

UNITED REPUBLIC OF TANZANIA
MINISTRY OF WORKS, COMMUNICATIONS AND TRANSPORT

**THE STUDY
ON
DAR ES SALAAM
ROAD DEVELOPMENT PLAN**

**FINAL REPORT
PART A : MASTER PLAN STUDY
PART B : FEASIBILITY STUDY**

SUMMARY

MARCH 1995

JAPAN INTERNATIONAL COOPERATION AGENCY

JAPAN ENGINEERING CONSULTANTS CO., LTD.

NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of the United Republic of Tanzania, the Government of Japan decided to conduct the study on Dar es Salaam Road Development plan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team headed by Mr.H.Muto, Japan Engineering Consultants Co., Ltd. and composed of members from Japan Engineering Consultants Co., Ltd. and Nippon Koei Co., Ltd., three times between October 1993 and December 1994.

The team held discussions with the officials concerned of the Government of the United Republic of Tanzania and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the United Republic of Tanzania for their close cooperation extended to the team.

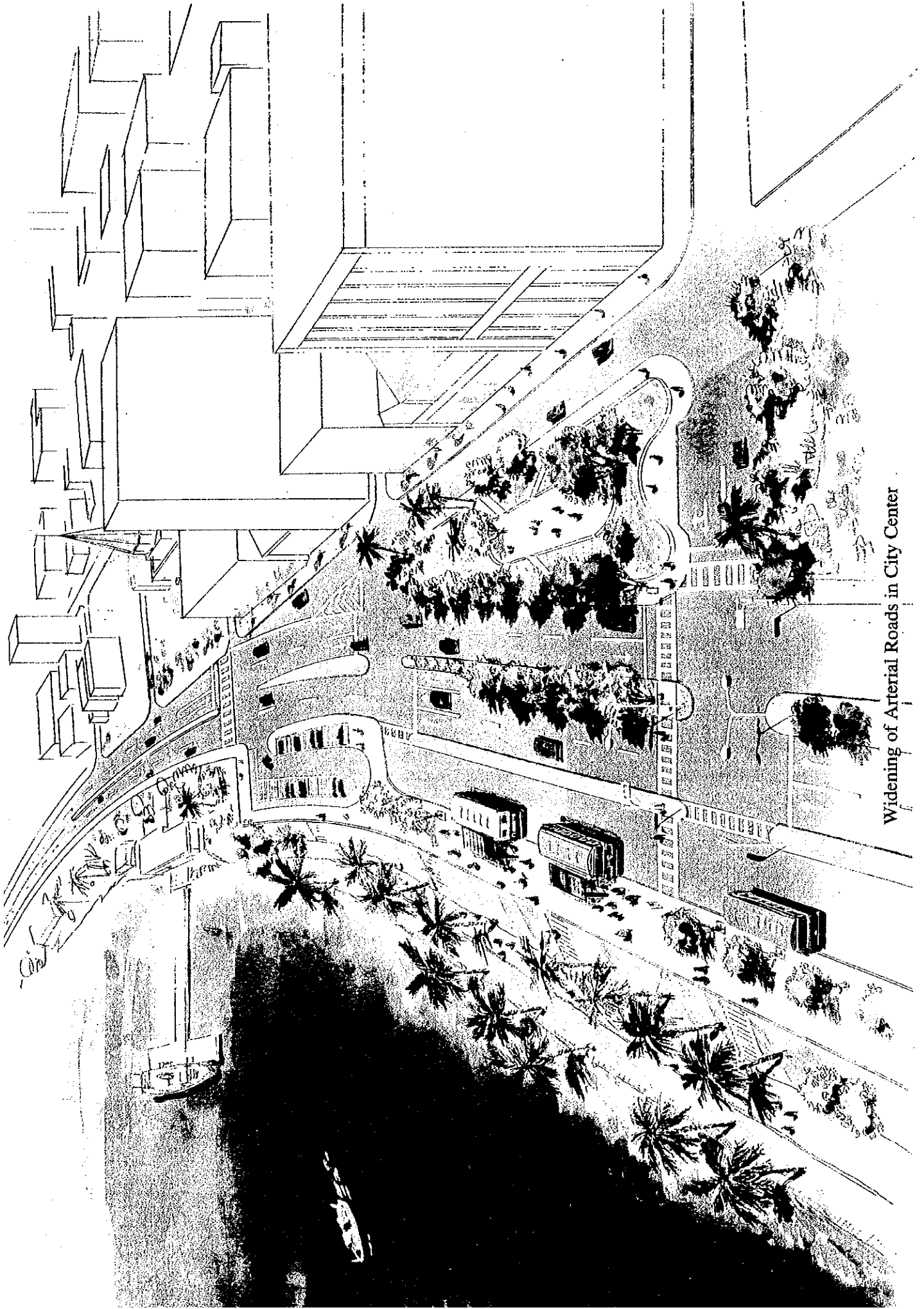
March 1995



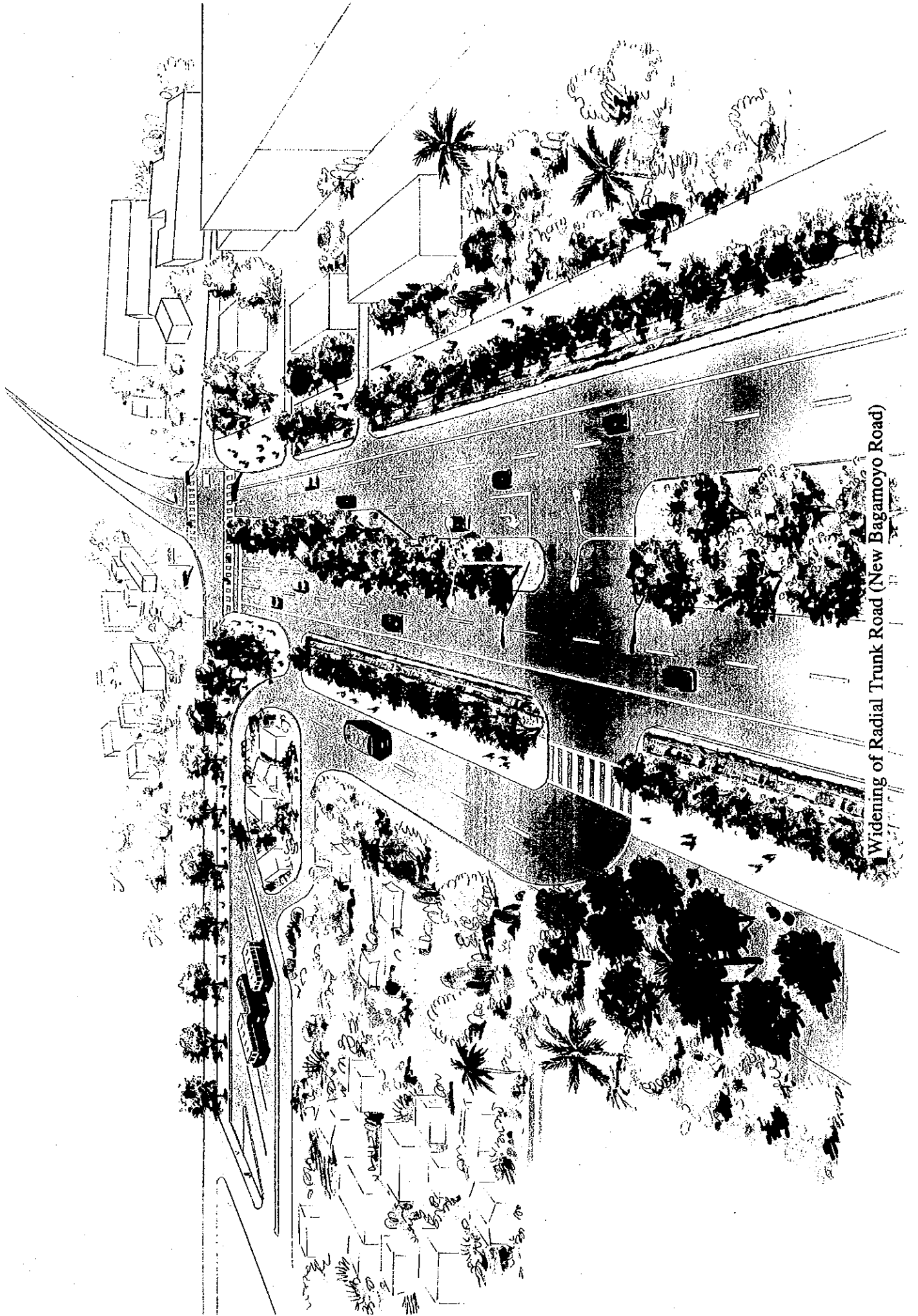
Kimirou Fujita

President

Japan International Cooperation Agency



Widening of Arterial Roads in City Center



Widening of Radial Trunk Road (New Bagamoyo Road)



Widening of Middle Ring Road

**Summary
of
Final Report for The Study
on
Dar es Salaam Road Development Plan**

Preface
Location Map
Frontispiece

CONCLUSION AND RECOMMENDATIONS..... CR-1

SUMMARY OF THE STUDY

PART A : MASTER PLAN STUDY

Chapter 1	Introduction	A-1
Chapter 2	Socio-economic Conditions.....	A-4
Chapter 3	Traffic Survey and Analysis.....	A-7
Chapter 4	Present Transportation System in Dar es Salaam	A-13
Chapter 5	Initial Environmental Examination.....	A-18
Chapter 6	Formulation of Urban Transportation Strategies.....	A-23
Chapter 7	Traffic Demand Forecast.....	A-33
Chapter 8	Road Development Plan.....	A-42
Chapter 9	Public Transport Development Plan	A-64
Chapter 10	Traffic Management Plan	A-74
Chapter 11	Short-term Development Plan and Implementation Schedule	A-84

PART B : FEASIBILITY STUDY

Chapter 12	Introduction	B-1
Chapter 13	Basic Design Standards and Right-of-way.....	B-2
Chapter 14	Engineering Survey and Analysis.....	B-6
Chapter 15	Preliminary Engineering Design.....	B-10
Chapter 16	Construction Plan and Cost Estimate.....	B-40
Chapter 17	Environmental Impact Assessment	B-45
Chapter 18	Implementation Plan.....	B-53
Chapter 19	Evaluation on Project Implementation.....	B-57
Chapter 20	Conclusion and Recommendations	B-61

CONCLUSION AND RECOMMENDATIONS

The following are the conclusion and recommendations made by the Study Team on the basis of the results of the Master Plan Study and the Feasibility Study for the “Dar es Salaam Road Development Plan”.

PART A: MASTER PLAN STUDY

A-1 Road Development Master Plan

The Study Team concluded that the Road Development Master Plan as shown in Fig.A.1 and Table A.1 shall be completed by the year 2010 from the viewpoint of urban development, transportation development, socio-economy and policy of the Tanzanian Government.

The Road Development Master Plan has been established taking into consideration the following Road Development Concepts accompanied with respective project components:

Development Concept 1: Road Development to Enhance the Urban Traffic Efficiency

- Widening of Arterial Roads in the City Center
- Widening of Middle Ring Road with the Construction of Missing Link
- Widening of Trunk Roads from 2 to 4 lanes
- Construction of Grade-separated Intersections at Major Trunk Roads

Development Concept 2: Road Development to Promote Urban Functions in the Intensified Urban Development

- Construction and Improvement of Collector Roads
- Rehabilitation of Pavement Condition on Local Roads
- Reconstruction of Bridges on Trunk Roads

Development Concept 3: Road Development to Stimulate the Development of the Potential Development Area

- Strengthening of Road Network in Kigamboni area including Construction of Bridges crossing Harbor
- Strengthening of Road Network along Pugu Road

Development Concept 4: Road Development to Prevent Haphazard Urban Sprawl

- Construction of Outer Ring Road
- Improvement of Trunk and District Roads in Rural Areas

Table A.1 Summary of Road Development Plan (1/2)

Unit: Million Tsh.

