

PART B
FEASIBILITY STUDY

CHAPTER 14 : INTRODUCTION

14.1 GENERAL

As stated in the Master Plan Study (Part A of this Study), High Priority Projects were selected among the road development plans proposed for the short-term plan. The selection of these high priority projects was made taking into consideration the following factors:

- Classified Road Development to improve Basic Human Needs and Community Environment
- To contribute settlement of existing Road Problems such as pavement deterioration, traffic congestion and poor drainage system
- To enhance Future Traffic efficiency
- To promote the Metropolitan Development
- Economic Efficiency of the investment
- Vitalization of local economy
- Minimizing resettlement on the viewpoint of environmental impact
- Availability of development fund
- Sustainability of maintenance fund
- Improvement of accessibility to public transport services
- Improvement of environment along the Proposed Project Roads
- Urgency of the project from the viewpoint of necessity and safety
- Consistency with national and regional policy.

The high priority projects consist of three categories; namely, road development plan, traffic management plan and public transport plan as outlined below:

(1) Road Development Plan

Trunk Road Development Plan:

1. Construction of Bypass missing link on Av. Julius Nyerere
2. Improvement of Av. Vladimir Lenine
3. Rehabilitation and improvement of Av. Acordos de Lusaka and Av. Guerra Popular
4. Rehabilitation and improvement of Av. de Angola
5. Rehabilitation and improvement of Av. Marien Ngouabi

Collector Road Development Plan:

1. Rehabilitation of industrial and commercial area roads
2. Rehabilitation of port area roads

Residential Area Roads:

1. Rehabilitation of District 1 area roads
2. Rehabilitation of District 2 area roads
3. Rehabilitation of District 3 area roads

(2) Traffic Management Plan:

Rehabilitation and Improvement of Intersections in the CBD

(3) Public Transport Plan:

Rehabilitation and Improvement of Bus Stops and Terminals

14.2 SUBJECT PROJECTS FOR THE FEASIBILITY STUDY**● Road Development Plan**

- 1) Construction of Missing Link on Av. Julius Nyerere (total length = about 5.6 km)
- 2) Improvement of Av. Vladimir Lenine
- 3) Rehabilitation and Improvement of Av. Acordos Lusaka, Av. Guerra Popular (total length = 3.5 km)
- 4) Rehabilitation and Improvement of Av. Angola (total length = 3.7 km)
- 5) Rehabilitation and Improvement of Av. Marien Ngouabi (total length = 1.9 km)
- 6) Rehabilitation of Industrial and Commercial Area Roads (total length = 6.03 km)
- 7) Rehabilitation of Port Area Roads (total length = 3.9 km)
- 8) Rehabilitation of District 1 Area Roads (total length = 8.7 km)
- 9) Rehabilitation of District 2 Area Roads (total length = 10.2 km)
- 10) Rehabilitation of District 3 Area Roads (total length = 9.5 km)

● Traffic Management Plan

Construction of Right-turn lanes and signals (14 intersections) and control of on-street parking in intersection areas.

● Public Transport Plan:

To provide suitable location and size of bus bays (22 bus bays) and one (1) terminal and to equip required function on to the bus terminal.

● A study on Road Maintenance and Management system

14.3 OBJECTIVES AND BASIC CONDITIONS OF THE FEASIBILITY STUDY PROJECTS

- 1) The target year for the priority projects has been established as a year 2010 in order to prepare suitable scale of the projects to meet a future traffic demand in the target year.
- 2) The objectives and basic components of the priority projects has been established and confirmed as shown in the Table 14.3.1. The detailed study on the selection of each project components has been described in the following chapters.
- 3) Basic policy of the selection of the alternatives on each projects has been prepared as shown in the Table 14.3.1.
- 4) Future traffic demand on the target year of 2010 has already been estimated as “mid-term” traffic volume on the base plan in Chapter 12.

Table 14.3.1 Objectives and Components of Feasibility Study

FS Project	Trunk Roads					Collector Roads		Residential Area Roads			Rehabilitation and Improvement of Traffic Management Facilities	Rehabilitation and Improvement of Bus Stops and Terminals
	1.Construction of Missing link on Av. Julius Nyerere	2.Improvement of Av. Vladinir Lenine	3.Rehabilitation and Improvement of Av. Acordos de Lusaka	4.Rehabilitation and Improvement of Av. Angola	5.Rehabilitation and Improvement of Av. Marien Ngouabi	1.Rehabilitation of Industrial and Commercial Area Roads	2.Rehabilitation of Port Area Roads	1.Rehabilitation of District 1 Area Roads	2.Rehabilitation of District 2 Area Roads	3.Rehabilitation of District 3 Area Roads		
1. General Target/Objectives, Target year: 2020	1. Protect/ improve Basic Human Needs and Community Environment 2. Contribute settlement of existing Road Problems 3. Enhance Future Traffic Efficiency 4. Promote the Metropolitan Development											
2. General Strategy for year 2020	1. Functional Classification of Road Network and Typical Cross-sections 2. Rehabilitation of Pavement and Drainage, Construction of Dual Carriageway (Lusaka, Angola and M. Ngouabi Rd.) and Improvement of Intersections in Central Area 3. Construction and Improvement of Dual Carriageway (Mozambiqu, Nyerere, Lusaka, Lenine, FPLM, M. Ngouabi Rd.) 4. Construction and Improvement of Outer and Middle Ring roads											
3. Project Objectives, Target year: 2010	1. Early Linking of Missing Link 2. Prevent Disaster 3. Basic Corridor for Future Extension	1. Decrease Traffic Congestion 2. Provide Better Public Transport	1. Smooth Vehicle Running 2. Decrease Traffic Congestion	1. -do- 2. -do-	1. -do- 2. -do -	1. -do-	1. -do-	1. -do-	1. -do-	1. -do-	1. -do- 2. -do- 3. Avoid Large-scale Investment	1. Provide Appropriate Bus Services 2. Settle Traffic Congestion
4. Project Measures/ Components for year 2010	1.Reconstruction of 2-lane Trunk Road 2.Measures for Landslide and Drainage 3.Land Preparaion for Widening	1. Construction of Bus Bay 2. Improvement of Intersection Concrete block (Block) Block	1. Pavement and Drainage Rehabilitation 2. Construction of Dual Carriageway As-con Block	1. -do- 2. Intersection Improvement As-con Block	1. -do- 2. -do- 3. Construction of Dual Carriageway As-con Block	1. -do- As-con Block	1. -do- As-con Block	1. -do- As-con Block	1. -do- As-con Block	1. -do- As-con Block	1. Installation of Right-turn lane and Signal 2. Control of On-street Parking 3. Traffic Control As-con Block U-shaped	1. Provide suitable location and size of bus bays/stations 2. Equip required Functions Block Block U-shaped
5. Alternatives	1. Route Alternatives 2. Stage construction	nil Semi-rigid	1. Widening of Right of Way Stabilization	nil Stabilization	nil Stabilization and BST	nil Stabilization and BST	nil Stabilization and BST	nil Stabilization and BST	nil Stabilization and BST	nil Stabilization and BST	nil Semi-rigid	nil Semi-rigid
Carriageway	Stabilized base/sub-base course (Stabilization)											
Footpath	nil	BST	BST	BST	BST	BST	BST	BST	BST	BST	nil	BST
Drainage	nil	nil	L-shaped	L-shaped	L-shaped	Open ditch	L-shaped	L-shaped	nil	nil	L-shaped	L-shaped

CHAPTER 15 : ENGINEERING SURVEY AND ANALYSIS

15.1 GEOLOGICAL INVESTIGATION

1) Geological Characteristics at the Site

Geological characteristics at the project site are summarized as follows.

- Basic formation at the site is Ponta Formation, which is predominantly consisting of coarse grained sandstone deposited in late Tertiary.
- The sandstone has been completely weathered at top tens of meters and changed into residual soil, such as sand, silty sand, coarse sand with gravel and so on.
- There is a fault along Av. J. Nyerere Road, running to north. The maximum differential level is about 30m.

2) Evaluation of Foundation Stratum

Evaluation of foundation stratum is made according to the core drillings, performed at three locations at the site shown in the Figure 15.1.1. The evaluation are summarized as follows.

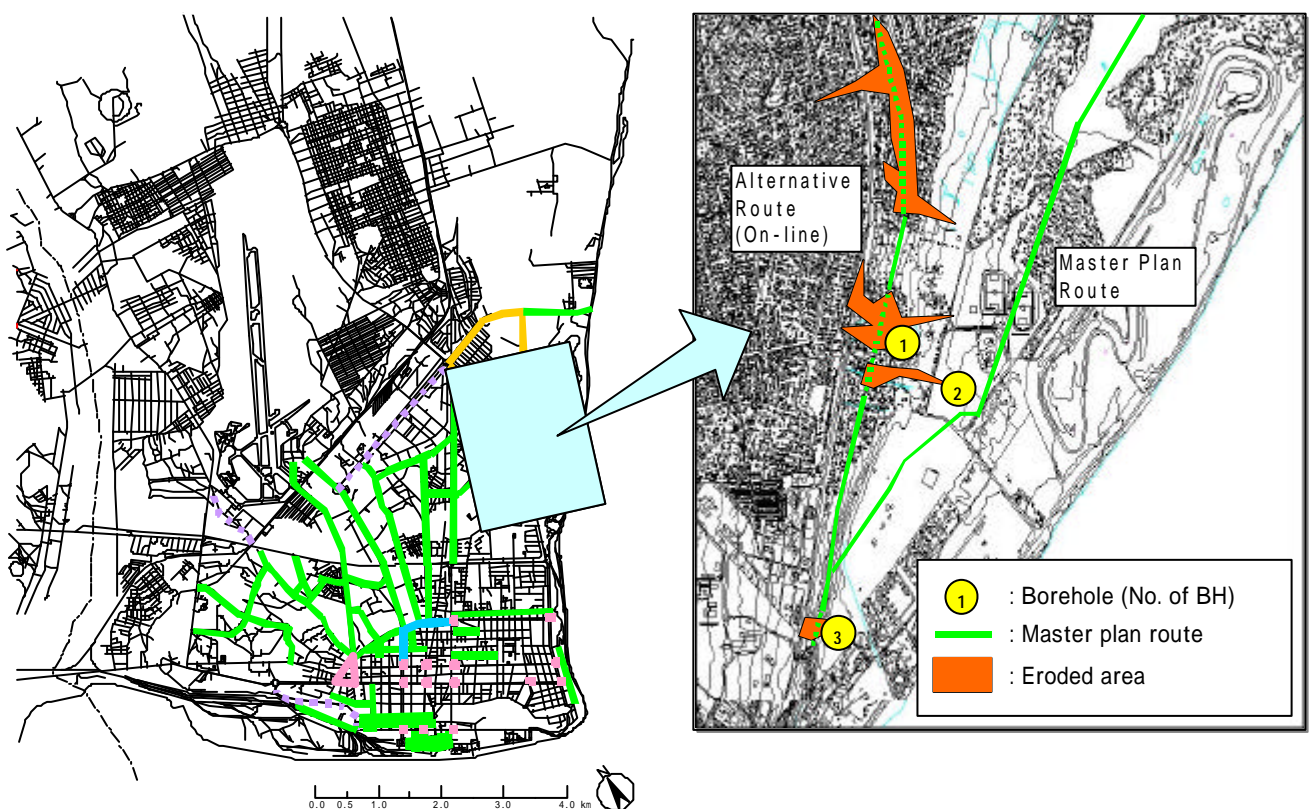


Figure 15.1.1 Location of Borehole

Bearing stratum for embankment

- Top portion may be loose and a certain amount of settlement may be caused. However, the settlement of loose sand takes place immediately right after on-loaded.

Bearing stratum for abutment and piers :

- Since unweathered sandstone fragment may be remained not in decomposed condition, which can damage the pile end if over-driven, bored type pile is preferred to the driven type.

Slope stability :

- Most of the soil at the project site is suitable for filling of embankment if properly compacted. However, both clay-cover and horizontal subsurface drains are necessary to prevent slope surface failure for filled embankment. And the slope angle should at least be equal or gentler than Vertical : Horizontal =1:1.5.
- For cut slope, the slope angle is desirable to be equal to or gentler than Vertical : Horizontal =1:1.0 at the place where the groundwater level is high. Clay-cover or subsurface drains are also necessary to prevent slope surface failure.

15.2 MATERIAL INVESTIGATION

1) Subsoil Conditions on Project Roads

Subgrade sampling and laboratory soil tests were performed at selected 36 locations on the project roads. The engineering properties of the sub-soil at the project site are summarized as shown in the Table 15.2.1. Basically, all material can be classified as excellent to good as per AASHTO.

Table 15.2.1 Engineering properties of soils at the site

		Plas- ticity	Maximum dry density, kN/m ³	Optimum moisture content, %	CBR, %	Cohe- sion, kN/m ²	Fric- tion,	Location
Stone fragment, gravel and sand		NP	1.7 and 1.9	7 and 10	24 and 48	-	-	T07 and T01/4
Fine sand	Red sand T01	NP	1.75 in average	8-9	20-25	2-7	28-25	Av24, C04, C07, C11, C16/1, C16/2, C21/1, C21/2, C24, C25, C27, C30, C31/1, C31/2, C33, T01/3, T01/5, T01/7, T03, T05, T06, T09/1, Y09/2
	Gray sand C27					0-8	33-37	
Silty or clayey gravel and sand		NP	1.80-1.95	10-11	30-35			AV25, C20, C22, C23, T01/1, T01/2, T01/6, T04, T09/2

2) Potential Borrow Pit Areas

- Soil borrow pit is located on a gently elevated hill at Marracuene, about 30km north to the Maputo city.
- The type of soil is same as is commonly distributed at the project site, reddish brown, fine to medium sand and it is believed that its quality is as excellent as above-mentioned red sand.

3) Potential Quarry Site for Aggregate

- Most potential quarry is located about 30 km to the south of Maputo. There are two types of rocks: Rhyolite and Basalt.
- The quality of Rhyolite looks weathered and a little fragile, it has enough strength as coarse aggregate, base course and other building stones.
- The quality of basalt is excellent, however the Basalt quarry is located relatively flat portion compared to Rhyolite quarry and it is necessary to dig downward to continue production of stones.

15.3 HYDROLOGICAL STUDY AND ANALYSIS

1) Rainfall Intensity

Rainfall Intensity in the Maputo city is being set up with the master plan in 1981 and be examined newly with the basic design study of the reconstruction of Av. Julius Nyerere in 2000. It is conceivable to adopt the Rainfall Intensity in the result of these studies to the drainage design.

**Table 15.3.1 Rainfall Depths (mm) and Intensities (mm/h, l/s/ha)
For Short Durations**

Return Period T (year)	Duration t(min)	Depth h(mm)	Intensity I	
			(mm/h)	(l/s/ha)
2	15	25	100	278
	30	37	74	206
	60	49	49	136
5	15	32	128	356
	30	48	96	267
	60	64	64	178
10	15	37	148	411
	30	56	112	311
	60	73	73	204
20	15	42	168	467
	30	64	128	356
	60	83	83	231
50	15	48	192	533
	30	74	148	411
	60	94	94	261
100	15	53	212	589
	30	82	164	456
	60	103	103	286

Source: Scope Assessment and Preliminary Design Study of Repair of Avenida Julius Nyerere

2) Run-off Factor

Through the evaluation of the site conditions in Maputo city, the run-off factor determined for the drainage design is proposed as follows.

- Urban Area : 0.75
- Semi-urban Area (High Density Residential Areas) : 0.55
- Semi-urban Area (Other Areas) : 0.20

15.4 TOPOGRAPHIC SURVEY

The Topographic Survey was made to obtain topographic data of the existing ground for the

preliminary design. The data was collected as a digital 3-D ground model in a format compatible with “MODELMAKER” computer software systems.

15.5 EXISTING CONDITIONS OF THE PROJECTS

The high priority projects consist of three categories; namely, road development plan, traffic management plan and public transport plan. The existing problems have been analyzed on each roads shown below.

1) Road Development Plan

Trunk Road Development Plan

6. Construction of Bypass missing link on Av. Julius Nyerere
7. Improvement of Av. Vladimir Lenine
8. Rehabilitation and improvement of Av. Acordos de Lusaka and Av. Guerra Popular
9. Rehabilitation and improvement of Av. de Angola
10. Rehabilitation and improvement of Av. Marien Ngouabi

Collector Road Development Plan:

3. Rehabilitation of industrial and commercial area roads
4. Rehabilitation of port area roads

Residential Area Roads:

4. Rehabilitation of District 1 area roads
5. Rehabilitation of District 2 area roads
6. Rehabilitation of District 3 area roads

2) Traffic Management Plan:

Rehabilitation and improvement of intersections in the CBD

3) Public Transport Plan:

Rehabilitation and improvement of bus stops and bus terminals

15.6 UTILITIES INVESTIGATION

Utilities investigation was carried out through hearings to the relevant authorities. Detail information and other information were collected through the topographic survey, visual site investigation and so on. Subject to be considered on the preliminary design are as follows.

- A lot of illegal house have been constructed within the right of way on collector roads and local area roads, these poles are taken in to those houses.
- The condition of tap water network and sewerage system at site has been changed from the information. Therefore detail site investigation such as trial dig etc. will be required prior to the detailed design and the execution of construction.

15.7 EVALUATION OF THE PILOT PROJECT

Through the implementation of the Pilot Project, 4 types of pavement structure and drainage were evaluated from the viewpoint of economy, durability, easiness of maintenance / repair and others. These evaluations should be the basis of the selection of structure type on the preliminary design.

Base course

	Cost comparison	Road classification	Traffic condition	Other usage
Graded crushed stone	1.00	- Trunk road - Collector road (urbanized area)	- Heavy traffic	- Bus terminal
Stabilized soil	0.46	- Collector road (semi-urbanized area)	- Low traffic	- Side walk - Road shoulder

Surface course

	Cost comparison	Road classification	Traffic condition	Other usage
Pre-mixed Asphalt Concrete	1.00	- Trunk road - Collector road (urbanized area)	- Heavy traffic	
DBST	0.42	- Collector road (semi-urbanized area)	- Low traffic	- Side walk - Road shoulder - Emergency repair
Inter-locking Concrete Block	1.15	- Collector road	- Heavy traffic - Low traffic	- Bus stop - Bus terminal

Roadside drainage

	Cost comparison	Road classification	Traffic condition	Other usage
U-drain (Concrete)	1.00	- Trunk road (urbanized area) - Collector road (urbanized area)	- Much pedestrian and vehicle crossing in urban area	
K-drain (Stabilized soil)	0.09	- Collector road (temporary construction)	---	- Temporary construction
K-drain (Concrete)	---	- Collector road (narrow ROW)	- Pedestrian and vehicle use same road space	- Access road - Local area road
V-drain (Concrete)	1.08	- Trunk road (semi-urbanized area)	- Less pedestrian and vehicle crossing	
V-drain (Stone pitching) (Wet masonry)	0.65	- Trunk road (semi-urbanized area) - Collector road	- Less pedestrian and vehicle crossing	

CHAPTER 16 : ENVIRONMENTAL SURVEY

The existing environmental situations of the proposed feasibility study project roads were identified by field survey, literature survey, interviews and discussions with authorities. Environmental survey items carried out are as shown below:

Natural Environmental survey

- Flora and fauna
- Geology and soils
- Flood hazard
- Groundwater

Social Environmental survey

- Landuse
- Infrastructure
- Cultural properties
- Economic activities
- Household and business opinion surveys
- Resettlement compensation

Environmental Pollution survey

- Air pollution

Survey results are used for the Environmental Impact Assessment (EIA) shown in the Chapter 20.

CHAPTER 17 : BASIC DESIGN STANDARD

17.1 DESIGN STANDARD

1) Functional Classification of the High Priority Roads

The recommendable Road Classification have been evaluated based on ANE's and SATCC design standards.

- Trunk Road:

1. Missing Link on Av. Julius Nyerere (total length = about 4.8 km)
2. Av. Vladimir Lenine:
3. Av. Acordos Lusaka and Av. Guerra Popular (total length = 3.5 km)
4. Av. Angola and Rua S. Cabral/Largo de Deta (total length = 3.7 km)
5. Av. Marien Ngouabi (total length = 1.9 km)

- Collector Road:

1. Industrial and Commercial Area Roads (total length= 6.03 km)
2. Port Area Roads (total length =3.9 km)

- Local Area Road:

1. District 1 Area Roads (total length = 8.7 km)
2. District 2 Area Roads (total length = 10.2 km)
3. District 3 Area Roads (total length =9.5 km)

2) Road Design Standards

The new road design standard have been proposed based on ANE's design standard as well as SATCC design standard.

3) Design Speed

The design speed was established taking into account the road classification, type of road and land-use situation along the proposed roads.

Table 17.1.1 Proposed Design Speeds

Project Road	Classification	Type of Road	Terrain Condition	Land-use Situation	Proposed Design Speed (km/hr)
Missing Link of Av. Julius Nyerere	Trunk Road	Street	Flat/Rolling	Urban Area	60
Av. Vladimir Lenine	Trunk Road	Street	Flat	Urban	50
Av. Acordos do Lusaka	Trunk Road	Street	Flat	Urban	60
Av. Guerra Popular	Trunk Road	Street	Flat	Urban	50
Av. Angola and Rua S. Cabral/Largo de Deta	Trunk Road	Street	Flat	Urban	50/40
Av. Marien Ngouabi	Trunk Road	Street	Flat	Urban	50/40
Industrial and Commercial Area Roads	Collector Road	Street	Flat	Urban	40
Port Area Roads	Collector/ Local Area Road	Street	Flat	Urban	40/30
District 1 Area Roads	Collector Road	Street	Flat/Rolling	Urban	40/30
District 2 Area Roads	Collector Road	Road	Flat	Semi-urban	40
District 3 Area Roads	Collector Road	Road/Street	Flat	Semi-urban	40

4) Pavement Design Standard

The Pavement Design methodology in Mozambique and SATCC is based on the “AASHTO Guide for Design of Pavement Structures”, 1993.

The Pavement Design Standard in this study should be applied based on the AASHTO standard. Furthermore,

- An appropriate improvement measure should be selected based on the Pavement Serviceability Index (PSI) for each existing road.

Table 17.1.2 Required Rehabilitation Measures of Pavement

PSI	Improvement Measure
Very Bad	Reconstruction from Subbase Course
Bad	Reconstruction from Base Course
Fair	Overlay
Good	Pot-hole patching
Very Good	Ordinary maintenance work

- The design period for pavement design under the Project should be 10 years for the project roads by considering the follows items.
 - the road maintenance regime of the MCM will be strengthened,
 - possible transfer of the road maintenance responsibility from the public sector to the private sector.

5) Drainage Design Standard

Drainage design standard should be determined referring with existing plans, study, and also comparing with Japanese standard.

