No.

JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)

MUNICIPAL COUNCIL OF MAPUTO
THE CITY OF MAPUTO
THE REPUBLIC OF MOZAMBIQUE

THE STUDY ON THE MASTER PLAN AND FEASIBILITY STUDY FOR THE ROAD DEVELOPMENT OF THE CITY OF MAPUTO IN THE REPUBLIC OF MOZAMBIQUE

FINAL REPORT

MAIN TEXT I

October 2001

Oriental Consultants Company Limited

Japan Engineering Consultants Company Limited

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PREFACE

In response to a request from the Government of the Republic of Mozambique, the Government of Japan decided to conduct The Study on The Master Plan and Feasibility Study for The Road Development of The City of Maputo in The Republic of Mozambique and entrusted the study to the Japan International Cooperation Agency (JICA).

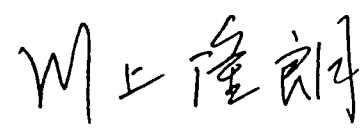
JICA selected and dispatched a study team headed by Mr. Kazuro Yanagida of Oriental Consultants Company Limited and consisted of Oriental Consultants Company Limited and Japan Engineering Consultants Company Limited to the Republic of Mozambique, three times between November 2000 and October 2001. In addition, JICA set up an advisory committee headed by Mr. Yasuhiro Sako, Director of Information System Division, Planning Department, Kinki Regional Development Bureau, Ministry of Land, Infrastructure and Transport between November 2000 and October 2001, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of the Republic of Mozambique, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Mozambique for their close cooperation extended to the teams.

October, 2001



Takao Kawakami
President
Japan International Cooperation Agency

Letter of Transmittal

October, 2001

Mr. Takao Kawakami
President
Japan International Cooperation Agency
Tokyo, Japan

We are pleased to submit to you the final report on The Study on The Master Plan and Feasibility Study for The Road Development of The City of Maputo in The Republic of Mozambique.

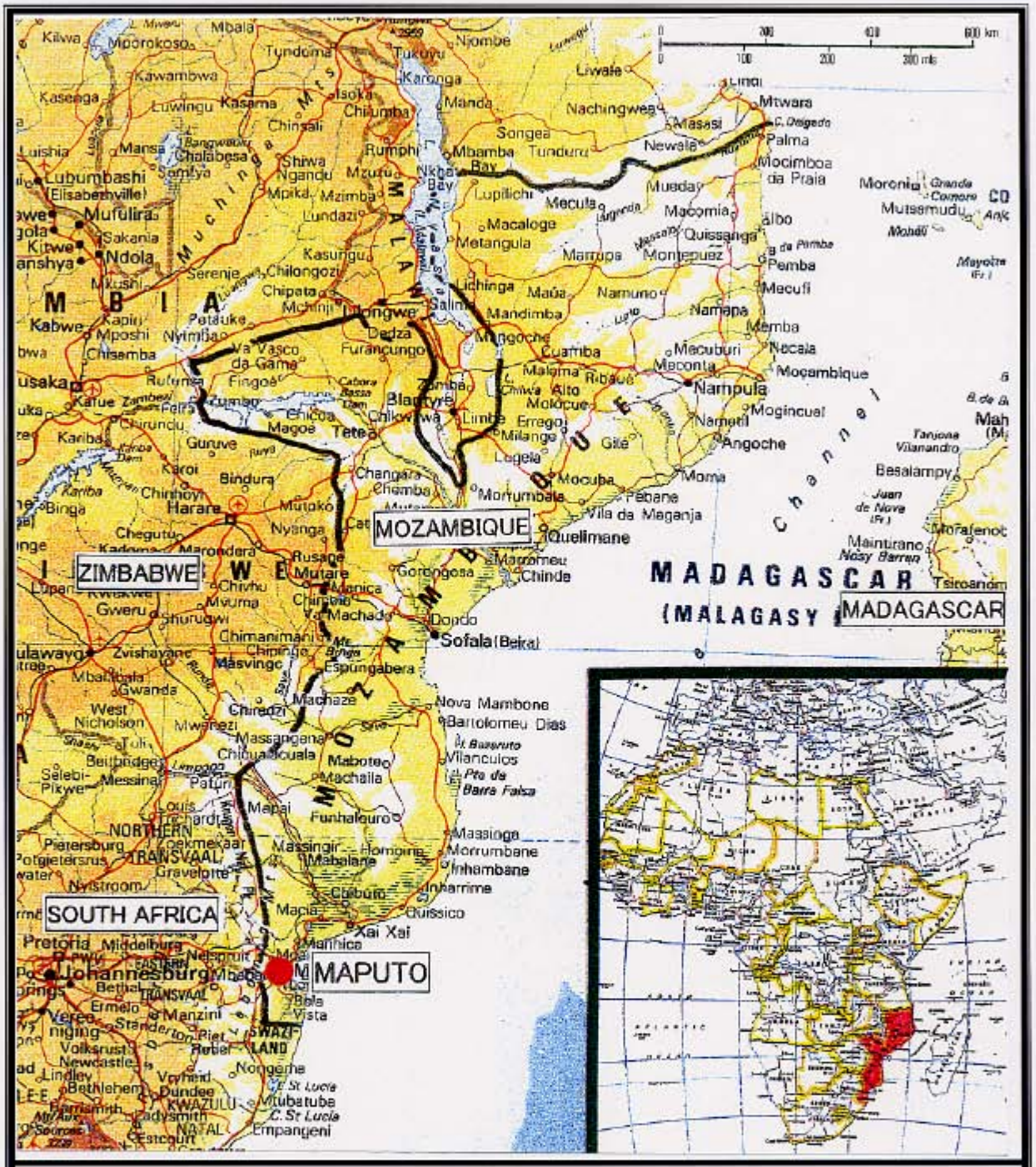
This study was conducted by Oriental Consultants Company Limited, under a contract to JICA, during the period from November 2000 to October 2001. In conducting the study, we have examined the feasibility and rationale of the study with due consideration to the present situation of Mozambique and formulated the most appropriate project.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, Ministry of Land, Infrastructure and Transport, Japan Highway Public Corporation. The Municipal Council of The City of Maputo, the JICA South Africa office and the Embassy of Japan in Mozambique for their cooperation and assistance throughout field survey.