Package No.	Name of Road	Length km	Lane No.	Construction Cost	Land Compensation Cost	Remarks
A-1	Widening of Arterial Roads in the City Center					
	- Widening of roads from 2 lanes to 4 Lane					
	Ohio Street	0.96	4	580		
	Sokoine Drive	0.67	4	400		
	Gerazani Road	1.40	4	900		
	Bandari Road	2.00	4	1,590		
	Kivukoni Front	0.40	4	240		
	- Construction of Seaside Promenade with car parking lots	Sum		200		To be provided along seaside
- UWT-Gerezani	0.24	4	140	20	Rail Sta. to be removed	
Sub Total	5.62		4,050	20		
A-2	Widening of Middle Ring Road with construction of Missing Link					
	- Widening of Roads from 2 lanes to 4 lane					
	Morocco Road	4.00	4	3,000		
	New Kigogo Road	2.80	4	2,450		
	Chang'ome Road	2.80	4	1,900		
- Missing Link of Middle Ring Road	0.75	4	440	20		
Sub Total	10.35		7,790	20		
A-3	Widening of Trunk Roads from 2 lanes to 4 lanes					
	- DTR-5: New Bagamoyo Road	4.40	4	4,000		Morocco-Wazo Hill Long-term
	DTR-5; Mpakani - Wazo hill section	12.60	4	9,040		
	- DTR-6: San Nujoma Road (Mpakani Road)	3.90	4	3,140		
	- DTR-3: Morogoro Road	11.00	4	10,010	280	
	- DTR-9: Uhuru Road	4.00	4	2,590	400	
	- DTR-13: United Nation Road	2.00	4	1,360	50	
	- DTR-4: Kilwa Road up to Mandera Road	3.20	4	2,180	80	
	DTR-4; Mandera Road up to Outer Ring	5.60	4	3,950	30	
	- New; Morocco Road - United nation Road	1.90	4	2,950	50	
Sub Total	48.60		39,220	890		
A-4	Grade Separation of Intersections					
8 location	Sum		25,760	0		
A-5	Construction and Improvement of Road Network inside Mandela Road					
	- UWT Road	2.00	4	360		Overlay Overlay
	- Uhuru Road	1.20	2	220		
	- Old Kigogo Road	6.50	2	2,670		
	- Old Kigogo - Tabata	1.50	2	620		
	- Morogoro-NIT (DTR-20)	1.40	2	570		
	- New Sinza Road	3.80	2	1,700		
	- Kagera Road	2.40	2	1,110		
	- Mwinjuma-H: Bagamoyo and Ext.	3.60	2	1,040	20	
	- DTR-25 Old Kigogo- Mandera	1.00	2	410		
	- DTR-36 Mikocheni Access	1.30	2	530		
	- DTR-38 Mwinjuma-Sinza	6.10	2	2,480	20	
	- DTR-39 Mwinjuma-New Bagamoyo	4.70	2	1,900	20	
	- Extention of Old Bagamoyo	6.70	2	2,750		
	- DTR-28 Temek-Mbagala	4.70	2	1,930		
	- DTR-18 Keniyatta-Toure Drive	7.60	2	680		
	- DTR-35 Chole Road	3.00	2	1,080		
- DTR-27 Haile Selasie	5.40	2	1,350			
Sub Total	62.90		21,400	60		
Sub Total (1)	127.52		98,220	990		

Exchange Rate: US\$1.00 = Tshs 490 = ¥110 (As of January 1994)

Table A.1 Summary of Road Development Plan (2/2)

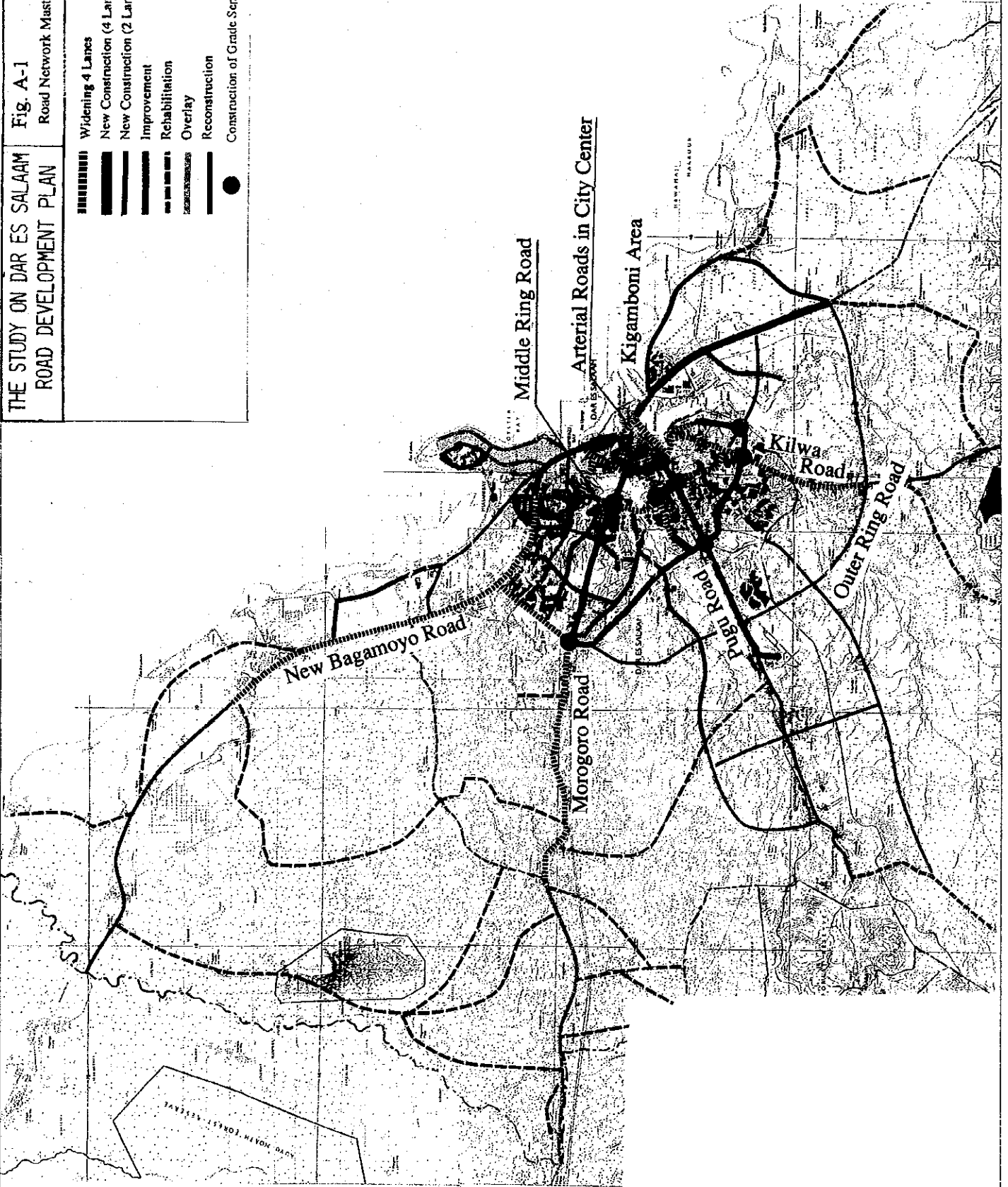
Unit: Million Tsh.

Package No.	Name of Road	Length km	Lane No.	Construction Cost	Land Compensation Cost	Remarks	
A-6	Rehabilitation of Pavement Condition on Local Roads						
	- Local Roads in Temeke area	13.90	2	2,090			
	- Local Roads in Ilala area	10.30	2	1,550			
	- Local Roads in Tabata	9.20	2	1,380			
	- Local Roads in Sinza area	9.20	2	1,380			
	- Local Roads in Mwinjuma area	17.20	2	2,580			
	Sub Total	59.80		8,980			
A-7	Reconstruction of Existing Bridges on Major Roads						
	2 Lanes Bridges - 7 no.	185	2	655			
	Sub Total			655			
A-8	Strengthening of Road Network in Kigamboni Area						
	- Improvement Kigamboni Ferry Port	Sum		1,260			
	- Harbor Bridge Access Road	2.80	2	25,470	280	Br. 1,400 m	
	- Kurashini Bridge Access Road	5.30	3	18,210	130	Br. 600 m	
	- DRR-23 Kongowe - Mjimwema	5.00	2	2,050			
	- DRR-14 Kivukoni-Vijibweni	6.50	2	2,670			
	- DRR-29 Tungu-Kibada	5.90	2	2,420			
	- DRR-2 Mwongozo-Gomvu	12.50	1	750			
	- DRR-3 Chekeniwasonga-Buyuni	43.10	1	2,590			
	- DRR-8 Kimbiji-Chekeniwasonga	11.50	1	690			
	- DRR-12 Kimbiji-Tungi-Songani	18.00	1	1,080			
	- DRR-22 DRR23 intersection-Kimbiji	43.00	2	7,740			
	- Kimbiji-Mnazi	13.40	1	800			
	- DRR-30 Kibada-Cezauloe	14.50	1	870			
		Sub Total	181.50		66,600	410	
A-9	Strengthening of Road Network along Pugu Road						
	Pugu South - short-term	9.00	2	4,350	140	New Construction	
	Pugu South	9.50	2	3,710	140	New Construction	
	Pugu North (DRR-17) - short-term	7.50	2	2,930	110	Improvement	
	Pugu North (DRR-17) Extension	7.50	2	3,080		New Construction	
	North-South Access	7.70	2	3,410	120	New Construction	
	Sub Total	41.20		17,480	510		
A-10	Construction of Outer Ring Road						
	Sub Total	22.00	2	9,710	70		
	Sub Total	22.00		9,710	70		
A-11	Improvement of Important Roads in Rural Area						
	DTR-5 New Bagamoyo beyond Wazo Hill	14.10	2	2,540			
	DTR-3 Morogoro beyond	13.60	2	1,220			
	DRR-1 Kawe-Goba- Mbezi	16.00	1	960			
	DRR-4 Pugu-Msongola	20.00	1	1,200			
	DRR-5 Bunji-Mbeweni	6.40	2	1,730			
	DRR-6 Kwembe- Kisosa	13.90	1	830			
	DRR-7 Kibamba-Magowe mpiji	9.00	1	540			
	DRR-9 Mikwanbe-Gezaule	20.00	1	1,200			
	DRR-10 Kunduchi-Unio- Boko	11.40	2	2,050			
	DRR-11 Msongola- Byuni	16.00	1	960			
	DRR-13 Pugu-Kajungeni	8.30	1	500			
	DRR-15 Bunji-Mabwepande-Mpiji	24.10	1	1,450			
	DRR-16 DIA-G/Mboto	7.20	2	1,300			
	DRR-17 Pugu-Kinyerezi	5.00	1	300			
	DRR-18 Mbezi-Maramba-Kwembi	8.00	1	480			
	DRR-19 Temboni-Kinyerezeni	9.00	1	540			
	DRR-20 Temboni-Coba	5.70	1	340			
	DRR-21 Coba-Mpiji	8.30	2	500			
	DRR-23 Kongowe-Mjimwema	12.60	2	2,270			
	DRR-24 Pugu-Chanika-Mbagala	46.40	1	8,350			
	DRR-25 Mbezi-Kwembe	4.50	1	270			
	DRR-26 Morogoro Road-Kiluvia	2.30	1	140			
	DRR-27 Wazo Hill - Goba	11.30	1	680			
	DRR-28 Kibo-Msewe	1.50	1	90			
		Sub Total	294.60		30,440	0	
		Sub Total (2)	599.10		133,865	990	
		Total	726.62		232,085	1,980	

**THE STUDY ON DAR ES SALAAM
ROAD DEVELOPMENT PLAN**

**Fig. A-1
Road Network Master Plan in 2010**

- ▬ Widening 4 Lanes
- ▬ New Construction (4 Lanes)
- ▬ New Construction (2 Lanes)
- ▬ Improvement
- ▬ Rehabilitation
- ▬ Overlay
- ▬ Reconstruction
- Construction of Grade Separated Intersection



A-2 Public Transport Development Plan

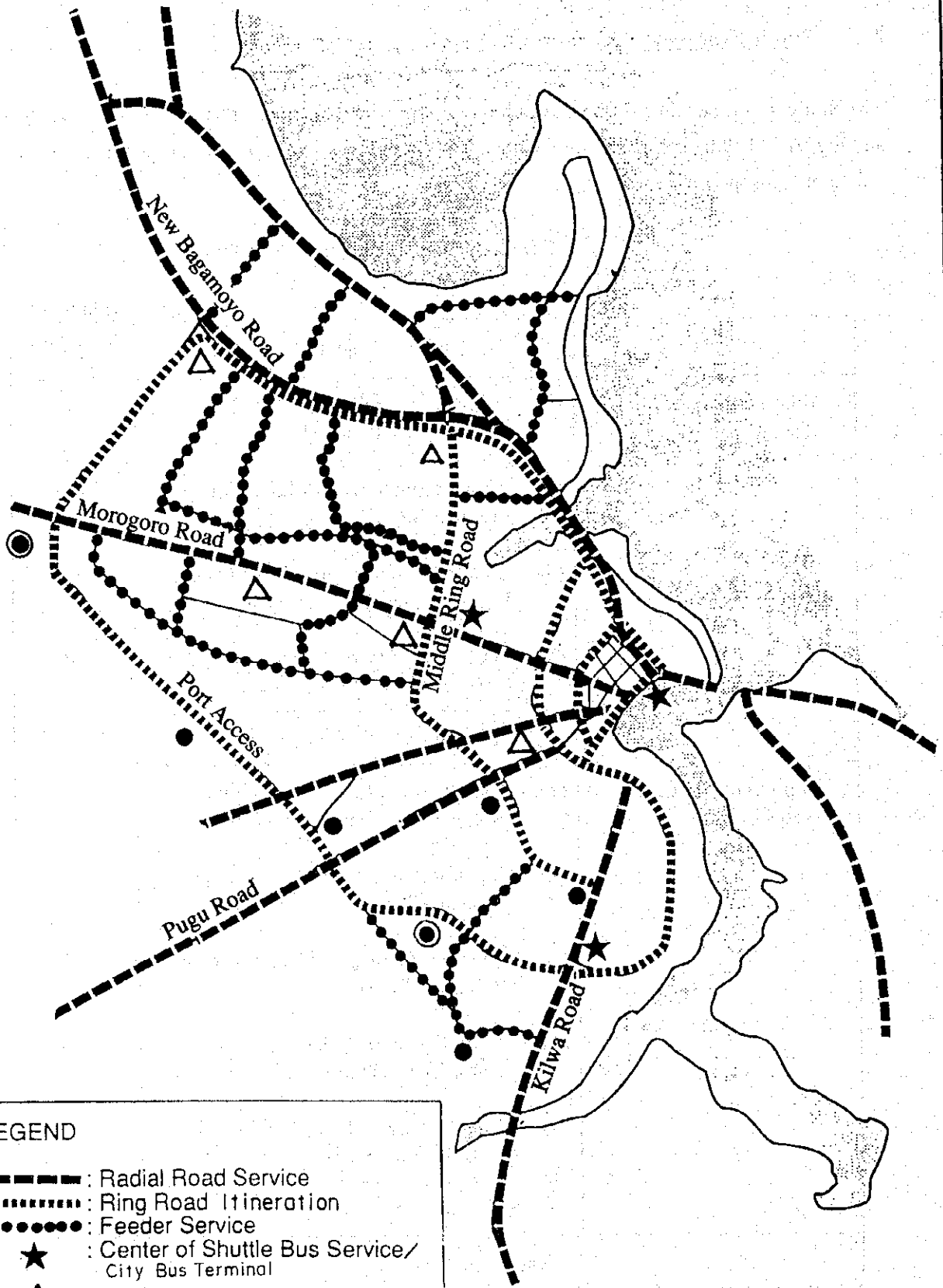
The Study Team concluded that the Public Transport Development Plan as shown in Table A.2 and Fig. A.2 shall be completed by the year 2010 in order to improve the transport services to the public on appropriate level.








