MINISTRY OF LOCAL GOVERNMENT AND HOUSING (MLGH)
LUSAKA CITY COUNCIL (LCC)

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE STUDY ON COMPREHENSIVE URBAN DEVELOPMENT PLAN FOR THE CITY OF LUSAKA IN THE REPUBLIC OF ZAMBIA

FINAL REPORT

VOLUME III

PRE-FEAIBILITY STUDY OF PRIORITY PROJECT

MARCH 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

KRI INTERNATIONAL CORP.

NIPPON KOEI CO., LTD.

JAPAN ENGINEERING CONSULTANTS CO., LTD.

EXCHANGE RATE

USD 1 = ZMK 3,582 = JPY 106.53

ZMK: Average rate of Bank of Zambia, from January 2008 to October 2008
JPY: Average rate of JICA rate, from January 2008 to October 2008

The Study
on
Comprehensive Urban Development Plan
for
the City of Lusaka
in
the Republic of Zambia

Final Report

SUMMARY

MAIN REPORT

VOLUME I COMPREHENSIVE URBAN DEVELOPMENT PLAN

VOLUME II MASTER PLAN OF SUB-PROGRAMS

VOLUME III PRE-FEASIBILITY STUDY OF PRIORITY PROJECTS

VOLUME III PRE-FEASIBILITY STUDY OF PRIORITY PROJECTS

Table of Contents

LIST OF TABLES

VOLUME III PRE-FEASIBILITY STUDY OF PRIORITY PROJECTS

LIST OF FIGURES

VOLUME III PRE-FEASIBILITY STUDY OF PRIORITY PROJECTS

THE OTHER VOLUMES

ABBREVIATIONS

ABO	Area-Based Organization
ACEZ	Association of Consulting Engineers of Zambia
AGOA	African Growth Opportunity Act
ADB	Asian Development Bank
AfDB	African Development Bank
BHN	Basic Human Needs
BID	Business Improvement District
BOD	Biochemical Oxygen Demand
CBD	Central Business District
CBD	Convention of Biological Diversity
CBO	Community Based Organization
CBE	Community Based Enterprise
CDF	Constituency Development Fund
GEF	Global Environment Facility
CEP	Copperbelt Environmental Project
CHC	Consumer Health Care
CIC	Community Interest Company
CIDA	Canadian International Development Agency
CIFOR	Centre for International Forestry Research
CP	Cleaner Production
CSO	Central Statistical office
DANIDA	Danish International Development Assistance
DDI	Domestic Direct Investment
DEO	District Education Office
DFID	Department for International Development
DF/R	Draft Final Report
DISS	Department of Infrastructure and Support Services
DPPH	Department of Physical Planning and Housing
DTF	Devolution Trust Fund
DWA	Development of Water Agency
ECHO	Economically strong, Environmental Friendly and Community Hope and Opportunity
ECZ	Environmental Council of Zambia
EIA	Environmental Impact Assessment
EU	European Union
FC	Faecal Coliform
FDI	Foreign Direct Investment
FNDP	Fifth National Development Plan
GDI	Gender Development Index
GDP	Gross Domestic Product
GHS	Globally Harmonized System
GIS	Geographical Information System
GOJ	Government of Japan
GPS	Global Positioning System
GRZ	Government of the Republic of Zambia
GTZ	German Technical Corporation
HDI	Human Development Index
HPPHSS	Housing, Public Health and Social Services Committee
IC/R	Inception Report
IEE	Initial Environmental Examination
IGA	Income Generation Activities
IMF	International Monetary Fund
IPPP	Industrial Pollution Prevention Programme

IT/R	Interim Report
JICA	Japan International Cooperation Agency
JST	JICA Study Team
KTC	Kamwala Trading Center
LCC	Lusaka City Council
LDHMT	Lusaka District Health Management Team
LIDP	Lusaka Integrated Development Plan
LRT	Light Rail Transit
LPPA	Lusaka Province Planning Authority
LSWSMP	Lusaka Solid Waste and Sanitation Management Project
LUSEED	Lusaka Sustainable Economic and Environmental Development
LWSC	Lusaka Water and Sewerage Company
MDG	Millennium Development Goal
MFEZ	Multi Facility Economic Zone
MEWD	Ministry of Energy and Water Development
MFNP	Ministry of Finance and National Planning
MLGH	Ministry of Local Government and Housing
MOCDSS	Ministry of Community Development and Social Services
MOE	Ministry of Education
MOU	Memorandum of Understanding
MOFED	Ministry of Finance and Economic Development
MOH	Ministry of Health
MoL	Ministry of Land
MoTENR	Ministry of Tourism, Environment and National Resource
MP	Member of Parliament
MSTVT	Ministry of Science, Technology and Vocational Training
MTC	Ministry of Transportation and Communication
MTEF	Medium Term Expenditure Framework
MWS	Ministry of Works and Supply
NACL	National Airport Corporation Limited
NDF	Nordic Development Fund
NGO	Non Governmental Organization
NHA	National Housing Authority
NHC	Neighbourhood Health Committees
NORAD	Norwegian Agency for International Development
NRDC	National Research and Development Center
NRFA	National Road Fund Agency
NWASCO	National Water Supply and Sanitation Council
O/D	Origin-Destination
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
O&M	Operation & Management
PCM	Project Cycle Management
PHC	Primary Health Care
PR	Progress Report
PPP	Public Private Partnership
PROSPECT	Programme of Support for Poverty Elimination and Community Transformation
PRP	Power Rehabilitation Project
PRSP	Poverty Reduction Strategy Paper
PTA	Public Transport Authority
PULSE	Peri-Urban Lusaka Small Enterprise Development Project
PUS	Planned Urban Settlement
PUSH	Programmes Urban Self-Help
PWD	Plans, Works and Development Committee
RBIPMA	Removing Barriers to Invasive Plant Management in Africa Project
RDA	Road Development Agency
RDC	Resident Development Committee

ROADSIP-I	Road Sector Improvement Programme Phase-I
RTSA	Road Transport and Safety Agency
RUSPS	Rapid Urban Sector Profiling for Sustainability
RWSS	Rural Water Supply and Sanitation
SADC	Southern African Development Community
SC	Steering Committee
SCP	Sustainable Cities Programme
SEA	Strategic Environment Assessment
SIDA	Swedish International Development Agency
SLP	Sustainable Lusaka Programme
SME	Small and Medium Enterprise
TEVETA	Technical Education, Vocational and Entrepreneurship Training Authority
TAZ	Traffic Analysis Zones
UBZ	United Bus Company of Zambia
UFW	Unaccounted for Water
USAID	United States Agency for International Development
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme
UNICEF	United Nations International Children's Emergency Fund
UNZA	University of Zambia
UUS	Unplanned Urban Settlement
VAT	Value Added Tax
VCUL	Valuation, Commercial Undertaking and Licensing Committee
VIP	Ventilated Improved Pit
VOC	Vehicle Operating Cost
WB	World Bank
WDC	Ward Development Committee
WDF	Ward Development Fund
WFP	World Food Programme
WG	Working Group
WHO	World Health Organization
WMD	Waste Management District
WMU	Waste Management Unit
WSPIP	Water Sector Performance Improvement Project
ZACCI	Zambia Association of Chambers of Commerce and Industry
ZAWA	Zambia Wildlife Authority
ZCCM IH	Zambia Consolidated Copper Mines Investments Holdings
ZCSMBA	Zambia Chamber of Small and Medium Business Association
ZDA	Zambia Development Agency
ZDC	Zone Development Committee
ZESCO	Zambia Electricity Supply Corporation
ZR	Zambian Railway

CHAPTER-1

INNER RING ROAD

CHAPTER-1 INNER RING ROAD

1.1 Introduction

The Inner Ring Road (Kasama- Kafue- Mumbwa Road) and MFEZ Access Road were selected as priority projects which are subject to pre-F/S through the evaluation process described in Section 1.6.5 of Volume II of this report as well as continuous discussions with the counterpart and relevant stakeholders.

It is a well-known issue that the road network in Lusaka needs circular roads to divert traffic concentration to and from the city center. Some circular roads, bypasses, or ring roads have been proposed to connect radial direction roads for years. However, most areas between the radial roads are already highly populated and it is difficult to construct a circular road without large-scale resettlement. The route of the proposed Inner Ring Road can minimize the number of resettlement. The Inner Ring Road runs along the power line where the right of way for a new road is available. The ring road is expected to play as a circular bypass for the center of the city.

On the other hand, the MFEZ Access Road will support the development of Lusaka South- Multi Facilities Economic Zone (LS-MFEZ). Construction of the road is also selected as a priority project because economic development is given high priority in the master plan.

Recently, housing developments to the south of the Inner Ring Road route and along the MFEZ Access Road route have been very active. It is very important to formulate the basic road network in this area.

This preliminary feasibility study was conducted to evaluate these projects in view of economical, engineering and environmental aspects. Figure 1.1.1 shows the location of the project.

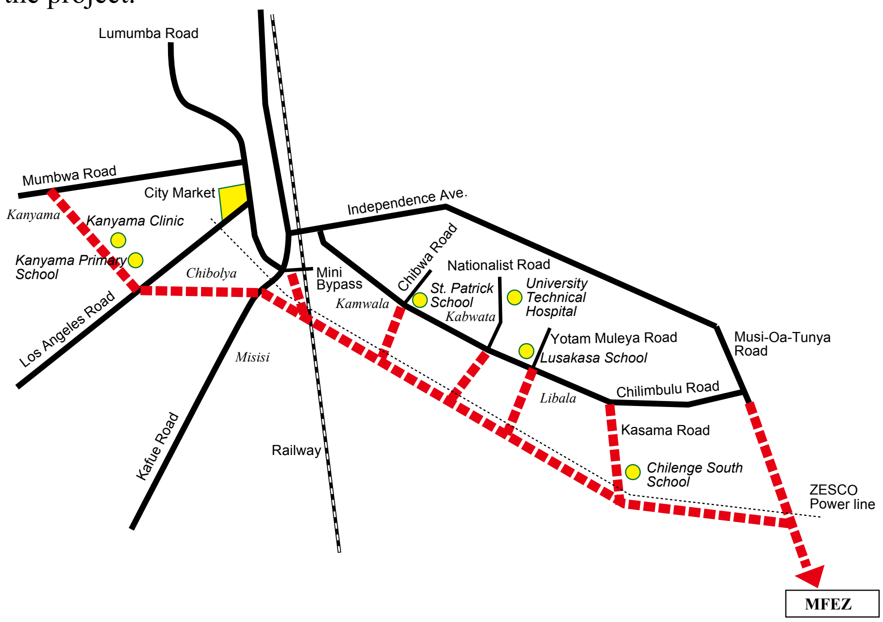


Figure 1.1.1 Location of Inner Ring Road and MFEZ Access Road

1.2 Traffic Volume Forecast

Traffic volume on the project roads was forecasted for the year 2015, 2020 and 2030. The same traffic forecast model in the master plan was applied to this feasibility study. The important assumption of the demand forecast is industrial development because the project includes the access road to the Lusaka South MFEZ. Table 1.2.1 shows the areas of industrial parks proposed in the master plan.

Table 1.2.1 Area of Industrial Parks

Unit: ha

Year	2015	2020	2030
Lusaka South MFEZ	30	240	400
Lusaka North MFEZ	150	213	355
Chibombo	0	50	141
South of Lusaka	0	135	307
West of Lusaka	0	340	737
Total	180	998	1,940

Source: JICA Study Team

Table 1.2.2 shows the traffic volume forecast by section. The results show that a 2-lane road is sufficient and economically feasible by 2020. The estimated increase in traffic volume from 2015 to 2020 is not high enough because traffic flow in 2020 is affected by the Middle Ring Road. Traffic volume in 2030 was estimated to be very large. It will be necessary to widen the Kafue Road – Kasama Road and Musi-Oa-Tuya Road Extension –MFEZ sections to 4-lane. The other sections would be also busy and 4-lane roads would be desirable, although 2-lane roads would be able to deal with the traffic.

Table 1.2.2 Traffic Volume of Inner Ring Road

Unit: PCU

Year		2015		2020		2030	
No	Section	Min	Max	Min	Max	Min	Max
1	Kafue Road - Kasama Road	8,400	14,400	11,100	17,800	46,800	52,900
2	Kafue Road - Mumbuwa Road	4,800	11,400	6,900	12,400	8,700	17,400
3	Chibwa Road Extension	7,900	11,500	11,600	11,600	17,800	19,300
4	Nationalist Road Extension	7,800	8,400	9,000	11,000	16,200	18,500
5	Yotam Muleya Road Extension	4,600	4,600	11,900	11,900	17,500	17,500
6	Kasama Road	7,600	14,500	8,100	17,500	17,500	22,100
7	Musi-Oa-Tuya Road Extension to MFEZ	7,500	10,800	88,000	13,600	40,500	59,500
8	Kasama Road - Musi-Oa-Tuya Extension	4,600	8,000	3,800	6,600	24,800	46,800

PCU: Passenger car unit
Source: JICA Study Team

Figure 1.2.1 shows the traffic flow in years 2015, 2020 and 2030. This is the same result of the master plan without the railway and arterial bus systems.

Source: JICA Study Team

Figure 1.2.1 Traffic Flow

1.3 Project Alternative

1.3.1 Concept of Alternative Selection

The Inner Ring Road uses the existing right of way along the power line and the existing road in Chibolya. This is the nearest route to the center of the city which is available for bypass. The construction of this road requires resettlement in Misisi, Chibolya, and Kanyama. Although the number of resettlement can be reduced if the road is constructed along low-density residential areas, the road can not satisfy the purpose as an inner ring road if it is constructed far from the city center. The alternative route should be near the center of the city, and should connect Mumbwa Road, Los Angeles Road, Kafue Road, and a road which provides the access to Chilimbulu Road. There are two possible alternatives for the inner ring road which can reduce the number of resettlement and simultaneously satisfy the purpose. One is the route which uses Chifundo Road, and the other is the route which runs through low-residential areas to the south of Chawama.

The MFEZ access road connects Independence Avenue and Lusaka South MFEZ. The route alignment is defined to minimize the resettlement. The purpose of this road is to provide access to the MFEZ. An alternative to this road is the access route from Kafue Road, which is proposed in the master plan, and is under study as part of the MFEZ project. Another alternative for the access to the MFEZ is constructing a new road from Leopard Hill Road. However, this route might not attract investors for the MFEZ because it is long detour to the MFEZ. This route should be considered together with the eastern part of the outer ring road, which is currently regarded as a medium term project. Hence, only a "zero-option" is considered for this alternative.

1.3.2 Alternative Route

The alternative route is shown in Figure 1.3.1.

(1) Alternative 1: Power Line Route (master plan route)

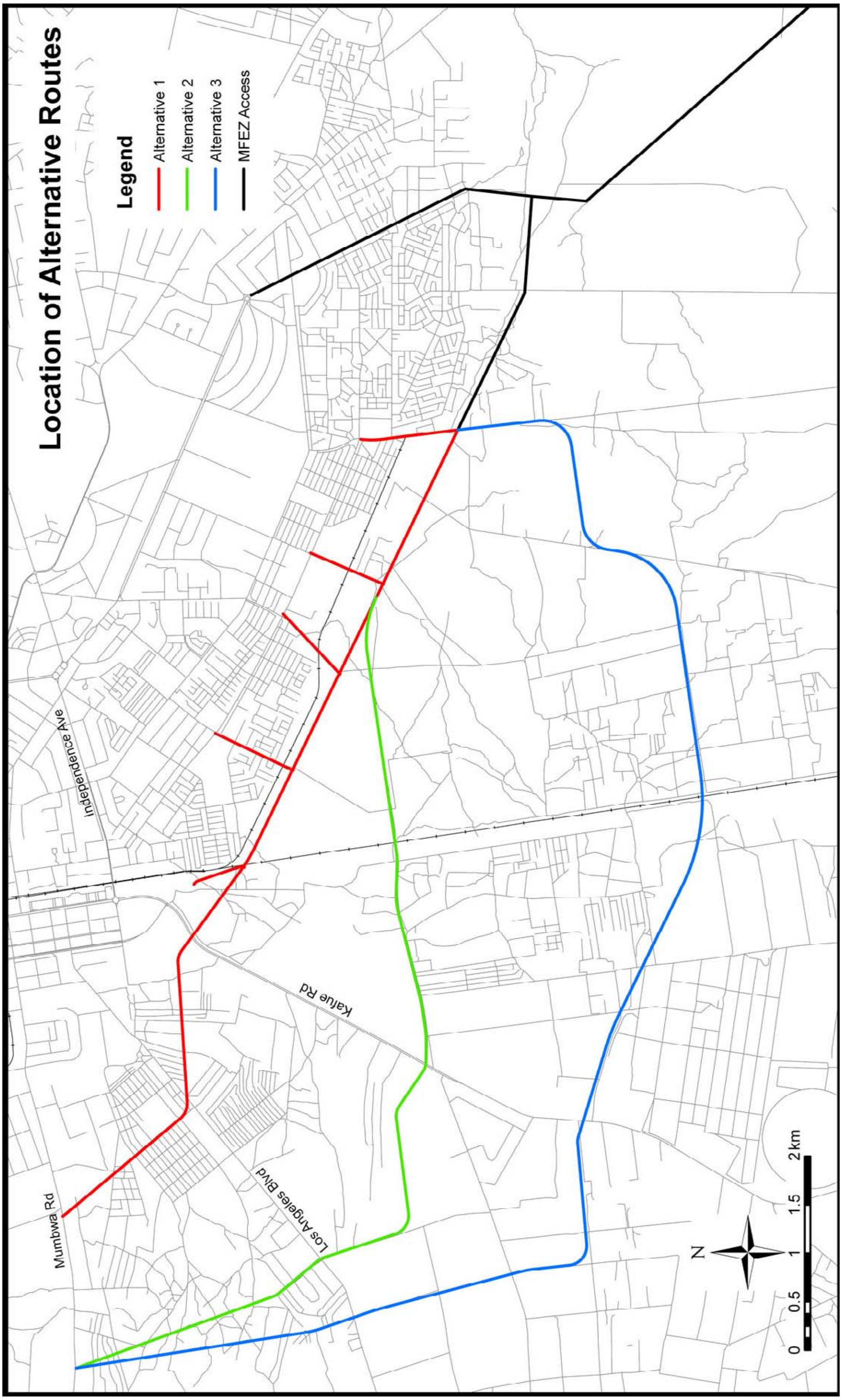
This is the proposed route as the Inner Ring Road in the master plan.

(2) Alternative 2: Chifundo Route

This route uses Chifundo Road between Kafue Road and the railway line, and the south boundary of the populated area of John Laing between Kafue Road and Los Angeles Road. Resettlement is inevitable between Los Angeles Road and Mumbwa Road. This route connects Chifundo Road and the extension of Yotam Mulleya Road, running through Kamwala South where some resettlement is necessary.

(3) Alternative 3: Middle Ring Route

This route starts from Kasama Road, and runs through Kamwala South area, the south of Jack, the north of York Farm, the existing roads in Makeni, and crosses Makeni Road, Los Angeles Road, until it reaches Mumbwa Road. This route is a similar route as the Middle Ring Road proposed in the master plan.



Source: JICA Study Team

Figure 1.3.1 Alternative Route of Inner Ring Road

1.3.3 Design and Cost Estimate of Alternatives

The design and cost of the power line route (Master Plan) is studied in Sections 1.4 and 1.5. The same design was applied for the other alternatives. The permanent 2-lane road of 16-m width is used for the section between Mumbwa Road and Kafue Road, and the transitional 2-lane road of 16-m width is used for the section between Kafue Road and Kasama Road. Table 1.3.1 shows the length of the alternative routes by section and work type.

