MINISTRY OF WORKS
UNITED REPUBLIC OF TANZANIA

NO. 1

BASIC DESIGN STUDY REPORT
ON
DAR ES SALAAM ROAD DEVELOPMENT PROJECT
IN
THE UNITED REPUBLIC OF TANZANIA

JANUARY, 1997

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JAPAN ENGINEERING CONSULTANTS 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 a basic design study on Dar Es Salaam Road Development Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tanzania a study team from July 31 to September 8, 1996.

The team held discussions with the officials concerned of the Government of Tanzania, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tanzania in order to discuss a draft basic design, and as this result, the present report was finalized.

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 teams.

January, 1997

Kimio Fujita
President
Japan International Cooperation Agency

Letter of Transmittal

January, 1997

We are pleased to submit to you the basic design study report on Dar Es Salaam Road Development Project in the United Republic of Tanzania.

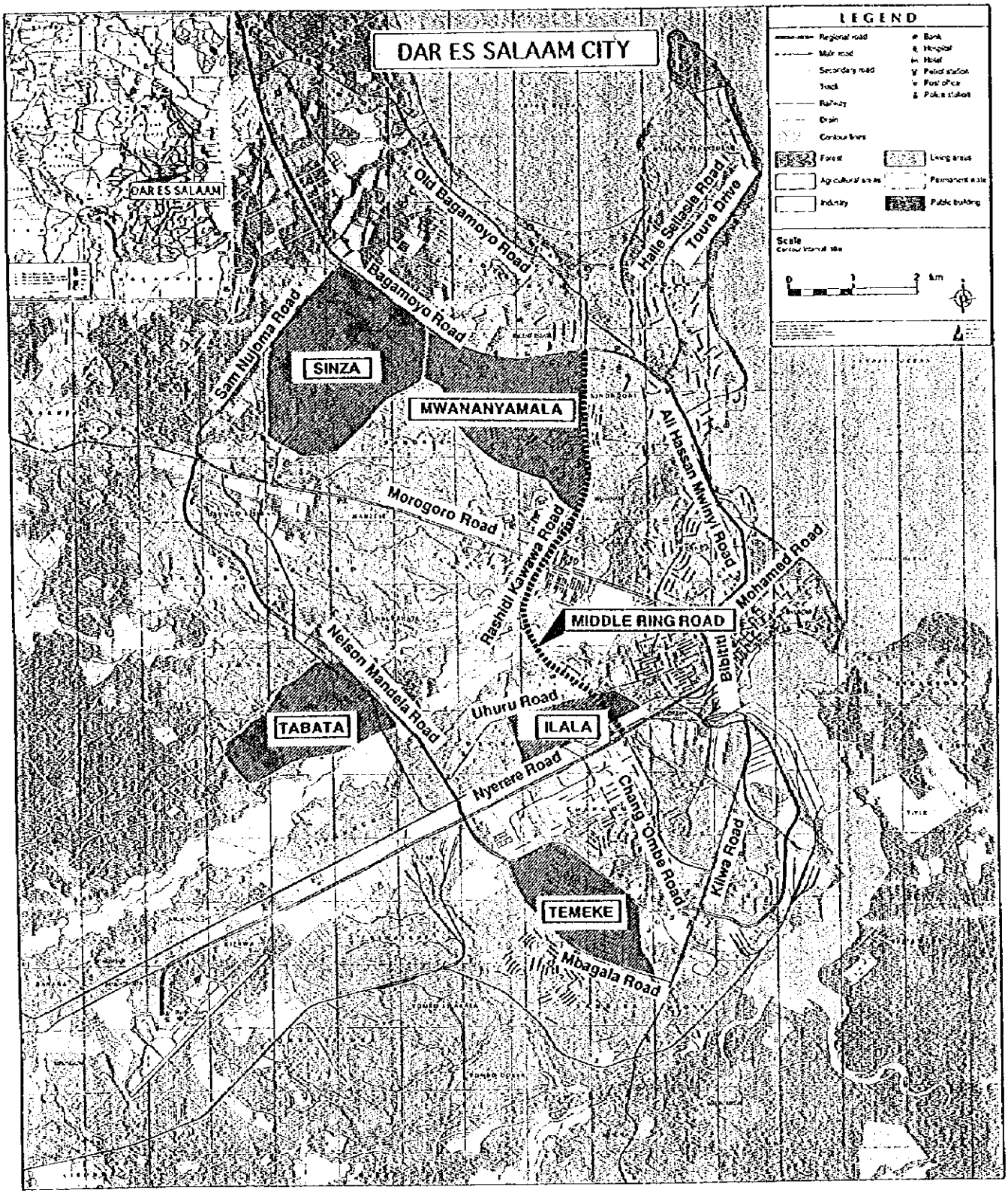
This study was conducted by Japan Engineering Consultants Co., Ltd. and Nippon Koei Co., Ltd., under a contract to JICA, during the period from July 29, 1996 to January 14, 1997. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tanzania and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

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

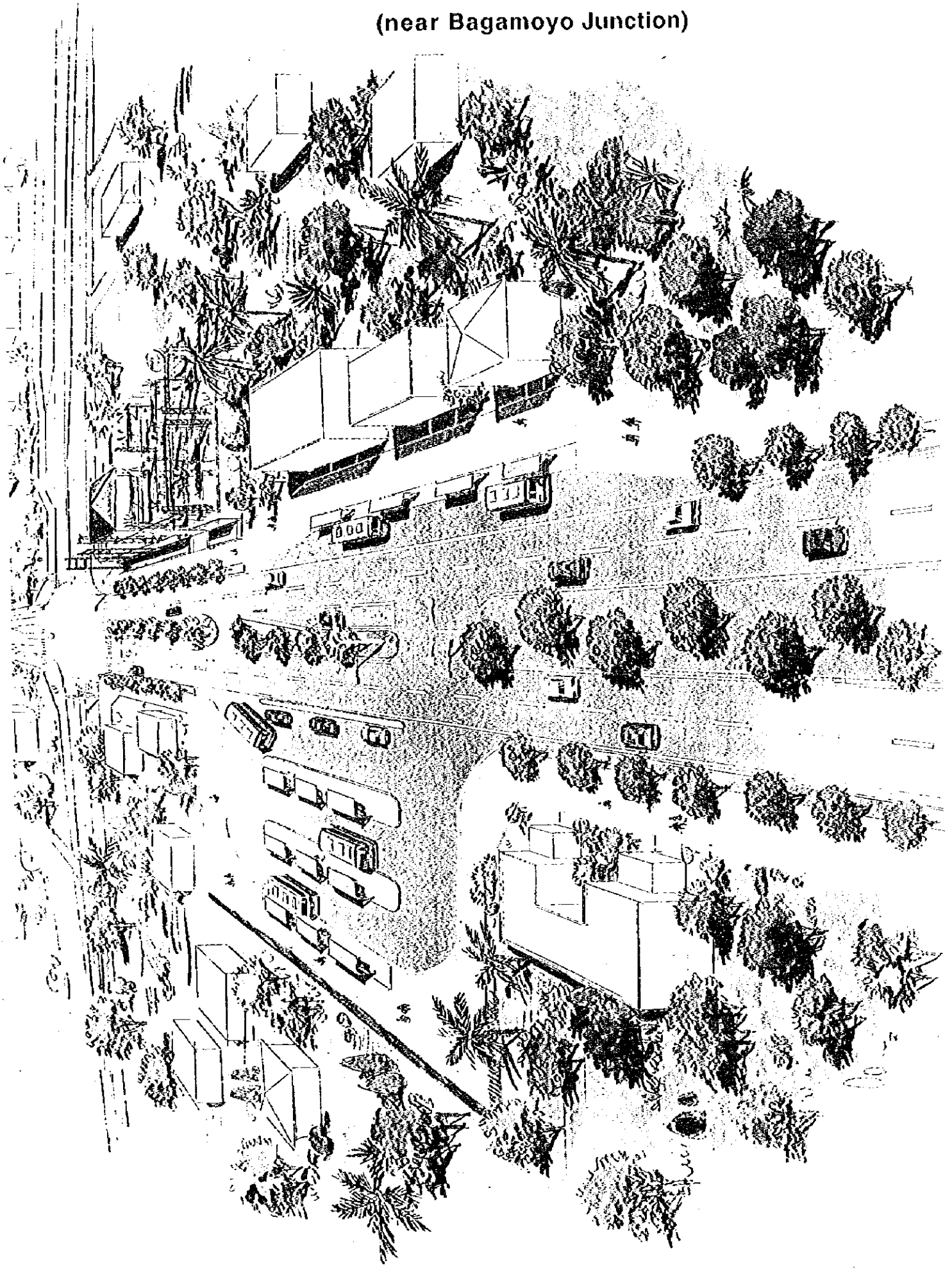
Very truly yours,

Hisashi Muto
Project manager,
Basic design study team on
Dar Es Salaam Road Development Project
Japan Engineering Consultants Co., Ltd.
Nippon Koei Co., Ltd.

LOCATION MAP OF THE STUDY



Perspective of Middle Ring Road
(near Bagamoyo Junction)



ABBREVIATIONS

A/P	: Authorization to Pay
ADT	: Average Daily Traffic
AI	: Asphalt Institute
BHN	: Basic Human Needs
CBD	: Central Business District
CBR	: California Bearing Ratio
CIP	: Community Infrastructure Programme
DCC	: Dar es Salaam City Commission
DRIMP	: Dar es Salaam Road Improvement and Maintenance Project
DTN	: Design Traffic Number
E/N	: Exchange of Note
ERP	: Economic Recovery Programme
GDP	: Gross Domestic Product
GNP	: Gross National Product
IDT	: Initial Daily Traffic
IRP	: Integrated Road Project
ITN	: Initial Traffic Number
JICA	: Japan International Cooperation Agency
MOW	: Ministry of Works
NUWA	: National Urban Water Authority
ODA	: Official Develpoment Assistance
PEHCOL	: Plant and Equipment Hire Company Limited
PIP	: Programme d'Investissement Public
PSI	: Present Serviceability Index
RPFB	: Rolling Plan and Forward Budget
SCP	: Sustainable Cites Programme
SDP	: Sustainable Dar es Salaam Project
TANESCO	: Tanzania Electric Supply Company Limited
TTCL	: Tanzania Telecommunication Company Limited
Tshs	: Tanzania shillings
UNDP	: United Nations Development Programme

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CHAPTER 1 BACKGROUND OF THE PROJECT

CHAPTER 1 BACKGROUND OF THE PROJECT

The United Republic of Tanzania (hereinafter referred to as Tanzania) lies along the eastern coast of the African Continent between 1°S and 11°S and has a land area of 945,000 km^2 and a population of 25.1 million (as of 1992) with an annual population increase rate of 2.4%. The distribution of Tanzania's population is characterised by a low density in the central part of the country and a much higher density in green areas located along the coast, Lake Victoria and Lake Tangangyika and also in the northern part of the country. The city of Dar es Salaam, the country's largest port city, has a population of 1.65 million, i.e. 6.5% of Tanzania's total population. The country is dominated by a tropical savannah climate and the mean annual rainfall and temperature in Dar es Salaam on the coast are approximately 1,100 mm and 26°C respectively, indicating the city's generally high temperature and high humidity.

Tanzania's total GNP in 1992 was 2,561 million US$ and its GNP per capita of 100 US$ puts the country in the UN category of a LLDC (Least among Less Developed Countries). In the early 1980's, Tanzania suffered from a serious economic crisis due to the oil shock in 1979, the war with Uganda and severe droughts, etc. In order to improve the situation, the government has adopted an economic liberalisation policy since 1984 and introduced a structural adjustment policy in 1986 to implement the Economic Rehabilitation Programme (ERP) for the period from 1986 to 1989 with the assistance of the World Bank and IMF which resulted in remarkable achievements, including a higher GDP growth rate than the population increase rate for 3 successive years during the ERP period. Despite such positive achievements, many problems remained unsolved, ranging from the slow rehabilitation of infrastructure to a low operation rate in the industrial sector, a chronic trade deficit and the accumulation of external debt.

Following the completion of the ERP, the Second Economic Rehabilitation Programme (ERP II) (1989 - 1992) was announced to proceed with such structural adjustment measures as reform of the investment and distribution systems, reform of state enterprises and manpower reduction in the public sector. Since fiscal 1993, the RPFB (Rolling Plan and Forward Budget), outlining the budget distribution plan and development plans (for the macroeconomy and each sector), has been employed and this RPFB is reviewed at the beginning of each fiscal year to formulate a rolling 3 year plan annually. The adoption of this RPFB is designed to compensate for the common shortcomings of a long-term development plan, such as the inflexibility of planning and separation of funding availability. In addition, it is also meant to compensate for the shortcomings of an annual plan, particularly the lack of conformity with long-term policies. These measures have improved the revenue shortage to a certain extent through a series of reforms, including the improvement of tax collection, although the overall fiscal deficit has remained due to an increased personnel cost and debt service, etc.

In the RPFB for fiscal 1995, current expenditure is the largest expenditure item, accounting for 80% of the total, followed by investment in infrastructure and other development (20% of the total). Investment in transport accounts for 43% of the total investment in infrastructure and the upgrading and improvement of existing roads, as in the case of the present Project, is the centre-piece of such investment. This preferential distribution of national investment funds indicates that rehabilitation of the existing road network is given high priority in Tanzania's national development plan which is the superior plan vis-a-vis the present Project.

The transport network in Tanzania currently consists of roads (82,000 km in length), 2 railway lines, 3 major ports, 2 international airports and more than 50 airports for domestic flights. The vastness of the national land and the relative disregard of new investment in and maintenance of the road network have pushed up the general transportation cost and have caused a general deterioration of the road network, constituting a significant factor is the restriction of economic activities. While the total road length is said to be 82,000 km, trunk roads account for a mere 10,000 km, of which only 3,000 km are properly paved.

In 1973, the Government of Tanzania transferred the planning, construction and maintenance of Class 2 local roads from the Ministry of Works (MOW) to local corporations in order to make the MOW concentrate on the construction of trunk roads. This reorganization failed to facilitate the construction of trunk roads, however, because of the general shortage of manpower, construction equipment and materials and also necessary funds. During the economic crisis in the early 1980's, road construction/improvement work virtually came to a standstill. The maintenance/repair of existing roads was seldom conducted let alone new roads constructed. The end result was a severe deterioration of the roads and even major trunk roads became impassable in many places, resulting in massive economic losses due to the sharp rise of the transportation cost, lengthening of the transportation time and damage to travelling vehicles.

The city of Dar es Salaam has a road network totalling 1,150 km, of which 148 km and 65 km are trunk roads and regional roads respectively. The city's growth and increased traffic demand due to Tanzania's remarkable economic growth in recent years have rapidly increased the traffic volume on the trunk road network. The resulting traffic congestion and destruction of roads are particularly visible in the city centre, hindering Tanzania's economic recovery. Recognising the need to prepare a comprehensive road network plan, the Government of Tanzania requested the Government of Japan's provision of technical cooperation for the Feasibility Study for the Dar es Salaam Road Development Master Plan in 1992. In response to this request, Japan International Cooperation Agency (JICA) conducted the Feasibility Study for the above Master Plan and priority projects from October, 1993 to March, 1995.

According to the traffic volume survey under this M/P study, the degree of traffic congestion is 160% in the case of many of the trunk roads in Dar es Salaam, showing that the traffic level is far higher than the available capacity and making it essential to increase the road capacity by widening the 108 km long radial as well as ring roads with 2 lanes. Moreover, the present road network of Dar es Salaam, mainly consisting of radial trunk roads and an incomplete trunk ring road, makes traffic from residential areas to industrial/port districts pass through the city centre, causing further traffic congestion in the city centre.

Meanwhile, the damage to local roads in the city's residential areas is so advanced that it can no longer be repaired by ordinary maintenance work, requiring urgent and full-scale rehabilitation. Such rehabilitation is, in fact, given high priority from the viewpoint of improving civic life.

There are 2 projects which are either at the planning stage or implementation stage and which are related to the present Project. These are the IRP II and the Community Infrastructure Development Project (CIP) financed by other aid organizations (World Bank and UNDP). The IRP II aims at developing the national trunk road network with a total budget of 650 million US$, of which 16.6 million US$ (2.6%) is earmarked for improvement of the Middle Ring Road and radial trunk roads in Dar es Salaam.

The 6.3 million US$ CIP aims at the development and maintenance of such infrastructural elements as roads, drainage, water supply, hygiene, waste treatment, electricity and telephone network in 9 districts of Dar es Salaam. It is planned to implement and complete the CIP in 4 years commencing in 1996 with a World Bank loan, funding by the Government of Tanzania and the participation and financial contribution of local inhabitants.