Table A.2 Public Transport Development Plan

Unit: Million Tsh.

Plan	Project	Estimated Cost
1 Improvement of Long-distance Bus Services	(1) Construction of West-bound Long-distance Bus Terminal	800
	(2) Construction of South-bound Long-distance Bus Terminal	450
	(3) Shuttle Bus Operation (West Bound Long-distance Bus Terminal)	60
	(4) Shuttle Bus Operation (South Bound Long-distance Bus Terminal)	30
	Subtotal	1,340
2 Improvement of City Bus Services	(1) Construction of City Bus Terminals (Sokoine Drive and Kariakoo)	60
	(2) Construction of Local Bus Stations (Terminal Type)	30
	(3) Construction of Local Bus Stations (Roadside Type)	75
	(4) Strengthening of Junctional Function (Major Bus Junctions)	40
	(5) Strengthening of Junctional Function (Small Bus Junctions)	30
Subtotal	235	
Grand Total		1,575

Exchange Rate: US\$1.00 = Tshs. 490 = ¥110 (As of January 1994)



LEGEND	
	: Radial Road Service
	: Ring Road Itineration
	: Feeder Service
	: Center of Shuttle Bus Service/ City Bus Terminal
	: Local Bus Station
	: Junction (Large)
	: Junction (Small)

THE STUDY ON DAR ES SALAAM
ROAD DEVELOPMENT PLAN

Fig. A.2 Public transport Development Plan

A-3 Traffic Management Plan

The Study Team concluded that the following Traffic Management Plan shall be implemented from the viewpoint of engineering, socio-economy and policy of the Tanzanian Government.

Table A.3 Summary of Traffic Management Plan

Plan	Components	Estimated Cost Million Tshs.
- Reduction of Roadside Parking	- Construction of 4 Nos. of Public Parking Garages	<u>12,000</u> 12,000
	- Street Parking Restriction	-
- Enhancement of Road Capacity by Adopting Proper Traffic Regulation in the City Center	- Introduction of One Way Traffic Regulation	-
	- Restriction of Heavy Buses and Heavy Trucks	-
	- Introduction of Non-through-traffic Routes	-
- Streamlining of Pedestrian Flow		<u>4,988</u>
	- Introduction of Pedestrian Mall	88
	- Provision of Pedestrian Crossing Bridges	350
	- Improvement of Pedestrian Way	4,550
- Improvement of Bottleneck Points		<u>227</u>
	- Traffic Signal	6
	- Pedestrian Signal	6
	- Improvement of Rotary Intersections	20
	- Restructuring of Intersections	189
	- Installation of Traffic Marking/Signs	6
Total		17,215

Exchange Rate: US\$1.00 = Tshs. 490 = ¥110 (As of January 1994)

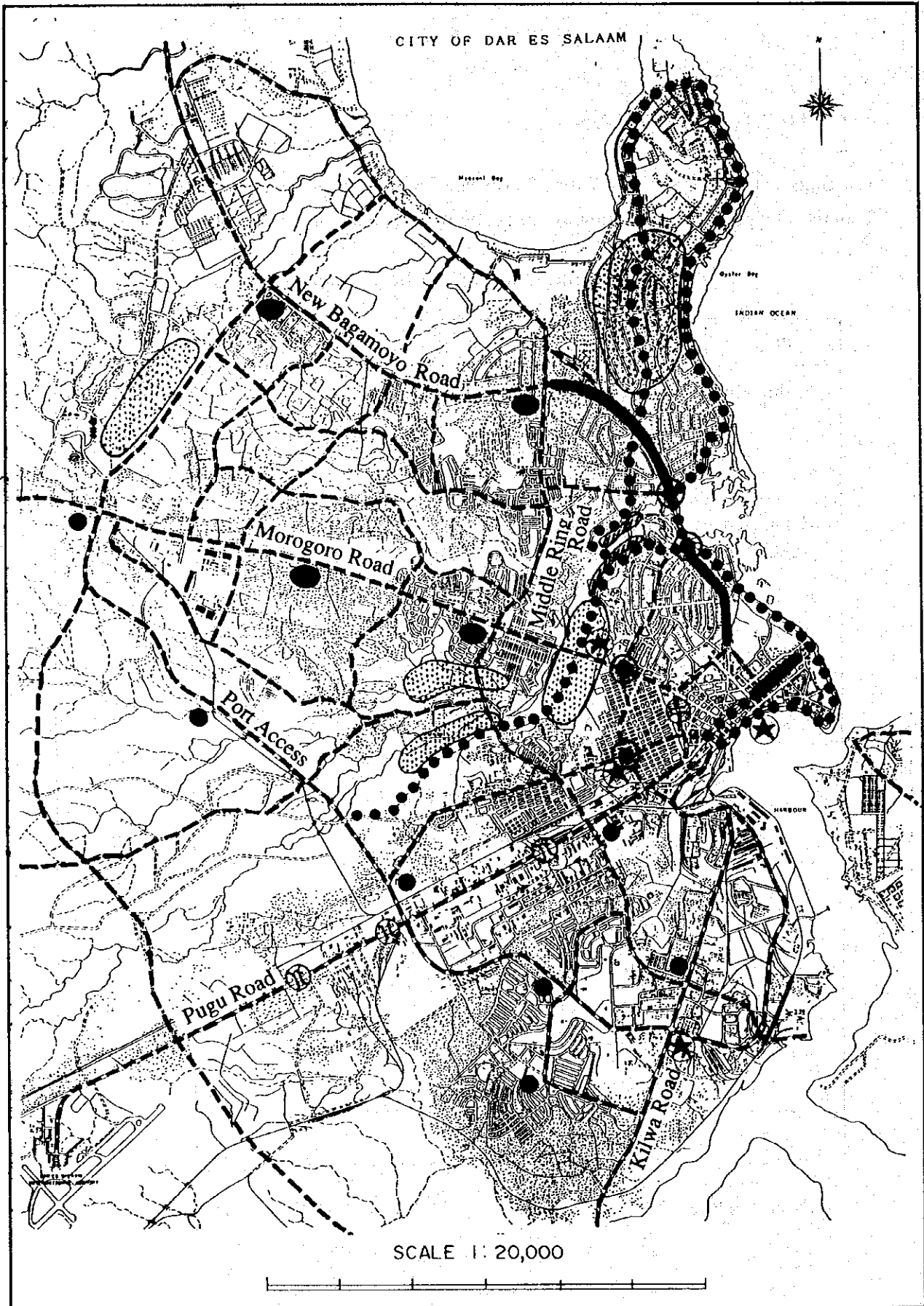










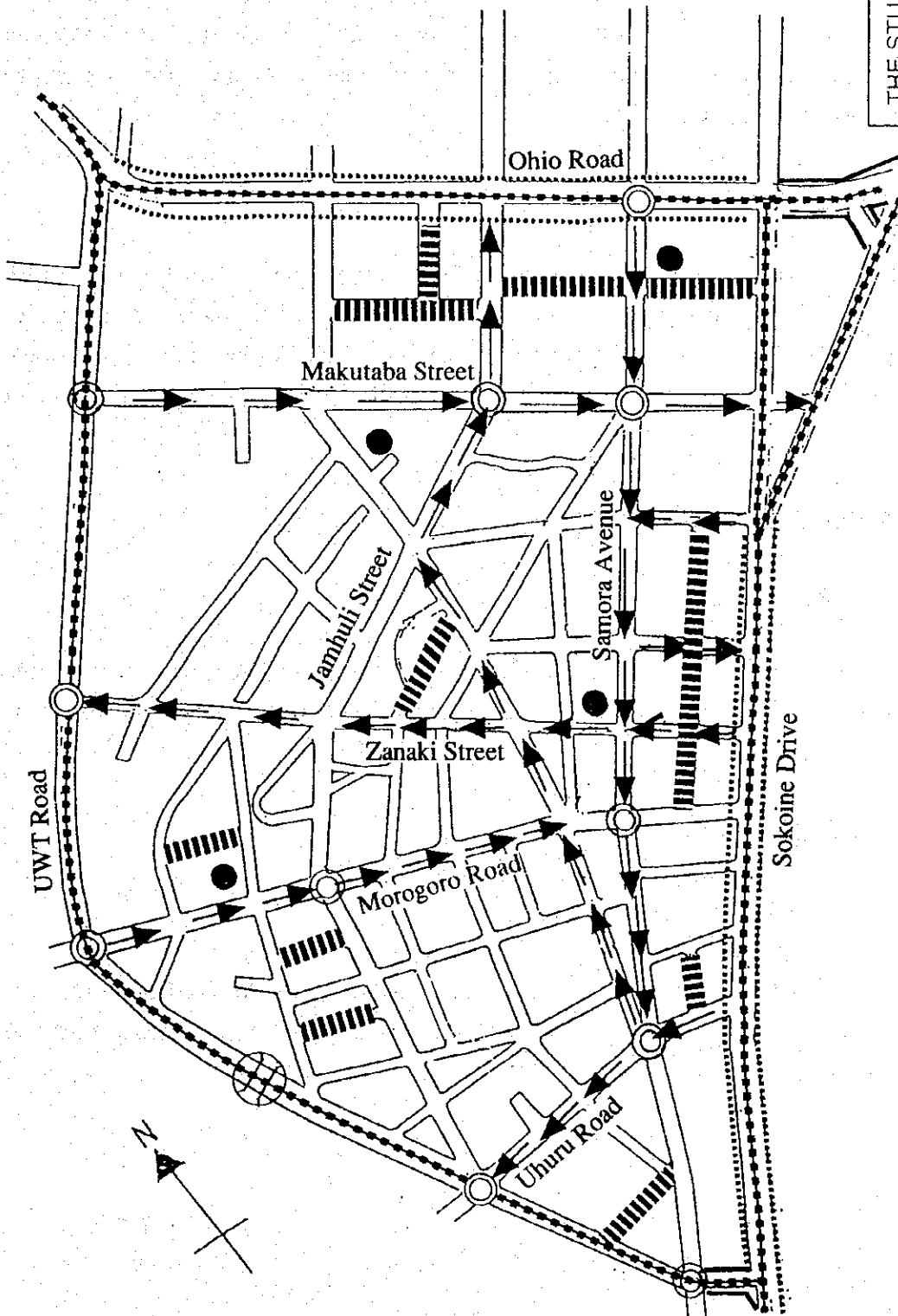


Fig.A.3(1)Traffic Management Plan

- | | | | |
|---|---------------------------------|---|----------------------------|
|  | Mangrove Areas |  | Bus Terminal |
|  | Roadside Trees |  | Bus Station |
|  | Residence Trees and Green Space |  | Bus Junctionon |
|  | Road with Sidewalk |  | Pedestrian Crossing Bridge |
|  | Pedestrian/ Bicycle Way |  | Improvement of Bottlenecks |



- Intersection to be Improved
- ⋯ New Construction
- ▬ Widening
- ▬ Non-restriction route for Heavy Vehicle
- ↑ One-way Traffic Regulation
- ▬ Non-through-traffic Route
- Multi-story Public Parking Garages
- ⊗ Pedestrian Crossing Bridge

THE STUDY ON THE DAR ES SALAAM ROAD DEVELOPMENT PLAN

Fig. A.3(2) Traffic Management Plan in City Center

A-4 Short-term Development Plan

The Short-term Development Plan for road, public transport and traffic management consisting of priority projects selected from the Master Plan are concluded to be implemented by the year 2000.

The basic attitude for formulating the Short-term Development Plan is to consider minimum level of improvement on transportation infrastructure and traffic management measures so as to extract maximum services from the existing facilities, to improve maximum level of transport services to the public and to secure the traffic safety.

A-5 Summary of the Required Cost

The required preliminary cost was estimated on the basis of work quantities and unit prices for the purposes of the Master Plan Study. The disbursement schedule of the Short-term and Long-term Development Plans has also been set forth as shown in Table A.4, in order to secure the yearly amount of funds required for the implementation of the Plan by the Government of Tanzania.

A-6 Economic and Financial Viability

(1) Economic Feasibility

It is concluded that the Development Master Plan for road, public transport and traffic management is technically and economically feasible with high economic indicators as shown below.

Benefit/Cost Ratio	= 1.46
Net Present Value	= 52,859 Million Tsh.
Internal Rate of Return (IRR)	= 15.7 %

Expected annual benefit derived from the implementation of the Master Plan in the year 2010 is estimated to be Tsh. 52.1 billion and total amount over 15 years after completion of the Master Plan would be Tsh. 815.7 billion.