Table 1.3.1 Route Length by Alternative

Unit: km

Section	Work Type	Power Line Route (Alternative – 1)	Chifundo Route (Alternative – 2)	Middle Road Route (Alternative – 3)
Kafue West	Construction	4.88	4.98	5.75
	Upgrading	1.06	1.87	3.37
	Subtotal	5.94	6.85	9.12
Kafue East	Construction	1.53	3.86	4.91
	Upgrading	2.05	1.65	1.91
	Subtotal	3.58	5.51	6.82
	Total	9.52	12.35	15.93

Source: JICA Study Team

The cost of the power line route is estimated in Chapter 1.5, while the following unit cost was used for the cost estimation of the other alternatives. The detailed breakdown of the unit cost estimation is shown in Table 1.3.3 – 1.3.6.

Table 1.3.2 Unit Cost for Alternative Analysis

Unit: thousand USD per km

	Kafue West	Kafue East
Construction	1,724	1,763
Upgrading	1,598	1,648

Source: JICA Study Team

Refer to Chapter 1.4 and 1.5 for the other engineering aspects of the cost estimates.

The number of resettlement buildings for each alternative was counted using the satellite image (Quick Bird, 2007–2008). It was counted to be 157 buildings for Alternative 1, 120 for Alternative 2, and 135 for Alternative 3.

The work period of the three alternatives were estimated at 24, 26, and 31 months for Alternatives 1, 2, and 3, respectively.

Table 1.3.3 Cost Estimation of Construction in Kafue East

Item	Description		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	4,800	768,000,000
Soft Rock Excavation			m^3	24,000	8,800	211,200,000
Subgrade Preparation			m^2	25,000	10,500	262,500,000
Subgrade		30 cm	m^3	45,000	3,150	141,750,000
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	7,500	600,000,000
Binder Course	As	5 cm	m^2	80,000	7,500	600,000,000
Base	Granular	15 cm	m^3	65,000	1,125	73,125,000
Sub-Base	Granular	30 cm	m^3	55,000	2,250	123,750,000
Prime Coat			m^2	3,400	7,500	25,500,000
Tack Coat			m^2	1,500	7,500	11,250,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	3,000	240,000,000
Binder Course	As	5 cm	m^2	80,000	3,000	240,000,000
Base	Granular	15 cm	m^3	65,000	450	29,250,000
Sub-Base	Granular	30 cm	m^3	55,000	900	49,500,000
Prime Coat			m^2	3,400	3,000	10,200,000
Tack Coat			m^2	1,500	3,000	4,500,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	3,000	90,000,000
Base		15 cm	m^3	65,000	450	29,250,000
Prime Coat			m^2	3,400	3,000	10,200,000
DRAINAGE						
Box Culvert			m	7,500,000	16	120,000,000
Pipe Culvert			m	1,750,000	32	56,000,000
Side Channel			m	517,500	2,000	1,035,000,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	4	270,000,000
Marking			m	2,000	4,000	8,000,000
Delineator			m	0	1,000	0
Traffic Sign			each	3,500,000	4	14,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	14	112,000,000
Planting			each	370,000	0	0
Sub-Total						5,134,975,000
INDIRECT COST						
Overhead and Profit			%	5,134,975,000	10	513,497,500
Field Expenses			%	5,134,975,000	1	51,349,750
Temporary Works			%	5,134,975,000	10	513,497,500
Employer's Site Requirements			%	5,134,975,000	2	102,699,500
Sub-Total						1,181,044,250
Total						6,316,019,250

Source: JICA Study Team

Table 1.3.4 Cost Estimation of Upgrading in Kafue East

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	3,150	504,000,000
Soft Rock Excavation			m^3	24,000	5,775	138,600,000
Subgrade Preparation			m^2	25,000	10,500	262,500,000
Subgrade		30 cm	m^3	45,000	3,150	141,750,000
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	7,500	600,000,000
Binder Course	As	5 cm	m^2	80,000	7,500	600,000,000
Base	Granular	15 cm	m^3	65,000	1,125	73,125,000
Sub-Base	Granular	30 cm	m^3	55,000	2,250	123,750,000
Prime Coat			m^2	3,400	7,500	25,500,000
Tack Coat			m^2	1,500	7,500	11,250,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	3,000	240,000,000
Binder Course	As	5 cm	m^2	80,000	3,000	240,000,000
Base	Granular	15 cm	m^3	65,000	450	29,250,000
Sub-Base	Granular	30 cm	m^3	55,000	900	49,500,000
Prime Coat			m^2	3,400	3,000	10,200,000
Tack Coat			m^2	1,500	3,000	4,500,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	3,000	90,000,000
Base		15 cm	m^3	65,000	450	29,250,000
Prime Coat			m^2	3,400	3,000	10,200,000
DRAINAGE						
Box Culvert			m	7,500,000	16	120,000,000
Pipe Culvert			m	1,750,000	32	56,000,000
Side Channel			m	517,500	2,000	1,035,000,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	4	270,000,000
Marking			m	2,000	4,000	8,000,000
Delineator			m	0	1,000	0
Traffic Sign			each	3,500,000	4	14,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	14	112,000,000
Planting			each	370,000	0	0
Sub-total						4,798,375,000
INDIRECT COST						
Overhead and Profit			%	4,798,375,000	10	479,837,500
Field Expenses			%	4,798,375,000	1	47,983,750
Temporary Works			%	4,798,375,000	10	479,837,500
Employer's Site Requirements			%	4,798,375,000	2	95,967,500
Sub-Total						1,103,626,250
Total						5,902,001,250

Source: JICA Study Team

Table 1.3.5 Cost Estimation of Construction in Kafue West

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	4,800	768,000,000
Soft Rock Excavation			m^3	24,000	8,800	211,200,000
Subgrade Preparation			m^2	25,000	10,000	250,000,000
Subgrade		30 cm	m^3	45,000	3,000	135,000,000
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	7,000	560,000,000
Binder Course	As	5 cm	m^2	80,000	7,000	560,000,000
Base	Granular	15 cm	m^3	65,000	1,050	68,250,000
Sub-Base	Granular	30 cm	m^3	55,000	2,100	115,500,000
Prime Coat			m^2	3,400	7,000	23,800,000
Tack Coat			m^2	1,500	7,000	10,500,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	3,000	240,000,000
Binder Course	As	5 cm	m^2	80,000	3,000	240,000,000
Base	Granular	15 cm	m^3	65,000	450	29,250,000
Sub-Base	Granular	30 cm	m^3	55,000	900	49,500,000
Prime Coat			m^2	3,400	3,000	10,200,000
Tack Coat			m^2	1,500	3,000	4,500,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	3,000	90,000,000
Base		15 cm	m^3	65,000	450	29,250,000
Prime Coat			m^2	3,400	3,000	10,200,000
DRAINAGE						
Box Culvert			m	7,500,000	16	120,000,000
Pipe Culvert			m	1,750,000	32	56,000,000
Side Channel			m	517,500	2,000	1,035,000,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	4	270,000,000
Marking			m	2,000	4,000	8,000,000
Delineator			m	0	1,000	0
Traffic Sign			each	3,500,000	4	14,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	14	112,000,000
Planting			each	370,000	0	0
Sub-total						5,020,150,000
INDIRECT COST						
Overhead and Profit			%	5,020,150,000	10	502,015,000
Field Expenses			%	5,020,150,000	1	50,201,500
Temporary Works			%	5,020,150,000	10	502,015,000
Employer's Site Requirements			%	5,020,150,000	2	100,403,000
Sub-Total						1,154,634,500
Total						6,174,784,500

Source: JICA Study Team

Table 1.3.6 Cost Estimation of Upgrading in Kafue West

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	3,000	480,000,000
Soft Rock Excavation			m^3	24,000	5,500	132,000,000
Subgrade Preparation			m^2	25,000	10,000	250,000,000
Subgrade		30 cm	m^3	45,000	3,000	135,000,000
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	7,000	560,000,000
Binder Course	As	5 cm	m^2	80,000	7,000	560,000,000
Base	Granular	15 cm	m^3	65,000	1,050	68,250,000
Sub-Base	Granular	30 cm	m^3	55,000	2,100	115,500,000
Prime Coat			m^2	3,400	7,000	23,800,000
Tack Coat			m^2	1,500	7,000	10,500,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	3,000	240,000,000
Binder Course	As	5 cm	m^2	80,000	3,000	240,000,000
Base	Granular	15 cm	m^3	65,000	450	29,250,000
Sub-Base	Granular	30 cm	m^3	55,000	900	49,500,000
Prime Coat			m^2	3,400	3,000	10,200,000
Tack Coat			m^2	1,500	3,000	4,500,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	3,000	90,000,000
Base		15 cm	m^3	65,000	450	29,250,000
Prime Coat			m^2	3,400	3,000	10,200,000
DRAINAGE						
Box Culvert			m	7,500,000	16	120,000,000
Pipe Culvert			m	1,750,000	32	56,000,000
Side Channel			m	517,500	2,000	1,035,000,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	4	270,000,000
Marking			m	2,000	4,000	8,000,000
Delineator			m	0	1,000	0
Traffic Sign			each	3,500,000	4	14,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	14	112,000,000
Planting			each	370,000	0	0
Sub-total						4,652,950,000
INDIRECT COST						
Overhead and Profit			%	4,652,950,000	10	465,295,000
Field Expenses			%	4,652,950,000	1	46,529,500
Temporary Works			%	4,652,950,000	10	465,295,000
Employer's Site Requirements			%	4,652,950,000	2	93,059,000
Sub-Total						1,070,178,500
Total						5,723,128,500

Source: JICA Study Team

Table 1.3.7 Construction Period Estimation

	Work Period per km	Alternative 1		Alternative 2		Alternative 3	
		Length (km)	Work Period (Month)	Length (km)	Work Period (Month)	Length (km)	Work Period (Month)
Kafue East							
New Construction							
Excavation	0.93	4.883	4.5	4.979	4.6	5.747	5.3
Base Course	0.61	4.883	3.0	4.979	1.5	5.747	1.8
Surface Course	0.28	4.883	1.4	4.979	1.4	5.747	1.6
Updrading							
Excavation	0.61	1.057	0.6	1.867	1.1	3.368	2.1
Base Course	0.31	1.057	0.3	1.867	0.6	3.368	1.0
Surface Course	0.28	1.057	0.3	1.867	0.5	3.368	0.9
Kafue West							
New Construction							
Excavation	0.93	1.528	1.4	3.855	3.6	4.903	4.6
Base Course	0.31	1.528	0.5	3.855	1.2	4.903	1.5
Surface Course	0.28	1.528	0.4	3.855	1.0	4.903	1.3
Updrading							
Excavation	0.58	2.047	1.2	1.650	1.0	1.916	1.1
Base Course	0.30	2.047	0.6	1.650	0.5	1.916	0.6
Surface Course	0.26	2.047	0.5	1.650	0.4	1.916	0.5
Others			9.0		9.0		9.0
TOTAL			23.7		26.4		31.3

Source: JICA Study Team

1.3.4 Traffic Volume Forecast of Alternative Routes

Traffic volume forecast for each alternative was carried out for the year 2015, by using the traffic forecast model in the master plan. Like in the master plan, the same origin-destination (OD) matrix in 2015 was used. The road network in the forecast consists of i) the existing roads (2008), ii) the access road from Kafue Road to LS-MFEZ[1], and iii) each alternative route.

Figure 1.3.2 shows the result of the forecast. For Alternative-1, the result is the same as shown in Table 1.2.2. Traffic volume of Alternative-2 was estimated at 6,000 – 16,000 PCU per day, while that of Aternative-3 was 7,000 – 16,000 PCU per day. In all cases, traffic volume to the east of Kafue Road is higher than that to the west.

[1] The access road to the MFEZ from Kafue Road (a part of Outer Ring Road) is regarded as part of base network for each alternative, because if this road does not exist, there is no access to the MFEZ in case of "zero option".

Source: JICA Study Team

Figure 1.3.2 Traffic Flow for Alternatives

1.3.5 Evaluation of Alternatives

Alternative consideration was conducted in terms of economic, social and environmental aspects, and economic, technical, environmental and social indicators were evaluated equally without any weighting for specific indicators. In this section, quantitative alternative evaluation is discussed mainly from the economic and technical view points, and qualitative/quantitative alternative considerations in terms of environmental and social considerations are described later in Section 1.4.7.

Several indicators were calculated for the evaluation, as shown in Table 1.3.8.

Traffic indicators like vehicle-kilometers are calculated for all traffic movements in Lusaka. All traffic indicators are high in case of the "zero-option". CO_2 reduction is highest in case of Middle Ring Route. This case also shows the lowest vehicle operating cost (VOC). On the other hand, savings in travel time cost, which represents the impact of congestion relief, is most significant in the case of the power line route (Master Plan case). The total economic benefit is highest in the case of the middle ring route. However, the differences of traffic indicators and economic benefits are very small among the three alternatives.

In view of construction cost, the power line route is the best. Cost efficiency is also highest in this case at the first year return of 58.6%. However, the number of resettlement is largest in this case. The Chifundo route is the case with the smallest number of resettlement. However, this route will divide the community in Chawama and widening of the road to 4-lane in the future will be difficult because it will require additional land acquisition and resettlement. The widening of the road will be easy in case in the power line route.

For the drainage system which is an important factor of the road project in Lusaka, the power line route can use Ngwere Stream near Kafue Road as the outfall area, while other routes need to carry water up to Chunga Stream in the industrial area.

Table 1.3.8 Comparison of Alternatives for Inner Ring Project

	Unit	Zero Option	Alt-1	Alt-2	Alt-3
Length	Km	-	22.9	25.5	30.0
Vehicle-km /day	Million	5.73	5.65	5.66	5.69
Vehicle-hour /day	Thousand	211	202	202	202
Fuel Consumption /day	Thousand Litter	845	816	817	814
CO_2 Emission /day	Ton	2087	2020	2023	2016
NOx Emission /day	Ton	3.15	3.13	3.14	3.14
SPM /day	Kg	166	165	166	166
VOC /day	USD thousand	1,391	1,348	1,349	1,345
Time Cost /day	USD thousand	771	735	736	737
Economic Benefit/ year	USD million	-	24.1	23.3	24.5
Economic Cost*[1]/ year	USD million	-	0.6	0.7	0.8
Construction Cost*[2]	USD million	-	50.4	59.4	66.1
Initial Economic Cost	USD million		39.9	45.2	51.7
First Year Return	%	-	55.7	45.4	42.5
Construction Period	Month	-	24	27	33
Area of land acquisition	ha	-	12.0	27.6	31.7
Resettlement	No.	-	157+3	120+3	135+3

Note *[1]: Annual economic cost = road maintenance cost
Note *[2]: Including land acquisition cost and resettlement cost
Note: FYR = (Annual Economic Benefit – Annual Economic Cost)/ Initial Economic Cost
Source: JICA Study Team

The negative impacts of "Zero Option" are 1i) decline of the industrial zone in the west of Town due to traffic congestion, ii) delay in MFEZ development, iii) increase in travel time at Kafue Roundabout and in Town, and iv) increase in CO_2 emission.

1.4 Preliminary Design

1.4.1 Roadway

(1) Road Section

The roadway design for the priority project was studied under the condition and characteristics of each section as shown in Table 1.4.1. All of the project roads are urban roads and there are restrictions on the width of their right-of-way to minimize the items subject for compensation, such as houses, shops and industrial facilities. The traffic volume forecast implies that the Kafue Road – Kasama Road section needs a 4-lane capacity in 2030, but 2-lane capacity is enough in the short- and medium-terms.

Table 1.4.1 Section of Inner Ring and MFEZ Access Road Project

No	Section	Length (km)	No. of Lanes		Road Function	Land Use (2030)*
			-2020	-2030		
1	Kafue Road - Kasama Road	5.940	2	4	Major Arterial	CC
2	Kafue Road - Mumbuwa Road	3.575	2	2	Minor Arterial	MR/ MX
3	Mini Bypass - Inner Ring Road	0.561	2	2	Minor Collector	MX
4	Chibwa Road Extension	0.891	2	2	Minor Collector	MX
5	Nationalist Road Extension	0.856	2	2	Major Collector	MX
6	Yotam Muleya Road Extension	0.822	2	2	Minor Collector	MX
7	Kasama Road	0.696	2	2	Minor Collector	MX
8	Musi-Oa-Tuya Road Extension to MFEZ	7.188	2	2	Minor Arterial	MR/ LR
9	Kasama Road - Musi-Oa-Tuya Extension	2.573	2	2	Minor Arterial	CC
	Total Length	23.102	2	2		

Note*: CC= Corridor Commercial, MX= Mixed Use, MR= Medium-dense Residential, LR= Low-dens Residential
Source: JICA Study Team

(2) Cross section

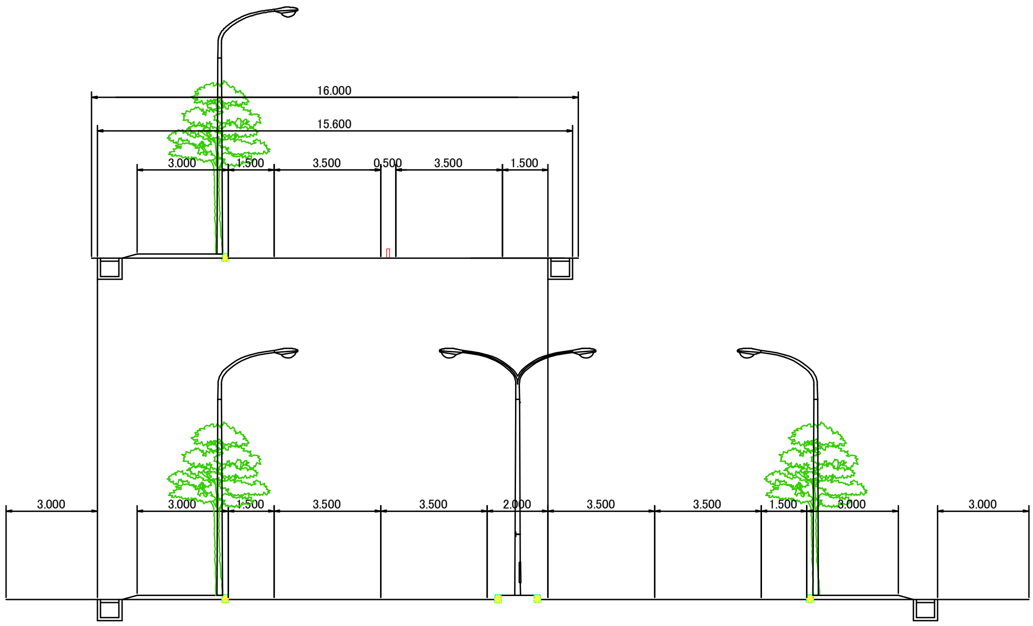
The cross section component was formulated with to the SATCC (Southern Africa Transport and Communications Commission) standard, the Zambia geometric standard and the Road Re-classification Study being carried out by RDA.

<u>Kafue Road – Kasama Road section</u>

The traffic volume forecast for this section indicates that it would not be feasible if the road is constructed as a 4-lane road at present. Instead of providing 4-lane road from the beginning, therefore, it is proposed to construct a 2-lane road for this section and widen the road to 4-lane in the future. The future 4-lane road should have a median because it is identified as a major arterial road. The cross section should be designed such that future widening will be possible without relocation and replacement of road facilities. The design of the section is as follows:

- Total width = 16.0 m
- Permanent sidewalk is installed only at one side.
- Sidewalk on the other side is not installed for the future widening
- Median space is prepared and chatter bars are installed.

Figure 1.4.1 illustrates the cross section of the transitional 2-lane road to the future 4-lane road.

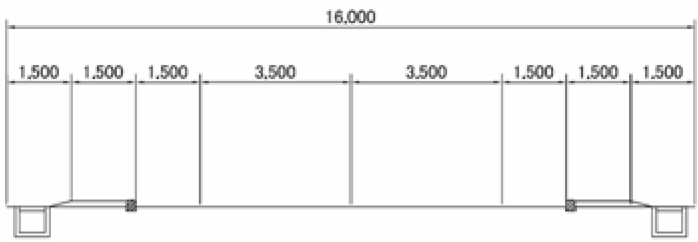


Source: JICA Study Team

Figure 1.4.1 Typical Cross Section (Kafue Road – Kasama Road)

<u>Mumbwa Road – Los Angeles Road – Kafue Road section / MFEZ Access</u>

This section is in the residential area of Chibolya and Kanyama. In addition to the carriageway of 7m, 1.5m for shoulder, 1.5m for walkway, and 1.5m for side channel are proposed as shown in the figure below. The shoulder width of 1.5m is enough for the accommodation of stopped vehicles in emergency cases.

