS

Traffic surveys were carried out regarding Cordon line survey, Screen line survey, Spot traffic volume survey, Screen turning movement survey at major intersections, Running speed survey and Axle load survey in November and December 2000.

6.2 TRAFFIC SURVEY COMPONENT

Traffic survey items are composed of bellows.

- Traffic Counts: pedestrians, cars, private minibuses, public mini buses (chapas), public midi buses, big buses, light goods, medium goods, heavy goods and motorcycles
- Traffic Signal intersections: turning movements by vehicle type (car, goods, bus), signal phasing and timing and queue length
- Origin Destination roadside Interviews: vehicle type, number of passengers, origin, destination, journey purpose, frequency of trip, load carried (if goods) and whether car drivers had an off-street parking space at home
- Journey Time Survey: To survey traffic speeds in morning, inter and evening time.
- Bus Occupancy Surveys: To determine bus passenger flows on major corridors.
- Bus Passenger Survey: to determine origin-destination data.
- Car Driver Interview: Origin, destination, journey purpose, amount paid for parking.

CHAPTER 7 : TRAFFIC SURVEY RESULT

7.1 O-D SURVEY AND JOURNEY TIME

According to the result of OD survey, the average numbers of passengers carried by each vehicle type as shown in Table 7.1.1. Bus is used many passengers.

Table 7.1.1 Passengers Per venicle Surveyed					
Vehicle Type	No. of passengers				
Car	2.1				
Bus	23.1				
Light Goods	2.4				
Medium Goods	4.0				
Heavy Goods	3.7				
Motor Cycle	1.3				
All Goods vehicles	3.6				

Table 7.1.1 Passengers Per Vehicle Surveyed

Furthermore, Table 7.1.2 presents the journey purposes of cars interviewed. Especially, the purpose for work is 50 % more. And propose of employers business and personal business is also 15 % more. The journey time is from 5 to 7 o'clock in the morning. For most of the routes, there is a general tendency for evening peak journey times to be higher than in the morning. It is around 5 o'clock in the evening.

Purpose	%
Work	57.2
Education	1.8
Shopping	5.4
Employers business	15.1
Personal business	15.7
Sport/leisure	2.0
Social	1.4
Other	1.4
Total	100.0

Table 7.1.2 Journey Purpose of Car Drivers

7.2 TRAFFIC COUNTS

3 cordons or screenlines were defined as follows :

- External Cordon– around the city boundary
- Outer Screenline following the railway
- Central Area Cordon around the city center (outside Av Mao Tse Tung, Av Marien Ngoubai and Av de Tanzania)

Figure 7.2.1 shows the proportions of total traffic in the city crossing these lines.



Figure 7.2.1 percentages of daily traffic Crossing Screenlines

7.3 BUS PASSENGER INTERVIEWS

Table 7.3.1 shows the numbers of interviewed passengers who expected to use 2 or more buses to complete their journeys. Nearly 40% of passengers used 2 or more buses. The highest proportion of interchanging passengers (83%)was found at Junta, where buses leave for destinations out of Maputo, and the lowest at Rua dos Luslades (6%), which is a terminal (Museo) for a large number of routes.

Number of Buses	Passengers	%
1	1371	60.6
2	829	36.6
3	64	2.8

 Table 7.3.1 Numbers of Buses Used per Journey

The average fare paid per passenger (excluding long distance trips) was 3,900 Mts.

7.4 AXLE LOADS

Table 7.4.1 and Table 7.4.2 list the average and maximum loads carried by goods vehicles surveyed in December 2000.

Table 7.4	Vehicles Unit: tonnes	
Vehicle Type	Maximum Load	
Light Goods	2.0	6.0
Medium Goods	2.9	12.5
Heavy Goods	9.2	26.0

Table 7.4.2 Axle Loads of Goods Vehicles				
Vehicle Type	Maximum Axle Load			
Light Goods	1.5	3.5		
Medium Goods	2.95	7.8		
Heavy Goods	4.7	7.8		

CHAPTER 8 ESTABLISHMENT OF SOCIO-ECONOMIC FRAMEWORK

8.1 PRESENT CONDITION

According to the census, the population of Maputo city was 550,000 people in 1980, but the one increased to 967,000 people in 1997. The rate of increase exceeds largely the 1.84% of population rates of increase of 3.37%, which is the average rate of whole country per year as shown in Table 8.1.1.

Table 8.1.1	Population Growth in Maputo, Matola and Mozambique					
	1980	1997	1980-1997			
	in thousand	in thousand	Per annum %			
Maputo City	550	967	3.37			
Matola City	206	425	4.35			
Mozambique	12,130	16,534	1.84			

Source : 1980 - Structural Plan of the Maputo Metropolitan Area Vol.

1997 – 2nd General Census of Population and Habitation 1997

Furthermore, according to the census in 1997, the employment population of Maputo city is about 300,000 people and the employment rate is 31.1% a shown in Table 8.1.2.

Table 8.1.2Employment Proportion in 1997					
	Maputo City Maputo Province				
		Urban	Rural		
Population	966,837	505,858	300,321		
Employment	300,959	145,634	128,526		
Employment	31.1%	28.8%	42.8%		
Proportion					

Source : 2nd General Census of Population and Habitation 1997

Other hand, Land use pattern in Maputo City is characterized by C.B.D. that covers the former urban area , and urban area expanding towards the north and the west as shown in Table 8.1.3.

		Table 8.1.3		Present Land Use			
	Urban	Suburban	Spontaneo us	Public	Garden	Green/ Vacant	Total
Area ha	762.3	2,416.4	2,201.7	812.7	52.2	767.1	7,014.1
Proportion %	10.9	34.5	31.4	11.6	0.7	10.9	100.0

Source: ENDEREÇAMENTO, Excluded Catembe, Inaka

FUTURE SOCIO-ECONOMIC FRAMEWORK 8.2

Population estimation in 2010 follows the estimation of 2,416,000 by Maputo Metropolitan Area Structural Plan. Population increase from 2010 to 2020 is estimated by an increase rate of 3.7 % per annum which Maputo Metropolitan Area Structural Plan indicates in its lower increase case, on the assumption that the inflow into metropolitan area will be restrained as shown in table 8.2.1.

Table 8.2.1 Population Forecast in Maputo Metropolitan Area by "Structural Plan"					
	Population	Population	2000-2010	Population	2010-2020
	2000	2010	per annum	2010	per annum
Maputo					
Metropolitan Area	1,632,000	2,416,000	4.00%	3,470,000	3.7%
P	opulation	Population	Growth	Pro	oportion
20	000	2010	Per ann	um %	
Maputo 1	,090,000	1,366,000	2.28	56.	5%
Matola 4	73,000	955,000	7.28	39.	5%
Province 7	0,000	97,000	3.32	4.0	%
Total 1	,632,000	2,416,000	4.00	100).0%

Table 8.2.1	Population	Forecast in	Maputo	Metropolitan	Area by	"Structural Plan"
	1			1	•	

"Province" consists Boane and Marracuene

Thus populations in 2020 are estimated by the same increase rate (3.7%) as approximately two times against in 2000.

Future employment proportion in Maputo city and Matola city is estimated at 31 % and 29 % respectively by following the present proportion by Census in 1997. Results of estimation of future employment based on the residence in Maputo and Matola are shown in Table8.2.2.

	Table 8.2.2 Employment Forecast by Residential Area					
		Maputo City	Matola City	Total		
1997	Population	966,837	424,662	1,412,024		
	Employment	300,959	* 123,700	424,700		
2010	Population	1,366,000	955,000	2,321,000		
	Employment	423,000	277,000	700,000		
2020	Population	1,960,000	1,370,000	3,330,000		
	Employment	608,000	397,000	1,005,000		
Employ	ment Proportion	31%	29%	30%		

: Estimated by the Employment Proportion of 29% of Maputo Province.

Land use plan of the Maputo Metropolitan Area in 2010 is shown in Figure 8.2.1.



Figure 8.2.1 land Use Plan in 2010 by the Structural Plan of the Maputo Metropolitan Area

CHAPTER 9: FUTURE TRAFFIC DEMAND

9.1 GENERAL METHODOLOGY

The primary tool used for forecasting traffic in this study was the JICA STRADA software. This is a traffic and transit assignment model, with a large number of supporting modules for matrix development and manipulation, network editing and reporting.

The basic approach adopted was to develop origin-destination tables from traffic data gained in the surveys, and simulate the highway network using JICA STRADA. A validated base year (2000) model was created in order to test the effects of changes to both the scale and pattern of trips in the future, and proposals to improve the highway network to accommodate these. Future year models the Study Team developed for the years 2020 and 2010.

There are four main data sources used for developing traffic forecasts as below:

- Highway network data derived from observations and formal surveys,
- Traffic data derived from the traffic surveys,
- · Car Ownership Data from local and national sources, and
- GRDP Estimates from national and international sources.

In addition, population and employment data as described in Chapter 8 were also used in the development of traffic forecasts.

9.2 CAR OWNERSHIP FORECASTING METHODOLOGY

It is widely observed that individual car ownership is strongly linked to personal or household income. At city or national level it is reasonable to take Gross Domestic Product (GDP) or Gross Regional Domestic Product (GRDP) as an indicator of average incomes in a country or region. In order to estimate the effect that increasing GRDP in Maputo will have on car ownership the Study Team have taken data from a number of developing and developed countries. These data are shown in Table 9.2.1

Area	GRDP/Capita	Cars owned per
	(US\$)	1000 people
Angola	660	18
Zambia	410	17
Tanzania	220	0.8
Mozambique	235	1.8
Zimbabwe	780	29
Botswana	3,310	15
Congo	130	17
Jakarta	1,090	72
Bangkok	2,741	85
Bayern (Germany)	21,955	540
South Africa	3,180	100
Mecklenburg (Germany)	8,718	470
Moscow	2,317	205

 Table 9.2.1 GRDP and Car Ownership, Selected Cities and Countries

A polynomial equation was fitted to this data. The best fit was found to be:

(1) $C = -2 \times G^2 / 1000000 + 0.0598 \times G - 19.041$

Where C = Car owned per 1000 population

G = GRDP per capita

However, this equation is too highly geared to the squared component giving unfeasibly low car ownership results at medium and high GRDP inputs. As a result the curve shown in Figure 9.2.1 was developed. The best curve has the equation :

(2) $C = -1 \times G^2 / 1000000 + 0.0474 \times G - 15.619$

Where C = Car owned per 1000 population

G = GRDP per capita



Figure 9.2.1 Synthesised GRDP vs Car Ownership Curve

GRDP in Maputo was estimated in 1998 by the World Bank to be \$980 per head. Application of the above formula gives a synthetic car ownership of 27.2 cars per 1000 population. This is only slightly below (7%) the observed value. Equation (2) was adopted for forecasting car ownership in Maputo.

9.3 DISSAGGREGATE CAR OWNERSHIP FORECASTING

Population data for each sub-district in Maputo was used as the basis for disaggregate car ownership forecasting. These data were allocated to traffic zones.

For each zone car ownership was estimated and the number of consequent trip generations calculated on the basis of a fixed trip rate per car for all zones of 3.8 car trips per day per vehicle. These synthetic trips were calibrated against trip generations from the OD Table so that the aggregate car ownership in Maputo that resulted matches the data.

The disaggregate car ownership estimates were then used to estimate GRDP/capita in each traffic zone. The formula used to convert car ownership to GRDP is as follows:

(3) $G = 0.03 \times C^2 + 20.5 \times C + 317.7$ Where C = Car owned per 1000 population G = GRDP per capita

The base year 2000 model was developed with 3 transport modes (car, goods and bus). Average vehicle occupancy for each type were found from the surveys and set as:

-	Buse Ieur IIVe	inge venicie oei
	Car :	2.1
	Goods :	3.6
	Bus :	19.7

 Table 9.3.1 Base Year Average Vehicle Occupancy

In order to estimate bus trip generations passenger flows were aggregated across the survey locations. This allows for an aggregate modal share of trip making across the city to be determined.

The ratio of bus passengers to car passengers is 2.9. This target was adopted in preparing disaggregate forecasts of bus trip generations. The general method adopted therefore assumed that :

 $\mathbf{B}_i = f(\mathbf{PNC}_i)$

Where B_i = bus trip generations in zone i PNC_i = population not owning a car in zone i

Such that :

$$\sum B_i = 2.9 \times \sum C_i$$

Where $C_i = car trip generations in zone i$

9.4 GRDP FORECASTS

Forecasting economic growth is not something that can be done with a great degree of certainty, especially in southern Africa. To a large extent, developing countries are simply not in control of their economies – the greater forces tend to international politics and multi-national capital. Since the end of the Civil War Mozambique has enjoyed economic growth, albeit from a very low base. The Study Team believe that in the short term the conditions exist for such growth to continue but feel that growth predictions over the longer term should be purposely conservative in order to hedge against potential political instability, wider international economic problems, inflation and devaluation of the currency. Furthermore the Study Team prefers to offer scenarios for economic growth without applying judgments at the outset.

For this study the Study Team have adopted three economic growth scenarios : low, medium and high as set out in Table 9.4.1

Period		-	
	Low	Medium	High
1998 to 2010	3%	4%	5%
2010 to 2020	2%	3%	5%

 Table 9.4.1
 Economic Growth Scenarios, Maputo, GRDP per head

The effect of these three scenarios on GRDP for Maputo is shown in Figure 9.4.1



Figure 9.4.1 Forecasts of GRDP per head, Maputo

The High scenario forecasts suggests that in 20 years time the population of Maputo will enjoy the same real income levels as that of Bangkok. This is highly implausible. For this reason alone, the Study Team believe that forecasting should concentrate on the Low and Medium scenarios.

9.5 DISAGGREGATE CAR AND BUS FORECASTS

Figure 9.5.1 shows total car and bus trip forecasts graphically. In considering the highway network required to absorb this demand it is very important to take account of the large rise in demand for bus travel ,and hence the numbers of vehicles expected on the network.. For the future the Study Team have assumed the same bus occupancy as observed in the surveys. Should bus occupancy rise, through an increase in the average size of vehicle, the overall effect in pcu (passenger car unit) terms is likely to be small.



Figure 9.5.1 Total Daily Forecast Bus and Car Trip Generations, Maputo

9.6 FUTURE YEAR BASE NETWORKS

In order to test options for road development programmes, 'Do-Minimum' networks were established for the forecast years of 2010, and 2020. The 2010 Do-Minimum network includes the following additions and amendments to the base network

- Improvement of Rua da Machava to Dual-2 lane standard between Av Vladimir Lenine and the City boundary at Machava, with high capacity at grade junctions at Av de Angola and Av Accordos do Lusaka, and an all movement junction at Av de Mozambique, with grade separation maintained.
- The completion of the improvement to EN4 from the city boundary to Av de Trabalho (in the base year network the capacity of these links was reduced to reflect the fact that traffic was surveyed during the construction period)
- The full rehabilitation to Dual-2 standard of Av Organacao dos Nacioas Unidas, which was flood damaged in February 2000.

The same network was also adopted for the 2020 Do-Minimum case

9.7 DO-MINIMUM TRAFFIC FORECASTS

Figures 9.7.1 to 9.7.3 show forecast volume to capacity ratios



Figure 9.7.1 Do-Minimum (2020) (Low Growth)



Figure 9.7.2 Do-Minimum (2020) (Medium Growth)



Figure 9.7.3 Do-Minimum (2020) (High Growth)

Figures 9.7.1 to 9.7.3 reveal that under all of the economic growth scenarios, by the year 2020 Maputo will become severely congested unless counter-measures are taken. The forecast average speeds on the network represent a massive deterioration in the level of service, to an extent that the economic development of city would be adversely affected.

The primary problem faced by the city will be the huge increase in demand for the north-south movement due to the massive population increase in Magoanine and areas on the north side of the city. The key roads which are likely to suffer from heavy and persistent congestion would be:

Low Growth

Av. de Mozambique Av Vladimir Lenine Av Julius Nyerere, north of Praca dos Combatentes Av Accordos do Lusaka Av 24 de Julho Av Guerra Populare

Medium Growth

As above plus

Rua da Machava, junctions with Av de Angola, Av Acccordos de Lusaka,

Av Vladimir Lenine

Av Julius Nyerere, south of Praca dos Juventudes

Av Mao Tse Tung

Av 25 de Septembro

Av de Angola

High Growth

As above plus Rua da Machava, whole length

From the above it is clear the urgent priorities in the future will be :

- Additional north-south capacity along the Av de Mozambique corridor
- Relief to traffic on Av Vladimir Lenine, through the re-instatement of Av Julius Nyerere or new north-south capacity on the east side of the city
- Development of the Av Accordos do Lusaka corridor and increase to a consistent capacity in the city center (Av Guerra Populare)
- Strengthening of the east-west capacity

CHAPTER 10 : INITIAL ENVIRONMENTAL EXAMINATION AND RECOMMENDATION OF MITIGATION MEASURES

10.1 GENERAL

As concerns the future road network (the master plan for the road development), it is required to examine whether striking environmental impacts arise from implementation of the project or not and to evaluate the results.