Table A.4 Summary of the Required Cost for the Implementation of the Master Plan

Unit: Million Tshs.

Development Plan	Short-term Plan (1995 - 1999)						Long-term Plan (2000 - 2010)	
	1995	1996	1997	1998	1999	Total Period	Average Annual Amount	Total Period
Category A: Road Development Plan	10,640	10,230	13,360	16,488	15,197	65,935	14,123	155,360
Category B: Public Transport Development Plan	1,095	-	-	-	-	1,095	44	480
Category C: Traffic Management Development Plan	315	1,975	1,200	-	-	3,490	1,264	13,900
Total	12,050	12,205	14,560	16,488	15,197	70,520	15,431	169,740

Exchange Rate: US\$1.00 = Tshs 490 = ¥110 (As of January 1994)

(2) Financial Viability

It is recommended that the amount of funds required for the implementation of the Short-term Plan shall be allocated by the Government of Tanzania considering the appropriate proportion between 16% of the required cost ratio inside the Integrated Road Projects II (IRP II) and 16% of Gross Regional Product (GRP) proportion of Dar es Salaam Region in the context of resources allocation.

Nevertheless, the cost required for Long-term Plan might occupy approximately 15% of the expectable amount of extended IRP during the planning period. The cost of Long-term Plan is also justified, when comparing to the 16% of GRP proportion of Dar es Salaam Region.

(3) Budgetary Arrangements

Taking into account past performance in resources allocation, financial supporting for the implementation of the Master Plan is strongly requested to international organizations and the donor community.

According to the magnitude and importance of the projects proposed in the Master Plan both functionally and technically, it is recommended that the most functional and urgent projects are expedient to be grant project and others are to be financed mostly by foreign loans and the rest by local funds.

A-7 High Priority Projects

The Study Team concluded that the High Priority Road Projects subject to the Feasibility Study should be among the priority road development projects in the Short-term Road Development Plan, through the evaluation of the following factors:

- Enhancement and improvement of urban traffic efficiency
- Promotion and stimulation of potential suburban development
- Prevention of haphazard urban sprawl
- Magnitude of required funds for construction
- Improvement of accessibility to public transport services
- Ease of construction in terms of land acquisition and local funds
- Necessity of high construction technology
- Urgency of the project from the viewpoint of safety
- Contribution to non-motorized transport

- Improvement of road-side environment

The High Priority Projects consist of three kind of components: namely, road development plan, traffic management plan and public transport plan as outlined below.

(1) Road Development Plan

- Package AS-1 : Widening of Arterial Roads in Central Area
- Package AS-2 : Widening of Middle Ring Road with construction of Missing Link
- Package AS-3 : Widening of Radial Trunk Roads

(2) Traffic Management Development Plan

- Arrangement of Public Parking Spaces within the Multi-story Parking Garage Annexed to the New Business Building Proposed by the National Housing Corporation at Samora Avenue
- Improvement of Intersections at Bottleneck Points
- Traffic Regulation in the City Center

(3) Public Transport Development Plan

- Construction of New Bus Terminal at Jangwani along Morogoro Road with Shuttle Bus Operation
- Strengthening of City Bus Terminals at Sokoine Drive and Kariakoo
- Improvement of Major Bus Terminals at Major Intersections

The basic attitude for selecting the High Priority Projects of traffic management plan and public transport plan is to consider minimum level of improvement on transportation infrastructure and traffic management measures so as to extract maximum services from the existing facilities.

PART B: FEASIBILITY STUDY

B-1 CONCLUSION

B-1-1 High Priority Projects to be Implemented in the Short-term Plan

The Study Team concluded that the following improvement measures shall be implemented in the Short-term Plan (1995 - 1999) from the viewpoint of engineering, socio-economy, environment and policy of the Tanzanian Government.

Table B.1 High Priority Projects to be implemented in the Short-term Plan

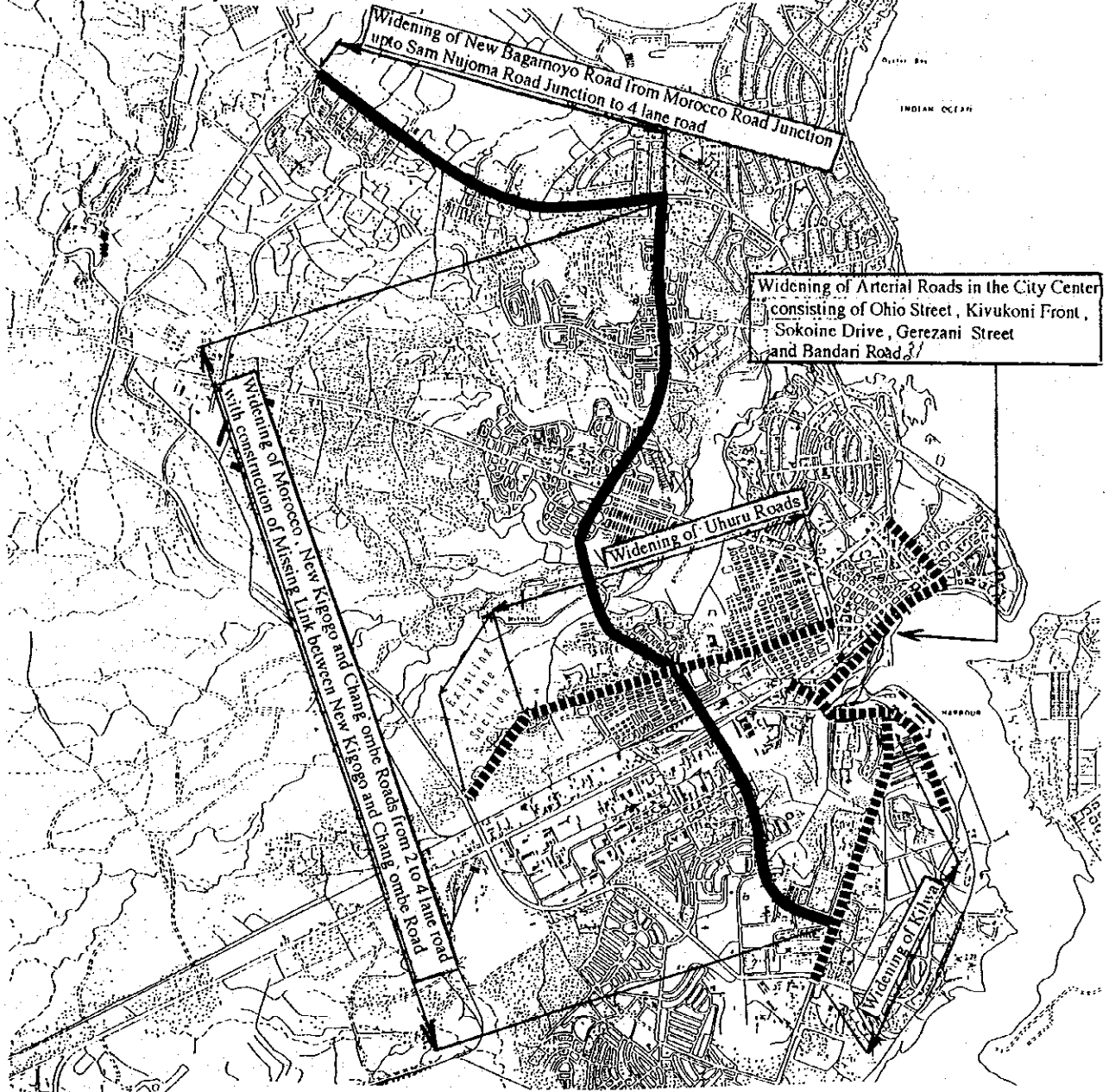
High Priority Projects to be Implemented in the Short-term Plan		Project Length (km)	Lane No.
Package A:	Widening of Middle Ring Road and New Bagamoyo Road from 2 to 4 lanes including:	<u>14.15</u>	<u>4</u>
A-1:	Widening of Middle Ring Road	<u>9.88</u>	<u>4</u>
	- Morocco Road	3.56	4
	- New Kigogo Road	2.78	4
	- Chang'ombe Road	2.80	4
	- Construction of Missing Link between New Kigogo and Chang'ombe Roads	0.74	4
A-2:	Widening of New Bagamoyo Road from Morocco Road Junction upto Mpakani Road Junction	<u>4.27</u>	<u>4</u>
Package B:	Widening of Arterial Roads in Central Area and Radial Trunk Roads including:	<u>13.84</u>	<u>4</u>
B-1:	Widening of Ohio, Sokoine, Gerezani and Bandari Roads from 2 to 4 lanes with Reconstruction of Gerezani Bridges	<u>5.98</u>	<u>4</u>
B-2:	Widening of Kilwa and Uhuru Roads	<u>7.86</u>	<u>4</u>
	- Kilwa Road	3.06	4
	- Uhuru Road	4.80	4

Exchange Rate: US\$1.00 = Tshs. 530 = ¥100 (As of July 1994)

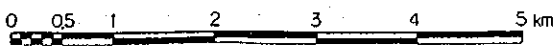
CITY OF DAR ES SALAAM



- Package A : Widening of Middle Ring Road and New Bagamoyo Road consisting**
- Widening of Morocco , New Kigogo and Chang'ombe Roads from 2 to 4 lane road with construction of Missing Link between New Kigogo and Chang'ombe Road
 - Widening of New Bagamoyo Road from Morocco Road Junction upto Sam Nujoma Road Junction to 4 lane road



- Package B : Widening of Arterial Roads in the City Center and Kilwa and Uhuru Roads consisting**
- Widening of Arterial Roads in the City Center consisting of Ohio Street , Kivukoni Front , Sokoine Drive , Gerezani Street and Bandari Road
 - Widening of Kilwa and Uhuru Roads



THE STUDY ON DAR ES SALAAM ROAD DEVELOPMENT PLAN

Fig B-1 High Priority Projects to be implemented

Package A : Widening of Middle Ring Road and New Bagamoyo Road consisting **—————**
 Package B : Widening of Arterial Roads in the City Center and Kilwa and Uhuru Roads consisting **-----**

B-1-2 Project Implementation Programme

The tentative implementation programme of the High Priority Projects with cost disbursement schedule has been prepared by the Study Team as shown in Table B.2 taking into consideration possibility of financial arrangements of the Tanzanian government as well as ease of implementation from the viewpoint of necessary arrangements required for land/house acquisition, resettlement and compensation.

B-1-3 Environmental Assessment

With the steadily increasing population in Dar es Salaam, it is predicted that reduction of the functional efficiency of the city and worsening of urban environment resulting from traffic congestion will be aggravated unless the present social infrastructure is improved.

The implementation of the High Priority Project will bring about many beneficial changes for the society, economy and environment as described below.

- Elimination of Flood Hazard

Overflow of water on the roads to include flooding has been observed in many places in Dar es Salaam due to the damaged road surface and insufficient drainage conditions. This flooding will be eliminated by improvement of the road pavement and roadside drainage in the course of the project implementation.

- Establishment of Mitigation Measures for Resettlement

Widening of the priority roads will require the acquisition of approximately 600 buildings along the road frontage.

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

- Prevention of Air Pollution

Unless the present road conditions are improved, air pollution will become much worse due to an increase of the traffic congestion.

It is concluded that the air pollution can probably be reduced to the level of international environmental preservation target, since the Project will reduce the traffic congestion on the roads.

- **Improvement of Roadside Areas and Reduction of Traffic Accidents**

It is concluded that the roadside environment will be improved by the provision of trees, lighting and other ancillary facilities with the implementation of the Project, for the conformity of pedestrians and near-by residents. Furthermore, traffic accidents will be reduced by the provision of safety measures proposed for drivers, pedestrians, cyclists and residents.

B-1-4 Economic Feasibility and Socio-economic Impact

(1) **Economic Feasibility**

It is concluded that each package of the High Priority Projects would be technically and economically feasible with very high values of economic indicators as shown below.

High Priority Project Package	Benefit/Cost Ratio (B/C)	Net Present Value (NPV) (Billion Tsh.)	Internal Rate of Return (IRR) (%)
Package A: Widening of Middle Ring Road and Bagamoyo Road	2.7	27.1	28.6
Package B: Widening of Arterial Roads in City Center and Kilwa and Uhuru Roads	3.1	26.8	35.6
Package (A + B)	2.8	47.3	29.7

(2) **Direct Benefits**

Direct benefits summing up the savings in vehicle operation cost and time cost are expected to be large. An annual benefit derived from the High Priority Projects in the year 2000 is expected to be Tsh. 8.7 billion and total amount over 15 years after completion of the projects would be Tsh. 212.8 billion.

(3) **Socio Economic Impact Expected**

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

(a) Improvement of Traffic Congestion on the Trunk Road Network

Due to the high rate of the city's expansion as well as the recent acute increase of traffic demand accompanying the economic recovery in Tanzania, the traffic flow on the city roads greatly increased and caused serious traffic congestion on the trunk roads which have insufficient traffic capacity due to having only 2 lanes.

The Widening of the Middle Ring Road and other trunk roads from 2 to 4 lanes will solve a chronic traffic congestion on the roads in the city. Also, it will improve not only the economic and social activities but also the daily life of the people in the city.

(b) Reduction of Traffic Concentration in the City Center

The concentration of traffic into the City Center has become worse and worse due to shortage of road capacity and lack of appropriate detour route for through traffic in the City Center.