(1) Return Period (based on the “Preliminary Design Study of Repair of Avenida Julius Nyerere”)

- Av.J.Nyerere and Outlet of Port Area Road :
 - Road drainage: 10 years
 - Box culvert to Outlet: 50 years
 - Outlet: 50 years
- Other roads : 2 years

(2) Run-off Factor

- Urban Area : 0.75
- Semi Urban Area (High Density Residential Areas) : 0.55
- Semi Urban Area (Other Areas) : 0.20

(3) Calculation of Discharge

- $Q = 1/360 \cdot C \cdot I \cdot A$
 - Q: Volume of Discharge (cu m)
 - C: Run-off Factor
 - I: Intensity (mm/hr)
 - A: Catchment Area (ha)

(4) Calculation of Channels

- $Q = A \cdot V$
 - Q: Capacity of Channel (cu.m/sec)
 - V: Water Velocity (m)
 - A: Area of Flow Water (sq.m)
- $V = 1/N \cdot R^{2/3} \cdot I^{1/2}$
 - V: Water Velocity (m)
 - N: Coefficient of Roughness
 - R: Hydraulic Radius
 - I: Incline
- Limitation of water velocity (V) : between 0.6m/sec to 3.0m/sec.

6) Structure Design Standard

(1) Bridge Design standard

The bridge design standard should be applied ANE's design standard.

(2) Box Culverts Design standard

For box culverts, sectional dimensions will be determined with referring to the Standard Box Culvert Design Drawings established by the Ministry of Land and Transport of Japan.

17.2 STANDARD TYPICAL CROSS-SECTIONS AND RIGHT-OF-WAY

Typical cross-sections for each road-type have been developed for the year 2010 along with traffic lane numbers determined taking into consideration road classification, type of road (Street and Road), land-use pattern and existing right-of-way conditions.

Figure 17.2.1 shows proposed typical cross-sections as well as required right-of-way width for each proposed road.

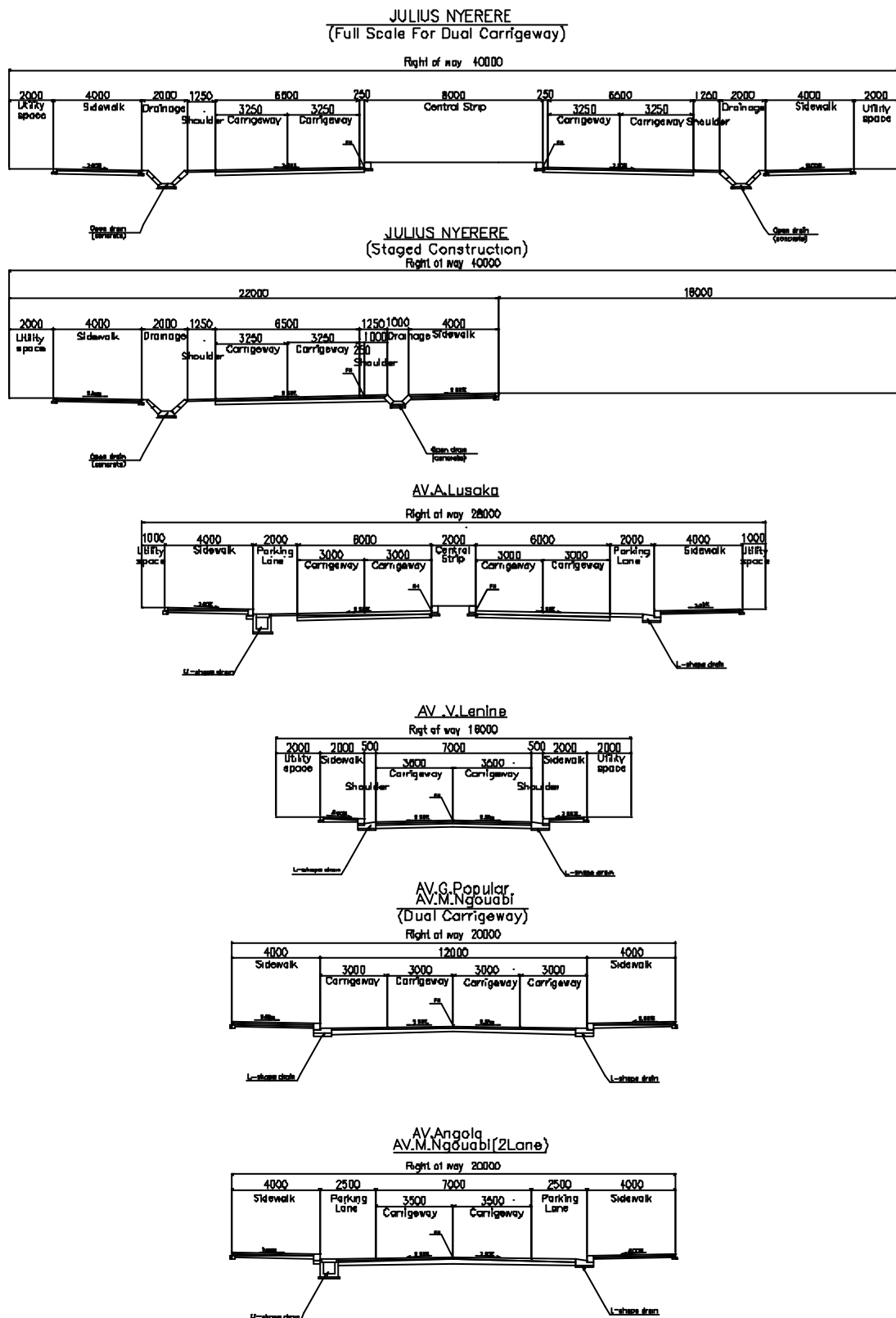


Figure 17.2.1 (1) Proposed Typical Cross-sections (Trunk Roads)

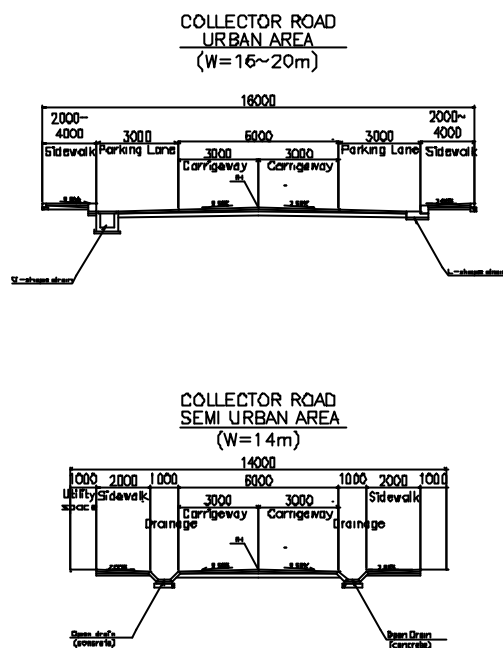


Figure 17.2.1 (2) Proposed Typical Cross-sections (Collector Roads)

CHAPTER 18 : PRELIMINARY ENGINEERING DESIGN

18.1 ALTERNATIVE ROUTE STUDY

The missing link of Av. J. Nyerere was caused by the flood and the erosion in February 2000. Av. J. Nyerere has been identified as one of the main corridors connecting the north area and the CBD and the connection of the missing link has also identified as one of the urgent project among the others. The basic route for the missing link has been studied in the master plan study and the route is recommended to pass the flood plain comparing the original route of the missing link through the evaluation of the costs and the benefits.

Based on the above, the alternative route study on the missing link of Av. Julius Nyerere has been carefully done in order to identify the appropriate alternative route to be analysed during the feasibility study.

1) Objectives and Policies

- Early linking of the missing link through construction of **two lane trunk road**
- To prevent Disaster through introduction of the required measures for the **land-slide and the storm drainage**
- To function as a basic corridor for future extension through preparation of land for **future widening**.
- No school zone and community cutting should be planned
- **The traffic capacity and the design speed** should be **high**
- **Access control to each housing** should be introduced

2) Characteristics of the Candidate Routes

Based on the above objectives and policies, the study team has selected four (4) candidates to the basic route as shown in the Figure 18.1.1. The following three points have made for the selection of the candidates :

- Short distance linking
- To connect with the collector roads
- To use a land of existing road

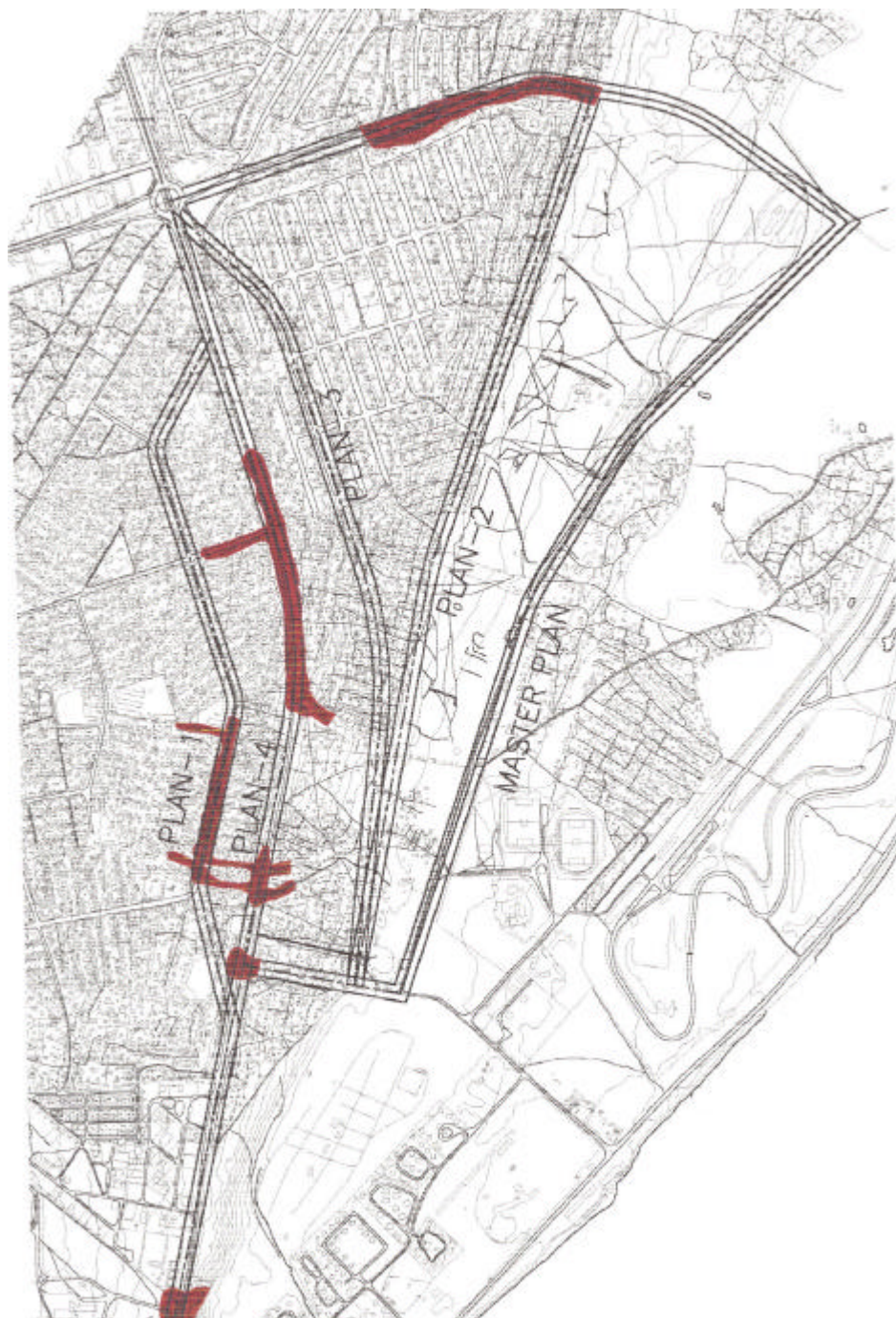


Figure 18.1.1 Candidate Route for Alternative Route

3) Selection of Alternative Route

The evaluation of each candidate route has been conducted based on the fitness in the objectives.

Table 18.1.1 Alternative Route for Av. Julius Nyerere

Objectives	Master Plan	Plan 1	Plan 2	Plan 3	Plan 4
Trip length (km)	5.6	3.1	5.1	3.4	3.1
Impact to daily life (community cutting)		×		×	
	(350)	(550)	(280)	(650)	(210)
Countermeasure for damaged area			×	×	
Right of way for 4 (resettlement houses)		×		×	
Result		×	×	×	

: No problem

: Acceptable

× : Unacceptable

4) Road Construction Work Items to be Needed

Road construction work items are shown in Table 18.1.2. Master Plan Route is needed more items for construction work than Plan 4 Route.

Table 18.1.2 Road Construction Work Items

Item	Master Plan Route	Plan 4 Route
Road length	5.6 km	3.1km
Public facilities relocation <ul style="list-style-type: none"> Telephone line Electric power line Water supply pipe 	Need to relocate partly Need to relocate widely Need to relocate partly	Need to relocate partly Need to relocate partly No need
House relocation	Need to relocate (Number of houses: 350)	Need to relocate slightly (Number of houses: 210)
Removal of the installed gabions	No need	Need to remove (1,300m3)
Earth work <ul style="list-style-type: none"> Cutting volume Banking volume 	80,000 m3 82,000 m3	Nothing 320,000 m3
Pavement Work	87,500 m2	58,000 m2
Structure work <ul style="list-style-type: none"> Box culvert 	Roundabout A: 3.0m × 3.0m Junction B: 2@3.5m × 2.0m Ravine 1: 5.0m × 5.0m	Ravine 4: 3.5m × 3.5m Ravine 3: 4.0m × 4.0m Ravine 2: 3.0m × 3.0m Ravine 1: 5.0m × 5.0m
<ul style="list-style-type: none"> Countermeasures of cut slope 	Concrete wall: partly (1,820m2)	Concrete wall: Nothig
Stream improvement	Need to improve: 1.7km	No need

18.2 TRAFFIC FORECASTS

1) Overall Feasibility Study Programme Results

- By 2005, Av. de Moçambique and Av Julius Nyerere will become congested following the growth in development in the north of the city.
- Av Vladimir Lenine will become more congested leading to the use of AV FPLM as a main north-south corridor. This will place pressure on Av Acordos de Lusaka particularly on the north section of Rua da Machava.
- In the city centre, severe congestion is expected on the main north-south roads of Av Guerra Populare, Av Karl Marx and Av Vladimir Lenine, as well east-west road of Av 25 de Setembro.
- By 2010, particularly on Av de Mozambique, Av Acordos de Lusaka and Av Vladimir Lenine, congestion will be even more severe. In the city center it is extremely likely that all the major north south arteries will be congested over most of the day.

2) Alternative Alignments for the re-instatement of Av Julius Nyerere

- In 2005, construction of missing link of Av. Julius Nyerere will contribute almost 25% of the total time saving of the feasibility study package, and this would rise to over 30% with the on-line option.
- In 2010, time saving by the on-line option will be 35% higher than by the off-line option.

3) Consideration of other packages in the Feasibility Study

Improvement of Av Vladimir Lenine (Package 2)

- Vehicle hour savings due the improvements in Package 2 are set out in Table1 8.2.1

**Table1 8.2.1 Estimated Time Savings (pcu hours per 16 hour day) in 2005
due to Package 2**

	Car	Truck	Buses	Total
Junction Improvements	170	57	68	295
Bus Bays	288	133	-142	279
Total	458	190	-74	574

Improvement of Av Acordos de Lusaka (Package 3)

- The total network time savings in 2005 are forecast to be 767 pcu-hours over the 16-hour day.

Improvement of Av de Angola (Package 4)

- Time savings due to the improvements are forecast to be 109 pcu-hours in 2005.

Improvements to Av Marien Ngouabi (Package 5)

- Time savings are forecast to be 277 pcu-hours per 16-hour day as a result of the improvements.

Area Based Packages (6 to 10)

- These lead to time savings for existing road users and those who divert to take advantage of the better quality surfaces, but in reality they may be built with limits, e.g. speeds humps, to protect residential amenity.

18.3 HIGHWAY DESIGN

1) Design Speed

The design speed of each project road has already been determined in Chapter 17. The detailed design speed of each project road is shown in **Table 18.3.1**.

2) Proposed Alignment

The horizontal and vertical alignments of each road will be almost same as the existing, except some sections where there is a drainage difficulty or steep alignment compared to the required road function.

3) Proposed Cross-section and Right-of-way

The determination of actual cross-section should be carefully analyzed especially in case of the rehabilitation of collector roads in District 2 and 3.

Table 18.3.2 shows where typical cross-sections and alternative modifications have been examined. The study team recommended the modification cases for the proposed cross-sections and Right-of-way because of the difficulty of entire land acquisition, as opposed to a modest reduction in the required function.