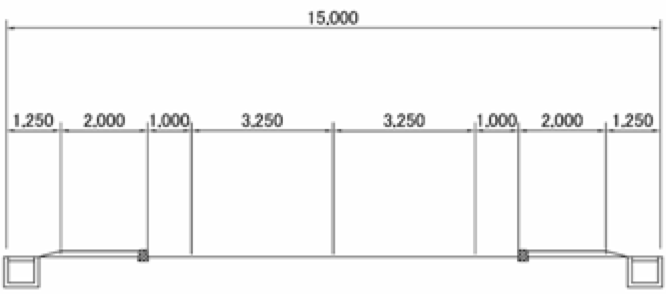


Source: JICA Study Team

Figure 1.4.2 Cross Section (Mumbwa Road – Kafue Road/MFEZ Access)

<u>Collector Roads</u>

The road width of collector roads is 15m, consisting of 6.5m carriageway, 1.0m shoulders, 2.0m walkways, and 1.25m side channel spaces as shown in the figure below.



Source: JICA Study Team

Figure 1.4.3 Cross Section (Collector Roads)

(3) Horizontal and Vertical Alignment

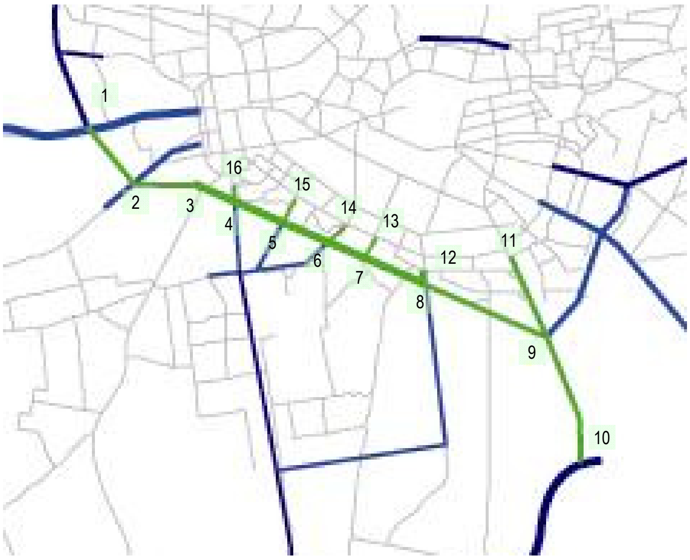
The horizontal and vertical alignments were prepared using computer-aided design (CAD) system. The design was done by using available satellite image (Quick Bird, 2007–2008) and contour lines in existing topographic maps.

The road plan and profile as the results of the foregoing design are attached in the Supplemental Data Book and Design Drawings.

1.4.2 Intersections

(1) Intersection Analysis

Preliminary intersections design was undertaken based on the number of lanes of intersecting roads and the projected traffic volume in 2015. As a result of preliminary intersection analysis, the at-grade type intersection is selected for all intersections on the inner ring road. T he figure below illustrates the location of intersections.



Source: JICA Study Team

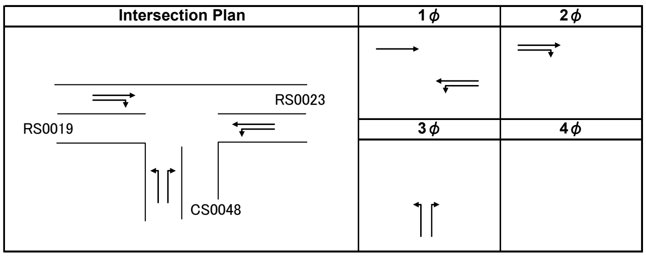
Figure 1.4.4 Intersections Location Map

The result of intersection capacity analysis based on the Highway Capacity Manual, Transportation Research Board, 1985 and the preliminary lane arrangements for the intersections are shown in Table 1.4.2.

Table 1.4.2 Intersection Capacity Analysis and Intersection Plan

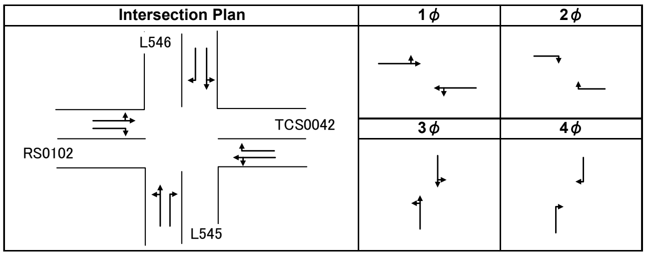
Intersection No.01

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RS0023	Left	1,380	153	1,149	0.133		
(Mumbwa	Straight	5,279	587	1,523	0.385		
Road)	Right	0	0	0	0.000		
CS0048	Left	1,540	171	1,149	0.149		
(IRR)	Straight	0	0	0	0.000		
	Right	1,511	168	1,447	0.116	40	0.605
RS0019	Left	0	0	0	0.000		
(Mumbwa	Straight	5,353	595	1,523	0.391		
Road)	Right	1,339	149	1,447	0.103		



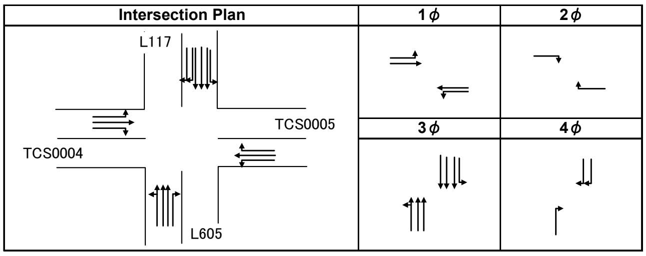
Intersection No.02

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
CS0042	Left	2,238	0	0	0.000		
(IRR)	Straight	2,082	480	1,315	0.365		
	Right	0	0	1,431	0.000		
L545	Left	533	0	0	0.000		
(Los Angels	Straight	2,416	327	1,440	0.227		
Road)	Right	2,281	253	1,431	0.177	60	0.821
RS0102	Left	962	0	0	0.000		
(IRR)	Straight	2,108	341	1,391	0.245		
	Right	679	75	1,431	0.052		
L546	Left	0	0	0	0.000		
(Los Angels	Straight	2,512	279	1,507	0.185		
Road)	Right	957	106	1,431	0.074		



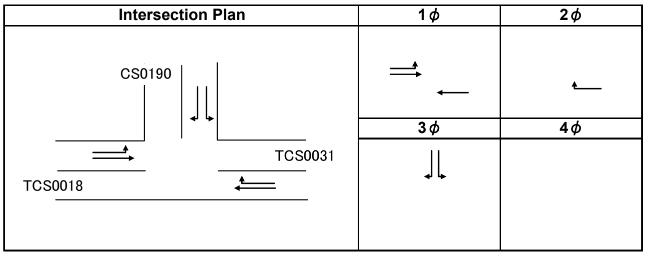
Intersection No.03

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0005	Left	2,285	254	1,174	0.216		
(IRR)	Straight	1,222	136	1,555	0.087		
	Right	1,284	143	1,477	0.097		
L605	Left	165	0	0	0.000		
(Kafue Road)	Straight	21,846	2445	4,657	0.525		
	Right	1,988	221	1,477	0.150	70	0.825
TCS0004	Left	3,476	386	1,174	0.329		
(IRR)	Straight	1,225	136	1,555	0.087		
	Right	191	21	1,477	0.014		
L117	Left	1,096	122	1,174	0.104		
(Kafue Road)	Straight	22,155	2462	4,666	0.528		
	Right	2,999	333	2,955	0.113		



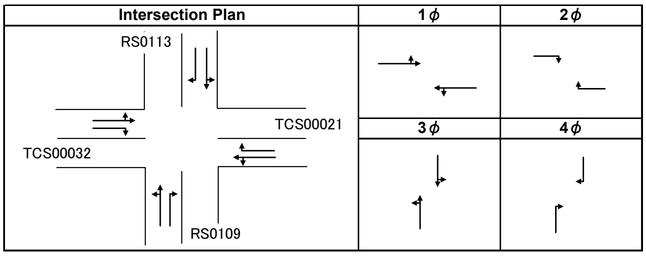
Intersection No.04

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS00031	Left	0	0	0	0.000		
(IRR)	Straight	3,980	442	1,555	0.284		
	Right	2,685	298	1,477	0.202		
TCS0018	Left	0	0	0	0.000		
(IRR)	Straight	4,119	458	1,555	0.294		
	Right	0	0	1,477	0.000	40	0.773
CS0190	Left	2,922	325	1,174	0.277		
	Straight	0	0	0	0.000		
	Right	0	0	1,477	0.000		



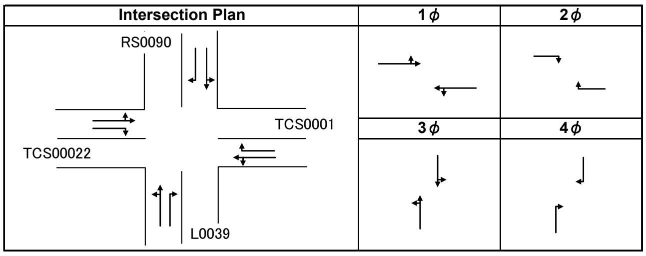
Intersection No.05

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS00021	Left	395	0	0	0.000		
(IRR)	Straight	4,846	582	1,479	0.394		
	Right	441	49	1,431	0.034		
RS0109	Left	1,112	0	0	0.000		
	Straight	655	197	1,274	0.155		
	Right	429	48	1,431	0.034	40	0.692
TCS00032	Left	613	0	0	0.000		
(IRR)	Straight	4,765	597	1,465	0.408		
	Right	1,003	111	1,431	0.078		
RS0113	Left	476	0	0	0.000		
	Straight	637	124	1,349	0.092		
	Right	670	74	1,431	0.052		



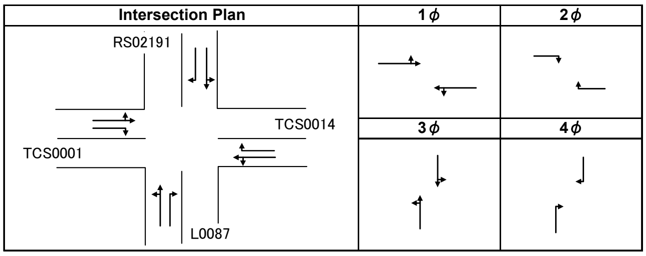
Intersection No.06

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0001	Left	152	0	0	0.000		
(IRR)	Straight	3,347	389	1,474	0.264		
	Right	36	4	1,416	0.003		
L0039	Left	1,355	0	0	0.000		
	Straight	936	255	1,274	0.200		
	Right	155	17	1,416	0.012	50	0.661
TCS00022	Left	657	0	0	0.000		
(IRR)	Straight	3,221	431	1,428	0.302		
	Right	1,291	143	1,416	0.101		
RS0090	Left	39	0	0	0.000		
	Straight	980	113	1,477	0.076		
	Right	748	83	1,416	0.059		



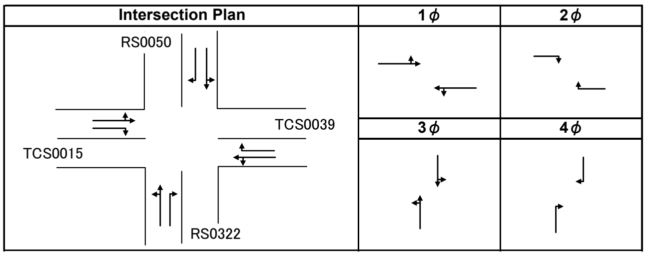
Intersection No.07

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0014	Left	0	0	0	0.000		
(IRR)	Straight	2,899	322	1,539	0.209		
	Right	217	24	1,462	0.016		
L0087	Left	0	0	0	0.000		
	Straight	0	0	1,539	0.000		
	Right	0	0	1,462	0.000	40	0.365
TCS0001	Left	655	0	0	0.000		
(IRR)	Straight	2,869	392	1,469	0.267		
	Right	0	0	1,462	0.000		
RS02191	Left	245	0	0	0.000		
	Straight	0	27	1,162	0.023		
	Right	761	85	1,462	0.058		



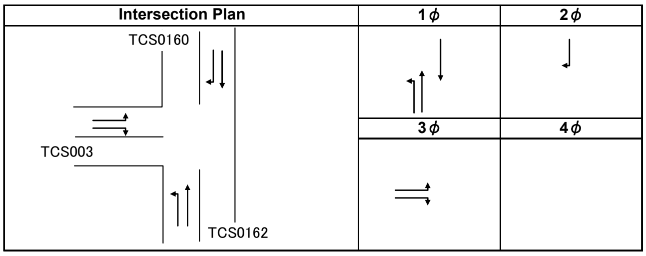
Intersection No.08

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0039	Left	102	0	0	0.000	50	0.729
(IRR)	Straight	2,159	251	1,490	0.168		
	Right	2,373	264	1,431	0.184		
RS0322	Left	890	0	0	0.000		
(Kasama	Straight	1,405	255	1,363	0.187		
Road)	Right	109	12	1,431	0.008		
TCS0015	Left	317	0	0	0.000		
(IRR)	Straight	2,234	283	1,461	0.194		
	Right	862	96	1,431	0.067		
RS0050	Left	2,400	0	0	0.000		
(Kasama	Straight	1,328	415	1,269	0.327		
Road)	Right	309	34	1,431	0.024		



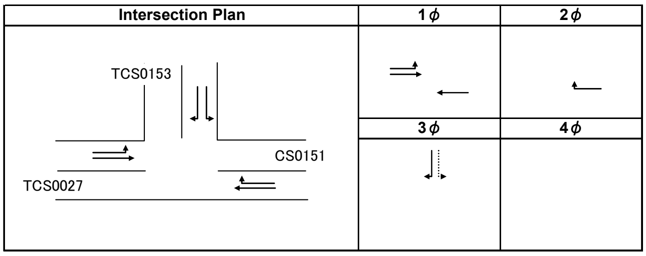
Intersection No.09

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0162	Left	1,351	150	1,137	0.132	60	0.520
(MFEZ Access	Straight	3,610	401	1,137	0.353		
Road)	Right	0	0	0	0.000		
TCS003	Left	699	78	1,137	0.069		
(IRR)	Straight	0	0	0	0.000		
	Right	1,527	170	1,431	0.119		
TCS0160	Left	0	0	0	0.000		
(MFEZ Access	Straight	3,680	409	1,137	0.360		
Road)	Right	621	69	1,431	0.048		
	Left	0	0	0	0.000		
	Straight	0	0	0	0.000		
	Right	0	0	0	0.000		



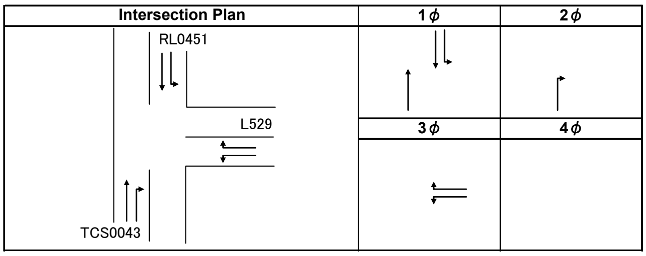
Intersection No.10

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
CS0151	Left	0	0	0	0.000	40	0.492
(Outer Ring	Straight	505	56	1,490	0.038		
Road)	Right	2,556	284	1,416	0.201		
TCS0027	Left	1,879	209	1,125	0.186		
(Outer Ring	Straight	539	60	1,490	0.040		
Road)	Right	0	0	0	0.000		
TCS0153	Left	2,540	282	1,125	0.251		
(MFEZ Access	Straight	0	0	0	0.000		
Road)	Right	1,780	198	1,416	0.140		
	Left	0	0	0	0.000		
	Straight	0	0	0	0.000		
	Right	0	0	0	0.000		



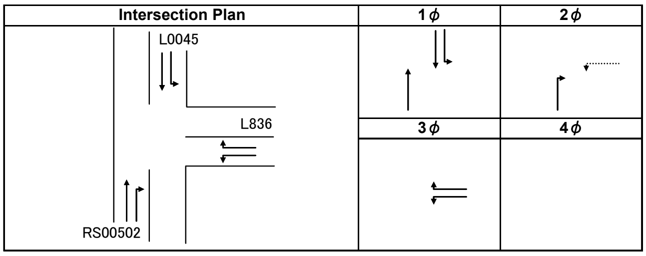
Intersection No.11

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L529	Left	689	77	1,137	0.068	40	0.444
	Straight	0	0	0	0.000		
	Right	1,808	201	1,431	0.140		
TCS0043	Left	0	0	0	0.000		
(MFEZ Access	Straight	3,421	380	1,507	0.252		
Road)	Right	626	70	1,431	0.049		
RL0451	Left	1,619	180	1,137	0.158		
(MFEZ Access	Straight	3,444	383	1,507	0.254		
Road)	Right	0	0	0	0.000		



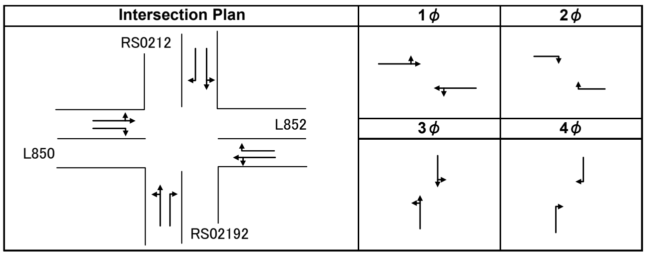
Intersection No.12

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L836	Left	58	6	1,125	0.005	40	0.389
(Maramba	Straight	0	0	0	0.000		
Road)	Right	796	88	1,416	0.062		
RS00502	Left	0	0	0	0.000		
(IRR Access	Straight	4,334	482	1,490	0.323		
Road)	Right	49	5	1,416	0.004		
L0045	Left	671	75	1,125	0.067		
(Kasama Road	Straight	4,289	477	1,490	0.320		
	Right	0	0	0	0.000		
	Left	0	0	0	0.000		
	Straight	0	0	0	0.000		
	Right	0	0	0	0.000		



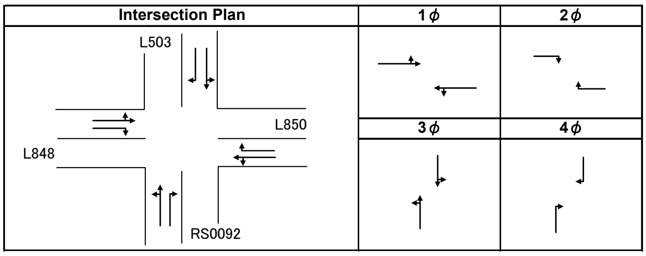
Intersection No.13

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L852	Left	0	0	0	0.000	50	0.573
(Chilimbulu	Straight	4,488	499	1,137	0.439		
Road)	Right	123	14	1,431	0.010		
RS02192	Left	627	0	0	0.000		
(IRR Access	Straight	302	104	1,386	0.075		
Road)	Right	0	0	1,431	0.000		
L850	Left	0	0	0	0.000		
(Chilimbulu	Straight	4,677	520	1,137	0.457		
Road)	Right	519	58	1,431	0.041		
RS0212	Left	190	0	0	0.000		
	Straight	372	62	1,262	0.049		
	Right	0	0	1,431	0.000		