The widening of the Middle Ring Road and Arterial Roads in the City Center will reduce the heavy concentration of traffic in the City Center by providing a direct detour route for the through traffic between the residential areas and the industrial and port areas.

(c) Basic Frame of Urban Development

The High Priority Project roads were planned to provide a basic frame for the urban trunk road network with sufficient road spaces for the future traffic demand in the Short-term Plan. Also, they are to provide a basic frame for the future urban development of Dar es Salaam sub-urban areas and Kigamboni area in the Long-term Plan.

(d) Improvement of Public Transport Services and Non-motorized Traffic

It should be pointed that the majority of city dweller are public and non-motorized transport users in Dar es Salaam; however, there are very few trunk roads in which the dedicated transport lanes for buses and bicycles/carts are provided.

The High Priority Projects will provide sufficient pedestrian walkways and cycle tracks on both sides as well as to provide suitable bus stations for changing purposes at every important intersection with the radial trunk roads.

(4) People and Area benefited by the Project

The Project will exert an influence on a large majority of people and area in Dar es Salaam as shown below.

- Total number of population that will benefit directly from the Project is estimated to be 1.5 million people who are living in the urban area of Dar es Salaam.
- Total number of population that will benefit indirectly from the Project is estimated to be 2.0 million people within the entire Region of Dar es Salaam.
- Area that will benefit from the Project would cover the whole urbanized areas of Dar es Salaam Region.

B-2 RECOMMENDATIONS

In order to materialize the Project, the Study Team recommends MWCT to take the following actions:

(1) Financing Measures Required

Since the project implementation will greatly enhance the urban traffic in and around Dar es Salaam, financing measures for capital investment are recommended to be obtained by means of foreign aid from the viewpoint of government budgetary situation and the past experience of road improvement in Dar es Salaam.

It is also recommended that supply measures of the required maintenance cost for the Project should be secured by strengthening of the existing Road Fund account.

(2) Allocation of Local Budget for Acquiring Land/House

It is recommended to allocate the necessary amount of local funds for acquiring the lands and houses which might be necessary for implementation of the Project.

Land and house acquisition should be conducted according to the project implementation schedule as follows:

Year	Schedule of Land/House Acquisition
1st year (1995)	Acquiring land and houses located at the Mpakani Road intersection on New Bagamoyo Road
2nd year (1996)	Acquisition/relocation of land and houses within the ROW along Middle Ring Road
3rd year (1997)	Acquisition/relocation of Land and houses within the ROW along the Arterial Roads in the City Center and Uhulu Road
4th year (1998)	Acquisition/relocation of Land and houses within the ROW along Kilwa Road

Furthermore, it is recommended that the land required for the road development should be controlled by the government 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 Project is started.

In order to prevent social, economic and environmental impacts of the resettlement on the residents, it is recommended that a suitable resettlement plan should be established paying a due attention to the following items:

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

(4) Improvement of Storm Drainage System

Although storm water drainage system is provided, two areas along the Kijitonyama River and the Gerezani Creak become inundated due to insufficient capacity of the existing channel and low land lying near the sea level, respectively.

On the other hand, the proposed improvement measures for the two inundated areas in terms of construction cost, construction period, etc. are too large to include as a part of the road construction project.

Therefore, it is recommended that the two inundated areas be incorporated into a river improvement or storm drainage improvement project that should be implemented in parallel with the road construction.

(5) **Regulations for River Basin Land-use**

Since houses are being randomly built in the river basins, it is recommended to establish proper land-use regulations for river basin and to properly maintain the storm water drainage system for them.

(6) **Establishment of Comprehensive Legislation for Air Pollution Prevention**

It is predicted that air pollution will worsen in Dar es Salaam by motor vehicles and factories due to accelerating industrialization.

It is therefore recommended to establish national legislation, including air pollution control law and periodic motor vehicle inspection system, as soon as possible.

(7) **Confirmation of Actual Location of Proposed Bus Service Facilities**

As the proposed roads are now being utilized for major bus service routes, improvement of bus service facilities has been proposed as one of the components of the High Priority Projects.

It is recommended that the actual location of the proposed bus stops, bus bays and bus stations be determined after holding discussions with bus operating companies and agencies concerned in order to realize smooth and safe bus operation.

(8) **Development of DRIMP Office as On-the-Job Training Center**

Road maintenance contract has been introduced in line with the MWCT's policy for using the private sector to maximize the efficiency of maintenance work in terms of cost, quality and progress. The full extent of contract maintenance, however, will need sufficient transition period due to the lack of resources and maintenance experience of local contractors.

In this regard, the Study Team recommends to develop the Office of DRIMP (Des es Salaam Road Improvement and Maintenance Project) located in Ilala Garden as a maintenance training center for urban roads. The purpose of this will be to provide on-the-job training for the staff of MWCT, DCC and private contractors, not only to meet the above-mentioned requirements of MWCT's policy but also to encourage maintenance on a contract basis.

SUMMARY OF THE STUDY

PART A : MASTER PLAN STUDY

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Dar es Salaam, which is the economic center and the most populated city in the United Republic of Tanzania, has grown at a remarkable rate in recent years. As a result of this growth, traffic congestion complicated by the poor state of the existing roads has become a major obstacle for further economic recovery, particularly within the Central Business District (CBD). The Government, in its wish to formulate a comprehensive road network plan, requested assistance of the Japanese Government to conduct The Study on Dar es Salaam Road Development Plan (hereinafter referred to as "the Study").

1.2 Objectives of the Study

The major objectives of the Study are:

- (1) To formulate a master plan for Road Development in Dar es Salaam for the period up to the year 2010 together with a traffic management plan for major arterial roads in Dar es Salaam.
- (2) To conduct feasibility study of the priority roads selected in the master plan.

1.3 Study Area and Roads to be Studied

The Study Area covers an entire area of Dar es Salaam Region. The roads to be studied include trunk roads and regional roads within the urban area in addition to some potential regional roads relating to future regional development of Dar es Salaam city/region area.

1.4 Work Schedule of the Study and Organization of the Study Team

The Study began in the middle of October 1993 and has concluded at the end of February 1995. An overall work flow illustrating inter-relationship of each activity in the Study is presented in Fig. 1.1. The Organizations of the Study Team, the Advisory Committee of JICA, the Steering Committee of the Government of Tanzania and the counterpart personnel assigned are summarized in Fig. 1.2.

Fig. 1.1 Work Flow Diagram

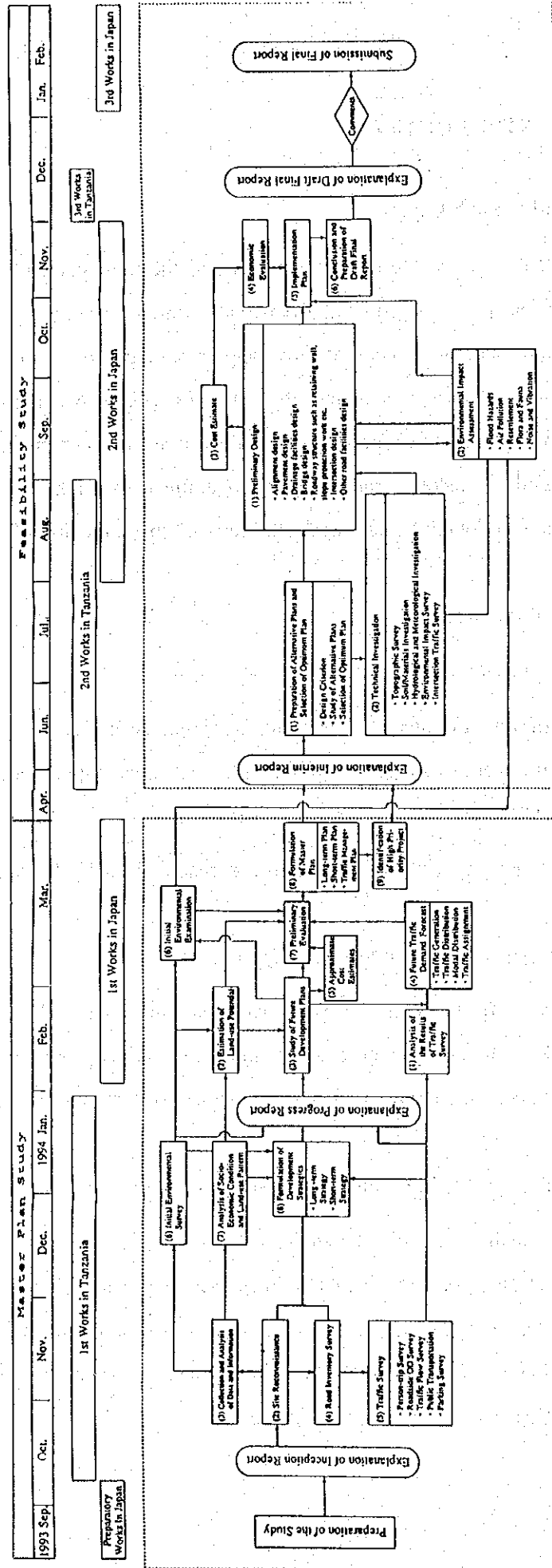
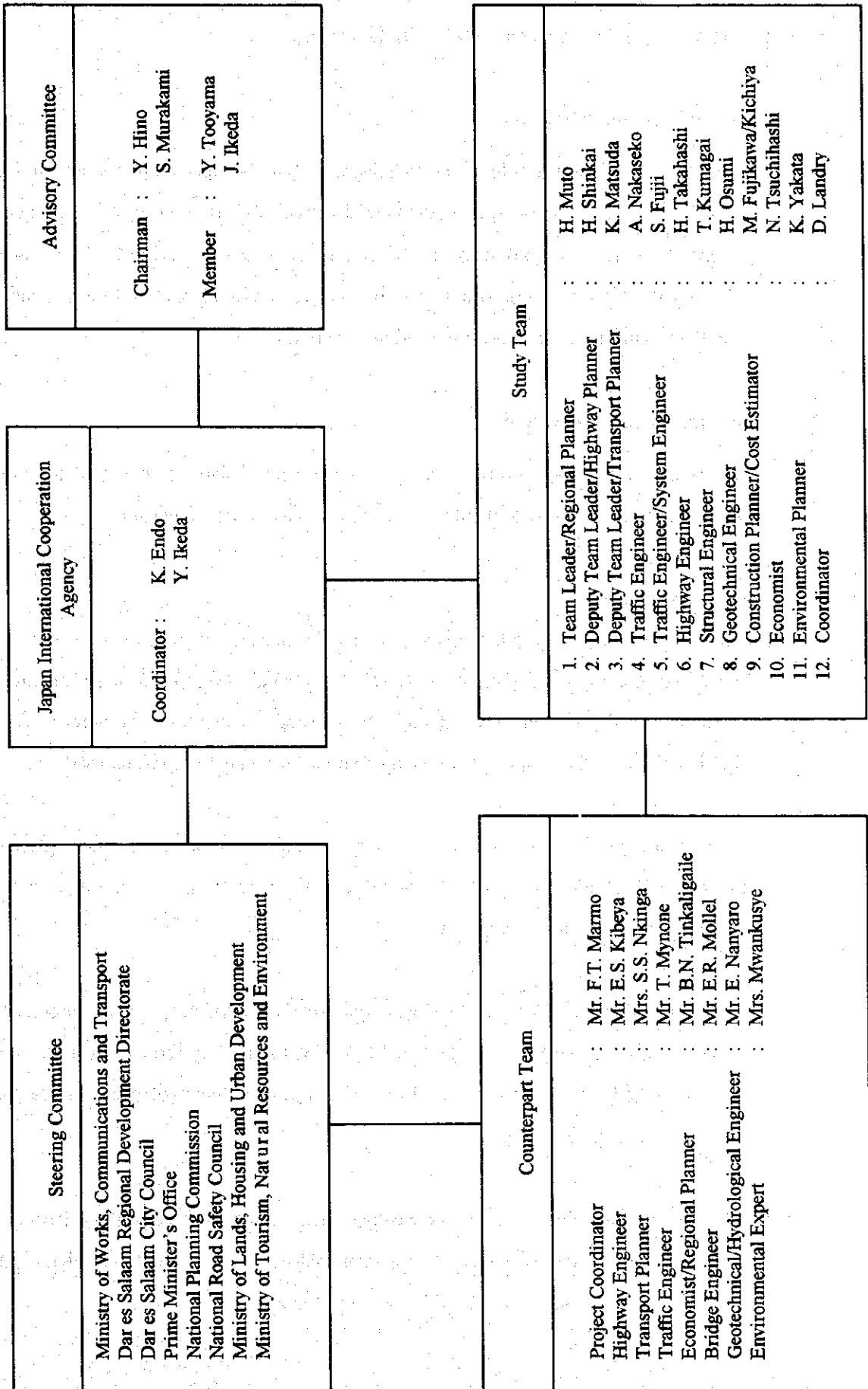


Fig. 1. 2 Organization Chart



CHAPTER 2 SOCIO-ECONOMIC CONDITIONS

2.1 The Role of Dar es Salaam

With regard to the future role of Dar es Salaam, the city is expected to continue to experience growth of national economic and commercial activities. Furthermore, it is expected that the government functions will remain centered in the city of Dar es Salaam for foreseeable period.

The city will also continue to dominate the industrial, commercial and transportation sector growth in Tanzania as well as for education and culture.

2.2 Existing Urban Condition

The existing urban conditions are in a poor state particularly with regard to problems of deteriorated infrastructure and public utilities as well as traffic congestion.