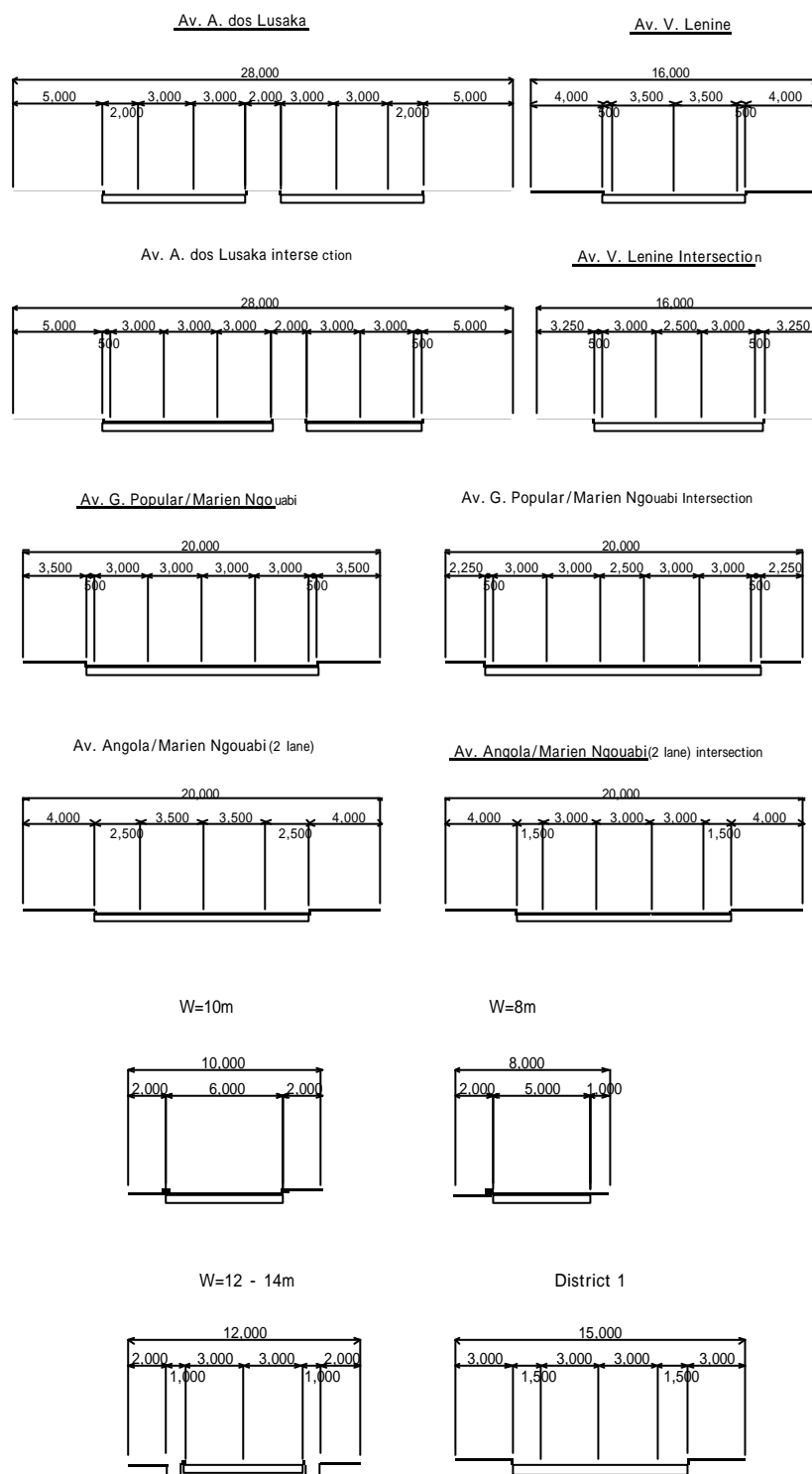


Figure 18.3.1 Typical Cross Section

Table 18.3.1 Higeway Design

Project Road			Traffic Volume (vehicle/day)		Road Length (m)	Existing Nos. of Lane	Proposed Nos. of Lane	Existing					Proposed					Landacquisition	Design Speed (km/h)			
			Existing	2010				Carrageway Width	Shoulder/ Parking Lane Width	Drainage Type	Sidewalk Width	Median Strip	Total Width	Carrageway Width	Shoulder/ Parking Lane Width	Drainage Type	Sidewalk Width			Utility Space	Median Strip	Total Width
1	1	Av. J. Nyerere	-	16,944	4.80	-	2	-	-	-	-	-	-	3.25	1.25	OD	4.00	2.00	-	22(40)	required	60
2	2	Av. V. Leninne	20,213	19,189	0.00	2	2	3.50	0.50	L	2.00	-	23	3.50	0.50	L	2.00	2.00	-	16	required	50
3	3-1	Av. A. Lusaka	29,318	30,489	2.80	4	4	3.00	2.00	L/OD	4.00	2.00	28	3.00	2.00	L/OD	4.00	1.00	2.00	28	None	60
4	3-2	Av. G. Popular	11,965	36,012	0.70	2	4	3.50	2.50	L	4.00	-	20	3.00	0.50	L	3.50	-	-	20	required	50
5	4-1	Av. Angola			3.10	2	2	3.00	2.50	L	4.00	-	20	3.50	2.50	L	4.00	-	-	20	None	50
6	4-2	Rua S. Cabral/Largo de Deta	13,448	23,799	0.60	2	2	3.00	2.50	L	4.00	-	20	3.50	2.50	L	4.00	-	-	20	None	50
7	5	Av. Marien Ngouabi(4 lane)	4,478	11,988	1.90	2	4	3.50	2.50	L	4.00	-	20	3.00	0.50	L	3.50	-	-	20	required	50
						2	2	3.50	2.50	L	4.00	-	20	3.50	2.50	L	4.00	-	-	20	None	50
8	6-1	Av. J. Michel	8,459	10,884	0.90	2	2	3.00	1.00	L	4.00	-	16	3.00	1.00	L	4.00	-	-	16	None	40
9	6-2	Av. F. de Magalhaes	8,413	10,884	1.30	2	2	3.00	3.00	L	4.00	-	20	3.00	3.00	L	4.00	-	-	20	None	40
10	6-3	Av. Z. Magalhaela	10,712	12,439	1.30	2	2	3.00	3.00	L	4.00	-	20	3.00	3.00	L	4.00	-	-	20	None	40
11	6-4	Av. M. Siad Barre	17,975	23,128	0.85	2	2	3.00	2.00	L	3.00	-	16	3.00	2.00	L	3.00	-	-	16	None	40
12	6-5	Av. Romao Fernandes	5,287	6,802	0.85	2	2	3.00	1.00	L	4.00	-	16	3.00	1.00	L	4.00	-	-	16	None	40
13	6-6	Rue 1229			0.25	2	2	3.00	3.00	L	3.00	-	16	3.00	3.00	L	3.00	-	-	16	None	40
14	6-7	Av. As Estancias			0.58	2	2	3.00	1.00	L	3.00	-	12	3.00	1.00	L	3.00	-	-	12	None	40
15	7-1	Rue Consiglieri Pedroso			0.00	2	2	3.00	1.00	L	2.50	-	13	3.00	1.00	L	2.50	-	-	13	None	30
16	7-2	Rue Joaquim Lapa			0.24	2	2	3.00	1.00	L	3.00	-	14	3.00	1.00	L	3.00	-	-	14	None	30
17	7-3	Rue do Bagamayo			0.44	2	2	3.00	0.00	L	3.00	-	12	3.00	0.00	L	3.00	-	-	12	None	30
18	7-4	Rue de Timor Leste			0.23	2	2	3.00	1.50	L	2.00	-	13	3.00	1.50	L	2.00	-	-	13	None	30
19	7-5	Av. Martires de Inhaminga	5,174	11,748	0.80	2	2	3.00	4.00	L	2.50	-	19	3.00	4.00	L	2.50	-	-	19	None	30
20	7-6	Other 6 roads			1.50	2	2	3.00	0.00	L	2.00	-	10	3.00	0.00	L	2.00	-	-	10	None	30
21	8-1	Av. Milargre Mabote	6,011	10,668	1.00	2	2	3.00	1.50	L	3.50	-	9	3.00	1.50	L	3.50	-	-	16	None	40
22	8-2	Av. da Malhangalene	3,307	10,776	0.94	2	2	3.00	1.00	L	2.00	-	12	3.00	1.00	L	2.00	-	-	12	None	40
23	8-3	Av. Para O Parmar			1.40	2	2	3.00	1.00	L	2.00	-	12	3.00	1.00	L	2.00	-	-	12	None	40
24	8-4	Av. Kaweme Nkrumah	2,691	6,747	1.61	2	2	3.00	1.00	L	2.00	-	12	3.00	1.00	L	2.00	-	-	12	None	40
25	8-5	Av. Paulo Samuei Kankhomba			0.55	2	2	3.00	1.00	L	6.00	-	20	3.00	1.00	L	6.00	-	-	20	None	40
26	8-6	Av. Emilia Dausse			0.85	2	2	3.00	1.00	L	6.00	-	20	3.00	1.00	L	6.00	-	-	20	None	40
27	8-7	Av. de Maguigwana			0.75	2	2	3.00	1.00	L	6.00	-	20	3.00	1.00	L	6.00	-	-	20	None	40
28	8-8	Av. Filipe Samuel Magaia			0.40	2	2	3.00	3.00	L	4.00	-	20	3.00	3.00	L	4.00	-	-	20	None	40
29	8-9	Av. Friedrich Engels			1.20	2	2	3.00	1.00	L	2.00	-	12	3.00	1.00	L	2.00	-	-	12	None	40
30	9-1	Rua 2282/2265			2.36	2	2	-	-	-	-	-	5	3.0(5.0)	-	LU/OD/U	2.00	0.5 ~ 1.0	-	8 ~ 14	required	40
31	9-2	Rua 2275			2.00	2	2	-	-	-	-	-	5	3.00	-	OD/U	2.00	1.00	-	14	required	40
32	9-3	Rua de Xipamanine	6,184	10,768	1.13	2	2	-	-	-	-	-	6	3.00	-	LU/OD/U	1.50	0.5 ~ 1.0	-	10 ~ 14	required	40
33	9-4	Rua dos Imaos Roby			1.30	2	2	3.00	1.50	-	1.50	-	12	3.00	1.50	OD/U	1.50	-	-	12	required	40
34	9-5	Rua 2315/2313			0.70	2	2	-	-	-	-	-	6	3.00	-	LU/OD/U	1.5 ~ 2.0	0.5 ~ 1.0	-	10 ~ 14	required	40
35	9-6	Rua 2309/2324			1.00	2	2	-	-	-	-	-	5	3.00	-	OD/U	2.00	1.00	-	14	required	40
37	9-7	Av. das Estancias			0.49	2	2	3.00	1.00	-	2.00	-	12	3.00	-	OD/U	1.50	0.50	-	12	required	40
38	10-1	Rua da Goa			0.80	2	2	-	-	-	-	-	6	3.00	-	LU	1.50	0.50	-	10	required	40
39	10-2	Rua da Lixera			0.79	2	2	-	-	-	-	-	7	3.00	-	LU	1.50	0.50	-	10	required	40
40	10-3	Av. Milagre Mbote	6,011	10,668	1.98	2	2	-	-	-	-	-	7	3.0(5.0)	-	LU	1.50	0.50	-	8 ~ 10	required	40
41	10-4	Av. da Malhangalene	3,307	10,776	1.83	2	2	-	-	-	-	-	6	3.0(5.0)	-	LU/OD/U	1.50	0.50	-	8 ~ 12	required	40
42	10-5	Rua 1 de Maio			1.49	2	2	-	-	-	-	-	6	3.00	-	OD/U	2.00	1.00	-	14	required	40
43	10-6	Rua 3306			0.49	2	2	-	-	-	-	-	14	3.00	-	OD/U	2.00	1.00	-	14	required	40
44	10-7	Rua 3523			1.00	2	2	-	-	-	-	-	14	3.00	-	OD/U	2.00	1.00	-	14	required	40
45	10-8	Rua 3576			1.10	2	2	-	-	-	-	-	14	3.00	-	OD/U	2.00	1.00	-	14	required	40

Table 18.3.2 Comparison of Application of Typical Cross Section and Proposed Modifications

Group No	Existing minimum road width (m)	Proposed road width (m)	House compensation cost(USD)	
			W=14m	Proposed Width
9. Rehabilitation of District 2 Area Roads			324,000	79,500
9.1 Rua 2282/2265	6	8,10,14	147,000	25,500
9.2 Rua 2275	6	8,10,12,14	123,000	34,500
9.3 Rua de Xipamanine(2291)	6	10,12	24,000	3,000
9.4 Rua dos Imaos Roby(2289)	12m (street type)	12m (street type)	0	0
9.5 Rua 2315/2313	6	10,14	18,000	7,500
9.6 Rua 2309/2324	6	14	12,000	9,000
9.7 Av. das Estancias(2000)	12m (street type)	12m (street type)	0	0
10. Rehabilitation of District 3 Area Roads			319,600	57,800
10.1 Rua da Goa(3027)	5	10	13,600	1,700
10.2 Rua da Lixera(3030)	7	10	39,100	0
10.3 Av. Milagre Mbote(3001)	8	8,10	107,100	5,100
10.4 Av. da Malhangalene(3259)	6	8,10,12	119,000	22,100
10.5 Rua 1 de Maio(3374)	6	8	40,800	28,900
10.6 Rua 3306	14	14	0	0
10.7 Rua 3523	14	14	0	0
10.8 Rua 3576	14	14	0	0
Construction of Missing Link on Av. Julius Nyerere(On Line)				502,000
Construction of Missing Link on Av. Julius Nyerere(Off Line)				528,000
Construction of Bus Terminal(Combatentes)				138,000

18.4 INTERSECTION DESIGN

1) Location of Intersections to be Improved

9 intersections will be improved by the road development project, and 14 intersections will be improved by the traffic management project.

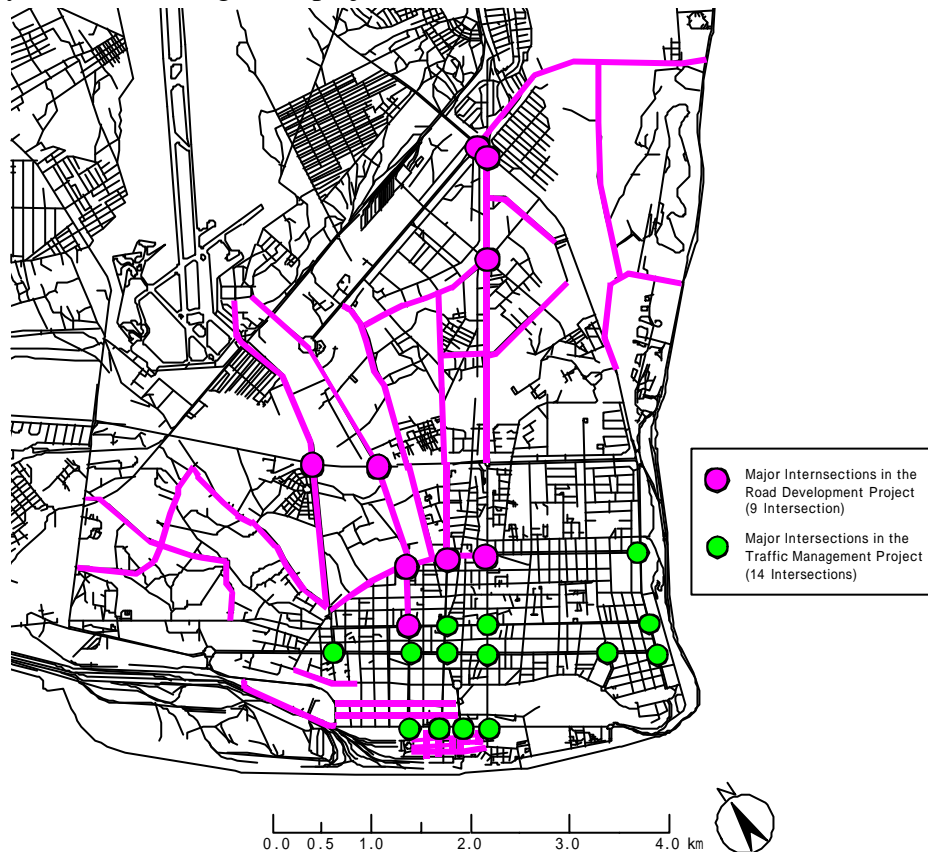


Figure 18.4.1 Location of Intersections to be Improved

2) Design Policy

(1) Geometric Design Criteria

- Design speed : 50 km/h
- Lane width : typically 3.5m
- Storage lane length : 50m
- Shift length : minimum 20m

(2) Shape of Intersections

- Crossing angle : minimum 60 degrees, preferably more than 75 degrees
- Type of intersection : small roundabout on trunk roads and major intersections should be changed to the normal cross-shaped intersection. On narrow collector roads in

sub-urban areas, small roundabout is recommended as the speed deduction device.

(3) Road Facilities Design

- Lane marking and channelization zebra for the adequate traffic flow control
- Pedestrian crossing and guard fences should be established for the pedestrian safety
- According to the parking control policy, bus stops close to the intersections should be relocated.
- Road lighting facilities should be relocated or newly installed.

18.5 STRUCTURE DESIGN

There are three and two box culverts on Master Plan Route and Plan 4 route on the construction of the missing link of Av. Julius Nyerere.

1) Master Plan Route

Table 18.5.1 Box Culvert Size

Location	Inner Section W(m) × H(m)	Overburden (m)	Top slab (mm)	Floor slab (mm)	Side wall (mm)	Haunch size (mm)
Ravine 1	5.0 × 5.0	0.5	400	500	500	200 × 200
Roundabout A	3.0 × 3.0	0.5	400	400	400	200 × 200
Junction B	3.5 × 2.0	0.5	400	400	400	200 × 200

2) Plan 4 Route**Table 18.5.2 Box Culvert Size**

Location	Inner Section W(m) × H(m)	Overburden (m)	Top slab (mm)	Floor slab (mm)	Side wall (mm)	Haunch size (mm)
Ravine 4	3.5 × 3.5	0.5	400	400	400	200 × 200
Ravine 3	4.0 × 4.0	0.5	400	400	400	200 × 200
Ravine 2	2.5 × 2.5	0.5	400	400	400	200 × 200
Ravine 1	5.0 × 5.0	0.5	400	500	500	200 × 200

18.6 DRAINAGE DESIGN**1) Solutions for Problems on the Existing Drainage System****(1) Urban area**

In urban area, most of drainage catchpit are blocked by soil/garbage due to lack of cleaning and flushing so that the drainage capacity are reduced.

Solutions of the problem are follows.

- Cleaning and flushing to drainage structure (Strengthening of maintenance)
- Protection for soil and garbage
- Improvement of location of catch-pit
- Strengthening the drainage capacity of outlets leading to the port

(2) Sub-urban area

In most of sub-urban area, there is no proper drainage system. Other area where has the drainage system are also blocked by soil/garbage same as the urban area.

Solutions of the problems are follows.

- Construction of new drainage systems
- Cleaning and flushing to drainage structure (Strengthening of maintenance)
- Activity of enlightenment of resident not to put garbage into open ditch
- Removal of squatters

2) Proposed Drainage Network

Proposed drainage network for the study area has been determined based on the concept and catchments basins mentioned in the Maputo Drainage Master Plan and a Preliminary Design Study of Repair of Avenida Julius Nyerere prepared in 2000.

Proposed drainage network for the study area shows Figure 18.6.1-18.6.3.

3) Design policy

Selection of drainage structure should be determined taking consideration into the evaluation of the Pilot project.

4) Proposed Drainage System for Study Area

In order to solve existing problem of drainage system, JICA Study Team has prepared following drainage system for study area.

Table 18.6.1 Proposed Drainage System for Study Area

Project Name		Contents
Trunk Road	Construction of Missing Link on Av.Julius Nyerere	Construction of New Drainage System (Open ditch,Catch pit,Box culvert) Cleaning of Existing Drainage System (Catch pit, Pipe)
	Rehabilitation and Improvement of Av.Acordos Lusaka	Construction of New Drainage System (Lu-side ditch)
	Rehabilitation and Improvement of Av.Angola	Construction of New Drainage System (Lu-side ditch)
	Rehabilitation and Improvement of Av.Marien Ngouabi	Construction of New Drainage System (L-side ditch) Cleaning of Existing Pipe
Collector Road	Rehabilitation and Industrial and Comercial Area Roads	Cleaning of existing drainage system (Catch pit, Pipe)
	Rehabilitation Port Area Roads	Construction of New Drainage System (Catch pit) Cleaning of Existing Drainage System (Catch pit, Pipe)
	Rehabilitation District 1 Area Roads	Cleaning of Existing Drainage System (Catch pit, Pipe)
	Rehabilitation District 2 Area Roads	Construction of New Drainage System (Open ditch,U-side ditch)
	Rehabilitation District 3 Area Roads	Construction of New Drainage System (Open ditch,U-side ditch)