Under these circumstances, the Government of Tanzania made a request to the Government of Japan in November, 1995 for the provision of grant aid for the widening and construction of the missing link (approximately 7 km in length) of the Middle Ring Road and also for the rehabilitation of local roads (approximately 34 km in total) in 5 areas of Dar es Salaam based on the proposal made by the above-mentioned F/S for the M/P for urgent implementation among short-term projects. This original request was subsequently reviewed because of the progressive damage to local roads through several rainy seasons after the original request, making it essential to urgently repair of some of the subject roads of the original request for rehabilitation and also because of the inclusion of some of the subject roads in the CIP of the World Bank/UNDP. Following reassessment, the Government of Tanzania selected 40 reods (approximately 55 km in total) in 5areas as the subject roads for rehabilitation with Japanese grant aid. The present Study Team accepted these 40 roads as the subject roads for the basic design study.

CHAPTER 2 CONTENTS OF THE PROJECT

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

The city of Dar Es Salaam has a total road length of 1,150 km, of which 148 km are trunk roads and 65 km are regional roads. The growth of the city as the economic center of Tanzania due to the country's recent economic growth and subsequent increase of the traffic demand has dramatically increased the traffic volume of the city's trunk road network, particularly in the city center.

According to the findings of a traffic survey conducted as part of JICA's Master Plan Study for the Dar es Salaam Road Development Project (DRDP) in November, 1993, the traffic congestion rate of most of the city's trunk roads is as high as 160%, far exceeding the design capacity of these roads. As a result, widening of the trunk radial as well as ring roads, totalling 108 km, which currently have only 2 lanes is urgently required.

The predominance of radial roads with a poorly developed ring road network in the city means that traffic between residential areas and the industrial area and harbour area must pass through the city center, thus aggravating the traffic congestion in the city center. Meanwhile, the road paving in residential areas of the city is much damaged to the extent that it cannot be rehabilitated by ordinary maintenance work. The rehabilitation of these highly damaged roads in residential areas has been given priority from the viewpoint of improving the standard of living in the city.

The JICA M/P Study proposed the present Project with the following objectives (to be achieved through widening of the Middle Ring Road, including construction of the missing link, and the rehabilitation of high priority local roads) to improve the situation described above and the Government of Tanzania made a request to the Government of Japan to provide grant aid for the implementation of the proposed Project.

(1) Elimination of the existing traffic congestion on trunk roads

(2) Reduction and dispersion of the traffic concentration in the city center

(3) Development of a reliable ring road together with construction of the missing link for through traffic between residential areas and the industrial area and port area

(4) Development of the road network to improve the public transport network

(5) Improvement of the level of satisfaction vis-a-vis Basic Human Needs

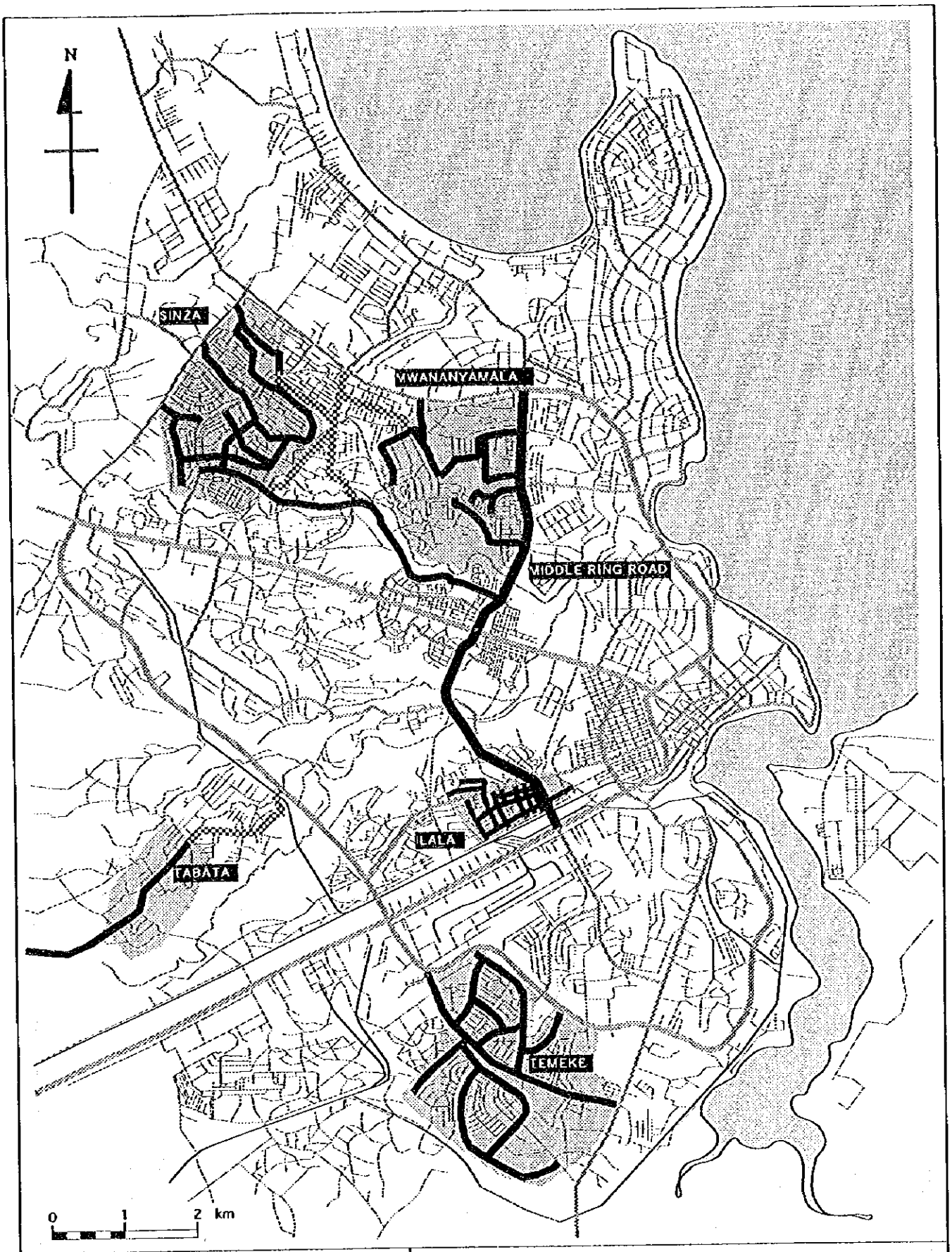
During the selection stage of the priority local roads to be rehabilitated under the Project, the road damage further progressed over a couple of rainy seasons, making the urgent rehabilitation of some local roads subject to the Project necessary. This urgent necessity was, in fact, met within the framework of the Community Infrastructure Development Project led by the World Bank and UNDP and the local roads shown in Fig.2-1 andTable 2-1 were selected as priority roads for rehabilitation in 5 areas. The Project, which constitutes Phase I of the Short-Term Rehabilitation Plan, consequently consists of the following 2 components.

(1) Widening of Middle Ring Road (7.09 km)

- Widening of Morocco and New Kigogo Roads from 2 to 4 lanes (6.34 km in total)
- Construction of the missing link between New Kigogo and Chung'ombe Road (0.75 km)
- Construction of sidewalks and bicycle lanes
- Construction of 3 bus stations at key intersections with radial trunk roads

(2) Rehabilitation of Local Roads (52.48 km)

- Rehabilitation of priority local roads in the Sinza area (15.96 km)
- Rehabilitation of priority local roads in the Hala area (7.37 km)
- Rehabilitation of priority local roads in the Mwananyamala area (7.56 km)
- Rehabilitation of priority local roads in the Temeke area (14.49 km)
- Rehabilitation of priority local roads in the Tabata area (3.40 km)



THE BASIC DESIGN STUDY ON
DAR ES SALAAM ROAD DEVELOPMENT
PROJECT

Fig.2-1 Objective Roads on the Study

: Objective Roads on this Basic Design Study

: CIP Project Roads by World Bank

Table 2-1 Review of Road Classification

(Unit : km)

No.	Road Name	Requested by DCC				Measured by the JICA Study Team						Existing Bus Route	Access to Hospital Educational, Police Other Public facility
		Total (1)	Trunk	Primary	Secondary	Total (2)	Trunk	Primary	Secondary	Tertiary	(2)-(1)		
1. Five Area Roads		54.98	9.00	24.65	30.33	52.48	0.00	24.91	26.25	1.32	-2.50		
Sinza Area		16.35	0.00	5.21	11.14	15.96	0.00	7.10	8.86	0.00	-0.39		
1	Road A	2.23		2.23		1.10		1.10			-1.13	O	O
2	Road B	2.11			2.11	3.42			3.42		1.31		O
3	Road C	2.24		2.24		1.00		1.00			-1.24		O
4	Road D	0.60			0.60	1.03			1.03		0.43		O
5	Road E	0.74		0.74		0.84			0.84		0.10		O
6	Road F	1.76			1.76	1.76			1.76		0.00		O
7	Road G	5.00			5.00	5.00		5.00			0.00	O	O
8	Road H	0.98			0.98	1.12			1.12		0.14		-
9	Road I	0.69			0.69	0.69			0.69		0.00		-
Mwananyamala Area		7.82	0.00	0.00	7.82	7.56	0.00	4.11	3.45	0.00	-0.26		
10	Bukina Street	0.63			0.63	0.63		0.63			0.00		O
11	Guita Street	0.63			0.63	0.63			0.63		0.00		O
12	Kinondoni P/School	0.48			0.48	0.48			0.48		0.00		O
13	Iseke Street	0.19			0.19	0.19			0.19		0.00		O
14	Malongwe Street	1.30			1.30	1.30			1.30		0.00		O
15	Malanga Street	0.91			0.91	0.65		0.65			-0.26		O
16	Iringa Street	1.56			1.56	1.56		1.56			0.00		O
17	Malanga to Bukina	0.70			0.70	0.70		0.70			0.00		O
18	Karafuu Street	0.85			0.85	0.85			0.85		0.00		O
19	Mwinyi Juma Street	0.57			0.57	0.57		0.57			0.00		O
Ilala Area		7.52	0.00	3.89	3.63	7.37	0.00	4.42	1.63	1.32	-0.15		
20	Lindi Street	1.36		1.36		1.36		1.36			0.00	O	O
21	Bungoni Street	0.64		0.64		0.64		0.64			0.00		O
22	Pangani Street	0.75		0.75		0.87		0.87			0.12		O
23	Tabora Street	0.55		0.55		0.45		0.45			-0.10		O
24	Morogoro Street	0.58			0.58	0.48				0.48	-0.10		O
25	Uhuru Street	0.62			0.62	0.50			0.50		-0.12		O
26	Arusha Street	0.59		0.59		0.59			0.59		0.00		O
27	Tukuyu Street	1.10			1.10	1.10		1.10			0.00		O
28	Sharif Shamba Street	0.54			0.54	0.54			0.54		0.00		O
29	Mwanza Street	0.22			0.22	0.27				0.27	0.05		-
30	Bukoba Street	0.57			0.57	0.57				0.57	0.00		O
Temeke Area		14.29	0.00	6.55	7.74	14.49	0.00	8.08	6.41	0.00	0.20		
31	Evereth Street	0.60			0.60	0.63			0.63		0.03	O	O
32	Yombo Street	1.00		1.00		1.00		1.00			0.00	O	O
33	Temeke Road	2.05		2.05		2.05		2.05			0.00	O	O
34	Mbagala Road	3.50		3.50		3.50		3.50			0.00	O	O
35	Wailes Road	0.78			0.78	0.85			0.85		0.07		O
36	Ruvuma Street	0.62			0.62	0.62			0.62		0.00		-
37	Chihota Street	1.00			1.00	1.10		0.13	0.97		0.10	O	O
38	Bububu Street	2.62			2.62	2.62		1.00	1.62		0.00	O	O
39	Mahunda Street	2.12			2.12	2.12		0.40	1.72		0.00	O	O
Tabata Area		9.00	9.00	9.00	0.00	7.10	0.00	1.20	5.90	0.00	-1.90		
40	Tabata Road	9.00		9.00	0.00	7.10		1.20	5.90	0.00	-1.90	O	O
2. Middle Ring Road													
	Total	7.08	7.08	0.00	0.00	7.09	7.09	0.00	0.00	0.00	0.01		
1	Morocco Road	3.58	3.58			3.58	3.58				0.00	O	O
2	New Kigogo Road	2.76	2.76			2.76	2.76				0.00	O	O
3	Missing Link	0.74	0.74			0.75	0.75				0.01	O (Shoutinoya st)	O (Shoutinoya st)
	TOTAL	62.06	16.08	24.65	30.33	59.57	7.09	24.91	26.25	1.32	-2.49		

2.2 Basic Concept of the Project

2.2.1 Basic Concept

The inter-ministerial meeting prior to the field survey for the Project and the field survey identified the following basic issues of the Project.

a) Decision on a realistic target for widening of the Middle Ring Road

b) Level crossing for the railway line in the missing link of the Middle Ring Road and the best new route for the missing link

c) Consideration of public bus transport as well as pedestrian and bicycle traffic

d) Examination of various paving improvement work

e) Selection of priority feeder and local roads

f) Development of an easy to maintain rainwater drainage system, including the final outlet

g) Preparation of a construction plan designed to foster the local construction industry

h) Preparation of a realistic project implementation plan

(1) Decision on Realistic Target for Widening of Middle Ring Road

It has been agreed by the Japanese and Tanzanian sides that the standard width and major intersection width to accommodate a flyover for the Middle Ring Road in the future will be 35 m and 45 m respectively. One reservation here, however, is that TANESCO, the power corporation which controls the high voltage cable buried under some sections of the Middle Ring Road, prefers to have an exclusive site for its power grid separate from the road site, in order to make grid maintenance easier.

Therefore, upon analyzing the current conditions of the underground power cable, the sites earmarked for road use, the sites required for road widening, and the sites for power cable maintenance, it was decided that a road width of 35 m on standard sections (including site for buried power cables) and 45 m on major intersections (again including site for buried power cables) would be the most realistic solution.

With regard to the missing link, the new road width is set at 25 m, the minimum width to satisfy the expected function of the Middle Ring Road to a certain extent in view of the absence of already earmarked Right of Way, the presumably high cost of compensation for land and buildings and lengthy negotiations with landowners regarding the option of

acquiring new land for road expansion. Moreover, regarding the banked sections that will cross over the three rivers along the route, the road width is again set at the minimum value of 25 m, in consideration of the fact that topographical conditions mean that the volume of banking earth required will be large and the poor soil conditions will make it necessary to take time-consuming strengthening measures.

(2) Examination of Best Route for Missing Link of Middle Ring Road

At present, the Middle Ring Road has a missing link between Uhuru Road and Pugu Road and, because of this missing link, the Middle Ring Road has been unable to fully perform its planned function. The JICA M/P Study examined several route alignments for this section for comparison purposes. The selected route was almost the shortest route, running between the Karume Memorial Stadium (a football stadium) and the Cemetery. A level crossing at the TRC railway line was opted for instead of a flyover crossing because of cost (less than half of that of the flyover crossing option) and the very low level of railway traffic (several trains a day).

For the present Project, these M/P study findings have been reviewed and agreed upon as the basic conditions. The detailed field survey for the Project, however, found it necessary to examine the following alternatives in view of the smooth implementation of the Project.

a) Alternative routes between the Karume Memorial Stadium site and Cemetery site

b) Two alternatives to ensure railway operation during the alignment alteration work for one railway track

1) Comparison of Road Alignment

While it is planned that the Middle Ring Road will pass between the Karume Memorial Stadium and the Cemetery, continuous expansion of the Cemetery has resulted in surplus land being unavailable, forcing the road route to run through the Stadium site or Cemetery site.

The Study Team examined the advantages and disadvantages of the route passing through the Stadium or the Cemetery. Consulted on this issue by the Study Team, the Government of Tanzania subsequently decided to opt for relocation of the Cemetery at its own responsibility in order to allow the Middle Ring Road to run through the present Cemetery site. The reasoning behind this decision was that construction of the missing link of the Middle Rink Road to assist the development of Dar es Salaam was essential,

like the Stadium, from the viewpoint of public welfare and that the Cemetery, although a public facility itself, served only specific beneficiaries.

2) Alternatives for Level Crossing Configuration

Construction of the missing link of the Middle Ring Road entails a level crossing at mainly 3 tracks of the TRC's switchyard, one of which has an elevational difference of some 2.5 m to the other 2 tracks, making it necessary to change its alignment. Following the detailed field survey and consultations with the TRC, the following 2 alternatives were proposed to allow train operation throughout the period of alignment alteration work.

① Construction of a new track beside the existing tracks for detour purposes

② Use of a side track next to one of the existing tracks for detour purposes during the alignment alteration work

A comparative analysis of the costs of these 2 alternatives found that alternative ② was less expensive and presented no technological problems. These findings were confirmed by the TRC and alternative ② was selected with the consent of the TRC.

The TRC has pointed out that the erection of a perimeter fence or wall will be required to protect its property if the Middle Ring Road crosses through the middle of the TRC's premises and the Government of Tanzania has agreed to provide such facilities.