(1) Land - use Pattern

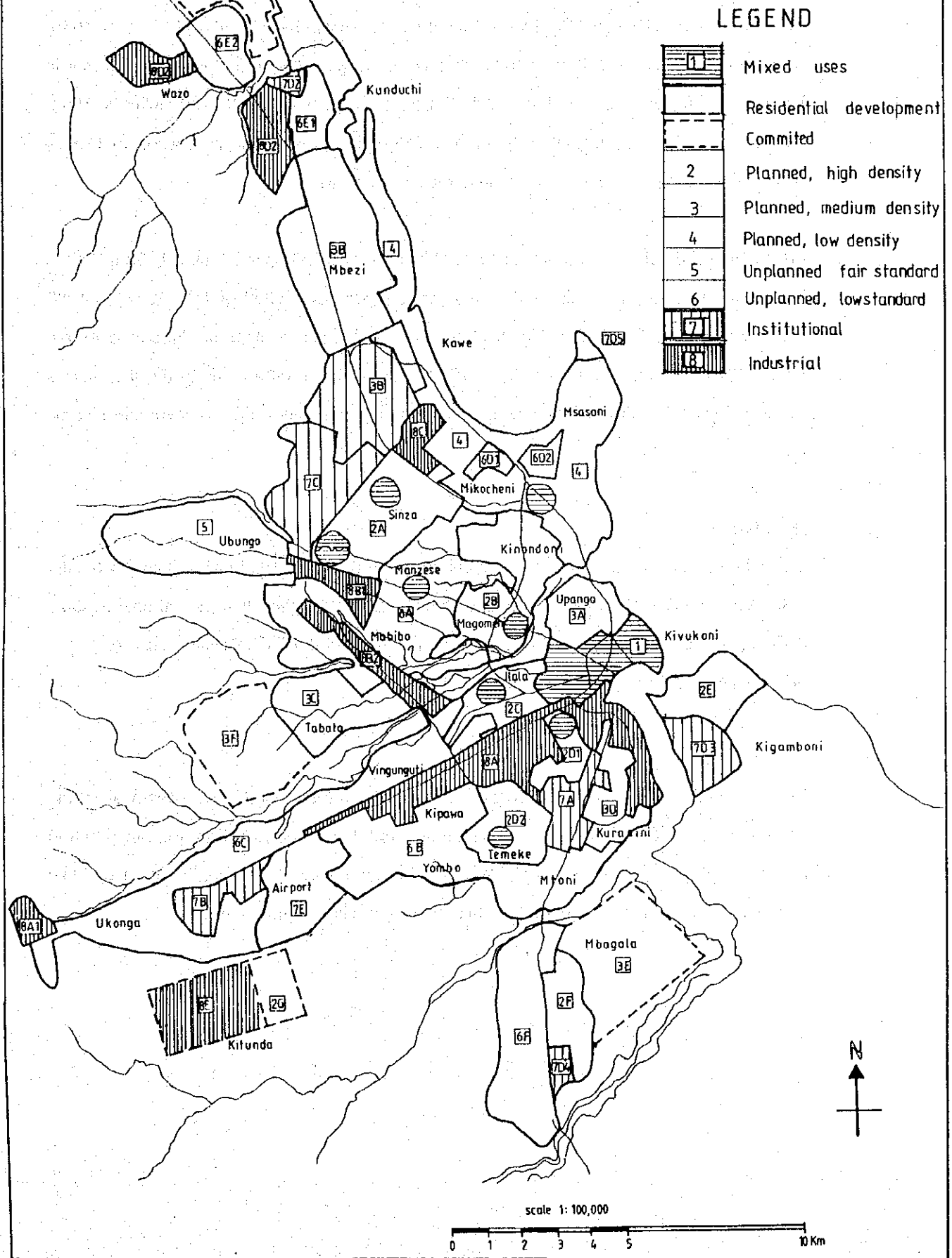
Urban expansion (growth) has followed along the main trunk roads; towards the towns of Bagamoyo, Morogoro, Kisarawe and Lindi. Residential development has primarily focussed on suitable land areas in between these trunk roads. The low, swampy area along the Msimbazi River and Creek creates a wedge in urbanization between trunk roads.

To the north of the city sea-shore, other residential development is taking place between Bagamoyo Road and the coast. However, expansion towards the west and south is still characterized as ribbon development.

To the east of Mzinga Creek is the Kigamboni urban area which is located adjacent to the oil refinery. This area is linked to the central area of the city by ferry crossing located at the entrance to the harbour of the creek. Road access to this area involves a considerable detour and considerable time

Industrial areas have primarily been developed towards the west along Pugu Road and south of the port along Mzinga Creek. Large industrial estates are also found along the Nelson Mandela Road, Morogoro Road and Bagamoyo Road.

Fig. 2.1 Existing Land-Use (1992) and Land-Use Concept (2000)



(2) Economic Activity and Income Level

Statistics of Gross Regional Product (GRP) of Dar es Salaam have been available since 1980.

Dar es Salaam GRP was Tshs. 9,462 million composing 25.2% of the total Gross Domestic Products (GDP) of Tanzania (Tshs. 37,454 million). It grew to Tshs.97,780 million in 1992, which was 14.2% of the total GDP (Tshs. 1688,634 million). The proportion of Dar es Salaam GRP to GDP has been declining in the past 12 years.

Per Capita production in Dar es Salaam was Tshs. 9,072 in 1980, and Tshs. 59,538 in 1992. To the same period, Tanzanian economy registered per-capita GDP of Tshs. 2,072 in 1980 and Tshs. 26,593 in 1992. Magnification ratio of Dar es Salaam production over the mainland was 4.38 in 1980 and 2.24 in 1992. Although the ratio tends to decline, Dar es Salaam Region is still drawing transmigrant working population due to favorable income level.

(3) Population

The Dar es Salaam Region had a population of 356,300 in 1967,843,100 in 1978, and 1,360,900 in 1988. The average annual growth rate was higher than the national average 8.1% for the period 1967 to 1978, and 4.9% for the period 1978 to 1988. This trend was due to transmigration from all over the country.

(4) Employment

Employment in the Dar es Salaam Region was clarified in the "1988 Census: Regional Profile - Dar es Salaam". Out of the total population of 1,360,900 in Dar es Salaam Region, 539,800 are the employed, of which 473,100 are in urban employment, and 66,700 in rural. The employment percentage to the total population for the whole region is 39.7%.

CHAPTER 3 TRAFFIC SURVEY AND ANALYSIS

3.1 Classification and Scope of Traffic Survey

In order to understand the characteristics of present traffic movement in Dar es Salaam and to prepare data necessary for future traffic demand forecast, the following traffic surveys were carried out in November and December 1993:

- (a) Home Interview Survey (Person Trip Survey)
- (b) Roadside OD Survey
- (c) Traffic Flow Survey
 - Roadside Traffic Counts
 - Intersection Traffic Counts
 - Vehicle Speed Survey
- (d) Bus Terminal Survey
- (e) Car Parking Survey
- (f) Traffic Generation/Attraction Survey
- (g) Traffic Accident Survey

3.2 Major Results of Traffic Survey

3.2.1 Traffic Volumes on Major Roads

Traffic volume on road network in Dar es Salaam is presented in Fig. 3.1, according to which traffic volume on major road is as follows:

Unit: ADT

Pugu Road	: 20,000 ~ 30,000
Morogoro Road	: 15,000 in average
Bagamoyo (Upanga) Road	: 15,000 in average
Nelson Mandela Road	: 15,000 in average
UWT Road	: 15,000 ~ 20,000

3.2.2 Historical Trend of Traffic Volume

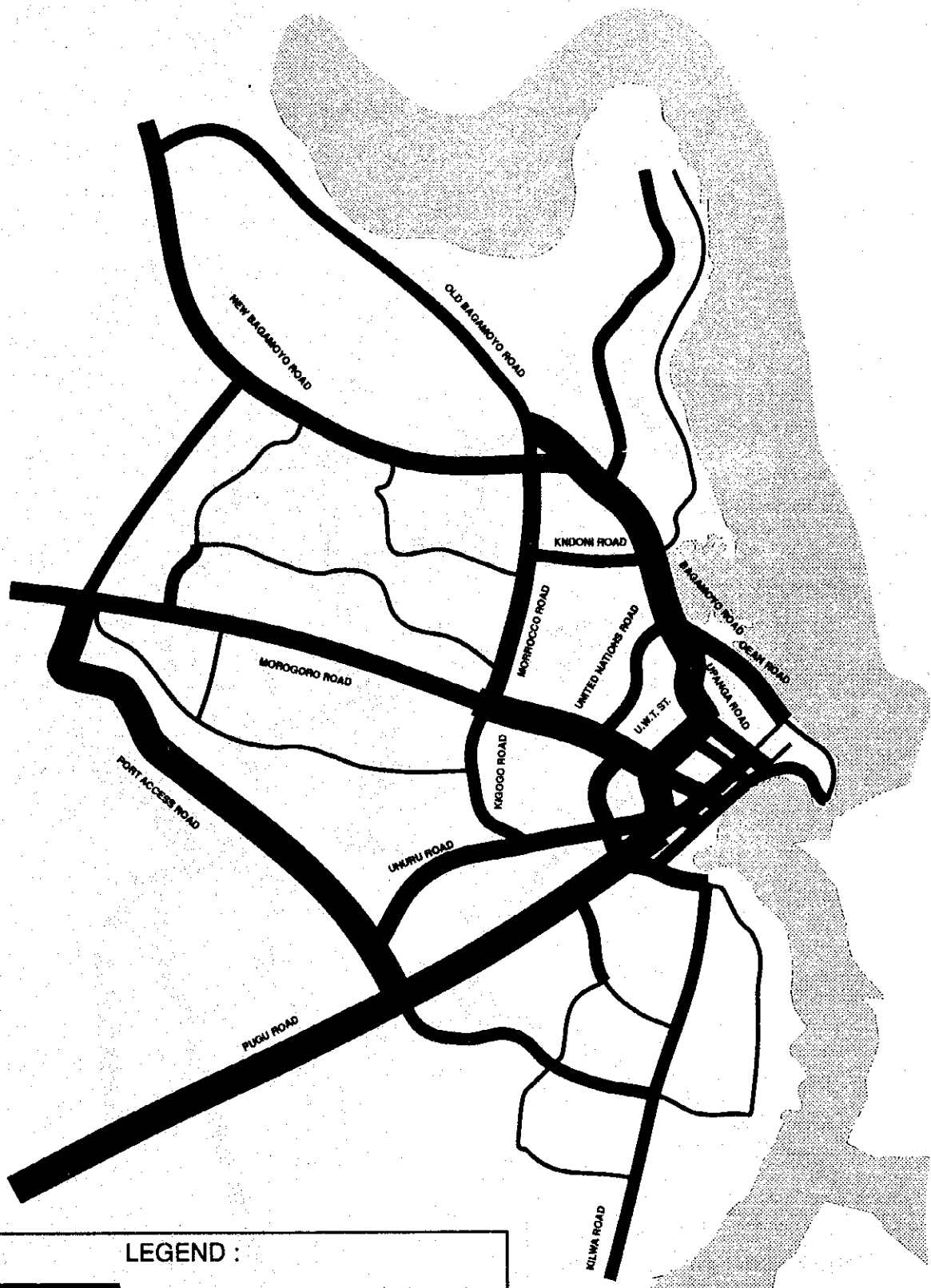
Compared with the traffic data obtained for the DRIMP Study *(JICA, 1989), road traffic in Dar es Salaam is found to be increasing at 3.1% annually.