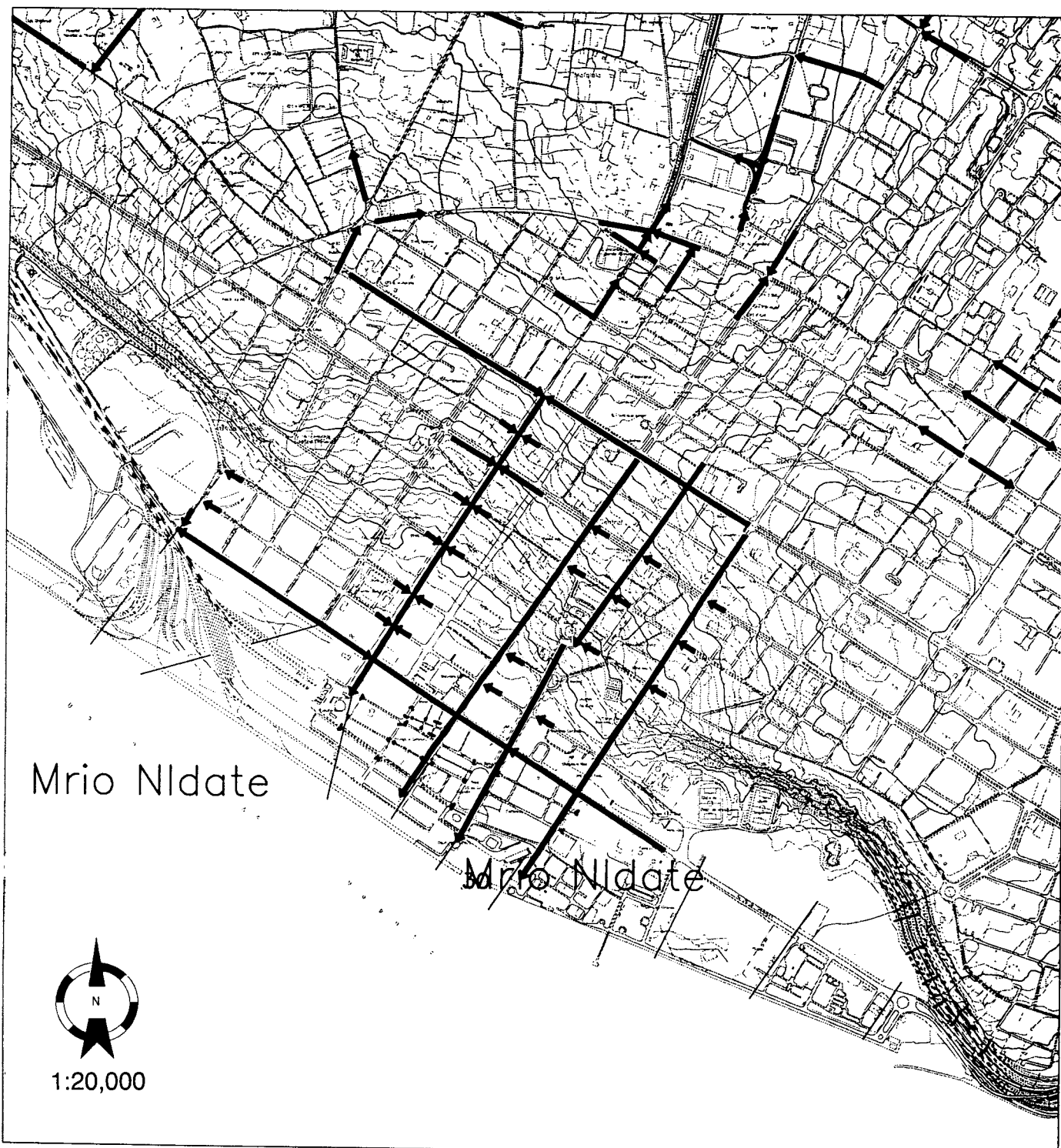


Figure 18.6.1 Proposed Drainage Network District 1

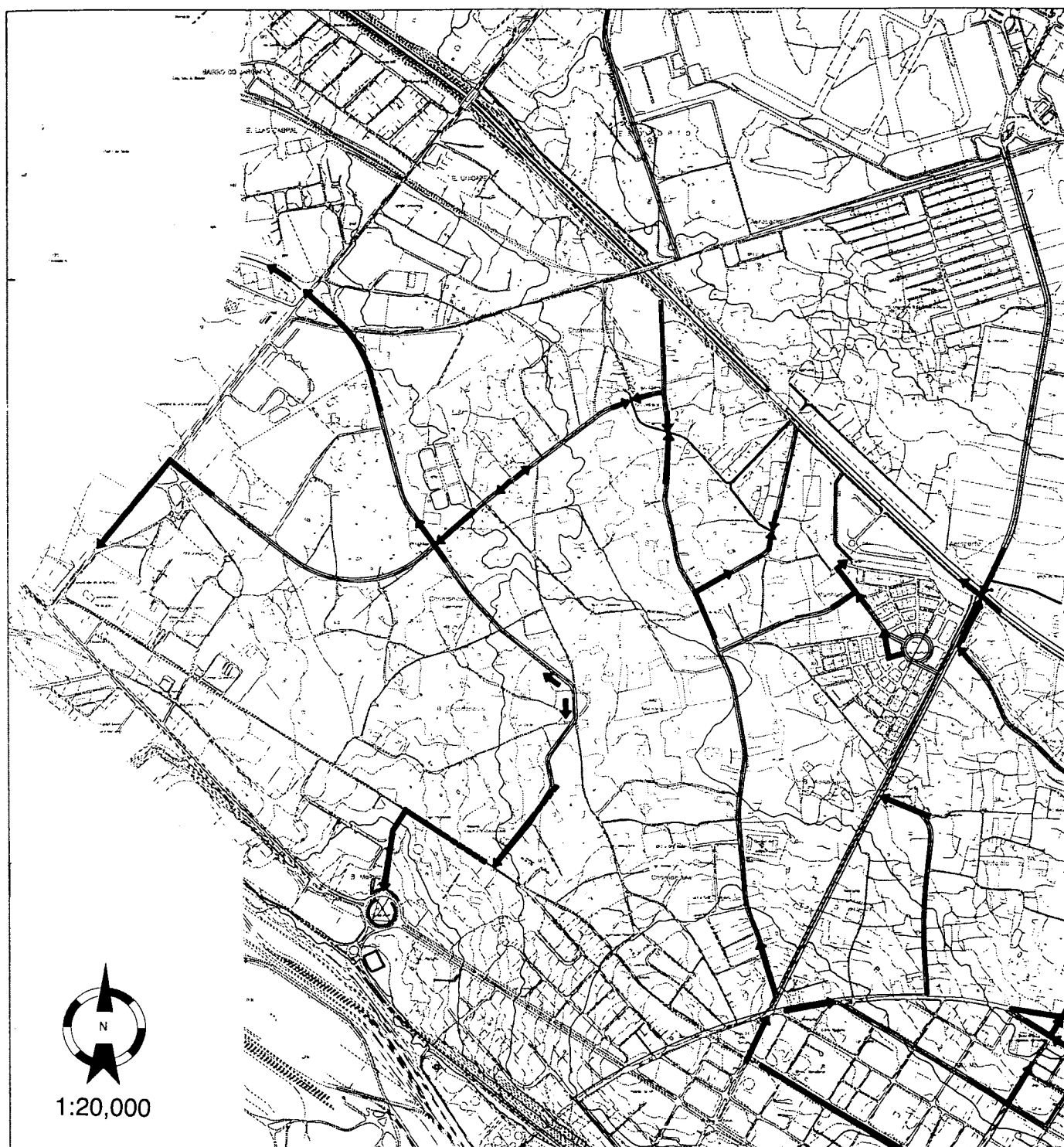


Figure 18.6.2 Proposed Drainage Network District 2

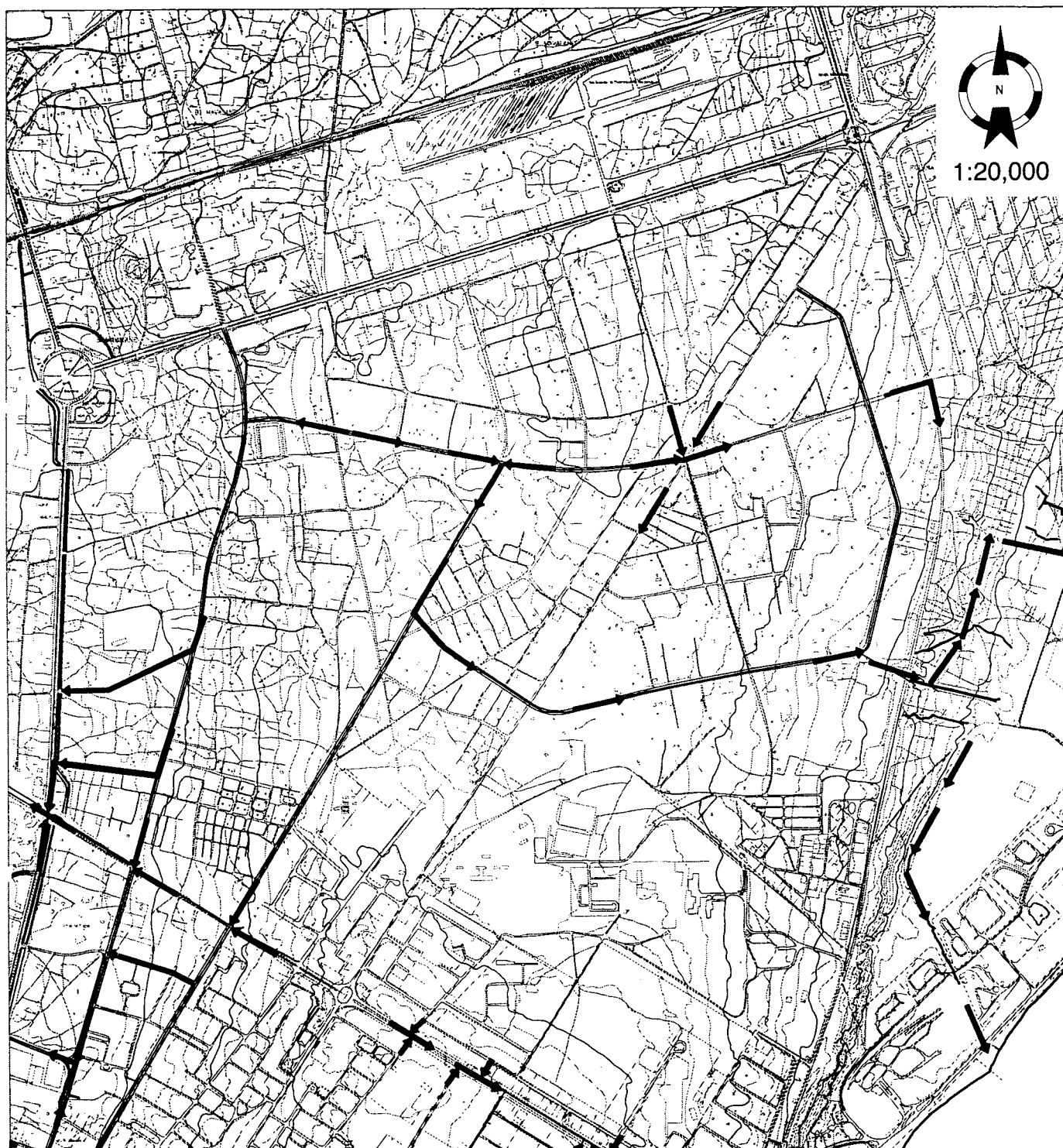


Figure 18.6.3 Proposed Drainage Network District 3

5) Proposed Drainage Structure Design

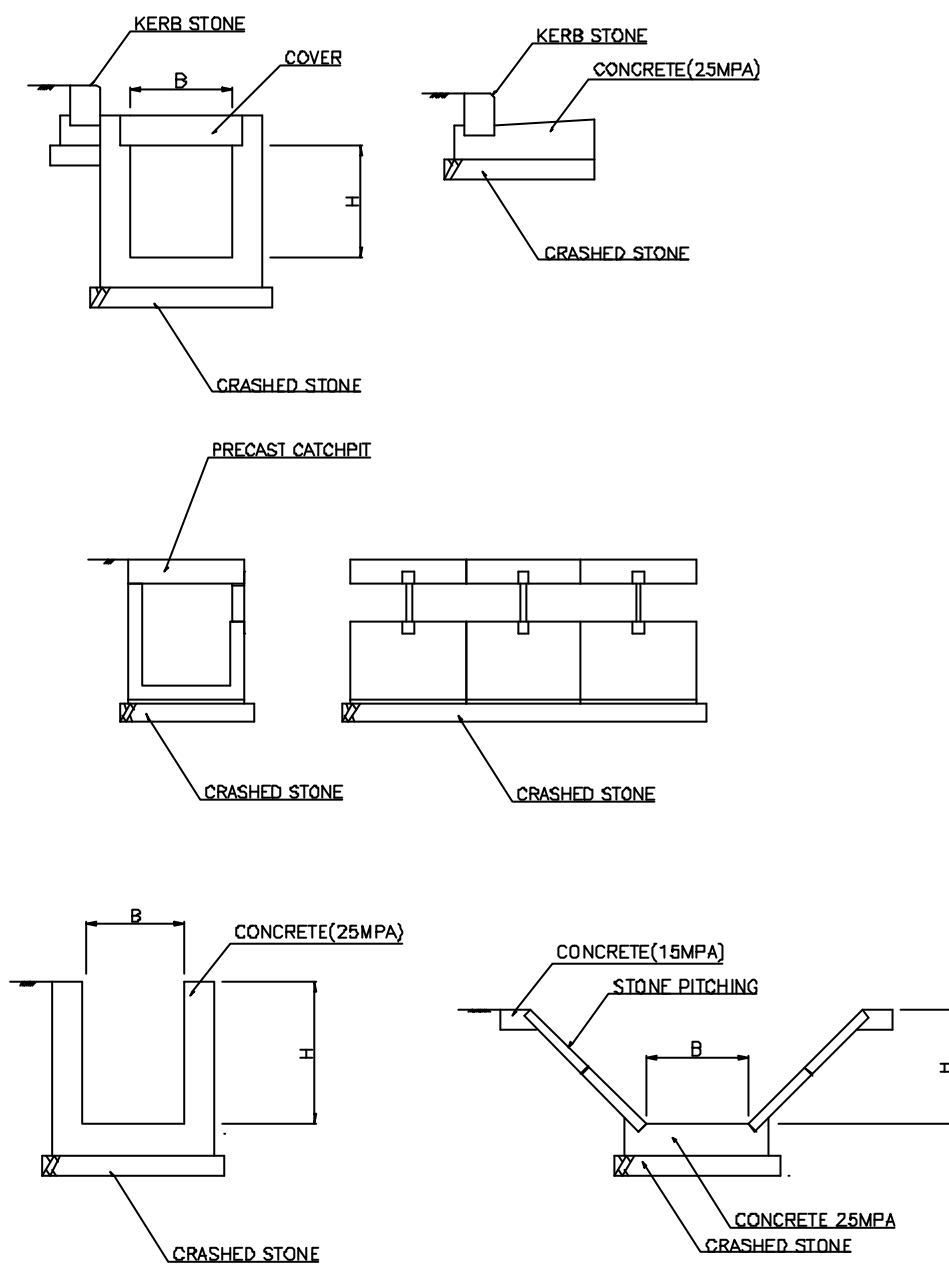


Figure 18.6.4 Proposed Drainage Structure

18.7 PAVEMENT DESIGN

1) Selection of Pavement Type

With considering the construction economy and local conditions, pavement type are selected as shown in the Table 18.7.1.

Table 18.7.1 Proposed Pavement Type

	Carriageway	Sidewalk
Trunk Road	AC	DBST
Industrial and Commercial Area Roads	AC	DBST
Port Area Roads	AC or Concrete Block	Concrete Block
District 1 Area Roads	AC	Concrete Block
District 2 Area Roads	Concrete Block	DBST
District 3 Area Roads	Concrete Block	DBST

2) Pavement Improvement Measures

Proposed pavement improvement measures based on the PSI are shown as Figure18.7.1.

3) Pavement Thickness Design

The pavement thickness design was carried out in accordance with AASHTO standard.

The thickness and the structure of individual layers of pavement were designed based on a comprehensive judgment of various factors including subgrade, estimated future traffic volume of heavy vehicles, climate conditions as well as economic aspects.

- The in-situ soil/gravel stabilized material is useful for base course and subbase course.
- The design traffic in 2015 after 10 years from the opening year should be used for design traffic.
- Design CBR for subgrade are determined as shown in Table 18.7.2.
- Table18.7.3, Figure18.7.2 shows the optimum pavement structures recommended to be applied for the proposed roads.

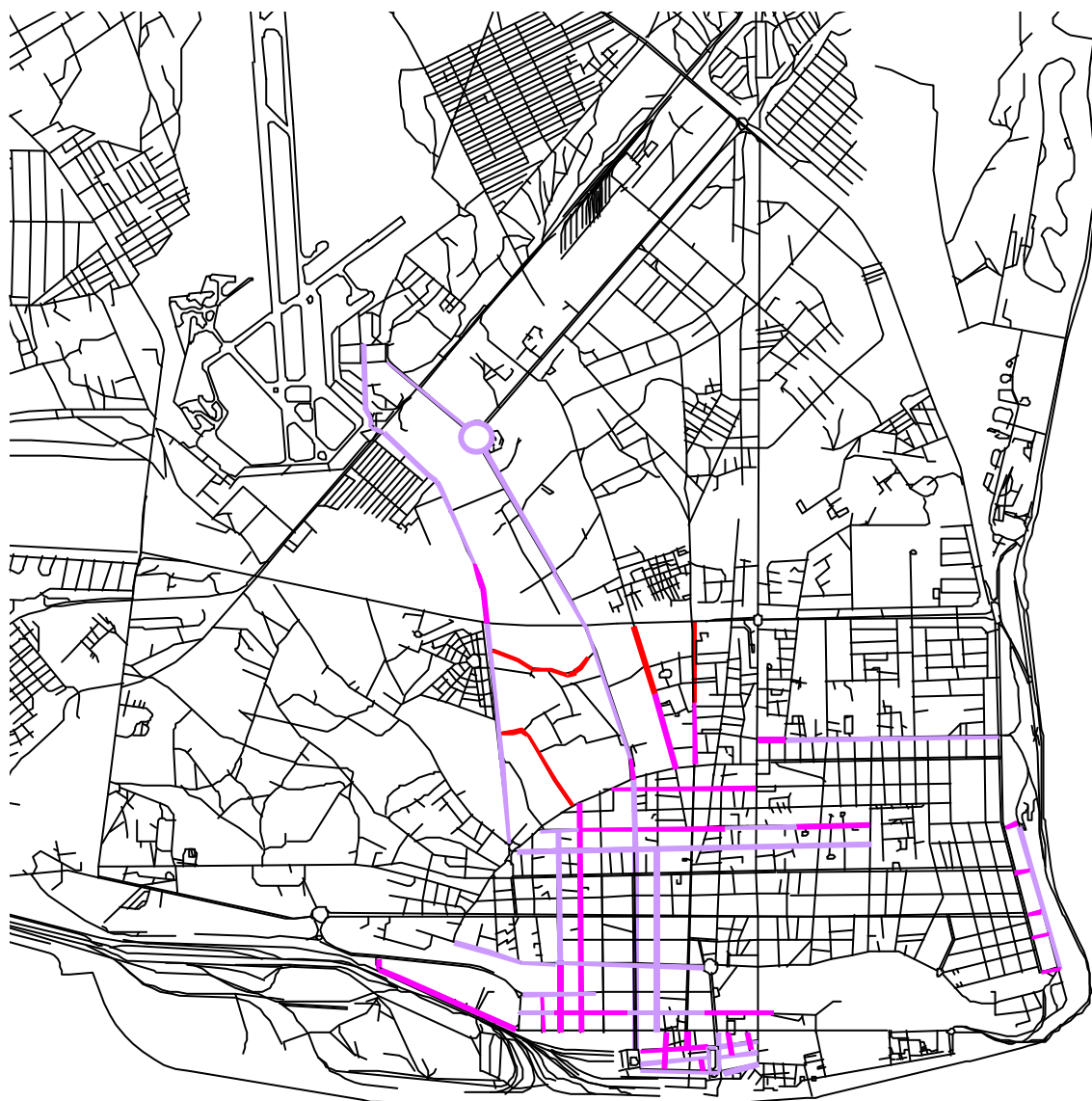
4) Pavement Structure of Carriageway at Around Intersections

Semi-flexible pavement will be adopted at around intersections, level crossings at railway lines, road hump sites and bus stops to prevent the deterioration of the paving due to oil

leaking from poorly maintained vehicles.

5) Pavement Structure of Sidewalk

The pavement structure to be applied for the sidewalk will be the simple pavement with DBST and a 10cm thickness base course (stabilized material).



LEGEND	Pavement Improvement Measures	PSI
—	Maintenance / Pot Hole Patching	$2.5 < \text{PSI} < 5.0$
—	Overlay	$1.5 < \text{PSI} < 2.5$
—	Reconstruction from Base Course	$0.5 < \text{PSI} < 1.5$
—	Reconstruction from Subbase Course	$0.0 < \text{PSI} < 0.5$

Figure 18.7.1 Pavement Improvement Measures

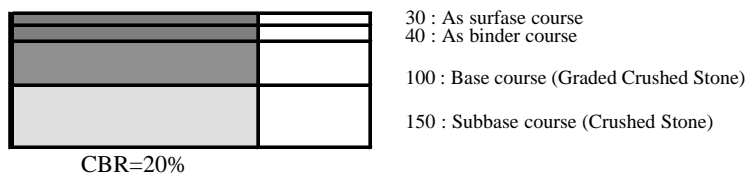
Table 18.7.2 Design CBR

Group No	Length (km)	Subgrade Strength(CBR)				Existing Pavement Thickness(cm)		Ave. Soaked CBR within each road
		Subgrade Soaked CBR (%)	Average Soaked CBR(%)	Design CBR (%)	*Subgrade Classification	Existing As Surface (cm)	Existing Base (cm)	
1. Construction of Missing Link on Av. J. Nyrere		39	39	30	S6	<i>None</i>	<i>None</i>	
2. Rehabilitation & Improvement of Av. A. Lusaka		24	24	20	S6			
2.1 Av. A. dos Lusaka(3013,4057)		22						
2.2 Av. G. Popular(1189)		32	26	20	S6			
3. Rehabilitation & Improvement of Av. Angola		-						
3.1 Av. Angola(3077)		34				5	15	
3.2 Rua S. Cabral(3081)/Largo de Deta(3079)		17				7	0	
4. Rehabilitation & Improvement of Av. Marien Ngouabi(1166)		22	22	20	S6	8	14	
5. Rehabilitation of Industrial & Commercial Area Roads		-						
5.1 Av. J. Michel(1070)		-						
5.2 Av. F. de Magalhães(1038)		-				3	16	
5.3 Av. Z. Magalhães(1034)		18	22	20	S6	3	20	
5.4 Av. M. Siad Barre(1203)		23				4	22	
5.5 Av. Romão Fernandes(1199)		-				3	15	
5.6 Rue 1229		24						
5.7 Av. As Estâncias(1030)		-				3	14	
6. Rehabilitation of Port Area Roads		-						
6.1 Rue Consiglieri Pedros(1022)		-						
6.2 Rue Joaquim Lapa(1020)		-						
6.3 Rue do Bagamayo(1016)		-	37	30	S6	2	20	
6.4 Rue de Timor Leste(1014)		-						
6.5 Av. Martires de Inhamitanga(1006)		37						
6.6 Other 6 roads		-						
7. Rehabilitation of District 1 Area Roads		-						
7.1 Av. Milagre Mabote(1369)		-				4	12	
7.2 Av. da Malhangalene(1357)		-				6	0	
7.3 Av. Para O Parnar(1426)		-						
7.4 Av. Kweme Nkrumah(1250)		27	25	20	S6	4	12	
7.5 Av. Paulo Samuel Kankhomba(1152)		-				2	16	
7.6 Av. Emilia Dausse(1138)		-				3	15	
7.7 Av. de Maguiguaná(1130)		22				2	12	
7.8 Av. Filipe Samuel Magaia(1183)		-				3	15	
7.9 Av. Friedrich Engels(1009)		41						
8. Rehabilitation of District 2 Area Roads		-						
8.1 Rua 2282/2265		23				1	18	
8.2 Rua 2275		38				<i>None</i>	<i>None</i>	
8.3 Rua de Xipamanine(2291)		32	26	20	S6	<i>None</i>	<i>None</i>	
8.4 Rua dos Imaos Roby(2289)		19				4	0	
8.5 Rua 2315/2313		16				<i>None</i>	<i>None</i>	
8.6 Rua 2309/2324		-				<i>None</i>	<i>None</i>	
8.7 Av. das Estâncias(2000)		-				3	14	
9. Rehabilitation of District 3 Area Roads		-						
9.1 Rua da Goa(3027)		-				1	2	
9.2 Rua da Lixera(3030)		16				1	5	
9.3 Av. Milagre Mbote(3001)		24				<i>None</i>	<i>None</i>	
9.4 Av. da Malhangalene(3259)		-	21	20	S6	<i>None</i>	<i>None</i>	
9.5 Rua 1 de Maio(3374)		22				5	15	
9.6 Rua 3306		-				<i>None</i>	<i>None</i>	
9.7 Rua 3523		-				<i>None</i>	<i>None</i>	
9.8 Rua 3576		-				<i>None</i>	<i>None</i>	

* Bold&Italic Numbers are shown as the existing pavement thickness which are adopted by pavement design. .

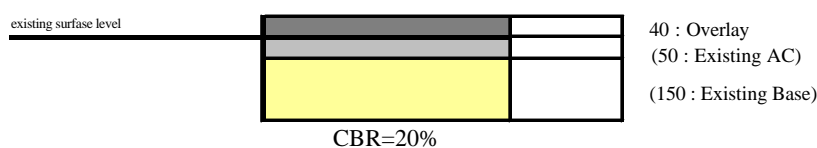
Proposed Pavement Structure

1. New construction of Missing Link on Av. J. Nyerere

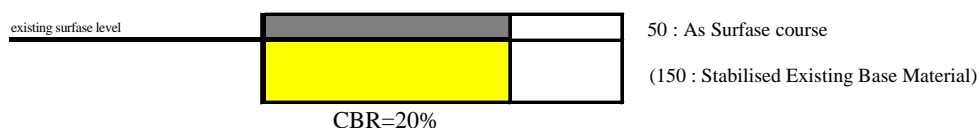


2. Rehabilitation & Imprpvement of Av. A. Lusaka / G. Popular

2.1 Overlay

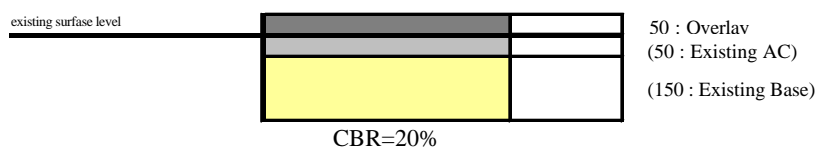


2.2 Reconstruction from Base course

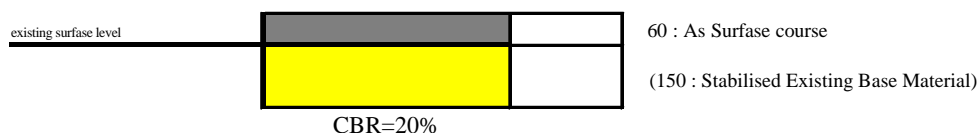


3. Rehabilitation & Improvement of Av. Angola / Rua S. Cabral/Largo de Deta

3.1 Overlay

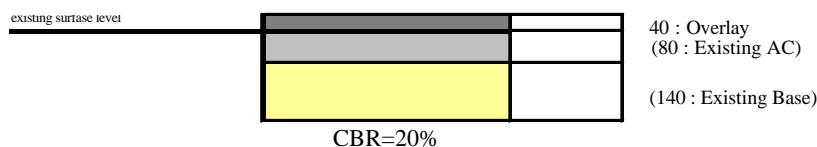


3.2 Reconstruction from Base course

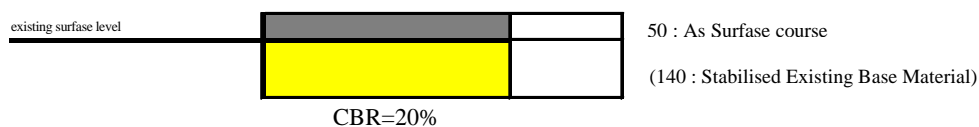


4. Rehabilitation & Improvement of Marien Ngouabi

4.1 Overlay

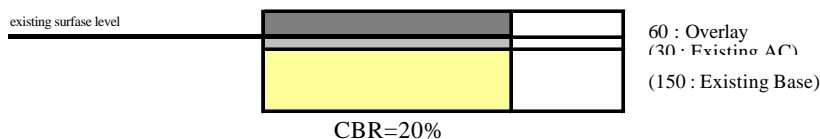


4.2 Reconstruction from Base course

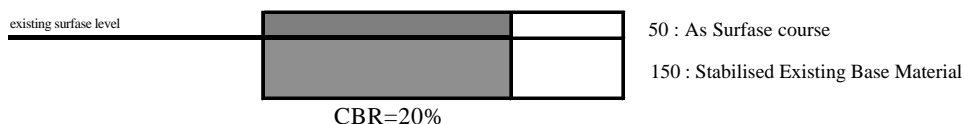
**Figure 18.7.2 Proposed Pavement Structures(1)**