The TRC is also concerned in regard to the possibility of traffic accidents at the proposed level crossing and the Government of Tanzania has, therefore, requested the Government of Japan's installation of a signal system and a barrier for the level crossing site in question. Although, the Study Team recognises the necessity for these facilities to prevent traffic accidents and the Tanzania Government is requested to install the existing signal system which is used ordinarily for the TRC considering operation and maintenance by the TRC.

(3) Consideration of Public Bus Transport as well as Pedestrian and Bicycle Traffic

As the traffic in Dar es Salaam mainly consists of public buses, pedestrians and cyclists, careful consideration should be given to the proper provision of exclusive space for pedestrians and cyclists along the Middle Ring Road and also to the introduction/ improvement of bus stations and bus stops at major intersections and along the route.

The Middle Ring Road is required to have a sufficient planned width capable of not only responding to the future expansion of public bus transport (introduction of bus lanes, etc.) but also of accommodating pedestrians, cyclists, non-motorised carts and tricycles for the physically handicapped with spacious sidewalks and street trees to provide pleasant shady areas.

As the most important means of mass transportation for the citizens of Dar es Salaam, bus transport is not efficiently run at present as the inadequate provision of bus stations forces many buses to queue up in the streets, aggravating the traffic congestion. To improve this situation, it is planned to introduce bus stops along the Middle Ring Road and transfer bus stations at the interchanges with major trunk roads. The planned consideration for non-motorised traffic will significantly contribute to better satisfying Basic Human Needs, one of the most important targets of Japanese grant aid, and this contribution can be regarded as being one of the benefits of the Project.

(4) Examination of Various Paving Improvement Work

The Project not only anticipates widening of the trunk road and the construction of a new section but also the implementation of various paving improvement measures, including strengthening of the paving of existing road sections and improvement of the paving of both feeder and local roads which is appropriate vis-a-vis the expected functions of the different types of roads. This road paving improvement work will be decided through a thorough examination of all aspects, including the case of maintenance after improvement.

In regard to the Middle Ring Road, the main trunk road subject to improvement, the decision to provide new asphalt concrete paving or overlay with a sufficient design strength will be made based on the findings of the roadbed CBR survey conducted for each road section during the Basic Design Study for the Project and the estimated future traffic volume while referring to the paving structure of other major trunk roads in Dar es Salaam.

In regard to feeder and local roads, the paving design will be decided based on the findings of the road surface conditions (PSI value) survey, paving structure survey, roadbed strength (CBR value) survey and traffic volume survey conducted for each road. The design must be appropriate vis-a-vis the functional characteristics of these roads, consisting of primary feeder roads linked to auxiliary trunk roads, secondary feeder roads linked to primary feeder roads and local roads spreading like a mesh from feeder roads.

Accordingly, instead of employing asphalt concrete for all of the subject feeder and local roads (total length: 52.48 km), only the primary feeder roads, which carry large traffic

volumes and act largely as arterial roads, will undergo asphalt concrete paving improvement, and the secondary feeder roads that branch off from the primary feeders will be given penetrative macadam paving which as a low initial investment cost and is easy to maintain. In this way, total project cost has been reduced and suitable paving improvement work that fits with the functional requirements of each road has been selected. As for local roads spreading like mash from feeder roads, it has been recommended that gravel paving would be appropriate, in view of the road improvement measures being carried out by the World Bank.

(5) Preliminary Examination of Initial Improvement Plan for Feeder and Local Roads and Selection of Priority Roads to be Improved

Having prepared the initial improvement plan based on the field survey findings, the implementation cost of the plan will be estimated through preliminary evaluation of the work required to improve the requested roads. If the initial cost estimate exceeds the scope of suitability for a grant aid project, higher priority feeder and local roads will be selected as the subject roads for improvement under the Project with the consent of the Government of Tanzania.

The improvement measures requested by the Government of Tanzania for feeder and local roads include not only paving improvement but also such integrated measures as roadbed improvement, drainage system construction and the repair of both shoulders and sidewalks, etc. As a result, it is likely that the scale of construction work under the Project will be expanded.

In order to keep the scope of work under the Project within the framework of a grant aid project, each requested road will be given priority ranking based on the preliminary evaluation of the project cost estimate for the initial improvement plan, in turn prepared based on the field survey findings.

The decision on priority ranking will take not only the degree of current damage to paving into consideration but also such important factors as the road standard (importance), traffic level (degree of congestion), road use by public transport (buses), land use along the road (government district, commercial district, industrial district, housing district and farming district, etc.), future road development plan, opinions of those people living along the road and political judgement of the Government of Tanzania, etc.

(6) Development of Easy to Maintain Rainwater Drainage System, Including Final Outlet

A plan to develop an easy to maintain rainwater drainage system will be prepared so that rainwater on a road is quickly drained through the roadside drainage system for discharge into a river. Standing water on a road causes damage to the road paving and also compromises road safety, making it necessary to plan a roadside drainage system to smoothly remove rainwater from the road surface.

The DRDP has introduced covered U-shaped side ditches to drain rainwater from the Middle Ring Road with little maintenance difficulty. However, the U-shaped side ditch drainage system has the shortcoming of restricting carriage alignment due to the need for the system to have a suitable gradient. Therefore, the introduction of a U-shaped side ditch system may lead to difficulties in terms of conforming to the alignment of the existing system and cutting or replacement of the existing paving or excessive overlay may be required. In view of this negative prospect, as the recommended policy of the Basic Design Study, it has been decided to introduce U-shaped side ditches and blind ditches, which make it easy to conform alignment with the existing system and thus reduce the need for reconstruction of existing road surfaces.

Drainage system development in Dar es Salaam has lagged behind the growth of the city, becoming a major problem. In areas where feeder and local roads are subject to rehabilitation under the Project, the conditions of the road drainage system are particularly bad as it has often been left in a damaged state or is non-existent. The poor drainage has caused such adverse impacts on local life as road erosion, increase of the number of impassable road sections and outbreaks of mosquitoes carrying malaria due to flooding or standing water over a long period of time.

Under these circumstances, the scope of the Project will not be restricted to the improvement of side ditches following road improvement but will also include the development of secondary drainage channels to river outlets, etc. with a view to improving the overall quality of local life.

(7) Preparation of Realistic Project Implementation Plan

The preparation of an implementation/construction plan for the Project based on the assumption that Japanese grant aid for the Project will be provided will require the prior completion of the work to be undertaken by the Government of Tanzania, i.e. acquisition of land and relocation of houses for widening of the Middle Ring Road. Further attention should be paid to stabilizing the new embankment section for the Middle Ring Road as the said section is located on the soft ground of a dry riverbed.

The Project has 2 components: (i) rehabilitation of feeder and local roads which does not require land acquisition and (ii) widening of the Middle Ring Road which requires compensation for land acquisition and the relocation of houses.

The acquisition of land and relocation of houses will be conducted by the Government of Tanzania. While there is no question regarding the capability of the Government of Tanzania to conduct such work in view of its experience of conducting similar work under grant aid projects in the past, approximately one year will be required to arrange the necessary budget and for the execution of the work. Accordingly, when preparing the implementation/construction plan for the Project, it will be necessary to schedule the feeder and local road rehabilitation first so that the compensation process for land acquisition and house relocation for the widening of the Middle Ring Road can be completed during the feeder and local road rehabilitation work.

As referred to earlier, the new embankment section for the Middle Ring Road involves the soft ground of a dry riverbed, necessitating a measure to stabilize the embankment. This stabilization can be conducted by either improving the soft ground itself or by employing the pre-loading method to be implemented prior to the main work. If a condition of grant aid is the completion of a project within a single fiscal year, this embankment work must be completed within one fiscal year, necessitating soft ground improvement work despite the higher cost. If a project can be extended over more than one fiscal year, however, the pre-loading method can be opted for. Under this method, pre-loading is conducted in the first project year and the main work is conducted in the following project year when the pre-loaded soil has stabilized. The overall cost of this method is much lower than the soft ground improvement method. The pre-loading method has, therefore, been selected for the implementation/construction plan of the Project with a view to reducing the overall project cost.

2.2.2 Selection of Feeder and Local Roads for Rehabilitation in Subject Areas

Prior to the field survey, it was understood by the Study Team that the priority roads for rehabilitation under the Project would be selected from the originally requested roads stretching for a total of 34 km. The scope of the request was subsequently extended to include the rehabilitation of 40 roads (total length of 52 km) in 5 areas and widening of the Middle Ring Road. As the necessity for and suitability of the rehabilitation of the requested roads were confirmed by the field survey, it was decided that the Basic Design Study would cover all of the requested roads. The field survey and work in Japan followed this decision to examine the state

of the subject areas and roads in detail and to verify the suitability of the Project as a grant aid project of the Government of Japan.

(1) Evaluation of Subject Areas

Prior to the detailed verification, the current conditions of local roads in the 5 subject areas of the Project were compared with those of other areas in Dar es Salaam.

In short, the roads in the 5 subject areas are highly deteriorated. While 63% and 13% of all local roads in Dar es Salaam require paving reconstruction and overlay respectively, 84% and 9% of the local roads in the 5 subject areas require paving reconstruction and overlay respectively, leaving only 7% of local roads which are manageable with ordinary maintenance work. These findings indicate a strong necessity for rehabilitation work. The socioeconomic conditions, including the population, in the 5 subject areas are compared to those in other areas of the city below.

All 5 areas are classified as planned residential areas and all, except the Tabata area, are designated high density residential areas with commercial and administrative quarters forming a district center. Accordingly, the population size of 10,000 - 150,000 is relatively larger than that of other areas. Due to their past development as planned residential areas, there are many public facilities, such as schools, clinics, police stations and post offices, in the 5 subject areas. They are, therefore, considered to be central areas in their own locality. In order to determine the relative importance of these areas compared to other areas in the city, the evaluation criteria shown in Table 2-2 were established. The criteria range from the degree of road damage in general, land use, population size and availability of community facilities as well as government improvement efforts. The evaluation results are shown in Table 2-3. The points scored by the 5 subject areas are higher than those of the 3 areas where the local roads have been rehabilitated by Japanese grant aid in the past and those of other areas, confirming the stronger necessity for road rehabilitation and the importance of the subject areas vis-a-vis other areas.

Table 2-2 Area Evaluation Criteria

Evaluation Item	Points
1. Road Deterioration	(40)
- Share of Heavily Deteriorated Area Roads > 80%	40
- Share of Heavily Deteriorated Area Roads > 60%	30
- Share of Heavily Deteriorated Area Roads > 40%	20
- Share of Heavily Deteriorated Area Roads ≦ 40%	10
2. Land Use	(20)
- CBD/Commercial/Industrial/Institutional Area	20
- Planned Residential Area + District Center	15
- Planned Residential Area	10
- Unplanned Residential Area	5
3. Population (Number of Beneficiaries)	(10)
- > 10,000	10
- < 10,000	5
4. Population Density	(10)
- Population Density > 80 persons/ha	10
- Population Density ≦ 80 persons/ha	5
5. Community Facilities	(10)
- Share of Total Area Community Facilities > Share of Area Population	10
- Share of Total Area Community Facilities ≦ Share of Area Population	5
6. Government Priority	(10)
- Highest Priority	10
- High Priority	5
Maximum Score	(100)

Table 2-3 Result of Area Evaluation

Area Name	Project	Existing Land-use	Area (ha)	Existing Population in 1992	Existing Population Density (Inhab/ha)	Community Facilities (Nos) ①	②	③	④	⑤	⑥	⑦	Total	Deteriorated Condition of Previously Paved Area Roads (km) Reconstruction	Overlay	Maintenance	Total	Distance from the Middle Ring (km)	Area Point 1. Road Deterioration	2. Land-use	3. Population	4. Population Density	5. Community Facilities	6. Government Priority	Total Point	Area Weight
-Kivukoni/Mahafukoge	DRIMP(I)	C.B.D.	290	35,400	122	1	-	2	3	5	6	4	21	-		17.5	17.5	2.7	10	20	10	10	10	5	65	-
			(1.5)	(2.2)									(10.4)			(100)	(100)									
-Koriakoo	DRIMP(IV)	Commertial	200	24,400	122	4	1	-	-	2	2	2	11	19.0	-	12.6	31.6	1.1	30	20	10	10	10	5	85	-
			(1.0)	(1.6)									(5.4)	(60.0)		(40.0)	(100)									
-Changombe	DRIMP(IV)	Industrial	320	-	-	-	-	1	-	-	-	-	1	8.0	-	6.6	14.6	0.8	20	20	5	5	10	5	65	-
			(1.6)	(-)									(0.5)	(54.8)		(45.2)	(100)									
-Sub-total	DRIMP	-	810	59,800	74	5	1	3	3	7	8	6	33	27.0	-	36.7	63.7	-	-	-	-	-	-	-	-	-
			(4.1)	(3.9)									(16.3)	(42.4)	(0)	(57.6)	(100)									
-Sinza	DRDP	P.L.A. High	460	55,000	120	4	1	-	0	1	1	-	7	14.96	1.00	0	15.96	4.5	40	15	10	10	5	10	90	0.90
		density + D.C.	(2.3)	(3.6)									(3.5)	(93.7)	(6.3)	(0)	(100)									
-Mwanayamala	DRDP	P.L.A. High	400	97,000	240	6	1	1	2	3	1	2	16	6.96	0.60	0	7.56	1.0	40	15	10	10	10	10	95	0.95
		density + D.C.	(2.0)	(6.4)									(7.9)	(92.1)	(7.9)	(0)	(100)									
-Ilala	DRDP	P.L.A. High	120	24,000	200	3	-	1	1	2	-	4	11	6.37	1.00	0	7.37	0.4	40	15	10	10	10	10	95	0.95
		density + D.C.	(0.6)	(1.6)									(5.4)	(86.4)	(13.6)	(0)	(100)									
-Temeke	DRDP	P.L.A. High	490	15,000	300	7	1	1	-	2	1	1	13	8.75	2.19	3.55	14.49	3.5	30	15	10	10	5	10	80	0.80
		density + D.C.	(2.5)	(9.9)									(6.4)	(60.4)	(15.1)	(24.5)	(100)									
-Tabata	DRDP	P.L.A. Medium	150	12,000	80	1	-	-	-	-	-	-	1	7.10	0	0	7.10	5.0	40	10	10	5	5	10	80	0.80
		density	(0.8)	(0.8)									(0.5)	(100)	(0)	(0)	(100)									
Sub-total	DRDP	-	1,620	338,000	210	24	3	34	4	9	3	7	53	44.14	4.79	35.50	52.48		-	-	-	-	-	-	-	-
			(8.2)	(22.3)									(26.2)	(84.1)	(9.1)	(6.8)	(100)									
Other Urban Area		P.L.A. High	1,500	247,000	160																					
		density	(7.6)	(16.3)																						
		P.L.A. Medium	1,880	97,300	52																					
		density	(9.5)	(6.4)																						
		P.L.A. low	2,290	72,300	32																					
		density	(11.6)	(4.8)																						
		Unplanned	7,140	655,700	92																					
		Residential	(36.2)	(43.2)																						
		Institution	2,670	36,500	14																					
			(13.5)	(2.4)																						
		Industrial	1,820	-	-																					
			(9.2)	(-)																						
Sub-total			17,300	1,117,200	65	50	18	6	11	15	7	9	116	120.0	34.1	32.7	186.8	3.0	30	18	10	5	10	5	78	-
			(87.7)	(73.7)									(44.0)	(64.2)	(18.3)	(17.5)	(100)									
Total			19,730	1,151,000	77	76	22	12	17	30	18	22	197	191.14	38.89	72.95	302.98		-	-	-	-	-	-	-	-
			(100)	(100)									(100)	(63.1)	(12.8)	(24.1)	(100)									

C.B.D. : Central Business District
P.L.A. : Planned Residential Area
D.C. : District Center

① Primary School
② Upper School
③ District Hospital
④ Other Hospitals
⑤ Post and Police Office
⑥ Transport Stations
⑦ Other Community Facilities

(2) Selection of Priority Roads for Rehabilitation

Based on the results of the evaluation of the importance of the 5 subject areas, a detailed evaluation of individual roads subject to rehabilitation under the Project was conducted to establish their priority and suitability for Japanese grant aid.

Seven factors, with 3 - 5 grades each (Table 2-4), were used for the scoring system for this evaluation, i.e. (i) PSI value obtained by the inventory survey on all of the subject roads, (ii) ADT obtained by the traffic volume survey and future traffic volume estimated in the JICA M/P Study, (iii) degree of damage to drainage facilities (the importance of factors (iii) was pointed out by the survey on the opinions of local residents), (iv) assigned functions of each road, (v) land use along the road, (vi) degree of impact on the lives of the public and (vii) intentions of the Government of Tanzania. The resulting score for each road was added to the evaluation results for the area in which the road is located to finalise the score as shown in Table 2-5.