10.2 ENVIRONMENTAL EVALUATION

1) Social Environment

Resettlement

There are a lot of shops, residential buildings settled along roads and streets. It is anticipated that there would be a resettlement will be required due to widening of the existing roads.

Economic Activities

Possibility of changes to economic structures and land use values including commercial activities and job opportunities will be considered by construction of road and widening section. These changes would have both positive and negative impacts depending on the circumstances and situations in the areas. Therefore, construction of road and widening section shall be planed and designed to mitigate possible negative impacts in accordance with future developments and land use plans.

Road and traffic

On these deteriorated roads, the vehicle speed is forced to be slow, and such low speed traffic aggravates the air pollution emitted from vehicle exhausts. Therefore, the traffic condition and the air pollution shall be improved by the improvement project.

Public Facilities

Public facilities, such as commercial facilities (markets), medical facilities, educational facilities, and cultural institutions, are mostly located in the center areas of Maputo city. These public facilities are taken a special care of consideration on congestion, accidents and others in this study.

Split Community

The communities have been formed not only by administrative, but also cultural boundaries, such as racial, linguistic, and religious differences. In case of improving the existing roads, these indigenous communities should not be affected.

Cultural Property

There are 18 items of cultural property mentioned in previous section under state protection in Maputo city. Some of them are not far from the improvement roads, therefore the construction of roads should be carefully designed to avoid negative impact on these cultural properties.

Solid Waste

Proper solid waste management will be required during the construction and operation stage respectively.

2) Natural Environment

Topography and Geology

No impact will be expected during and after the improvement.

Soil Erosion

No impact will be expected during and after the improvement. However, there are intensive rainfalls in the rain season, it is necessary to take a notice on soil erosion at final design and construction stages.

Ground Water

No impact on the ground water is expected. On the other hand, the quality of ground water will be improved because of the development of a drainage ditch of roads.

Flora and Fauna

Mangroves, open green space and street trees exist in the project area. However, no impact on mangroves and open green space will be expected. Regarding street trees, some impact will be expected due to the road construction and widening.

Meteorology

No impacts can be predicted on the meteorological situation.

3) Environmental Pollution

Air Pollution

As a result of the calculation, apparently, environmental loads of NO_x , CO and CO_2 caused by vehicle traffic will decrease by the implementation of the projects.

Water Pollution

No impact on water is expected in the area. However, during the construction stage, the surplus soil, construction debris and so on shall be controlled to avoid contamination of the Maputo bay.

Noise and Vibration

The increase of total numbers of vehicles in the study area, namely, the increase of noise level will be concerned in the future. Therefore, some of mitigation measures should be considered.

10.3 RECOMMENDATION OF MITIGATION MEASURES

1) Social Environment

Resettlement

There should be necessity to establish a rule on compensation for resettlement by the government. And it is important to make a resettlement plan in which opinions of residents are admitted.

Economic Activities

Special policy to promote new economic activities along roads shall be considered to mitigate negative impacts on existing economic activities by the projects in accordance with the situations of areas.

Public Facilities

Traffic safe facilities that mitigate traffic accidents such as pedestrian crossing, guard fence and traffic signs and so on are expected to be constructed.

Split of Community

Mitigation measures to the split of primary school zones are considered as follows:

- To establish pedestrian crossing

- To limit car speed

Cultural property

As some of the state protected cultural properties are near by improvement roads, special care should be given during the construction period. It is important to make a work plan that include the specific contracting clauses to define responsibilities of constructing companies and workers who will actually to the construction work.

Solid Waste

In order to mitigate impacts on solid waste of the projects, proper solid waste management by official management (in addition, by constructing companies during the construction period) will be required during the construction and operation stage respectively.

2) Natural Environment

Soil Erosion

As there are intensive rainfalls in the rain season, it is necessary to take notice on soil erosion. At final design and construction stages to mitigate soil erosion, several countermeasures such as planting, slope protection and construction of drainage ditch will be necessary in accordance with the soil situations.

Flora and Fauna

Street trees that are in conflict with road development can be replaced with new trees. Therefore, at design stage the space for trees should be considered.

3) Environmental Pollution

Air Pollution

1) During Construction Period

To prevent the fugitive dust emission and its dispersion, it is proposed to provide a water sprinkling system at the construction site, particularly for residential areas.

2) During Operation Phase

- Establishment of a national standard regarding air quality, emission of vehicle exhausts gas quantity and quality.
- Introduction of an obligatory car inspection system.
- Build up a public traffic system, and convert car use to public traffic use.
- Improvement of road structures:

The concentration of automotive emissions decreases by diffusion as the distance from the road increases. Therefore, it is important to maintain distance between roads and dwellings by the establishment of buffer zones and greenbelts.

- Improvement of traffic flow:

Improvement of speed and control of starting and stopping is expected to reduce the concentration of exhaust gas from vehicles.

Noise and Vibration

- 1) During Construction Period
- Use low noise producing equipment
- Control daily operation hours
- 2) During Operation Phase
 - Introduction of obligatory systems for equipping muffler devices with adequate quality controlled by a technical standard and a muted horn with a national standard on every vehicle will be principal measures for mitigating road noise.
 - Facilities to mitigate future noise level issue such as a planted area, green belt and so on are expected to be constructed along the roads.

CHAPTER 11 : FORMURATION OF ROARD DEVELOPMENT MASTER PLAN

11.1 INTRODUCTION

As described in Chapter 8, urbanization of Maputo City will continue at fairly high speed. The future population of Maputo City is expected to grow up to about 2 times as large as present, while future employment will also grow up to about 2 times as large as present as shown in Table 11.1.1.

However, this urbanization will not follow the trend of the past that is characterized by a strong concentration of business functions in the city center and disorderly expansion of residential area in the suburbs.

For a lot of reasons, the Road Development Plan as well as the urban development plan should enhance the urban activities in order to avert economic inefficiency brought about by urban biases.

	Present	2010	2020
Population ('000)	1,090	1,366	1,960
Employment ('000)	301	423	608
Total Daily Trip ('000)	500	750	1,100

Table 11.1.1 Prospects of Urban Development of Maputo

11.2 ROAD DEVELOPMENT CONCEPT

Based on the future traffic demand forecast on the basis of the land-use development plan, the following road development concepts have been evaluated:

- Classified Road Development to improve Basic Human Needs and Environment
- Road Development to solve Existing Road Problems
- Road Development to enhance Future Traffic Efficiency
- Road Development to promote Metropolitan Development

1) Classified Road Development to improve Basic Human Needs and Environment

The Road Network System should be developed in a hierarchic manner based on the Road Classification proposed by the Study Team together with its functions as shown in Table 11.2.1 and recommendable location of trunk roads is shown in Figure 11.2.1. The proposed road classification is mainly concerned with following two types of roads.

- Primary Trunk Road and Trunk Road ------ Trunk Roads
- Collector Road and Local Area Road ----- Community Roads

			Expec	ctable Functi	on		Target			
Road Class	Ті	raffic Func	tion	Con	nmunity S Function	Service n				
	Speed	Traffic	Access control	Access to Public Facility	Bus/ Emerg. vehicle	Access to Community zone	Location	Traffic capacity	Speed	
Primary Trunk Rd.	High/ Medi.	Heavy	Full control	Partial access	Full service	No school zone cut/ penetration	Outside school zone	High	High/ medi. 60-80	
Trunk Rd.	High/ medi.	Heavy	Partial control	Direct access	Full service	No school zone cut/ penetration	Outside school zone	High	High/ medi. 60-80	
Collector Rd.	Medi.	Medi.	No control	Direct access	Full service	Direct access	Inside school zone	Medi.	Medi. 30-5-	
Local area Rd.	Low	Small	No control	Indirect access	Partial service	Direct access	Inside school zone	Small	Low 20-40	

 Table 11.2.1 Proposed Functions of Classified Roads

2) Road Development to solve Existing Road Problems

Identification of the existing road problems of the Maputo City has been conducted in previous chapter. The major problems identified are:

- Deterioration of Road Pavement in urbanized area (See Figure 11.2.2)
- Heavy Deterioration of Community Roads in sub-urbanized area
- Traffic Congestion (See figure 11.2.3 and 11.2.4)
- Poor Drainage System
- Poor Road Maintenance

3) Road Development to enhance Future Traffic Efficiency

Based on the future traffic assignment on the Road Network of "Do Minimum" case which consists of the existing road network plus a widening of Mashava Road from 2 to 4 lane carriageways committed by the Central Government, expected heavy traffic congestion on the following North-South Corridors and on the roads in the city center should be solved by either widening of existing carriageways or new construction of Bypasses for alternatives as follows.

Av. Mocambique:	-	Widening to Dual Carriageway, or
	-	Construction of New Bypass

- Av. Julius Nyerere: Widening to Dual Carriageway on northern section and
 - Reconstruction of Dual Carriageway on Missing Link or
 - New construction of Bypass on Missing Link
- Av. Acordos de Lusaka: Increasing traffic capacity by widening dual carriageway on entire section and by improvement of intersections through construction of grade separation or well designed signal junction
- Av.Vladimir Lenine: Increasing of traffic capacity by construction of proper bus stops and improvement of intersections due to difficulty of large amount of land acquisition and compensation for widening of existing road to dual carriageway.

Av. F.P.L.M:- Extension and widening of Av.F.P.L.M or
- Strengthening of Av. Julius Nyerere, Av. Vladimir Lenine and Av.
Acordos de Lusaka

Av. Marien Ngouabi: - Extension and Widening of Av.Marien Ngouabi

4) Road Development to promote Metropolitan Development

In the Structure Plan of the Metropolitan Maputo, the future Trunk Road Network is already prepared as shown in Figure 11.2.5. This Trunk Road Network links with important urban facilities efficiently and also future potential development areas as well as follows.

- Extension of Outer Ring Road (extension of Rue 5.750) to Matola
- Widening of Middle Ring Road (Machava Road)
- Widening of Av. Mocambique or construction of New Bypass
- Widening of Av. Julius Nyerere or construction of New Bypass
- Extension and Widening of Av. F.P.L.M



Figure 11.2.1 Recommendable Location of Trunk Roads



Figure 11.2.2 Road Pavement to Be Improved





Figure 11.2.4 2020 Do-Minimum Medium Growth







Figure 11.2.6 Metropolitan Maputo Structure Plan

11.3 PUBLIC TRANSPORT DEVELOPMENT CONCEPT

1) Development concept of Public Transport

Based on the Future Traffic Estimation, Future Demand of Bus Traffic would grow rapidly. In order to enhance the Future Bus Traffic efficiency, following development concepts for Public Transport are proposed.

Existing Problems	Required Measures						
Lack of Public Transport Services	Open Public Transport Operation by Road						
	Rehabilitation of existing Bus Route						
	Settle un-serviced areas through improvement of Collector Roads						
Shortage/congestion of Bus Stops	Construction of proper Bus Stops on Trunk						
	Roads						
Congestion/shortage of Bus Terminals	Construction of proper Bus Terminals with						
	enough space for Markets near Trunk Road						
	Intersections						
Slow Bus Operation	Introduction of Bus Lanes on Dual						
	Carriageway Roads for smooth operation of						
	Buses						
Lack of Bus Information	Installation of Information Boards at each						
	Bus Stop and Terminal						

Table 11.3.1 Public Transport Development Concept

2) Proposed Bus Route and Facilities

Existing trunk routes of Public Buses operate on the two North-South Corridors and on the two East-West Corridors. Future Trunk Bus Routes should be traced on the existing routes and bus operations on the Missing Link of Av. Julius Nyerere re-opened. And suspended Bus route due to the road surface condition on Av. Angola should be also re-opened. (See Figure 11.3.1)

ROAD DEVELOPMENT OF THE CITY OF MAPUTO JI<u>CA_STUDY TEAM</u>



Figure 11.3.1 Public Transport Improvement Plan

11.4 ROAD DEVELOPMENT ALTERNATIVES

1) Establishment of Road Development Alternatives

Based on the development concepts with the necessary measures to be improved for Road Development and Public Transport Development, the following six alternatives for Road Development for long-term target (year 2020) have been proposed.

In case of Trunk Road Development, recommended locations for proposed Trunk Roads has been identified and limited. Therefore, the magnitude of Trunk Road Development including numbers of carriageway, type of major intersection and Road Classification could become a proposed component to be varied in the alternatives as follows; (see Table 11.4.1-2 and Figure 11.4.1-6)

Figure 11.4.7 shows proposed typical cross-sections as well as required right-of-way width to be applied for each road development plans. Furthermore the preliminary construction costs were estimated as shown in table 11.4.3.

Do Minimum case	: On-going road development projects, such as widening of Machava road
	to be a dual carriageway with grade separation withAv. Mocambique and
	emergency drainage repair of heavy eroded section (Missing Link) of Av.
	Julius Nyerere have been included in this case.
Conception Plan	: Conception Plan is the basic plan which the Maputo Municipality is
	expecting and all the necessary measures have been incorporated in the
	plan. (See Figure 11.4.1)
Plan A case	: Based on the preliminary evaluation of the Conception Plan,
	construction of alternative bypass for the Missing Link of Av Julius
	Nyerere and shorting of widening sections of extension of Av. F.P.L.M.
	and Av. Marien Ngoubai have been incorporated in the plan in order to
	avoide.huge construction cost for the reconstruction of the Missing Link
	of Av. Julius Nyerere and huge impacts on ressettlment for the widening
	of the extension of Av. F.P.L.M. and Av. Marien Ngouabi. (See
	Figure11.4.2)
Plan B case	: Adding Grade Separations and Intersection Improvements into the Plan
	Ain order to strengthen traffic capacity of road network of PlanA. (See
	Figure 11.4.3)
+ Bypass 1 case	: Based on the future traffic assignment on the road network of the Do
	Minimum Case, the traffic demand on the Av. Mocanbique would become

large compared to the traffic capacity of the existing road. Therefore, construction of a new bypass instead of widening of existing Av. Mocanbique to each alternative road networks has been incorporated. (See Figure 11.4.4-6)

Based on the above evaluations of the road development components, following six road development alternatives have been established;

	1.4.1 Road Development Alternatives
Alternatives	Components
Do Minimum (base case)	Existing road network plus on-going rod projects
Plan 1	Conception Plan case
Plan 2	Plan A case
Plan 3	Plan B case
Plan 4	Conception Plan case plus Bypass 1 case
Plan 5	Plan A case plus Bypass 1 case
Plan 6	Plan B case plus Bypass 1 case

Table 11.4.1 Road Development Alternative

Table 11.4.2 Comparison of Road Development Components by Alternative									
Main	Section	Existing	Do	Plan	Plan	Plan	Plan	Plan	Plan
components		network	Minimum	1	2	3	4	5	6
Primary Trun	k Rd. – North-South (Corridor –(I	No. of lane)						
Av.	North	2	2	2	2	2	4	4	4
Mocambique	South	2	2	4	4	4	2	2	2
Corridor	Bypass	-	-	-	-	-	4	4	4
Av. Julius	Norht	2	2	4 +	4	4 +	4 +	4	4 +
Nyerere				GS1		GS1	GS1		GS1
	Missing link	-	-	4	-	-	4	-	-
	Bypass	-	-	-	4	4	-	4	4
	South	4	4	4	4	4	4	4	4
Trunk Rd(N	o. of lane)								
Machava		2	4 + GS1	4 +	4 +	4 +	4 +	4 +	4 +
Rd.				GS2	GS1	GS2	GS2	GS1	GS2
Av. FPLM	West	-	-	4	-	-	4	-	-
	Central	4	4	4	4	4	4	4	4
	East	-	-	4	4	4	4	4	4
Av. Marien	West	2	2	4	2	2	4	2	2
Ngoabai	East	2	2	4	4	4	4	4	4
Collector Rd. (Pavement Type)									
	District 1 Rd.	As	As.	As.	As.	As.	As.	As.	As.
	District 2/3 Rd.	E/G	E/G	As.	AS.	As.	As.	As.	As.
	District 4/5 Rd.	E/G	E/G	As.	AS.	As.	As.	As.	As.
	Potential area Rd.	E/G	E/G	E/G	E/G	E/G	E/G	E/G	E/G
Area Rd. (Pavement Type)									
	District 1 Rd.	G/As.	G/As.	As.	AS.	As.	As.	As.	As.
	District 2/3 Rd.	E/G	E/G	G/As	G/As	G/As	G/A	G/A	G/A
							S .	s .	s.
	District 4/5 Rd.	E/G	E/G	E/G	E/G	E/G	E/G	E/G	E/G
	Potential area Rd.	E/G	E/G	E/G	E/G	E/G	E/G	E/G	E/G

Table 11.4.2 Comparison of Road Development Components by Alternative

GS1: One Grade Separation, GS2: Two Grade Separations, As: Asphalt Pavement, E: Earth Road, G: Gravel Roa

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Figure 11.4.1 Proposed Road Development Alternative (Plan 1) Figure 11.4.2 Proposed Road Development Alternative (Plan 2)



Figure 11.4.3 Proposed Road Development Alternative (Plan 3) Figure 11.4.4 Proposed Road Development Alternative (Plan 4)

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Figure 11.4.5 Proposed Road Development Alternative (Plan 5)

Figure 11.4.6 Proposed Road Development Alternative (Plan 6)