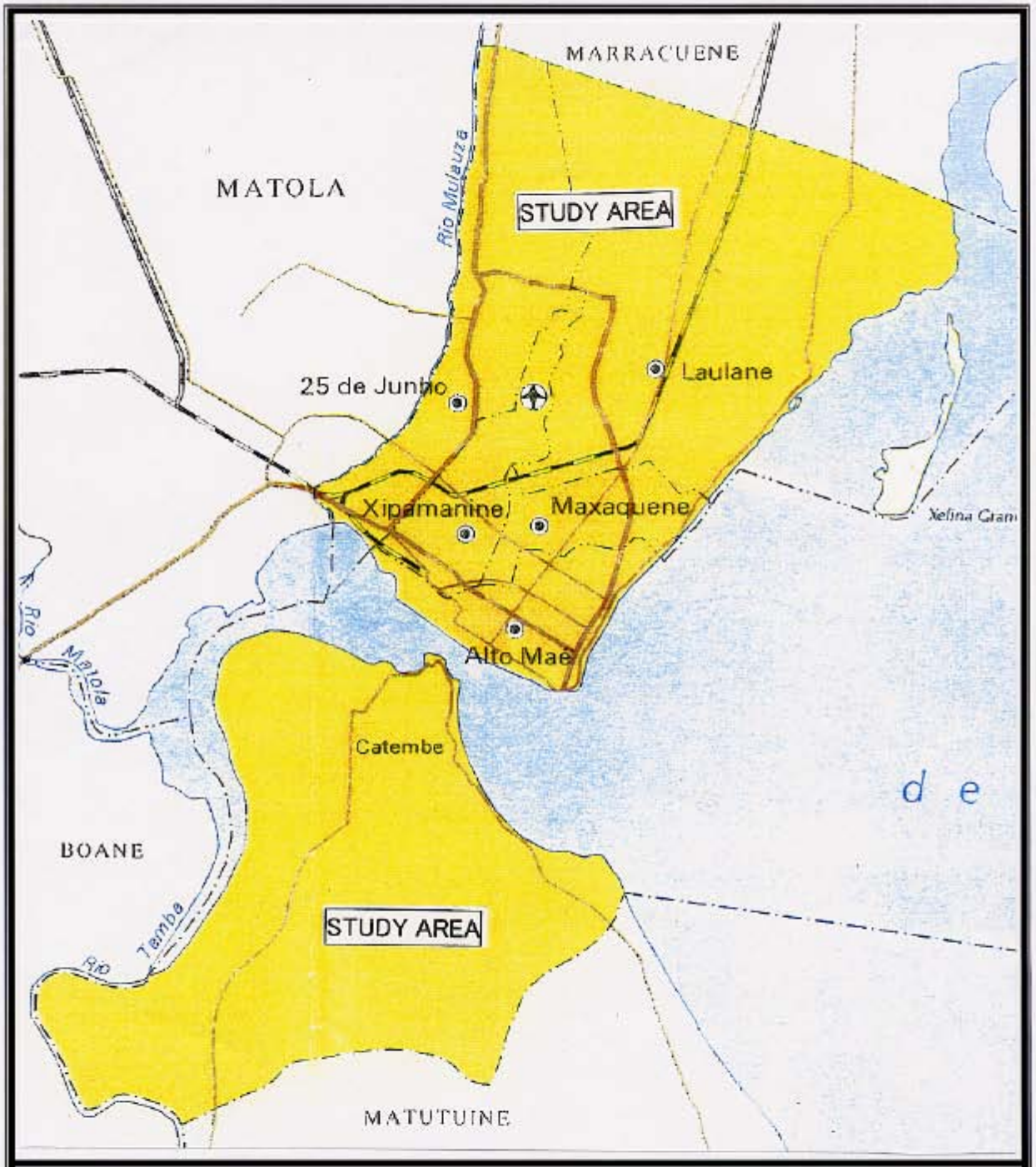
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

Kazuro Yanagida
Project manager,
Study Team for The Study on The
Master Plan and Feasibility Study
for The Road Development of The City
of Maputo
Oriental Consultants Company Limited



LOCATION MAP



LOCATION MAP

Alternative Route of the Missing Link of Av. Julius Nyerere

Establishment of Bus Bays on Trunk Roads（Av. Vladimir Lenine）

SUMMARY OF THE STUDY

SUMMARY OF THE STUDY

1. BACKGROUND OF THE STUDY

Maputo City, the capital of Mozambique, has no established road development plan, and road expansion is lagging behind the recent growth of road traffic demand. In addition, existing road facilities are suffering progressive damage to the road structure, due to inadequacy and delay in maintenance, causing deterioration of the road service level.

The Mozambique Government requested assistance of the Japanese Government to implement the Study on the Master Plan and Feasibility Study for Road Development in the City of Maputo in the Republic of Mozambique (hereinafter referred to as the Study).

2. OBJECTIVES OF THE STUDY

The objectives of the Study are listed below:

1) Development of a Master Plan on the Maputo City Road Network (target year 2020),
2) Implementation of a feasibility study related to high priority projects, and
3) Proposition of a road structure appropriate to local conditions, proposals related to maintenance, and implementation of technology transfer through the project.

3. AREA COVERD BY THE STUDY

The Study area covers an entire City of Maputo excluding Inhaca Island. The Catembe area on the other side of Maputo Bay is included in the Study area.

4. PRESENT SITUATION ON THE EXISTING ROAD NETWORK

The rehabilitation and repair of major streets were conducted by the World Bank Programme, in length of 160km in Maputo city from April to September 1999. The major works were the pothole patching, resealing for paved roads, re-gravelling for gravel roads and cleaning of existing drainage. In spite of passing only one year after completion of this rehabilitation project, there are some potholes at intersections or flood prone areas, it is caused of traffic congestion. Main reasons are lack of appropriate drainage maintenance and poor performance of pavement rehabilitation. Furthermore major trunk roads such as Av. Julius Nyerere, Av. ONU etc., were seriously damaged by heavy rainfall in February 2000. Part of these roads are still disconnected and causing the traffic congestion in the city.

Furthermore the urbanization of the Maputo city is expected highly to continue, population and workforce population will be double in the year 2020.

5. ROAD ADMINISTRATION OF THE MAPUTO CITY

Since 1999, the MCM takes a full responsibility of construction and management for urban roads in Maputo. Road maintenance, management and operation are conducted by the relevant departments and it is causing confusion of jurisdiction of the maintenance for different to each part of road and drainage facilities. Furthermore there are problems as shown below, these are causing the delay of repair of pavement and drainage facilities.

- No maintenance plan for long period
- Jurisdiction of the road maintenance is different for each part of road and drainage facilities
- Poor performance for road management
- Shortage of budget for road management

6. FORMURATION OF THE ROAD DEVELOPMENT MASTER PLAN

6.1 BASIC POLICY

1) Road Development Plan

Basic policy for establishment of the road development plan was made based on the area development plan and future traffic assignment.

(1) Road Classification for Satisfaction of BHN and Improvement of PRSP and Local Area Environment

The road network system should be developed in a hierarchic manner based on the road classification proposed by the Study Team together with its functions. Proposed road classifications are ;

- Primary trunk roads and trunk roads : Trunk roads
- Collector roads and local area roads : Community roads

(2) Road Development to Solve Existing Road Problems

The existing road problems of the Maputo city identified are ;

- Deterioration of road pavement in urbanized area
- Heavy deterioration of community roads in sub-urbanized area
- Traffic congestion

- Poor drainage system
- Poor road maintenance

(3) Road Development to Enhance Future Traffic Efficiency

Expected heavy traffic congestions on major corridors should be solved by the following measures ;

- Av. da Mozambique : Widening to dual carriageway, or construction of new bypass
- Av. Julius Nyerere : Widening to dual carriageway on northern section, and reconstruction or new construction of bypass for missing link
- Av. Acordos de Lusaka : Increasing of traffic capacity by widening dual carriageway on entire section and improvement of intersections by grade separation or signalled junction
- Av. Vladimir Lenine : Increasing of traffic capacity by construction of proper bus stops and improvement of intersections
- Av. F.P.L.M : Extension and widening or strengthening of surrounding road network

(4) Road Development to Promote Metropolitan Development

In order to promote the concept of the Structure Plan of the Metropolitan Maputo, trunk road network should link with future road network efficiently.

2) Public Transportation Plan

Based on the future traffic estimation, future demand of bus traffic is expected to grow rapidly. In order to enhance the bus traffic efficiently, following concept for public transport development were proposed.

(1) Solve The Lack of Public Transport Services

- Open public transport operation by road rehabilitation of existing bus route and un-serviced collector roads

(2) Solve The shortage / Congestion of Bus Stops

- Construction of proper bus stops on trunk roads

(3) Solve The Slow Bus Operation

- Construction of proper bus terminals with enough space for markets near intersections of trunk roads

(4) Solve The Lack of Bus Informations

- Installation of information facilities at each bus stops and terminals

3) Urban Traffic Management Plan in the Central Business District (CBD) of the Maputo City

After implementation of the road development plan, future traffic congestion in the year 2020 will be solved drastically, however congestion in the city centre will be remained due to insufficient traffic management. Therefore the following traffic management measures should be introduced in the CBD of the Maputo city.