Those roads scoring 75 or more points were the Middle Ring Road (sections totalling 7.1 km) and primary feeder roads in the Mwinyijmara, Hala and Sinza areas (13 roads totalling 15.6 km). Because of the high priority and suitability of these roads, they have been selected as the subject roads for rehabilitation under the Project(see Fig.2-2).

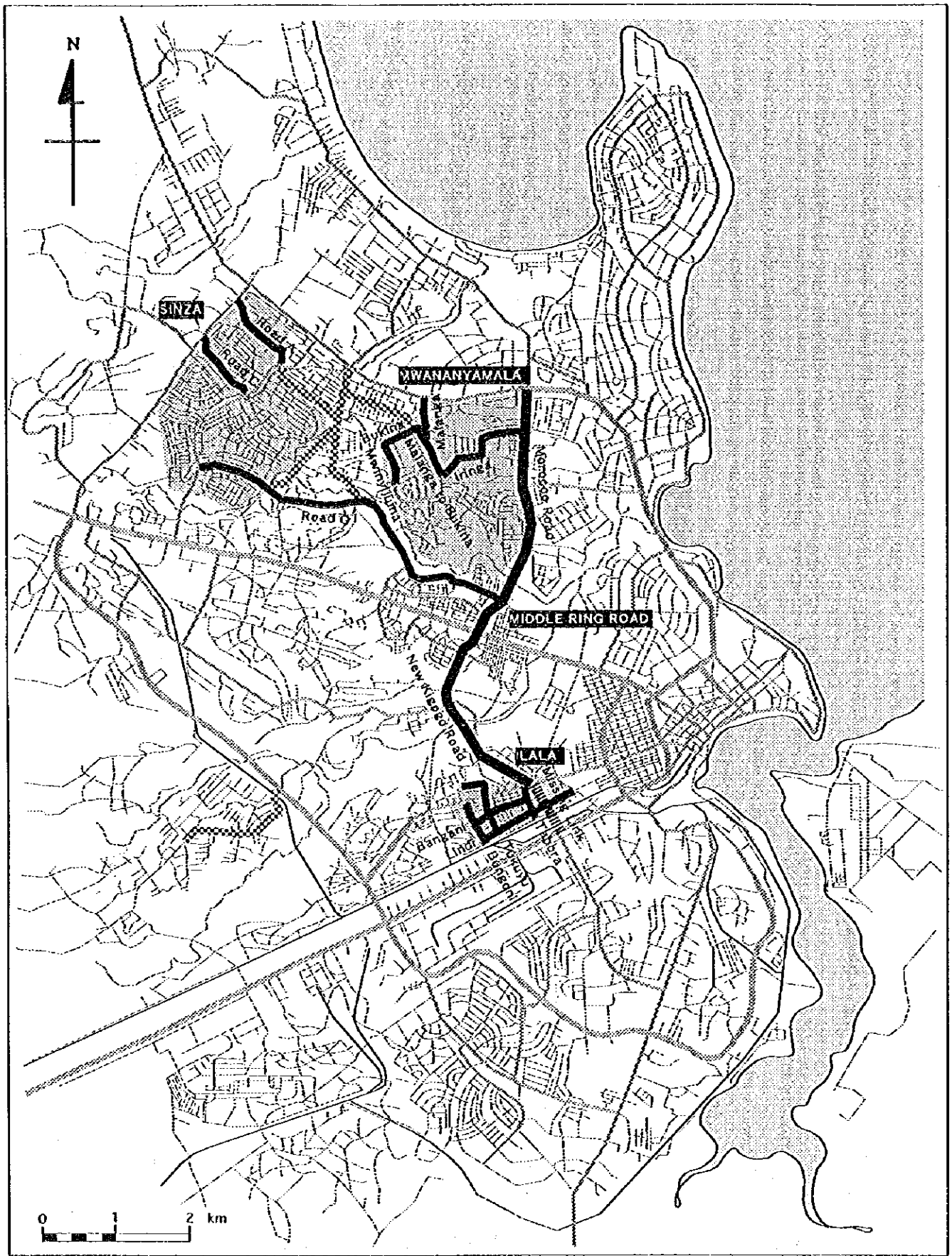
The other roads in the above three areas and roads in Temeke and Tabata areas (27 roads totalling 36.9 km) have been given secondary priority and it is believed that a follow-on project to the present Project in the medium-term time scale will be necessary to rehabilitate these roads.

Table 2-4 Priority Road Selection Criteria

Evaluation Item	Points		Remarks
	Trunk Roads	Local Roads	
1. Technical Evaluation	(60)	(60)	
1.1 Degree of Damage to Existing Paving	(15)	(25)	
- Difficult to Pass (PSI < 1.3)	15	25	Reconstruction
- Very Bad (PSI < 2.0)	15	20	Replacement of base course
- Bad (PSI < 3.5)	15	15	Overlay
- Normal (PSI > 4.0)	10	10	Patching
- Good (PSI = 5.0)	5	5	Routine maintenance
1.2 Current Traffic Volume	(30)	(15)	
- Future ADT > 20,000	30	15	
- ADT > 10,000	25	15	
- ADT > 5,000	20	15	
- ADT > 1,000	15	15	
- ADT > 100	10	10	
- ADT ≦ 100	5	5	
1.3 Degree of Damage to Drainage Facilities	(15)	(20)	
- Area Liable to Flooding	15	20	
- Lack of Drainage System	15	15	
- Partial Damage/Poor Drainage	10	10	
- Normal	5	5	
2. Socioeconomic Evaluation	(20)	(20)	
2.1 Road Functions	(10)	(10)	
- Trunk Road	10	10	
- Primary Feeder Road	5	10	
- Secondary Feeder Road	5	5	
- Tertiary Feeder Road	6	0	
2.2 Land Use Along Route	(10)	(10)	
- Commercial, Industrial, Densely Populated	10	10	
- Residential	5	5	
- Undeveloped	0	0	
3. Impacts on BHN	(10)	(10)	
- Public Transport Route	10	10	
- At Least One Public Facility Along Route	5	5	
- Little Impact	0	0	
4. Government Intentions (Priority)	(10)	(10)	
- Highest Priority	10	10	
- High Priority	5	5	
- Other	0	0	
Maximum Score	(100)	(100)	

Table 2-5 Selection of High Priority Roads

NO.	ROAD NAME	TOTAL LENGTH	1-1 Pavement Deterioration: Each Length of PSI Value 1.0≤PSI≤1.5	1.5<PSI≤2.0	2.0<PSI≤3.5	3.5<PSI≤5.0	POINT	1-2 Traffic Volume: Passer Traffic (A/D)	Freight Traffic in 2000	POINT	1-3 Drainage Condition: Passes Condition	POINT	2-1 Road Classification: Classification	POINT	2-2 Land use	POINT	3 Social Demand: Needs: Facilities	POINT	4 Government Policy: POINT	TOTAL POINT	AREA WEIGHT	WEIGHTED TOTAL POINT	HIGH PRIORITY ROADS (WTP ≥ 75)
Sinza Area		15.96	7.93	7.03	1.00	0.00																	
1	Road A	1.10	0.00	0.70	0.40	0.00	18	1,200	-	15	Flooded	20	Primary	10	5	Bus Route	10	10	88	0.90	79		○
2	Road B	3.42	2.02	1.00	0.40	0.00	23	800	-	10	Flooded	20	Secondary	5	5	2 facilities	5	10	78	0.90	70		-
3	Road C	1.00	1.00	0.00	0.00	0.00	25	1,100	-	15	Flooded	20	Primary	10	5	2 facilities	5	10	90	0.90	81		○
4	Road D	1.03	1.03	0.00	0.00	0.00	25	500	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	80	0.90	72		-
5	Road E	0.84	0.40	0.44	0.00	0.00	23	700	-	10	Flooded	20	Secondary	5	5	2 facilities	5	10	78	0.90	70		-
6	Road F	1.76	1.16	0.60	0.00	0.00	24	500	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	79	0.90	71		-
7	Road G	5.00	1.40	3.40	0.20	0.00	22	2,000	-	15	Corrupted	15	Primary	10	5	Bus Route	10	10	87	0.90	78		○
8	Road H	1.12	0.72	0.40	0.00	0.00	24	500	-	10	Corrupted	15	Secondary	5	5	1 facility	5	10	74	0.90	66		-
9	Road I	0.69	0.20	0.49	0.00	0.00	22	1,600	-	15	Corrupted	15	Secondary	5	5	1 facility	5	10	77	0.90	69		-
Mwanayamala Area		7.56	4.66	2.30	0.60	0.00																	
10	Bukina Street	0.63	0.63	0.00	0.00	0.00	23	700	-	10	Flooded	20	Primary	10	5	1 facility	5	10	83	0.95	78		○
11	Guita Street	0.63	0.63	0.00	0.00	0.00	23	200	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	78	0.95	74		-
12	Kiennolmi P/School	0.48	0.08	0.40	0.00	0.00	21	200	-	10	Flooded	20	Secondary	5	5	2 facilities	5	10	76	0.95	72		-
13	Iseke Street	0.19	0.00	0.19	0.00	0.00	20	200	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	75	0.95	71		-
14	Malongwe Street	1.30	0.40	0.30	0.60	0.00	20	400	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	75	0.95	71		-
15	Malanga Street	0.65	0.45	0.20	0.00	0.00	24	600	-	10	Flooded	20	Primary	10	5	Bus Route	10	10	89	0.95	84		○
16	Iringa Street	1.56	1.20	0.36	0.00	0.00	24	600	-	10	Flooded	20	Primary	10	5	3 facilities	5	10	84	0.95	79		○
17	Malanga to Bukina	0.70	0.70	0.00	0.00	0.00	25	900	-	10	Flooded	20	Primary	10	10	Bus Route	10	10	95	0.95	90		○
18	Karafuu Street	0.85	0.00	0.85	0.00	0.00	20	200	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	75	0.95	71		-
19	Mwinyi Juma Street	0.57	0.57	0.00	0.00	0.00	23	200	-	10	Flooded	20	Primary	10	5	1 facility	5	10	83	0.95	78		○
Ilala Area		7.37	2.90	3.47	1.00	0.00																	
20	Lindi Street	1.36	0.16	0.40	0.80	0.00	20	300	-	10	Flooded	20	Primary	10	5	1 facility	5	10	80	0.95	76		○
21	Dungoni Street	0.64	0.24	0.40	0.00	0.00	22	500	-	10	Flooded	20	Primary	10	5	1 facility	5	10	82	0.95	77		○
22	Pangani Street	0.87	0.40	0.47	0.00	0.00	23	300	-	10	Flooded	20	Primary	10	5	1 facility	5	10	83	0.95	78		○
23	Tabora Street	0.43	0.20	0.23	0.00	0.00	23	400	-	10	Flooded	20	Primary	10	5	1 facility	5	10	83	0.95	78		○
24	Morogoro Street	0.48	0.00	0.28	0.20	0.00	18	200	-	10	Flooded	20	Tertiary	0	10	1 facility	5	10	73	0.95	69		-
25	Uhuru Street	0.50	0.30	0.20	0.00	0.00	23	200	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	78	0.95	74		-
26	Arusha Street	0.59	0.19	0.40	0.00	0.00	22	200	-	10	Flooded	20	Secondary	5	5	1 facility	5	10	77	0.95	73		-
27	Tukuyu Street	1.10	1.00	0.10	0.00	0.00	25	300	-	10	Flooded	20	Primary	10	5	2 facilities	5	10	85	0.95	80		○
28	Shant Shamba Street	0.54	0.34	0.20	0.00	0.00	23	200	-	10	Flooded	20	Secondary	5	5	2 facilities	5	10	78	0.95	74		-
29	Mwanza Street	0.27	0.07	0.20	0.00	0.00	22	200	-	10	Flooded	20	Tertiary	0	5	1 facility	5	10	72	0.95	68		-
30	Bukuba Street	0.57	0.00	0.57	0.00	0.00	20	200	-	10	Flooded	20	Tertiary	0	5	1 facility	5	10	70	0.95	66		-
Temeke Area		14.49	5.42	3.33	2.19	3.55																	
31	Everett Street	0.63	0.60	0.03	0.00	0.00	25	200	-	10	No Facility	15	Secondary	5	5	Bus Route	10	10	80	0.80	64		-
32	Yombo Street	1.00	0.00	0.20	0.80	0.00	16	200	-	10	No Facility	15	Primary	10	5	Bus Route	10	10	76	0.80	60		-
33	Temeke Road	2.05	0.00	0.00	0.00	2.05	10	8,200	-	15	No Facility	15	Primary	10	10	Bus Route	10	10	80	0.80	64		-
34	Mbagala Road	3.50	1.40	0.20	0.40	1.50	18	700	-	10	No Facility	15	Primary	10	5	Bus Route	10	10	78	0.80	62		-
35	Wailes Road	0.85	0.00	0.60	0.25	0.00	19	200	-	10	No Facility	15	Secondary	5	5	1 facility	5	10	69	0.80	55		-
36	Ruvuma Street	0.62	0.22	0.20	0.20	0.00	21	200	-	10	No Facility	15	Secondary	5	5	1 facility	5	10	71	0.80	56		-
37	Chihota Street	1.10	0.60	0.50	0.00	0.00	23	500	-	10	No Facility	15	Primary/Secondary	7	5	Bus Route	10	10	80	0.80	64		-
38	Dububu Street	2.62	1.60	0.00	0.42	0.00	23	200	-	10	No Facility	15	Primary/Secondary	7	5	Bus Route	10	10	80	0.80	64		-
39	Mahunda Street	2.12	1.00	1.00	0.12	0.00	22	200	-	10	No Facility	15	Primary/Secondary	7	5	Bus Route	10	10	79	0.80	63		-
Tabata Area		7.10	6.10	1.00	0.00	0.00																	
40	Tabata Road	7.10	6.10	1.00	0.00	0.00	24	800	-	10	No Facility	15	Primary/Secondary	7	2	Bus Route	10	10	78	0.80	62		-
Middle King Road		6.34	0.00	0.00	0.60	5.74																	
41	Morocco Street	3.58	0.00	0.00	0.00	3.58	10	13,000	41,000	30	Partly Corrupted	10	Trunk	10	10	Bus Route	10	10	90	1.00	90		○
42	Kigogo Street	2.76	0.00	0.00	0.60	2.16	12	13,000	32,000	30	Partly Corrupted	10	Trunk	10	10	Bus Route	10	10	92	1.00	92		○



THE BASIC DESIGN STUDY ON
DAR ES SALAAM ROAD DEVELOPMENT
PROJECT

Fig. 2-2 Objective Roads to be Improved on this Project

: Widening of Middle Ring Road (from 2 to 4 lane)

: Construction of Missing Link (4 lane)

: Rehabilitation of Local Road

: CIP Project Roads by World Bank

2.3 Basic Design

2.3.1 Basic Design Concept

The conditions and concepts adopted for preparation of the basic design for the Project are explained in this section.

(1) Natural Conditions

Dar es Salaam has annual rainfall of approximately 1,100 mm with high monthly rainfall recorded in the main rainy season of April and May. In designing the capacity of the drainage facilities, a surplus capacity of some 20% above the rainfall intensity will be allowed. As many of the city's roads have no drainage facilities, causing such social problems as poor or non-existent drainage, flooding and the outbreak of mosquitoes carrying malaria, the road rehabilitation work will include not only improvement/ construction of the roadside drainage system but also total drainage routes upto a final discharge point. In principle, the construction work will avoid the rainy season. However, it is believed that paving work can be conducted with little difficulty as the local rain does not last long, certainly not as long as a full day.

The ground in Dar es Salaam predominantly consists of sandy silt and the alluvial layer along a branch of Msinbaji River, running through the city, is more than 15 m thick. The design of the embankment for the Middle Ring Road, which crosses the alluvial layer along this branch, should incorporate measures to stabilize the embankment in view of its likely settlement if such measures are not implemented.

(2) Socioeconomic Conditions

While the power supply situation in Dar es Salaam is relatively stable at present due to the recent rehabilitation of the thermal power station, planned power cuts are implemented during the dry season because of the strong dependence of hydropower generation. In the coming years, however, the power supply situation is expected to further improve due to the commencement of work to expand thermal power generation using the natural gas produced in southern Tanzania.

In contrast, the water supply situation in Dar es Salaam is very tight. In addition to a shortage of water at two sources, the high leakage rate of the water supply system and inadequate supply volume and pressure cause stoppage of the water supply in various parts of the city during the dry season. It will, therefore, be necessary to extract the water for sprinkling and other purposes at the project sites from minor rivers and wells in the city.

While traffic congestion and queues are observed on trunk roads in Dar es Salaam, hardly any congestion is observed on local roads due to the low level of traffic. While this presents a good prospect for the rehabilitation of local roads, a construction plan which allows the current level of traffic must be prepared for the widening of the Middle Ring Road. The frequent traffic accidents throughout the city have become a social problem, necessitating the installation of such safety facilities as traffic signals.