4-lane widening of Av. da Mozambique



4-lane widening of Julius Nyerere



4-lane widening of Inner Ring Road



Collector Road (2lane)



Collector Road (Semi Urban/Rural)

Collector Roads (minimum width)

/Utility Space

Figure 11.4.7 Proposed Typical Cross-sections

Table 11.4.3 Preliminary Construction Costs and Project Costs for each Alternative (1/	oject Costs for each Alternative (1/2)
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										Projec	t Road	Non Project Rd.	ĺ
										Routine M	Routi,&Period, M.	Routine&	
										0-10 years	10-20 years	Periodic M	
										o ro years	2% appual	r critoure in:	
Dlan 1					a a						1.0%/1.0 year		
		<u> </u>	C.C x 10%	C.C x 2%	C.C x 10%		D 1				10%/10year		
	Road	Construction	Contingonou	Administration	Engineering	Subtotal	Relocation	House	Project Cost	Maintenance	Maintenance	Main 44	Cost
Project	Length	Cost	Contingency	Cost	Service	Subtotal	Cost of	Compensation	Floject Cost	Cost I	Cost2	Maintenance	Grand Total
	(km)	(USD)	(USD)	(USD)	(USD)	(USD)	Public Utilities	Cost (USD)	(USD)	(Before Project)	(After Project)	Cost3(USD)	(USD)
1 Public Transport(Bus Terminal)		1 385 000	138 500	27.700	138 500	1 689 700	(03D)	0	1 689 700	(03D)	346.250	0	2 035 950
2 Traffic Circulation(Link Signal)		2 430 000	243 000	48 600	243 000	2 964 600	0	0	2 964 600	0	607 500	0	3 572 100
3 Grade Separation(2 no.)		4,300,000	430,000	86,000	430.000	5,246,000	0	238,900	5,484,900	0	1.075.000	0	6.559.900
4 Construction of Primary Trunk Roads	15.05	16.136.656	1.613.666	322,733	1.613.666	19,686,721	3.027.750	104.100	22.818.571	180,600	4.034.164	0	27.033.335
5 Construction of Trunk Roads	71.92	56.517.004	5,651,700	1.130.340	5,651,700	68,950,745	10.664.311	4,606,100	84.221.156	863.040	14,129,251	0	99.213.447
6 Improvement / Rehabilitation of Collector Roads	92.28	26.722.943	2.672.294	534.459	2.672.294	32,601,991	6.528.849	1.637.900	40.768.739	665.514	6.680.736	19.884.186	67,999,175
6.1 Roads District 1	18.64	7,419,453	741.945	148.389	741.945	9.051.733	0	40.000	9.091.733	223,620	1.854.863	13,488,748	24.658.965
6.2 Roads District 2	10.23	2.346.996	234,700	46.940	234.700	2.863.335	1.239.050	743.200	4,845,586	61.356	586.749	1.729.983	7.223.674
6.3 Roads District 3	9.48	2 681 145	268 115	53 623	268 115	3 270 997	1 148 054	543 900	4 962 952	56,850	670.286	517 733	6 207 821
6.4 Roads District 4	27.26	7.408.405	740,840	148,168	740.840	9.038.254	1,963,946	79,200	11.081.400	163.572	1.852.101	2.016.145	15.113.218
6.5 Roads District 5	26.69	6.866.944	686.694	137.339	686.694	8.377.671	2,177,798	231.600	10.787.069	160,116	1.716.736	2.131.577	14,795,498
7 Improvement of Catembe Roads	9.00	5,119,025	511,903	102.381	511,903	6.245.211	2,177,790	251,000	6.245.211	54,000	1,279,756	2,131,377	7.578.967
Total	188.25	112 610 630	11 261 063	2 252 213	11 261 063	137 384 968	20 220 909	6 587 000	164 192 877	1 763 154	28 152 657	19 884 186	213 992 875
Plan ?	100.25	112,010,050	11,201,005	2,202,210	11,201,005	157,501,900	20,220,909	0,007,000	101,192,077	1,705,151	20,102,007	19,001,100	210,772,075
							D 1						
	Road	Construction	Contingancy	Administration	Engineering	Subtotal	Relocation Cost of	House	Project Cost	Maintenance	Maintenance Cost2	Maintananaa	Cost
Project	Length	Cost	(USD)	Cost	Service	(UCD)	Dublic Utilities	Compensation	(USD)	(Refere Project)	(After Project)	Cost2(USD)	Grand Total
	(km)	(USD)	(USD)	(USD)	(USD)	(USD)	(USD)	Cost (USD)	(USD)	(USD)	(USD)	C0813(03D)	(USD)
1 Public Transport(Bus Terminal)		1.385.000	138,500	27,700	138,500	1,689,700	0	0	1.689.700	0	346.250	0	2.035.950
2 Traffic Circulation(Link Signal)		2.430.000	243.000	48,600	243.000	2,964,600	0	0	2,964,600	0	607,500	0	3.572.100
3 Grade Separation(2 no.)		0	0	0	0	0	0	0	0	0	0	0	0
4 Construction of Primary Trunk Roads	15.05	16,136,656	1,613,666	322,733	1,613,666	19,686,721	3,027,750	104,100	22,818,571	180,600	4,034,164	0	27,033,335
5 Construction of Trunk Roads	53.89	37,164,356	3,716,436	743,287	3,716,436	45,340,514	6,331,962	2,030,300	53,702,775	646,716	9,291,089	0	63,640,580
6 Improvement / Rehabilitation of Collector Roads	92.28	26,722,943	2,672,294	534,459	2,672,294	32,601,991	6,528,849	1,637,900	40,768,739	665,514	6,680,736	21,178,695	69,293,684
6.1 Roads District 1	18.64	7,419,453	741,945	148,389	741,945	9,051,733	0	40,000	9,091,733	223,620	1,854,863	13,488,748	24,658,965
6.2 Roads District 2	10.23	2,346,996	234,700	46,940	234,700	2,863,335	1,239,050	743,200	4,845,586	61,356	586,749	2,076,377	7,570,067
6.3 Roads District 3	9.48	2,681,145	268,115	53,623	268,115	3,270,997	1,148,054	543,900	4,962,952	56,850	670,286	961,804	6,651,892
6.4 Roads District 4	27.26	7,408,405	740,840	148,168	740,840	9,038,254	1,963,946	79,200	11,081,400	163,572	1,852,101	2,016,145	15,113,218
6.5 Roads District 5	26.69	6,866,944	686,694	137,339	686,694	8,377,671	2,177,798	231,600	10,787,069	160,116	1,716,736	2,635,621	15,299,542
7 Improvement of Catembe Roads	9.00	5,119,025	511,903	102,381	511,903	6,245,211	0	0	6,245,211	54,000	1,279,756	0	7,578,967
Total	170.23	93,257,981	9,325,798	1,865,160	9,325,798	108,528,737	15,888,560	3,772,300	128,189,597	1,546,830	22,239,495	21,178,695	173,154,616
Plan 3													
	Poad	Construction			Engineering		Relocation			Maintenance	Maintenance		Cost
	Koau	Construction	Contingency	Administration	Engineering	Subtotal	Cost of	House	Project Cost	Cost 1	Cost2	Maintenance	C IT I
Project	Length	Cost	(USD)	(USD)	Service	(USD)	Public Utilities	Cost (USD)	(USD)	(Before Project)	(After Project)	Cost3(USD)	Grand Total
	(km)	(USD)		(03D)	(USD)		(USD)	C031 (03D)		(USD)	(USD)		(USD)
1 Public Transport(Bus Terminal)		1,385,000	138,500	27,700	138,500	1,689,700	0	0	1,689,700	0	346,250	0	2,035,950
2 Traffic Circulation(Link Signal)		2,430,000	243,000	48,600	243,000	2,964,600	0	0	2,964,600	0	607,500	0	3,572,100
3 Grade Separation(2 no.)		4,300,000	430,000	86,000	430,000	5,246,000	0	238,900	5,484,900	0	1,075,000	0	6,559,900
4 Construction of Primary Trunk Roads	15.05	16,136,656	1,613,666	322,733	1,613,666	19,686,721	3,027,750	104,100	22,818,571	180,600	4,034,164	0	27,033,335
5 Construction of Trunk Roads	53.89	37,164,356	3,716,436	743,287	3,716,436	45,340,514	6,331,962	2,030,300	53,702,775	646,716	9,291,089	0	63,640,580
6 Improvement / Rehabilitation of Collector Roads	92.28	26,722,943	2,672,294	534,459	2,672,294	32,601,991	6,528,849	1,637,900	40,768,739	665,514	6,680,736	21,178,695	69,293,684
6.1 Roads District 1	18.64	7,419,453	741,945	148,389	741,945	9,051,733	0	40,000	9,091,733	223,620	1,854,863	13,488,748	24,658,965
6.2 Roads District 2	10.23	2,346,996	234,700	46,940	234,700	2,863,335	1,239,050	743,200	4,845,586	61,356	586,749	2,076,377	7,570,067
6.3 Roads District 3	9.48	2,681,145	268,115	53,623	268,115	3,270,997	1,148,054	543,900	4,962,952	56,850	670,286	961,804	6,651,892
6.4 Roads District 4	27.26	7,408,405	740,840	148,168	740,840	9,038,254	1,963,946	79,200	11,081,400	163,572	1,852,101	2,016,145	15,113,218
6.5 Roads District 5	26.69	6,866,944	686,694	137,339	686,694	8,377,671	2,177,798	231,600	10,787,069	160,116	1,716,736	2,635,621	15,299,542
7 Improvement of Catembe Roads	9.00	5,119,025	511,903	102,381	511,903	6,245,211	0	0	6,245,211	54,000	1,279,756	0	7,578,967
Total	170.23	93,257,981	9,325,798	1,865,160	9,325,798	113,774,737	15,888,560	4,011,200	133,674,497	1,546,830	23,314,495	21,178,695	179,714,516