(1) Public Transportation Planning

- Removal of bus stops close to intersections, improvement of bus stops, establishment of bus stops on collector roads, introduction of bus lane

(2) Urban Traffic Management Measures

- Improvement of intersections (establishment of right-turn lane, improvement of traffic signals)

4) Road Maintenance Plan

The road and drainage condition in Maputo city is poor due to lack of the road maintenance, therefore the following sustainable road maintenance policy should be established.

(1) Efficiency of the Road Maintenance and Introduction of Privatisation

The road maintenance consists of three categories ; routine maintenance, periodic maintenance and emergency maintenance. Programme for routine and periodic maintenance should be established for to operate the proper road maintenance effectively. Furthermore the quality of road maintenance should be increased by the competition of each private enterprise for the introduction of privatisation.

(2) Introduction of New Road Department

It is necessary to restructure the existing organization and establish the new road department for systematic road maintenance, consisting the following five sections ; management section, road development planning / design section, road maintenance planning / design section, procurement section, emergency maintenance section.

6.2 ROAD DEVELOPMENT ALTERNATIVES

Based on the development concepts with the necessary measures to be improved for road development and public transport development, the following six alternatives for road development for long-term target (year 2020) were proposed.

Alternatives	Components
Do-Minimum (base case)	Existing road network and on-going road development projects will be consisted.
Plan 1	The basic plan, which the MCM is expecting and all the necessary measures have been incorporated.
Plan 2	Based on the preliminary evaluation of the conception plan, construction of alternative bypass for the missing link of Av. J. Nyerere and widening of Av. M. Ngouabi have been incorporated.
Plan 3	Adding grade separation and intersection improvements into the Plan 2 in order to strengthen traffic capacity of road network.
Plan 4	Adding construction of bypass of Av. Mozambique instead of widening of existing road into the Plan 4, 5, 6, to bear the future traffic demand on Av. Mozambique.
Plan 5	
Plan 6	

6.3 FUTURE TRAFFIC DEMAND FORECAST

In case of the Do-minimum case, the bottleneck links having more than 1.5 volume to capacity ratio could be identified as almost all links on the trunk roads by the year 2020. In case of Plans 1 and 3, the bottleneck links become minimum on the trunk road network. Expect in the city centre, bottlenecks especially at the intersections should be settled out through the improvement of intersections and traffic management plan. Therefore Plans 1 and 3 would be well matched to the long-term traffic demand and are recommendable. In case of Plan2, bottlenecks could be identified on the trunk road network and in the city centre. This network is not so well matched to the long-term traffic demand and accordingly Plan 2 alternative is not recommendable from the viewpoint of traffic efficiency. In case of Plan 4, Bottlenecks would become minimum on the trunk road network and this plan also could become one of the recommendable road network for further consideration. Bottleneck on the trunk road network could be identified in Plan 5 and 6 in the year 2020 and this shows both road networks are not recommendable from the viewpoint of traffic efficiency.

From these evaluations, the road networks which could meet the future traffic demand efficiently would be the Plan 1, 3 and 4 from the viewpoint of traffic functions required for long-term road development.

6.4 ECONOMIC / FINANCIAL ANALYSIS

The cost is needed to be discounted into economic cost, which deduct the fringe value of

market price, such as import tax, subsidy and wage regulation. Using the following equation, the Plan 3 is the most recommended plan in terms of economic efficiency.

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

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

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

As seen in the following result of the financial analysis, about one third of the total cost can be covered by the road budget of the MCM. Meanwhile, fuel tax revenue and foreign aid are expected to cover of 25% and 44% of the total cost respectively.

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

7. IMPLEMENTATION PLAN

Implementation programme was planned in short-term, middle-term and long-term, furthermore its packages of the project were made by each drainage system / storm water basin.

Implementation programme of each project for the short, the middle and the long-term plans

are prepared based on the objectives of each term. Project road of the short-term plan is consisted with 57 km and its project cost is estimated as 37 million USD by the year 2005. Project road of the middle-term plan is consisted with 69 km and its project cost is estimated as 47 million USD by the year 2010. The short / middle-term plan should be implemented in approximately 9 years.

Road project of the long-term plan is consisted with 32 km and its project cost is estimated 34 million USD by the year 2020. The long-term plan should also be implemented in approximately 5 years.

Furthermore, the maintenance cost such as routine maintenance and periodic maintenance cost will be added until the target year in 2020 after completion of the project.

8. IDENTIFICATION OF THE FEASIBILITY STUDY PROJECTS

Based on the evaluation of the middle-term projects, the identification of the high priority project for the Feasibility Study has been conducted in order to meet a most important, necessary and consistent road development plan as shown below.

	Length	1 Importance		2 Necessity		3 Impact		4 BHN Access		5 Govern-mental Policy	6 Total	7 Priority Project for FS
		Road Class	Present Traffic	IRI	Congestion	Land Use	No. of Settlement	Public Facility	Emergency Vehicle			
	km											
A. Primary Trunk Road												
A.1 Widening of Av. de Mozambique + Rehabilitation of Northern Section	15.05	A	A	C	B	A(Com. Res)	19 A	A	A	A	A'	
B. Trunk Road												
B.1 Construction of Missing Link on Av. Julius Nyerere	4.80	A	A	A	A	A(Com. Res)	162/2=81 B	A	A	A	A	◎
B.2 Improvement of Av. Vladimir Lenine	3.20	A	A	A	A	A(Com.)	0 A	A	A	A	A	◎
B3. Improvement of Av. Acordos de Lusaka	2.85	A	A	A	B	A(Com. Res)	0 A	A	A	A	A	◎
B4. Improvement of Av. Angola	3.09	A	A	B or C	A	A(Com. Res)	0 A	A	A	A	A	◎
B5. Improvement of Av. Marien Ngouabi	1.88	A	A	A	A	A(Com./Res)	31 A	A	A	A	A	◎
C. Collector Road												
C1. Improvement of Industrial and Commercial Area Roads												
- Av. ONU												
- Av. Eduardo												
- Av. Josina Machel												
- Av. Fernao de Magalhaes												
- Av. Zedequias Manganhela	17.04	A	A	A	A or B	A	0 A	A	A	A	A	◎
C2. Improvement of Port Area Roads												
- R. Consiglieri Pedroso - Praca 25 de Junho - R. Marques de Pombal												
- R. do Bagamoyo - R. Joaquim Lapa												
- Av. Martires de Inhaminga - R. de Timor Leste												
C3. Improvement of Residential Area Roads												
Dist. 1	1.60	A	A	A	A or B	A(Com. Res)	10 A	A	A	A	A	◎
Dist. 2	10.23	A	A or B	A	B	A(Com./Res)	140 B	A	A	A	A	◎
Dist. 3	8.48	A	A or B	A	B	A(Com./Res)	126 B	A	A	A	A	◎
Dist. 4	28.41	A	B	A	B	B(Res.)	3 A	A	B	A	A'	
Dist. 5	25.58	A	B	A	B	B(Res.)	49 A	A	B	A	A'	
	122.17											
	A:Tru Colle.		A>5,000	A:IRI > 8	A>1.0		A<50					
	B:Urb.Ar.Rd.		B>2,000	B:IRI > 6	B>0.5		B<200					
	C:Rural		C<2,000	C:IRI < 4	C<0.5		C>200					

9. OBJECTIVES AND COMPONENTS OF THE PROJECTS

Feasibility Study Project has been selected as the High Priority Projects among the middle -term project of the road development plans proposed in the Master Plan. The objectives and components of the Project consists three categories; namely, road development plan, traffic management plan and public transport plan as outlined below.

1) Objectives of the Projects

The objective of the projects is shown in next table.

2) Project Component

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.

- Road Development Plan
  1) Construction of Missing Link on Av. Julius Nyerere (total length = about 4.8 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.