(3) Local Construction Industry

Revision of the Minimum Wages Act has raised the monthly minimum wage to 30,000 Tsh (approximately 1.7 times higher than the previous level). However, revision of the Income Tax Act has increased the tax rate and expanded the scope of taxable income since July, 1996 and all allowances except the housing allowance has become taxable. Social insurance is charged at 20% of the monthly income (half of which is contributed by the employer) and the labour union fee stands at 2% of the monthly income. In addition, a premium for the workmen's accident compensation insurance is payable on the annual income at a pre-determined rate for each type of job. The unit labour cost for the Project consists of the revised minimum wage, the above-described insurance fees and various allowances.

With regard to construction materials, while cement and asphalt are produced domestically, the quality is slightly inferior to that of imported products. Standard reinforcing bars and steel are mainly imported and are available through importers. General-purpose construction materials, such as subgrade materials, sand for concrete and crush stone, are all available locally. In the case of locally manufactured concrete forms, the quality is very poor, resulting in a short life and poor concrete surface finish. Other special materials must be imported. The supply source for traffic signals and road lighting equipment must be decided, taking into consideration the need for compatibility with existing traffic signals and road lighting equipment in Dar es Salaam, most of which were made in Japan, and the intentions of the MOW and DCC.

The Government of Tanzania decided some time ago not to increase the quantity of construction machinery in its possession in order to facilitate the growth of local road construction companies and to reduce the maintenance cost of such machinery. Revision of the Investment Act and Regulations to ease controls on the establishment of private leasing companies for construction machinery also contributed to this decision. Following this decision, Plant and Equipment Hire Co., Ltd. (PEHCOL), a construction machinery leasing company, was established in 1992 under the IRP-1 of the World Bank and the major road construction machines owned by the MOW were transferred to PEHCOL with a view to leasing them to regional construction departments and contractors. However, many of these

machines were procured 10 - 20 years ago and the lack of maintenance funds and maintenance skills have now reduced the rate of workable machines to some 15% of the total. It is planned to supplement these machines and to foster private investment in these machines in 2 - 3 years time under the IRP-2.

As half of the road construction machines owned by private road construction companies in Tanzania are based in Dar es Salaam, it will not be difficult to obtain such machines. Some construction companies have actually started to lease their machines. Under these circumstances, it was assumed that the construction machinery required for the Project could be leased and a survey was conducted to find the likely unit lease costs (excluding operator and fuel costs). The unit costs obtained in Tanzania would be compared with the standard machinery hire cost in Japan to determine the most appropriate procurement method for construction machinery.

Two local construction companies and 2 Japanese construction companies in Dar es Salaam have a heating type asphalt mixing plant with a production capacity of 30 - 40 tons/hr. In addition, a German company is operating a 60 tons/hr plant which is leased from the DCC. The actual operating rate of these plants depends on the supply of aggregate and is approximately 53% in general.

The same companies operating an asphalt plant also have a 30 tons/hr crushed stone plant at Kunduti, located some 22 km north of Dar es Salaam, and Bogo, located some 33 km north of Dar es Salaam, for the crushing of coral stone. As this crushed coral stone has a high dust content, it is inappropriate as an asphalt concrete aggregate but can be used as a subgrade material. At Kunduti, however, the bedrock is beginning to be depleted and it appears difficult to obtain the total quantity of required subgrade material for the Project from this quarry site. Promising rocky sites capable of producing the concrete and asphalt concrete aggregate for the Project are located at Lukoba Quarry (some 128 km from Dar es Salaam) and Mikese Quarry (some 144 km from Dar es Salaam), offering granite. As the production of crushed stone of 5 mm in size is critical for use as an aggregate, the real operation rate will be approximately 33%.

(4) Local Construction Companies

There are 493 registered construction companies in Tanzania, 211 of which (approximately 43%) are based in Dar es Salaam. These companies are classified into 6 grades based on the annual work value. There are 20 Grade 1 companies, of which 18 are concentrated in Dar es Salaam. These Grade 1 companies have worked for the World Bank and ODA projects and are technically capable of working as subcontractors for the Project. The construction plan

for the Project should, therefore, allow the use of local construction companies as subcontractors when deemed feasible.

(5) Maintenance Capability

The DCC maintains a total road length of 1,150 km in Dar es Salaam and some 930 km of feeder and local roads are unpaved gravel or earth roads. The maintenance of these roads is conducted by the MOW, DCC and DRIMP Office which is a special road construction and maintenance organization established by the DCC in cooperation with the MOW.

The DRIMP Office conducts the planning, coordination, funding consolidation, land acquisition, relocation of existing structures, work management and routine road maintenance (cleaning, pot hole repair, weeding and drainage cleaning and repair, etc.) for roads constructed/rehabilitated by Japanese grant aid and its competence in these areas is highly reliable. It will be necessary to secure the participation of the DRIMP Office in the Project for the proper maintenance of the rehabilitated/improved roads after completion of the Project. Funding for road maintenance has been stable due to the Road Fund which was established in 1993 to specially finance the construction and maintenance of roads in Tanzania.

Given the present road maintenance capability of and budgetary appropriation by the DCC, no special problems are anticipated in regard to the maintenance of the rehabilitated roads under the Project. However, if the further extension of the road length requiring maintenance due to the improvement/rehabilitation of roads goes beyond the capacity of the existing maintenance equipment with no prospect of new equipment being procured, it will be necessary to introduce a durable road improvement method which requires little routine maintenance.

(6) Right of Way and Underground Utilities

1) Right of Way

① Local Roads

At those sections where the road site is clearly established, the present Right of Way width will be used. At those sections without a clearly established Right of Way, the Right of Way width will be established in the basic design.

② Middle Ring Road

The Right of Way is clearly established for both Morocco Road and New Kigogo Road. In principle, the basic design will adopt horizontal alignment which does not

change the established Right of Way width unless absolutely necessary. In the case of those sections where the planned road width is wider than the existing Right of Way width, the basic design will establish new Right of Way boundary lines.

2) Underground Structures

The Morocco Road section of the Middle Ring Road has a power cable (suspended), telephone line (underground), water pipes (main and branch) and sewer pipes. In the case of the telephone line, as the manhole structure is capable of withstanding vehicle weight, those manholes located on the carriageway will be simply raised. The water mains (concrete pipes with a diameter of 1,200 mm) have a soil cover of 2.0 m and cutting of the existing road should be avoided where possible to establish vertical alignment requiring the minimum volume of relocation work.

New Kigogo Road has similar utility facilities to Morocco Road and the same construction principles will, therefore, apply. At the river crossing site, a high voltage power line traverses above the road. With extension of the road width, the existing pylons will interfere with the road construction clearance and, therefore, new pylons must be erected to ensure a proper distance between the road and the pylons.

(7) Principles Regarding Design Grade of Road Facilities

The planned rehabilitation work for the subject local roads does not mean raising of their grade. Consequently, no alignment improvement, etc. will, in principle, be conducted and the work will be restricted mainly to rehabilitation of the existing paving and drainage facilities. However, the acquisition of additional land is proposed for those sections where the current road width does not meet the width required to perform the road functions proposed under the Project.

In the case of the Middle Ring Road where widening to 4 lanes and construction of the missing link are proposed, the existing road alignment will be improved to raise its grade as a trunk road.

(8) Construction Schedule

The selected roads for improvement/rehabilitation are 13 roads (totalling 15.6 km) in 3 areas where the particularly serious damage required urgent improvement and the Middle Ring Road (totalling 7.1 km). It is planned to complete the entire work in 2 phases or 3 years as shown below.

	Phase 1	Phase 2
Subject Road	Local Roads	Middle Ring Road
Detailed Design Period	4.5 months	6 months
Construction Period	12 months	19 months

Based on the past performance, it will require approximately one year for the Government of Tanzania to conduct the necessary budgetary appropriate and to disburse the compensation for land acquisition and house relocation necessitated by widening of the Middle Ring Road.

The project implementation schedule will feature the rehabilitation of local roads in Phase 1, during which time the land acquisition and house relocation in connection with the Middle Ring Road widening work will be completed, and will then feature the widening and construction of the missing link of the Middle Ring Road in Phase 2. The embankment section of the Middle Ring Road will be subject to widening work on the soft ground of the dry riverbed. Pre-loading work will be conducted prior to the commencement of the main work and the paving and structure work under the Project will commence when 90% of the expected final settlement level has been confirmed.

2.3.2 Basic Plans

(1) General Plan

(a) Improvement Measures

The Project principally consists of the rehabilitation and widening of existing roads. In principle, the planned rehabilitation of local roads intends rehabilitation of the existing paving without improving the road alignment. The paving rehabilitation work is classified into 2 categories, i.e. asphalt overlay and reconstruction of the base course upward or sub-base course upward, depending on the degree of damage to the existing paving. As most of the subject local roads currently lack drainage facilities, the construction of drainage facilities will be necessary.

In the case of the Middle Ring Road where widening work and construction of the missing link are planned, new horizontal and vertical alignments should be designed to use the existing paving at as many sections as possible to reduce the overall cost.

The following principles for the road facility improvement/rehabilitation have been confirmed by the Government of Tanzania.

1) Carriageway Improvement

Local Roads

Either asphalt concrete overlay or reconstruction of the paving will be conducted.

Middle Ring Road

Either asphalt concrete overlay or reconstruction of the paving will be conducted to ensure the smooth flow of a large traffic volume. At the widening sections, the new horizontal and vertical alignments should try to incorporate the existing paving without any extra work.

2) Sidewalk Improvement

Local Roads

As the existing sidewalks of some of the subject local roads are not damaged, only maintenance work will be conducted. In the case of those roads without sidewalks, the shoulders will be used as sidewalks.

Middle Ring Road

A planting zone with a width of 1.5 m will be introduced between the carriageway and sidewalks in view of pedestrian safety and environmental care along this trunk road.

3) Shoulder Improvement

Shoulders with a width of 2.5 m will be introduced for local roads. These shoulders will also function as sidewalks.

4) Drainage Improvement

Local Roads

Most local roads currently lack drainage facilities. The existing side ditches are often found to be buried or damaged due to the undulating road surface caused by destruction of the carriageway paving. These facilities will be either rehabilitated or repaired. New side ditches will be constructed along those sections where they are currently missing. An open ditch with a concrete lining will be introduced on one side of the road while an earth side ditch will be introduced on the other side. Both will be connected to the existing drainage channel.

Middle Ring Road

The existing drainage facilities cover some 30% of the entire route. New U-shaped side ditches with a removable cover for easy cleaning will be constructed at those sections where no drainage facilities currently exist. As in the case of local roads, drainage channels upto the final outlet will be constructed to ensure proper drainage from the roadsides.

5) Major Intersection Improvement

Local Roads

The introduction of a mini roundabout will be planned for those intersections where extra land is available. In addition, the introduction of road humps will be planned at intersections with trunk roads or near such public facilities as schools to ensure both pedestrian safety and safe traffic.

Middle Ring Road

Based on the traffic volume survey findings, the necessity to install a traffic signal system will be examined for intersections with major trunk roads.

(b) Determination of Design Period

- Design Period of Paving

The design period for paving is set at 15 years for the Middle Ring Road, a major trunk road, and 10 years for local roads.

- Rainfall Return Period for Drainage Facilities

The design rainfall return period for the culverts crossing rivers will be 50 years. For roadside drainage, a return period of 3 years will be used. In the case of the design capacity for crossing pipes and channels to the final outlet, a return period of 10 years will be used.

(c) Determination of Design Standards

In principle, the design standards used in Tanzania will be referred to as the principal design standards. However, as the existing standards mainly deal with roads in rural areas, they are not particularly suitable for urban roads such as those subject to rehabilitation under the Project. In view of this situation, the road design standards

applicable to the Project-related roads have been established through consultations with the Tanzanian side.

As far as the types of road are concerned, the roads are firstly classified as urban roads or rural roads as in the case of the Road Structure Ordinance in Japan. Urban roads are further classified into 4 categories, i.e. (i) major trunk roads/trunk roads, (ii) primary feeder roads, (iii) secondary feeder roads and (iv) block roads.

Table 2-6 shows the design speed, the width of each road component and the geometric structural standards for each type of road. Fig. 2-3 shows the standard cross-section of the Middle Ring Road and local roads where the above standards, etc. are applied. Changes of the width of some road components of the Middle Ring Road and the reasons for these changes are described in Appendix B-5.

1) Paving Design

The Asphalt Overlay and Pavement Rehabilitation published by the Asphalt Institute, USA will be referred to for design of the overlay and reconstruction work. In the case of the surface dressing paving design, the TRL (Transport Research Laboratory, UK) Road Note 31 will be referred to.

2) Drainage Design

A return period of 50 years for rivers will be used for the drainage design calculations while a return period of 3 years will be used for roadside drainage (to determine the capacity of the U-shaped side ditches). The popularly used rational formula will be used for discharge calculations.

3) Structures Design

The Collection of Standard Box Culvert Cross-Sections issued by the Japanese Ministry of Construction will be used for reference purposes for the cross-section design of structures. Structural calculations will be conducted at the detailed design stage.

4) Railway Standards

The East African Railways Corporation Engineering Manual Vol. 1 - Technical Instructions (1962) obtained from the TRC will be referred to as the railway design standards.

Table 2-6 Design Standard for Urban Roads

Classification	Design Speed (km/hr)	Design Traffic Volume (pcu/day)	No. of lane	Typical Cross Section: Recommendable Right of way (m)	Total Road Width (m)	Carriageway (m)	Shoulder (m)	Sidewalk (m)	Planting zone (m)	Center Strip (m)	Drainage System	Utility Space (Recommendable) (m)	Considerable Pavement Type: Recommendable	Alternative
Trunk Road	60	10,000~	4	45+5	45(Grade separation for future)	3.25 x 4	0.5 x 2	3.0 x 2	4.0 x 2	11.0	L or U-shaped Drain	5	A.C.	A.C.
				35+10	35(Standard)	3.25 x 4	0.5 x 2	3.0 x 2	1.5 x 2	8.0	L or U-shaped Drain	10		
				25	25(Minimum)	3.25 x 4	0.5 x 2	3.0 x 2	-	2.0	L or U-shaped Drain			
Primary Distributer	40~50	4,000~10,000	2	20	20	3.0 x 2	2.5 x 2		-	-	Open Ditch	3	A.C.	A.C./ DBST
Secondary Distributer	40	500~4,000	2	15	15	3.0 x 2	1.5 x 2		-	-	Open Ditch	3	A.C./ DBST	DBST
Tertiary Distributer	20~40	~500	1	12	10	4.0 x 1	1.5 x 2		-	-	Open Ditch	3	Gravel	Gravel

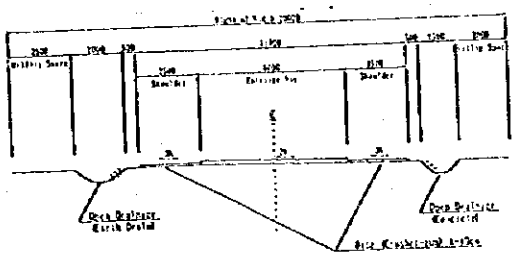
A.C.:Asphaltic concrete
DBST :
Double Bituminous Surface Treatment

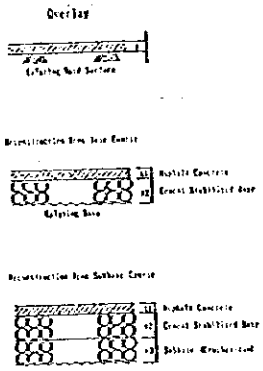
Classification	Tanzania Geometric Design Standards: Minimum Radius Curve (m)	Supererevation Limits Curve Radious (m)	Maximum Gradient (%)	Minimum Vertical Curve Radius: Crest(m)	Minimum Vertical Curve Radius: Sag(m)	Minimum Vertical Curve Length (m)	Adequate Camber (%)	Stopping Sight Distance (m)	Passing Sight Distance (m)
Trunk Road	150 (150)	1,200 (2,000)	5 (5)	14A (1,400)	16A (1,000)	- (50)	2.0(A.C.)	75 (75)	400 (250)
Primary Distributer	100 (100)	800 (1,300)	5 (6)	10A (800)	12A (700)	- (40)	2.0(A.C.) 2.5(DBST)	55 (55)	330 (200)
Secondary Distributer	75 (60)	500 (800)	6 (7)	6A (450)	8A (450)	- (35)	2.0(A.C.) 2.5(DBST)	40 (40)	250 (150)
Tertiary Distributer	50 (30)	300 (500)	6 (8)	4A (250)	6A (250)	- (25)	3.0(Gravel)	30 (30)	180 (100)

Note : ( ) Japanese Road Standard
Minimum Gradient=0.5%
A : algebraic differrence in grade(%)