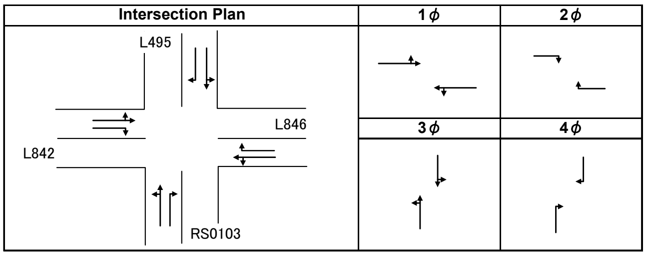
Intersection No.14

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L850	Left	787	0	0	0.000	50	0.791
(Chilimbulu	Straight	2,742	392	1,219	0.322		
Road)	Right	1,659	184	1,431	0.129		
RS0092	Left	45	0	0	0.000		
(IRR Access	Straight	1,175	136	1,151	0.118		
Road)	Right	839	93	1,431	0.065		
L848	Left	1,049	0	0	0.000		
(Chilimbulu	Straight	2,860	435	1,237	0.352		
Road)	Right	44	5	1,431	0.003		
L503	Left	1,690	0	0	0.000		
	Straight	1,110	311	1,360	0.229		
	Right	1,049	117	1,431	0.082		



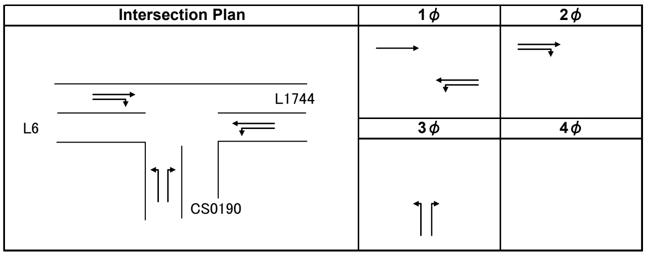
Intersection No.15

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L846	Left	666	0	0	0.000	60	0.817
(Chilimbulu	Straight	3,848	502	1,192	0.421		
Road)	Right	156	17	1,431	0.012		
RS0103	Left	1,362	0	0	0.000		
(IRR Access	Straight	1,440	311	1,317	0.236		
Road)	Right	696	77	1,431	0.054		
L842	Left	197	0	0	0.000		
(Chilimbulu	Straight	3,798	444	1,155	0.384		
Road)	Right	1,357	151	1,431	0.106		
L495	Left	167	0	0	0.000		
	Straight	1,534	189	1,174	0.161		
	Right	213	24	1,431	0.017		



Intersection No.16

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L1744	Left	0	0	1,174	0.000	80	0.853
(Lumumba	Straight	5,269	585	1,555	0.376		
Chilimbulu Rd.)	Right	0	0	0	0.000		
CS0190	Left	2,932	326	1,174	0.278		
(IRR Access	Straight	0	0	0	0.000		
Road)	Right	0	0	1,477	0.000		
L6	Left	0	0	0	0.000		
(Lumumba	Straight	5,151	572	1,555	0.368		
Chilimbulu Rd.)	Right	2,642	294	1,477	0.199		



TV/day = Directional daily traffic volume
V = Adjusted flow rate (h)
S = Adjusted saturation flow rate
v/s = Degree of saturation
C = Cycle time
Σw/s = Total degree of saturation
Source: JICA Study Team

(2) At-grade intersection with railway

One railway crossing (Zambia Railways) will be located on Class IA Section (Kafue Bypass – Chibolya). Since the section is scheduled to be a two-lane transitional cross section in the short term program, it will be an at-grade intersection. Grade separation at the crossing location will be determined upon implementation of the final 4-lane (multiple lanes) road in the future.

1.4.3 Pavement

The pavement design was undertaken in accordance with the Pavement Design Guide, Roads Department, Ministry of Works and Supply, 1994.

The sub-grade is proposed to ensure a CBR value of over 8. The pavement structure was studied based on the accumulated axle load calculated from traffic volume forecast and the sub-grade condition.

1.4.4 Drainage System

(1) Present Issues in the Road Sections

The Inner Ring Road (Kasama Road to Mumbwa Road) passes along inundation–prone areas such as Soweto Market area, Misisi, Kamwara, Kamwara South, and Kabwata. In addition to the flooding, a lot of rainwater pools appear in the unpaved roads during the rainy season, which sometimes hinder traffic and cause economic loss.

Characteristics of the flooding and inundation in the project area are:

The process of inundation is slow.

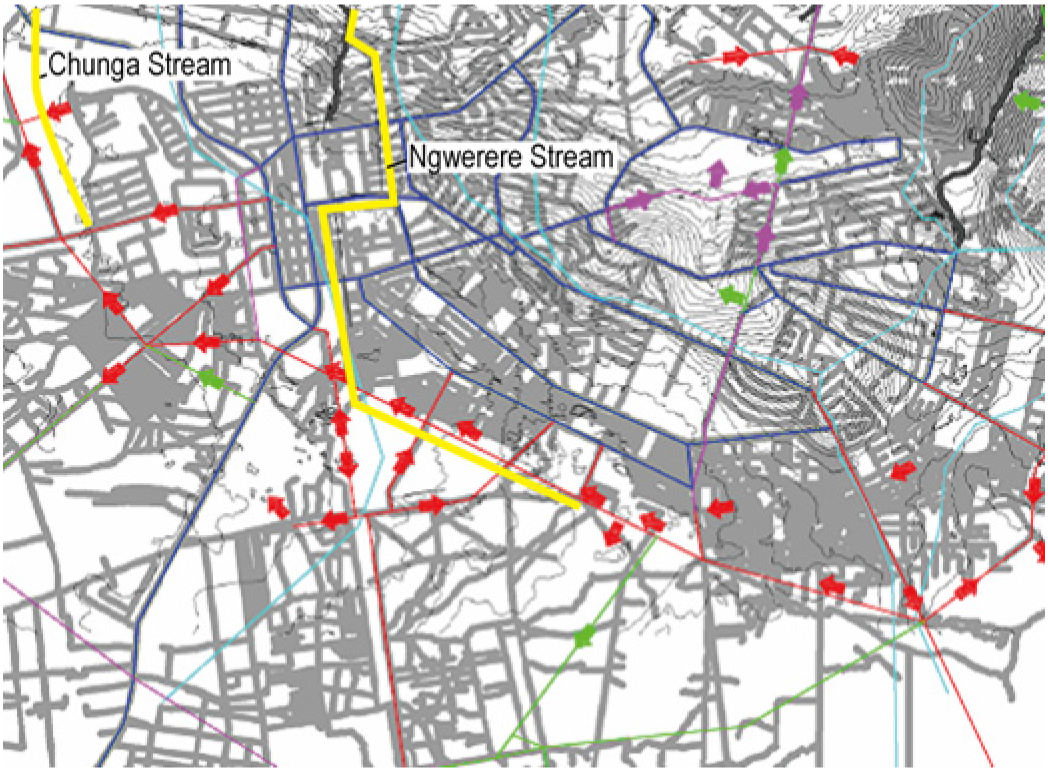
Insufficient drainage in the area results in long inundation periods.

The topography is almost flat and the gradient is small.

The downward direction of the slope is i) from east to west on Musi-Oa-Tuya Road to Mumbwa Road, and ii) from north to south on Independence Avenue to LS-MFEZ.

The project should consider the flow of rainwater and the flooding problem in this area. The road itself cannot solve the flooding problem but it can contribute to reduce the flooding by providing a drainage system.

Figure 1.4.5 indicates the water flow direction along the project road routes.



Source: JICA Study Team

Figure 1.4.5 Present Water Flow Directions

(2) Design Concept

The road cross section will have a high point in the middle of the carriageway and a cross slope downward to both edges. Surface water flows into the side channel along both sides of the road. The side channel conveys the surface water to outfalls that have sufficient draining capacity. If the outfalls are not available or their capacity is not enough, the water should be conveyed to the infiltration forest area.

(3) Proposed Drainage System

The drainage channel on both sides of the project road will function as the drainage system. The direction of water flow in the drainage channel and their outfall areas are summarized as follows:

<u>Inner Ring Road section</u>

Surface water flows from east to west along this section, with the Ngwerere Stream and Chunga Stream as the outfalls for the drainage system. These streams should be rehabilitated and improved, or at least, clearing and dredging in the streams are necessary.

Table 1.4.3 Proposed Inspection Program

Direction	Length	Outfall
Kasama Road → Chawama Access / North-South Railway	4.272 km	Ngwerere Stream
Chawama Access / North-South Railway → Kafue Road → Los Angeles Road → Mumbwa Road	4.478 km	Chunga Stream

Source: JICA Study Team

MFEZ Access section

The drainage system between Kasama Road and Musi-Oa-Tuya Extension is integrated to the drainage same of the inner ring road. Ngwerere Stream is the outfall of the drainage system. In the section between Musi-Oa-Tuya Extension and LS-MFEZ, the drainage channels at both sides of the road convey surface water from Independence Avenue to LS-MFEZ. The outfall for the system is in the MFEZ area.

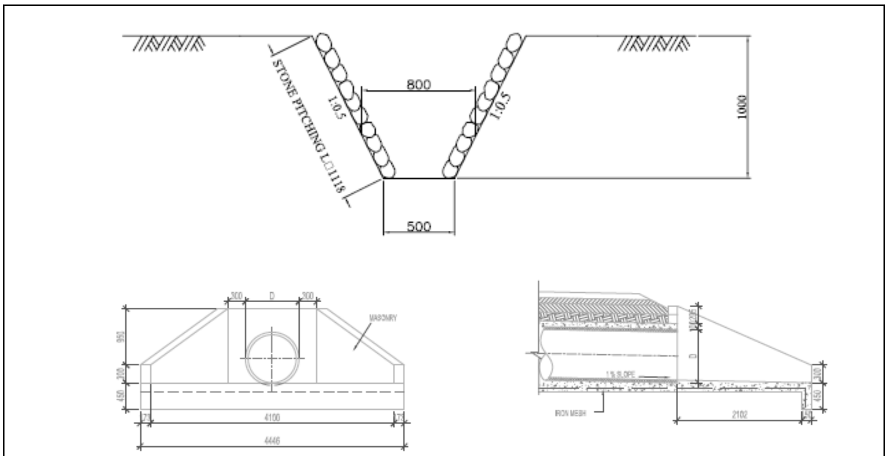
Table 1.4.4 Proposed Rehabilitation Method by Damage Type

Direction	Length	Outfall
Independence Avenue → LS-MFEZ	6.777 km	Forest Area
Musi-Oa-Tuya Extension → Kasama Road	3.502 km	Ngwerere Stream

Source: JICA Study Team

(4) Proposed Drainage Structures

Drainage structures such as concrete curbs, haunched pipes, side ditches, channels, and pipe culverts are the typical structures applied in Zambia. Figure 1.4.6 shows two examples of these structures.



Source: JICA Study Team

Figure 1.4.6 Drainage Structures (Upper: Side ditch, Lower: Cross drain)

1.4.5 Other Facilities

(1) Traffic Signals

All intersections, which are shown in Figure 1.4.3, need the installation of traffic signals because their saturation level is high. Flexible signal phasing is proposed for the traffic signal to expand the traffic capacity.

(2) Traffic Safety Devices

Traffic safety devices include road markings, traffic signs, and median islands. These facilities are planned to be installed for the entire section.

(3) Street Lighting

The street lights are planned to be installed on the street sections of the arterial roads which have frequent traffic access.

(4) Planting

Planting should be done along new construction section on Independence Avenue – LS-MFEZ (part of Access to LS-MFEZ).

1.4.6 Summary of Preliminary Design

The results of preliminary design and estimates of design quantities for the project roads are summarized as follows:

Table 1.4.5 Mumbwa Road – Kafue Road – Kasama Road

		Kafue Road – Kasama Road	Mumbwa Road – Kafue Road
Type of Project		New Construction: 4.883 km Upgrading: 1.057 km	New Construction: 1.528 km Upgrading: 2.047 km
Road Length		5.940 km	3.575 km
Carriageway (Lane) width		3.50 m x 2 (paved)	3.50 m x 2 (paved)
Shoulder		1.50 m x 2 (paved)	1.50 m x 2 (paved)
Side Walk		3.00 m (one side)	1.50 m (both side)
Total Road Width		16.00 m	16.00 m
Number of Intersections		1-major intersection	2-major intersection
Earthwork		Excavation: 75,842 m^3 Subgrade: 18,711 m^3	Excavation: 38,180 m^3 Subgrade: 10,725 m^3
Carriageway Portion	Surface Course: Base Course: Subbase Course: Area of Pavement Work:	10 cm 15cm 30 cm 44,550 m^2	10 cm 15 cm 30 cm 25,025 m^2
Shoulder Portion	Surface Course: Base Course: Subbase Course: Area of Pavement Work:	10 cm 15cm 30 cm 17,820 m^2	10 cm 15 cm 30 cm 10,725 m^2
Sidewalk Portion	Surface Course: Base Course: Area of Pavement Work:	Multiple bituminous surface dressing 15 cm 17,820 m^2	Multiple bituminous surface dressing 15 cm 10,725 m^2
Cross Drainage		Pipe Culverts: 12 locations, 192 m in total length	Pipe Culverts: 7 locations, 112 m in total length
Surface Drainage		Drainage Channel: 11,880 m	Drainage Channel: 7,150 m
Traffic Signals		4 locations	8 locations
Traffic Safety Devices		Markings: 23,760 m Traffic Signs: 24 locations	Markings: 14,300 m Traffic Signs: 14 locations
Traffic Light		63 Nos.	44 Nos.

	Access to LS-MFEZ	5 Collector Roads
Type of Project	New Construction: 6.797 km Upgrading: 2.964 km	New Construction: 0.771 km Upgrading: 3.055 km
Road Length	9.761 km	3.826 km
Carriageway (Lane) width	3.50 m x 2 (paved)	3.25 m x 2 (paved)
Shoulder	1.50 m x 2 (paved)	1.00 m x 2 (paved)
Side Walk	1.50 m (both side)	2.00 m (both side)
Total Road Width	16.00 m	15.00 m
Number of Intersections	3-major intersection	4-major intersection
Earthwork	Excavation: 117,632 m^3 Subgrade: 29,283 m^3	Excavation: 28,149 m^3 Subgrade: 9,756 m^3

Carriageway Portion	Surface Course: Base Course: Subbase Course: Area of Pavement Work:	10 cm 15cm 30 cm 68,327 m^2	10 cm 15 cm 20 cm 24,869 m^2
Shoulder Portion	Surface Course: Base Course: Subbase Course: Area of Pavement Work:	10 cm 15cm 30 cm 29,283 m^2	10 cm 15 cm 30 cm 7,652 m^2
Sidewalk Portion	Surface Course: Base Course: Area of Pavement Work:	Multiple bituminous surface dressing 15 cm 29,283 m^2	Multiple bituminous surface dressing 15 cm 15,304 m^2
Cross Drainage		Pipe Culverts: 19 locations, 304 m	Pipe Culverts: 7 locations, 112 m in total length
Surface Drainage		Drainage Channel: 19,522 m	Drainage Channel: 7,652 m
Traffic Signals		12 locations	16 locations
Traffic Safety Devices		Markings: 39,044 m in total Traffic Signs: 39 locations	Markings: 15,304 m in total Traffic Signs: 15 locations
Traffic Light		110 Nos.	54 Nos.
Planting		288 Nos.	

Source: JICA Study Team

1.4.7 Alternatives for Environmental and Social Considerations

The preliminary design was done considering environmental and social impact. The number of resettlements was minimized under the planned alignment. In addition to economic and technical evaluation in Section 1.3.5, the environmental and social impacts of the alternatives are considered and summarized in Table 1.4.6. As a result, Alternative 1 is also considered the best option in terms of environmental and social considerations since overall its has more benefits, even though impact of resettlement would be the largest.

Table 1.4.6 Alternative Considerations for Environmental and Social Considerations

Items	Alt. 1	Alt. 2	Alt. 3	Zero Option	
Land Acquisition and Resettlement Cost in million USD	3.4	6.1	5.9	0	1. Not contributing to the planned Lusaka South MFEZ project; and 2. Negative impacts on social and economic activities by worsened traffic congestion.
No. of Structures to be Displaced	160	123	138	0	
Land Acquisition ha	12.0	27.6	31.7	0	
Difficulty to Connect to Existing Drainage	Not Difficult	Slightly Difficult	Slightly Difficult	n.a.	
Traffic Congestion Relief in Town and Access to Existing Roads	Good	Slightly Good	Slightly Good	n.a.	
Air Pollutant Emission ton /day	NOx: 3.13; SPM: 165	NOx: 3.14; SPM: 166	NOx: 3.14; SPM: 166	NOx: 3.15; SPM: 166	

* See the detailed results in Section 1.3.5 of this Chapter
Source: JICA Study Team

The flexibility of the design is constrained due to the site condition. In addition to the above-considerations, there are more more alternatives to reduce the number of resettlement from the planned alignment as follows:

Case-1: To change the location of intersection with Mumbwa Road
Case-2: To separate the road by Los Angeles Road
Case-3: To reduce the road width

The idea of Case-1 is to use a stone quarry to reduce the number of resettlements in Kanyama. In this case, the alignment of Inner Ring Road will not be conformed to the master plan network. In addition, construction cost will be larger because of the stone quarry. This case will take job opportunity at the stone quarry from the community.

In Case-2, the section between Mumbwa Road and Los Angeles Road and the section between Los Angeles Road and Kafue Road have different intersection with Los Angeles Road. In this case, two T-intersections of arterial roads will be close each other.

As for Case-3, the width of Inner Ring Road is proposed as 16m. It was proposed considering the function as an arterial road. Reduction in the width of walkway, shoulder, carriageway, and drainage space will reduce the function of the road. Increase in traffic accidents and environmental problem will be expected. In addition, the difference of the number of resettlements from the original width is small.

In conclusion, these alternatives will cause other negative social impacts of the planned design.

1.5 Preliminary Cost Estimate

1.5.1 Construction Plan

Lusaka has a tropical savannah climate; the dry and rainy seasons last from May to September and from October to April, respectively. It is reported that the rain in rainy season does not continue for a whole day. Considering the characteristics, although earth works should preferably be avoided in the rainy season, the negative impacts of the weather on paving work would be small.

Most of construction equipment is imported from South Africa and can be procured in Zambia. Accordingly, the construction equipment and materials for the project will be procured in either Zambia or South Africa except for some special equipment. Asphalt plant will be procured from outside Zambia.

Most of materials for road construction can be procured in Zambia. However, it may be necessary to import paints for road markings, traffic signals, road lighting apparatus, delineators and chatter bars from South Africa as these products are currently used in Lusaka.

In principle, the construction machinery required for the project will be procured in Zambia, although some of the equipment such as asphalt finisher, line marker, compressor and generator should be considered to be procured from South Africa.

1.5.2 Cost Items and Conditions of Cost Estimate

The construction cost was estimated based on the recent information and updated data from local consultants and the Lusaka City Council (LCC).

The cost items and conditions of the cost estimates are:

Table 1.5.1 Cost Items of the Preliminary Cost Estimate

Component / Element	Particular Conditions
Project Cost	
a. Construction Cost	
Direct Cost	Estimated by unit costs and quantities
Indirect Cost	
Overhead and Profit	10 % of the direct cost
Field Expenses	1 % of the direct cost
Temporary Works	10 % of the direct cost
Employer's Site Requirements	2 % of the direct cost
b. Land Acquisition	Estimate based on recent land cost data
c. Compensation	30,000,000 ZMK/house
d. Relocation/Removal of Utilities	10 % of the construction cost Including power lines, telecom lines and water main pipes
e. Taxes	VAT, etc. 16 % of the construction cost
f. Administration Cost	2 % of the construction cost
g. Engineering Cost	10 % of the construction cost
h. Contingency	10 % of the construction cost

Source: JICA Study Team

1.5.3 Construction Cost

The construction cost was estimated for each road section, using the following unit costs, which are the most recent information obtained from local consultant companies.