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$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Project	Length	Cost	Contingency	Cost	Service	Subtotal	Cost of	Compensation	Project Cost	Cost 1	Cost2	Maintenance	Grand Total
I halk Transport(this Transp	, i i i i i i i i i i i i i i i i i i i	(km)	(USD)	(USD)	(USD)	(USD)	(USD)	(USD)	Cost (USD)	(USD)	(USD)	(USD)	Costs(USD)	(USD)
$ \frac{1}{2} \operatorname{restriction}_{r$	1 Public Transport(Bus Terminal)		1,385,000	138,500	27,700	138,500	1,689,700	0	0	1,689,700	0	346,250	0	2,035,950
	2 Traffic Circulation(Link Signal)		2,430,000	243,000	48,600	243,000	2,964,600	0	0	2,964,600	0	607,500	0	3,572,100
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	3 Grade Separation(2 no.)		4,300,000	430,000	86.000	430,000	5,246,000	0	238,900	5,484,900	0	1.075.000	0	6.559.900
Construction of Track Roads P10 55(3):7041 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 5,8(3):704 6,8(3):704 5,8(3):704 6,8(3):704 5,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 6,8(3):704 70,8(3):704 6,8(3):704 70,8(3):704 70,9(3):735 70,904 70,8(3):704 6,8(3):704 70,8(3):704 70,904 70,8(3):704 70,904 70,8(3):704 70,904 70,8(3):704 70,904 70,8(3):704 70,904 70,8(3):704 70,904 70,9(3):704 70,904 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70,9(3):704 70	4 Construction of Primary Trunk Roads	15.1	30,515,476	3.051.548	610.310	3.051.548	37.228.881	0	0	37.228.881	180,600	7.628.869	0	45,038,350
b provement // Rehabilitation of Callector Roads 202 20/27/240 23/24/09 24/27/240 23/24/09 25/27/240 23/26/290 6.5/27/280 605/270 605/270 605/270 605/270 605/270 605/270 605/270 605/270 10/28/270 13/28/270 23/26/270 23/270 <td>5 Construction of Trunk Roads</td> <td>71.9</td> <td>56,517,004</td> <td>5,651,700</td> <td>1,130,340</td> <td>5,651,700</td> <td>68,950,745</td> <td>10.664.311</td> <td>4,606,100</td> <td>84.221.156</td> <td>863,040</td> <td>14.129.251</td> <td>0</td> <td>99.213.447</td>	5 Construction of Trunk Roads	71.9	56,517,004	5,651,700	1,130,340	5,651,700	68,950,745	10.664.311	4,606,100	84.221.156	863,040	14.129.251	0	99.213.447
6.1 8.8 ads District 1 11.6 al. 7.41.943 (49.94) 7.41.945 (9.94) 9.41.933 (22.60) 1.384.363 (1.384.56) 1.384.363 (1.384.56) 1.384.363 (1.385.96) 7.22.060 (1.384.363 (1.385.96) 7.22.060 (1.384.363 (1.385.96) 7.22.060 (1.384.363 (1.385.96) 7.22.060 (1.384.363 (1.356 (1.356.3	6 Improvement / Rehabilitation of Collector Roads	92.3	26,722,943	2.672.294	534,459	2.672.294	32,601,991	6.528.849	1.637.900	40.768.739	665,514	6.680.736	19.884.186	67.999.175
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	6.1 Roads District 1	18.6	7,419,453	741.945	148.389	741.945	9.051.733	0	40,000	9.091.733	223,620	1.854.863	13,488,748	24.658.965
6.3. Roads Diarrie: 1 9.5 2.6.8.1,45 2.8.1,15 3.2.7097 1.4.8.04 4.4.000 4.9.02.92 5.6.8.0 0.70.280 5.7.7.33 6.2.70.281 6.4. Roads Diarrie: 5 2.6.7 6.8.6.9.44 6.66.9.44 1.07.33.0 68.6.9.44 0.90.8.327.07 2.1.77.70 231.00 1.0.9.73.090 1.0.9.13.72.1 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.34 2.1.9.77.35 0.0 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.9.70 9.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.75.90 7.7.9.7	6.2 Roads District 2	10.2	2,346,996	234,700	46,940	234,700	2,863,335	1.239.050	743,200	4,845,586	61.356	586.749	1.729.983	7.223.674
6.4 Roads District 4 273 7,408,405 740,404 144,108 740,840 9,083,224 1,093,406 7,07,00 11,001,404 143,572 1,452,101 2,016,145 15,113,218 7. Improvement of Catembe Roads 9.0 5,110,025 511,002 10,233,10 66,205,211 10,001,00 10,218,10 6,225,211 510,001 1,727,592 7,775,962 Tail 12,099,944 12,099,944 12,099,945 154,092,128 17,193,190 6,452,000 17,803,181 1,763,154 11,781,148 8,113,218 Forget Roads Construction Construction Construction Roads Construction Roads Roads Mainteasee Mainteasee Mainteasee Mainteasee Mainteasee Mainteasee Mainteasee Construction Cons	6.3 Roads District 3	9.5	2.681.145	268.115	53.623	268,115	3.270.997	1.148.054	543,900	4,962,952	56.850	670.286	517,733	6.207.821
6.5.8 Roads District 5 22.6 6.866.94 017.03 02.177.79 221.00 00.787.00 10.116 1.71.673 2.11.975.76 7.775.78 Trait 281 25.699.449 12.698.944 2.269.945 2.397.89 12.698.944 12.698.944 2.397.89 12.698.944 12.698.944 2.397.89 12.698.945 12.698.944 2.397.89 12.698.945 <td>6 4 Roads District 4</td> <td>27.3</td> <td>7 408 405</td> <td>740 840</td> <td>148 168</td> <td>740 840</td> <td>9 038 254</td> <td>1 963 946</td> <td>79,200</td> <td>11 081 400</td> <td>163 572</td> <td>1 852 101</td> <td>2 016 145</td> <td>15 113 218</td>	6 4 Roads District 4	27.3	7 408 405	740 840	148 168	740 840	9 038 254	1 963 946	79,200	11 081 400	163 572	1 852 101	2 016 145	15 113 218
7. Important of Catembe Roads 9.0 5. 119.023 511.903 102.97.89 5.253.967 6.245.21 0 0 6.245.21 54.000 1.279.759 0 7.783.967 Pin 5 281 126,989.449 12,989,445 154,927.128 17,193,159 6.482,000 17,63,154 31,747,362 19,884,186 211,993.441 231,997.343 Project Cost (USD) Contraction (USD) Cost (USD) Contraction (USD) Subtoal (USD) Release Foreic (USD) Project Cost (USD) Maintenants (USD) Release Cost of (USD) Maintenants (USD) Maintenants Cost of (USD) Maintenant Cost of (USD) Maintenants Cost of (USD)	6.5 Roads District 5	26.7	6.866.944	686,694	137,339	686,694	8.377.671	2,177,798	231,600	10,787,069	160,116	1.716.736	2.131.577	14,795,498
Tetal 281 126,989,449 12,098,945 2,339,789 12,698,945 154,927,128 17,193,159 6,482,900 178,603,187 1,763,154 31,747,362 19,884,186 231,997,890 Project Road (km) Construction (km) Construction (km) Construction (USD) Construction (USD) Subtration (USD) Subtration (USD) Reset (USD) Reset (USD) <t< td=""><td>7 Improvement of Catembe Roads</td><td>9.0</td><td>5,119,025</td><td>511,903</td><td>102,381</td><td>511,903</td><td>6,245,211</td><td>0</td><td>0</td><td>6,245,211</td><td>54,000</td><td>1,279,756</td><td>0</td><td>7,578,967</td></t<>	7 Improvement of Catembe Roads	9.0	5,119,025	511,903	102,381	511,903	6,245,211	0	0	6,245,211	54,000	1,279,756	0	7,578,967
Phospect Construction (km) Construction (km) Construction (km) Administration (km) Engineering (kUSD) Subtol (kDSD) Relaction (kUSD) Hence (construction kost) Maintenance (const) Maintena	Total	281	126,989,449	12,698,945	2,539,789	12,698,945	154,927,128	17,193,159	6,482,900	178,603,187	1,763,154	31,747,362	19,884,186	231,997,890
Project Rodd (usb) Contingent (usb) Administration (usb) Ensistent (usb) Subtral (usb) Relacion (usb) Howe (usb) Maintenance (usb) Maintenance (usb) 1 Public Transport(las Terminal) 0.0 1.435.00 12.430.00 22.70.00 1335.00 1.0.897.00 1.699.700 (usb) 1.699.700 1	Plan 5													
Project Longth (km) Contingency (km) Contisent (km) <th< td=""><td></td><td>Road</td><td>Construction</td><td></td><td>Administration</td><td>Engineering</td><td></td><td>Relocation</td><td>House</td><td></td><td>Maintenance</td><td>Maintenance</td><td></td><td>Cost</td></th<>		Road	Construction		Administration	Engineering		Relocation	House		Maintenance	Maintenance		Cost
(km) (UBD)	Project	Length	Cost	Contingency	Cost	Service	Subtotal	Cost of	Compensation	Project Cost	Cost 1	Cost2	Maintenance	Grand Total
1 Public Transport(Bus Terminal) 0.0 1385.00 1385.00 27,700 1385.00 2,964.00 0 1,689,700 0 346,250 0 2.035,950 2 Trafic Circulation(Link Sgnal) 0.0 2,430,000 243,000 243,000 2,964,600 <		(km)	(USD)	(USD)	(USD)	(USD)	(USD)	(USD)	Cost (USD)	(USD)	(Before Project) (USD)	(After Project) (USD)	Cost3(USD)	(USD)
2 Traffic Circulation(Link Signal) 0.6 2,43,000 243,000 243,000 243,000 243,000 2,964,600 0 <td>1 Public Transport(Bus Terminal)</td> <td>0.0</td> <td>1.385.000</td> <td>138.500</td> <td>27.700</td> <td>138,500</td> <td>1.689.700</td> <td>0</td> <td>0</td> <td>1.689.700</td> <td>0</td> <td>346.250</td> <td>0</td> <td>2.035.950</td>	1 Public Transport(Bus Terminal)	0.0	1.385.000	138.500	27.700	138,500	1.689.700	0	0	1.689.700	0	346.250	0	2.035.950
3 Grade Separation(2 no.) 0	2. Traffic Circulation(Link Signal)	0.0	2.430.000	243,000	48.600	243.000	2,964,600	0	0	2,964,600	0	607.500	0	3,572,100
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	3 Grade Separation(2 no.)	0.0	0	0	0	0	0	0	0	0	0	001,200	0	0
5 Construction of Trunk Roads 53.9 37,164,356 37,164,356 743,287 37,164,36 45,340,514 6,331,962 2,030,300 53,702,775 664,67,16 9,291,089 0 63,640,580 6 Improvement / Rehabilitation of Collector Roads 92.3 26,72,294 32,607,294 53,4459 2,672,294 53,400 4,787,739 665,514 6,680,736 21,78,695 69,295,684 6.1 Roads District 2 10.2 2,346,996 234,700 46,940 234,700 2,863,335 1,239,050 743,200 4,845,586 61,356 586,749 2,076,377 7,570,067 6.3 Roads District 3 9.5 2,661,15 53,623 266,115 3,270,997 1,148,054 543,900 4,962,952 56,850 670,286 961,804 6,518,92 6.4 Roads District 5 26.7 6,866,944 148,168 740,840 9,038,252,11 10,787,069 160,116 1,716,736 2,635,621 1,529,552 1,829,552,100 1,852,100 1,852,500 1,852,500 <	4 Construction of Primary Trunk Roads	15.1	30,422,876	3.042.288	608,458	3.042.288	37.115.909	0	0	37,115,909	180,600	7.605.719	0	44,902,228
6 Improvement / Rehabilitation of Collector Roads 92.3 26,722,943 72,7294 534,459 22,672,294 32,601,991 6,528,849 1,637,900 40,708,739 665,514 6,680,736 21,178,695 69,293,684 6.1 Roads District 1 18.6 7,419,453 741,945 144,389 741,945 9,051,733 0 40,000 9,091,733 223,020 1,854,863 13,488,748 24,658,965 6.2 Roads District 2 10.2 2,45,199 234,700 46,940 233,700 4,964,054,335 1,239,050 1,48,054 543,900 4,962,952 56,850 670,286 961,804 6,651,892 6,651,892 6,651,892 6,651,892 6,651,892 6,651,892 1,529,542 1,18,000 1,07,769 160,116 1,716,736 2,635,621 15,299,542 15,46,830 1,532,422 12,397,771 2,177,798 231,600 10,787,099 160,116 1,716,736 2,635,621 15,299,542 7 Improvement of Catembe Roads 9.0 5,119,025 511,903 102,314 <td>5 Construction of Trunk Roads</td> <td>53.9</td> <td>37,164,356</td> <td>3,716,436</td> <td>743,287</td> <td>3,716,436</td> <td>45,340,514</td> <td>6,331,962</td> <td>2,030,300</td> <td>53,702,775</td> <td>646,716</td> <td>9,291,089</td> <td>0</td> <td>63,640,580</td>	5 Construction of Trunk Roads	53.9	37,164,356	3,716,436	743,287	3,716,436	45,340,514	6,331,962	2,030,300	53,702,775	646,716	9,291,089	0	63,640,580
6.1 Roads District 1 18.6 7.419.453 741.945 9.051.733 0 40.000 9.091.733 223.620 1.854.863 13.488.748 24.658.965 6.2 Roads District 2 10.2 2.346.996 234.700 2.863.335 1.239.050 743.200 4.456.2952 56.850 61.356 586.749 20.763.77 7,570.067 6.4 Roads District 3 9.5 2.681.145 25.623 26.81.15 53.623 226.81.15 32.70.971 1,148,054 543.900 4,962.952 56.850 670.286 91.804 6.651.892 6.4 Roads District 4 26.7 6.866.944 686.694 137.339 686.694 83.77.671 2.177.798 231.600 163.572 1.852.101 2.016.145 15.13.218 7 Improvement of Catembe Roads 9.03 5.11.903 102.381 511.903 6.245.211 0 0 6.245.211 51.600 1.248.633 2.178.695 191.023.509 Total Cost Contingency (USD) Administration (USD) Cost (USD) Contingency (USD) <th< td=""><td>6 Improvement / Rehabilitation of Collector Roads</td><td>92.3</td><td>26,722,943</td><td>2,672,294</td><td>534,459</td><td>2,672,294</td><td>32,601,991</td><td>6,528,849</td><td>1,637,900</td><td>40,768,739</td><td>665,514</td><td>6,680,736</td><td>21,178,695</td><td>69,293,684</td></th<>	6 Improvement / Rehabilitation of Collector Roads	92.3	26,722,943	2,672,294	534,459	2,672,294	32,601,991	6,528,849	1,637,900	40,768,739	665,514	6,680,736	21,178,695	69,293,684
6.2 Roads District 2 10.2 2.346,996 234,700 46,940 234,700 2.863,335 1,239,050 743,200 4.845,586 61,356 586,749 2.076,377 7,570,067 6.3 Roads District 3 9.5 2.681,15 256,815 53,623 268,115 3,270,997 1,148,054 543,900 4,962,952 56,850 670,286 961,804 6,651,892 6.5 Roads District 4 27.3 7,408,405 740,804 148,168 740,840 9,038,271 2,177,798 231,600 10,787,069 160,116 1,716,736 2,635,621 15,299,542 7 Improvement of Catembe Roads 9.0 5,119,025 511,903 102,381 511,903 6,245,211 0 0 6,245,211 54,000 1,279,756 0 7,578,967 7 Improvement of Catembe Roads 9.0 5,119,025 511,903 103,242.00 2,064,84 103,242.00 12,860,810 3,668,200 142,486,935 1,546,300 2,581,105 21,178,69 9,103,2359 Project Road Cost (USD) Contingency (USD) Administration (USD) Cost (USD) Cost (USD) Co	6.1 Roads District 1	18.6	7,419,453	741,945	148,389	741,945	9,051,733	0	40,000	9,091,733	223,620	1,854,863	13,488,748	24,658,965
6.3 Roads District 3 9.5 2.681,145 268,115 53,623 268,115 3,270,997 1,148,054 543,900 4,962,952 56,850 670,286 961,844 6,651,892 6.4 Roads District 4 27.3 7,408,405 740,840 148,168 740,840 9,038,254 1,963,946 77,000 11,081,400 163,572 1,852,101 2,016,145 15,113,29,542 7 Improvement of Catembe Roads 9.0 5,119,025 511,903 102,381 511,903 62,452,211 0.0 6,245,211 54,000 1,279,756 0.0 7,578,967 Total 2.63 103,244,20 0,324,420 2,064,884 10,324,420 2,557,925 12,860,810 3,682.00 142,486,93 1,546,830 25,811,05 21,178,695 10,023,503 Project Road Construction Cost Cost Reform Subtotal Subtotal Subtotal Subtotal Subtotal Subtotal House Cost of Cost of Cost of Cost of Cost of Subtotal Subtotal Subtotal Subtotal Subtotal Subtotal Subtotal Sub	6.2 Roads District 2	10.2	2,346,996	234,700	46,940	234,700	2,863,335	1,239,050	743,200	4,845,586	61,356	586,749	2,076,377	7,570,067
6.4 Roads District 4 27.3 7,408,405 740,840 148,168 740,840 9,038,254 1,963,946 79,200 11,081,400 163,572 1,852,101 2,016,145 15,113,218 6.5 Roads District 5 20.7 6,866,694 686,694 137,339 686,6694 8,377,671 2,177,798 231,600 10,073,069 160,116 1,716,736 2,633,621 15,293,542 7 Improvement of Catembe Roads 20.3 103,244,20 103,24,420 125,957,925 12,860,810 3,668,200 142,486,93 15,46,830 25,811,050 21,178,695 15,178,967 Project Road Length (km) Contingency (USD) Administrato Cost (USD) Subtoal Cost (USD) Relocation Cost of (USD) House Cost of (USD) House Cost of (USD) House Cost of (USD) House Cost of (USD) House Cost of (USD) House Cost of (USD) Relocation Cost of (USD) House Cost of (USD) Relocation Cost of (USD) House Cost of (USD) Relocation Cost of (USD) House Cost of (USD) Relocation Cost of (USD) Maintenance Cost of (USD) Maintenance Cost of (USD) Maintenance Cost of (USD) Maintenance Cost of (USD) Maintenance (USD) Maintenanc (OSD) Cost of Cost of (USD)	6.3 Roads District 3	9.5	2,681,145	268,115	53,623	268,115	3,270,997	1,148,054	543,900	4,962,952	56,850	670,286	961,804	6,651,892
6.5 Roads District 5 26.7 6.866.944 686.694 137,339 686.694 8,377,671 2,177,798 231,600 16,016 1,716,736 2,635,621 15,299,542 7 Improvement of Catembe Roads 9.0 5,119,025 511,903 102,381 511,903 6,245,211 0 0 6,245,211 54,000 1,279,756 0 7,578,967 Total 2.0 0.32,44,20 2.064,884 10,324,420 125,957,92 12,860,810 3,668,20 142,486,93 1,546,83 25,811,050 21,178,095 19,023,059 Pan 6 Road Construction Cost Contingency (USD) Administration Cost (USD) Subtal Relocation Cost (USD) Maintenanc Cost (USD) Maintenanc Cost <br< td=""><td>6.4 Roads District 4</td><td>27.3</td><td>7,408,405</td><td>740,840</td><td>148,168</td><td>740,840</td><td>9,038,254</td><td>1,963,946</td><td>79,200</td><td>11,081,400</td><td>163,572</td><td>1,852,101</td><td>2,016,145</td><td>15,113,218</td></br<>	6.4 Roads District 4	27.3	7,408,405	740,840	148,168	740,840	9,038,254	1,963,946	79,200	11,081,400	163,572	1,852,101	2,016,145	15,113,218
7 Improvement of Catembe Roads9.05,119,025511,903102,381511,9036,245,211006,245,21154,0001,279,75607,578,967Total263103,244,20010,324,4202,064,88410,324,420125,957,92512,860,8103,668,200142,486,9351,546,83025,811,05021,178,69519,023,509Plan 6ProjectRoad Length (km)Construction (USD)Contingency (USD)Administration Cost (USD)Engineering Service (USD)Subtoal (USD)Relocation Cost (USD)Maintenance Cost	6.5 Roads District 5	26.7	6,866,944	686,694	137,339	686,694	8,377,671	2,177,798	231,600	10,787,069	160,116	1,716,736	2,635,621	15,299,542
Total 263 103,244,200 10,324,420 2,064,884 10,324,420 125,957,925 12,860,810 3,668,200 142,486,935 1,546,830 25,811,050 21,178,695 191,023,509 Pla6 Road Length (km) Construction Cost (USD) Contingency (USD) Administration Cost (USD) Engineering Service (USD) Subtotal (USD) Relocation Public USD) House Cost (USD) Maintenance Cost (USD) Maintenance Cost (USD) Maintenance (USD) Maintenance Cost (USD) Maintenance (USD) Cost (USD) Maintenance Cost (USD) Maintenance Cost (USD) Maintenance (USD) Cost (USD) Maintenance Cost (USD) Maintenance (USD) Maintenance Cost (USD) Maintenance (USD) Maintenance (USD)<	7 Improvement of Catembe Roads	9.0	5,119,025	511,903	102,381	511,903	6,245,211	0	0	6,245,211	54,000	1,279,756	0	7,578,967
Plan 6ProjectRoad LengthConstruction (USD)Contingency (USD)Administration Cost (USD)Engineer Servici (USD)Subtoal (USD)Relocation Cost of (USD)House Cost of (USD)Project Cost (USD)Maintenance Cost (USD)Cost Grand Total (USD)Cost Grand Total (USD)Maintenance Cost (USD)Cost Grand Total (USD)Cost Grand Total (USD)Maintenance Cost (USD)Cost Grand Total (USD)Cost Grand Total (USD)Maintenance Cost (USD)Cost Grand Total (USD)Cost Grand Total (USD)Cost Grand Total (USD)Cost Grand Total (USD)Cost (USD)Maintenance Cost (USD)Cost Grand Total (USD)Cost Grand Total (USD)Cost Grand Total (USD)Maintenance Cost (USD)Cost Grand Total (USD)Cost Grand Total (USD)Cost Grand Total Cost (USD)Maintenance Cost (USD)Cost Grand Total Cost (USD)Cost Grand Total (USD)Cost Grand Total Cost (USD)Cost Grand Total Cost (USD)Cost Grand Total Cost (USD)Cost Grand Total Cost (USD)Cost Grand Total Cost (USD)Cost Grand Total Cost (USD)Maintenance Cost (USD)Maintenance Grand Total Cost (USD)Maintenance Cost (USD)Cost<	Total	263	103,244,200	10,324,420	2,064,884	10,324,420	125,957,925	12,860,810	3,668,200	142,486,935	1,546,830	25,811,050	21,178,695	191,023,509
ProjectRoad Length (km)Construction Cost (km)Administration (kgs)Engineerin Service (USD)Subtoal (USD)Relocation Cost of (USD)House opensation Cost of (USD)Maintenance Cost of (USD)Maintenance Cost of (USD)Maintenance Cost of (USD)Maintenance Cost of (USD)Maintenance Cost of Cost of (USD)Maintenance Cost of Cost of USD)Maintenance Cost of Cost of USD)Maintenance Cost of Cost of USD)Maintenance Cost of Cost of Cost of USD)Maintenance Cost of Cost	Plan 6							-		-				
Project Length (km) Cost (USD) Cost (USD) Service (USD) Subtal (USD) Cost of public (USD) Cost of public (USD) Cost of public (USD) Project Cost (USD) Cost of public (USD) Cost of public (USD) <t< td=""><td></td><td>Road</td><td>Construction</td><td></td><td>Administration</td><td>Engineering</td><td></td><td>Relocation</td><td>House</td><td></td><td>Maintenance</td><td>Maintenance</td><td></td><td>Cost</td></t<>		Road	Construction		Administration	Engineering		Relocation	House		Maintenance	Maintenance		Cost
Km (USD) (U	Project	Length	Cost	Contingency	Cost	Service	Subtotal	Cost of	Compensation	Project Cost	Cost 1	Cost2	Maintenance	Grand Total
I Public Transport(Bus Terminal) 0.0 1,385,000 138,500 27,700 138,500 1,689,700 0 1,689,700 0 346,250 2,035,950 2 Traffic Circulation(Link Signal) 0.0 2,430,000 243,000 48,600 243,000 2,964,600 0 0 2,964,600 0 607,500 0 3,572,100 3 Grade Separation(2 no.) 0.0 4,300,000 430,000 86,000 430,000 5,246,000 0 238,000 5,484,900 0 1,075,000 0 6,559,900 4 Construction of Primary Trunk Roads 15.1 30,422,876 3,042,288 608,458 3,7115,909 0 0 3,702,775 646,716 9,91,089 0 63,640,580 5 Construction of Trunk Roads 5.3 3,716,436 743,287 3,716,465 45,340,514 6,331,962 2,030,300 53,702,775 646,716 9,91,089 0 63,640,580 6 Improvement / Rehabilitation of Collector Roads 92.3 26,72,294 2,672,294 32,601,991 6,528,849<		(km)	(USD)	(USD)	(USD)	(USD)	(USD)	(USD)	Cost (USD)	(USD)	(USD)	(USD)	C0313(03D)	(USD)
2 Traffic Circulation(Link Signal) 0.0 2,430,00 243,000 243,000 243,000 2,964,600 0 0 2,964,600 0 607,500 0 3,572,100 3 Grade Separation(2 no.) 0.0 4,300,000 430,000 86,000 430,000 5,246,000 0 238,900 5,484,900 0 1,075,000 0 6,559,900 4 Construction of Primary Trunk Roads 15.1 30,42,288 608,458 3,042,288 37,115,909 0 0 37,115,909 180,600 7,605,719 0 430,020,288 63,1962 2,033,300 53,702,775 646,716 9,910,89 0 64,360,580 63,219,62 2,030,300 53,702,775 646,716 9,910,80 0 63,045,88 61,80a 52,849 1,637,900 40,768,739 665,514 6,650,736 21,178,695 69,243,684 61,80a 61,91,914,53 741,945 741,945 9,051,733 0 40,000 9,091,733 223,620 1,854,863 13,488,748 24,658,965 6.1 Roads District 1 <td< td=""><td>1 Public Transport(Bus Terminal)</td><td>0.0</td><td>1.385.000</td><td>138,500</td><td>27,700</td><td>138,500</td><td>1.689.700</td><td>0</td><td>0</td><td>1.689.700</td><td>0</td><td>346.250</td><td>0</td><td>2,035,950</td></td<>	1 Public Transport(Bus Terminal)	0.0	1.385.000	138,500	27,700	138,500	1.689.700	0	0	1.689.700	0	346.250	0	2,035,950
3 Grade Separation(2 no.) 0.0 4,300,000 430,000 86,000 430,000 5,246,000 0 238,900 5,484,900 0 1,075,000 0 6,559,900 4 Construction of Primary Trunk Roads 15.1 30,422,876 3,042,288 608,458 3,042,288 37,115,909 0 0 37,115,909 180,600 7,605,719 0 44,902,228 5 Construction of Trunk Roads 53.9 37,164,356 3,716,436 743,287 3,716,436 45,340,514 6,331,962 2,030,00 53,702,775 646,716 9,990,900 63,604,580 6 Improvement / Rehabilitation of Collector Roads 92,3 2,672,294 32,612,224 534,459 2,672,294 32,610,991 6,528,849 1,637,900 40,768,739 665,514 6,650,735 21,178,695 69,293,684 6.1 Roads District 1 18.6 7,419,453 741,945 148,389 741,945 9,051,733 0 40,000 9,091,733 223,620 1,84,863 13,488,748 24,658,965	2 Traffic Circulation(Link Signal)	0.0	2,430,000	243,000	48,600	243,000	2,964,600	0	0	2,964,600	0	607,500	0	3,572,100
4 Construction of Primary Trunk Roads 15.1 30,422,876 3,042,288 608,458 3,042,288 37,115,909 0 0 37,115,909 180,600 7,605,719 0 44,902,228 5 Construction of Trunk Roads 53.9 37,164,356 3,716,436 743,287 3,716,436 45,340,514 6,331,962 2,030,300 53,702,775 646,716 9,291,089 0 63,640,580 63,640,580 61,80a District 1 18.6 7,419,453 741,945 2,672,294 32,601,991 6,528,849 1,637,900 40,768,739 665,514 6,680,736 21,178,695 69,293,684 61,80a District 1 18.6 7,419,453 741,945 148,389 741,945 9,051,733 0 40,000 9,091,733 223,620 1,854,863 13,488,748 24,658,965	3 Grade Separation(2 no.)	0.0	4,300,000	430,000	86,000	430,000	5,246,000	0	238,900	5,484,900	0	1,075,000	0	6,559,900
5 Construction of Trunk Roads 53.9 37,164,356 3,716,436 743,287 3,716,436 45,340,514 6,331,962 2,030,300 53,702,775 646,716 9,291,089 0 63,640,580 6 Improvement / Rehabilitation of Collector Roads 92.3 26,722,943 2,672,294 534,459 2,672,294 32,601,991 6,528,849 1,637,900 40,768,739 665,514 6,680,736 21,178,695 69,293,684 6.1 Roads District 1 18.6 7,419,453 741,945 148,389 741,945 9,051,733 0 40,000 9,091,733 223,620 1,854,863 13,488,748 24,658,965	4 Construction of Primary Trunk Roads	15.1	30,422,876	3,042,288	608,458	3,042,288	37,115,909	0	0	37,115,909	180,600	7,605,719	0	44,902,228
6 Improvement / Rehabilitation of Collector Roads 92.3 26,722,943 2,672,294 534,459 2,672,294 32,601,991 6,528,849 1,637,900 40,768,739 665,514 6,680,736 21,178,695 69,293,684 6.1 Roads District 1 18.6 7,419,453 741,945 148,389 741,945 9,051,733 0 40,000 9,091,733 223,620 1,854,863 13,488,748 24,658,965	5 Construction of Trunk Roads	53.9	37,164,356	3,716,436	743,287	3,716,436	45,340,514	6,331,962	2,030,300	53,702,775	646,716	9,291,089	0	63,640,580
6.1 Roads District 1 18.6 7,419,453 741,945 148,389 741,945 9,051,733 0 40,000 9,091,733 223,620 1,854,863 13,488,748 24,658,965	6 Improvement / Rehabilitation of Collector Roads	92.3	26,722,943	2,672,294	534,459	2,672,294	32,601,991	6,528,849	1,637,900	40,768,739	665,514	6,680,736	21,178,695	69,293,684
	6.1 Roads District 1	18.6	7,419,453	741,945	148,389	741,945	9,051,733	0	40,000	9,091,733	223,620	1,854,863	13,488,748	24,658,965
6.2 Roads District 2 10.2 2,346,996 234,700 46,940 234,700 2,863,335 1,239,050 743,200 4,845,586 61,356 586,749 2,076,377 7,570,067	6.2 Roads District 2	10.2	2,346,996	234,700	46,940	234,700	2,863,335	1,239,050	743,200	4,845,586	61,356	586,749	2,076,377	7,570,067
6.3 Roads District 3 9.5 2,681,145 268,115 53,623 268,115 3,270,997 1,148,054 543,900 4,962,952 56,850 670,286 961,804 6,651,892	6.3 Roads District 3	9.5	2,681,145	268,115	53,623	268,115	3,270,997	1,148,054	543,900	4,962,952	56,850	670,286	961,804	6,651,892
6.4 Roads District 4 27.3 7,408,405 740,840 148,168 740,840 9,038,254 1,963,946 79,200 11,081,400 163,572 1,852,101 2,016,145 15,113,218	6.4 Roads District 4	27.3	7,408,405	740,840	148,168	740,840	9,038,254	1,963,946	79,200	11,081,400	163,572	1,852,101	2,016,145	15,113,218
6.5 Roads District 5 26.7 6,866,944 686,694 137,339 686,694 8,377,671 2,177,798 231,600 10,787,069 160,116 1,716,736 2,635,621 15,299,542	6.5 Roads District 5	26.7	6,866,944	686,694	137,339	686,694	8,377,671	2,177,798	231,600	10,787,069	160,116	1,716,736	2,635,621	15,299,542
7 Improvement of Catembe Roads 9.0 5,119,025 511,903 102,381 511,903 6,245,211 0 0 6,245,211 54,000 1,279,756 0 7,578,967	7 Improvement of Catembe Roads	9.0	5,119,025	511,903	102,381	511,903	6,245,211	0	0	6,245,211	54,000	1,279,756	0	7,578,967
Total 263 107,544,200 10,754,420 2,150,884 10,754,420 131,203,925 12,860,810 3,907,100 147,971,835 1,546,830 26,886,050 21,178,695 197,583,409	Total	263	107,544,200	10,754,420	2,150,884	10,754,420	131,203,925	12,860,810	3,907,100	147,971,835	1,546,830	26,886,050	21,178,695	197,583,409