*The Study on Road Improvement and Maintenance in Dar es Salaam

3.2.3 Characteristics of Road Traffic

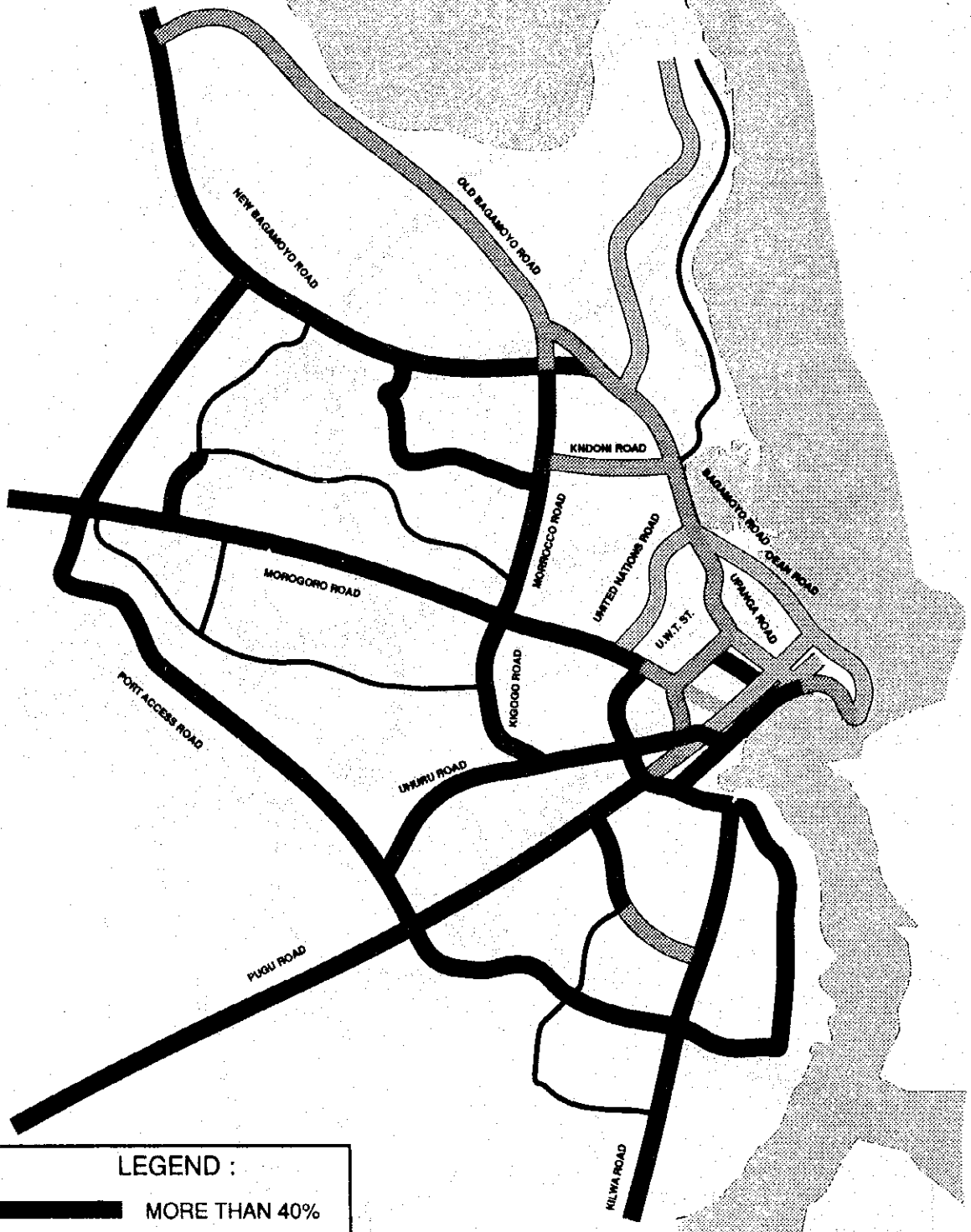
Characteristics of road traffic in Dar es Salaam are described as below.

- Large share of passenger car (more than 75%) could be found on such road as Sokoine Drive and Samora Avenue, which are located in the city center.
- Large share of trucks could be found on Nelson Mandela Road where share of trucks in total vehicles is more than 40%.
- Peak hour of traffic could be seen during 7:00 ~ 8:00 in the morning and 15:00 ~ 16:00 in the evening. Peak hour ratio is about 12%.
- Large vehicle/capacity ratio could be seen on such roads as Morocco Road, Uhuru Road, Sokoine Drive and Gerezani Road as shown in Fig. 3.2.
- Bus Users
Total number of bus users in the city center is estimated at about 300,000/day, of which about 4,000 are long-distance bus users.
- Parking
Total number of vehicles parked in the city center, which is the area encompassed by UWT Road, Sokoine Drive and Ohio Street is estimated to be 120,000 per day, whilst the number of authorized parking spaces in this area is only 4,000. This fact suggests serious shortage of parking spaces.
- Traffic Accident
Uhuru Road and Kilwa Road tend to show high accident rate as shown Fig. 3.3.
- Characteristics of Person Trip
Total number of trip in urban area, the area within Nelson Mandela Road, is about 3 million per day. Large percentage of bus usage, which is as high as 47%, is one of the characteristics of PT in Dar es Salaam.
- Present OD Pattern
High concentration of traffic in the city center is found in present OD pattern of urban traffic as shown in Fig. 3.4.



LEGEND :

	MORE THAN 15,000 Vehicle / 12h
	15,000 - 10,000 Vehicle / 12h
	10,000 - 5,000 Vehicle / 12h
	LESS THAN 5,000 Vehicle / 12h

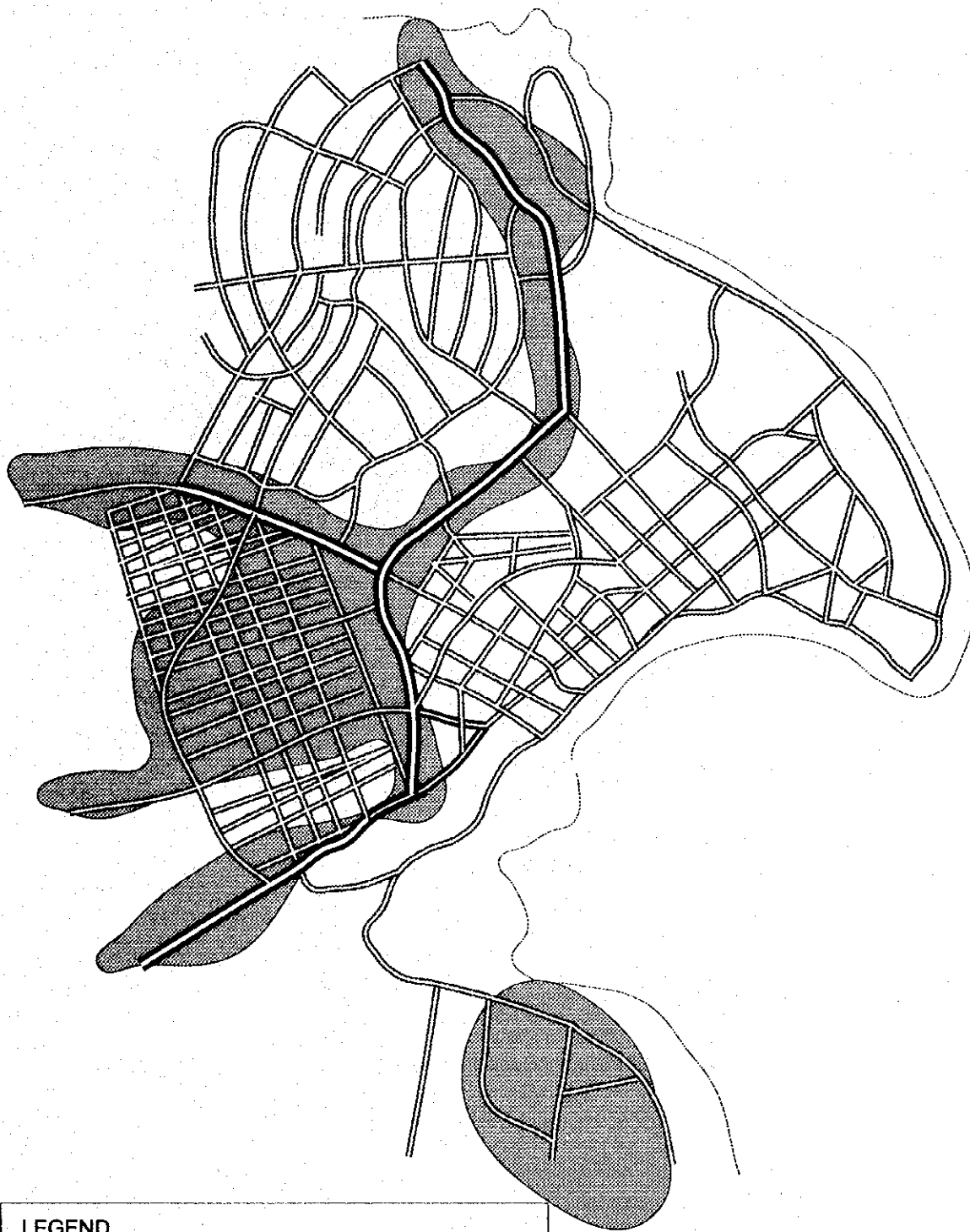


LEGEND :


	MORE THAN 40%
	40 - 30%
	30 - 20%
	20 - 10%
	LESS THAN 10%

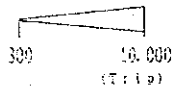
THE STUDY ON DAR ES SALAAM ROAD DEVELOPMENT PLAN

FIG 3.2 Heavey Vehicle Ratio



LEGEND

 AREA OF ACCIDENT PRONE ROADS



CHAPTER 4 PRESENT TRANSPORTATION SYSTEM IN DAR ES SALAAM

4.1 General

Based on road inventory survey, available statistics, observations and characteristics of urban transportation, major problems and issues have been identified as explained below.

4.2 Identification of Existing Problems and Issues

4.2.1 Road Network

(1) Existence of Missing Link on Major Trunk Road

The route consisting of Morocco Road, New Kigogo and Chang'ombe Roads, could be identified as the city's Middle Ring Road functioning as a major trunk thoroughfare. This ring road, however, does not form a complete semicircular network because of a missing link between New Kigogo Road and Chang'ombe Road, and therefore functions inefficiently as a trunk road in dispersing traffic to and from the city center, which results in traffic congestion on Morogoro, UWT and Pugu Roads.

(2) Shortage of Traffic Capacity on Trunk Roads in the City Center

The traffic situation in the city center is steadily becoming worse due to insufficient traffic capacity of roads, such as Sokoine Drive, Samora Avenue, Gerezani Street, Ohio Street, Azikiwe/Makataba Street, Zanaki Street and Morogoro Road. These roads are expected to become trunk roads forming a basic frame of the city center. According to the results of traffic survey, these roads carry a traffic volume of 10,000 to 13,000 per day which is beyond the traffic capacity of 2-lane road.

The congestion of these roads could be improved in the short term by introduction of new traffic management policy which is not, however, a permanent solution for the relief of congestion on arterial roads in the city. In order to maintain the function of Dar es Salaam as an administrative, economic and social center of Tanzania, it will be necessary to upgrade many roads from 2 to 4 lanes to solve the shortage of traffic capacity.

Possible roads for upgrading could be Ohio Street, Sokoine Drive and Gerezani Street which will form the 4-lane ring road surrounding the city center by connecting with UWT Road. These roads could be widened to 4-lane road without much troubles in buildings removal and compensation.

(3) Inefficiency in Creek Crossing Capacity between City Center and Kigamboni Area

Ferry services are operating at Kigamboni Creek with an average frequency of 3 times per hour for both directions between the city center and the northern tip of Kigamboni Peninsula. The number of passengers and vehicles transported by the ferry in 1992 were estimated to be about 8.1 million and 235 thousand respectively, or 22,000 persons/day and 650 vehicles/day respectively.

Ferry operation would continue in the near future and shortage of creek crossing capacity between the city center and Kigamboni would become serious.

As a solution the expansion of ferry capacity would not meet anticipated traffic demands caused by development of Kigamboni; limited capacity and unreliable operation. Ferry capacity could only be expanded by increase of the ferries; however, the operational difficulty from a safety stand point could prove to be an obstacle.

(4) Shortage of Collector Roads in the Sub-urban Areas

The road density in the area inside Nelson Mandela Road is extremely low because of an insufficient road network there. Areas within Nelson Mandela Road are characterized as being sub-urban with steadily increasing population.

The collector road network forms a link between trunk roads and roads in neighborhood areas which are directly related to local economic and social activities. Therefore, development of these roads is essential not only for facilitating anticipated traffic demands but also for promoting homogeneous urban development in such sub-urban areas.

(5) Lack of Efficient South-westwards Pugu Road Network

It has been observed that urban expansion has been proceeding along Pugu Road. Areas in this sector have been identified by the Government of Tanzania as potential residential and industrial development areas in the next five years. Unfortunately there now only exists a minor 1-lane gravel or earth road without engineering.

It will be necessary to provide an efficient all-weather road network in these areas in order to promote well-balanced and orderly development.

(6) Traffic Congestion of Trunk Roads

Trunk roads in the Dar es Salaam Region have been upgraded under improvement projects assisted by various donor countries and international funding agencies, including

the Japanese Government and World Bank. However, some trunk roads, such as Uhuru Road, Sokoine Drive and Gerezani Street, Bandari Road, New Bagamoyo Road between Morocco and Mpakani Roads, New Kigogo Road and Mpakani Road have remained as 2-lane roads. Traffic volume on these roads has already exceeded the capacity of 2-lane roads which has resulted in heavy and chronic traffic congestion on a daily basis.

(7) Bottlenecks on Existing Bridges in DSM Region

It has been observed through road inventory survey that existing bridge structures are generally narrow and old which will need improvement or reconstruction. Some of these bridges are in a critical state which requires urgent rehabilitation or total replacement from a safety stand point. This is especially true for bridges on Morogoro and New Bagamoyo Roads which are viewed as dangerous because of the narrow width where large vehicles cannot pass each other at the same time.

(8) Pavement Deterioration of Local Roads in Temeke, Ilala, Tabata, Sinza and Mwinijuma Areas

Local main roads, located in the city's urban areas are seriously deteriorated to such an extent that normal routine maintenance is no longer effective. Of these roads located in Central / Kariakoo Area were or will be improved under the Road Rehabilitation and Improvement and Maintenance Projects (DRIMP). The roads located in Temeke, Ilala, Tabata, Sinza and Mwinijuma areas still remained in poor condition.

Since these roads are directly related to the daily life of the people, improvement will be essential as well as urgent.

(9) Poor Maintenance of Roadside Drainage Facilities

Roadside drainage in urban areas are generally served by lined channel and underground piped system. However, many are not working properly, or are in poor working conditions caused mainly by the long-time absence of proper and timely maintenance due to financial constraints. The small capacity of maintenance work and inappropriate policies regarding regular maintenance and rehabilitation for drainage system have been caused by the same financial constraints.

Since roadside drainage is essential not only to maintain pavement life but also for ensuring traffic safety, it is required for MWCT to strengthen maintenance capability for drainage facilities by establishing a special maintenance team in charge of roadside drainage.