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 Commertial 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 Ploblems 3. Enhance Future Traffic Efficiency 4. Promote the Metropolitan Development											
2. General Strategy for year 2020	1. Functional Classification of Road Network and Typical Closs-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 Extention	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 Land-slide and Drainage 3.Land Preparaion for Widening	1. Construction of Bus Bay 2. Improvement of Intersection	1. Pavement and Drainage Rehabilitation 2. Construction of Dual Carriageway	1. -do- 2. Intersection Improvement	1. -do- 2. -do- 3. Construction of Dual Carriageway	1. -do-	1. -do-	1. -do-	1. -do-	1. -do-	1. Installation of Right-turn lane and Signal 2. Control of On-street Parking 3. Traffic Control	1. Provide suitable location and size of bus bays/stations 2. Equip required Functions
Carriageway	Asphalt-concrete(As-con)	Concrete block (Block)	As-con	As-con	As-con	As-con	As-con	As-con	As-con	As-con	As-con	Block
Footpath	Bitumenous Surface Treatment(BST)	Block	Block	Block	Block	Block	Block	Block	Block	Block	Block	Block
Drainage	Open ditch	nil	U-shaped	U-shaped	U-shaped	U-shaped	U-shaped	U-shaped	Open ditch	Open ditch	U-shaped	U-shaped
5. Alternatives	1. Route Alternatives 2. Stage construction	nil	1. Widening of Right of Way	nil	nil	nil	nil	nil	nil	nil	nil	nil
Carriageway	Stabilized base/sub-base course (Stabilization)	Semi-rigid	Stabilization	Stabilization	Stabilization and BST	Stabilization and BST	Stabilization and BST	Stabilization and BST	Stabilization and BST	Stabilization and BST	Semi-rigid	Semi-rigid
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

10. Preliminary Engineering Design

10.1 DESIGN STANDARD

The recommendable Road Classification of the Feasibility Study Project has been evaluated based on ANE's and SATCC design standards.

10.2 HIGHWAY DESIGN

The two alternative routes of the missing link of Av. Julius Nyerere were selected through the evaluation of distance, connection with the collector roads, possibility of the usage of existing right-of-way. Furthermore the best alternative route was selected through the comparison of the two routes, "Master Plan route" was selected as the Feasibility Study Project road due to cheaper initial cost and better IRR.

10.3 PRELIMINARY COST ESTIMATION

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

11. IMPLEMENTATION PROGRAMME

The Directorate of Roads and Bridges, the Municipal Council of Maputo is recognized as 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.

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. Also the overall implementation schedule for each project was set up, and the priority order of the project road was set up through the consideration of the following factors, construction schedule, land acquisition, compensation for house and buildings, relocation of utilities, design and execution of preparatory works.

Priority	Proposed Roads
1 st (Package C)	- 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)	- 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)	- 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)

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	----			■	■		

12. PROJECT EVALUATION

12.1 Economic Analysis

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%. The results of the analysis for 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.

12.2 Financial Analysis

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.

13. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

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.

14. CONCLUSION AND RECOMMENDATIONS

14.1 CONCLUSION OF THE FEASITIBITY STUDY PROJECT

1) Effect of the Project

- Improvement of Traffic Congestion on the Trunk Roads Network

Time saving by execution of the Feasibility Study Project are estimated as follows.

- Improvement of Av. V. Lenine : 574 pcu-h/day
- Improvement of Av. A. Lusaka : 767 pcu-h/day
- Improvement of Av. da Angola : 109 pcu-h/day
- Improvement of Av. M. Ngouabi : 277 pcu-h/day

- Increase of Traffic Capacity In CBD by Improvement of Intersections
- Improvement of The Public Transport Services

The passenger time saving of the bus transport by improvement of the local area roads will give the benefit for low-income people because the bus is the main mode of transport for low-income population.

- Improvement of Traffic Functions by Establishment of Bus Bays and Bus Terminals
- Contribute PRSP through Rehabilitation of Local Area Roads in District 2 and 3

Area drainage network will be constructed through the project, it will prevent the storm water disaster and improve the community environment through the secure of good traffic conditions and creation of good access to public community facilities.

- Improvement of Roadside Environment

Road development is expected to reduce the emission level from vehicle operation by optimise travel speed, at 325 ton of carbon oxides, 19 ton of nitrogen oxides, and 174 ton of carbon dioxides in a year 2010.

2) Economic Evaluation

The results of the analysis for 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 ration of each project is more than 1 (or IRR=12%).

3) Environmental Impact Assessment (EIA)

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.

14.2 RECOMMENDATIONS FOR IMPREMENTATION OF THE PROJECT

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

1) Financial Measure Required

According to the financial analysis for the projects, it is reconfirmed that the MCM is able to prepare around 0.5 million USD of annual budget exclusively for the project implementation. However the financial situation of the MCM is not wealthy enough, it is impossible to bare whole project cost of 38 million USD by MCM. Therefore the study team suggested to MCM to share some of responsibility in administration cost, routine maintenance cost, and value added tax payment while the main component of costs such as construction cost, engineering cost, etc. will be supported by the international grants.

In addition, the study team suggested to MCM to 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.
- Allocation of local budget for house compensation

2) Proper Planning for Re-settlement of Residents

- Budget allocation for house compensation
- Alternative location for displaced people
- Fulfil requirements of life for the re-settled people
- Consensus with re-settled people through discussions

3) Improvement of Storm Drainage System

(1) Recommendable Road Drainage System

- U-shaped drain with cover : urbanized area and local area road in narrow ROW
  (Pre-cast concrete type will be more preferable for repair)
- V-shaped open drain : trunk roads in sub-urban area, local area roads
  (concrete or stone pitching)
- K or L-shaped drain : local area roads in narrow ROW.
  (concrete blocks)

(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.

- Cleaning, dredging, prevention of garbage dumping etc., should be done by the resident people.

  (Enlightenment of such action should be initiated by district offices in cooperation with the new road department of MCM)