5. Rehabilitation of Industrial & Commercial Area Roads

5.1 Overlay

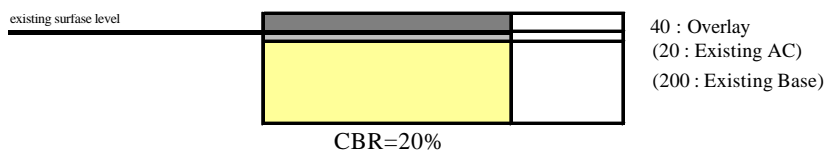


5.2 Reconstruction from Base course

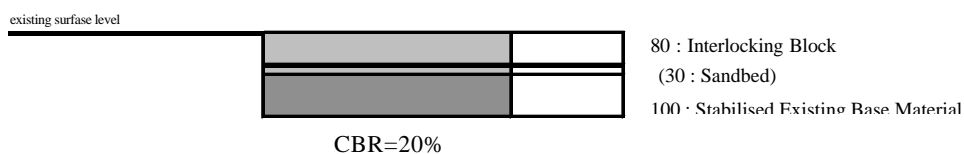


6. Rehabilitation of Port Area Roads

6.1 Overlay

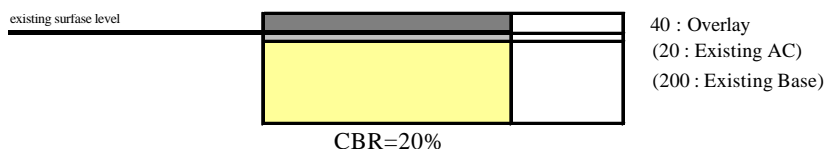


6.2 Reconstruction from Base course

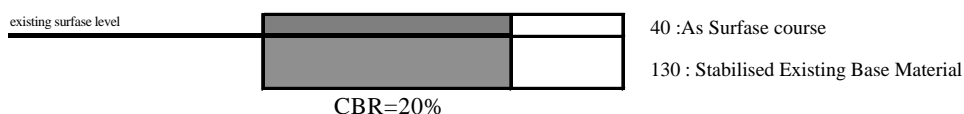


7. Rehabilitation of District 1 Area Roads

7.1 Overlay



7.2 Reconstruction from Base course



8. Rehabilitation of District 2&3 Area Roads

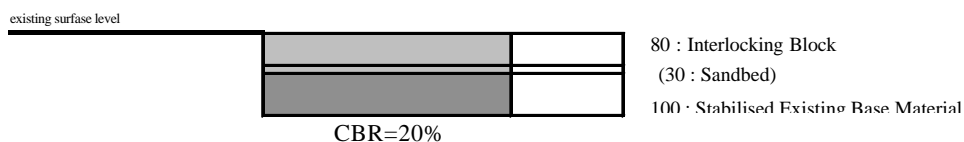


Figure 18.7.2 Proposed Pavement Structures(2)

Table 18.7.3 (1) Pavement Design for Overlay

Pavement Design for Overlay

Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	SN _{eq} (Structure Number of existing pavement)									
							*Subgrade Classification	Existing Pavement Thickness	Existing As Surface (cm)	Existing Base (cm)	surfacing	base	SN _{eq}	SN _{req}	SN _{eq}	Overlay
											0.35	0.12				0.4
3. Rehabilitation & Improvement of Av. A. Lusaka	0.00															Proposed
3.1 Av. A. dos Lusaka(3013,4057)	3.60		3.50	0.10			S6	50	150	17.50	18.00	1.40	1.96	0.56	35.46	40
3.2 Av. G. Popular(1189)	0.65		0.65				S6	50	150	17.50	18.00	1.40	1.96	0.56	35.46	40
4. Rehabilitation & Improvement of Av. Angola	0.00															
4.1 Av. Angola(3077)	3.05		3.05				S6	50	150	17.50	18.00	1.40	2.10	0.70	44.41	50
4.2 Rua S. Cabral(3081)/Largo de Deta(3079)	0.65		0.65				S6	50	150	17.50	18.00	1.40	2.10	0.70	44.41	50
5. Rehabilitation & Improvement of Av. Marien Ngouabi(1166)	1.80		1.30	0.50			S6	80	140	28.00	16.80	1.76	1.81	0.04	2.745	40
6. Rehabilitation of Industrial & Commercial Area Roads	0.00															
6.1 Av. J. Michel(1070)	1.70		1.70				S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.2 Av. F. de Magalhaes(1038)	1.30			1.30			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.3 Av. Z. Magalhaes(1034)	1.77			1.77			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.4 Av. M. Siad Barre(1203)	1.39		0.89	0.50			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.5 Av. Romao Fernandes(1199)	1.55			1.55			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.6 Rue 1229	0.24			0.24			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
6.7 Av. As Estancias(1030)	0.58			0.58			S6	30	150	10.50	18.00	1.12	1.97	0.85	53.91	60
7. Rehabilitation of Port Area Roads	0.00															
7.1 Rue Consiglieri Pedrosa(1022)	0.45			0.45			S6	20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.2 Rue Joaquim Lapa(1020)	0.25		0.25				S6	20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.3 Rue do Bagamavo(1016)	0.45		0.45				S6	20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.4 Rue de Timor Leste(1014)	0.25		0.25				S6	20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.5 Av. Martires de Inhamitanga(1006)	0.45		0.45				S6	20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
7.6 Other 6 roads	1.68		0.25	1.43			S6	20	200	7.00	24.00	1.22	1.72	0.49	31.4	40
8. Rehabilitation of District 1 Area Roads	0.00															
8.1 Av. Milagre Mabote(1369)	1.03			0.50	0.53		S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.2 Av. da Malhangalene(1357)	0.99			0.49	0.50		S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.3 Av. Para O Parmar(1426)	1.29			1.29			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.4 Av. Kwame Nkrumah(1250)	1.60		1.00	0.60			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.5 Av. Paulo Samuel Kankhomba(1152)	2.35			2.35			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.6 Av. Emilia Dausse(1138)	2.27			2.27			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.7 Av. de Maguiguana(1130)	2.40			2.40			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.8 Av. Filipe Samuel Magaia(1183)	1.76			1.76			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
8.9 Av. Friedrich Engels(1009)	1.58		1.08	0.50			S6	30	130	10.50	15.60	1.03	1.60	0.57	36.35	40
9. Rehabilitation of District 2 Area Roads	0.00															
9.1 Rua 2282/2265	2.36				2.36		S6	1	18				1.65			
9.2 Rua 2275	2.01				2.01		S6	None	None				1.65			
9.3 Rua de Xipamanine(2291)	1.13				1.13		S6	None	None				1.65			
9.4 Rua dos Inaos Roby(2289)	1.30				1.30		S6	4	0				1.65			
9.5 Rua 2315/2313	1.11				1.11		S6	None	None				1.65			
9.6 Rua 2309/2324	0.68				0.68		S6	None	None				1.65			
9.7 Av. das Estancias(2000)	1.07				1.07		S6	3	14				1.65			
10. Rehabilitation of District 3 Area Roads	0.00															
10.1 Rua da Goa(3027)	0.76				0.76		S6	1	2				1.61			
10.2 Rua da Lixera(3030)	0.79				0.79		S6	1	5				1.61			
10.3 Av. Milagre Mbote(3001)	1.98				1.98		S6	None	None				1.61			
10.4 Av. da Malhangalene(3259)	1.86				1.86		S6	None	None				1.61			
10.5 Rua 1 de Maio(3374)	1.50				1.50		S6	5	15				1.61			
10.6 Rua 3306	0.52				0.52		S6	None	None				1.61			
10.7 Rua 3523	0.95				0.95		S6	None	None				1.61			
10.8 Rua 3576	1.10				1.10		S6	None	None				1.61			
	56.18	0.00	15.46	20.59	20.13	0.00										

* Bold&Italic Numbers are shown as the existing pavement thickness which are adopted by pavement design. .

Table 18.7.3 (2) Pavement Design for Reconstruction

Pavement Design for Reconstruction from Base course							SN _{exs} (Structure Number of existing pavement)														
							Existing Pavement Thickness		surfacing	base	SN _{exst}	SN _{required}	SN _{eff}	Proposed Pavement Thickness			Surface	Base (Stabilised)	Base (Stabilised existing base)	SN	
							Existing As Surface (mm)	Existing Base (mm)						0.35	0.12	As Surface (mm)					Stabilised Base (mm)
Group No	Length(km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification	Existing As Surface (mm)	Existing Base (mm)	0.35	0.12	SN _{exst}	SN _{required}	SN _{eff}	As Surface (mm)	Stabilised Base (mm)	Stabilised Existing Base (mm)	0.4	0.2	0.08	SN

* Bold&Italic Numbers are shown as the existing pavement thickness which are adopted by pavement design. .

Table 18.7.3 (3) Pavement Design for New Construction

Pavement Design for New Construction								SN required	Proposed Pavement Thickness			Surface	Base	Subbase	SN
Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification		As Surface (mm)	Base (mm)	Subbase (mm)	0.4	0.14	0.11	
1. Construction of Missing Link on Av. J. Nyrere	4.80					4.80	S6	1.82	70.00	100.00	150.00	28.00	14.00	16.50	2.30

Pavement Design for New Construction								SN required	Proposed Pavement Thickness			Surface	Sandmat	Stabilised Base	SN
Group No	Length (km)	Maintenance	Overlay	Reconstruction from Base course	Reconstruction from Subbase course	New Construction	*Subgrade Classification		Concrete Block (mm)	Sandmat (mm)	Stabilised Base (mm)	0.4	0	0.20	
7. Rehabilitation of Port Area Roads	0.00														
7.1 Rue Consiglieri Pedroso(1022)	0.45			0.45											
7.2 Rue Joaquim Lapa(1020)	0.25		0.25												
7.3 Rue do Bagamayo(1016)	0.45		0.45												
7.4 Rue de Timor Leste(1014)	0.25		0.25												
7.5 Av. Martires de Inhaminga(1006)	0.45		0.45												
7.6 Other 6 roads	1.68		0.25	1.43											
9. Rehabilitation of District 2 Area Roads	0.00														
9.1 Rua 2282/2265	2.36					2.36									
9.2 Rua 2275	2.01					2.01									
9.3 Rua de Xipamanine(2291)	1.13					1.13									
9.4 Rua dos Imaos Roby(2289)	1.30					1.30									
9.5 Rua 2315/2313	1.11					1.11									
9.6 Rua 2309/2324	0.68					0.68									
9.7 Av. das Estancias(2000)	1.07					1.07									
10. Rehabilitation of District 3 Area Roads	0.00														
10.1 Rua da Goa(3027)	0.76					0.76									
10.2 Rua da Lixera(3030)	0.79					0.79									
10.3 Av. Milagre Mbote(3001)	1.98					1.98									
10.4 Av. da Malhangalene(3259)	1.86					1.86									
10.5 Rua 1 de Maio(3374)	1.50					1.50									
10.6 Rua 3306	0.52					0.52									
10.7 Rua 3523	0.95					0.95									
10.8 Rua 3576	1.10					1.10									
	27.43	0.00	1.65	1.88	0.00	23.90									

18.8 ROAD FACILITIES DESIGN

1) Pedestrian Crossing

- Pedestrian crossings will be introduced at intersections with trunk roads and near public facilities (such as schools, churches and hospitals, etc.).
- Humps and appropriate road signs will be introduced to slow down the traffic.

2) Bus Facilities Design

(1) General Requirement

- Bus stops should be scaled for 2-3 buses at junctions of trunk bus routes.
- 3.0m of bus stop width should be secured. Meantime 3.0m of carriageway width should also be secured basically.
- At least one bus shelter with signboard should be established at each bus stops, it should have bench, information boards showing timetable, route map etc.
- Car parking should be prohibited around bus stops in length of 30m from bus stops.

(2) Implementation Programme

Improvement of bus stops carried out with Road Development Project, Traffic Management Project and Public Transportation Project are listed as shown in the Table 18.8.1.

3) Lighting and Other Road Facilities

- Lighting facilities should be introduced at signalled intersections, channelized intersections and pedestrian crossings to ensure safe travelling at night.
- Chatter-bars will be installed along the centre line at those sections without lighting to ensure safe travelling at night.

Table 18.8.1 Bus Stop List

No.	Road Name	Project category	Type			Total
			Bus Terminal	Bus Bay	Roadside	
T1	Av. Julius Nyerere	Road Development		5		9
		Public Transportation	1			
		Traffic Management		3		
T2	Av. Vladimir Lenine	Public Transportation		9		12
		(Excluded)			3	
T3	Av. Acordos do Lusaka	Road Improvement			4	4
		Public Transportation				
T4	Av. Guerra Popular	Road Development			2	4
		Traffic Management		1		
		(Excluded)			1	
T5	Av. da Angola	Road Improvement			5	5
T9	Av. Marien Ngouabi	Road Development			5	5
T10	Av. da FPLM	Public Transportation			5	5
-	Av. 25 de Setembro	Traffic Management		2		5
		(Excluded)			3	
-	Av. 24 de Julho	Traffic Management		4		9
		(Excluded)			5	
-	Av. Edward Mondlane	Traffic Management		4		9
		(Excluded)			5	
-	Av. Mao Tse Tung	Traffic Management				3
		(Excluded)			3	
C2/C32	Av. da Malhangalene(1357/3259)	Road Rehabilitation		3		3
C16	Av. Martires de Inhamitanga(1006)	Public Transportation	1			1
C21	Rua 2282/2265	Road Rehabilitation		3		3
C22	Rua 2275	Road Rehabilitation		1		1
C23	Rua de Xipamanine(2291)	Road Rehabilitation		1		1
C24	Rua dos Imaos Roby(2289)	Road Rehabilitation		3		3
C25	Rua 2315/2313	Road Rehabilitation		2		2
C26	Rua 2309/2324	Road Rehabilitation		1		1

4) Road Signs and Markings

- Road signs shown below should be established.

- Warning signs
- Regulatory signs
- Other

- Road markings shown below should be established.

- Lane marking (solid line)
- Lane marking (dotted line)
- Direction arrow
- Stop line
- Channelization zebra
- Pedestrian crossing zebra
- Roadside parking strip
- Roadside strip
- Speed hump zebra

18.9 RELOCATION AND PROTECTION OF PUBLIC UTILITIES

1) Relocation of Public Utilities

The existing utilities were investigated by the study team referring to the available data obtained from the authorities and agencies concerned. All utilities to be affected by the construction of the proposed roads must be relocated and replaced or protected, it is shown in a separated volume entitled “Drawing”.

Normally, the authorities or agencies concerned are responsible for the relocation and replacement at their own cost.

2) Compensation of Public Properties

Compensation of public properties will be necessary by widening of the following roads.

- Av. Marien Ngouabi / Av. Guerra Popular
- Av. V. Lenine
- District 2 and 3 Area Roads
- Industrial and Commercial Area Roads/Port Area Roads/District 1 Area Roads

CHAPTER 19 : CONSTRUCTION PLAN AND COST ESTIMATE**19.1 CONDITIONS AFFECTING THE CONSTRUCTION SITES****1) Social Conditions**

- Holidays : Sunday (52 days), National holidays (7 days), Religious holidays (Christmas, Easter : 21 days)
- Working Hours : 8 hours per day, 48 hours per week

2) Weather Conditions**Table 19.1.1 Efficiency of construction works during rain season**

	Jan	Feb	Mar	Apr-Oct	Nov	Dec	Efficiency
Earthwork	50-60%	50-60%	60-70%	100%	50%	50%	70%
Pavement work	50-60%	50-60%	60-70%	100%	50%	50%	
Drainage work	100%	100%	100%	100%	100%*	100%*	
Structural work	100%	100%	100%	100%	100%	100%	

* : Structural works under the groundwater level is should be stopped in November and December due to groundwater.

3) Labour Force

- Labours engaging in the project are assumed to the labour sent by local contractor.
- Except foreman or skilled worker, some of these staffs may be from foreign countries such as South Africa etc.

4) Construction Materials**Cement**

- Cement is assumed to be supplied by local supplier.

Ready-Mixed Concrete

- Ready-mixed concrete is assumed to be supplied by the local contractor's batching plant located in Matola, 30km from the centre of Maputo city.

Crushed Stone

- Crushed Stone for concrete and road works is assumed to be supplied from the local

contractor's crushing plant located in Boane, 47km from the centre of Maputo city

Sand

- Sand for concrete is assumed to be supplied from the local contractor's crushing plant located in Boane, 47km from the centre of Maputo city.

Filling and Sub-grade Materials

- Filling and Sub-grade Materials is assumed to be supplied from the borrow pit along EN4 toll road, 30km from the centre of Maputo city.

Pre-cast Concrete Products

- Concrete products imported from South Africa, Swaziland etc. are available in Mozambique.
- The following pre-cast concrete products are available in Mozambique.
 - Kerb stone
 - L-shaped side ditch
 - LU
 - Catch pit
 - Soaking pit
 - Pipe culvert

Asphalt (bituminous materials)

- Asphalt mixture is assumed to be supplied by the local contractor's mixing plant located in Matola, 30km from the center of Maputo city.
- Bituminous materials are imported from South Africa.

Steel (reinforcement and steel materials)

- Reinforcement and other structural steel material is assumed to be imported from South Africa.

5) Construction Machinery and Plant

- The following machinery and plant are available in Mozambique.
 - Bulldozer
 - Motor grader
 - Wheel loader
 - Vibration roller
 - Macadam roller

- Tire roller
- Dump truck
- Truck crane
- Vibro-hammer
- Back hoe
- Generator
- Compressor
- Concrete plant
- Concrete pump car
- Asphalt plant
- Asphalt finisher

6) Local Contractors

- Government-Owned Companies : Not investigated
- Private Companies :
 - CMC Co., Ltd.
 - CETA Co., Ltd.
 - (Murray & Roberts Co., Ltd)

7) Access of Construction Materials and Machinery to the Site

- Construction materials and machineries are delivered from suppliers warehouse and local contractor's yard to the site through trunk roads.

8) Relocation of public Utilities

- Normally the authorities or agencies concerned are responsible for the relocation and replacement of electric facilities, telephone cables, water mains at their own cost.

9) Traffic Management During the Construction

- Diversion roads should be properly provided with appropriate traffic signs and guides.
- Also, night work should be considered to minimize the traffic congestion during the construction of proposed roads in the centre of the city.
- Widening of the existing roads sometimes requires relocation of existing bus bays and bus stops, temporary facilities should be provided during the construction.

19.2 CONDITIONS FOR COST ESTIMATE

- 1) Project cost consists of the following items:
 - Construction cost
 - Construction
 - House compensation and house relocation
 - Structure strengthening
 - Consultant fee
 - Contingency for price escalation and physical change
 - Administration cost of Mozambican Government
- 2) All construction work will be executed by private contractors.
- 3) The unit cost of each cost component was determined based on the economic conditions in 2001 of Mozambique.
- 4) The structure strengthening is consists of the training and guidance of the new road maintenance system, the procurements of training and maintenance equipments and the construction of training room. This cost is uniformly estimated at 0.56 million US\$.
- 5) The consultant fee consists of detailed engineering design and construction supervision and has been estimated at 8 % of construction cost. Tendering will be required at the time of tender and it is estimated that this will be equivalent to 2% of construction cost. Therefore the consultant fee will be estimated at 10 % of construction cost.
- 6) House compensation and relocation utilities costs were determined by the EIA survey.
- 7) Contingency for price escalation and physical change is estimated at 10 % of construction cost.
- 8) Administration Cost of Mozambique Government is estimated at 1 % of construction cost.
- 9) Currency
Exchange Rate: 1 US\$ = 22,000 Mts.= 125.00 Yen, 1 Mts. = 0.00568 Yen (July 2001)
- 10) Taxation is uniformly 17 % to merchandise as VAT in Mozambique.

11) Maintenance cost is classified into the routine maintenance cost and the periodic maintenance cost. The routine maintenance cost is estimated at annual 1.5 % of construction cost. And the periodic maintenance cost is estimated at 10 % every ten years after completion of construction work.

12) Foreign and Local Currency Portions for Construction Materials are as shown below.

Table 19.2.1 Foreign and Local Currency Portions for Construction Materials

Items		Currency Portion	
		Foreign	Local
a.	Concrete produced by batches plant including material	0%	100%
b.	All equipment and plants for road construction	0%	100%
c.	Asphalt (Bituminous, coat, etc) for pavement material including production costs by plants	0%	100%
d.	Reinforcing bar (deformed steel bar D 10 ~ 32 mm)	0%	100%
e.	Raw materials such as sand, aggregate, rock, and embankment material are locally available.	0%	100%
f.	Concrete products such as pipes, piles	0%	100%
g.	Form work (timber, steel including manufacturing)	0%	100%
h.	Frame support/ scaffolding work	0%	100%
i.	Labour (including expatriate expert labour)	3%	97%
j.	Fuel (gasoline, diesel)	0%	100%

13) Standard of Productivity

Standard of productivity is given from “Standard Productivity for Construction Works, 2001, Ministry of Land, Infrastructure and Transport, Japan”.

19.3 UNIT RATES

1) Unit Prices of Materials, Labour and Equipment

The unit prices of labour forces, materials and equipments are estimated through hearing to the relevant road development authorities and local contractors in Mozambique, on the basis of the similar road or bridge project executed in and around Maputo city.

2) Unit Costs for Major Working Items

The unit cost for major working items, calculated for each working items, are estimated based on the preliminary construction schedule and method, natural and social conditions, availability of local materials and equipment, labour force etc.

19.4 WORK QUANTITIES

The work quantities are calculated on the basis of the preliminary engineering design described in the Chapter 18.

19.5 ESTIMATED CONSTRUCTION COSTS

The summary of the construction cost for major working items are as shown in the Table 19.5.1.