4.2.2 Public Transport System

The issues pertaining to public transport are attributed to the following nature of on-going services:

- (1) Public transport services which cannot meet the needs of growing demand

Disruption of balance between supply and demand for public transport is one of the causes of unsatisfactory public transport services in Dar es Salaam. This is due to the shortage of the total number of bus fleets.

- (2) Public transport services concentrated in the city center

Concentration of trips into the city center due to dense location of urban facilities, has resulted in congestion along most radial roads which are connected to the city center. This is evident in the number of overcrowded buses and long waiting-time for public transport services during peak hours of traffic along these corridors.

- (3) Poor service level provided by present bus system

Poor service levels due to poor management and operation systems are lowering amenities in public transport services. This is evident in the lack of information systems, poor terminal facilities, irregular operation of buses as well as the high fee levels compared with amount of services received by users. Financial constraints of bus companies and the shortage of subsidies from the government are other causes of this problem.

4.2.3 Traffic Management

Issues pertaining to traffic management are based on the following nature of the city's urban traffic patterns:

- (1) Lack of functional hierarchy among roads in Dar es Salaam

Most of roads in the city center are used in a disorderly fashion accommodating mixture of vehicular traffic, pedestrians, and mass transits. The operation of heavy vehicles is sometimes even seen on urban streets and collector roads. These lead to an incomplete road network and varied mixture of land-use in urban areas.

(2) Shortage of parking space

The shortage of parking spaces is forcing a large number of automobile parking on roadside, lowering road capacities to a great extent. Roadside parking is a major cause of intrusion of pedestrians into carriageways, increase in accidents and lowering drive speeds.

(3) Creation of bottleneck points in urban traffic

The lack of reliable traffic signals at intersections of urban arterial roads traffic magnifies the congestion. Intersections with no turning lanes, short storage length and no designation of pedestrian crossing lanes are observed as bottleneck points in urban traffic in Dar es Salaam.

CHAPTER 5 INITIAL ENVIRONMENTAL EXAMINATION

An Initial Environmental Examination has been conducted in five potential impact issues; i.e. flood hazards, resettlement, flora and fauna, air pollution, and noise and vibration. It is revealed that all but one (flora and fauna) will have a high potential of impacts to environment.

5.1 Findings

(1) Flood hazards

Rapid population growth has resulted in large tracks of unplanned housing and commercial development along natural drainage channels, topographical depressions and flood plains where proper engineered roads, storm water drainage and other infrastructure are often lacking.

Because of heavy annual rainfall, low lying topography and impermeable surfaces of the roads, housings and factories have been often inundated or severely damaged by flood waters.

Of the thirteen areas identified as being flood-prone areas, all are affected by the flooding or other factors associated with flooding: 10 are situated in a river drainage basins; 6 lack proper drainage maintenance and/or have inlet grates being blocked; 6 possess no drainage devices at all; 3 have improper-sized drainage channels.

(2) Resettlement

During the past road rehabilitation, land acquisition were required to increase road width; several structures within the right-of-way were removed, compensation paid and relocation of residents were made. During the past road widening projects, further structures illegally encroaching on the designated right-of-way were removed at the owners own expense with no compensation being paid.

The high priority road development projects planned for densely populated residential areas will require the further use of right-of-way. Accordingly, further land acquisition will be needed in which compensation payment and resettlement of residents to the places to be prepared for the settlement, shall be done.

(3) Flora and Fauna

Mangroves are considered to be the most important issue in the areas outside of the potential road development. Street trees with subsequent importance exist in small amount, which can be readily replaced if damaged or destroyed during the road improvement.

(4) Air pollution

a. Construction-generated particulate matters

Upon observation of construction equipment travelling over the unpaved tracks during road construction, fairly large quantity of suspended dust particles were generated. Temporarily in nature, such particulate matters dispersed by the wind or the traffic movement would be a potential health concern to the residents living in the vicinity of the road under construction.

b. Examination of air quality

Although the overall air quality along the roadside area is not so bad, the density of carbon monoxide (CO) and nitrogen oxides (NO_x) which are generated by the automobiles under idling and engine loading conditions (2000 rpm/40 km/h) are substantially high. NO₂ gases either in ambient air or generated by the automobiles under similar engine conditions are negligible. (See Fig. 5.1)

(5) Noise and vibration

With respect to noise and vibration caused by the road construction, recorded values are deemed high enough to cause a temporary public nuisance.

Although the level of traffic noise along the roadside areas are deemed high, they are not so high as to create a public nuisance, or adversely affect the living of the residents. In addition, the road traffic vibration levels are relatively low if compared to the published guideline, and as such not to be anticipated to cause a public nuisance. Nevertheless, since the future traffic volume will imminently increase, noise and vibration generated by passing motor vehicles might have adverse effects on the residents along the roads.

5.2 Other considerations

(1) Legislation

In order to lessen any impact in the future regional growth as a direct result of road development, the government involvement in the establishment of land-use control and safety environmental standards will be essential. Through the proper planning and legislation (most important is enforcement) along with the policy instruments of pricing and taxation, more efficient use of natural resources and effective mitigation measures might be realized.

(2) Emission Testing

For the incentive to cope with the misuse of natural resources and air pollution, the periodic testing of emissions and establishment of emission standards for automobiles should be instituted. As such, air pollution could be reduced simply by implementing the testing, collection of testing fees and the continuous enforcement of all legislation concerning emission standards.

Fig. 5.1 EXHAUST GAS DENSITY BY TYPE OF VEHICLE

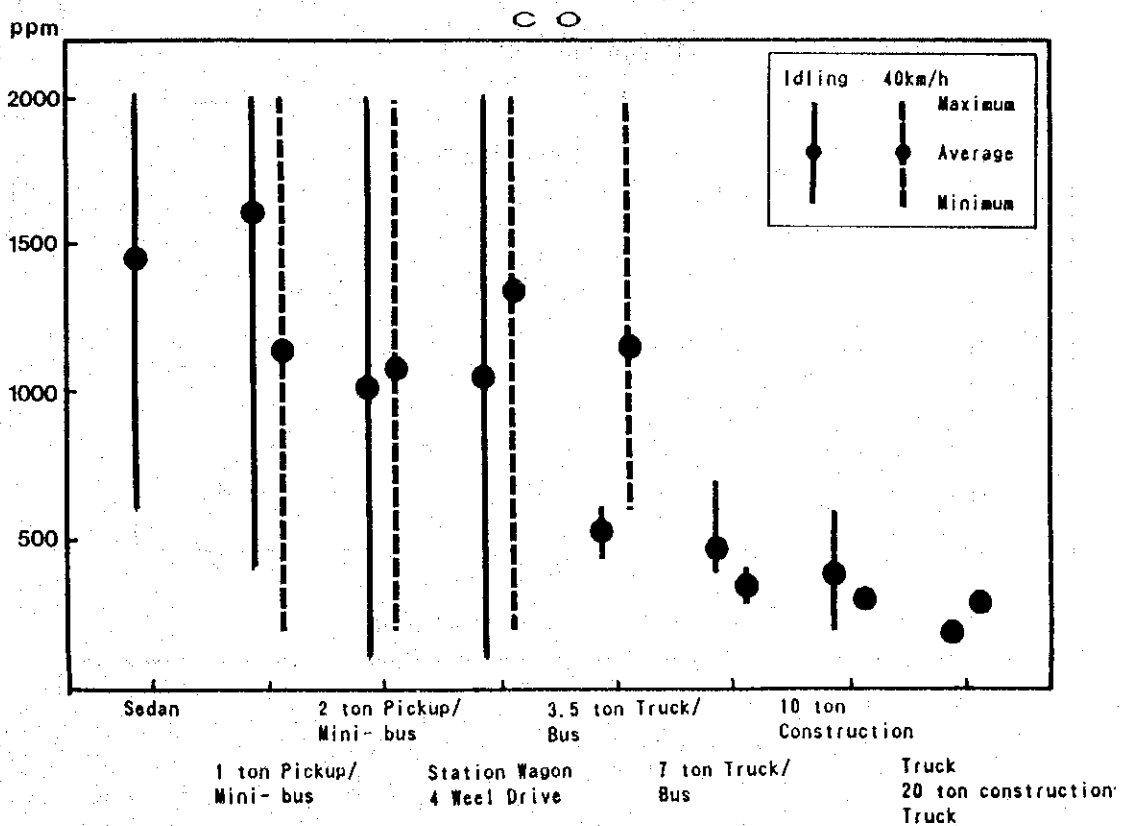
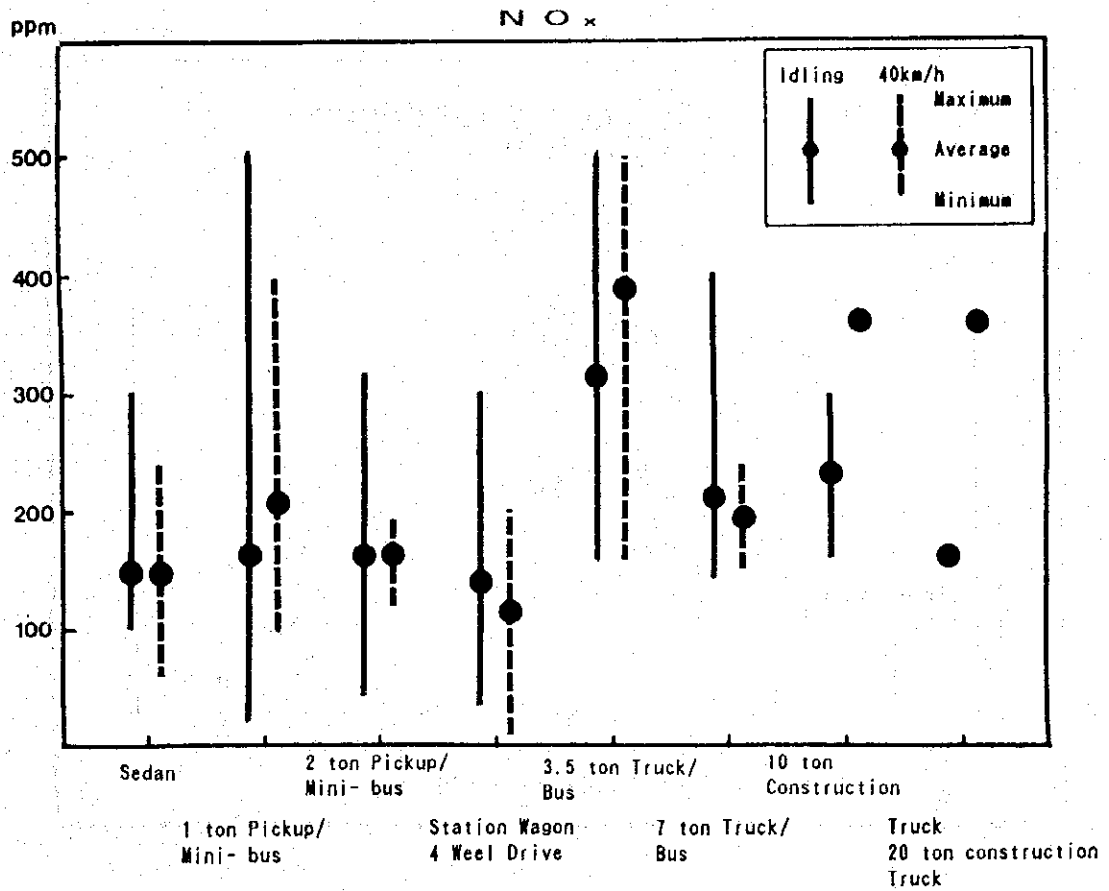


Fig. 5.2 VEHICLE NOISE SOURCES
SMALL VEHICLE

10 November 1993

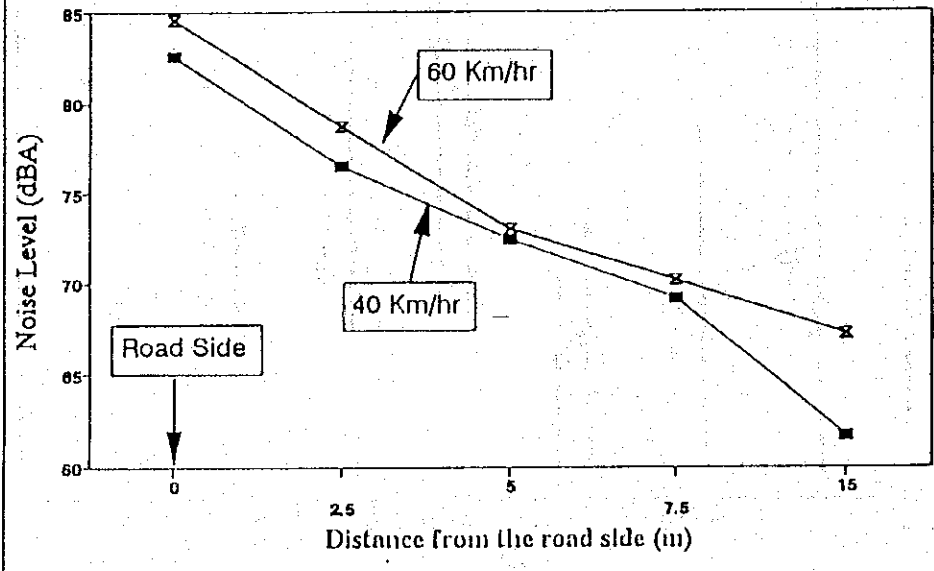


Fig. 5.3 VEHICLE NOISE SOURCES
LARGE VEHICLE

10 November 1993