Table 1.5.2 Unit Cost by Work Items

Work Item	Unit Cost	Remarks
EARTHWORK		
Embankment (Gravel)	144,000 ZMK/m^3	Including 1km hauling from Borrow Pit, formation
Embankment (Common Soil)	45,000 ZMK/m^3	Including 1km hauling from Borrow Pit, formation
Hard Rock Excavation	160,000 ZMK/m^3	Including embankment, formation
Soft Rock Excavation	24,000 ZMK/m^3	Including embankment, formation
Removal of Top Soil	20,000 ZMK/m^3	Remove surface on existing road as unsuitable material, less than 20cm in thickness
Subgrade Preparation	25,000 ZMK/m^2	Compact 90% of maximum dry density
PAVEMENT WORK		
Subgrade	45,000 ZMK/m^3	15cm in thickness, Compact 93% of maximum dry density
Granular Subbase	55,000 ZMK/m^3	15cm in thickness, Compact 95% of maximum dry density
Granular Base	65,000 ZMK/m^3	15cm in thickness, Compact 97% of maximum dry density
Cement Stabilized Base	20,000 ZMK/m^3	15cm in thickness, contain 4% cement
- Portland Cement	1,250,000 ZMK/ton	for cement stabilized base
Prime Coat	3,400 ZMK/m^2	MC-30, 1l/m2
Tack Coat	1,500 ZMK/m^2	1l/m2
Asphalt Wearing Course	80,000 ZMK/m^2	5cm in thickness
Multiple Bituminous Surface Dressing	30,000 ZMK/m^2	
- Bitumen	9,500 ZMK/litre	
- Aggregate 19.0mm	165,000 ZMK/m^3	
- Aggregate 9.5mm	165,000 ZMK/m^3	
- Fog Spray	4,200 ZMK/litre	
Concrete Work	1,150,000 ZMK/m^3	
Structural Excavation	48,000 ZMK/m^3	
DRAINAGE STRUCTURES		
RC Bridge	16,000,000 ZMK/m^2	Including substructure, foundation (4,000 USD/m^2 x 4,000)
PC Bridge	20,000,000 ZMK/m^2	Including substructure, foundation (5,000 USD/m^2 x 4,000)
Box Culvert	7,500,000 ZMK/m	1.0m x 1.0m, Double
Pipe Culvert	1,750,000 ZMK/m	Diameter: 500mm
Side Channel	517,500 ZMK/m	0.5m x 0.5m (0.45m3/m x 1150000 ZMK/m^3)
ANCELLARY WORKS		
Traffic Signal	67,500,000 ZMK/each	Including electric work
Marking	2,000 ZMK/m	
Delineator		
Traffic Sign	3,500,000 ZMK/each	
Guard Rail	320,000 ZMK/m	
Traffic Light	8,000,000 ZMK/each	
Planting	370,000 ZMK/each	18,500 K/m3 x 20m3/each
EARTHWORK (additional)		
Clearing and Grubbing	1,200 ZMK/m^2	
Excavation of Surplus Material	38,000 ZMK/m^3	from borrow pit
Spreading surplus material	7,500,000 ZMK/ha	from borrow pit

Source: JICA Study Team

The quantity of the work items by section and the estimated costs are shown in the following tables.

Table 1.5.3 Construction Cost of Kafue Road – Kasama Road Section

Item	Description		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	26768	4,282,872,000
Soft Rock Excavation			m^3	24,000	49075	1,177,789,800
Subgrade Preparation			m^2	25,000	62370	1,559,250,000
Subgrade		30 cm	m^3	45,000	18711	841,995,000
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	44550	3,564,000,000
Binder Course	As	5 cm	m^2	80,000	44550	3,564,000,000
Base	Granular	15 cm	m^3	65,000	6683	434,362,500
Sub-Base	Granular	30 cm	m^3	55,000	13365	735,075,000
Prime Coat			m^2	3,400	44550	151,470,000
Tack Coat			m^2	1,500	44550	66,825,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	17820	1,425,600,000
Binder Course	As	5 cm	m^2	80,000	17820	1,425,600,000
Base	Granular	15 cm	m^3	65,000	2673	173,745,000
Sub-Base	Granular	30 cm	m^3	55,000	5346	294,030,000
Prime Coat			m^2	3,400	17820	60,588,000
Tack Coat			m^2	1,500	17820	26,730,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	17820	534,600,000
Base		15 cm	m^3	65,000	2673	173,745,000
Prime Coat			m^2	3,400	17820	60,588,000
DRAINAGE						
Box Culvert			m	7,500,000	0	0
Pipe Culvert			m	1,750,000	192	336,000,000
Side Channel			m	517,500	11880	6,147,900,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	4	270,000,000
Marking			m	2,000	23760	47,520,000
Delineator			m	0	5940	0
Traffic Sign			each	3,500,000	24	84,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	63	504,000,000
Planting			each	370,000	0	0
Sub-Total						27,942,285,300
INDIRECT COST						
Overhead and Profit			%	27,942,285,300	10	2,794,228,530
Field Expenses			%	27,942,285,300	1	279,422,853
Temporary Works			%	27,942,285,300	10	2,794,228,530
Employer's Site Requirements			%	27,942,285,300	2	558,845,706
Sub-Total						6,426,725,619
Total						34,369,010,919

Source: JICA Study Team

Table 1.5.4 Construction Cost of Mumbwa Road – Kafue Road Section

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	13,475	2,156,064,000
Soft Rock Excavation			m^3	24,000	24,705	592,917,600
Subgrade Preparation			m^2	25,000	35,750	893,750,000
Subgrade			m^3	45,000	10,725	482,625,000
PAVEMENT (Carriage Way)						
Wearing Course	As	cm	m^2	80,000	25,025	2,002,000,000
Binder Course	As	cm	m^2	80,000	25,025	2,002,000,000
Base	Granular	cm	m^3	65,000	3,754	243,993,750
Sub-Base	Granular	cm	m^3	55,000	7,508	412,912,500
Prime Coat			m^2	3,400	25,025	85,085,000
Tack Coat			m^2	1,500	25,025	37,537,500
PAVEMENT (Shoulder)						
Wearing Course	As	cm	m^2	80,000	10,725	858,000,000
Binder Course	As	cm	m^2	80,000	10,725	858,000,000
Base	Granular	cm	m^3	65,000	1,609	104,568,750
Sub-Base	Granular	cm	m^3	55,000	3,218	176,962,500
Prime Coat			m^2	3,400	10,725	36,465,000
Tack Coat			m^2	1,500	10,725	16,087,500
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	10,725	321,750,000
Base		cm	m^3	65,000	1,609	104,568,750
Prime Coat			m^2	3,400	10,725	36,465,000
DRAINAGE						
Box Culvert			m	7,500,000	0	0
Pipe Culvert			m	1,750,000	112	196,000,000
Side Channel			m	517,500	7,150	3,700,125,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	8	540,000,000
Marking			m	2,000	14,300	28,600,000
Delineator			m	0	3,575	0
Traffic Sign			each	3,500,000	14	49,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	44	352,000,000
Planting			each	370,000	0	0
Sub-total						16,287,477,850
INDIRECT COST						
Overhead and Profit			%	16,287,477,850	10	1,628,747,785
Field Expenses			%	16,287,477,850	1	162,874,779
Temporary Works			%	16,287,477,850	10	1,628,747,785
Employer's Site Requirements			%	16,287,477,850	2	325,749,557
Sub-Total						3,746,119,906
Total						20,033,597,756

Source: JICA Study Team

Table 1.5.5 Construction Cost of Musi-Oa-Tunya – MFEZ Section

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	32,297	5,167,584,000
Soft Rock Excavation			m^3	24,000	59,212	1,421,085,600
Subgrade Preparation			m^2	25,000	71,880	1,797,000,000
Subgrade			m^3	45,000	21,564	970,380,000
PAVEMENT (Carriage Way)						
Wearing Course	As	cm	m^2	80,000	50,316	4,025,280,000
Binder Course	As	cm	m^2	80,000	50,316	4,025,280,000
Base	Granular	cm	m^3	65,000	7,547	490,581,000
Sub-Base	Granular	cm	m^3	55,000	15,094	830,214,000
Prime Coat			m^2	3,400	50,316	171,074,400
Tack Coat			m^2	1,500	50,316	75,474,000
PAVEMENT (Shoulder)						
Wearing Course	As	cm	m^2	80,000	21,564	1,725,120,000
Binder Course	As	cm	m^2	80,000	21,564	1,725,120,000
Base	Granular	cm	m^3	65,000	3,235	210,249,000
Sub-Base	Granular	cm	m^3	55,000	6,469	355,806,000
Prime Coat			m^2	3,400	21,564	73,317,600
Tack Coat			m^2	1,500	21,564	32,346,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	21,564	646,920,000
Base		cm	m^3	65,000	3,234	210,249,000
Prime Coat			m^2	3,400	21,564	73,317,600
DRAINAGE						
Box Culvert			m	7,500,000	0	0
Pipe Culvert			m	1,750,000	224	392,000,000
Side Channel			m	517,500	14,376	7,439,580,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	8	540,000,000
Marking			m	2,000	28,752	57,504,000
Delineator			m	0	7,188	0
Traffic Sign			each	3,500,000	29	101,500,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	80	640,000,000
Planting			each	370,000	288	106,560,000
Sub-total						33,303,542,200
INDIRECT COST						
Overhead and Profit			%	33,303,542,200	10	3,330,354,220
Field Expenses			%	33,303,542,200	1	333,035,422
Temporary Works			%	33,303,542,200	10	3,330,354,220
Employer's Site Requirements			%	33,303,542,200	2	666,070,844
Sub-Total						7,659,814,706
Total						40,963,356,906

Source: JICA Study Team

Table 1.5.6 Construction Cost of Kasama Road- Musi-Oa-Tunya Section

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	160,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	9,220	1,475,232,000
Soft Rock Excavation			m^3	24,000	16,904	405,688,800
Subgrade Preparation			m^2	25,000	25,730	643,250,000
Subgrade			m^3	45,000	7,719	347,355,000
PAVEMENT (Carriage Way)						
Wearing Course	As	cm	m^2	80,000	18,011	1,440,880,000
Binder Course	As	cm	m^2	80,000	18,011	1,440,880,000
Base	Granular	cm	m^3	65,000	2,702	175,607,250
Sub-Base	Granular	cm	m^3	55,000	5,403	297,181,500
Prime Coat			m^2	3,400	18,011	61,237,400
Tack Coat			m^2	1,500	18,011	27,016,500
PAVEMENT (Shoulder)						
Wearing Course	As	cm	m^2	80,000	7,719	617,520,000
Binder Course	As	cm	m^2	80,000	7,719	617,520,000
Base	Granular	cm	m^3	65,000	1,158	75,260,250
Sub-Base	Granular	cm	m^3	55,000	2,316	127,363,500
Prime Coat			m^2	3,400	7,719	26,244,600
Tack Coat			m^2	1,500	7,719	11,578,500
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	7,719	231,570,000
Base		cm	m^3	65,000	1,158	75,260,250
Prime Coat			m^2	3,400	7,719	26,244,600
DRAINAGE						
Box Culvert			m	7,500,000	0	0
Pipe Culvert			m	1,750,000	80	140,000,000
Side Channel			m	517,500	5,146	2,663,055,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	4	270,000,000
Marking			m	2,000	10,292	20,584,000
Delineator			m	0	2,573	0
Traffic Sign			each	3,500,000	10	35,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	30	240,000,000
Planting			each	370,000	0	0
Sub-total						11,491,529,150
INDIRECT COST						
Overhead and Profit			%	11,491,529,150	10	1,149,152,915
Field Expenses			%	11,491,529,150	1	114,915,292
Temporary Works			%	11,491,529,150	10	1,149,152,915
Employer's Site Requirements			%	11,491,529,150	2	229,830,583
Sub-Total						2,643,051,705
Total						14,134,580,855

Source: JICA Study Team

Table 1.5.7 Construction Cost of Collector Roads

Item	Discription		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	0	0
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	11,260	1,801,560,000
Soft Rock Excavation			m^3	24,000	16,890	405,351,000
Subgrade Preparation			m^2	25,000	32,521	813,025,000
Subgrade			m^3	45,000	9,756	439,033,500
PAVEMENT (Carriage Way)						
Wearing Course	As	cm	m^2	80,000	24,869	1,989,520,000
Binder Course	As	cm	m^2	80,000	24,869	1,989,520,000
Base	Granular	cm	m^3	65,000	3,730	242,472,750
Sub-Base	Granular	cm	m^3	55,000	4,974	273,559,000
Prime Coat			m^2	3,400	24,869	84,554,600
Tack Coat			m^2	1,500	24,869	37,303,500
PAVEMENT (Shoulder)						
Wearing Course	As	cm	m^2	80,000	7,652	612,160,000
Binder Course	As	cm	m^2	80,000	7,652	612,160,000
Base	Granular	cm	m^3	65,000	1,148	74,607,000
Sub-Base	Granular	cm	m^3	55,000	1,530	84,172,000
Prime Coat			m^2	3,400	7,652	26,016,800
Tack Coat			m^2	1,500	7,652	11,478,000
PAVEMENT (Sidewalk)						
Surface	DBST		m^2	30,000	15,304	459,120,000
Base		cm	m^3	65,000	2,296	149,214,000
Prime Coat			m^2	3,400	15,304	52,033,600
DRAINAGE						
Box Culvert			m	7,500,000	0	0
Pipe Culvert			m	1,750,000	128	224,000,000
Side Channel			m	517,500	7,652	3,959,910,000
ANCELLARY WORKS						
Traffic Signal			each	67,500,000	16	1,080,000,000
Marking			m	2,000	15,304	30,608,000
Delineator			m	0	3,826	0
Traffic Sign			each	3,500,000	15	52,500,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	54	432,000,000
Planting			each	370,000	0	0
Sub-total						15,935,878,750
INDIRECT COST						
Overhead and Profit			%	15,935,878,750	10	1,593,587,875
Field Expenses			%	15,935,878,750	1	159,358,788
Temporary Works			%	15,935,878,750	10	1,593,587,875
Employer's Site Requirements			%	15,935,878,750	2	318,717,575
Sub-Total						3,665,252,113
Total						19,601,130,863

Source: JICA Study Team

1.5.4 Project Cost

Unit cost of land acquisition was estimated by type of land based on the Government Valuation Department Bulletin and LCC Main Valuation Roll 2007 as shown in the table below.

Table 1.5.8 Unit Land Cost

Code	Area Type of Land	Unit Cost (ZMK/Acre)	Unit Cost (ZMK/m2)
A	GRZ, MOL, LCC (Government Land)	0	0
B	CBD	1,000,000,000	250,000
C	Outside CBD	600,000,000	150,000
D	Industrial	400,000,000	100,000
E	Residential	450,000,000	112,500
F	Un-residential, Compound Area, Firm	200,000,000	50,000
G	Satellite Area	100,000,000	25,000

Source: JICA Study Team (Estimated from Government Valuation Department Bulletin and LCC Main Valuation Roll 2007)

From the above unit costs, land acquisition and compensation costs were estimated as follows.

Table 1.5.9 Land Acquisition Cost and Compensation Cost

	Inner Ring Road		MFEZ Access Road		Major Collector Roads (5)	Total
	Mumbwa-Kafue Rd.	Kafue-Kasama Rd.	Kasama-Musi-Oa-Tunya	Musi-Oa-Tunya MFEZ		
Land Acquisition						
Land Type	A	A/ D	A	A/ F	E	
Unit Cost (K/m2)		100,000		50,000	112,500	
Acquisition Area		4,228		95,408	20,730	120,366
Cost		422,800,000		4,770,400,000	2,332,125,000	7,525,325,000
(US$)		118,035		1,331,770	651,068	2,100,872
Compensation						
No. of buildings	93	64	3			160
Unit Cost (K/no.)	30,000,000	30,000,000	30,000,000			
Cost	2,790,000,000	1,920,000,000	90,000,000			4,800,000,000
(US$)	778,894	536,013	25,126			1,340,034

Source: JICA Study Team

The estimated project cost is thus summarized as follows.

Table 1.5.10 Summary of Project Cost

Unit: Million US$

	Inner Ring Road		MFEZ Access Road		Major Collector Roads (5)	Total
	Mumbwa-Kafue Rd.	Kafue-Kasama Rd.	Kasama-Musi-Oa-Tunya	Musi-Oa-Tunya MFEZ		
Construction	5,593	9,595	3,946	11,436	5,472	36,042
Land Acquisition	0	118	0	1,332	651	2,101
Compensation	779	536	25	0	0	1,340
Utility Relocation	559	959	395	1,144	547	3,604
Tax	895	1,535	631	1,830	876	5,767
Administration	112	192	79	229	109	721
Engineering	559	959	395	1,144	547	3,604
Contingency	559	959	395	1,144	547	3,604
Total	9,056	14,855	5,865	18,257	8,750	56,783

Source: JICA Study Team

1.6. Operation and Maintenance

1.6.1 Operation and Maintenance Program

Roads and drainage cleaning is the minimum requirement for the maintenance work after the completion of the project. It is recommended that the cleaning work should be carried out at least once a month as routine maintenance. The routine maintenance should be scheduled and organized based on daily inspection.

Since the traffic on the project road is expected to increase in the near future, the periodic maintenance and rehabilitation should be programmed to ensure the good riding quality.

The following routine and periodic inspection is proposed.

Table 1.6.1 Proposed Inspection Program

Level of Inspection	Frequency	Methodology
Routine Inspection	- Once a day for inspection on the roadway - Two to four times a year for outside the roadway	On-vehicle inspection
Periodic Inspection	- Once a year	On-foot inspection by a group of engineers and technicians
Special Inspection	- Once in every five years	On-foot inspection of a specific site or section by a team of professional engineers and technicians for specific purposes, such as acquisition of actual data needed to establish a rehabilitation program

Source: JICA Study Team

Based on these inspections, an appropriate annual maintenance program should be formulated.

1.6.2 Operation and Maintenance Cost

1) Routine Maintenance

Routine maintenance works will consist of road and drainage cleaning.

It is assumed that the routine maintenance cost is 5% of the maintenance and rehabilitation cost.

2) Periodic/Preventive Maintenance and Minor/Major Rehabilitation

The typical methods of periodic maintenance and minor/major rehabilitation works for each type of road damage are presented in the following table:

Table 1.6.2 Proposed Rehabilitation Method by Damage Type

Type of Damage	Periodic/Preventive Maintenance	Minor Rehabilitation	Major Rehabilitation
Raveling	Seal		
Potholes	Patching	Overlaying	Replacement of Base / Sub-base Course
Block Cracking	Seal, Patching		Resurfacing
Longitudinal Cracking	Crack Seal		

Source: JICA Study Team

The five-year maintenance program was proposed with the following basic conditions:

- The routine maintenance and inspection will be done every year.
- Pothole patching will be done on the third year of the maintenance program as periodic maintenance work.
- Overlaying will be done on the fifth year of the maintenance program as a minor rehabilitation .
- The five-year maintenance program will be undertaken recurrently up to year 2030.

3) Maintenance Cost

The unit costs for maintenance works were assumed as shown in the table below:

Table 1.6.3 Unit Cost of Maintenance Works

Level of Requirement	Major Work	Unit Cost	Remarks
Periodic Maintenance	Patching	740,000 ZMK/m^3	Refer to data in the recent maintenance report
Minor Rehabilitation	Overlaying	1,600,000 ZMK/m^3	Estimated based on recent information from local consultant

Source: JICA Study Team (Unit cost was obtained from local consultant companies.)

The total maintenance cost for the Inner Ring Road and LS-MFEZ Access for five years was estimated at ZMK 11.5 billion (USD 3.2 million) as shown in Table 1.6.4.

Table 1.6.4 Maintenance Cost for Five Years

Item	Unit Cost (ZMK)	Quantity	Frequency	Cost for five years ZMK million
Periodic Maintenance	740,000	28m^3	Third Year	20.7
Minor Rehabilitation	1,600,000	6,848m^3	Fifth Year	10,956.8
Routine Maintenance	5% of above	-	Every Year	548.9
Total				11,526.4

Source: JICA Study Team

1.7 Economic Evaluation

1.7.1 Methodology

Economic evaluation was carried out by calculating the Economic Internal Rate of Return (EIRR) and Net Present Value (NPV) of this project. For the NPV, a discount rate of 10% was used.