Table 19.5.1 Construction Cost (1)

Item	Unit	Unit Price	Missing Link Julius Nyerere				Unit Price	Trunk Roads		Industrial/Commercial Area Roads		Port Area Roads		District 1 Area Roads	
			On Line	On Line Amount	Off Line	Off Line Amount		Trunk Roads Total	Trunk Roads Amount	IC Area Roads Total	IC Area Roads Amount	Port Area Roads Total	Port Area Roads Amount	District 1 Area Roads Total	District 1 Area Roads Amount
Macadamize	m														
Overlay	m														
Re Base	m														
Road Length(m)	m							9720		8510		3390		12 895	
Road Width	m							16' 20"		12' 20"		12' 8"			
Carriageway	m														
Seewalk	m														
Drain	m														
Utility	m														
Total Width(m)	m													12' 20"	
Embankment Height(m)	m														
Access Road (m)	m														
Bus bay	240 sq														
Extra bus bay	130 sq														
Improve Intersection	no.														
Earth Works															
Embankment	cu.m	5.47	200,000	1,093,150	80,000	437,260	3.01			81	244				
Cut	cu.m	1.98	220,000	431,335	82,000	160,770									
Excavation common	cu.m						1.98			11,992	23,512	2,220	4,371		
Removal of existing pavement(5cm)	cu.m	0.50	8,000	4,000	8,000	4,000	0.00	715		2,758				2,438	
Cut Slope	sq.m	3.20	25,200	82,172	18,200	59,340									
Fill Slope	sq.m	2.21	4,390	9,608	29,100	64,276									
Out Slope	sq.m	8.00	28,450	236,400	47,300	378,400									
Stone Protection	(Sub-total)		sub-total	1,857,170	sub-total	1,104,550	sub-total		sub-total	23,752	sub-total	4,371	sub-total		
Pavement Works															
Carriageway	m														
Overlay	sq.m						13.00	28,200	1,023,880						
	sq.m						16.00	22,400	358,400			22,662	362,840	71,780	902,880
	sq.m						19.00			36,500	693,500				
	sq.m									0	0		0		
	sq.m									0	0		0		
Asphalt Surface Course	sq.m	9.40	19,720	184,750	38,310	362,100									
	sq.m						13.83	13,900	186,872					30,960	415,790
	sq.m	14.54	6,900	100,300	6,780	98,560	14.54	28,010	407,108	50,960	871,668				
	sq.m									0	0		0		
	sq.m	12.32	21,670	266,950	40,210	495,350				0	0		0		
Semi Flexible Pavement	sq.m	10.00	19,000	19,000	1,000	19,000	3.75	10,800	40,485						
Base course (Graded Crushed Stone)	100 sq.m	5.65	20,600	116,860	30,220	221,530	5.65								
Base course (Stabilised Existing Material)	100 sq.m	4.38	38,380	158,530	81,370	287,570	4.38	29,500	128,668			10,612	46,280	18,200	79,350
	150 sq.m						6.43	14,300	91,948	50,960	385,543			30,960	199,070
Subbase course (Stabilised)	150 sq.m						6.43	4,656	28,652			10,612	68,256	18,200	117,026
Concrete Block Pavement(150mm x 150mm x 30mm)	sq.m						19.00	2,056	37,048			10,612	191,070	18,200	327,600
Concrete Subgrade	sq.m	1.13	36,360	40,985	61,370	69,177									
Shoulder	sq.m						3.75								
CBST	sq.m	3.75	7,790	29,202	14,380	53,402	3.75							8,572	32,142
Base course (Stabilised)	100 sq.m						4.38							8,026	37,960
Seewalk	sq.m						0			4					
CBST	sq.m	3.75	14,000	52,812	44,490	166,772	3.75			28,230	105,820				
Base course (Stabilised)	100 sq.m	4.38	14,000	61,430	44,490	193,090	4.38			28,230	121,080				
Concrete Block Pavement(150mm x 150mm x 30mm)	sq.m						19.00	58,900	884,756			7,868	118,012	53,280	709,200
Base course (Stabilised)	100 sq.m						4.38	58,950	257,022			7,868	34,302	53,280	232,300
Kerb Stone	m	12.00	2,460	29,920	5,010	60,180	12.00	6,440	77,280						
	(Sub-total)		sub-total	1,053,770	sub-total	1,098,280	sub-total	3,521,440	sub-total	2,179,612		820,560		3,172,750	
Drainage Works															
Clearing and flushing of existing drainage pipe	m						3.00	4,076	12,227	13,093	39,273	4,683	14,050	18,457	55,370
Man Drain	m														
R0.3 x H0.3	m						61.96								
R0.3 x H0.4	m	36.66	1,900	69,650	7,250	265,844	61.96								
R0.3 x H0.5	m														
Kubinga drain	m						16.00								
side ditch	m	16.00	1,748	27,972	1,748	27,972	16.00							3,990	56,982
Urbanised drain	m														
0.4 x 0.4	m														
0.45 x 0.45	m						104.36								
0.5 x 0.5	m						113.94								
0.6 x 0.6	m						117.58								
0.6 x 0.6	m													600	94,586
0.6 x 0.6	m						154.61								
0.6 x 0.7	m						180.21								
0.7 x 0.7	m						187.81								
0.7 x 0.8	m						204.42								
0.7 x 0.9	m						220.51								
0.7 x 1.0	m						0.00								
0.7 x 1.1	m						0.00								
0.7 x 1.2	m						0.00								
0.7 x 1.3	m						0.00								
1.0 x 1.1	m	441.63			480	212,000		65.65							
Open Drain (Stone Pitching) 0.7 x 0.7	m							76.42							
Open Drain (Stone Pitching) 0.8 x 0.8	m							0.00							
1.0 x 1.0	m							0.00							
1.0 x 1.2	m							0.00							
1.0 x 1.5	m							0.00							
Open Drain (Stone Pitching) 1.0 x 1.0	m						100.93								
Open Drain (Stone Pitching) 1.2 x 0.8	m	89.42	470	46,586											
Open Drain (Stone Pitching) 1.2 x 1.2	m	81.92	570	36,394											
Open Drain (Stone Pitching) 0.8 x 0.6	m	57.76	1,100	64,712	1,200	69,330									
Open Drain (Stone Pitching) 1.2 x 0.6	m	69.67	400	27,860											
Earth Drain 0.3 x 0.4	m	4.57	2,490	11,330	3,020	16,080									
UL	m														
0.5 x 0.5	m						130.00							900	117,000
0.5 x 0.85	m						190.00		1,349,000						
0.5 x 0.85	sq	30.00	80	2,400	178	5,300		62	3,000	854	25,536	398	10,170	1,091	35,290
Soakaway	m						200.16		32	21,000					
Collection Coodule	m	100.00	800	81,000	2,490	249,000									
Plot culvert	no.							100.00	60	65,125					
D90	m						132.33								
D90	m	178.45	80	14,252			178.45	500	89,075					70	12,470
D90	m							230.71							
D1000	m						410.90								
D1500	m						748.79				900	673,880			
	(Sub-total)		sub-total	381,488	sub-total	845,610	sub-total	1,605,150	sub-total	64,800		698,102			372,110
Outlet Construction															
Block Pitching	sq.m	20.00	0		3,846	76,920									
Sodding	sq.m	8.13	0		7,480	60,812									
Excavation & Filling	cu.m	4.97	0		5,100	25,460									
Box culvert	m														
3000x2000	m	1,910.81	100	191,081	0										
2500x2200	m	1,530.32	50	76,516	0										
2500x2000	m	1,262.84	20	25,257	50	64,142									
3000x2000x2	m	2,635.22	0		50	131,765									
	(Sub-total)		sub-total	293,254	sub-total	358,992	sub-total		248,522	sub-total	25,530		10,170		62,905
Miscellaneous Works															
Lamp Mast	m	3.00	1,900	5,700	3,200	9,800	3.00	21,360	64,080	8,510	25,530	3,390	10,170	10,835	31,905
Roundabout	#						761.68	1	762						
Chatter bar	no						20.00	1,584	31,680						
small (including pedestrian signal)	no						2,000.00	32	64,000					8	16,000
Small (including pedestrian signal)	no														
Buss stop shelter	no							88	88,000						
Harp	no							1,000.00						15	15,000
concrete slab (1.5 x 1.0 x 0.15)	no							60.00							
Roundabout Block	m	12.00	1,040	12,480	1,390	16,680									
Time Block	m	12.00	390	4,720	2,520	30,250									
Tee	sq.m	10.00	300	3,000	580	5,800									
Street Light	set	3,000.00	40	120,000	165	495,000									
Gabion	cu.m	300.00	400	138,000	400	138,000									
Vertical Drain	m	61.84	480	29,696	220	15,420									
Removal Gabion	100.00	11,300		113,000			</								

Table 19.5.1 Construction Cost (2)

Item	Unit	District 2 Area Roads		District 3 Area Roads		Public Transportation		Traffic Management	
		District 2 Area Roads Total	District 2 Area Roads Amount	District 3 Area Roads Total	District 3 Area Roads Amount	Bus Terminal Total	Bus Terminal Amount	Imposes of Intersection	Intersection Amount
Maintenance	m								
Overlay	m								
Re Base	m								
Road Length(m)	m	9130		908					
Road Width	m	12-14		10-14					
Carriageway	m								
Sidewalk	m								
Drain	m								
Utility	m								
Total Width(m)	m								
Embankment Height(m)	m								
Access Road (no)	no								
Bus bay	no	284							
Extra bus bay	no	134							
Improvement Intersection	no								
Earth Works									
Embankment	cu.m	24,632	7377	2459	7392				
Cut	cu.m								
Excavation common	cu.m	10,022	19,22	9,322	2,430				
Removal of existing pavement(5-cm)	cu.m								
Cut Slope	sq.m								
Fill Slope	sq.m								
Slope Protection (Subtotal)	sq.m		9392	9632					
Pavement Works									
Carriageway									
Overlay	sq.m								
Asphalt Surface Course	sq.m								
Asphalt Binder Course	sq.m								
Semi Flexible Pavement	sq.m								
Base course (Graded Crushed Stone)	sq.m								
Base course (Stabilised Electric Material)	sq.m								
Subbase course (Stabilised)	sq.m								
Concrete Block Pavement(150mm-thickbed=30mm)	sq.m								
Concrete Subgrade	sq.m								
Shoulder	sq.m								
DEST	sq.m								
Base course (Stabilised)	sq.m								
Sidewalk	sq.m								
DEST	sq.m								
Base course (Stabilised)	sq.m								
Concrete Block Pavement(150mm-thickbed=30mm)	sq.m								
Base course (Stabilised)	sq.m								
Sub Slope	sq.m								
Drainage Works									
Cleaning and flushing of existing drainage pipe	m								
Open Drain									
80.3xH0.3	m								
80.3xH0.4	m								
Kerbstone drain	m								
Leaky drain	m								
U shaped drain	m								
0.4x0.4	m								
0.45x0.45	m								
0.5x0.5	m								
0.5x0.6	m								
0.6x0.6	m								
0.6x0.7	m								
0.7x0.7	m								
0.7x0.8	m								
0.7x0.9	m								
0.7x1.0	m								
0.7x1.1	m								
0.7x1.2	m								
0.7x1.3	m								
1.0x1.1	m								
Open Drain (Stone Pitching) 0.7 x 0.7	m								
Open Drain (Stone Pitching) 0.8 x 0.8	m								
1.0 x 1.0	m								
1.0 x 1.2	m								
1.0 x 1.5	m								
Open Drain (Stone Pitching) 1.0 x 1.0	m								
Open Drain (Stone Pitching) 1.2 x 0.9	m								
Open Drain (Stone Pitching) 1.2 x 1.2	m								
Open Drain (Stone Pitching) 1.2 x 0.6	m								
Earth Drain 0.3 x 0.4	m								
Manhole									
0.5x0.5	m								
0.5x0.65	m								
catchall	no								
Soakaway	no								
Collecting Conduit	m								
Pipe culvert	no								
D400	m								
D600	m								
D800	m								
D1000	m								
D1500	m								
Outlet Construction									
Block Pitching	sq.m								
Sodding	sq.m								
Excavation&Filling	cu.m								
Box culvert									
3000x3000	m								
2500x2500	m								
2500x2000	m								
3000x2000x2	m								
Miscellaneous Works									
Line Marking	m								
Roundabout	no								
Chatter bar	no								
Signalisation (pedestrian signal)	no								
Shift of signal (including pedestrian signal)	no								
Busstop shelter	no								
14 mm	no								
Concrete sign(1.5 x 1.0 x 0.15)	m								
Boundary Block	m								
Tree Block	m								
Tree	set								
Street Light	set								
Gabion	cu.m								
Vertical Drain	m								
Removal Gabion	cu.m								
Removal Kerb Stone	m								
Removal Boundary Block	m								
Grass	sq.m								
Salvage of Utility									
Electricity Line(Overhead)33kv	m								
Electricity Line(Overhead)22kv	m								
Electricity Line(Overhead)11kv	m								
Electricity Line(underground)33kv	m								
Electricity Line(underground)22kv	m								
Electricity Line(underground)11kv	m								
Telephone Line(Overhead)	m								
Telephone Line(underground)	m								
Water Main D=300	m								
Water Main D=300	m								
Sewerage	m								
House compensation									
Residence(small)	no								
Residence(middle)	no								
Residence(large)	no								
Commercial Building(small)	no								
Commercial Building(medium)	no								
Commercial Building(large)	no								
Factory	no								

1) House / building compensation cost

- House / building compensation cost was estimated based on the unit cost obtained through environmental survey.
- District 2 : 1,500US\$
- District 3 : 1.700US\$
- Existing Alignment of Av. Julius Nyerere : 2,000US\$

			House compensation cost(USD)	
Group No	Existing minimum road width (m)	Proposed road width (m)	W=14m	Proposed Width
9. Rehabilitation of District 2 Area Roads			324,000	79,500
9.1 Rua 2282/2265	6	8,10,14	147,000	25,500
9.2 Rua 2275	6	8,10,12,14	123,000	34,500
9.3 Rua de Xipamanine(2291)	6	10,12	24,000	3,000
9.4 Rua dos Imaos Roby(2289)	12m (street type)	12m (street type)	0	0
9.5 Rua 2315/2313	6	10,14	18,000	7,500
9.6 Rua 2309/2324	6	14	12,000	9,000
9.7 Av. das Estancias(2000)	12m (street type)	12m (street type)	0	0
10. Rehabilitation of District 3 Area Roads			319,600	57,800
10.1 Rua da Goa(3027)	5	10	13,600	1,700
10.2 Rua da Lixera(3030)	7	10	39,100	0
10.3 Av. Milagre Mbote(3001)	8	8,10	107,100	5,100
10.4 Av. da Malhangelene(3259)	6	8,10,12	119,000	22,100
10.5 Rua 1 de Maio(3374)	6	8	40,800	28,900
10.6 Rua 3306	14	14	0	0
10.7 Rua 3523	14	14	0	0
10.8 Rua 3576	14	14	0	0
Construction of Missing Link on Av. Julius Nyerere(On Line)				502,000
Construction of Missing Link on Av. Julius Nyerere(Off Line)				528,000
Construction of Bus Terminal(Combatentes)				138,000

- Utilities relocation cost was estimated based on the unit cost obtained through hearing to local contractors.

[illegible]

3) Other costs

- Engineering cost : 10% of the construction cost
- Contingency cost : 10% of the construction cost consisting 5% of physical and 5% of price contingencies
- Administration cost : Total 1% of the construction cost during preparation and implementation

19.7 SUMMARY OF THE PROJECT COSTS

The project cost including construction cost, compensation cost for houses and buildings, physical contingency and price contingency as well as the engineering costs etc., is shown in the Table 19.7.1.

Table 19.7.1 Summary of the Project Cost

Unit: mil. US\$

Phase	Project Road Length (km)	Grand Total*			
		C/C		H/C	
(1) Construction Cost					
- Av. J. Nyerere	5.6	5.05	(11.60)	0.53	(0.50)
- Av. V. Lenine	---	0.13		0.00	
- Av. A. Lusaka	2.8	1.76		0.00	
- Av. Angola	3.7	2.05		0.00	
- Av. M. Ngouabi	2.6	1.43		0.12	
- Industrial/ Commercial Area	6.0	2.29		0.00	
- Port Area	3.9	1.53		0.00	
- District 1 Roads	8.7	3.61		0.00	
- District 2 Roads	10.2	3.62		0.50	
- District 3 Roads	9.5	4.28		0.18	
- Traffic Management Facilities	---	2.80		0.00	
- Bus Stops and terminals	---	0.56		0.14	
Sub Total (a)		29.12	(35.67)	1.47	(1.44)
(2) Structural Strengthening Cost		0.56	(0.56)	---	---
Sub Total (b)		0.56	(0.56)	---	---
Total Construction Cost (a)+(b)		29.68	(36.23)	1.47	(1.44)
(3) Consultant Fee (DD/SV=10% of Construction Cost)		2.91	(3.57)	---	---
(4) Contingency for Price Escalation and Physical Change (10% of Construction Cost)		2.91	(3.57)	---	---
(5) Administration Cost of Mozambique Government (1% of Construction Cost)		---	---	0.29	(0.36)
Sub Total (6) = (3) + (4) + (5)		5.82	(7.13)	0.29	(0.36)
Total (1) + (2) + (6)		35.50	(43.36)	1.76	(1.80)

*: C/C: Construction Cost () = Julius Nyerere Plan 4

H/C: House Compensation including Relocation of Utilities

Exchange Rate 1 US\$ = 22,000 Mts = ¥ 125.00 (July 2001),

or 1 Mt = ¥ 0.00568

19.8 MAINTENANCE COST

- Annual routine maintenance cost : 1.5% of the construction cost,
- Periodic maintenance cost : 10% of the construction cost
(it will be cost 10 years after opening of the project roads)

CHAPTER 20 : ENVIRONMENTAL IMPACT ASSESSMENT

20.1 GENERAL

The objectives of the EIA are ;

- To identify existing environmental situations in the project area
- To estimate and evaluate possible environmental impacts of the proposed project
- To consider countermeasure to mitigate negative impacts of the project

As a “scooping” result of the initial environmental examination (IEE), the items required for EIA are as shown in the Table 20.1.1. In addition, following items will be in consideration for environmental impact assessment.

- | | |
|-----------------------------------|--------------------------------|
| -Geomorphology, Geology and Soils | -Solid waste |
| -Flood hazard | -Health, Safety and Well being |
| -Water resources | |

20.2 SITE CONDITIONS

Site conditions are summarized as shown in the Table 20.2.1.

20.3 ENVIRONMENTAL IMPACT ESTIMATION AND ASSESSMENT

The summary of the potential impacts and their significance with and without mitigations are shown in the Table 20.3.1.

The most of the impacts are short term and the benefits are long term.

20.4 RECOMMENDATION OF MITIGATION MEASURES

Summaries of the mitigation measures concerning the possible environmental impacts during the project implementation and responsible body considered are presented in Table 20.4.1.

Table 20.2.1 Outline of environment along the proposed roads/projects

F/S Project		Social and Economical Environment	Physical and Natural Environment	Public Nuisance
Trunk Roads	1.Construction of Missing Link on Av. Julius Nyerere	•More and more houses have been built in the coastal plain, and some of elementary school are also located here.	Swamps of coastal plain are located here. Rich in the greenery of trees.	Heavy dust is flung up when motor vehicles run on the road where the surface is not paved.
	2.Restoration of Av. Juluis Nyerere	•Many residences are located here.	Rich in the greenery of trees.	•The erosion damages are very significant due to the heavy rain. Av. Juluis Nyerere wre cut.
	3.Improvement of AV.Vladimir Lenine	•Many residences as well as commercial facilities (market) are located here.	Poor in the greenery of trees.	•The traffic volume of this road is generally heavy, resulting in severe traffic congestion.
	4.Rehabilitation and Improvement of AV. Acordos de Lusaka and Av. Guerra Popular	•Many residences as well as commercial facilities are located here.	•Trees are lined along the road and cultural property of Estatua“samora machel” (Samora machel statue)are located here.	•The traffic volume of these roads are generally heavy, therefore, it cannot be said that the current situation of air and sound environments of the area are favorable.
	5.Rehabilitation and Improvement of AV. Angola and Rua S. Cabral/Largo de Deta	•Many factories and commercial facilities as well as residences are located here.	•Open drainage canal is installed along this road.	
	6.Rehabilitation and Improvement of AV. Marien Ngouabi	•Many residences as well as commercial facilities are located here.	•Many trees are lined along the road.	•Heavy dust is flung up when motor vehicles run on the road where the surface is damaged.
Collector Roads	1.Rehabilitation of Industrial and Commercial Area Roads	•Many factories and warehouses are located here. the port is also located in this area.	Some trees are planted along roads.	•Surface are badly damaged on these areas, and accordingly dust is flung up when motor vehicles pass over the roads. It worsens the atmospheric environment of the roadside area.
	2.Rehabilitation of Port Area Roads	•Many factories and warehouses as well as commercial facilities are located here. Railway station is also located in the area.	•Trees are lined along the road and many of the cultural properties are located in this area.	
Residential Area Roads	1.Rehabilitation of District 1 Area Roads	•Many residences are located in these areas.	•Trees are planted from place to place along roads and around houses.	•Due to the surface of roads are badly damaged as well as unpavement, heavy dust is flung up when motor vehicles run on the roads.
	2.Rehabilitation of District 2 Area Roads			
	3.Rehabilitation of District 3 Area Roads			
Rehabilitation and Improvement of Bus Terminal		•Many residences and one market are located here.	---	•The congestion of bus terminal

Table 20.3.1 Summary of Environmental Impact

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.1 Resettlement of Residents										
		Resettlement of residents within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts due to road widening	The social impacts of removal and resettlement of residents located alongside the target roads within these districts.	N	H	H	M	H	H	M
20.4.2 Air Pollution										
		Construction activities	Dust generated	N	M	L	M	M	M	L
		Raising speed of vehicle due to improvement of roads	Exhaust gas caused by vehicle traffic	P	M	H	M	M	M	M/H
		Restoration of original JN ¹⁾	Formation of roadside buffer belt		-NO ₂ ; 0.015 ~ 0.019 ppm < 0.08 ppm (WHO 24 hr. Avg.) -CO; 0.524 ~ 0.569 ppm < 10 ppm (Japan 24 hr. Avg.)					

H = High, M = Medium, L = Light (refer to Appendix 20.1 for definitions for severity, duration, probability and spatial extent)

1) JN = Av. Julius Nyerere

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive e	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.3 Noise										
		Construction activities	Noise generated by construction activities and diversion of traffic to accommodate construction	N	M	L	M	M	M	L
		Improved road conditions following construction	Noise generated by improved road conditions following construction.	P	M/L	H	M	M	M/L	M/H
		Restoration of JN	Formation of roadside buffer belt							
					Daytime;L _{Aeq} = 60.1 ~ 64.5 < 65 dB Nighttime;L _{Aeq} = 51.9 ~ 57.4 < 60 dB (Japanese standard)					
20.4.4 Vibration										
		Construction activities	Vibration generated by construction activities and diversion of traffic to accommodate construction	N	M	L	M	M	M	L
		Improved road conditions following construction	Vibration generated by improved road conditions following construction.	P	M/L	H	M	M	M/L	M/H
		Restoration of JN	Formation of roadside buffer belt							
					Daytime;L _{Aeq} = 38.8 ~ 47.2 < 70 dB Nighttime;L _{Aeq} = 33.3 ~ 42.7 < 65 dB (Japanese standard)					
20.4.5 Geomorphology, Geology and Soils										
		Construction of New Section on JN	The impact of construction activities on the soils of the low-lying coastal areas and swamps in the Costa de Sol District	N	M	M	M	L	M	M
		Restoration of original JN	The impact on soil erosion	P	H	H	H	L	M	H
		Upgrading of target roads and construction of stormwater drains	The impact of upgrading and repair of trunk, collector and area roads which are currently in existence, on the underlying geology and soils	Not significant since roads are currently already existing						
		Sourcing of road building material	The impact of quarrying road building material on geomorphology, geology and soils	This does not form part of the scope of works.						