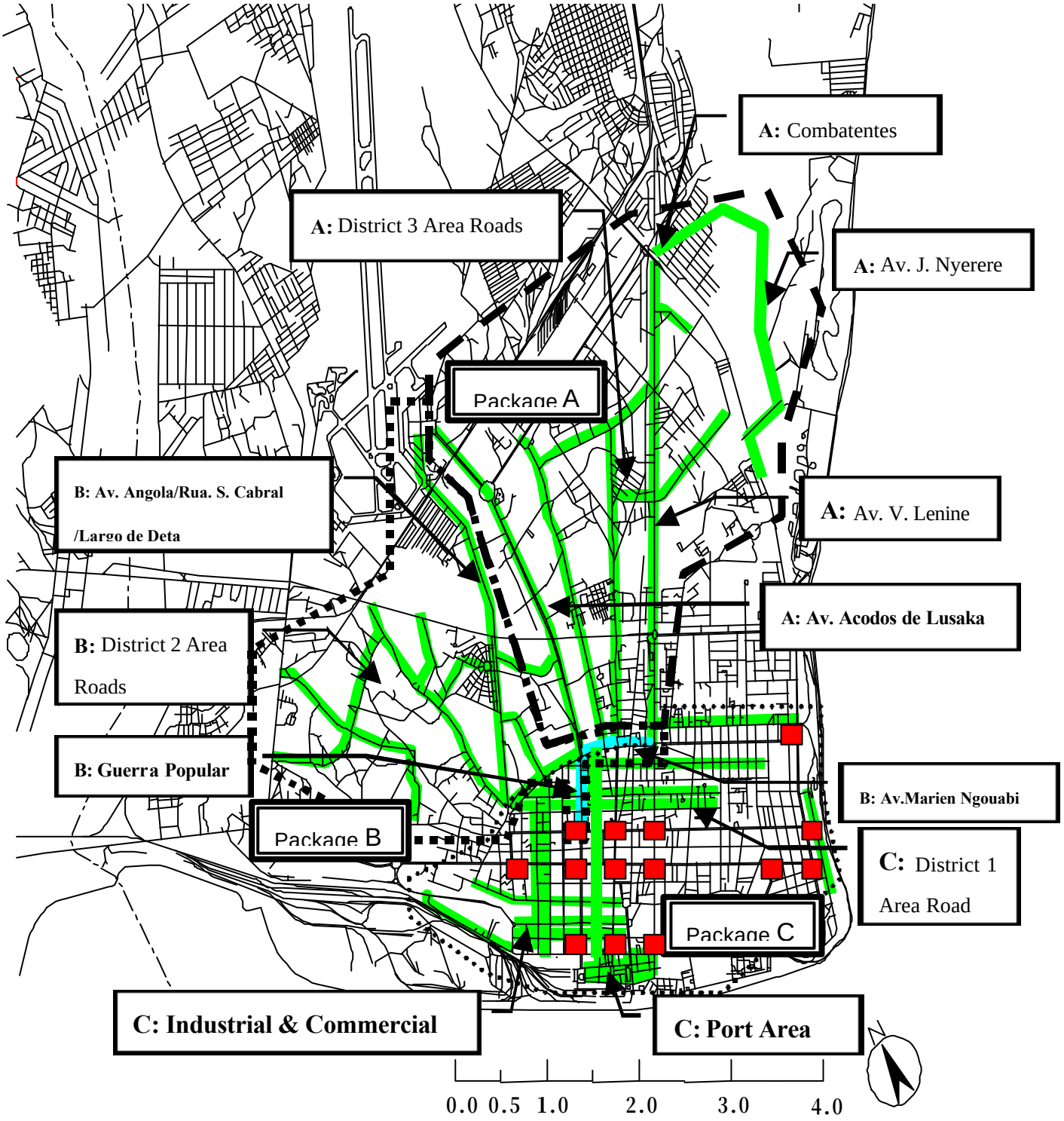
(3) Improvement of Area Drainage System by MCM

- Project for improvement / restoration of local area drainage system should be conducted by relevant department of MCM.

  (It should be proceeded in parallel with the progress of the road development projects)

4) Structural Strengthening of the New Road Department

- Establishment of New Road Department (Organization)
- Introduction of Privatizaion on Road Maintenance Work
- Establishment and Implementation of for Maintenance Programme (Basic Policy and Technical Issue)
- Structural Strengthening of the New Road Department (Construction of the Training Room, Procurement of the Expert for the Road Maintenance, Installation of Maintenance and Training Equipments, On the Job Training for Road Maintenance, Technical Support by ANE)


A: Combatentes
A: District 3 Area Roads
A: Av. J. Nyerere
Package A
B: Av. Angola/Rua. S. Cabral /Largo de Deta
A: Av. V. Lenine
A: Av. Acodos de Lusaka
B: District 2 Area Roads
B: Guerra Popular
B: Av.Marien Ngouabi
Package B
C: District 1 Area Road
Package C
C: Industrial & Commercial
C: Port Area
0.0 0.5 1.0 2.0 3.0 4.0

FINAL REPORT

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ABBREVIATIONS

(In alphabetical order)

AASHTO	:	American Association of State Highway and Transportation Officials
ANE	:	Administração Nacional de Estradas (National Road Administration of Mozambique)
B/C	:	Benefit / Cost Ratio
BHN	:	Basic Human Needs
CBD	:	Central Business District
CBR	:	California Bearing Ratio
CO	:	Carbon Monoxide
dB	:	Decibel
DBST	:	Double Bitumen Surface Treatment
DSM	:	Directorate of Municipal Service
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
FIRR	:	Financial Internal Rate of Return
GDP	:	Gross Domestic Products
HDI	:	Human Development Index
HDM	:	Highway Development Management
HNMS	:	Highway Network Management System
IEE	:	Initial Environmental Examination
IRI	:	International Roughness Index
IRR	:	Internal Rate of Return
JICA	:	Japan International Cooperation Agency
MCM	:	Municipal Council of (the city of) Maputo
Mt	:	Meticals
NO_2	:	Nitrogen Dioxide
NOx	:	Nitrogen Oxides
NPV	:	Net Present Value
OD	:	Origin-Destination (matrix)
pcu	:	Passenger Car Unit
ppm	:	Parts per Million
PRSP	:	Poverty Reduction Strategy Paper
PSI	:	Present Serviceability Index
ROCS	:	Road and Coastal Shipping Projects
ROW	:	Right-of-Way
SATCC	:	Southern African Transport & Communications Commission
STRADA	:	System for Traffic Demand Analysis
TPM	:	Transportes Públicos de Maputo (Municipal Public Transportation Operator)
UNDP	:	United Nations Development Programme
VAT	:	Value Added Tax
VOC	:	Vehicle Operation Cost
WHO	:	World Health Organization

The following foreign exchange rate is applied in the study :

1 US dollar = 22,000 Meticals = 125.00 Japanese Yen (July 2001), or

1 Meticals = 0.00568 Japanese Yen

PART A

MASTER PLAN

CHAPTER 1

INTRODUCTION

CHAPTER 1 : INTRODUCTION

1.1 BACKGROUD

Maputo City is located on largely flat land, an alluvial upland of unconsolidated sandy soil. Accordingly, natural drainage of rainwater, etc. and miscellaneous discharges are made as diverted to the Indian Sea to the east and the land to the west because of the terrain characterized by plateaus. There is no established road development plan including drainage functions for Maputo City. Although principal roads consist of trunk roads running in a radial pattern from the city center, traffic is currently concentrated in the city center because of a lack of ring roads.

The pavement is satisfactory for the roads in the city center and National Highway Route 1. On other roads, however, the pavement is deteriorated due to breakaway, collapse, etc. Roads other than trunk roads around the urban area are not paved, suffering excessive road surface deterioration after concentrated heavy rain and causing traffic problems. Finally, most of the roads are without drainage systems and no road maintenance is carried out, which resulted in considerable damage in various locations of the city during floods in February 2000.

1.2 OBJECTIVES

Problems related to traffic situation of Maputo City may be summarized as follows:

- Delay in development and expansion of roads due to insufficient financial strength,
- Progressive deterioration of existing roads, and
- Over-concentration of urban functions, growth in the traffic demand, and the increasing mobility of people that accompanies socioeconomic development.

On the basis of above road-related problems, the objectives of the Study are as below:

a) Development of the Maputo City Road Network Development Master Plan (target year 2020),
b) Implementation of a feasibility study related to high priority projects, and
c) Proposition of a road structure appropriate to local conditions, proposals related to maintenance, and implementation of technology transfer through the project.

1.3 STUDY AREA

The Study will be made over the entire City of Maputo excluding Inhaca Island. The Catembe area on the other side of Maputo Bay is included in the study area.