Table 11.4.3 Preliminary Construction Costs and Project Costs for each Alternative (2/2)

A-65

ROAD DEVELOPMENT OF THE CITY OF MAPUTO JICA STUDY TEAM

2) Results of Future Traffic Assignment

Figure 11.4.8-13 shows the results of Future Traffic Congestion of each road development alternatives in the year of 2020.

In case of the Do Minimum, the bottleneck links having more than 1.5 volume to capacity ratio could be identified as almost all links on the Trunk Roads by the year 2020. This shows the road network of the Do Minimum will not functioned well against the long-term traffic demand.

In case of Plans 1 and 3, the bottleneck links would become minimum on the Trunk Road network except in the city center. These bottlenecks especially at the intersections would be settled out through the improvement of intersections and Traffic Management Plan. Therefore, Plans 1 and 3 would be well matched to the long-term traffic demand and are recommendable road network option for long-term period.

In case of Plan 2, bottlenecks could be identified on the Trunk Road network and in the city center. This network is not so well matched to the long-term traffic demand and accordingly Plan2 alternative is not recommendable from the viewpoint of traffic efficiency.

In case of Plan 4, bottlenecks would become minimum on the Trunk Road network and this also could become one of the recommendable road network for further consideration.

Bottlenecks on the Trunk Road networks could be identified in Plan 5 and 6 in the year of 2020 and this shows both of these road networks are not recommendable from the viewpoint of traffic efficiency.

On the other hand, the total average speed of the Do Minimum network in the year of 2020 would drop down to 13.5 km/hr from existing average speed of 30.6 km/hr due to the total congestion rate of 1.51 compared to the existing rate of 0.59.

While the total average speeds of each alternative networks in the year of 2020 would become almost same level of the existing average speed and the total congestion rates of each alternative networks shows slightly lower than 1.0 except Plans 2 and 5.

From these evaluations, the road networks which could meet the future traffic demand efficiently would be the road networks of Plans 1, 3 and 4 from the viewpoint of traffic functions required for long-term road development. The details of the future traffic assignment on each alternative road networks are shown in the Chapter 9.



Figure 11.4.8 Future Traffic Assignment on Plan 1



Figure 11.4.9 Future Traffic Assignment on Plan 2



Figure 11.4.10 Future Traffic Assignment on Plan 3



Figure 11.4.11 Future Traffic Assignment on Plan 4



Figure 11.4.12 Future Traffic Assignment on Plan 5



Figure 11.4.13 Future Traffic Assignment on Plan 6

11.5 ECONOMIC ANALYSIS

The study team has formulated six network plans from Plan 1 to Plan 6, while the network of "Do minimum" case is also made as a base case.

The benefit is calculated by subtracting the VOC of respective plan from the VOC of the "Do minimum" case. This would be thought as a surplus that the society acquires by implementation of the respective plan.

The cost is needed to be discounted into economic cost, which deduct the fringe value of market price, such as import tax, subsidy and wage regulation. Since all alternative plans have virtually the same cost structure and the aim of this analysis is to prioritize the best alternatives, a standardized conversion factor of 0.9 is applied to all alternatives, while Base case contains much of labor-oriented maintenance so that SCF of 0.7 is applied.

From the total economic cost, annual cost is estimated by assuming 5 years of the investment period and an interest rate of 12% per annum. The following equation is used.

Annualized Cost = Total Cost x R x $[(1+R)^n]/[(1+R)^n - 1]$

Where, R = discount rate (12%) and n = investment period (5 years)

From this context, the comparison of economic analysis results is described as follows.

	PCU-km	PCU-hour	VOC (\$/day)	VOC (mil.\$ / year)	Benefit (mil.\$ / vear)	Total Cost (mil.\$)	Net Total Cost (mil. \$)	Cost (mil.\$ / vear)	/
Do minimum (Base Case)	4,543,801	337,439	1,850,576	675.5	0.0	12.0	-	-	-
Plan 1	4,506,895	140,114	1,489,253	543.6	131.9	192.6	180.6	50.1	2.63
Plan 2	4,619,160	161,354	1,530,305	558.6	116.9	155.8	143.8	39.9	2.93
Plan 3	4,562,664	153,613	1,505,729	549.6	125.9	161.7	149.7	41.5	3.03
Plan 4	4,521,176	149,241	1,498,949	547.1	128.3	208.8	196.8	54.6	2.35
Plan 5	4,595,195	159,284	1,520,195	554.9	120.6	171.9	159.9	44.4	2.72
Plan 6	4,661,212	166,181	1,550,304	565.9	109.6	177.8	165.8	46.0	2.38

 Table 11.5.1
 Comparison of economic analysis results

Source: JICA Study Team

When comparing the cost-benefit ratios of alternative plans, it can be concluded that "Plan 3" is the most recommended plan in terms of economic efficiency.

11.6 FINANCIAL ANALYSIS

From the context of the previous estimation, the study team recommends that the financial arrangement of the Master Plan's implementation be structured as displayed in Table 11.6.1.

As seen in the Table, about one third of the total cost can be covered by the road budget of the MCM. Meanwhile, fuel tax revenue and foreign aid are expected to cover of 25% and 44% of the total cost respectively. Even though the foreign aid is playing an important role in the first term, it is the MCM's self budgeting which is taking a leading role in the later term.

 Table 11.6.1 Financial Arrangement for the Implementation of the Master Plan

 Unit: Million USD

	Term (2003 ~ 2010)	Term (2011 ~ 2020)	Total (2003 ~2020)	%	Remarks
Cost					
Development	68.3	65.4	133.7	74%	
Maintenance	20.7	25.3	46.0	26%	
TOTAL	89.0	90.7	179.7	100%	
Finance					
The MCM Budget	24.2	31.2	55.4	31%	Road Budget
Fuel Tax Revenue	18.6	26.9	45.5	25%	6% of fuel tax revenue from Maputo
Foreign Aid	46.1	32.7	78.8	44%	For imported materials
Other					Additional, if needed
TOTAL	89.0	90.7	179.7	100%	

Source: JICA Study Team

11.7 ESTABLISHMENT OF ROAD DEVELOPMENT MASTER PLAN

1) Conclusive Evaluation of Road Development Master Plan

As the results of the future traffic estimations on each alternative road networks, the road networks of the Plan 1, 3 and 4 are well suited to the future traffic demand in the year 2020. The results of the economic evaluation of the road development alternatives and the financial sustainability of the funding show that the road development Plan 3 is the most economically efficient and financially sustainable.

In order to select a most efficient, effective, consistent and sustainable road development plan, a conclusive evaluation of road development plans has been developed based on the following five criteria:

(1) Efficiency

Efficiency is the economic viability of the investment for the implementation of the road development plan on the viewpoint of the national economy. The indicator is the B/C ratio from the economic evaluation.

(2) Effectiveness

Effectiveness is the degree to which the road development achieves its purposes and objectives from the viewpoint of engineering aspects. The indicators consist following three sub-criteria:

- Road passable in rainy day; Total pavement length / Total road length of trunk and collector roads
- Accessibility; Total average speed adopted in the future traffic estimation
- Settlement of bottleneck; Numbers of bottlenecks on the Trunk Roads network
- (3) Impact

Impacts are the effects whether the road development has effects on its surroundings in term of economic, social and environmental factors. The indicators are evaluated and selected as following three sub-criteria:

- Vitalization of local economy: Total Benefit bone by the road development
- Improvement of accessibility to major industry
- Environmental impact: Numbers of houses and factories which need to be re-located for the road development

(4) Relevance

Relevance is the degree of consistency with national and regional policy.

(5) Sustainability

Sustainability is the degree whether the government can achieve its target of financially self-reliance.

The indicators are selected as following two sub-criteria:

- Availability of development fund: External resources required
- Sustainability of maintenance fund: Total maintenance cost/Financial capacity of MCM

Table 11.7.1 shows the result of the total evaluation of the road development alternatives and the Plan 3 is selected as the most efficient, effective, relevant and sustainable plan for the long-term road development master plan.