Fig. 2-3 Design Typical Cross Section

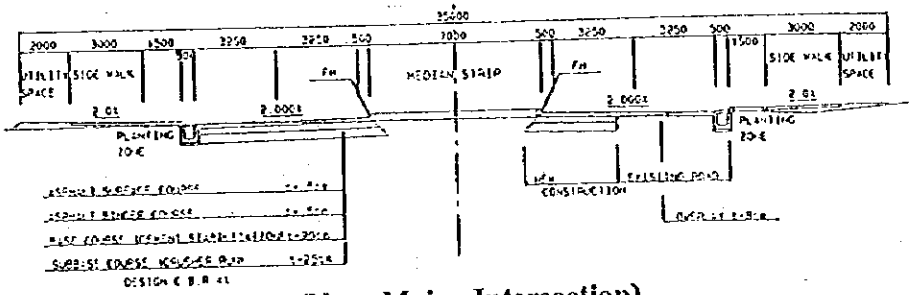
Typical Cross Section of Local Road



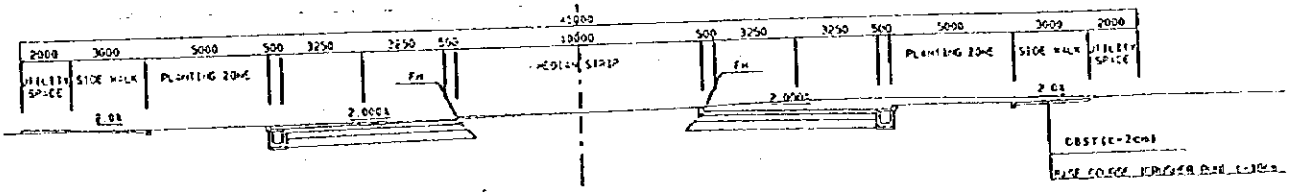


Typical Cross Section of Middle Ring Road

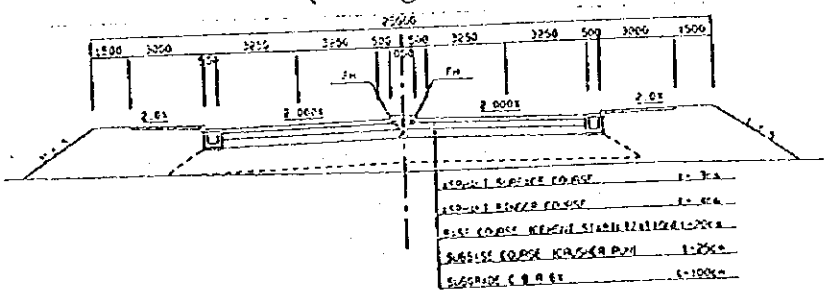
(General Section)



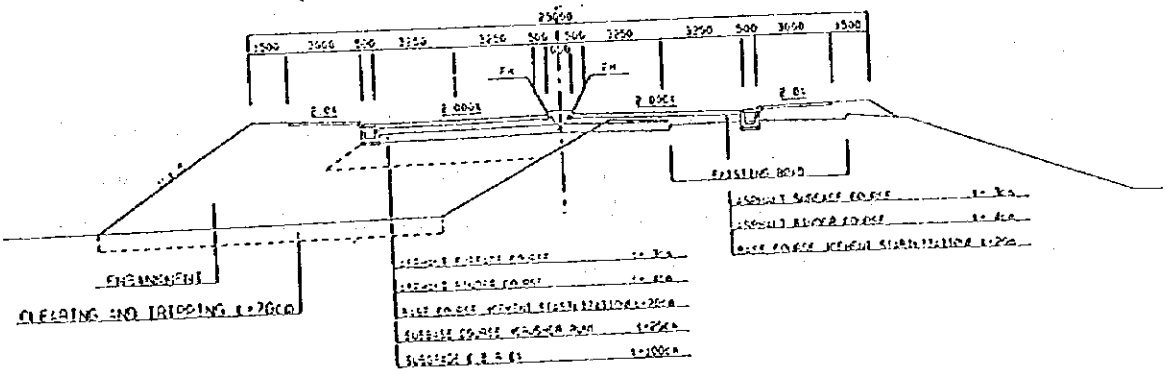
(Near Major Intersection)



(Missing Link)



(Embankment Section at River Crossing)



(2) Facilities Plan

(a) Alignment Design

1) Middle Ring Road

• Horizontal Alignment

In principle, the existing road width will be employed to minimise the necessity for house relocation. In addition, the horizontal alignment will be determined in view of locating underground structures for public utilities under sidewalks or the central median in order to keep the relocation work volume to a minimum.

• Vertical Alignment

In principle, the vertical alignment is designed to minimise the elevational difference between the road surface and neighbouring areas. In the case of the valley section of Morocco Road, however, an embankment with a height of 1 - 2 m will be constructed to raise the road surface from the existing road to provide a sufficient cross-section for the river flow. The required embankment height will be decided based on the cross-section of the box culvert to be installed, in turn decided by the flow rate calculation. At the two valley crossing sections of New Kigogo Road, the ridge section will be cut by 1 - 2 m to achieve a better view for road safety purposes which is currently hampered by the present vertical alignment with large undulations. Following this work, the relocation of some water pipes will be necessary at the intersection between New Kigogo Road and Old Kigogo Road.

• Embankment at Valley Sections (River Crossing Sites) of Morocco Road and New Kigogo Road

The expected height of the embankment at the above sections is approximately 4 m and the possible necessity to adopt settlement prevention measures will be examined based on the geological survey findings.

2) Local Roads

• Horizontal Alignment

As the work involving local roads is rehabilitation work, the horizontal alignment of these roads will not, in principle, be altered. At those sites where the required width is unavailable, new alignment, with the minimum requirement for house relocation, will be considered.

- Vertical Alignment

  In principle, the design road surface elevation will be the same as or higher than the present elevation to avoid flooding. In the case of road sites with large undulations, the ridge section should be cut to minimise the need for an embankment at the valley section.

(b) Paving Design

The paving design for the Project consists of overlay design and reconstruction paving design. Each design will be based on the current conditions of the existing road paving identified by the field survey and on the estimated future traffic volume determined by the traffic volume survey. The calculation results for both types of work, i.e. overlay and reconstruction are shown on Table 2-7~2-8, and the tables and data used for calculation purposes are shown on Table 2-9~2-11, Fig 2-4. It has been decided to employ cement stabilisation treatment for the base course to enable a reduction of the paving thickness in view of an overall cost reduction of the Project.

(c) Drainage Design

Drainage facilities are important for the maintenance of roads, for safe traffic and for prolongment of the service period of roads, particularly paving. The drainage network involving the subject roads was confirmed on-site with the assistance of a DCC official in charge of drainage. Super-elevation or the cross slope of carriageways and sidewalks will be designed to ensure the adequate drainage of surface water while avoiding causing any inconvenience or danger to road users. It has been decided that the cross slope of carriageways will be 2% and surface water will be collected by side ditches for discharge to the final outlet.

<u>Local Roads</u>

Of the 12 subject local roads, only 2 roads have some kind of drainage system at present. As there is currently no through connection to the final outlet, the construction of a drainage link to the final outlet from side ditches is proposed. A U-shaped concrete lined open side ditch will be constructed on one side of these local roads which currently have no drainage system and an earth side ditch will be constructed on the other side. A drainage link from these ditches to the final outlet will also be constructed.

Middle Ring Road

The drainage facilities for the Middle Ring Road will comprise U-shaped side ditches with a cover for easy cleaning. As the new alignment will be designed to allow use of the existing paving, there will be some sections where the drainage slope is not compatible with the vertical alignment of the road. U-shaped flexible side ditches or vertical drains will be introduced at these sections to drain rainwater to the final outlet.

While box culverts will be employed for the river crossing sections to allow the undisturbed flow of river water, drainpipes (diameter of 1,000 mm) will be introduced every 100 m as stand-by drainage facilities. Box culverts will be used at the 3 intersections between the Middle Ring Road and rivers as suggested by the Feasibility Study to ensure a sufficient river channel cross-section. The river channel alignment will be firmly established some 20 m upstream and downstream of the intersections with wire cylinder wall and cylinder lining on the river bed will be constructed to prevent scouring (gabion) and concrete lining of the river bed.

Table 2-7 Calculation Results of Paving Design for Local Road

Improvement Measures	Type	Total Thickness	Pavement Structure	Name of Road
Overlay	Ov-1	3cm	Asphalt Concrete 30	Lindi Street
	Ov-2	4cm	Asphalt Concrete 40	Road G
	Ov-3	9cm	Asphalt Concrete 90	Road A
Reconstruction from Base Course	Re(AC)-1-1	13cm	Asphalt Concrete 30 Cement Stabilized 100 130	Road G Iringa Street Malanga to Bukina Lindi Street Pangani Street
	Re(AC)-1-2	18cm	Asphalt Concrete 30 Cement Stabilized Base 150 180	Road A
	Re(AC)-1-4	14cm	Asphalt Concrete 40 Cement Stabilized Base 100 140	Malanga Street Tukuyu Street
	Re(AC)-1-5	20cm	Asphalt 50 Cement Stabilized 150 200	Bungoni Street Tabora Street
Reconstruction from Subbase Course	Re(AC)-2-1	23cm	Asphalt 30 Cement Stabilized Base 100 Subbase 100 200	Road G Iringa Street Malanga to Bukina Mwinyijuma Street Bukina Street
	Re(AC)-2-2	33cm	Asphalt Concrete 30 Cement Stabilized Base 150 Subbase 150 330	Road A Bungoni Street
	Re(AC)-2-3	28cm	Asphalt Concrete 30 Cement Stabilized Base 100 Subbase 150 260	Lindi Street
	Re(AC)-2-4	33cm	Asphalt Concrete 30 Cement Stabilized Base 150 Subbase 150 330	Malanga Street
	Re(AC)-2-5	38cm	Asphalt Concrete 30 Cement Stabilized Base 150 Subbase 200 380	Road C

Table 2-8 Calculation Results of Paving Design for Middle Ring Road

Improvement Measures	Type	Total Thickness	Pavement Structure	Name of Road
Overlay		8cm	Asphalt 80	Morocco Road
Reconstruction		27cm	AC surface 30 AC binder 40 Cement Stabilized Base 200 270	New Kigogo Road
		55cm	AC surface 30 AC binder 40 Cement Stabilized Base 200 Subbase 250 550	Morocco Road
		47cm	AC surface 30 AC binder 40 Cement Stabilized Base 200 Subbase 200 470	New Kigogo Road Missing Link

Table 2-9 Paving Design for Overlay

AREA ROADS

Road Name	Length (km)	Existing Daily Heavy Vehcle in 1996 (nos)	Estimated IDT Heavy Vehcle in 1999 (nos)	One way IDT (nos)	Initial Traffic Number ITN	Annual Growth Rate (%)	Design Period (year)	Ajustment Factor	DTN Heavy Vehcle in 2009	Design CBR (%)	Full Depth Pavement Thickness (Ta) (mm)	Existing Pavement Surface (mm)	Existing Pavement Base (mm)	Existing Pavement Sub-base (mm)	Conversion Factor Surface	Conversion Factor Base	Conversion Factor Sub-base	Tao (mm)	Overlay Depth (mm)	Overlay Type
Sinza Area	7.10																			
Road A	1.10	60	67	34	9	4	10	0.60	5	6	145	20	100	100	0.6	0.3	0.2	62	83	Ov-3
Road C	1.00	60	67	34	9	4	10	0.60	5	5	160	20	100	100	0.6	0.3	0.2	62	98	Ov-4
Road G	5.00	100	112	56	15	4	10	0.60	9	20	100	20	100	100	0.6	0.3	0.2	62	38	Ov-2
Mwananyamala Area	2.91																	0	0	
Malanga Street	0.65	30	34	17	5	4	10	0.60	3	6	130									
Iringa Street	1.56	30	34	17	5	4	10	0.60	3	20	80									
Malanga to Bukina	0.70	40	45	22	7	4	10	0.60	4	12	110									
Ilala Area	4.42																			
Lindi Street	1.36	15	17	8	2	4	10	0.60	1	6	110	25	100	275	0.6	0.3	0.2	100	10	Ov-1
Bungoni Street	0.64	25	28	14	4	4	10	0.60	2	4	150									
Pangani Street	0.87	15	17	8	2	4	10	0.60	1	12	80									
Tabora Street	0.45	20	22	11	3	4	10	0.60	2	4	150									
Tukuyu Street	1.10	15	17	8	2	4	10	0.60	1	4	130									

Annual Growth Rate 4%

*Average Gross Mass 10.0t

*Single Axle Load 8.2t

MIDDLE RING ROAD

Road Name	Length (km)	Existing Daily Heavy Vehcle in 1996 (nos)	Estimated IDT Heavy Vehcle in 2001 (nos)	One way IDT (nos)	Initial Traffic Number ITN	Annual Growth Rate (%)	Design Period (year)	Ajustment Factor	DTN Heavy Vehcle in 2016	Design CBR (%)	Full Depth Pavement Thickness (Ta) (mm)	Existing Pavement Surface (mm)	Existing Pavement Base (mm)	Existing Pavement Sub-base (mm)	Conversion Factor Surface	Conversion Factor Base	Conversion Factor Sub-base	Tao (mm)	Overlay Depth (mm)	Overlay Type
Morocco Road	3.58	650	955	478	210	8	15	1.36	285	4	270	150	100	200	0.8	0.3	0.2	190	80	
New Kigogo Road	2.76	650	955	478	210	8	15	1.36	285	6	230	60	100	100	0.7	0.3	0.2	92	138	

Annual Growth Rate 8%

*Average Gross Mass 13.6t

*Single Axle Load 8.2t

Table 2-10 Paving Design for Reconstruction from Base

AREA ROADS

Road Name	Length (km)	Existing Daily Heavy Vehicle in 1996 (nos)	Estimated IDT Heavy Vehicle in 1999 (nos)	One way IDT (nos)	Initial Traffic Number ITN	Annual Growth Rate (%)	Design Period (year)	Ajustment Factor	DTN Heavy Vehicle in 2009	Design CBR (%)	Full Depth Pavement Thickness (Ta) (mm)	Pavement Structure	Proposed Pavement Thickness: Surface (mm)	Proposed Pavement Thickness: Cement stabilized Base (mm)	Proposed Pavement Thickness: Sub-base (mm)	Existing Subbase (mm)	Conversion Factor: Surface	Conversion Factor: Base	Conversion Factor: Sub-base	Tao (mm)	Reconstruction Type
Sinza Area	7.10																				
Road A	1.10	60	67	34	9	6	10	0.60	5	6	145	A.C.	30	150	0	200	1.00	0.55	0.20	153	Re(AC)-1-2
Road C	1.00	60	67	34	9	4	10	0.60	5	5	160	A.C.	30	200	0	110	1.00	0.55	0.20	162	Re(AC)-1-3
Road G	5.00	100	112	56	15	20	10	0.60	9	20	100	A.C.	30	100	0	100	1.00	0.55	0.20	105	Re(AC)-1-1
Mwananyamala Area	2.91																				
Malanga Street	0.65	30	34	17	5	4	10	0.60	3	6	130	A.C.	40	100	0	190	1.00	0.55	0.20	133	Re(AC)-1-4
Iringa Street	1.56	30	34	17	5	4	10	0.60	3	20	80	A.C.	30	100	0	190	1.00	0.55	0.20	123	Re(AC)-1-1
Malanga to Bukina	0.70	40	45	22	7	4	10	0.60	4	12	110	A.C.	30	100	0	200	1.00	0.35	0.20	70	Re(AC)-1-1
Ilala Area	4.42																				
Lindi Street	1.36	15	17	8	2	4	10	0.60	1	6	110	A.C.	30	100	0	275	1.00	0.55	0.20	140	Re(AC)-1-1
Dungoni Street	0.64	25	28	14	4	4	10	0.60	2	4	150	A.C.	50	150	0	150	1.00	0.55	0.20	163	Re(AC)-1-5
Pangani Street	0.87	15	17	8	2	4	10	0.60	1	12	80	A.C.	30	100	0	150	1.00	0.55	0.20	115	Re(AC)-1-1
Tabora Street	0.45	20	22	11	3	4	10	0.60	2	4	150	A.C.	50	150	0	150	1.00	0.55	0.20	163	Re(AC)-1-5
Tukuyu Street	1.10	15	17	8	2	4	10	0.60	1	4	130	A.C.	50	100	0	150	1.00	0.55	0.20	135	Re(AC)-1-4