The major economic benefits of the Inner Ring Road are savings on travel time costs (TTC) and vehicle operating costs (VOC), which are important benefits for economic analysis of road projects. On the other hand, the Inner Ring Road is expected to improve accessibility to the Kamwala South area. The project will significantly increase the land value in this area. Although the land value by itself can be computed using market prices, it is difficult to estimate the portion of the contribution from the Inner Ring Road to the increase in land value. Therefore, only the TTC and VOC savings were considered as the economic benefits from the Inner Ring Road.

The direct economic benefit of MFEZ Access road is the economic benefit from LS-MFEZ itself. However, the benefit from the road is only a part of the total benefit from LS-MFEZ and it is difficult to identify the portion of the road to the total benefit. Instead of estimating the MFEZ benefit, TTC and VOC savings were also considered as the economic benefit from this project. For the evaluation, it was assumed that access from Kafue Road would be included in the MFEZ project.

The same OD data was used as in the master plan analysis. For traffic volume calculation, the road network data of the "with project" and "without project" cases were prepared for years 2015, 2020, and 2030. The network in the "with Project" case consists of the master plan road network with the Inner Ring Road and the 2-lane MFEZ Access roads. The network in the "without project" case" consists of the master plan network excluding the Inner Ring Road and MFEZ Access road. The master plan proposes railway lines and arterial buses, which will reduce the economic benefit of the road project. The railway and arterial bus systems were excluded from the transport network because there are some vague assumptions required for the demand forecast.

1.7.2 Vehicle Operating Cost

Vehicle operating cost (VOC) was calculated each for car, bus, and truck by applying HDM-4, which is a popular model of VOC calculation for economic evaluation. Table 1.7.1 shows the unit prices used for the analysis. Likewise, CO_2 emission is also estimated by using the fuel consumption calculated in HDM-4. The conversion rate for CO_2 is 2.36 ton/ liter for petroleum, and 2.738 for diesel. Since the recent wholesale price of fuel has been fluctuating, the average price in 2006 was used in the evaluation.

Table 1.7.1 Unit Prices for HDM-4 Analysis

	Fuel USD/liter	Lubricant (USD/liter)	Vehicle (USD/vehicle)	Tire (USD/No.)	Maintenance (USD/hour)	Crew (USD/hour)
Car	0.6	4.5	5,000	100	2.9	0.0
Minibus	0.6	4.5	8,000	188	2.9	2.2
Truck	0.7	4.5	12,500	850	2.9	2.2

Source: JICA Study Team

Table 1.7.2 shows the calculated VOC by vehicle speed. As shown in the table, the most economical speed is 60 km/h.

Table 1.7.2 Vehicle Operating Cost

VOC per vehicle-1000km **Unit: USD**

Speed	Paved			Unpaved		
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK
10	290.9	254.1	586.8	323.9	275.3	648.9
20	186.8	154.0	367.0	219.5	175.1	428.8
30	153.9	122.5	298.9	186.9	143.8	361.2
40	139.8	107.8	269.6	173.1	129.9	332.7
50	133.7	100.5	256.4	168.0	122.8	320.5
60	131.8	96.3	249.7	166.5	119.0	312.8
70	133.6	95.3	251.7	170.0	118.8	316.1
80	137.9	96.7	259.6	177.4	121.8	326.2
90	146.5	98.9	271.5	188.2	125.6	341.4
100	157.1	102.7	287.6	202.7	131.2	360.8

Source: JICA Study Team

The total VOC savings was estimated at USD 4.9 million per year in 2015, USD 5.1 million in 2020, and USD 10.6 million in 2030. The benefit in 2030 came largely from the LS-MFEZ development of 400 ha.

1.7.3 Travel Time Cost

Passenger travel time cost (TTC) was calculated from time values estimated from the result of the household interview survey conducted by the JICA Study Team in 2006. The future time values are estimated from the assumption of per capita GDP growth. Time cost for goods was not estimated due to the difficulty of estimation. Table 1.7.3 shows the estimated travel time values.

Table 1.7.3 Time Value

Unit: USD

Year	Time Value per passenger		Time Value per vehicle		Ratio to 2007	
	Bus	Car	Bus	Car	Bus	Car
2007	0.300	2.25	3.00	2.70	1.00	1.00
2015	0.420	2.41	4.20	2.89	1.40	1.07
2020	0.528	2.75	5.28	3.29	1.76	1.22
2030	0.840	3.47	8.40	4.16	2.80	1.54

Source: JICA Study Team

TTC savings per year was estimated at USD 4.8 million in 2015, USD 8.3 million in 2020, and USD 39.4 million in 2030. It is very high in 2030 because of the heavy congestion anticipated to occur without the Inner Ring Road and the long trip of travel demand for LS-MFEZ

Tables 1.7.4 – 1.7.6 show the calculation sheets for VOC and TTC for the year 2015, 2020, and 2030.

Table 1.7.4 Calculation of VOC and TTC (2015)

Vehicle-km (per day) With Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	35,776	176,195	62,052	12,922	56,917	22,822	48,697	233,112	84,874	366,683
20	50,005	241,497	83,230	7,893	31,539	10,014	57,898	273,036	93,244	424,179
30	21,443	126,394	62,163	0	0	0	21,443	126,394	62,163	209,999
40	7,617	54,569	40,482	0	0	0	7,617	54,569	40,482	102,668
50	1,949	11,091	5,281	0	0	0	1,949	11,091	5,281	18,321
60										
70										
80										

Vehicle-km (per day) Without Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	43,044	217,309	73,057	15,519	67,149	26,321	58,562	284,458	99,378	442,398
20	41,507	200,600	68,852	7,555	30,992	10,088	49,063	231,592	78,940	359,595
30	22,226	125,998	62,386	0	0	0	22,226	125,998	62,386	210,610
40	7,975	55,290	40,841	0	0	0	7,975	55,290	40,841	104,106
50	2,100	11,079	5,236	0	0	0	2,100	11,079	5,236	18,415
60										
70										
80										

Vehicle-km Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	7,268	41,114	11,004	2,597	10,232	3,499	9,865	51,346	14,503	75,714
20	-8,497	-40,897	-14,378	-338	-547	74	-8,835	-41,444	-14,304	-64,584
30	783	-396	223	0	0	0	783	-396	223	611
40	358	721	359	0	0	0	358	721	359	1,437
50	151	-12	-45	0	0	0	151	-12	-45	94
60										
70										
80										

VOC Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	3,739	10,449	6,458	1,421	2,817	2,271	5,161	13,265	8,728	27,154
20	-2,532	-6,300	-5,277	-112	-96	32	-2,644	-6,396	-5,245	-14,285
30	178	-48	67	0	0	0	178	-48	67	197
40	70	78	97	0	0	0	70	78	97	244
50	27	-1	-12	0	0	0	27	-1	-12	14
60										
70										
80										
										13,324

Fuel Saving (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	1,676	9,592	2,810	638	2,513	1,043	2,314	12,105	3,853	18,272
20	-1,082	-5,182	-2,298	-48	-76	15	-1,130	-5,258	-2,283	-8,670
30	75	-37	30	0	0	0	75	-37	30	68
40	30	58	46	0	0	0	30	58	46	133
50	12	-1	-6	0	0	0	12	-1	-6	5
60										
70										
80										

CO2 Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	3,955	22,637	7,695	1,505	5,931	2,855	5,461	28,568	10,550	44,578
20	-2,553	-12,229	-6,291	-113	-179	41	-2,666	-12,408	-6,250	-21,324
30	177	-88	83	0	0	0	177	-88	83	171
40	70	136	127	0	0	0	70	136	127	332
50	28	-2	-16	0	0	0	28	-2	-16	10
60										
70										
80										
										23,768

Travel Time (per day)

Speed	With Case			Without Case			Time Saving			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
Hours	6,749	33,526	12,891	7,429	37,026	13,892	680	3,500	1,002	5,182
USD							2,855	10,112	0	12,967

Source: JICA Study Team

Table 1.7.5 Calculation of VOC and TTC (2020)

Vehicle-km (per day) With Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	69,207	396,533	128,740	17,337	81,479	29,089	86,544	478,013	157,830	722,386
20	51,406	270,054	103,007	6,476	27,190	9,025	57,882	297,244	112,032	467,158
30	22,280	121,966	82,265	0	0	0	22,280	121,966	82,265	226,511
40	10,094	61,094	71,186	0	0	0	10,094	61,094	71,186	142,373
50	4,351	51,149	102,579	0	0	0	4,351	51,149	102,579	158,078
60										
70										
80										

Vehicle-km (per day) Without Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	70,562	408,823	131,051	20,041	94,163	33,650	90,603	502,986	164,701	758,291
20	52,451	276,903	108,695	6,166	26,581	9,281	58,617	303,484	117,977	480,078
30	22,701	120,090	84,463	0	0	0	22,701	120,090	84,463	227,254
40	8,557	50,248	65,103	0	0	0	8,557	50,248	65,103	123,908
50	4,493	51,828	102,746	0	0	0	4,493	51,828	102,746	159,068
60										
70										
80										

Vehicle-km Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	1,355	12,290	2,311	2,705	12,683	4,561	4,059	24,973	6,872	35,904
20	1,045	6,849	5,688	-310	-609	256	736	6,240	5,945	12,920
30	420	-1,876	2,198	0	0	0	420	-1,876	2,198	742
40	-1,537	-10,846	-6,083	0	0	0	-1,537	-10,846	-6,083	-18,465
50	142	680	168	0	0	0	142	680	168	989
60										
70										
80										

VOC Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	697	3,123	1,356	1,480	3,492	2,960	2,177	6,615	4,316	13,108
20	312	1,055	2,088	-102	-107	110	209	948	2,198	3,355
30	96	-230	657	0	0	0	96	-230	657	523
40	-300	-1,169	-1,640	0	0	0	-300	-1,169	-1,640	-3,109
50	25	68	43	0	0	0	25	68	43	137
60										
70										
80										
										14,013

Fuel Saving (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	312	2,867	590	664	3,115	1,359	977	5,982	1,949	8,908
20	133	868	909	-44	-85	52	89	783	961	1,833
30	40	-177	297	0	0	0	40	-177	297	161
40	-127	-865	-783	0	0	0	-127	-865	-783	-1,776
50	11	50	22	0	0	0	11	50	22	83
60										
70										
80										

CO2 Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	737	6,767	1,616	1,568	7,352	3,721	2,305	14,118	5,337	21,760
20	314	2,048	2,489	-103	-199	142	211	1,848	2,630	4,690
30	95	-417	814	0	0	0	95	-417	814	492
40	-300	-2,043	-2,145	0	0	0	-300	-2,043	-2,145	-4,488
50	26	118	60	0	0	0	26	118	60	204
60										
70										
80										
										22,658

Travel Time (per day)

Speed	With Case			Without Case			Time Saving			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
Hours	10,133	56,632	23,368	11,111	61,961	25,200	978	5,329	1,832	8,140
USD							5,166	17,554	0	22,720

Source: JICA Study Team

Table 1.7.6 Calculation of VOC and TTC (2030)

Vehicle-km (per day) — With Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	141,373	863,270	246,700	16,882	85,745	30,236	158,254	949,015	276,935	1,384,204
20	72,932	389,077	134,086	7,512	29,299	8,503	80,444	418,376	142,590	641,410
30	66,383	355,310	153,880	0	0	0	66,383	355,310	153,880	575,573
40	27,217	158,285	111,255	0	0	0	27,217	158,285	111,255	296,757
50	26,173	186,216	286,075	0	0	0	26,173	186,216	286,075	498,463
60	14,443	83,930	112,507	0	0	0	14,443	83,930	112,507	210,881
70	7,092	38,160	21,132	0	0	0	7,092	38,160	21,132	66,384
80	4,931	30,799	19,307	0	0	0	4,931	30,799	19,307	55,037

Vehicle-km (per day) — Without Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	150,137	909,118	254,908	20,725	103,479	36,667	170,862	1,012,597	291,575	1,475,034
20	74,480	408,239	145,994	7,187	29,540	8,433	81,667	437,779	154,427	673,873
30	61,572	326,171	130,780	0	0	0	61,572	326,171	130,780	518,523
40	27,851	161,840	112,236	0	0	0	27,851	161,840	112,236	301,927
50	26,653	186,763	281,318	0	0	0	26,653	186,763	281,318	494,735
60	14,324	82,499	110,734	0	0	0	14,324	82,499	110,734	207,557
70	7,653	41,742	21,424	0	0	0	7,653	41,742	21,424	70,819
80	6,615	37,583	20,137	0	0	0	6,615	37,583	20,137	64,334

Vehicle-km Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	8,764	45,848	8,208	3,843	17,734	6,431	12,607	63,582	14,640	90,829
20	1,548	19,161	11,907	-324	241	-70	1,224	19,402	11,837	32,463
30	-4,811	-29,139	-23,100	0	0	0	-4,811	-29,139	-23,100	-57,050
40	634	3,555	981	0	0	0	634	3,555	981	5,170
50	480	547	-4,756	0	0	0	480	547	-4,756	-3,728
60	-119	-1,432	-1,773	0	0	0	-119	-1,432	-1,773	-3,324
70	562	3,582	292	0	0	0	562	3,582	292	4,435
80	1,684	6,784	829	0	0	0	1,684	6,784	829	9,297

VOC Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	4,509	11,652	4,817	2,103	4,882	4,173	6,612	16,534	8,990	32,136
20	461	2,952	4,370	-107	42	-30	354	2,994	4,340	7,688
30	-1,095	-3,571	-6,905	0	0	0	-1,095	-3,571	-6,905	-11,571
40	124	383	264	0	0	0	124	383	264	771
50	85	55	-1,220	0	0	0	85	55	-1,220	-1,079
60	-20	-138	-443	0	0	0	-20	-138	-443	-601
70	92	341	73	0	0	0	92	341	73	507
80	278	656	215	0	0	0	278	656	215	1,149
										29,001

Fuel Saving (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	2,021	10,696	2,096	944	4,356	1,916	2,965	15,052	4,013	22,030
20	197	2,428	1,903	-46	33	-14	151	2,461	1,889	4,501
30	-459	-2,742	-3,125	0	0	0	-459	-2,742	-3,125	-6,327
40	52	284	126	0	0	0	52	284	126	462
50	38	40	-623	0	0	0	38	40	-623	-545
60	-9	-100	-239	0	0	0	-9	-100	-239	-349
70	47	253	43	0	0	0	47	253	43	342
80	151	505	136	0	0	0	151	505	136	792

CO_2 Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	4,770	25,243	5,740	2,228	10,279	5,247	6,997	35,522	10,987	53,507
20	465	5,729	5,210	-108	79	-39	357	5,808	5,171	11,336
30	-1,084	-6,471	-8,557	0	0	0	-1,084	-6,471	-8,557	-16,113
40	124	669	346	0	0	0	124	669	346	1,139
50	89	95	-1,706	0	0	0	89	95	-1,706	-1,522
60	-22	-236	-655	0	0	0	-22	-236	-655	-913
70	110	597	117	0	0	0	110	597	117	824
80	357	1,193	371	0	0	0	357	1,193	371	1,921
										50,179

Travel Time (per day)

Speed	With Case			Without Case			Time Saving			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
Hours	22,204	131,160	48,232	25,432	150,611	52,734	3,228	19,451	4,502	27,181
USD							27,112	80,877	0	107,989

Source: JICA Study Team

1.7.4 CO_2 Reduction

CO_2 reduction is part of the economic benefits of the project. It is a quantifiable benefit and the reduction through the project was calculated as also shown in Tables 1.7.4 to 1.7.6 above. The yearly reduction was estimated at 8.7 million ton in 2015, 8.3 million ton in 2020, and 18.3 million ton in 2030. However, the assumption for the calculation is not stable because the estimated fuel consumption for CO_2 emission was based on typical vehicle models in HDM-4. Hence, the method of determining the cost of CO_2 in tons in terms of USD is also unstable. Nevertheless, it is expected that vehicles will be replaced with more energy efficient types.

1.7.5 Project Cost

The capital cost of the project is estimated as USD 56.8 million. A conversion factor of 0.8 for construction cost was assumed, while the other economic costs were assumed to be the same as the financial costs. Hence, the total economic cost was estimated at USD 43.8 million as shown in Table 1.7.7. The maintenance cost was estimated as USD 0.6 million per year.

Construction period was assumed to be five years from 2009, with an assumed annual cost allocation of 10%-30%-30%-30%, and the opening year was assumed as 2013.

Table 1.7.7 Economic Cost of Inner Ring Road and MFEZ Access

Unit: USD million

Cost Item	Project Cost	Conversion Factor	Economic Cost
Construction	36.0	0.8	28.8
Land Acquisition	2.1	1.0	2.1
Building Relocation/ Compensation	1.3	1.0	1.3
Relocation/ Removal of Utilities	3.6	1.0	3.6
Taxes	5.8	0.0	0.0
Administration	0.7	1.0	0.7
Engineering	3.6	1.0	3.6
Contingency	3.6	1.0	3.6
Total	56.8		43.8

Source: JICA Study Team

1.7.6 EIRR and NPV

Table 1.7.8 shows the economic cost and benefit stream of the project up to 2032. From this, the EIRR of the project was calculated to be 23%, and NPV was calculated at USD 73 million. The result shows that the project is economically feasible.

Table 1.7.8 Benefit and Cost Stream of Inner Ring Road and MFEZ Access

Unit: USD 1,000

Year	Capital Cost	O&M Cost	Total Cost	VOC Saving	Time Saving	Total Benefit	Benefit - Cost Flow
2009	4,162		4,162				-4,162
2010	12,486		12,486				-12,486
2011	12,486		12,486				-12,486
2012	12,486		12,486				-12,486
2013		636	636	4,763	3,309	8,072	7,436
2014		636	636	4,813	4,021	8,834	8,198
2015		636	636	4,863	4,733	9,596	8,961
2016		636	636	4,914	5,445	10,359	9,723
2017		636	636	4,964	6,157	11,121	10,485
2018		636	636	5,014	6,869	11,883	11,247
2019		636	636	5,065	7,581	12,645	12,010
2020		636	636	5,115	8,293	13,408	12,772
2021		636	636	5,662	11,405	17,067	16,431
2022		636	636	6,209	14,517	20,726	20,091
2023		636	636	6,756	17,630	24,386	23,750
2024		636	636	7,303	20,742	28,045	27,409
2025		636	636	7,850	23,854	31,705	31,069
2026		636	636	8,397	26,967	35,364	34,728
2027		636	636	8,944	30,079	39,023	38,388
2028		636	636	9,491	33,191	42,683	42,047
2029		636	636	10,038	36,304	46,342	45,706
2030		636	636	10,586	39,416	50,002	49,366
2031		636	636	10,586	39,416	50,002	49,366
2032		636	636	10,586	39,416	50,002	49,366

Source: JICA Study Team

1.7.7 Sensitivity Analyses

Table 1.7.9 shows the sensitivity analysis of the project. The project will still be feasible even in the case of a 20% increase in costs and a 30% decrease in benefits.

Table 1.7.9 Sensitivity Analysis of EIRR of the Project

		Benefit		
		-10%	-20%	-30%
Cost	+10%	20%	19%	17%
	+15%	20%	18%	17%
	+20%	19%	18%	16%

Source: JICA Study Team

1.8 Environmental and Social Considerations Study for the Inner Ring Road Project

1.8.1 Current Environmental Condition of the Project Site

In addition to the general environmental and social conditions of the City of Lusaka which is described in Chapter 7 of Volume I, the project site specific information collected through the public hearings and site visits is presented in the following sections.

(1) Land Use and Local Economy

The local economic status of the project site varies. The planned road runs through Unplanned Urban Settlements (UUS), namely the Kanyama Compound, Chibolya Compound and Misisi Compound, going through the open space along the power transmission line, and reaches a newly developing residential area up to the MFEZ project site which was a former forest reserve.