Items	Indicator	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
1.Efficiency	Cost-benefit ratios	А	А	А	А	А	А
(Economic		(2.63)	(2.93)	(3.03)	(2.35)	(2.72)	(2.38)
viability)							
2.Effectiveness (Engine	ering Viewpoint)	-				-	-
2.1 Road passable	Pavement % of trunk/	А	А	А	А	А	А
	collector Rd.	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
2.2 Accessibility	Av. Speed (km/hr)	А	В	А	А	В	В
		(32.2)	(28.6)	(29.7)	(30.3)	(28.8)	(28.4)
2.3 Bottleneck	No. of bottleneck	А	В	А	А	В	С
Decreeing		(1)	(5)	(2)	(1)	(5)	(10)
3. Impact							
3.1 Vitalization of	Total benefit	A (132)	A (117)	A (126)	A (128)	A (121)	A (110)
local economy (mil.\$/year)							
3.2 Improvement of	А	А	А	А	А	А	
industry							
3.3 Environmental	No. of house/factories	С	В	В	С	В	В
impact	demolished	(760/9)	(642/-)	(677/-)	(760/9)	(642/-)	(677/-)
4. Relevance							
4.1 National	Consistency	А	А	А	В	В	В
Development policy							
4.2 Regional	Consistency	А	А	А	В	В	В
development policy							
5. Sustainability							
5.1 Availability of	External resources	С	А	А	D	В	В
development fund	required (mil.\$)	(113.1)	(72.3)	(78.8)	(131.1)	(90.1)	(96.7)
5.2 Sustainability of	Total maintenance	В	А	А	В	В	В
maintenance fund	cost/Financial scale of	(0.89)	(0.81)	(0.83)	(0.96)	(0.87)	(0.89)
	MCM (mil.\$/mil.\$)						
Total evaluation		С	В	Α	D	С	С
A: Very high	B: High	C: Medium	D: Low				

 Table 11.7.1 Conclusive Evaluation of Road Development Plans

2) Project Components of the Road Development Master Plan

The objectives of the road development master plan have been established as shown below;

- Classified Road Development to improve Basic Human Needs and Environment
- Road Development to settle Existing Road Problems
- Road Development to enhance Future Traffic Efficiency
- Road Development to promote the Metropolitan Development

The components of the road development master plan consists the followings;

A. Construction of Primary Trunk Road

A-1 Widening and Reconstruction of Av. Mozambique

In order to establish the basic frame of the urban road network system in Maputo as well as to cope up with the anticipated traffic demand in future, it is recommended either to widen from 2 to 4 lane or to reconstruct Av. Mozambique as follows;

• Widening from Av. Do Trabalho junction to Rue 5750 junction (8.3km)

• Reconstruction Existing road from Rue 5750 junction up to the border (6.8km) Construction of Grade Separation with Machava road will be done during the implementation of the on-going Machava road project.

B. Construction of Trunk Roads

Bv-1 Widening and New Construction of Av. Julius Nyerere

In order to establish the basic frame of the urban road network system as well as to cope up with the future traffic demand, it is inevitably necessary to widen from 2 to 4 lane for existing sections and to construct a new dual carriageway bypass for the alternative solution of the Missing Link of Av. Julius Nyerere as follows;

- Widening from Rue 5750 junction to Av. FPLM junction (4.9km)
- Construction of Grade Separated Junction with Av. FPLM
- Reconstruction of Rue 4685 (2.8km)
- Construction of new dual carriageway bypass from Av. FPLM junction to the existing 2lane section of Av. Julius Nyerere. (4.8km)

• Widening of the existing 2lane section of Av. Julius Nyerere. (2.2km)

Bv-2 Improvement of Av.V.Lenine

Due to secure the heavy traffic congestion occurring by the lack of Bus-bay and the concentration of traffic, Av. V.Lenineis should be improved through a construction of proper size of Bus-bay and a improvement of the intersection with Av. Julius Nyerere.

Bv-3 Rehabilitation of Av. Acordos do Lusaka and Widening of Av. Guerra Popular

The pavements of Av. A. do Lusaka and Av. Guerra Popular start deterioration and the traffic congestion on Av. Guerra Popular become critical, therefore followings are necessary.

- Rehabilitation of Av. A. do Lusaka (2.9km)
- Construction of Grade Separation with Machava road
- Widening from 2 to 4 lane carriageway with construction of proper size of Bus-bay the existing 2 lanes section of Av. Guerra Poprlar. (0.7km)

Bv-4 Reconstruction of Av. Angola and Rua S. Cabral/Largo de Deta

• The pavement of Av. Angola requires reconstruction. (3.1km)

• The pavement of Rua S. Cabral/Largo de Deta requires reconstruction.

(0.6km)

Bv-5 Reconstruction of Rua de Igreja

Existing Rua de Igreja is heavily deteriorated, required the total reconstruction

(7.5km)

Bv-6 Reconstruction of Rue 5751

For the future expansion of the city to the north and to improve the existing pavement deterioration, the reconstruction of Rue 5751 is necessary. (5.9km)

Bh-1 Reconstruction of Rua Paulino Santos Gil and Av.ONU

In order to streamline the heavy goods vehicles from the industrial and the port area, the heavy deterioration of the pavement of Rua Paulino Santos Gil and Av. ONU should be reconstructed.

- Reconstruction of Rua Paulino Santos Gil (0.2km)
- Reconstruction of Av. ONU (1.5km)

Bh-2 Widening and Reconstruction of Av.Marien Ngouabi

Due to the heavy congestion and deterioration, Av. Marien Ngouabi should be widened to dual carriageway and be reconstructed.

- Widening from Av. Mao Tse Tung junction to Av. A. de Lusaka (0.9km)
- Reconstruction from Av. A. de Lusaka to Av. de Angola (1.0km)

Bh-3 Rehabilitation and Extension of Rue 5750

In order to improve the existing pavement deterioration and to promote the Maputo Metropolitan Development, Rue 5750 should be improved as follows:

- Rehabilitation of existing Rue 5750 (3.8km)
- Extension of Rue 5750 to Matora border (0.7km)

Bh-4 New construction of Maputo Border Road

In order to provide an access serve to the northern potential development area, new construction of Maputo Border Road is necessary. (7.6km)

C. Reconstruction of Collector Roads

Based on the road development concept in terms of Basic Human Needs and Environment, the following collector roads in each area should be reconstructed due to heavy deterioration.

- Reconstruction of collector and selected area roads in District 1 (18.7kn)
- Reconstruction of collector roads in District 2 (10.2km)
- Reconstruction of collector roads in District 3 (9.5km)
- Reconstruction of collector roads in District 4 (30.7km)
- Reconstruction of collector roads in District 5 (25.5km)
- Reconstruction of collector roads in Catembe area (9.0km)

	Road		Construction	Project Cost	
Project	Length	Lane	Cost	(million USD)	Remarks
	(km)	No.	(million USD)	(IIIIIIOII USD)	
1 Construction/Improvement of Bus Terminas			1.39	1.69	
2 Instration of linked signals			2.43	2.96	
3 Construction of two Grade Separations			4 30	5.48	
4 Construction of Primory Trunk Boods	15.05		16.14	22.40	
4 Construction of Frinary Trunk Roads	15.05		10.14	22.02	
A-1 Reconstruction of Av. Mozambique (North Section)	6.80	2	5.22	6.37	
A-1 Widening of Av. Mozambique (South Section)	8.25	4	10.92	16.45	
5 Construction of Trunk Roads	51.59		35.51	51.15	
Bv-1 Av. Julius Nyerere	11.90		18.84	26.58	
Widening of Av. Julius Nyerere(1257) (South Section)	2.20	4	2.55	3.92	
Reconstruction and Extension of Rua 4685	2.80	4	2.51	3.06	
New construction of New J. Nyerere 1	3.00	4	4 1 1	5 33	
New construction of New J. Nyerere 2(t)	1.80		2.49	3.42	
New I Nyerere (Box)	0.00	4	0.18	0.22	
Widening of Av. Julius Nucroro(4001) (North Section)	4.00	4	5.40	8.68	
New construction of Bridge on Av. Julius Nyerere	4.90	4	1.60	1.05	
By 2 Improvement of Av. V. Lening	0.00	4	1.00	0.72	
By 2 Improvement of EDI M	0.00		0.00	0.73	
DV-2 Improvement of FPLW By 3 Rehabilitation of Av. Acordes do Lucaka (2012)	2.85	4	0.15	0.19	
By 3 Rehabilitation of Av. Acordes do Lusaka(5015)	2.44	4	0.12	0.16	
BV-5 Reliabilitation of AV. Acordes do Lusaka(4057)	0.42	4	0.13	0.10	
BV-3 widning and improvement of AV. Guerra Popular(1189)	0.70	4	0.41	0.77	
Bv-4 Reconstruction of Av. Angola(3077)	3.09	4	2.31	2.82	
Bv-4 Rehabilitation of Rua S. Cabral(3081)/Largo.Deta(3079)	0.61	2	0.41	0.50	
BV-5 Reconstruction of Rua de Igreja(North Section)	5.75	2	1.92	3.04	
Bv-5 Reconstruction of Rua de Igreja(South Section)	1.75	2	0.58	0.93	
BV-6 Reconstruction of Rua 5/51	5.90	2	1.97	3.60	
Bh-I Reconstruction of Rua Paulino Santos Gil (1207)	0.23	4	0.12	0.19	
Bh-1 Rehabilitation of ONU(1040)	0.52	4	0.27	0.43	
Bh-I Rehabilitation of ONU(2002)	1.02	4	0.52	0.84	
Bh-2 Widening and Rehabilitation of Av. Marien Ngouabi(1166)	1.88	4	1.57	3.09	
Bh-3Rua 5750	0.65		1.34	1.64	
Improvement of Rua 5750	0.00	2	0.07	0.08	
New construction of Rua 5750 extension(t)	0.65	2	0.47	0.57	
New construction of Rua 5750 extension(Box)(t)	0.00	2	0.81	0.98	
Bh-4 New construction of Maputo Border Road	7.60	2	3.31	4.34	
6 Reconstruction of Collector Roads	94.58		28.38	43.33	
6.1 Roads in District 1	18.64		7.42	9.09	
Av. Milagre Mabote(1369)	1.00	2	0.23	0.32	
Av. da Malhangalene(1357)	0.94	2	0.22	0.26	
Av. Para O Palmar(1426)	1.40	2	0.32	0.40	
Av. Kawame Nkrumah(1250)	1.61	2	0.58	0.71	
Av. Paulo Samuel Kankhomba(1152)	0.55	2	0.20	0.24	
Av. Emilia Dausse(1138)	0.85	2	0.31	0.37	
Av. de Maguiguana(1130)	0.75	2	0.27	0.33	
Av. Josina Michel(1070)	0.90	2	0.32	0.39	
Ay, Fernao de Magalhaes(1038)	1.30	2	0.47	0.57	
Ay, Zedequias Manganhela(1034)	1.30	2	0.47	0.57	
Av. Mohamed Siad Barre(1203)	0.85	2	0.31	0.37	
Av. RomaoFernandes(1199)	0.85	2	0.31	0.37	
Av. Filipe Samuel Magaia(1183)	0.40	2	0.14	0.18	
R. Consiglieri Pedroso(1022)/R. Joaquim Lapa(1020)	0.80	2	0.29	0.35	
R do Bagamayo(1016)/R de Timor Leste(1014)	0.80	2	0.52	0.63	
Av Martires de Inhaminga(1006)	0.80	2	0.52	0.63	
Port Area(6 roads)	1 50	2	0.77	0.05	
Rua 1229	0.25	2	0.32	0.39	
Av. das Estancias(1030)	0.58	2	0.44	0.53	
////. dus Lisunenus(1050)	0.56	2	0.44	0.55	
Av. Friedrich Engels(1009)	1.20	2	0.43	0.53	

Table 11.7.2 Project Components of Road Development Master Plan (1/2)

Duciant	Road	Lane	Construction	Project Cost	Remarks
Project	(km)	No.	(million USD)	(million USD)	Remarks
6.2 Roads in District 2	10.23		2.35	4.85	<u>.</u>
Rua 2282/2265	2.36	2	0.53	1.16	
Rua 2275	2.01	2	0.45	0.79	
Rua de Xinamanine(2291)	1.13	2	0.25	0.61	
$\frac{1}{2} \frac{1}{2} \frac{1}$	1.10	- 2	0.20	0.51	
Rua dos finaos Roby(2207) Rua 2315/2313	0.70	2	0.29	0.31	
Due 2200/2224	1.00	2	0.10	0.32	
Kua 2509/2524	1.00	2	0.22	0.41	
Kua 2522 Av. das Estancias(2000)	0.49	2	0.28	0.77	
6.3 Roads in District 3	9.48	2	2.68	4.96	
Rua da Goa(3027)	0.80	2	0.20	0.37	
$\frac{1}{2} \frac{1}{2} \frac{1}$	0.00	2	0.20	0.37	
Av Milagre Mahote(3001)	1.98	2	0.18	1.22	
Av da Malhangalene (3259)	1.83	2	0.66	1.16	
Rua 1 de Majo (3374)	1.49	2	0.35	0.76	
Rua 3306	0.49	2	0.11	0.22	
Rua 3523	1.00	2	0.23	0.40	
Rua 3576	1.10	2	0.26	0.45	
6.4 Roads in District 4	29.56		9.07	13.64	
Rua 4029/4040/CFM(4027)	2.50	2	0.58	0.92	
Rua 4160	1.11	2	0.26	0.40	
Rua 4453/4821	2.40	2	0.56	0.88	
Rua 4935/4844/4755	2.55	2	0.59	0.93	
Rua 4412	2.10	2	0.49	0.77	
Rua 4787/4433/4345	3.10	2	0.72	1.13	
Rua 4286/4282	1.40	2	0.32	0.51	
Rua do Aeroport(4109)	1.13	2	0.26	0.41	
Rua da Beira (4113)	1.60	2	0.37	0.59	
Kua da Belfa (4397)	0.02	2	0.14	0.23	
Kua $4395/4342$ Dua das Mahotas (4060)	1.40	2	0.34	0.51	
$R_{119} 4680$	3.60	2	0.34	1.18	
New Road	2.30	2	1.49	2.08	
Reconstruction of Rua 4870 extension	2.30	2	1.66	2.56	
6.5 Roads in District 5	26.69		6.87	10.79	
Rua 5578	0.70	2	0.17	0.27	
Rua 5578 extension(Matola)	1 20	2	0.39	0.56	
Rua 5650/5584	2.00	2	0.45	0.71	
Rua 5512	0.90	2	0.22	0.35	
Rua 5512 extension (Matola)	1.20	2	0.39	0.56	
Rua 5578-5512(new road)	1.30	2	0.32	0.48	
Rua 5514	1.75	2	0.43	0.84	
Rua da Paz(5501)	1.75	2	0.43	0.72	
Rua do Bagamayo((5319)	1.35	2	0.33	0.51	
Rua de Sao Paulo(5312)	0.69	2	0.17	0.26	
Rua 5500	0.90	2	0.21	0.33	
Rua 5280/5296	1.50	2	0.35	0.55	
Rua 5260	1.65	2	0.38	0.60	
Rua 5315	2.90	2	0.67	1.06	
Rua 5005/5021 Rua do Jardin(5088)	1.90	2	0.42	0.08	
Rua da Agricultura(5086)	1.45	2	0.52	0.70	
Rua 5763	1.00	2	0.27	0.42	
Rua 5754	0.80	2	0.19	0.29	
Reconstruction of Catembe Roads	9.00	2	5.12	6.25	
7 Total	170.22		02 27	122.60	

Table 11.7.2 Project Components of Road Development Master Plan (2/2)

11.7.3 Establishment of Public Transport Development Plan

The objectives of the public transport development plan have been established as shown below:

- Public Transport Development to service in un-serviced area
- Public Transport Development to improve Bus Stop facilities
- Public Transport Development to streamline the congestion of Bus Terminal
- Public Transport Development to improve slow bus operation efficiently
- Public Transport Development to provide information properly

The components of the public transport development plan consists the followings:

A. Public Transport Development to service in un-serviced area

In order to solve the existence of un-service area of Public Bus Operation, Road Rehabilitation and new construction of Trunk and Collector Roads have been proposed in the road development master plan for the smooth operation of bus transport even in each community area.

B. Public Transport Development to improve Bus Stop facilities

Traffic congestions occur on the existing single carriageway trunk roads, due to lack of proper size of Bus Stop facilities. Therefore, construction of proper size of Bus Stop with bus-bay is necessary and these measures have been incorporated into the proposed projects of the road development master plan

C. Public Transport Development to streamline the congestion of Bus Terminal

In order to solve the congestion of Bus terminals, Construction of four new bus terminals and improvement of three bus terminals have been proposed with proper spaces for buses, taxis, trucks and markets.

Detailed identification of Development Plan for Bus Terminals will be conducted during the Feasibility Study of this study.

D. Public Transport Development to improve slow bus operation

In order to improve the slow bus operation on the trunk roads, an introduction of Bus Lane on a dual carriageway trunk road, which will be improved during the implementation of the road development master plan, is recommendable measure. Detailed identification of Bus Lane will be conducted during the Feasibility Study of this study.

E. Public Transport Development to proved information properly

In order to solve the lack of information of bus operation, installation of information board at each Bus Stop and Bus terminal should be conducted.

The public transport plan has been prepared based on the future traffic assignment result on the road network of Plan3 with the traffic demand of the year 2010. Although the future demand of public transport will grow in the year 2020, an introduction of the bus lane together with a policy of exchanging bus size to large will bring efficient bus operation and planed bus facilities efficiently.