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.6 Flood Hazard										
		Construction of New Section on JN and restoration of original JN	The impact of flood hazard due to stormwater	P	H	H	H	H	H	H
		Upgrading of target roads and construction of stormwater drains								
20.4.7 Water Resources										
		Construction of New Section on JN.	The impact of construction activities on the natural surface water flow and quality within the Low-lying coastal areas and Mangroves.	N	M	M	M	M	H	M/H
		Upgrading of target roads and construction of stormwater drains	The impact of stormwater drains on surface water quality.	P	H	H	H	M	H	H
			The impact of stormwater drains on groundwater levels.	No Impact anticipated other than possible slight lowering of water table due to effective drainage of surface water						
20.4.8 Protected or ecologically sensitive zones										
	Swamps	Construction of New Section on JN.	The impact of road construction on the ecological functioning of the Swamps in the Costa de Sol District: Direct impact of construction.	N	M	L	M	L	H/M	M
				The impact of road construction on the ecological functioning of the Swamps in the Costa de Sol District: Indirect impact of introducing new settlements to area.	N	H	H	M	H	H

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.9 Urban Environmental Quality										
(1)	Aesthetics (Street trees)	The upgrading, improvement of target roads within the Central Districts	The impact of resurfacing and upgrading target roads on street trees	No impact anticipated as trees will not be removed.						
		The widening of the roads Av. GP ²⁾ and Av MN ³⁾	The impact of road widening on street trees	N	M	M	M	L	M	H
2)	Solid Waste	Construction activities	The impact of solid waste and hazardous waste generated during construction on the environment	N	M	L	M	L	M	M
20.4.10 Social and Cultural Environments										
(1)	Social and cultural environment:Provi sion of services and access to facilities	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on Public Transport	P	H	L	H	M	H	---
			Impact on waste collection services	P	H	L	M	M	H	---
			Impact on supply and maintenance of services	P	M	L	M	M	M	---
			Impact on access to markets, hospitals, schools and other facilities	P	H	L	H	M	H	---
		Construction of New section of JN and restoration of original JN	Impact on access to markets, hospitals, schools and other facilities	P	M	L	M	M	M	---
		Upgrade of target roads within Central District	Impact on access to markets, hospitals, schools and other facilities	P	M	H	H	M	M	---

2) GP=Av. Guerra Popular

3) MN= Av. Marien Ngouabi

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
(2)	Health, Safety and Well Being	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on pedestrian and motorist safety	P	H	H	H	M	H	---
			Impact on Residents health by improving access to waste collection trucks and provision of effective drainage.	P	H	H	H	M	H	---
		Widening of. GP and MN	Impact on pedestrian and motorist safety	P	H	H	H	L	H	---
		Construction activities	The impact of construction activities on motorist and pedestrian safety.	N	M/L	L	M/L	L	M/L	L
(3)	Cultural Environment	Upgrading, improvement and resurfacing of roads within the Central District	The impact of road reconstruction and repair activities on cultural properties.	No impact anticipated other than short term inconvenience during construction and long-term benefits of improved access to these sites						

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
20.4.11 Economic environment										
(1)	Formal commercial activities	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on businesses located along target roads.	N	M	L	M	L	M	L
			The long term impacts on the businesses of improved road surfaces	P	H	H	H	M	H	---
		Upgrading of roads within the Central District	The short term impacts of construction activities on businesses located along target roads.	N	M/L	L	M	L	M/L	L
			The long term impacts on the businesses of improved road surfaces	P	M	H	H	M	M	H
		Construction of the new JN section and restoration of original JN	The impact on improved access to Av Marginal from the Polana-Canico district	P	M	H	M	M	M	---
(2)	Markets and informal commercial activities	Construction of the new JN section, Upgrading of roads within Minkadjuine and aeroporto districts	Short term impact on the Praça dos Combaterites market, and markets located along roads Rua dos Irmaos Roby and Rua 2.522 (Aeroporto B District)	N	M	L	M	L	M	L
			Long term impact on the Praça dos Combaterites market, and markets located along roads Rua dos Irmaos Roby and Rua 2.522 (Aeroporto B District)	P	M	H	M	M	M	H

Ref.	AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	CRITERIA				SIGNIFICANCE	
					Severity	Duration	Probability	Spatial extent	Without mitigation	With mitigation
(3)	Informal individual traders (ie tomatoe, cashew nut etc vendors)	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on vendors located along target roads.	P	M	L	M	L	M	H
			The long term impacts of improved road surfaces and access on the businesses.	No significant impact since most of the trade comes from surrounding residents, although conditions for selling would be improved by the addition of a sidewalk.						
(4)	Industrial activities	Upgrade of target roads	The impact of road upgrades on light and heavy industries located along	P	M/L	H	M	L	M/L	---
(5)	Employment opportunities	Employment of Unskilled labour	The impact of employment on social upliftment and increase spending power	P	M	L	M	M	M	H
(6)	Maputo economic growth	Upgrade of all target roads according to 2020 plan	The impact of road upgrades on general economic growth in Maputo.	P	H	H	H	H	H	---

Table 20.4.1 Summary of Mitigation Measures on Environmental Impact and Responsible Body

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positiv	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.1 Resettlement of Residents							
	Resettlement of residents within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts due to road widening	The social impacts of removal and resettlement of residents located alongside the target roads within these districts.	N	-To establish a rule on compensation for resettlement by the government. -To explore alternative options to resettlement -To undertake a complete inventory and assessment of each affected property -To undertake an investigation for a suitable alternative location for displaced families		--	--
20.5.2 Air Pollution							
	Construction activities	Dust generated	N	-To provide a water sprinkling system at the construction site	--	--	
	Raising speed of vehicle due to improvement of roads	Exhaust gas caused by vehicle traffic	P	-To establish National standard regarding air quality, emission of vehicle exhaust gas quantity and quality -To introduce an obligatory car inspection system -To improve traffic flow		--	--

; High concerned, ; Light concerned, --; No concerned

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.3 Noise							
	Construction activities	Noise generated by construction activities and diversion of traffic to accommodate construction	N	-Construction activities to be limited to normal working hours only	--	--	
	Improved road conditions following construction	Noise generated by improved road conditions following construction.	P	-To introduce 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. -Conversion of land use from residential to commercial in urban area		--	--
20.5.4 Vibration							
	Construction activities	Vibration generated by construction activities and diversion of traffic to accommodate construction	N	-Construction activities to be limited to normal working hours only	--	--	
	Improved road conditions following construction	Vibration generated by improved road conditions following construction.	P	-To manage the maintenance of road pavement		--	--
20.5.5 Geomorphology, Geology and Soils							
	Construction of New Section on JN	The impact of construction activities on the soils of the low-lying coastal areas and mangrove swamps in the Costa de Sol District	N	-All topsoil and subsoil removed during construction activities should be stockpiled in such a manner as to maintain its viability and protected against erosion.	--	--	

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.6 Flood Hazard							
	Construction of New Section on JN	The impact of flood hazard due to stormwater	P	-To design and construct new drainage systems which have enough capacity	--		
	Upgrading of target roads and construction of stormwater drains						
20.5.7 Water Resources							
	Construction of New Section on JN.	The impact of construction activities on the natural surface water flow and quality within the Low-lying coastal areas and Mangroves.	N	-To take precautions to ensure that neighbouring residences are not impacted by stormwater runoff from the road during construction -To allow for the unimpeded flow of tidal and seasonal waters within the swamps	--	--	--
20.5.8 Protected or ecologically sensitive zones							
Swamps	Construction of New Section on JN.	The impact of road construction on the ecological functioning of the swamps in the Costa de Sol District: Direct impact of construction.	N	-To limit every activity within this region as small an area as possible -To design a drainage system which is allowed for unimpeded flow of tidal and seasonal waters within the swamps -To make a financial provision for the remediation of sensitive areas damaged during construction	--	--	--
		The impact on the ecological functioning of the swamps in the District: Indirect impact of introducing new settlements to area	N	-To control strictly inflow of new settlements to this area		--	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.9 Urban Environmental Quality							
(1) Aesthetics (Street trees)	The upgrading, improvement of target roads within the Central Districts	The impact of resurfacing and upgrading target roads on street trees		-All trees not directly affected by construction activities, should nevertheless be protected against accidental damage.	--		--
	The widening of the roads Av. GP and Av. MN	The impact of road widening on street trees	N	-To acquire permits for all trees which will be removed during construction activities -To make financial provision for the replacement of all trees removed during construction		-- --	--
(2) Solid Waste	Construction activities	The impact of solid waste and hazardous waste generated during construction on the environment	N	-To dispose of all solid waste produced during construction at the municipal landfill site north of Maputo	--	--	
20.5.10 Social and Cultural Environments							
(1)Social and cultural environment: Provision of services and access to facilities	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on Public Transport	P	-Allowance to be made for formal bus stops on collector roads.	--		--
		Impact on waste collection services	P	-To devise a waste collection strategy for areas currently not serviced by the municipal trucks		--	--
		Impact on supply and maintenance of services	P	-To identify the location of pipelines and cables supplying services to the area prior to initiating construction activities in order to minimise the chance of interference	--		
		Impact on access to markets, hospitals, schools and other	P				
	Construction of New section of JN and restoration of original JN	Impact on access to markets, hospitals, schools and other facilities	P				
	Upgrade of target roads within Central District	Impact on access to markets, hospitals, schools and other facilities	P				

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
(2) Health, Safety and Well Being	Upgrade of collector roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene residential districts	Impact on pedestrian and motorist safety	P	-Safe pedestrian crossing points to be provided opposite school, markets, churches, bus terminals etc	--		--
		Impact on Residents health by improving access to waste collection trucks and provision of effective drainage.	P				
		Widening of GP and MN	P				
	Construction activities	The impact of construction activities on motorist and pedestrian safety.	N	-A safety officer to be appointed at each construction site. -Effective traffic control and monitoring to be provided at construction sites and along detours.		-- --	
(3) Cultural Environment	Upgrading, improvement and resurfacing of roads within the Central District	The impact of road reconstruction and repair activities on cultural properties.		-To maintain access to cultural sites during construction -To make provision for adequate parking in close vicinity to cultural sites		-- --	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
20.5.11 Economic environment							
(1)Formal commercial activities	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on businesses located along target roads.	N	-To restrict to disruption of access to businesses during road resurfacing activities as a short period as possible	--	--	
	Upgrading of roads within the Central District	The short term impacts of construction activities on businesses located along target roads.	N	-To restrict to disruption of access to businesses during road resurfacing activities as a short period as possible	--	--	
(2)Markets and informal commercial activities	Construction of the new JN section, Upgrading of roads within Minkadjuine and aeroporto districts	Short term impact on the Praca dos Combaterites market, and markets located along roads Rua dos Irmaos Roby and Rua 2.522 (Aeroporto B District)	N	-To provide an alternative location for all markets displaced by the road upgrading/construction activities		--	--

AFFECTED ENVIRONMENT	ACTIVITY	NATURE OF IMPACT/BENEFIT	Negative/positive	MITIGATION MEASURES	Responsible Body		
					Government	Consultant	Contractor
(3) Informal individual traders (ie tomatoe, cashew nut etc vendors)	Upgrading of roads within the Chamanculo, Xipamanine, Aeroporto and Maxaquene districts	The short term impacts of construction activities on vendors located along target roads.	P	-To make allowance on sidewalks and pavements to accommodate informal vendors		--	--
(4) Industrial activities	Upgrade of target roads	The impact of road upgrades on light and heavy industries located along target roads	P	-To restrict disruption of access to businesses during road resurfacing activities to as short a period as possible	--	--	
(5) Employment opportunities	Employment of Unskilled labour	The impact of employment of social upliftment and increase spending power	P	-Labour intensive means of construction should be applied. -Unskilled labour should be sourced from the district in which the construction is being undertaken.		-- --	
(6) Maputo economic growth environment	Upgrade of all target roads according to 2020 plan	The impact of road upgrades on general economic growth in Maputo.	P	-A policy of using local suppliers of goods and services should be applied where ever possible.		--	--

20.5 CONCLUSIONS

In summary, the environmental impact assessment shows that the impact of the project on the roadside environment and the surrounding areas will be less than the allowable level for the assessed items and it will be possible to maintain the quality of the environment at an appropriate level.

To mitigate the negative impacts and maximise the benefits, possible measures to deal with all of the environmental issues in the future are recommended to ensure that the city of Maputo will be with the favourable urban environment being created.

The followings summarise the results of the assessment and recommendation on main 5 items:

1) Resettlement of residents

- Resettlement should be approached with transparency and equality, upholding the rights of the individual as entrenched in the country's constitution.
- There should be necessity to establish a rule on compensation for resettlement by the government.
- Alternative options to resettlement should be explored before a final decision to proceed with expropriation and relocation is effected.
- A complete inventory and assessment of each affected property be undertaken prior to establishing the cost of compensation.
- An investigation for a suitable alternative location for displaced families should be undertaken. This should fulfil the requirements of the affected parties, within reason, – such as access to places of work, markets, public transport, medical facilities, schools and provision of services such as water, electricity, sewage and telecommunications.

2) Air pollution

- Establishing an air pollution control law.
- Establishing a national standard regarding air quality, emission of vehicle exhausts gas quantity and quality.
- Introducing periodic and obligatory car inspection system.
- Build up a public traffic system, and converting car use to public traffic use.

3) Noise and Vibration

- In Mozambique, it is necessary to establish regulations for controlling noise and vibration in the principle cities including Maputo.

- 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.
- Conversion of land use from residential to commercial in urban area will also be effective.
- The management for maintenance of road pavement that keep the surface of roads in smooth will be principal measures for mitigation vibration.

4) Flood hazard

- To accelerate improvement of the rainwater drainage system and to conduct proper maintenance regularly.

5) Ecological sensitive zones

- Selecting other alternative route that is not located the coastal plain.
- Any activity within this region should be limited to as small an area as possible.
- There should be necessity to design a drainage system which is allowed for unimpeded flow of tidal and seasonal waters within the swamps.
- Financial provision should be made for the remediation of sensitive areas damaged during construction.
- Inflow of new settlements to this region should be limited strictly.

CHAPTER 21 : IMPLEMENTATION PLAN

21.1 EXECUTING AGENCY

The Directorate of Roads and Bridges, the Municipal Council of Maputo is the government agency responsible for the execution of the implementation of the Project. And National Roads Administration is also the executing agency for supporting the Municipal Council of Maputo.

21.2 SELECTION OF THE BEST ALTERNATIVE ROUTE OF AV.JULIUS NYERERE

Before setting implementation schedule of the projects, the first critical question that should be solved is the selection of the best route of Av. J. Nyerere. Since it is expected to play an important role of the road network of Maputo, draft economic analysis is primarily conducted on the two alternative routes of Av. J. Nyerere, and then the road network with the best alternative route of Av. J. Nyerere shall be the final set of the F/S projects.

The two alternative routes of Av. J. Nyerere have been thoroughly described in the chapter (18), thus here is just presenting the costs and benefits accrued from the two alternatives with different routes of Av. J. Nyerere as shown in Table 21.2.1.

It is obvious that the Off-Line is the better alternative route, because the initial cost is cheaper than On-line. Although NPV of Off-Line is less than On-line, IRR and B/C is much better than Off-Line. Furthermore the construction of On-Line is very difficult for drainage work and slope protection against heavy rain such as February 2000. Therefore the favorite route of the missing link of Av. J. Nyerere should select Off-Line.

Table 21.2.1 Comparison of Two Alternative Routes (Year: 2021)

Alternatives	Construction Cost for J.N.	Total Cost	IRR	B/C	NPV
JN. Off-Line	5.05 mil. USD	35.5 mil. USD	29.8%	2.97	54.6 mil. USD
JN. On-Line	15.8 mil. USD	48.4 mil. USD	27.4%	2.70	63.6 mil. USD

Source: JICA study team

21.3 PROJECT PACKAGING

Based on the proposed drainage systems for each storm water basin, each component of the Feasibility Study Projects has been combined into the following Packages. Location of the projects are shown in the Figure 21.3.1.

Package A: Road and Public Transportation Projects in Polana-Canico area

(total length=19.6km)

Package B: Road, Public Transportation and Traffic Management Projects in

Maxaquene, Malhangalene, Mahalala, Urbanizacao, Munhuana, Xipamanine, Chamanculo and Central area

(total length=16.5km)

Package C: Road and Public Transportation Projects in Altmae, Central,

Polana-Cimento, Coop and Sommerschield area

(total length=18.6km)

Package D : for Structure Strengthening of Road Maintenance Organization

21.4 CONSTRUCTION PERIOD OF EACH PROJECT PACKAGING

The construction period for each project package was estimated as follows.

- Package A : **2 years**
- Package B : **1.5 years**
- Package C : **1 year**
- Package D : **2 years**

21.5 PREPARATORY WORKS

The period of required preparatory works, consisting of the land acquisition, the house compensation, the relocation utilities and the Engineering services, is estimated **1.5 years**.

21.6 IMPLEMENTATION SCHEDULE

The recommended overall implementation schedule for each project was set up as shown in the Figure 21.6.1.

21.7 INVESTMENT PROGRAMME

The investment program of the project, consisting proposed road, traffic management, public

transportation and structural strengthening, has been made on the basis of the implementation schedule, as shown in the Table 21.7.1.

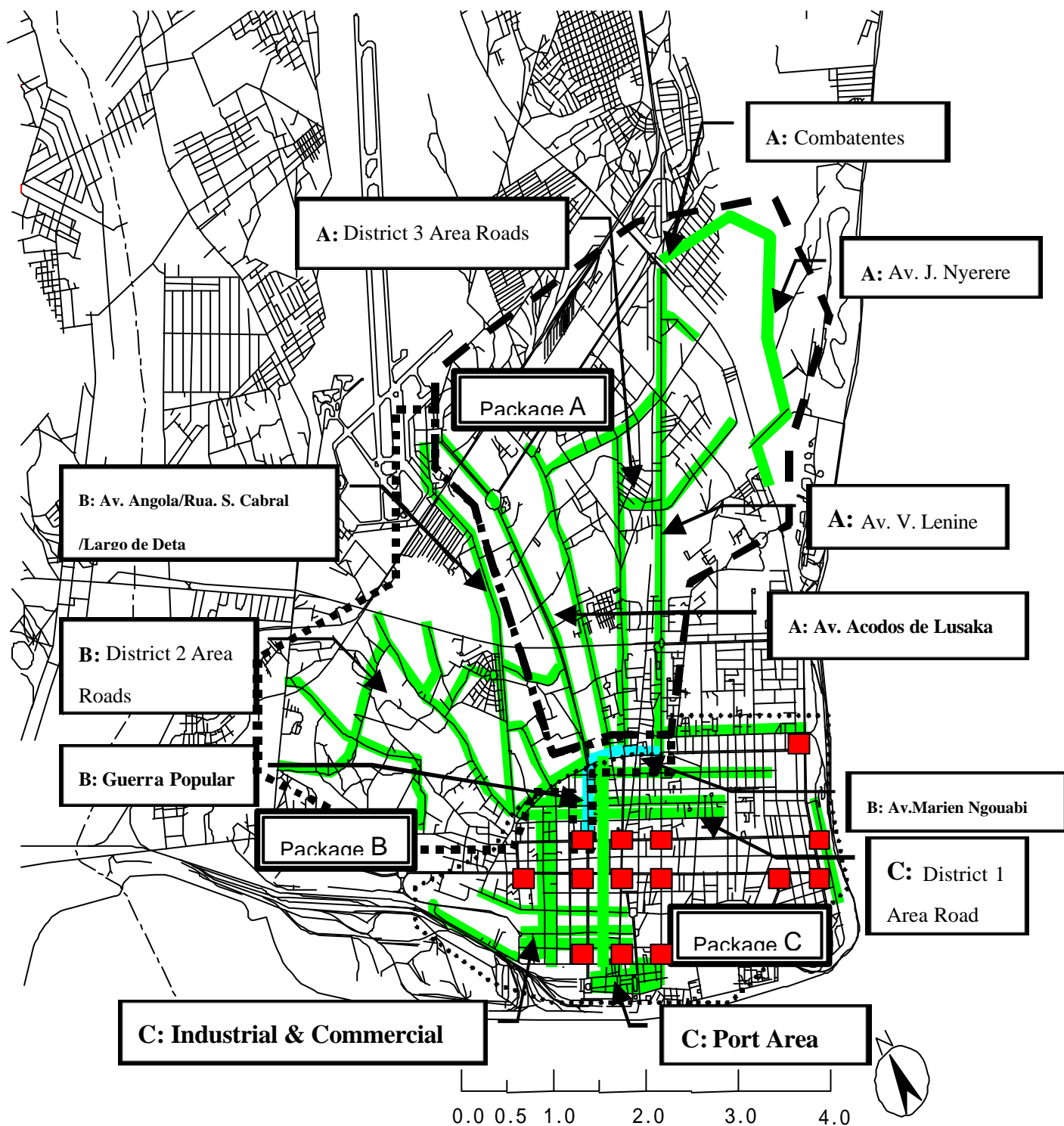


Figure 21.3.1 Project Packaging

Package No.	Proposed Facilities to be Implemented	Project Road Length (km)	High Priority Projects to be implemented in the Short-term Plan					
			1 st. year	2nd. year	3rd. Year	4th. Year	5th. year	
			2002	2003	2004	2005	2006	2007
Preparatory Works	Land Acquisition, House Compensation, Relocation of Utilities, Engineering Services	----						
Package A	Road and Public transportation Projects in Polana-Canico area	19.6						
Package B	Road, Public Transportation and Traffic Management Projects in Altmae, Central, Polana-Cimento, Coop and Sommerschield area	16.5						
Package C	Road and Public transportation Projects in Altomae and Polana-Cimento area	18.6						
Package D	Structure Strengthening of Road Maintenance Organization	----						

Figure 21.6.1 Proposed Implementation Schedule of High Priority Project

Table 21.7.1 Tentative Investment Programme of High Priority Projects

Unit: mil. US\$

Phase	Project Road Length (km)	1 st. year		2 nd. Year		3 rd. year		4 th. Year		5 th. Year		Grand Total	
		2002		2003		2004		2005		2006			
		C/C	H/C	C/C	H/C	C/C	H/C	C/C	H/C	C/C	H/C	C/C	H/C
(1) Construction Cost													
- Package A	17.1	0.00	0.38	0.00	0.38	8.98	0.00	2.24	0.00	0.00	0.00	11.22	0.75
- Package B	16.5	0.00	0.00	0.00	0.31	0.00	0.31	3.96	0.00	5.94	0.00	9.90	0.62
- Package C	18.6	0.00	0.14	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	0.14
Sub Total (a)		0.00	0.51	8.00	0.69	8.98	0.31	6.20	0.00	5.94	0.00	29.12	1.51
(2) Structural Strengthening Cost		0.00	---	0.00	---	0.28	---	0.28	---	0.00	---	0.56	--
Sub Total (b)		0.00	---	0.00	---	0.28	---	0.28	---	0.00	---	0.56	--
Total Construction Cost (a)+(b)		0.00	0.51	8.00	0.69	9.26	0.31	6.48	0.00	5.94	0.00	29.68	1.51
(3) Consultant Fee (DD/SV=10% of Construction Cost)		0.20	---	1.13	---	0.79	---	0.48	---	0.32	---	2.91	--
(4) Contingency for Price Escalation and Physical Change (10% of Construction Cost)		0.00	---	0.80	---	0.90	---	0.62	---	0.59	---	2.91	--
(5) Administration Cost of Mozambique Government (1% of Construction Cost)		---	0.12	---	0.06	---	0.06	---	0.03	---	0.03	---	0.29
Sub Total (6) = (3) + (4) + (5)		0.20	0.12	1.93	0.06	1.69	0.06	1.10	0.03	0.91	0.03	5.82	0.29
Total (1) + (2) + (6)		0.20	0.63	9.92	0.74	10.94	0.37	7.58	0.03	6.85	0.03	35.50	1.80

C/C: Construction Cost H/C: House Compensation including relocation of utilities

Exchange Rate 1 US\$ = 22,000 Mts = ¥ 125.00 (July 2001), or 1 Mts = ¥ 0.00568

CHAPTER 22 : PROJECT EVALUATION

22.1 GENERAL

Project evaluation is comprehensively conducted with economic cost-benefit analysis, non-economic evaluation with other benefits, and financial analysis of the project implementation.