The Kanyama, Chibolya and Misisi Compounds are residential areas for low income households. These compounds are located near the central area and consist of local markets, small-scale shops and small-scale but heavily populated low-cost residential structures. In Chibolya, there are some factories along the major road.

Industrial Area in Chibolya Compound

Illegal Charcoal Market in Misisi Compound under Transmission Lines

In Kamwala, Kabwata, Libala and Chilenge Wards, the proposed alignment passes through most of the open space along the transmission line, which is used by local drivers and residents as a road. Along the transmission line, some residential areas with medium-sized structures were observed during the field surveys. Additionally, there are some illegal land uses such as small-scale movable shops, farming, quarrying and waste dumping along the transmission line.

Illegal Movable Shop along Transmission Lines

Illegal Dumping along Transmission Lines

In Lubwa Ward, there are already existing paved and unpaved roads. The major land use is residential with some commercial structures.

Lastly, in Chisankane Ward of Kafue District, there is a newly developed residential area with medium-scale structures, and housing construction has been mushrooming overnight.

Existing Road in Lubwa Ward

Newly Developed Residential Area in Chilenje Ward

(2) Air Quality

According to the Lusaka Environment Outlook (LEO) Report, overall air pollution level in Lusaka is considered insignificant compared to other industrial areas such as Copperbelt. Additionally, the ambient air quality level is unknown because it is not currently monitored in Zambia, even though an ambient air quality standard was established by the Air Pollution Control (Licensing and Emissions Standards) Regulations, 1996.

However, according to the LEO Report, ambient air quality is considered one of the emerging environmental issues in Lusaka due to the recent increase in vehicles, cement manufacturing industries, coal use, coal-, wood- and diesel-fired boilers. Additionally, the Environmental Council of Zambia (ECZ) considers vehicle emission as one of the critical air pollution issues and is monitoring emission from vehicles with the assistance from the WB and Nordic Development Fund.

Even though there is no available or documented air quality data, the overall air quality in the project site is considered fair since the project site does not have any major polluting sources such industrial areas or heavy traffic.

(3) Noise & Vibration

There are no monitoring records or standards on noise and vibration levels for industrial, commercial, residential areas or for the roadsides in Zambia. The noise level and noise emission standards for construction sites, plants, machinery, motor vehicles, aircraft including sonic booms, industrial and commercial activities are planned to be established by the ECZ according to the EPPCA 1990. It is observed that recognition of noise and vibration as pollution is not yet common in Zambia because the standards have not yet been established and noise and vibration are still not included in the Third Schedule of "Issues to be Considered when Preparing Terms of Reference for Environmental Impact Statements" under the EPCC (EIA) Regulation 1997.

The overall noise and vibration level in the project site is considered fair since the project site does not have many major noise/vibration generating sources such industrial areas or heavy traffic. However, there could be some localized noise and vibration impacts from drivers' and residents' behaviors such as loud music or blowing of horns.

(4) Hydrological Situation and Rainwater

Recently, the City of Lusaka experienced inundation in the past few years during the rainy season, and flooding had become one of the urgent environmental and sanitation issues. Based on the hearings with LCC staff, people in some areas of the project site, such as Chibolya and Misisi Compounds, suffered from inundation during the rainy season in 2008. Additionally, during the stakeholder meeting on 7 Nov. 2007, a participant expressed concern about inundation and questioned the availability of rainwater drainage structures from the inner ring road project.

(5) Fauna, Flora & Biodiversity

There is no official protected area such as a forest reserve, national park or game management area in the project site. Additionally, most of the project site is located in the urban areas of the capital city.

(6) Cultural Heritage

No cultural heritage sites are identified by the List of Heritage Sites provided by the National Heritage Conservation Commission.

(7) Involuntary Resettlement

The number of residential and non-residential structures in the Right of Way (ROW) is approximately 160. These were identified using available satellite images and the breakdown is as shown in Table 1.8.1. However, due to the rapid expansion of housing construction in the project site and the inclusion of abandoned structures, the number of affected structures is subject to change and shall be identified by a future field survey. Some major involuntary resettlement is expected in three heavily populated compounds, namely Kanyama, Chibolya and Misisi.

Table 1.8.1 Approx. Number of Residential and Non-residential Structures in the ROW

Name of Compound/Ward	Harry Mwaanga Nkumbla Ward incl. Kanyama & Chibolya Compounds	Nkoloma Ward incl.	Kamwala Ward	Kabwata Ward	Chilenje Ward	Chisankane Ward	Total
No of Structures to be Resettled.	95	64	Not available by satellite images	Not available by satellite images	Not available by satellite images	3	162

Note: Identified by satellite images taken between July 2007 and April 2008
Source: JICA Study Team

(8) Indigenous and Ethnic People

There are two indigenous tribes in Lusaka, namely the Soli and the Lenje; however, in city of Lusaka, there are more tribes lives, and no conflict among tribes is observed.

Poverty is one of the biggest challenges in the city of Lusaka. According to the household interview survey of PT Survey conducted by the JICA Study Team, approximately 75% of the UUS residents live on income under the overall poverty line. Therefore, it is expected that the poor households in Chibolya and Misisi Compounds would be affected by the project.

1.8.2 Considerations of the Alternative Alignments including the Zero Option

Considerations of 2 alternative alignments as well as the zero option were conducted in terms of technical, economic and environmental & social considerations. The details are described in Section 1.3. 5 and 1.4.7 of this Chapter.

1.8.3 Environmental and Social Impacts of the Inner Ring Road Project

The Environmental and Social Considerations Study was conducted for the inner ring road project with the existing data. The results of the impact assessment and proposed outline of the Environmental Management Plan (EMP) and proposed Environmental Monitoring Plan (EMoP) will be described in the following sections.

(1) Approach to the Impact Assessment

The Environmental and Social Considerations study was conducted to assess environmental and social impacts of the project referring to the relevant laws, regulations and standards of Zambia and the JICA Guidelines for Environmental and Social Considerations. The relevant laws and regulations in Zambia are listed in Section 2.3.4 of Volume I. For the impact assessment, there are 31 environmental impact items that were ranked from A to D (both positive/negative) depending on their environmental and social significance in accordance with the rating criteria listed below.

Rating Criteria

- A+/-: Significant positive/negative impact is expected.
- B+/-: Positive/negative impact is expected to some extent.
- C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
- Blank: No impact is expected.

(2) Summary of the Environmental and Social Impacts of the Inner ring Road Project

The summary of environmental and social impacts of the inner ring road project is shown in Table 1.8.2. The significant impacts will be discussed in the following sections.

Table 1.8.2 Summary of Environmental and Social Impacts of the Inner Ring Road Project

Env. Impacts / Impact Phase	Social Environment														Natural Environment									Pollution							
	1.Involuntary Resettlement	2.Local Economy such as Employment & Livelihood, etc.	3.Land Use & Utilization of Local Resources	**4. Social Institutions such as Split of Communities**	5.Existing Social Infrastructures & Services	**6.The poor, indigenous & ethnic people**	7.Misdistribution of Benefit & Damage	8.Cultural Heritage	9.Local Conflict of Interest	10.Water Usage or Water Rights & Rights of Common	11.Sanitation	12.Hazards (Risk), Infectious Diseases such as HIV/AIDS	13.Accidents	14.Traffic Jam & Congestion	15.Topography & Geographical Features	16.Soil Erosion	17.Groundwater	18.Hydrological Situation & Rainwater	19.Coastal Zone	20.Fauna, Flora & Biodiversity	21.Meteorology	22.Landscape	23.Global Warming	**24.Air Pollution**	25.Water Pollution	26.Soil Contamination	27.Waste	**28.Noise & Vibration**	29.Ground Subsidence	30.Offensive Odor	31.Bottom Sediment
Design Phase	A-					A-																									
Construction Phase		B+	B+	B-	B-									B-										B-			B-	B-		B-	
Operation Phase		A+	B+/C-	A-			B-		B-				B+/-	A+				B+				B+	B+	A-				A-		B-	

Source: JICA Study Team

(3) Expected Negative Environmental and Social Impacts

The description of environmental and social impacts of the inner ring road project by each stage is shown in Table 1.8.3.

Table 1.8.3 Description of Environmental and Social Impacts of the Inner Ring Road Project

	No.	Likely Impacts	Ranking			Description
			Design	Construction	Operation	
Social Environment	1	Involuntary Resettlement	A-	-	-	Involuntary resettlement is expected in the built-up areas in Harry Mwaanga Nkumbula Ward, Nkoloma Ward, Kamwala Ward, Kabwata Ward, Libala Ward, Chilenje Ward, Lubwa Ward of Lusaka District and Chisankane Ward of Kafue District, although this has been minimized as much as possible by considering alternative routes. Especially, in UUSs such as Kanyama, Chibolya and Misisi Compounds, approximately 157 residential and non-residential structures are expected to be affected. Currently, about 160 structures, including residential/non-residential structures, are identified by the satellite images.
	2	Local Economy such as Employment & Livelihood, etc.	-	B+	A+	Economic activities would be facilitated due to improved access between the town and the planned economic zone in Chisankane, Multi-facility Economic Zone (MFEZ) provided by the inner ring road. People would be benefited by reduced traffic congestion in the town and a new route of the mini-bus services in the medium/long run, and employment of casual labor during construction in the short run.
	3	Land Use and Utilization of Local Resources	-	B+	B+/C-	Existing land use would not be changed significantly but improved by the project because it consists of 40% improvement of existing roads and 60% construction of a new road. Additionally, for the newly constructed road, approximately 7 km of open space is used by local drivers and residents as a road. Utilization of local resources will also be improved by the inner ring road project because the project is integrated and planned as a part of the Comprehensive Urban Development Plan. On the other hand, there would be a possibility that the inner ring road construction would cause urban sprawl only if land use control is not effectively implemented.
	4	Social Institutions such as Split of Communities	-	B-	A-	Division of communities is expected in the heavily populated areas where the inner ring road is newly constructed such as Kanyama, Chibolya and Misisi Compounds and Chilenje during construction and operation.
	5	Existing Social Infrastructures and Services such as Traffic/Existing Public Facilities	-	B-	B+	Access to existing social infrastructure such as the existing roads, schools, churches, police posts and other public facilities could be disturbed during construction. During operation, access to the existing social facilities such as University Teaching Hospital would be improved by the project.
	6	Indigenous and ethnic people	A-	-	-	Illegal occupants, who tend to be the poor, could be adversely affected if they are involuntarily resettled. However, the extent of the impact would be assessed by the results of the socio-economic survey which is still under process.
	7	Misdistribution of Benefit & Damage	-	-	B-	Inequality between beneficiaries and the Project Affected Persons (PAPs) would occur to some extent.
	8	Cultural Heritage	-	-	-	Cultural heritages are not identified by observations during the site visits.

	No.	Likely Impacts	Ranking			Description
			Design	Construction	Operation	
	9	Local Conflict of Interests	-	-	B-	Conflicts of interests related to the road development could occur among beneficiaries and the PAPs.
	10	Water Usage or Water Rights & Rights of Common	-	-	-	No significant impact on water use is expected.
	11	Sanitation	-	-	-	In the short-term, deterioration of sanitary conditions could occur in & around the project site during construction.
	12	Hazards (Risk) Infectious Diseases such as HIV/AIDS	-	-	-	It is expected that most construction laborers would be hired locally in/around Lusaka, which has enough labor supply. The probability to spread infectious HIV/AIDS due to the project is considered low.
	13	Accidents	-	-	B+/-	Traffic accidents could increase due merely to the increased number of the vehicles. On the other hand, it could decrease because of the newly constructed sections when the road is designed in accordance with regulations and standards, and is improved from its unpaved de-facto conditions.
	14	Traffic Jam and Congestion	-	B-	A+	During construction, the access to the existing road would be disturbed for the short-term. Some traffic jam would be expected in the central area due to the construction in the short-term. In operation, the traffic jam would be improved not only in the inner ring road network as well as the other major network around the town.
Natural Environment	15	Topography & Geographical Features	-	-	-	No impact is identified since the project site is flat and located in the urban area.
	16	Soil Erosion	-	-	-	No impact is identified since the project site is flat and located in the urban area. Soil erosion could be caused at the borrow pits; however, it is unlikely to happen for the inner ring project since appropriate management of borrow pits is required in the EIA's approval by ECZ.
	17	Groundwater	-	-	-	No significant impact is identified in the inner ring road project.
	18	Hydrological Situation and Rainwater	-	-	B+	Flooding was identified as one of the urban problems during the rainy season by many stakeholders. The lined rainwater drainage has been originally designed for the inner ring project to prevent inundation in the lower areas of Lusaka.
	19	Coastal Zone (Mangroves, Coral Reefs, Tidal Flats, etc.)	-	-	-	There is no coastal zone in Zambia.
	20	Fauna, Flora and Biodiversity	-	-	-	There are no protected areas such as forest reserves or national parks in the project site. Precious fauna and flora rarely exist because the project site is located in the central area of the capital city.
	21	Meteorology	-	-	-	No significant impact is identified in the inner ring road project.
	22	Landscape	-	-	B+	The road construction would improve landscape in unplanned areas the planned design of the network, especially UUSs and around de-facto road along the transmission line.
	23	Global Warming	-	-	B+	The overall CO_2 emission would be decreased due to smooth traffic flow in the inner ring road.

	No.	Likely Impacts	Ranking			Description
			Design	Construction	Operation	
	24	Air Pollution	-	B-	A-	Deterioration of ambient air quality would temporarily occur from construction machineries and vehicles during construction. Ambient air quality would be worsened by the increase in vehicle traffic during operation. However, dust would be improved due to a change from unpaved to paved road conditions.
Pollution	25	Water Pollution	-	-	-	No impact on water quality is expected since water use/wastewater would be very limited only at the construction site during construction.
	26	Soil Contamination	-	-	-	No impact on soil contamination is expected since waste water would be very limited only at the construction site.
	27	Waste	-	B-	-	Disposal of the construction residue of the project would be expected during construction. Existing dumped waste in the project site needs to be appropriately cleared.
	28	Noise and Vibration	-	B-	A-	Noise (B- in construction; A- in operation): Noise levels would temporarily be higher due to equipment and machineries used during construction. Moreover, noise level would be worsened by the increased number of vehicle traffic during operation. Vibration (B- in construction; no impact in operation): At present, perception of vibration as a pollution problem in Zambia is very low. Additionally, the vibration impact is often localized and less direct compared to the noise impact. Therefore, impact of the vibration level is minor and negligible.
	29	Ground Subsidence	-	-	-	No impact is identified because the planned road project does not involve any dense structures even though bedrock is considered fragile in some areas of Lusaka City.
	30	Offensive Odor	-	B-	B-	Offensive odors could be caused by construction waste and machinery during construction. Offensive odors from vehicle emission gases are expected to worsen locally but with less significant impact.
	31	Bottom Sediment	-	-	-	No significant impact is identified in the inner ring road project because the planned road does not cross any river.

Source: JICA Study Team

1.8.4 Outline of the Environmental Management Plan for the Inner Ring Road Project

The outline of the Environmental Management Plan (EMP) for the Inner Ring Road Project is proposed as described in Table 1.8.4.

Table 1.8.4 Outline of the EMP for the Inner Ring Road Project

Impact No.	Significant Negative Impacts	Proposed EMP	Implementing Organization	Responsible Organization
1	Involuntary Resettlement	Adequate public consultation with the PAPs and the Resettlement Action Plan shall be prepared in accordance with the World Bank's Operational Policy 4.12. The RAP shall include consideration of the appropriate relocation site(s), information disclosure to and discussions with resettlers, appropriate infrastructure in a new relocation site(s) and compensations and livelihood assistance. Special attention shall be given to the vulnerable sectors, such as lower-income residents, the illegal occupants without the Occupancy License, the elderly, disabled, women and children.	LCC/MLGH	LCC/MLGH
3	Land Use and Utilization of Local Resorces	Proper land use control shall be strengthened to prevent urban sprawl around the inner ring road as suggested in the Urban Development Master Plan of City of Lusaka.	LCC/MLGH	LCC/MLGH
4	Social Institutions incl. split of communities	Sufficient consultation on the project and relocation with the PAPs shall be conducted to minimize impacts of split of communities by considering alternative relocation site(s) and crossings.	LCC/MLGH	LCC/MLGH
5	Existing Social Infrastructures & Services such as Traffic	Provide sufficient staff to control traffic during construction and detours access to existing social infrastructures such as schools, churches and hospitals.	Contractor	LCC/MLGH
14	Existing Public Facilities; and Traffic Jam & Congestion			
6	The poor, Indigenous & Ethnic People ,	Adequate public consultation and agreement between the government and PAPs are needed. Special attention shall be given to the vulnerable sectors, such as the lower-income residents, the illegal occupants without the Occupancy License, the elderly, disabled, women and children.	LCC/MLGH	LCC/MLGH
7	Local Conflicts of Interest			
9	Misdistribution of Benefit & Damage			
13	Accidents	Safety design in accordance with regulations. Provide pedestrian ways and crossings with signals During construction, the contractor needs to comply with Zambian and international laws and regulations on working conditions. Oil or any other chemical spillage shall be avoided to prevent any accidents as well as groundwater/soil contamination by providing workers with information and education on the proper handling of oil/chemicals.	Contractor	LCC
24	Air Pollution	To mitigate dusts during construction, periodically sprinkle water on the line, earth mixing sites and temporary roads where these are close to the communities. Adopt low air pollution emitting equipment, vehicles and methodology for construction, if available. Provide temporary barriers or screens during construction, if necessary. Provide roadside planting where adequate land is available. Equipment and vehicles shall be well-maintained to keep air pollution at a minimum.	Contractor	LCC

Impact No.	Significant Negative Impacts	Proposed EMP	Implementing Organization	Responsible Organization
27	Waste	Consult with the Waste Management Unit of LCC to handle dumped waste in the project site in Chalala when clearing the site. Secure appropriate disposal sites for construction residue in advance. Consult with the local authority for use of the excess soil, if necessary.	Contractor	LCC
28	Noise & Vibration	Adopt low noise and vibration emitting equipment, vehicles and methodology for construction, if available. Avoid nighttime construction activities near communities. Provide temporary barriers or screens during construction, if necessary. Provide roadside planting where adequate land is available. Noise and vibration standards of industrial enterprises shall be enforced to protect construction workers. If there is strong noise, earplugs shall be worn, and working time shall be limited. Equipment and vehicles shall be well-maintained to keep their noise/vibration at a minimum.	Contractor	LCC
30	Offensive Odor	Keep equipment and vehicles well-maintained to minimize offensive odor. Provide roadside planting where adequate land is available.	Contractor	LCC

Source: JICA Study Team

1.8.5 Outline of the Environmental Monitoring Plan for the Inner Ring Road Project

The outline of the Environmental Monitoring Plan (EMoP) for the Inner Ring Road Project is proposed as described in Table 1.8.5.

Table 1.8.5 Outline of the EMoP for the Inner Ring Road Project

Impact No.	Significant Negative Impacts	Proposed EMoP	
		Internal Monitoring	Auditing (External Monitoring)
1	Involuntary Resettlement	Monitoring of resettlement and compensation shall be formulated separately in the RAP by LCC/MLGH. The RAP framework will be proposed and described in the Annex Report which will be issued in Feb. 2009.	• Environmental Auditing is required by the EPPC (EIA) Regulations, 1997 for the developer to conduct a post-assessment environmental audit within 12-16 months after the completion of the project or the commencement of the project, whichever is earlier. • Monitoring shall be conducted by at least 2 persons of the EIA Team or qualified persons appointed by the developer and approved by the ECZ. • The monitoring report shall be prepared by the developer and submitted to the ECZ.
24	Air Pollution	**During Construction:** Monitor dust regularly by a site visit of the person in charge from the LCC/MLGH. Monitor air quality (e.g. SO_2, PM_{10}, NOx, CO, Pb & dust) in consultation with ECZ, if necessary and/or when any complaints are received from local residents. **During Operation:** Monitor air quality (e.g. SO_2, PM_{10}, NOx, CO, Pb & dust) in consultation with ECZ. Monitoring at least twice a year (dry season & rainy season) is suggested.	
26	Noise	**During Construction:** Monitor roadside noise level (LAeq) in consultation with ECZ, if necessary and/or when any complaints are received from local residents. **During Operation:** Monitor roadside noise level (LAeq) in consultation with ECZ, if necessary and/or when any complaints are received from local residents. Monitoring at least once a year is suggested.	