11.8 THE PLAN FOR URBAN TRAFFIC MANAGEMENT IN CBD OF THE MAPUTO CITY

1) General

After implementation of the road development plan mentioned in the Chapter 11.7, future traffic congestion in the year 2020 will be dissolved drastically. However, the traffic congestion in the city centre will be remained due to insufficient traffic management. Also the residential environment will become worth due to traffic demand corresponding to the population growth.

2) Area Zone

The policy of the area zoning is as follows.

- Land use pattern will not be changed in the future.
- Each town block is separated by the trunk road network and public / private bus routes. Minimum unit of town block is about 400m in radius, where bus user is accessible in six minutes on foot.

- The area along the main trunk road should also be designated to as the commercial area. Area zoning is as shown in the Figure 11.8.1.

3) Public Transportation Planning in the CBD

At least one bus stop should be established on each town block of the residential area, to cover the residential area 400m in radius. Distribution plan of bus routes is shown in the Figure 11.8.2.

The following items should be requested in order to improve Bus Stop.

- Removal of Bus Stops Close to Intersections
- Improvement of the Bus Stop
- Establishment of Bus Stops on the Collector Road



Figure 11.8.2 Establishment of Bus Route and Bus Stops

4) Urban Traffic Management Measures

Improvement of Intersections

In order to increase the traffic capacity, the following measure shall be established to the major intersections on the trunk road network shown in the Figure 11.8.3.

1. Establishment of Right-turn Lane

The right-turn lane with right-turn signal should be constructed on the major intersections for safety traffic turning.

2. Improvement of Traffic Signals

Signal pattern timing should be adequately adjusted according to the traffic movement. Furthermore, traffic signals should be established to the un-signalled intersections where the bus routes cross with the trunk roads.

In the longer term, introduction of self-controlled signals by vehicle detection system, linked signal, remote controlled signals are conceivable.

ROAD DEVELOPMENT OF THE CITY OF MAPUTO IICA STUDY TEAM





Figure 11.8.3 Location of Intersections to be Improved





5) Implementation Schedule

The time period of implementation of traffic management in CBD is to be divided into 2 phases, short-mid period (2001-2010) and long period (2010-2020) as shown in the Table 11.8.1.

The objectives of the project in each term should be as follows.

Short-mid Term (2001-2010)

- Solution of the bottleneck and traffic congestion
- Promotion of the area traffic management measure
- Development of basic traffic / transportation facilities
- Introduction of the traffic flow control by the traffic dispersion, regulation etc.

Long Term (2010-2020)

- Establishment of the traffic demand control (the drastic measure)
- Drastic solution of elimination of the road parking
- Introduction of the advanced traffic control measure

			R o in	ads to troduc	be ed	SI	nort-m	id term	proje	t	Long	term pr	oject
Traffic management measures			Trurk road	Collector road	Community road	Solution of bottleneck	Area traffic management	Development of traffic facility	Traffic demand control	improvement of traffic dispertion	Traffic demand control	Elimination of on-street parking	Advanced traffic control
Traffic management	Improvement of	Establishment of right-turn lane											
on the trunk road	intersections	Establishment of right-turn signal											
		Installation of new signal											
		Re-setting of signal pattern											
	Improvement of car park	Removal of parking close to intersections											
		Widening of roadside / median car park											
		Improvement of median car park											
		Establishment of regulatory signs / markings											
		Construction of off-street parking											
		Introduction of parking charge											
Improvement of public	Improvement of bus	Re-settlement of bus stops close to intersections											
transportation	operation	Improvement of bus stops											
		Construction of bus terminal											
Residential area traffic	Elimination of through traffic	Establishment of regulatory signs / markings											
management		Establishment of speed control devices											
	Establishment of padestrian	Establishment of pedestrian crossings											
	safety facilities	Repair of sidewalks											
Traffic demand management measure	Promotion of the traffic modal shift	Establishment of park&ride facilities											
	Traffic demand control	Introduction of road pricing in CBD											
	Introduction of advanced	Introduction of linked traffic signals											
	traffic management measure	Establishment of traffic control centre											

Table 11.8.1 Implementation Schedule

According to the consideration of the traffic management measure and its implementation schedule, the following projects are recommendable. Project A and B are recommendable as the priority project in the short-mid term. Detailed programme of the other project will also be considered in the feasibility study.

Short-mid Term Project

A. Improvement of Intersections (Figure 11.8.5, Table 11.8.2)

- A-1 Establishment of the turn-right lane (14 intersections), including establishment of additional traffic signals
- A-2 Re-arrangement of signal pattern

B. Improvement of Bus Routes (Figure 11.8.6, Table 11.8.3)

- B-1 Improvement of bus terminal (1 nos.) and bus bay (8 nos.)
- B-2 Establishment / re-settlement of, bus strip on the TPM route (50 nos.), bus strip on the small/medium bus route (18 nos.), including sign boards, markings etc.

C. Improvement of Car Parks

C-1 Enforcement for prohibition of car parks close to the intersections, bus stops etc.

D. Improvement of Community Roads

- D-1 Enforcement of speed limit and one-way traffic including establishment of signs, markings etc.
- D-2 Establishment of road safety facilities (pedestrian crossings, speed humps etc.)
- D-3 Rehabilitation of sidewalks
 - * Detailed plan will be considered in the feasibility study. Some part will be included in the road network improvement programme.

Long Term Project

- E. Construction of Off-street Car Parking Facilities
 - E-1 Construction of off-street car parking facilities
 - E-2 Introduction of parking charge for on-street parking
 - E-3 Enforcement for prohibition of on-street parking
- F. Improvement of Traffic Control
 - F-1 Introduction of linked traffic signals

F-2 Establishment of vehicle detection system and self controlled traffic signals

FG-3 Establishment of traffic control centre

G. Traffic Demand Management in CBD

ROAD DEVELOPMENT OF THE CITY OF MAPUTO JICA STUDY TEAM



Figure 11.8.5 Location of Major Intersections to be Improved by the Project

	Nos of Inte	ersections	
Location	To be improved by traffic	To be improved by Road	Total
	management project	project	
1. M.T.Tung/ J.Nyerere	0		1
2. M.T.Tung/ V.Lenine		0	1
3. M. Ngonabi/ K.Marx		0	1
4. M. Ngonabi/ Lusaka		0	1
5. E.Mondlane/ J.Nyerere	0		1
6. E.Mondlane/ V.Lenine	0		1
7. E.Mondlane/ K.Marx	0		1
8. E. Mondlane/ G.Popular		0	1
9. 24 de Julho/ J.Nyerere	0		1
10. 24 de Julho/ R. dos Lusiadas	0		1
11. 24 de Julho/ V.Lenine	0		1
12. 24 de Julho/ K.Marx	0		1
13. 24 de Julho/ G.Popular	0		1
14. 24 de Julho/ Zambia	0		1
15. 25 de Setembro/ V.Lenine	0		1
16. 25 de Setembro/ S.Machel	0		1
17. 25 de Setembro/ K.Marx	0		1
18. 25 de Setembro/ G.Popular	0		1
Total	14 nos,	4 nos,	18 nos

 Table 11.8.2
 Contents of Improvement of Intersections

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Figure 11.8.6 Location of Improvement of Bus Routes

Location	Bus improve	ement project	Bus improvement	Bus facilities to be	Total
Location	Bus Terminal	Bus Bay	Bus Bay	enforcement	Totai
1. M.T.Tung /J.Nyerere			0		1
2. M.T.Tung /M.Machava				0	1
3. M.T.Tung / K.I.Sung				0	1
4. M.T.Tung /S.Allende				0	1
5. M.T.Tung /A. Cabral				0	1
6. M.T.Tung /V. Lenine		0			1
7. M.Ngonabi /K.Marx			0		1
8. M.Ngonabi / Lusaka			0		1
9. M.Ngonabi /R.F.Farinha				0	1
10. Angola /M. Ngonabi			0		1
11. E. Mondlane /J.Nyerere				0	1
12. E. Mondlane /C.A.Cardoso				0	1
13. E.Mondlane /A.Cabral				0	1
14. E.Mondlane /V.Lenine		0			1
15. E.Mondlane /K.Marx		0			1
16. E.Mondlane /G.Popular		0			1
17. E.Mondlane /R.F.Farinha				0	1
18. E.Mondlane /Zambia				0	1
19. 24 de Julho /J.Nyerere		0			1
20. 24 de Julho /S.Allende				0	1
21. 24 de Julho /A.Cabral				0	1
22. 24 de Julho /V.Lenine		0			1
23. 24 de Julho /K.Marx		0			1
24. 24 de Julho /G.Popular		0			1
25. 24 de Julho /R.F.Farinha				0	1
26. 24 de Julho /Zambia		0			1
27. 25 de Setembro /P.R.Mugabe				0	1
28. 25 de Setembro /Central C				0	1
29. 25 de Setembro /B.O.Mulanga				0	1
30. 25 de Setembro /K.Marx		0			1
31. 25 de Setembro /G.Popular		0			1
32. 25 de Setembro /M.S.Barre				0	1
33. P.dos Trabalhadores	0				1
34. P.25 de Junho			0	0	1
35. R. dos Lusiadas					1
36. C.Lusaka			0		1
	1x5=5nos	11x2=22nos	6x2=12nos	18x2=36nos	36x2=72nos

6) Preliminary Cost Estimation

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Project costs for the above two projects are preliminary estimated as shown in the Table 11.8.4.

Table 11.8.4 Freiminary Cost Estimation for the Project in CBD									
ect		Nos.	Construction	Contingency	Administration	Engineering Service	Sul		

Project	Nos.	Construction Cost (USD)	Contingency (USD)	Administration cost (USD)	Engineering Service (USD)	Subtotal (USD)
A. Improvement of Intersections	13	1,510,661	151,066	30,213	151,066	1,843,007
B. Improvement of Bus stops *	76	401,003	40,100	8,020	40,100	489,224
	Total	1,911,665	191,166	38,233	191,166	2,332,231

* 1 bus terminal, 1 bus bay, 2 bus strip (large), 6 bus strip (med/sml) are included in the road network improvement programme.

ODD

CHAPTER 12: MIDDLE TERM PLAN FOR ROAD DEVELOPMENT AND MAINTENANCE

12.1 ROAD MAINTENANCE PLAN

1) Road Maintenance Policy and Maintenance Cycle

Road Maintenance Policy

The condition of roads and drainages in Maputo city is poor because of lacking the road maintenance. The road maintenance policy should be established for sustainability.

<Efficiency of the road maintenance and Introduction of Privatisation> The road maintenance consists of three categories;

- Routine Maintenance

Grading/Levelling, Pot hole patching, Cleaning of road surface(removal of soil and garbage), Cleaning of existing Open drain(glass cutting, removal of garbage), Cleaning and flushing of existing pipe and catch-pit

- <u>Periodic Maintenance</u>
 Resealing/Overlay and Reconstruction, Improvement of Drainage system
- <u>Emergency Maintenance</u> Urgent repair of road deterioration

Maintenance programme for routine maintenance and periodic maintenance should be established for to operate the proper road maintenance effectively. But routine/periodic maintenance should be done by the private enterprise. The Municipal should concentrate to manage and supervise the maintenance activity of the private enterprise.

Introduction of privatisation to routine maintenance and periodic maintenance should be necessary for vitalisation of economic activity. The total cost of road maintenance will be reduced, but quality of road maintenance will increase by the competition of each private enterprise for the introduction of privatisation.

Before the introduction of privatisation, the municipal council execute the routine/periodic maintenance. Emergency maintenance will be done by direct force and private enterprise for quick action.

<Introduction of New Road Department>

Proposed new road department consists the following five sections;

- Management Section
- Road Development Planning/Design Section
- Road Maintenance Planning/Design Section
- Procurement Section
- Preparation of the evaluation list of contractors/consultants
- Procurement of construction services
- Inspection of construction services
- Preparation of construction unit prices
- Emergency Maintenance Section

2) Maintenance Cycle

The project roads will need overlay or sealing for the periodic maintenance after 10 years from the completion of the project.

The concept of maintenance cycle is shown as Figure 12.1.1. And the road maintenance activities required for this road master plan are shown as below;

- A. Routine Maintenance of Maputo City Roads (Total length 830 km)
- B. Periodic Maintenance of the Road Development Project Roads
- C. Periodic Maintenance of the Roads of which the Urgent Repair have been done in 1999



Figure 12.1.3 Maintenance Cycle

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3) Implementation Alternatives at mid-term(2010)

Based on the development concepts with the necessary measures to be improved for Road Development and Road Maintenance, the following three-implementation alternatives for Road Development and Maintenance for mid-term target (year 2010) have been proposed. Summary of Implementation Alternative at Mid-term is shown in Table 12.1.1.

Base Plan:

- Road Development Project:

The Trunk Road of Plan 3 of which Rua Igreja, Potential Area Roads and extension Rua 5750 are excepted and The Collector roads (District 1 to 5) are improved and rehabilitated during the mid-term (2010).

- Road Maintenance Project:

The objective roads of the Road Development Project will be maintained by the routine maintenance activities by the road department after the completion of the Road Development Project.

Alternative 1:

- Road Development Project:

The Road Development of this case is consisted the Base Plan and an improvement of the Potential Area Trunk Roads.

- Road Maintenance Project: This case is as same as the base plan.

Alternative 2:

- Road Development Project:

The Trunk Road of Plan 3 of which Rua Igreja, Potential Area Roads and extension Rua 5750 are excepted and The Collector roads (District 1 to 3) are improved and rehabilitated during the mid-term (2010).

- Road Maintenance Project:

This case is as same as base plan.

Plan	Project Roads	20 Pla	20 in 3	20 Ba	10 ase	20 Altern	10 ative 1	20 Altern	10 ative 2
	Trunk Road		-	2.					
	- Av. de Mozambique								
	Trabalho Jct. to Rua 5750								
	Jct.	4 lane		4 lane		4 lane		4 lane	
	(2) reconstruction of from								
	Rua 5750 Jct. to tha border	2 lane		2 lane		2 lane		2 lane	
	- Av. Julius Nyerere								
	new construction of Missing								
	Link	4 lane		2 lane		2 lane		2 lane	
	- Av. A. do Lusaka(Reconst.)								
	/ Av. Guerra								
Road Development	Popular(Widening)								
	- Av. de Angola /	2 lane							
	Rua S. Cabral/Largo de Deta			-		-		-	
	(Reconstruction)								
	- Rua de Igreia								
	- Potential Area			-				-	
	Collector Road							-	
	- District 1.2.3								
	- District 4.5								
	Area Road								
	- District 1			-		-		-	
		Periodic	Routine	Periodic	Routine	Periodic	Routine	Periodic	Routine
	Trunk Road								
Road Maintenance	- Project Road	O.L.	Α	-	Α	-	Α	-	Α
	- Non Project Road	O.L.	Α	O.L.	В	O.L.	В	O.L.	В
	Collector Road	~							
	- District 1.2.3	S	A	-	A	-	A	-	A
	- District 4.5	S	Α	-	Α	-	Α	-	В
	Area Road	a		.					
	- District I	S	A	0.L.	В	O.L.	В	O.L.	В
Routine Maintenance A : After Project									
	Routine Maintenance D: Defore Project								
	O L · Overlav								
	U.L Re ·	Reconst	ruction						

 Table 12.1.1
 Summary of Implementation Alternatives at Mid-term(2010)

Inplementation Alternatives

4) Economic Analysis of Implementation Alternative s of Mid Term Plan

In order to select the best implementation schedule in terms of economic efficiency, economic analysis is conducted on alternative implementation schedules such as "Base plan", "Alt 1", and "Alt 2'. According to the economic evaluation, Base Plan was most efficient plan as shown in Table 12.1.2 and Project component is shown in Figure 12.1.2.

Case	Do Minimum	Base Alter		Alterna	ative 1	Alterna	native 2	
Traffic Assignment								
Traffic Congestion	The bottleneck links having more than 1.5 volume to capacity ratio could be identified as almost all links on the Trunk Roads by the year 2010.	The bottleneck links would become minimum on the Trunk Road network except in the city center. These bottlenecks especially at the intersections will be settled out through the improvement of intersections and Traffic Management Plan.						
Cost Estimate		Total Cost (million USD)	107.8	Total Cost (million USD)	113.8	Total Cost (million USD)	84.4	
		Construction Cost(million USD)	82.9	Construction Cost(million USD)	88.4	Construction Cost(million USD)	61.0	
		Maintenances Cost(million USD)	24.9	Maintenances Cost(million USD)	25.4	Maintenances Cost(million USD)	23.4	
Road Length		126km		139km		72km		
Economic								
Analysis		2.86		2.78		2.64		
Evaluation		Recommended						
L	l	l				L		



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12.2 IMPLEMENTATION PROGRAMME

1) General

The Implementation Programme consists of the Road Development, the Road Maintenance/Operation, the Public Transport Development and the City Centre Traffic Management Plan.

As reported in Chapter 11 and Chapter 12.1, the goal period of Road Development is planned in Short Term and Middle Term. The Implementation Programme of Middle Term Road Development Plan should be established paying attention to the following items;

- Respect the storm water basin and drainage system,
- Priority given to the easiness of implementation,
- Priority given to the rehabilitation of missing link, and
- Establish a flexible institution.