22.2 ECONOMIC ANALYSIS

The benefit is calculated from a saving of VOC (Vehicle Operating Cost) including passenger time cost, which is applied from a VOC model based on HDM currently used in Mozambique. Benefits are calculated on full projects as a whole program and each individual project.

Economic analysis is conducted with streams of discounted benefit and costs with which the project life is assumed at 20 years and discounted rate is set as 12%.

Economic analysis results of the whole projects are all favorable as $B/C=2.7$, $NPV=41.5$ million USD, and $IRR=27.9\%$.

For economic analysis of each project, virtually all of projects are feasible from economic point of view, since B/C none of the projects is less than 1 (or $IRR=12\%$). Especially, projects of trunk roads such as Av. Lusaka and Av. Julius Nyerere are highly effective compared with collector roads.

Sensitivity analysis has shown that the economic viability of the projects is robust.

22.3 NON-ECONOMIC EVALUATION

In order to evaluate effects of the projects in a more comprehensive manner, benefits which are not quantified in the economic term are examined. The non-economic benefits mentioned are transport benefit for low-income people, accessibility improvement, job creation effect, flood protection, and air pollution reduction.

Transport benefit for low-income people focuses on bus transport, since a bus is the main mode of transport for low-income population. The passenger time saving of the bus transport is calculated for each project and it indicates that not only trunk road projects but also area road projects have competitive importance for bus passenger time saving, therefore for low-income population.

Accessibility improvement effect is estimated by calculating the size of population inhabiting around the project roads. The results show that area road projects such as District 2 Road

project have more benefited population, therefore the area road projects are important in terms of a direct impact on people. The improvement of accessibility by the projects is addressed also by describing the expansion of the accessible area of hospitals, police stations and fire stations.

Job creation effect of project implementation is mentioned as positive impacts on people in Maputo, since the joblessness is the main factor of the poverty clinging to people's life. It is estimated that the project implementation will bring about 443 thousands jobs which include 254 thousands jobs for unskilled labour that would be much more related to low -income people.

Flood protection effect is expected by the project implementation since project roads facilitate the drainage systems. The drainage system prevents flood-related damages such as destruction of houses, obstruction of commercial business, etc. It is, however, difficult to quantify such effects. Besides, the flood obstructs the smooth traffic flow by reducing the traffic capacity of the roads. It is estimated that around 9 thousands USD worth of VOC would be saved by the drainage system in a rainy day.

Road development is expected to reduce the emission level from vehicle operation by optimize the vehicle speed. It is estimated that the implementation of the road projects will save emissions at 325 ton of carbon oxides, 19 ton of nitrogen oxides, and 174 ton of carbon dioxides in a year of 2010. Since the reduction of CO₂ is a global agenda for every country, the road development is meaningful not only as a domestic transport issue, but also for a global issue.

22.4 FINANCIAL ANALYSIS

In the M/P study, financial capability of the MCM has been estimated at around 1.8 million USD for road-related budget. For more realistic estimation, it is reconfirmed that the MCM is able to prepare around 0.5 million USD of annual budget exclusively for the project implementation.

Cost requirement of the project implementation is estimated in a stream by years, and the total cost is estimated to be 38 million USD. Since the cost is unlikely to be covered by the limited MCM's budget, the study expects international grants to support the main component of costs such as construction cost, engineering cost, etc, while the MCM will share some of responsibility in administration cost, routine maintenance cost, and value added tax payment.

Even though the main part of the costs are expected to be covered by the international grant, it is the MCM to pay around total of 4 million USD for costs required for the MCM. It is obvious that the limited project budget (0.5 million USD) of the MCM can not cover around 1 million USD of the annual cost requirement. The study addresses the fuel tax revenue, none of which is used for Maputo in spite of fuel tax paid by drivers in Maputo, to be an additional source of funding.

Risks for the project implementation are considered in terms of finance. A series of risk minimizing measures are recommended. First of all, a financial management unit is recommended to be established and an able personnel should be appointed as an exclusive manager for the unit in order to facilitate all means to conduct following measures, such as to scrutinize the available budget of the MCM for the project, to hold meetings with ANE for fuel tax refund, to establish connections with international donors, to establish connections with related departments of the national government, to consider other source of funding such as urban development tax, and to consider rescheduling of the implementation plan in case of a substantial lack of finance.

CHAPTER 23: MANAGEMENT SYSTEM AND OPERATIONS

23.1 GENERAL

In the field of the road maintenance and repair, the MCM should establish a new road maintenance policy introducing a privatisation in order to accelerate the effective and the efficient daily, routine and periodic maintenance of the road as well as maximization of the national resources.

The one of the components of this project includes the structural strengthening of the following fields in order to meet the required functions of the new DRB of the MCM for to introduce the privatisation to the road maintenance.

23.2 INTRODUCTION OF NEW ROAD DEPARTMENT

a) Existing Problem of the Implementation Agency

The road maintenance by the DRB has not done as well because of lack of staffs, availability of the maintenance equipments and the maintenance budget.

b) Proposed Organization of New Road Department

The new road department should be established as soon as possible to due to introduce a privatisation to accelerate the effective and the efficient daily, routine and periodic maintenance of the road as well as maximization of the national resources.

The proposed new road department is shown as follows.

b)-1 Introduction of Planning Section

- Stock of Road Inventory Data and utilization of Road Inventory Data
- Establishment and Review of Previous Road Development Plan
- Establishment and Review of Road Maintenance Programme
- Regulation with the Municipal Directorate of Construction and Urbanization

b)-2 Introduction of Design Section

- Preparation of Design Standard
- Evaluation of Road Design
- Regulation with the Agencies of the Public Utilities

b)-3 Introduction of Procurement Section

- Preparation of Standard Construction Unit Prices for each work items
- Preparation of Standard Specification and Contract Documents
- Preparation of Short List of Contractors and Consultants
- Procurement of construction services
- Inspection of the construction service
- Evaluation of the construction services

b)-4 Introduction of Management Section

- Budget Allocation
- Administration
- Regulation of the other municipal

b)-5 Introduction of Emergency Maintenance Section

- Maintenance Patrol
- Emergency maintenance
- Maintenance of equipments

c) Introduction of New Financial Support

The MCM should consider to introduce the sources of funding such as fuel tax refund, urban tax charge, parking charge, etc due to establish a sustainable road maintenance system.

23.3 STRUCTURE STRENGTHEN OF THE NEW ROAD DEPARTMENT

.The required structural strengthening of the fields for the new road department is shown as follows.

- Training of operation for upgrading data on road maintenance and planning
- Training of theory and practical operation on road maintenance
- Training of administrative and supervise staff for maintenance works
- Training of mechanics and operators and technical staffs

The measures for structure strengthen of the new road department are shown as follows.

1) Construction of the Training Room

There is enough space to construct the proposed training room that need the space about 200m² at the property of the existing DRB.

2) Dispatch of the Expert for the Road Maintenance

In consideration of the scarcity of adequate inland trainers, some experts would be invited to the DRB.

Required experts for the Road Maintenance

- Method of establishment of Road Development Programme
- Method of establishment of Road Maintenance Programme
- Method of Traffic Forecast
- Method of Financial Analysis

3) Installation of the Maintenance and Training Equipments

The road maintenance equipments and management equipments should be installed for an efficient road maintenance management.

4) On the Job Training for road maintenance

The capability of the evaluation for a rehabilitation done by the private enterprises should be strengthen to manage the road maintenance efficiency.

Training of the actual maintenance should be implemented by on the job training by the contractor.

5) Technical Support by ANE

ANE should give support to the new road department for strengthening of the road maintenance capability.

CHAPTER 24 : CONCLUSION AND RECOMMENDATIONS

24.1 CONCLUSION

The feasibility study proved that project roads of Package A, B and C are technically, economically and environmentally feasible having a high economic internal rate of return of 38.6 %, 20.5 % and 23.0 % with a average respectively.

Therefore the projects should be realized within the earliest possible time, in the following priority order taking into consideration the functions of the involved roads, especially early linking of the missing link of Av. J. Nyerere on trunk road is important and is necessary to increase the surround economic, to reduce the traffic congestion of other trunk road. However it is necessary to arrange house compensations, relocation of utilities and so on. Therefore the priority order of the project road should be considered through all factors.

Priority	Proposed Roads
1 st (Package C)	<ul style="list-style-type: none"> - Rehabilitation of pavement and drainage on Industrial and Commercial Area Roads (L = 6.03 km) - Rehabilitation of pavement and drainage on Port Area Roads (L = 3.9 km) - Rehabilitation of pavement and drainage on District 1 Area roads (total length = 8.7 km) - Improvement of Bus Bays and Bus terminal (23 numbers)
2 nd. (Package A)	<ul style="list-style-type: none"> - New construction of the Bypass missing link of Av. J. Nyerere (L = 5.6 km) - Improvement of Av. V. Lenine - Improvement of Av. A. Lusaka (L = 2.8 km) - Construction of the Bus terminal at the Combatentes Plaza - Rehabilitation of pavement and drainage on District 3 Area Roads (total length = 9.5 km)
3 rd. (Package B)	<ul style="list-style-type: none"> - Widening of Av. G. Popular (L = 0.7 km) - Improvement of Av. Angola (L = 3.1 km) and S. Cabral/Largo de Deta (L = 0.6 km) - Improvement and widening of Av. M. Ngouabi (L = 1.9 km) - Rehabilitation of pavement and drainage on District 2 Area Roads (total length = 8.7 km) - Improvement of Intersections in the CBD (14 intersections)

Table 24.1.1 shows the summary of the project feature for the above roads.

It is noted the following major benefits and effects are expected to accrue from the implementation of the Projects.

1) Improvement of Traffic Congestion on the Trunk Roads Network

Due to the high rate of the city's expansion as well as the recent remarkable increase of traffic demand accompanying the economic recovery in Maputo area, the traffic flow on the city roads has greatly increased and caused serious traffic congestion on the trunk roads which have insufficient traffic capacity due to having only 2 lanes for the unsuitable road structure and the deterioration of pavement surfaces.

The Widening of Av. Marien Ngouabi and Av. Guerra Popular from 2 to 4 lanes and the improvement of Av. Angola and Av. Acordos Lusaka will solve chronic traffic congestion on the roads in the city. Accordingly, it will improve not only economic and social activities but also the daily life of the people in the city.

2) Improved PRSP through Rehabilitation of Local Area Roads

Area roads in District 2 and District 3 are almost unpaved and narrow road. Therefore most of local area roads are impossible to pass smoothly due to lack of drainage system in rainy season. Such road environment is caused to delay the development and economic growth of community area.

In order to create a better environment and to enhance economical effect in the existing Community Area as well as create good access to public community facilities in the community area, local area roads should be rehabilitated for improving PRSP.

Table 24.1.1 Summary of Project Feature

		Project Road	Design Speed	Carriageway Width	Shoulder/ Parking Lane Width	Sidewalk Width	Utility Space	Median Strip	Total Width	Drainage Type	House compensation
			(km/h)	(m)	(m)	(m)	(m)	(m)	(m)		
Package A	trunk roads	Av. J. Nyerere	60	3.25	1.25	4.00	2.00	-	22(40)	V	required
		Av. V. Lenine	50	3.50	0.50	2.00	2.00	-	16	L	required
		Av. A. Lusaka	60	3.00	2.00	4.00	1.00	2.00	28	L/V	None
	District 3 area roads	Rua da Goa	40	3.00	-	1.50	0.50	-	10	LU	required
		Rua da Lixera	40	3.00	-	1.50	0.50	-	10	LU	required
		Av. Milagre Mbote	40	3.0(5.0)	-	1.50	0.50	-	8~10	LU	required
		Av. da Malhangalene	40	3.0(5.0)	-	1.50	0.50	-	8~12	LU/V/U	required
		Rua 1 de Maio	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua 3306	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua 3523	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua 3576	40	3.00	-	2.00	1.00	-	14	V/U	required
Package B	Collector roads	Av. G. Popular	50	3.00	0.50	3.50	-	-	20	L	required
		Av. Angola	50	3.50	2.50	4.00	-	-	20	L	None
		Rua S. Cabral/Largo de Deta	50	3.50	2.50	4.00	-	-	20	L	None
		Av. Marien Ngouabi(4 lane)	50	3.00	0.50	3.50	-	-	20	L	required
			50	3.50	2.50	4.00	-	-	20	L	None
	District 2 area roads	Rua 2282/2265	40	3.0(5.0)	-	2.00	0.5~1.0	-	8~14	LU/V/U	required
		Rua 2275	40	3.00	-	2.00	1.00	-	14	V/U	required
		Rua de Xipamanine	40	3.00	-	1.50	0.5~1.0	-	10~14	LU/V/U	required
		Rua dos Imaos Roby	40	3.00	1.50	1.50	-	-	12	V/U	required
		Rua 2315/2313	40	3.00	-	1.5~2.0	0.5~1.0	-	10~14	LU/V/U	required
		Rua 2309/2324	40	3.00	-	2.00	1.00	-	14	V/U	required
		Av. das Estancias	40	3.00	-	1.50	0.50	-	12	V/U	required
Package C	I/C area roads	Av. J. Michel	40	3.00	1.00	4.00	-	-	16	L	None
		Av. F. de Magalhaes	40	3.00	3.00	4.00	-	-	20	L	None
		Av. Z. Magalhães	40	3.00	3.00	4.00	-	-	20	L	None
		Av. M. Siad Barre	40	3.00	2.00	3.00	-	-	16	L	None
		Av. Romão Fernandes	40	3.00	1.00	4.00	-	-	16	L	None
		Rue 1229	40	3.00	3.00	3.00	-	-	16	L	None
		Av. As Estancias	40	3.00	1.00	3.00	-	-	12	L	None
	Port area roads	Rue Consiglieri Pedroso	30	3.00	1.00	2.50	-	-	13	L	None
		Rue Joaquim Lapa	30	3.00	1.00	3.00	-	-	14	L	None
		Rue do Bagamayo	30	3.00	0.00	3.00	-	-	12	L	None
		Rue de Timor Leste	30	3.00	1.50	2.00	-	-	13	L	None
		Av. Martires de Inhamitanga	30	3.00	4.00	2.50	-	-	19	L	None
		Other 6 roads	30	3.00	0.00	2.00	-	-	10	L	None
	District 1 area roads	Av. Milagre Mabote	40	3.00	1.50	3.50	-	-	16	L	None
		Av. da Malhangalene	40	3.00	1.00	2.00	-	-	12	L	None
		Av. Para O Pamar	40	3.00	1.00	2.00	-	-	12	L	None
		Av. Kaweme Nkrumah	40	3.00	1.00	2.00	-	-	12	L	None
		Av. Paulo Samuei Kankhomba	40	3.00	1.00	6.00	-	-	20	L	None
		Av. Emilia Dausse	40	3.00	1.00	6.00	-	-	20	L	None
		Av. de Maguigana	40	3.00	1.00	6.00	-	-	20	L	None
		Av. Filipe Samuel Magaia	40	3.00	3.00	4.00	-	-	20	L	None
		Av. Friedrich Engels	40	3.00	1.00	2.00	-	-	12	L	None

V: Open ditch type, L: L-shaped type, LU: L-shaped lid and U-shaped type, U: U-shaped type

3) Improvement of Intersections in the CBD

In order to increase the traffic capacity on intersection in CBD, some intersections of the trunk roads should be improved to keep the smooth traffic flow. The following measures should be established to the major intersections.

<Establishment of Right-turn Lane>

The right-turn lane should be constructed to the major intersections on Av. Mao Tue Tung, Av. Eduardo Mondlane, Av. 24 de Julho and Av. 25 de Setembro for Av. J. Nyerere, R. dos Lusíadas, Av. Vladimir Lenine, Av. Karl Marx, Av. Guerra Popular and Av. da Zambia.

<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-signalized intersections where the bus routes cross with the trunk roads.

4) Improvement of Public Transport Services

Based on the future traffic estimation, future demand of bus traffic would grow rapidly. In order to enhance the future bus traffic efficiency, the development concepts are as follows.

<Completion of public transport services>

In order to open the public transport services to un-served area, branch bus routes on collector roads and local area, which should be improved.

<Smoothly bus operation>

In order to operate smoothly buses, it needs to adopt bus lanes on the dual carriageway road such as Av. Eduardo Mondlane.

<Completion of bus information>

In order to use easily buses for passengers, bus information system should be improved and information board should be installed at bus stops.

5) Improvement of Bus Bays and Bus Terminals

Bus stopping on carriageway causes traffic congestion problem at Bus Stops due to shortage of proper bus bay space of the main carriageway. Therefore, construction of properly sized

Bus Stop with bus bays and shelters should be needed.

Existing problem at bus terminals are caused by lack of proper spaces for buses, taxis and trucks, and market activities. Therefore, existing bus terminals should be equipped with proper stopping and moving spaces for buses, taxis, trucks and market spaces.

6) Improvement of Roadsides Environment

The population and the traffic volume are steadily increasing every year in Maputo city. Therefore, in order to reduce the aggravation of environment caused by traffic congestion, the implementation of the high priority project will bring many beneficial effects on socio-economic, natural environment and social environment as described below.

- Establishment a rule of Resettlement

The new construction of the missing link of Av. J. Nyerere and the widening of Av. M. Ngouabi and Av. G. popular will certainly require the resettlement of houses.

It is concluded that the mitigation measures should include appropriate house compensation for resettlement, securing places for persons to move to, and to settle various problems associated with the resettlement.

- Prevention of Air pollution

Unless the existing road conditions and road network are improved, the air pollution will become much worse due to an increase of the traffic condition.

It is concluded that the air pollution can be reduce to the level of a national standard, since the unpaved roads and the traffic congestion will improve and reduce respectively.

- Prevention of Noise and Vibration

Unless the existing road surface conditions are improved, the noise and vibration to the houses along the roads will become much worse due to the traffic volume increase.

It is concluded that the noise and the vibration will be reduce to the level of a national standard, since the deteriorated road surfaces will improve.

- Prevention of Flood Hazard

Overflow of water on the roads including flooded water has been observed in many places due to damaged roads and insufficient drainage condition.

It is concluded that the drainage system will be eliminated by improvement of the project implementation

24.2 RECOMMENDATIONS

In order to materialize the projects, the Study team recommends that MCM takes the following actions.

1) Financial Measure Required

According to the cash flow analysis for the projects in Chapter 22, the financial situation of the MCM is not wealthy enough. In order to conduct surely the projects, the MCM should consider the following financial resources:

- To ensure the MCM own budgets and the return of the fuel tax during projects activities,
- To ensure the foreign budget for the periodic and routine maintenance, and
- To establish the Road Fund account in the MCM.

2) Allocation of Local Budget for House Compensation

It is recommended to allocate the necessary amount of local funds for house compensation and utilities relocation which might be necessary for implementation of the Projects. House compensation and utilities relocation should be conducted according to the project implementation schedule as follows:

Year	Schedule of H/C and U/L
1 st. year (2002)	House compensation on missing link of Av. J Nyerere and District 3 local area roads and Utilities relocation of on Av. J. Nyerere and Bus Stops and Terminals
2 nd. year (2003)	House compensation on missing link of Av. J. Nyerere, Av. M. Ngouabi, Av. G. Populae, District 2 and 3 local area roads and Utilities relocation of Av. J. Nyerere, District 2 and 3 local area roads
3 rd. year (2004)	House compensation on Av. M. Ngouabi, Av. G. Popular and District 2 local area roads and Utilities relocation of District 2 local area roads

Furthermore, it is recommended that the land required for the road development should be controlled by the MCM until the actual development takes place.

3) Forming a Suitable Resettlement Plan

Resettlement of the residents and workers along the project roads will be required before the implementation of the projects is started. In order to prevent social, economic and environmental impacts of the resettlement on the residents in advance, it is recommended that a suitable resettlement plan should be established paying due attention to the following items:

- Funding the resettlement compensation,
- Securing places to move the persons to be resettled,
- Ensuring the living standards in the places to move into, and
- Holding discussions with the residents to be resettled to reach a mutual consent.

4) Improvement of Storm Drainage System

The flooding damage of existing Av. J.Nyerere was almost caused by the defectiveness of drainage system in February 2000. Because the type of drainage was the pipe culvert and the lack of maintenance against accumulated sand and solid waste. From such viewpoints, the following measure should be conducted.

(1) Recommendable Road Drainage System

Road drainage systems of project roads should be considered the following methods.

- U-shaped drain with cover, which can remove for cleaning inside the drainage and can load directly vehicles, should be used in urbanized area and local area road in narrow ROW. Its width is narrow and easy to cover with concrete lid shaped flat type or L type. Pre-cast concrete type will be more preferable for repair.
- V-shaped open drain is made from concrete or stone pitching. The former should be used to trunk roads in sub-urban area. And the latter should be used to trunk roads and local area roads.
- K or L-shaped drain is made from concrete blocks or stabilized soil. The former should be used local area roads for temporary construction. The latter should be used to local area roads in narrow ROW.

(2) Routine Maintenance of Roadside Drainage by MCM and Resident People

Routine / periodic maintenance of drainage facilities, consisting cleaning, repair and reconstruction of drainage facilities, should be conducted by the new road department

of MCM.

In addition, easy maintenance such as cleaning, dredging, prevention of garbage dumping etc., should be done by the resident people. Therefore, enlightenment of such action should be initiated by district offices in cooperation with the new road department of MCM.

(3) Improvement of Area Drainage System by MCM

Project for improvement / restoration of local area drainage system should be conducted by relevant department of MCM. Such improvement project should be proceeded in parallel with the progress of the road development projects.

5) Establishment of DRB Maintenance System

In order to function effectively the DRB by the implementation of the high priority project, the Study Team recommends to the MCM to establish the following new road department.

- Planning Section
- Design Section
- Procurement Section
- Management Section
- Emergency Maintenance Section