1.4 STUDY PROCEDURE

The Study comprises two phases: (1) at the First Phase, review, analysis and evaluation of the existing condition, implementation of pilot project, formulation of master plan and selection of high priority projects were conducted; (2) at Second Phase, feasibility studies of the high priority projects and seminar will be executed. The detailed activities for each phase are as follows:

1) First Phase: Review, analysis and evaluation of the existing condition, implementation of pilot project, formulation of master plan and selection of high priority projects

1)-1 Preparatory Work in Japan

(1) Collection, review and analyses of relevant information, data, and materials
(2) Preparation of Inception Report

1)-2 First Mission to Mozambique

(1) Presentation and Explanation of the Inception Report
(2) Review of existing pertinent studies
(3) Collection and Analysis of Existing Data and Information
(4) Execution of Traffic Surveys
  (a) Cordon Line Survey
  (b) Screen line Count
  (c) Spot traffic Volume Survey
  (d) Screen Turning movement data at major intersections
  (e) Running Speed Survey
  (f) Axle Load Survey
(5) Road facility inventory and survey of the present condition
  We will survey the total road length of about 150 km and for 30 intersections.
(6) Pilot project plan and design
  (a) Planning the pilot project

(b) Survey of natural conditions

(c) Designing the pilot project

(7) Implementation of the pilot project

(8) Establishment of a Socioeconomic Framework

(9) Forecasting Traffic Demand

(a) Generation of a database

(b) Forecasting of future traffic demand

(10) Preparation and Presentation of Progress Report

(11) Execution of IEE

(12) Study of public transportation

(13) Study on the future road network

- Study on the future road network
- Study on road standards
- Comparative study of substitute routes

(14) Study of the road evaluation method

(15) Development of a road network rehabilitation plan

(16) Study on development of sources of financing for roads

(17) Developing a road development plan

(18) Extraction of projects to be covered by the feasibility study

- New road construction road improvement projects
- Existing road rehabilitation project

(19) Establishing EIA (Environmental Impact Assessment) items

2) Second Phase : Feasibility studies of the high priority projects, execution of seminar

2)-1 First Project Work in Japan

Preparation of the Interim Report

2)-2 Second Mission to Mozambique

(1) Presentation and Explanation of the Interim Report

(2) Execution of Detailed Natural Conditions Surveys

(3) Execution of EIA

(4) Study of the design standard

(5) Study of design methods for pavement and drainage facilities

(6) Preliminary design

(7) Study before construction

(8) EIA (Environmental impact assessment)

(9) Approximate estimation
(10) Development of the project implementation plan
(11) Economic Evaluation
  (a) Economic analysis
  (b) Sensitivity analysis
  - Benefit
  - Cost
  - Investment by year

(12) Financial Analysis
(13) Review of the road maintenance system
(14) Maintenance plan proposal
(15) Overall evaluation and recommendation

2)-3 Second Project Work in Japan

Preparation of draft final report

2)-4 Third Mission to Mozambique

1) Explanation of Draft of Final Report
2) Technology transfer seminar

2)-5 Third Project in Japan

Preparation of the final report

2)-6 Delivery of Final Report

Delivery of the Final Report to Mozambique

The work flow of Study is as shown in Figure1.4.1 on the following page.

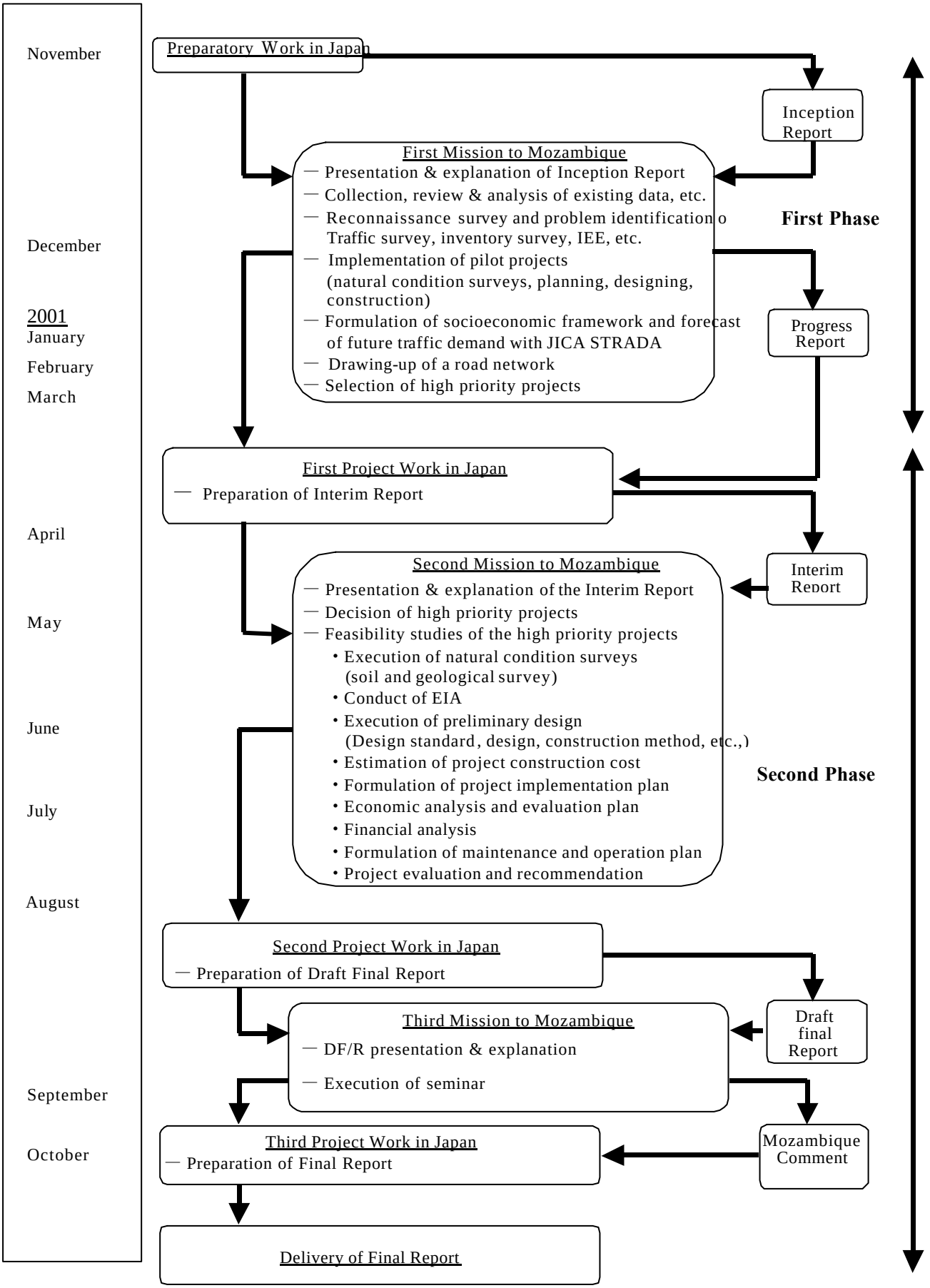

Figure 1.4.1 Study Flow

1.5 STUDY ORGANIZATION

The study carried out jointly by the JICA Study Team, which comprises members of Oriental Consultants Company Limited in associated with Japan Engineering Consultants Company Limited, which is organized by JICA, and the Municipal Council of Maputo (hereinafter referred to as "MCM") counterparts organized by the Government of Mozambique. For the duration of the Study, the following committees were set up.

- JICA Advisory Committee
- MCM Steering Committee

The study organization among these institutions is as shown in Figure 1.5.1.