2) Project Packaging for Respecting Storm Water Basin

In order to implement the construction works practically for the road and road related development plans, a drainage work becomes one of the key element of the project implementation.

Based on the existing storm water basin, the MCM has prepared the area distribution of each drainage system as shown in Figure 12.2.1 and Table 12.2.1. Therefore, the packaging of the projects by each drainage system/ storm water basin is necessary.



Figure 12.2.1 Storm Water Basin

Construction	Contents
Order	
Package 1	♦ New construction of new J. Nyerere
	♦ Improvement of Av. V. Lenine
	♦ Rehabilitation/improvement of collector and local area roads in
	the east area of District 3
Package 2	♦ Rehabilitation of Av. A. Lusaka
	♦ Widening of Av. G. Popular
	♦ Reconstruction of Av. Angola
	♦ Widening and reconstruction of Av. M. Ngouabi
	Rehabilitation/improvement of collector roads in the northwest
	area of District 1
	♦ Rehabilitation/improvement of collector and local area roads in
	the northeast area of District 2
	♦ Rehabilitation/improvement of collector and local area roads in
	the west area of District 3
Package 3	♦ Reconstruction of Rua P. S. Gil and Av. ONU
	♦ Rehabilitation/improvement of collector roads in the south area of
	District 1
	♦ Rehabilitation/improvement/installation of traffic management
	facilities
	♦ Construction of bus terminal
Package 4	♦ Rehabilitation/improvement of collector roads in the east area of
	District 1
Package 5	♦ Rehabilitation/improvement of collector and local area roads in
	the south area of District 2
	♦ Maintenance of drainage and pavement of Av. Trabalho
Package 6	♦ Widening of Av. Mozambique
	♦ Rehabilitation/improvement of collector and local area roads of
	District 5
Package 7	♦ Reconstruction of Rua de Igreja
	♦ Rehabilitation/improvement of collector and local area roads of
	District 4
Package 8	♦ Extension of Rua 5750
	♦ Reconstruction of Rua 5751
Package 9	♦ Reconstruction of Rua Igreja(4647)(North Section)
Package 10	♦ Reconstruction of collector roads in Catembe area

 Table 12.2.1
 Packaging for Respecting Storm Water Basin

3) Implementation Programme

Short Term

The project packages for the short term plan have been divided into three categories (See Table 12.2.2).

- Emergency Implementation Package; Package 1
- Necessary Implementation Package; Package 2
- Easy Implementation Package; Package 3, 4 and 5

Construction	Contents
Order	
Package 1	♦ New construction of new J. Nyerere
	♦ Improvement of Av. V. Lenine
	♦ Rehabilitation/improvement of collector and local area roads in
	the east area of District 3
Package 2	♦ Rehabilitation of Av. A. Lusaka
	♦ Widening of Av. G. Popular
	♦ Reconstruction of Av. Angola
	♦ Widening and reconstruction of Av. M. Ngouabi
	\diamond Improvement of Av. Das FPLM(4000)
	\diamond Rehabilitation/improvement of collector roads in the northwest
	area of District 1
	\diamond Rehabilitation/improvement of collector and local area roads in
	the northeast area of District 2
	\diamond Rehabilitation/improvement of collector and local area roads in
	the west area of District 3
Package 3	♦ Reconstruction of Rua P. S. Gil and Av. ONU
	\diamond Rehabilitation/improvement of collector roads in the south area of
	District 1
	\diamond Rehabilitation/improvement/installation of traffic management
	facilities
	\diamond Construction of bus terminal
Package 4	\diamond Rehabilitation/improvement of collector roads in the east area of
	District 1
Package 5	\diamond Rehabilitation/improvement of collector and local area roads in
	the south area of District 2
	♦ Maintenance of drainage and pavement of Av. Trabalho

 Table 12.2.2
 Short Term Project Plan

Middle Term Project

Following this manner, each project components of the middle term plans have also been classified as shown in Table 12.2.3. The middle term project plan should be defined by considering to develop as the suburban residences from CBD and to deteriorate the road surface condition in district 2 and district 3. Therefore, package 6 and 7 should be included in
the middle term project plans.

Tuble 12.2.5 Whene Fermi Froject							
Construction Order	Contents						
Package 6	 ♦ Widening of Av. Mozambique ♦ Rehabilitation/improvement of collector and local area roads of District 5 						
Package 7	 ♦ Reconstruction of Rua de Igreja ♦ Rehabilitation/improvement of collector and local area roads of District 4 						

 Table 12.2.3
 Middle Term Project

Long Term Project

The long term project plans are defined by consisting of package 1, 2, 4, 8, 9 to 10 as shown in Table 12.2.4.

Construction	Contents							
Order								
Package 1	♦ Widening of Av. Julius Nyerere (North Section)							
Package 2	♦ Construction of two Grade Separations							
	♦ Widening /Rehabilitation of Av. Marien Ngouabi(1166)							
Package 4	♦ Widening of Av. Julius Nyerere (South Section)							
	♦ Reconstruction of Rua Igreja(4647)(South Section)							
Package 8	♦ Extension of Rua 5750							
	♦ Reconstruction of Rua 5751							
Package 9	♦ Reconstruction of Rua Igreja(4647)(North Section)							
Package 10	♦ Reconstruction of collector roads in Catembe area							

1 and 12.2.4 Long relimint 100000000000000000000000000000000000	Table	12.2.4	Long	Term	Projec
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The Implementation Programme of the short term and middle term plans will be established following the above mentioned manner as well as the evaluation of the magnitude of the cost required as shown in Table 12.1.2.

4) Institutional Reform

Before starting the project implementation, preparatory works, such as a designing and planning of the project, house compensation, other budgetary arraignment and a institutional strengthening, should be implemented.

Among the preparatory works, the institutional reform will be a key element of the project implementation. Therefore, the Implementation Programme of the middle term and the long term plans should include the institutional reform as shown in Proposed Organization.

5) Implementation Programme of Each Project

Implementation Program of each project for the short, the middle and the long-term plans is prepared based on the objective of each term as shown in Table 12.2.5 and Figure 12.2.2.

According to Table 12.2.5, Project Road of the short term plan is consisted with 57 km and is estimated the project cost as thirty-seven million US dollars by 2005. Project Road of the middle term plan is consisted with 69 km and is estimated the project cost as forty-seven million US dollars by 2010. The short/middle term plan should be implemented in approximately nine years.

Road Project of the long-term plan is consisted with 32 km and is estimated the project cost as thirty-four million US dollars by 2020. The long-term plan should also be implemented in approximately five years.

Furthermore, the maintenance cost such as routine maintenance and periodic maintenance are added until the target year in 2020 after completing of Project Road.

Project Name	Project Term	Package No.	Project Length (km)	Project Cost (mil. USD)	2001	2005	2010	2015	2020
		1	9.05	9.75		_			
Road		2	24.60	16.09					
Development	Short Term	3	11.38	5.78					
Development		4	5.66	2.42					
		5	6.11	2.99					
Road Development			56.80	37.03					
Poard		2							
Maintenance	Short Term	3	20.30	18.96					
Project		4							
Tioject		5							
Pub. Transpot	Short Term	3	0.00	1.69					
Tr. Manage	Short Term	3	0.00	2.33					
Short Term Project Plans			77.10	60.01					
Road	Road Development Middle term		39.39	33.58					
Development			29.36	13.63					
Middle Term Project Plans			68.75	47.21					
Road Development		1	4.90	8.68					
	long term	2	1.88	6.05					
		4	3.95	4.85					
		8	6.55	5.24					
		9	5.75	3.04					
		10	9.00	6.25					
Long Term Project Plans			32.03	34.11					
Total Project Plans			177.88	141.33					

 Table 12.2.5
 Implementation Programme



Figure 12.2.2 Implementation Programme of Each Term

CHAPTER 13 : IDENTIFICATION OF THE FEASIBILITY STUDY

13.1 IDENTIFICATION OF THE PROJECT FOR THE FEASIBILITY STUDY

As the results of the preliminary evaluation of the middle term project and the middle term implementation programme, the project components of the priority road development, rehabilitation/improvement road, public transport development and traffic management plan have been confirmed.

Based on the above evaluation, the identification of the high priority project for the Feasibility Study has to be conducted. In order to select a most important, necessary and consistent road development plan, a conclusive evaluation of road development projects has been developed based on the following five criteria:

(1) Importance

Importance is the road importance on the viewpoint of engineering aspects. The indicators consist following sub-criteria:

- Road classification; Trunk and Collector road is classified as A and Urban area road is classified as B and Rural area road is C.
- Existing Traffic Volume: Traffic volume (>5000pcu): A, Traffic volume (>2000pcu): B and Traffic volume (<2000pcu): C

(2) Necessity

Necessity is the road conditions how the existing road facing the problems on the viewpoint of engineering aspects. The indicators consist following sub-criteria:

- Existing Pavement Roughness: IRI>8: A, IRI>6: B, IRI>4: C
- Traffic congestion: existing traffic par capacity ratio(t/c)>1.0: A, t/c>0.5: B and t/c<0.5: C

(3) Impact

Impacts are the effect whether the road development has effects on its surroundings in terms of socio-economy and environmental aspects. The indicators consist following sub-criteria.

- Improvement accessibility to roadside area: Commercial and industrial area: A, Residential area: B and Rural area: C
- Environmental impact: Numbers of houses need to be relocated (No.<50): A, No.<200: B and No.>200: C

(4) Contribution

Contribution is the effects whether the road projects contribute to the improvement of the Basic Human Needs (BHN). The indicators consist following sub-criteria:

- Accessibility improvement to public community facilities
- Accessibility improvement of Emergency vehicle services
- (5) Consistence

Consistency is the degree of consistency with the government policy

Table 13.1.1 shows the result of the evaluation of the road development projects for the middle term plan and the high priority projects to be evaluated during the further Feasibility Study are the entire road development projects nominated in the short term plan. In addition, the priority projects identified for the public transport development and the traffic management as well as the institutional projects are also important projects to be evaluated during the further engineering study.

13.2 ENVIRONMENTAL ITEMS TO BE STUDIED DURING THE FEASIBILITY STUDY

1) Conclusion of IEE

Environmental items requiring EIA

Evaluation is required to carry out a further Environmental Impact Assessment (EIA) for high priority road development in Maputo city.

According to the results of the IEE study in the previous sections, the items which are evaluated as category "B" are considered to be affected by the execution of projects to be covered by the feasibility study. Consequently, the environmental components which will be required to implement EIA can be shown below:

- Resettlement
- Air pollution
- Noise and vibration

		h Inportance Necessit		2	3		4		ંડ	6	7 Priority	
	Length			Nece	Necessity		Impact		BHN			
							No. of	Ace	cess	mental	Total	Project
		Road	Present		Conges-	Land	Settle-	Public	Emergen	Policy		
	km.	Class	Traffic	IBI	ton	Use	ment	Facility	Vehicle			F/S
Primary Trunk Road	10.000					1			1			
A.1 Widdening of Av. de Mozambique - Rehabilitation of Nothern Section	15.05	A	A	c	в	A(Cam Res)	19 A	A	A	A	A'	
Trunk Road												
B.1 Construction of Missing	4.80			4		A/Com Bar)	162(2=\$1-B	545		4		
Link on Av. Julius Nyerere	9.00	A		^ _		AUCTIN 1005)	100/2-01 D	A.	<u>n</u>	A	_ n	
B.2 Improvement of Av. Vladimir Lenine	3.20	A	A	A	A	A(Com)	0 A	A	A	A	A	۲
63. Improvement of Av. Acordos de Lusa	ca 2.85	A	A	A	B-	A(Cam Res)	A 0	A	A	A	A	0
84. Improvement of Av. Angola	3.09	A	A	B or C	A	A(Cam Res)	0 A	A	A	A	A	0
85. Improvement of Av. Marien Ngouabi	1.88	А	A	A	A	A(Cam/Res)	31 A	A	A	A	А	٢
. Collector Road												
C1. Improvement of Industrial and												
Commercial Area Roads	_					-						
- Av. ONU			-									
- Av. Estancias												
- Av. Josina Machel		_		-	-		-					
- Av. Femai de Mgalhaes												
- Av. Ze decpine Mangahela	17.04	A	A	A	A or B	A	A 0	A	A	A	A	۲
C2. Improvement of Port Area Roads					-							
- R. Consiglien Pedroso - Parca 25 de Janho - R. Margues de Ponbal												
- R. do Bagamoyo - R. Joaquin Lapa												
- Av. Martires de Inhamiga - R. de Timor Lecie												
C3. Improvement of Residential Area Roa	ds											
Dist. 1	1.60	A	A	A	AorB	A(Cam Rec)	10 A	A	A	A	A	0
Dist. 2	10.23	A	AorB	A	в	A(Cam/Res)	140 B	A	A	A	A	0
Dist. 3	8.48	A	A or B	A	B.	A(Cam/Res)	126 B	A	A	A	A	0
Dist. 4	28.41	A	В	A	B	B(Res.)	8 A	A	B	A	A'	
Dist 5	25.54	A	в	A	в	B(Res.)	49 A	A	в	A	A'	
	122.17	1.12									0.050	
	3 /Ten (7 -De		455.000	A TRT > 9	451.0		1050					
	B.The A-D	4	R-3,000	BIDI > 4	RS0 S		8,200	-				
	D. OOR AS D	<i>a</i> .	D+2,000	CIDI ~ 6	Dr0.3		0.200		-			
	CENTR		C<2,000	CIRI < 4	C40.5		C>200					

Table 13.1.1 High Priority Road Development project of Feasibility Study

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a) Resettlement

To evaluate an environmental impact on resettlement of residents, the number of households and facilities (commerce facilities, etc.) along targeted high priority roads should be identified. In addition to these, it should be important to understand the economic conditions of inhabitants, living environment and household opinion on improvement project and resettlement issues, etc.

Regarding compensation for resettlement, there is a compensation system for involuntary resettlement in Mozambique. However, there is neither any precise regulation nor law on resettlement. Generally, it is agreed upon in the talks between local people and the Maputo city government to pursue resettlement with help of consultants. Therefore, past experience on resettlement and compensation measures shall be reviewed and the feasibility of applying them shall be evaluated. In addition, there should be necessity to establish a rule on compensation for resettlement by the government.

Issues arising from resettlement of residents along targeted high priority roads and the need for mitigation will take the following considerations:

- Likely social and cultural tensions between newly arrived residents and residents living in adjacent areas.
- Likely cultural anxieties among resettled residents due to loss of livelihood or inability to continue livelihood in new areas

b) Air pollution

By predicting total amounts of pollutants emitted from vehicle exhausts, their impact to the environment and possible mitigation measures to be introduced to high priority roads should be carefully studied. In addition, mitigating measures to combat excessive particulate matter during road construction should be examined in practical manner.

Regarding prediction of air pollution in the target year, there are several prediction methods. The principal method is to calculate them by using several parameters such as traffic volume by each vehicle type, vehicle velocity (km/h) and meteorology (wind speed (m/s)), etc. Therefore, these parameters shall be obtained or assumed from existing data or other studies at the EIA stage to make the necessary prediction.

c) Noise and vibrations

A prediction of the noise level and vibration level generated from automobile traffic and road construction machinery along targeted high priority roads to adjacent residential areas should be made. Based on qualitative assessment, proper mitigation targets can thus be estimated.

Regarding prediction of the noise level in the target year, there are several prediction models currently used in other studies. Selection of the suitable model in this study should be made by considering the situation of the study area and the purpose of this study. As one of the models, the equivalent continuous A-weighted sound pressure level (L_{eq}) can be calculated by use of several parameters such as average power level (dB(A)), vehicle average interval (m), vehicle velocity (km/h), distance between noise source (m) and the monitoring position.

Regarding prediction of the vibration level, a model proposed by the Public Works Research Institute of the Ministry of Construction of Japan can be considered to utilize. According to this model, the highest value of 80% range of vibration level (L_{10}) can be calculated by use of several parameters such as traffic volume by each vehicle type, vehicle velocity (km/h), situation of road construction and road surface, etc.

Therefore, these parameters on calculation of noise and vibration level shall be obtained or assumed from existing data or other studies at the EIA stage to make the necessary prediction.

Other environmental items requiring further study

Other environmental items which were evaluated as category" C "require further studies in the areas where high priority roads of improvement projects exist as discussed in the previous section. Environmental items for further study and a brief study plan are, therefore, shown in Table 13.2.1.

Environmental Item		Study Plan					
	Economic Activities	To study future land use plan and future economic structures in the target areas of the improvement project. To predict impacts on economic activities.					
Social vvironment	Traffic and Public Facilities	To identify the distribution of public facilities (such as markets, hospitalsand schools,etc.) in the target areas of the projects. To predict impacts such as congestion, accidents on the public facilities.					
Ш	Cultural Property	To survey and identify the distribution of the cultural properties in the target areas of the projects. To predict impacts on the cultural properties.					
Natural Environment	Flora and Fauna	To study and identify the inhabitants of the flora and fauna in project areas. To predict impacts on inhabitants.					