Annual Growth Rate 4%

*Average Gross Mass 10.0t

*Single Axle Load 8.2t

MIDDLE RING ROAD

Road Name	Length (km)	Existing Daily Heavy Vehicle in 1996 (nos)	Estimated IDT Heavy Vehicle in 2001 (nos)	One way IDT (nos)	Initial Traffic Number ITN	Annual Growth Rate (%)	Design Period (year)	Ajustment Factor	DTN Heavy Vehicle in 2016	Design CBR (%)	Full Depth Pavement Thickness (Ta) (mm)	Pavement Structure	Proposed Pavement Thickness: Surface (mm)	Proposed Pavement Thickness: Base (mm)	Proposed Pavement Thickness: Sub-base (mm)	Existing Subbase (mm)	Conversion Factor: Surface	Conversion Factor: Base	Conversion Factor: Sub-base	Tao (mm)	Reconstruction Type
Morocco Road	3.58	650	955	478	210	8	15	1.36	285	4	270	AC	100	200	100	200	1.00	0.55	0.3	0.20	280
New Kigogo Road	2.76	650	955	478	210	8	15	1.36	285	6	230	AC	70	200	100	100	1.00	0.55	0.3	0.20	230

Annual Growth Rate 8%

*Average Gross Mass 13.6t

*Single Axle Load 8.2t

Table 2-11 Paving Design for Reconstruction from Sub-Base

AREA ROADS

Road Name	Length (km)	Existing Daily Heavy Vehicle in 1996 (nos)	Estimated IDT Heavy Vehicle in 1999 (nos)	One way IDT (nos)	Initial Traffic Number ITN	Annual Growth Rate (%)	Design Period (year)	Ajustment Factor	DTN Heavy Vehicle in 2009	Design CBR (%)	Full Depth Pavement Thickness (Ts) (mm)	Pavement Structure	Proposed Pavement Thickness: Surface (mm)	Proposed Pavement Thickness: Cement stabilized Base (mm)	Proposed Pavement Thickness: Sub-base (mm)	Existing Subbase (mm)	Conversion Factor: Surface	Conversion Factor: Cement stabilized Base	Conversion Factor: Sub-base	Sub-base	Tao (mm)	Reconstruction Type
Sinza Area	7.10																					
Road A	1.10	60	67	34	9	6	10	0.60	5	6	145	AC	30	150	150	0	1.00	0.55	0.25	0.20	150	Re(AC)-2-2
Road C	1.00	60	67	34	9	4	10	0.60	5	5	160	AC	30	150	200	0	1.00	0.55	0.25	0.20	163	Re(AC)-2-3
Road G	5.00	100	112	56	15	20	10	0.60	9	20	100	AC	30	100	100	0	1.00	0.55	0.25	0.20	110	Re(AC)-2-1
Mwanayamala Area	2.91																					
Malanga Street	0.65	30	34	17	5	4	10	0.60	3	6	130	A.C.	30	100	200	0	1.00	0.55	0.25	0.20	135	Re(AC)-2-4
Iringa Street	1.56	30	34	17	5	4	10	0.60	3	20	80	A.C.	30	100	100	0	1.00	0.55	0.25	0.20	110	Re(AC)-2-1
Malanga to Bukina	0.70	40	45	22	7	4	10	0.60	4	12	110	A.C.	30	100	100	0	1.00	0.55	0.25	0.20	110	Re(AC)-2-1
Mwanyijuma Street	0.57	10	11	6	1	4	10	0.60	1	6	110	A.C.	30	100	100	0	1.00	0.55	0.25	0.20	110	Re(AC)-2-1
Bukina Street	0.63	10	10	5	1	4	10	0.60	1	6	110	A.C.	30	100	100	0	1.00	0.55	0.25	0.20	110	Re(AC)-2-1
Uele Area	4.42																					
Lindi Street	1.36	15	17	8	2	4	10	0.60	1	6	110	A.C.	30	100	150	0	1.00	0.55	0.25	0.20	123	Re(AC)-2-3
Bungoni Street	0.64	25	28	14	4	4	10	0.60	2	4	150	A.C.	30	150	150	0	1.00	0.55	0.25	0.20	150	Re(AC)-2-2
Panyani Street	0.87	15	17	8	2	4	10	0.60	1	12	80	A.C.	30	100	100	0	1.00	0.55	0.25	0.20	110	Re(AC)-2-1
Tabora Street	0.45	20	22	11	3	4	10	0.60	2	4	150	A.C.	30	150	150	0	1.00	0.55	0.25	0.20	150	Re(AC)-2-2
Tukuyu Street	1.10	15	17	8	2	4	10	0.60	1	4	130	A.C.	30	150	150	0	1.00	0.55	0.25	0.20	150	Re(AC-2-2

Annual Growth Rate 4%

*Average Gross Mass 10.0t

*Single Axle Load 8.2t

MIDDLE RING ROAD

Road Name	Length (km)	Existing Daily Heavy Vehicle in 1996 (nos)	Estimated IDT Heavy Vehicle in 2001 (nos)	One way IDT (nos)	Initial Traffic Number ITN	Annual Growth Rate (%)	Design Period (year)	Ajustment Factor	DTN Heavy Vehicle in 2016	Design CBR (%)	Full Depth Pavement Thickness (Ts) (mm)	Pavement Structure	Proposed Pavement Thickness: Surface (mm)	Proposed Pavement Thickness: Base (mm)	Proposed Pavement Thickness: Sub-base (mm)	Existing Subbase (mm)	Conversion Factor: Surface	Conversion Factor: Base	Conversion Factor: Sub-base	Sub-base	Tao (mm)	Reconstruction Type
Morocco Road	3.53	650	955	478	210	8	15	1.36	285	4	270	AC	100	200	250	0	1.00	0.55	0.25	0	273	
New Kinyoo Road	2.76	650	955	478	210	8	15	1.36	285	6	230	AC	70	200	200	0	1.00	0.55	0.25	0	230	

Annual Growth Rate 8%

*Average Gross Mass 13.6t

*Single Axle Load 8.2t

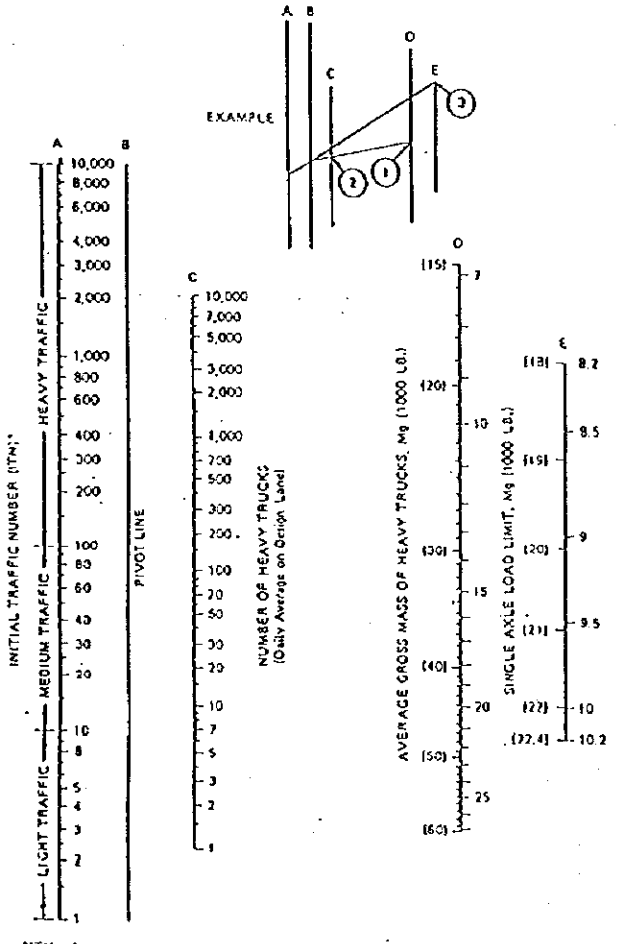
Fig. 2-4 Chart and Table used for Paving Design Calculation

TABLE III-4—INITIAL TRAFFIC NUMBER ADJUSTMENT FACTORS

Design Period, Years (n)	Annual Growth Rate, percent (r)					
	0	2	4	6	8	10
1	0.05	0.05	0.05	0.05	0.05	0.05
2	0.10	0.10	0.10	0.10	0.10	0.10
4	0.20	0.21	0.21	0.22	0.22	0.23
6	0.30	0.32	0.33	0.35	0.37	0.39
8	0.40	0.43	0.46	0.50	0.53	0.57
10	0.50	0.55	0.60	0.66	0.72	0.80
12	0.60	0.67	0.75	0.84	0.95	1.07
14	0.70	0.80	0.92	1.05	1.21	1.40
16	0.80	0.93	1.09	1.28	1.52	1.80
18	0.90	1.07	1.28	1.55	1.87	2.28
20	1.00	1.21	1.49	1.84	2.29	2.86
25	1.25	1.60	2.08	2.74	3.66	4.92
30	1.50	2.03	2.80	3.95	5.66	8.22
35	1.75	2.50	3.68	5.57	8.62	13.55

$$\text{Factor} = \frac{(1 + r)^n - 1}{20r}$$

where r = annual growth rate
n = design period, years



*ITN value may require correction where the MIX of automobiles and light trucks is relatively high. See Figure III-2.

Figure III-1. Traffic analysis chart.

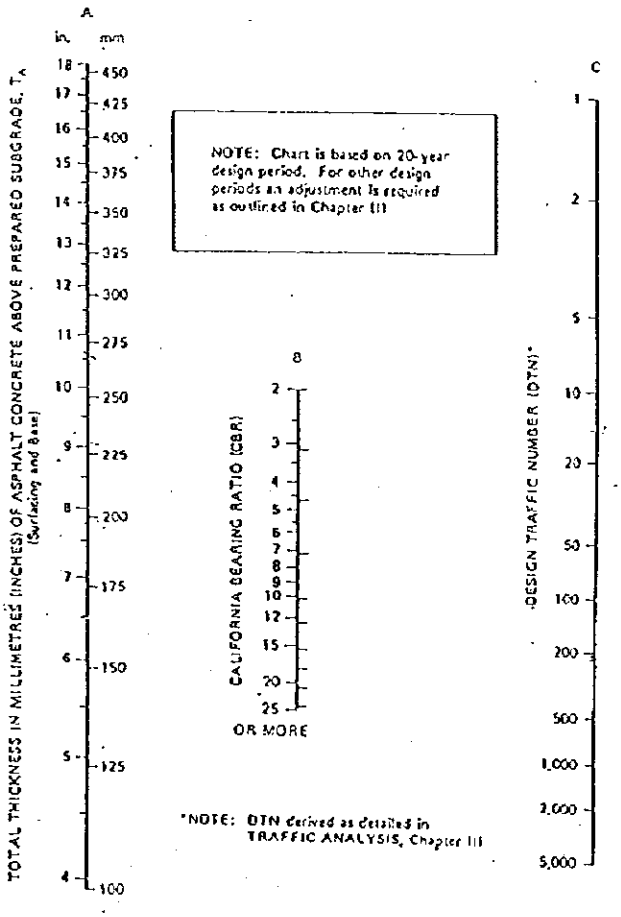


Figure IV-1. Thickness requirements for asphalt pavement structures using subgrade soil CBR or plate-bearing values.

(d) Sidewalk Design

1) Middle Ring Road

Mount-up type sidewalks will be employed to ensure pedestrian safety and a planting area will be introduced along the boundary between the carriageway and each sidewalk.

2) Local Roads

The shoulders will also act as sidewalks in view of the limited land availability and the low traffic volume of not more than 1,000 vehicles/day.

(e) Shoulder Design

Local Roads

The shoulders for local roads will be made by crusher run (t = 10 cm).

Middle Ring Road

The paving of the shoulders will be the same as the carriageway paving in order to ensure smooth drainage into the side ditches. (If the same paving as that on the carriageway is not used, vehicle traffic on the shoulders will eventually create severe undulations on the shoulders, making it difficult to drain rainwater off to the side ditches).

(f) Intersection Design

The Middle Ring Road has a high level of traffic volume of nearly 13,000 vehicles/day at some sections and it is necessary to control those intersections with other trunk roads to avoid traffic congestion and to ensure the safety of pedestrians. The hourly traffic volume at key intersections of the Middle Ring Road is shown in Table 2-12. These figures were used to determine the capacity at intersections without signals in order to establish whether or not it will be necessary to install a traffic signal system(Table 2-13).

Table 2-12 Hourly Traffic Volume at Main Intersections of Middle Ring Road

Crossing Road	Hourly Traffic Volume	
	Crossing Road	Middle Ring Road
Ali Hassan Mwinyi Road	2,100	1,200
Iringa Street	60	1,000
Kinondoni Street	680	1,200
Mwinyijuma Road	660	1,200
Malongwe Street	40	1,100
Road G	150	1,000
Konda Street	110	1,000
Morogoro Road	3,000	1,300
Mikumi Street	270	800
Old Kigogo Road (1)	400	900
Old Kigogo Road (2)	70	1,000
Uhuru Street	2,000	1,300
Nyerere Road	3,900	1,800

Table 2-13 Necessity for New Traffic Signal System at Main Intersections of Middle Ring Road

Intersection With	Traffic Capacity of Priority Junction	Necessity for Traffic Signal
Ali Hassan Mwinyi Road	Inadequate	Yes
Iringa Street	Adequate	Priority Intersection
Kinondoni Street	Inadequate	Yes
Mwinyijuma Road	Inadequate	Yes
Malongwe Street	Adequate	Priority Intersection
Road G	Adequate	Priority Intersection
Konda Street	Adequate	Priority Intersection
Morogoro Road	Inadequate	Yes
Mikumi Street	Adequate	Priority Intersection
Old Kigogo Road (1)	Adequate	Priority Intersection
Old Kigogo Road (2)	Adequate	Priority Intersection
Uhuru Street	Inadequate	Yes
Nyerere Road	Inadequate	Yes

At the following intersections, the widening work will necessitate replacement of the existing traffic signal system or the installation of a new system.

Type of Intersection	New Signal System	Replacement	Total
Cross-Shaped	2 Sites	2 Sites	4 Sites
	Uhuru Street Nyerere Road	Ali Hasaan Mwinyi Road Morogoro Road	
T-Shaped	2 Sites	0	2 Sites
	Kinondoni Road Mwinyijuma Road		
Total	4 Sites	2 Sites	6 Sites

A linked traffic signalling system should be introduced at the intersections with Kinondoni Road and Mwinyijuma Road because of the short distance of 220 m between these 2 intersections to ensure smooth traffic flow.

(g) Bus Station and Bus Stop Design (Middle Ring Road)

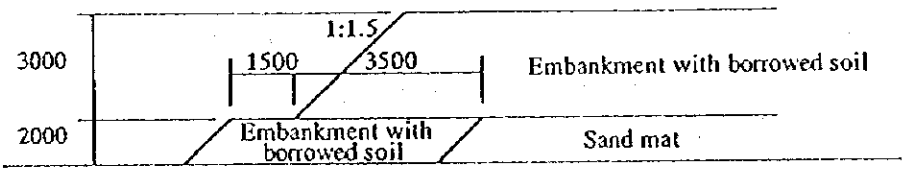
Semi-elastic Asphalt paving is proposed in front of the bus stations and bus stops to prevent deterioration of the paving due to leaked oil from stopping buses. The bus stop locations will be decided based on the present locations, taking the positions of intersections and roads crossing the Middle Ring Road into consideration. Three bus stations of the type proposed by the Study for the Dar es Salaam Road Development Project are planned at the intersections with New Bagamoyo Road, Morogoro Road and Uhuru Road. It will be necessary to finalise the bus stop locations at the detailed design stage through consultations with bus operators.

(h) Embankment Design

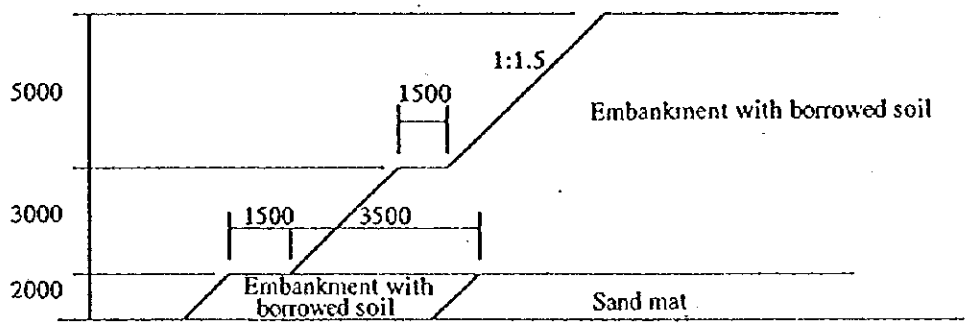
1) Design on Embankment Cross-Section

The shape of the embankment cross-section will be inferred based on the slope stabilisation calculation and settlement calculation (see separate papers on these calculations) for the 3 sites where Morocco Road or New Kigogo Road crosses three valleys.