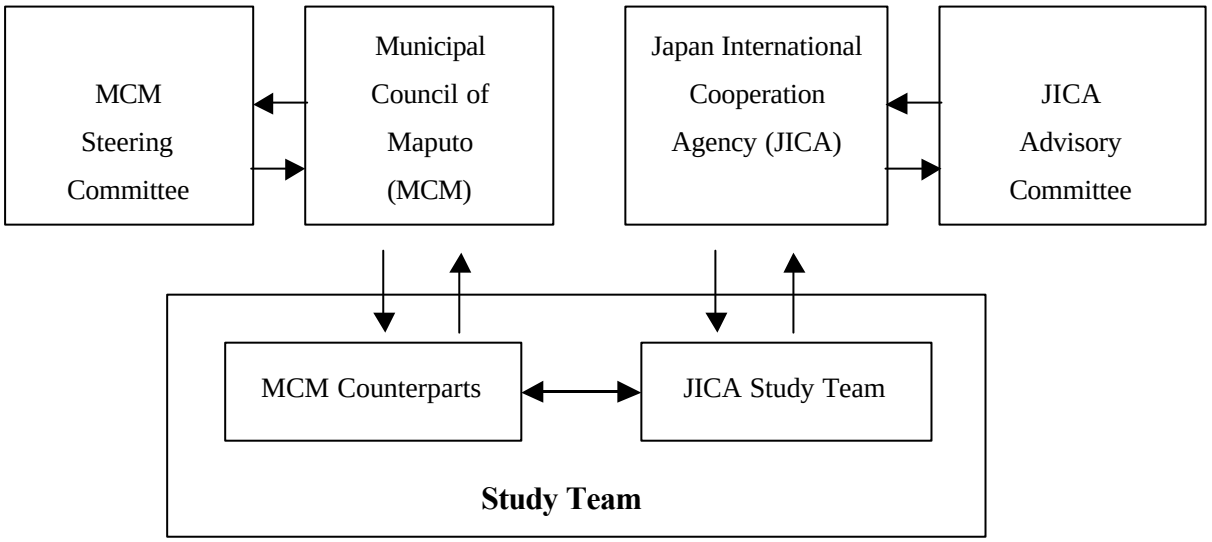

Figure 1.5.1 Study Organization

The members of the Mozambique counterpart team, steering committee, JICA Study Team, JICA steering committee, and JICA staff are as shown below.

(1) Members of Counterpart Team

Mr. Missael Cumbe	Chief of Counterpart Team
Mr. Jose Roanda	Member of Counterpart Team
Mr. Anival	ditto
Ms. Hermenigila Psongo	ditto
Ms. Maria Rosa	ditto
Ms. Marta Chivambo	ditto

(2) Members of Steering Committee

Ms. Ana Margarida de Sousa	Councilor
Mr. Zacarisas Cossa	ditto
Mr. Alfred Baduro	
Mr. Missael Cumbe	Director of Roads and Bridges
Mr. Jose Roanda	Director of Water and Sanitation
Mr. NiranjSacarlar	Director of
Mr. Jose Chembeze	
Ms. Terfesa Chissequene	Director of
Mr. Arlindo Francisco	

(3) Member of the JICA Study Team

Mr. Kazuro Yanagida	Project Manager
Mr. Keigo Konno	Road Planning
Mr. Yasushi owaki	Urban planning
Dr. Sion Haworth	Traffic Survey/Traffic Demand Forecasting
Mr. Hisashi Muto	Road Design (1)
Mr. Tetsuro Izawa	Road Design (2)
Mr. Hiroaki Takahashi	Road Drainage/ Maintenance
Mr. Atsushi Kamiyama	Natural Condition/ Supervising
Mr. Takahiro Miyoshi	Economical Analysis/ Evaluation
Mr. Yuingping Deng	Environmental Assessment/ Impact Assessment

(4) Member of the JICA Advisory Committee

Mr. Yasuhiro Sako	Head of Committee
Mr. Masanori Tsukamoto	Road Plan

CHAPTER 2

PRESENT SITUATION

CHAPTER 2 : PRESENT SITUATION

2.1 NATURAL CONDITIONS

2.1.1 Topography

Maputo is located at the southern end of the Republic of Mozambique. It lies within a range defined by 25 49' 09" and 26 05' 23" south Lat. and 32 26' 15" and 33 00' 09" east Long. The City faces the Indian Sea to the east and stretches inland to the north. The City borders Matola City with the Infulene River between them. To the south, is the Catembe area on the opposite side of the Matola estuary.

The terrain is generally flat and there are no high mountains, but the old city rises to a highland in the southeast, projecting like a peninsula 66 m above sea level. (See Figure.-2.1.1) Such relatively high terrain continues to Kenneth Kaunda Av., with Embassy Street on the north side and to Vladimir Lenine Av. on the west side.

Lowlands in the city, in areas such as Malhangalene, Maxaquene, Mafalala and Munhuana, are occupied by squatters. These areas were completely inundated by the flood caused during Cyclone Eline in February 2000.

The terrain dips while undulating gradually in a fan pattern toward the inland. The urban area is developed around the highland and spreads toward the lowland. The area in which the Mavalane International Airport exists is relatively elevated and was not affected by the flood.

2.1.2 Climate and Hydrology

The average temperature in Maputo is about 19℃ in July (winter) and about 26℃ in January (summer) (see Table 2.1.1). Recent observation shows that the temperatures higher than 40℃ are sometimes recorded during the wet season. In any case, the annual average maximum temperature is about 31℃ and the annual average minimum temperature is 13℃. Annual precipitation in Maputo is about 900 mm (see Table 2.1.2). Heavy flooding due to abnormal weather, such as the one that occurred this year, may occur.

2.1.3 Geology

Geological features of Maputo include mostly red silt mixed with sandy soil. These strata dip from east toward the west. The lowland is covered with yellowish white sandy soil. The bottom layer of the red silt-mixed sandy soil is distributed toward the north at altitudes ranging from zero to –20 m. The substratum consists of clay-mixed sand, about 40 m thick at the southern end of the city. (See Figure 2.1.2)

Most characteristic is the fact that two faults exist on both sides of the City. The distance between eastern and western fault positions is about 8 km. The fault on the east side runs almost straight from the southeastern end along Friedrich Engels Av. and Julius Nyerere Av. to the north-northeast. The fault on the west side, which is called the Infulene valley, runs nearly parallel to the one on the east side. The Infulene River flows through this valley.
The shift in the fault on the east side is as high as about 30 m. The fault on the west side is about 10 to 20 m, varying toward the north.

2.1.4 Earthquake

Maputo city is located in the low area of an earthquake activity standard. Three or more earthquake magnitude earthquakes is not recorded the ranges of 130 km of radius from center of Maputo city among the past 14 years, which was between 1966 and 1979, by each earthquake observation center of Mozambique, Zimbabwe and South Africa.

In Mozambique history, at Namaacha, which is located at 50 km west from Maputo city, the earthquake magnitude 5 grade occurred three times, 4 grade occurred twice and 3 grade occurred twice. The earthquake grade was the Mercalli scale.

There are two large-scale faults in Maputo city periphery. If the earthquake will occurs around Maputo city, The earthquake magnitude will be 5 to 6 grade, which is equal to 8 grade in the Mercalli scale. However the earthquake over 6 grade will not occur around Maputo city because of the low level of the earthquake activity. Therefore the cycle of earthquake occurrence will be as follows.

- Magnitude 8 : 9,000 year
- Magnitude 7 : 3,800 year
- Magnitude 6 : 660year

It is conceivable that Maputo city is adequate to classify into the area of earthquake magnitude 6 (Mercalli scale).

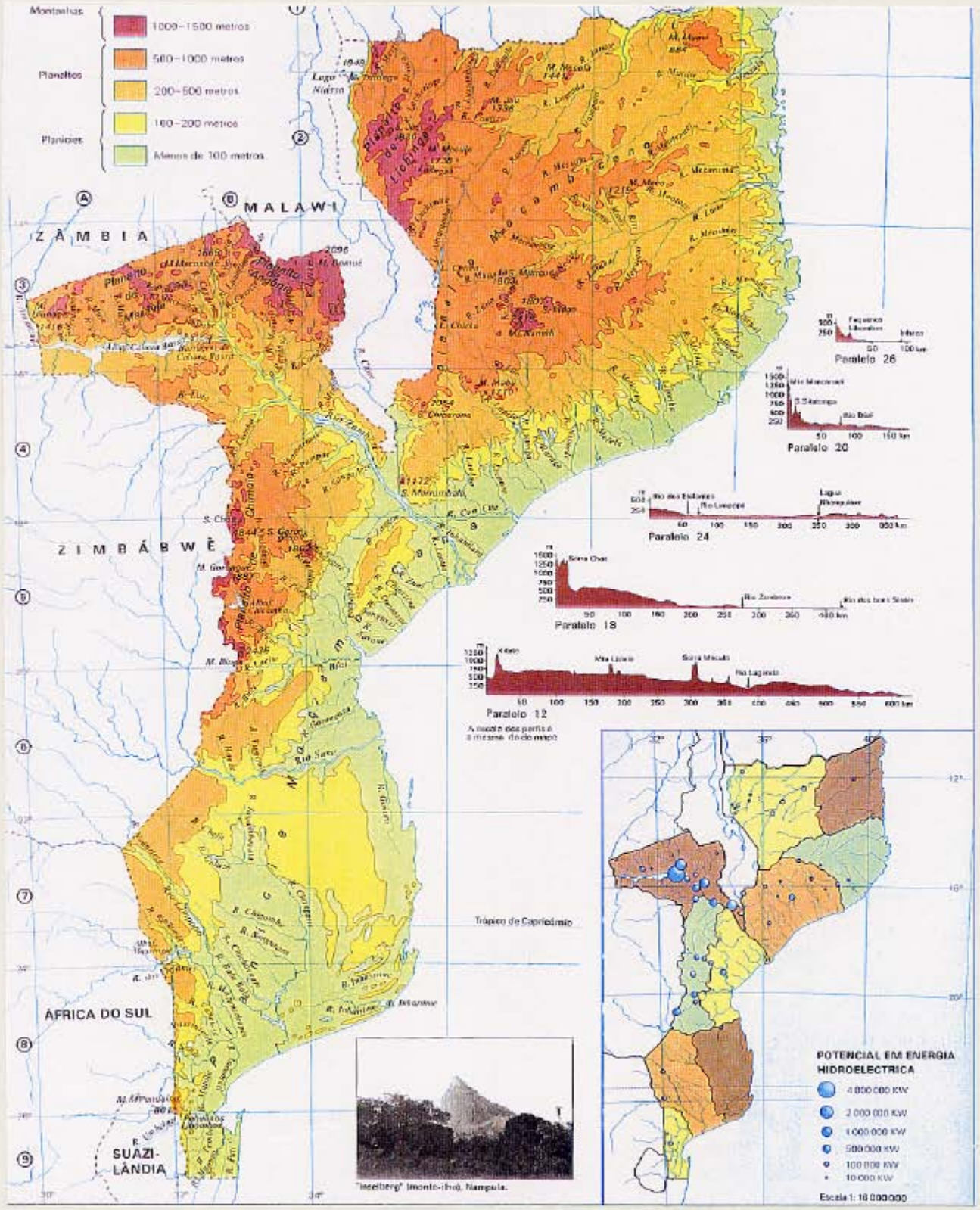

Figure 2.1.1 Topographic Map

Source : ATRAS GEOGRÁFICO VOLUME 1 2a edição, revista e actualizada, Ministério da Educação

Table 2.1.1 Temperature in Maputo City

TEMPERATURE (Monthly Max, ℃)

Year	Jan.	feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1990	30.1	29.3	29.9	28.0	26.2	25.4	25.4	24.2	25.3	27.5	27.6	28.6	27.3
1991	31.0	30.4	29.8	28.6	26.8	24.1	24.1	26.4	28.0	27.3	28.9	28.4	27.8
1992	30.7	32.2	30.5	29.9	28.5	26.7	26.7	25.8	28.2	29.1	29.2	31.1	29.1
1993									26.4	26.0	26.5	29.7	27.2
1994	28.9	29.2	29.6	28.0	26.6	26.3	24.6	25.2	26.3	24.5	27.9	21.1	26.5
1995	29.9	30.2	28.9	27.9	25.6	24.3	24.8	25.3	26.7	27.7	27.9	28.5	27.3
1996	29.6	30.4	28.6	27.0	26.1	25.1	23.4	24.5	27.4	27.5	29.3	29.9	27.4
1997	29.7	29.5	29.7	28.0	25.3	26.1	24.0	26.2	25.9	26.0	27.7	29.1	27.3
1998	30.0	30.2	31.0	29.2	27.3	26.4	25.1	26.4	27.0	26.0	28.1	29.0	28.0
1999	30.7	29.5	29.7	28.0	26.9	25.9				25.6	29.4	30.1	28.4
2000	28.5	29.2	29.1	27.2	25.7	25.4	24.5	25.7					26.9
Ave.	29.9	30.0	29.7	28.2	26.5	25.6	24.7	25.5	26.8	26.7	28.3	28.6	27.6

TEMPERATURE (Monthly Min, ℃)

Year	Jan.	feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1990	22.1	21.9	21.7	20.2	17.1	14.5	15.2	15.1	16.2	18.9	19.3	21.7	18.7
1991	22.9	22.6	21.7	19.3	17.4	14.7	14.3	15.0	17.9	19.6	20.6	21.3	18.9
1992	23.0	23.9	22.2	21.1	18.0	16.2	14.3	13.8	17.6	18.9	21.1	23.0	19.4
1993									17.2	19.1	19.2	21.5	19.3
1994	21.7	21.8	21.9	19.6	16.9	14.8	13.2	14.4	17.0	16.8	20.2	20.7	18.3
1995	22.3	22.8	21.5	19.1	17.1	14.1	14.2	15.6	17.9	19.8	20.2	20.9	18.8
1996	22.6	22.4	20.5	18.1	17.3	14.6	13.1	14.5	17.9	19.1	20.9	22.0	18.6
1997	22.6	22.0	21.6	18.5	15.9	14.4	14.6	15.8	18.2	17.9	19.2	20.4	18.4
1998	21.9	22.6	22.0	20.1	17.5	14.8	14.8	15.3	17.1	18.2	20.0	21.3	18.8
1999	22.8	22.0	22.6	19.7	17.0	14.7				17.5	20.8	22.7	20.0
2000	20.7	22.0	21.6	18.2	15.0	14.9	13.7	14.6					17.6
Ave.	22.3	22.4	21.7	19.4	16.9	14.8	14.2	14.9	17.4	18.6	20.2	21.6	18.8

TEMPERATURE (Monthly Average, ℃)

Year	Jan.	feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
1990	26.1	25.6	25.8	24.1	21.7	19.9	20.1	19.6	20.7	23.2	23.4	25.2	23.0
1991	27.1	26.5	25.7	24.0	22.1	19.4	19.8	20.7	22.9	23.4	24.8	24.8	23.4
1992	26.8	28.0	26.4	25.5	23.3	21.5	20.2	19.8	22.9	24.0	25.1	27.0	24.2
1993									21.8	22.5	22.9	25.6	23.2
1994	25.3	25.5	25.7	23.8	21.8	20.5	18.9	19.8	21.6	20.7	24.0	20.9	22.4
1995	26.1	26.5	25.2	23.5	21.4	19.2	19.5	20.4	22.3	23.7	24.0	24.7	23.0
1996	26.1	26.4	24.6	22.6	21.7	19.8	18.3	19.5	22.7	23.3	25.1	26.0	23.0
1997	26.2	25.7	25.6	23.3	20.6	20.3	19.3	21.0	22.0	22.0	23.5	24.8	22.9
1998	25.9	26.4	26.5	24.7	22.4	20.6	20.0	20.9	22.0	22.1	24.1	25.1	23.4
1999	26.8	25.8	26.2	23.9	21.9	20.3				21.5	25.1	26.4	24.2
2000	24.6	25.6	25.3	22.7	20.3	20.2	19.1	20.2					22.3
Ave.	26.1	26.2	25.7	23.8	21.7	20.2	19.5	20.2	22.1	22.6	24.2	25.1	23.2

Source: National Meteorology Institute