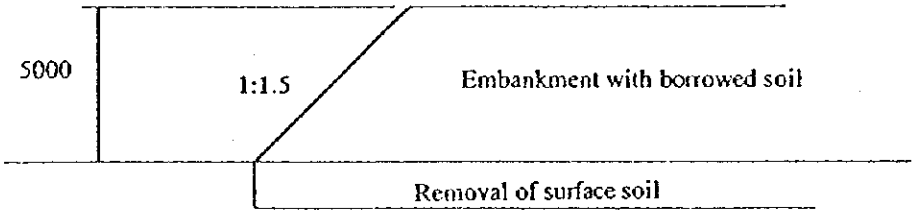
Type A (near BH1) Morocco Road



Type B (near BH2) Morocco Road



Type C (near BH3-6) New Kigogo Road



2) Banking Material

It is planned to procure the banking material to be used for the embankments in question from the Manyema borrow pits and the constant used for the calculation is based on the Geotechnical Investigation Report. It is proposed to look for better material, if possible, at the detailed design stage in view of the nature of this banking work involving a relatively high embankment on soft ground.

3) Work Processes

Prior to the banking work at the valley sections of Morocco Road, a 2 m thick sand mat will be laid on the valley surface to establish trafficability for the construction machinery and the drainage layer above the soft ground. Following laying of this sand mad, banking at the sloping sections will be conducted using borrowed soil.

After completing the preparatory work described above, further banking will c conducted using borrowed soil to achieve an approximate layer thickness of 30 cm (degree of compaction: rd Max: 90%). As a fair amount of settlement (approximately 127 cm) is expected to occur at the sites in question, the use of a settlement board is proposed as part of the preparatory work for the banking work while carefully checking the settlement volume.

At the 2 valley crossing sites of New Kigogo Road, the survey upto the present does not indicate the existence of soft ground. Consequently, adoption of the common banking method whereby the surface soil is removed and banking is conducted with a finished thickness of 30 cm each time is proposed.

4) Road Crossing Sites of Structures

At the valley sections of Morocco Road, it is proposed to commence with the banking work for the widening sections and work for the structures under the existing road, to be followed by work for the structures in the newly banked sections after the stabilisation of settlement of the embankment at widening sections (150 days, assuming 90% final settlement).

(i) Structures Design

Local Roads

In principle, no work involving structures will occur in the case of local roads as only rehabilitation of the existing road is planned.

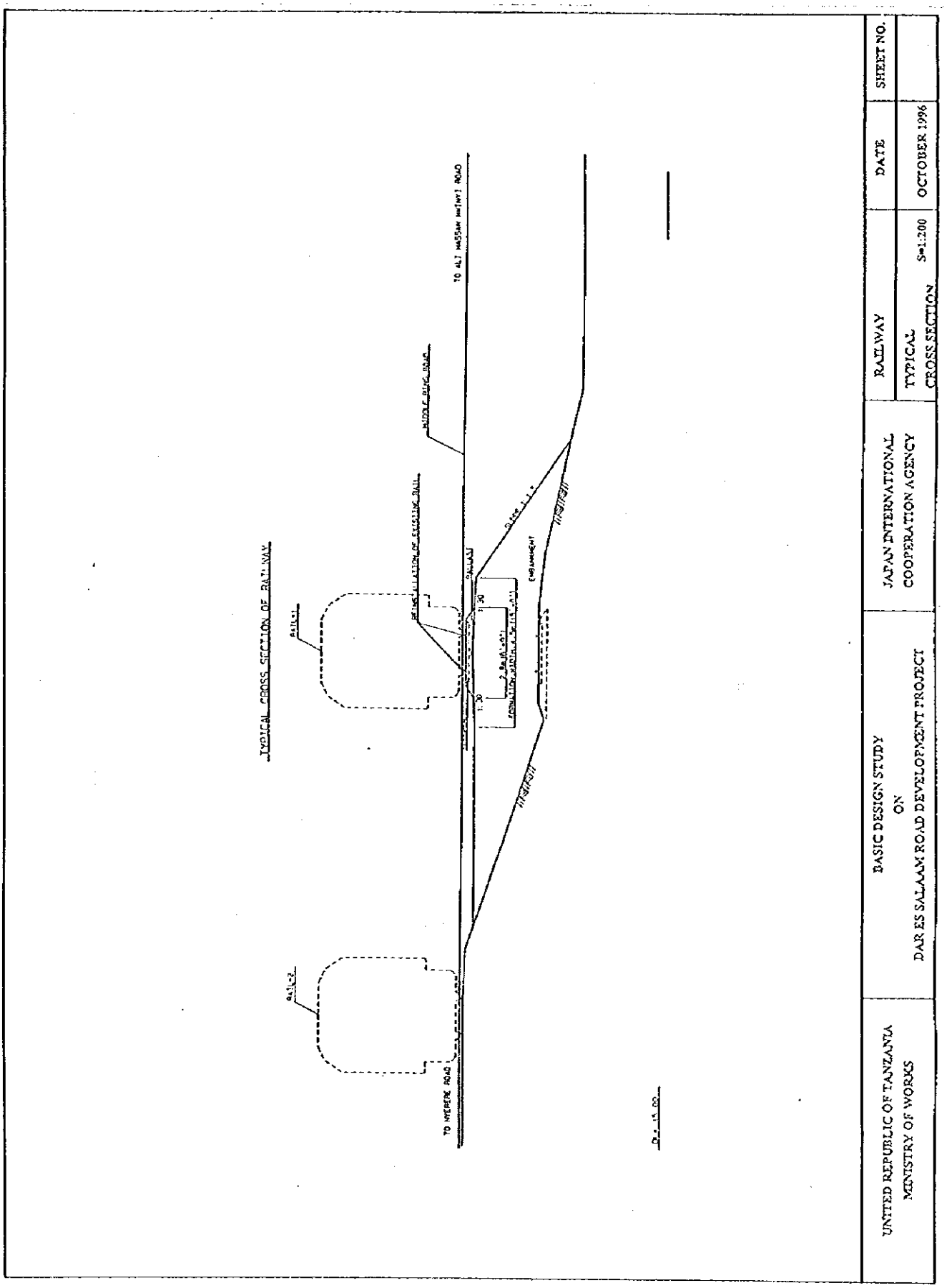
Middle Ring Road

Box culverts will be introduced at those intersections with rivers. The existing box culverts will be unchanged as the cross-section is sufficient vis-a-vis the anticipated drainage volume. In principle, the box culvert construction work will be conducted in stages while maintaining the traffic flow.

(j) Railway Track Realignment and Railway Crossing Design

At the site where the Middle Ring Road crosses railway tracks, the rail elevation of the main track and side track are 19.18 m and 21.20 m respectively. The vertical alignment of the main track will be realigned to raised it by 20.4 m in order to provide a level crossing with the Middle Ring Road. During the work to raise the elevation of the main track, the side track will be temporarily used as the main track, necessitating the construction of a detour from the main track to the side track at a site which will not affect the work on the main track at the crossing site with the Middle Ring Road.(see Fig.2-5)

Fig. 2-5 Cross Section at Railway Crossing



(k) Auxiliary Facilities Design

1) Road Marking Plan

Road markings are necessary not only for the indication of carriageways but also for traffic guidance and the indication of stop lines at an intersection to ensure smooth traffic flow as well as the safety of pedestrians.

- Local Roads

  Primary feeder roads will have a centre line and road side lines. A pedestrian crossing will be marked near public facilities.

- Middle Ring Road

  A centre line and road side lines will be marked along the entire route. A stop line, pedestrian crossing and road markings (left turn, straight, right turn and zebra markings) will be introduced at intersections.

2) Tree Planting Plan

In order to establish a good roadside environment along the route of the Middle Ring Road, trees should be planted on the median strip and boundary zones between the carriageways and sidewalks.

3) Hump and Mini-Roundabout Plan

A hump will be introduced at an intersection between a local road and trunk road and also near schools to ensure traffic safety. The existing half moon-shaped humps in Dar es Salaam results in much impact on the paving when ever a vehicle crosses them, accelerating the paving deterioration (progressed distortion). The use of trapezium-shaped humps is, therefore, proposed instead. Trapezium-shaped hums are currently being experimented with in the Temeke area under the supervision of a professor of road engineering of the University of Dar es Salaam. The introduction of a mini-roundabout at 2 intersections in the Ilala area where there is ample land is proposed.

(l) Relocation and Protection of Public Utility Facilities

The planned widening of the Middle Ring Road will necessitate the relocation of the following facilities.

- Water Supply Line

Φ 100 under	:	971 m
Φ 150	:	2,463 m
Φ 200 upper	:	2,177 m

- Power Line

33 KV	:	1,655 m
11 KV	:	3,076 m
Low kV	:	1,366 m

In some cases, existing underground telephone cables will be located under the widened sections of the Middle Ring Road. As the buried depth is sufficient and as telephone cable maintenance is conducted from cable pits, however, no relocation of telephone cables is considered necessary. While the cable pits located on the carriageways have sufficient structural strength to resist the traffic load, it will be necessary to raise the crown height level with the planned road surface elevation.

(m) Land Acquisition and Property Compensation Plan

Middle Ring Road

Because of the nature of the work planned for the Middle Ring Road under the Project, the establishment of new road boundary lines and the relocation of houses at 275 sites will be necessary. The road boundaries set under the Project are shown in the Basic Design Drawings - Site Plan attached to this report.

Local Roads

No road boundary is established for Malanga Road in the Mwanayamala area. New boundary lines for a road width of 20 m (primary road) will, therefore, be introduced under the Project.

(n) Work Quantities

Based on the design of the various project components described above, the main work quantities have been calculated as described in Table 2-13. See Appendix B-6 for details of the work quantities for local roads by area and also for the detailed comparison results between the F/S and B/D study stages on the work quantities for the Middle Ring Road.

(3) Basic Design Drawings

The following drawings have been prepared for the basic design and are attached at the end of this report.

1) Location Map and Project Area
2) Improvement Plan of Local Roads
3) Improvement Plan of Middle Ring Road
4) Improvement Plan of Railway Crossing
5) Improvement Plan of Drainage Facilities
6) Traffic Signal and Traffic Light Plan
7) Bus Station and Bus Stop Plan
8) Land Aquisition Plan

Table 2-13 Main Work Quantity

No.	Work Item	Standards	Unit	Quantity		
				Phase 1	Phase 2	Total
1	< Earth Work >					
1-1-1	Excavation and Removal of Surplus Soil	Common Soil	m3	14,787	26,459	41,246
1-1-2	Excavation and Temporary Storage	Common Soil	m3	0	40,507	40,507
1-2-1	Sub-Grade Banking	Borrowed Soil	m3	15,503	16,000	31,503
1-2-2	Sub-Grade Banking	Recycled Soil	m3	0	0	0
1-2-3	Roadbed Banking	Borrowed Soil	m3	0	55,996	55,996
1-2-4	Roadbed Banking	Recycled Soil	m3	0	40,507	40,507
1-2-5	Sand Mat Work		m3	0	4,000	4,000
1-3-1	Slope Work	Cutting	m2	0	5,611	5,611
1-3-2	Slope Work	Banking	m2	0	19,414	19,414
1-4	Removal of Existing Paving		m3		2,438	2,438
2	< Paving Work >					
2-1	Surface Levelling		m2	165,107	155,164	320,271
2-2-1	Sub-Base Course Work	t=100mm	m2	33,750	0	33,750
2-2-2	Sub-Base Course Work	t=150mm	m2	9,100	0	9,100
2-2-3	Sub-Base Course Work	t=200mm	m2	9,425	46,115	55,540
2-2-4	Sub-Base Course Work	t=250mm	m2	0	41,326	41,326
2-3-1	Base Course Work	t=100mm	m2	64,692	0	64,692
2-3-2	Base Course Work	t=150mm	m2	22,290	11,902	34,192
2-3-3	Base Course Work	t=200mm	m2	0	95,866	95,866
2-4-1	Asphalt Base Course Work	t=30mm	m2	0	0	0
2-4-2	Asphalt Base Course Work	t=40mm	m2	0	54,540	54,540
2-4-3	Asphalt Base Course Work	t=50mm	m2	0	41,326	41,326
2-5-1	Asphalt Surface Course Work	t=30mm	m2	80,532	54,540	135,072
2-5-2	Asphalt Surface Course Work	t=40mm	m2	0	0	0
2-5-3	Asphalt Surface Course Work	t=50mm	m2	6,450	53,228	59,678
2-6-1	Asphalt Overlay Work	t=30mm	m2	8,800	0	8,800
2-6-2	Asphalt Overlay Work	t=40mm	m2	1,200	0	1,200
2-6-3	Asphalt Overlay Work	t=80mm	m2	0	19,589	19,589
2-6-4	Asphalt Overlay Work	t=90mm	m2	2,400	0	2,400
2-7	Interlocking Block Work	t=80mm	m2	324	0	324
2-8	Sidewalk Sub-Grade Work	t=100mm	m2	0	47,396	47,396
2-9	Sidewalk Surface Layer Work	Random Paving	m2	0	47,396	47,396
2-10	Uneven Surface Paving Work	t=50mm	m2	0	6,039	6,039
2-11	Shoulder Sub-Grade Work	t=100mm	m2	74,150	0	74,150
2-12	Median Strip Boundary Block Work		m	0	15,724	15,724
3	< Drainage Work >					
3-1-1	New Trapezoidal Side Ditch Work	Concrete W300H500	m	10,243	0	10,243
3-1-2	New Trapezoidal Side Ditch Work	Concrete W300H600	m	250	0	250
3-1-3	New Trapezoidal Side Ditch Work	Concrete W300H700	m	3,130	0	3,130
3-1-4	New Trapezoidal Side Ditch Work	Concrete W300H800	m	470	0	470
3-1-5	New Trapezoidal Side Ditch Work	Concrete W500H800	m	0	2,167	2,167
3-1-6	New Trapezoidal Side Ditch Work	Turf W500H500	m	10,493	0	10,493
3-1-7	New Trapezoidal Side Ditch Work	Turf W500H800	m	2,080	0	2,080
3-2-1	New U-Shaped Drain Work	400x500	m	0	13,637	13,637
3-2-2	New U-Shaped Drain Work	400x900	m	0	1,400	1,400
3-3-1	New L-Shaped Street Gutter Work	New	m	920	2,157	3,077
3-3-2	New L-Shaped Street Gutter Work	Realignment	m	1,840	0	1,840
3-4-1	New Type A Gutter Inlet Work	500x400x650	No. of Sites	32	820	852
3-4-2	New Type B Gutter Inlet Work	800x800x1000	No. of Sites	0	34	34
3-5-1	New Type A Catch Basin Work	1000x1000x1700	No. of Sites	0	20	20
3-5-2	New Type B Catch Basin Work	1000x1000x2700	No. of Sites	0	14	14
3-5-3	New Type C Catch Basin Work	1500x1500x2000	No. of Sites	0	16	16
3-6	Existing Catch Basin Repair Work		No. of Sites	64	25	89
3-7	Existing Side Ditch Cleaning Work		m	2,312	0	2,312
3-8-1	Pipe Culvert Work	Φ300; 360° lining	m	2,575	0	2,575
3-8-2	Pipe Culvert Work	Φ400; 360° lining	m	180	1,117	1,297
3-8-3	Pipe Culvert Work	Φ500; 360° lining	m	540	0	540
3-8-4	Pipe Culvert Work	Φ600; 360° lining	m	160	396	556
3-8-5	Pipe Culvert Work	Φ400; 90° lining	m	0	457	457
3-8-6	Pipe Culvert Work	Φ600; 90° lining	m	0	119	119
3-8-7	Pipe Culvert Work	Φ1,000; 90° lining	m	0	1,055	1,055
3-8-8	Pipe Culvert Work	Φ1,200; 90° lining	m	0	36	36
4	< Structure Work >					
4-1-1	Box Culvert Work	2@3.6x3.2,30.0m	No. of Sites	0	1	1
4-1-2	Box Culvert Work	2@5.0x2.9,12.0m	No. of Sites	0	1	1
4-1-3	Box Culvert Work	2@5.0x2.9,13.0m	No. of Sites	0	1	1
4-1-4	Box Culvert Work	4@5.0x2.9,17.0m	No. of Sites	0	1	1
4-1-5	Box Culvert Work	3@2.0x2.0,19.0m	No. of Sites	0	1	1
5	< Auxiliary Road Work >					
5-1-1	Traffic Signal Installation Work	New	No. of Sites	0	4	4
5-1-2	Traffic Signal Installation Work	Relocate	No. of Sites	0	2	2
5-2-1	Road Lighting Installation Work	New	No. of Sites	0	5	5
5-2-2	Road Lighting Installation Work	Relocate	No. of Sites	0	2	2
5-3	Road Marking Work	Solid Line W=15 cm	m	46,890	35,600	82,490
5-4	Roadside Planting Work	Medium-to-Low Trees	No. of Trees	0	1,996	1,996
5-5	Railway Roadbed Replacement Work		Set	0	1	1
5-6	Bus Stop Roof Installation Work		No.	0	66	66