Source: JICA Study Team

1.8.6 Further EIA Procedure and Draft TOR of EIA for the Inner Ring Road Project

The environmental and social considerations study of the inner ring road was conducted to utilize the results for the official EIA procedure by the LCC and MLGH after the JICA Study. Further EIA process and the Draft TOR of the EIA are described below.

(1) Need for the official EIA

The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations of 1997 requires an EIA for the Inner Ring Road Project under the second schedule of the regulations which states as follows.

> *All major roads outside urban areas, the construction of new roads and major improvements over 10 km in length or over 1 km in length if the road passes though a National Park or Game Management Area.*

(2) Further EIA Procedure

The official procedure in Zambia is also described in Section 2.3.4 of Main Text I. The procedure has been started by LCC and MLGH with assistance from the JICA Study Team between Nov. 2008 and Feb. 2009 and the following steps 1-4 have been conducted during the JICA Study:

1. A stakeholder meeting with ward representatives was organized on 7th Nov. 2008 for scoping impacts and the EIA's TOR preparation in accordance with ECCP (EIA) Regulations. Comments and suggestions from participants were collected.

2. The draft TOR together with CVs of the EIA Team, the Minutes of Meetings, and the participants' list with their signatures were submitted to the ECZ for approval.

3. Proceeding the socio-economic surveys for the RAP framework preparation and the air quality and noise baseline surveys for the EIA.

4. A stakeholder meeting with ward representatives was organized on 27th Jan. 2009 to inform the study outcomes and mitigation measures including RAP framework, and obtain comments and suggestions from participants.

The Environmental and Social Considerations Study in this chapter was conducted with the eixiting data, hearings and field visits. The further outcomes of the detailed surveys such as the air quality and noise survey, the socio-economic survey and details of the stakeholder meetings, are discussed in Annex 2. The results of environmental and social impact assessment of Section 1.8.3 were reviewed and updated with the survey results in the Annex 2..

The Proposed TOR of the EIA including RAP is described below.

Table 1.8.6 Proposed TOR of the EIA for the Inner Ring Road Project

Item	Description	Action Taken by	Remarks (Standards and References)
Activities to be conducted by MLGH & LCC within the JICA Study			
Alternative Consideration	Consideration of Alignments	Conducted within the JICA Study.	Minimize the number of households to be resettled and the magnitude of the split of communities as well as maximize the project benefits.
Air Quality	CO, NOx, SO2, PM10, Pb and Total Dust at five locations	Conducted within the JICA Study.	Evaluate impacts referring to the Zambian Ambient Air Standard, Japanese Ambient Air Standard, or/and WHO air standard.
Noise	LAeq at 5 locations	Conducted d within the JICA Study.	Evaluate impacts referring to the Japanese and/or WHO ambient noise standard for road side.
Socio-economic Survey	Targeting 20% of the total number of households to be resettled	Conducted d within the JICA Study.	Sampling rate of the Asian Development Bank's Good Practice Handbook shall be applied.
RAP Framework	Based on the results of the socio-economic survey, the census survey and stakeholder meetings held to prepare the RAP.	Conducted within the JICA Study.	In accordance with 1) the Zambian practice based on the Zambian Lands Acquisition Act, Town and Country Planning Act and the World Bank's Operational Policy as well as 2) the JICA Guidelines for Environmental and Social Considerations.
Stakeholder Meetings	Public consultation meetings during the three stages are required at minimum. A seminar was conducted as the 1st stakeholder meeting to brief the project background on July 2008; One public consultation meeting was arranged as the 2nd stakeholder meeting in Nov. 2008 for scoping impacts; and Another public consultation meeting will be organized as the 3rd stakeholder meeting in Jan. 2009 to provide the outcomes of the EIA/RAP surveys.	Conducted/ to be conducted within the JICA Study.	The JICA Guidelines require stakeholder meetings for the three stages. The seminar conducted in July 2008 was considered to be for the 1st stage Two stages of public consultation meetings are required by the Zambian EIA regulation, ECCP (EIA) Regulations.
Activities needed to be finalized by MLGH & LCC after the JICA Study			
Official EIA Finalization	The Environmental and Social Considerations Study shall be reviewed and updated by LCC/MLGH when submitting as an EIA report to the ECZ.	Needs to be updated and officially finalized by LCC and MLGH.	None.
Official RAP Formulation	Full RAP preparation including the full census survey and local stakeholder meetings with potential resettlers.	Needs to be updated and officially finalized by LCC and MLGH.	Same as described in above RAP Framework Section
Stakeholder Meetings	One to two more stage(s) of the public consultation meeting shall be conducted to finalize the RAP.	Needs to be organized by LCC and MLGH.	Same as described in above Stakeholder Meeting Section.

Source: JICA Study Team

1.9 Project Implementation

1.9.1 Organizational Framework

Considering the present institutional frameworks for project implementation, the overall institutional framework for the Project implementation is depicted in Figure 1.9.1.

The Government agencies involved in the project implementation are LCC (Lusaka City Council), MLGH (Ministry of Local Government and Housing), RDA (Road Development Authority) and NRFA (National Road Fund Agency).

The LCC is a project implementation agency and responsible for the construction works. In addition, it shall be responsible for the following other tasks:

- Preparation of land acquisition and compensation program/schedule;
- Undertaking actual procedures for land acquisition and compensation such as public consultation, negotiation, disbursement;
- Organization of tendering procedures;
- Preparation of program and schedule of operation and maintenance; and
- Organization and carrying out of operation and maintenance works.

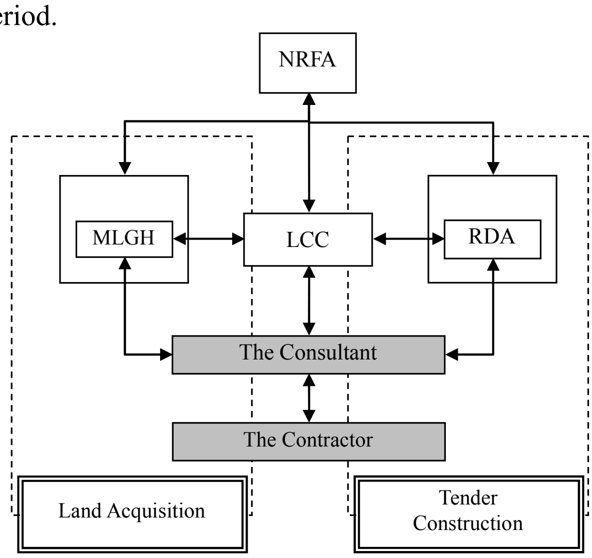
The MLGH is responsible for assessment and cost estimation of the land acquisition and compensation program.

The RDA is the supporting agency for the project implementation in all aspects.

The NFRA is a financing agency for all matters in the project implementation, such as land acquisition and compensation, relocation of utilities, operation and maintenance after the completion.

The ECZ: is responsible for all environmental matters regarding the Project, including finalization and implementation of coordination of interests at the field level, if any, between local communities and government agencies.

The MLGH will conduct the administrative work, coordination and preparation between the government and funding agency. The RDA and the Engineering Department of Lusaka City Council will conduct the technical control and supervision of the project. The Lusaka City Council will also be responsible for road maintenance in the post-project period.



Source: JICA Study Team

Figure 1.9.1 Institutional Framework of Project Implementation

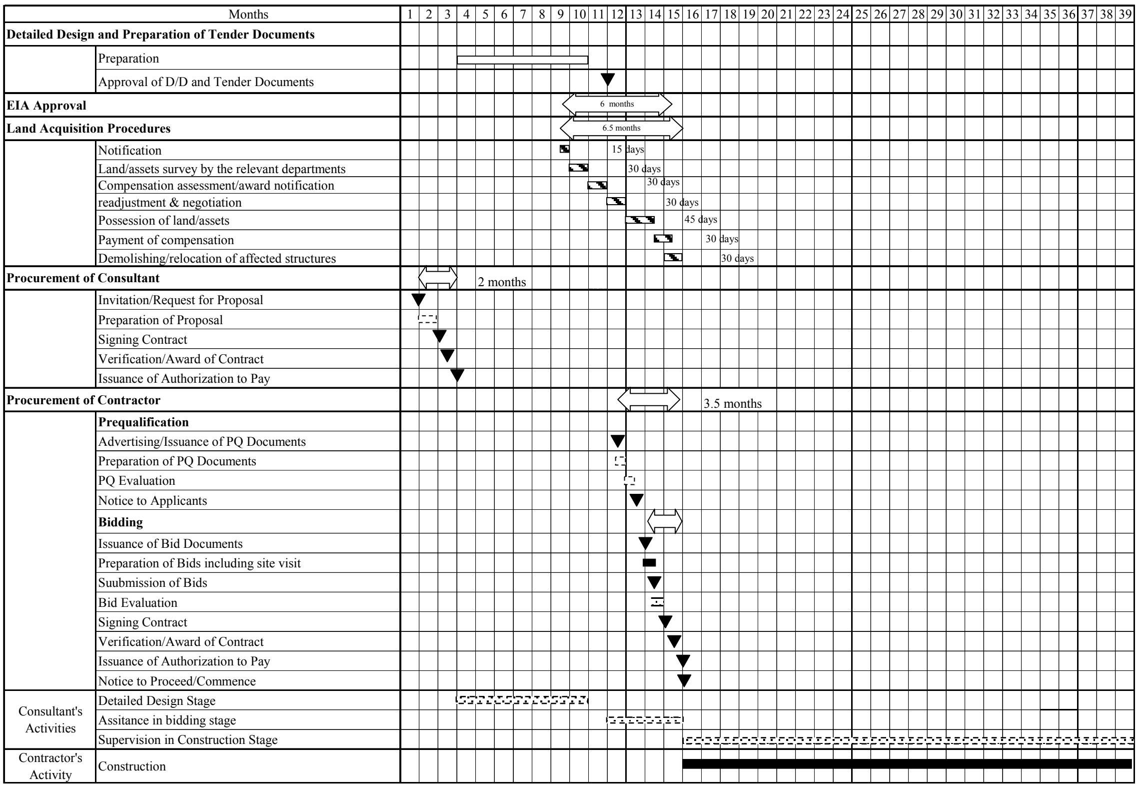
1.9.2 Financing Arrangement

The total cost was estimated as USD 56.8 million. This is approximately half of the yearly available funding for NRFA from the fuel levy and the budget of the Government of Zambia. In total, the cost of the MFEZ Access accounts for USD 24.1 million. From the budget estimates for the road sector in Lusaka, the cost can be covered by the domestic budget but high priority should be given to the road project in Lusaka compared to the road projects in other parts of Zambia.

1.9.3 Implementation Schedule

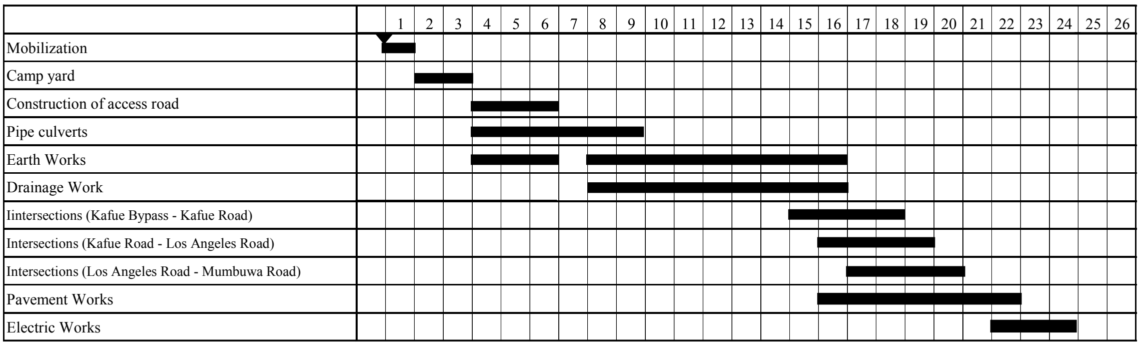
The necessary period for the implementation of the project was studied. Approximately 3.5 months is required for procurement of civil work contractor(s) through prequalification and bidding. EIA approval and land acquisition procedures will take six months and 6.5 months, respectively. Among these activities, a critical path prior to the commencement of the civil works is the EIA approval and land acquisition procedures which take 6.5 months in total. It is estimated that construction of both Inner Ring Road and MFEZ Access take 24 months and 20 months, respectively.

The tentative overall implementation schedule and the construction schedules are illustrated in Figure 1.9.2, 1.9.3, and 1.9.4. If the construction commences in October 2010, it will be completed by September 2012.



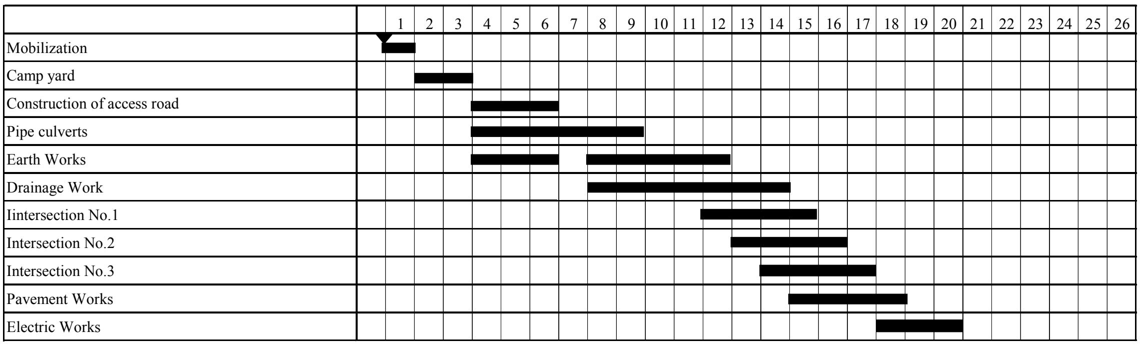
Source: JICA Study Team

Figure 1.9.2 Tentative Overall Implementation Schedule



Source: JICA Study Team

Figure 1.9.3 Tentative Construction Schedule (Inner Ring Road)



Source: JICA Study Team

Figure 1.9.4 Tentative Construction Schedule (MFEZ Access)

1.10 Conclusion and Recommendations

1.10.1 Conclusion

The economic analysis shows that the project will be economically feasible. The economic internal rate of return (EIRR) of 23% and the net present value (NPV) of USD 73 million can justify the project. The economic analysis excludes the economic cost and benefit of the widening of the Inner Ring Road and MFEZ Access from 2-lane to 4-lane. Traffic volume forecast shows that these roads should be 4-lane in 2030, and it would also be feasible project.

The Inner Ring Road project requires resettlement in Misisi, Chibolya, and Kanyama. To reduce the number of resettlement, two other routes were studied. These new alternatives show almost the same benefit as the master plan route but the cost becomes higher. Thus, the master plan route is found to be the most cost-efficient. Comparing the differences of the cost and the number of resettlements, the master plan route is the best route for the project road.

From the viewpoint of engineering, there is no significant difficulty in this project other than land acquisition and resettlement. The crossing with the railway line can be dealt with properly as an at-grade crossing. The only concern is the intersection with Kafue Road which is already a busy road. The preliminary study shows that the intersection can deal with the traffic. However, since the distance of the intersections is short, further traffic analysis is needed.

1.10.2 Recommendations

1) Phased Development

The Inner Ring Road project requires resettlement and faces a risk of delay due to the resettlement schedule. On the other hand, there is no resettlement in the east side of the railway line. The section from the railway line to the east can be connected to Kafue Road with the short distance road between mini-bypass and the crossing point of Kafue Road – Kasama section and the railway line. In view of the traffic flow, this route is not necessarily better than the originally proposed route. However, this can be an alternative route if resettlement takes time. The recommended components of the Inner Ring Road for the phased development are presented as follows:

Table 1.10.1 Development Phase Option 1

	Phase-I	Phase-II
Section	Kafue Road – Mini Bypass – Railway crossing – Kasama Road & 5 collector roads	Mumbwa Road – Kafue Road – Railway crossing
Length (km)	8.8	4.5
Cost (USD million)*	18.7	10.7
No. of resettlement	0	157

Note*: Cost excludes TAX.
Source: JICA Study Team

There is another phasing option that could be considered: instead of avoiding the resettlement in Misisi, the Kafue Road – Kasama Road section is constructed as Phase-I. The following is a description of this option.

Table 1.10.2 Development Phase Option 2

	Phase-I	Phase-II
Section	Kafue Road –Kasama Road & 5 collector roads	Mumbwa Road – Kafue Road
Length (km)	9.7	3.6
Cost (USD million)*	21.2	8.2
No. of resettlement	64	93

Note*: Cost excludes TAX.
Source: JICA Study Team

This alternative is better in view of traffic flow. However, this still faces the risk relating to resettlement. The risk of implementation of Development Phase 1 is smaller, and the Phase I development between the mini-bypass and Kasama Road is recommended for quick implementation.

2) Drainage System

Improvement and ensuring the capacity of the following outfalls will be indispensable for the proper functioning of the proposed drainage system.

- Existing Ngwerere Stream and Chunga Stream should be improved by means of dredging or enlarging the discharge area in order to have sufficient drainage capacity.

- Sufficient forest area should be reserved in the LS-MFEZ

3) Operation and Maintenance

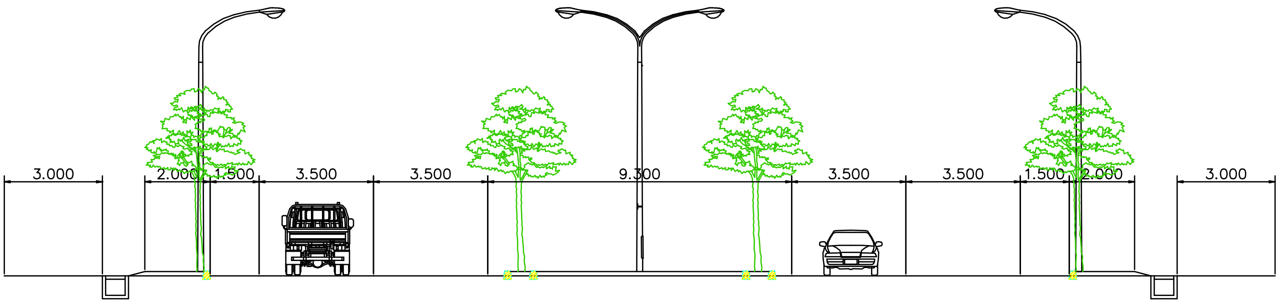
The proposed routine/periodic maintenance and minor rehabilitation should be considered for ensuring better road condition and riding quality in the future.

Furthermore, formulation of an appropriate program, including budget allocation and funding arrangement, will be indispensable.

4) Road Reserve for Future Widening

The section between Kafue Road and Kasama Road is planned as 2-lane road in the short-term and as 4-lane in long-term. The width of the future 4-lane road is recommended to be 35 m. Since housing developments have been booming in the project area, it is necessary to reserve the right-of-way for the future road.

In case that a particular lane for public transport is required in the future, a proposed cross section for consideration is illustrated below:



Source: JICA Study Team

Figure 1.10.1 Cross-section for Public Transportation

5) Strengthening Development Control of LCC

The south area along the Inner Ring Road is a city property and the LCC has already designated the alignment of roads and streets based on the land use plan of this area. However, some houses are constructed on the roads and streets. These houses are illegal but the LCC does not have enough capacity to control illegal housing because its number of staff is small. Although the Inner Ring Road will improve the living environment in this area by providing good access by road, the project will accelerate illegal construction unless LCC strengthens its development control. It is recommended that LCC's number of staff for building control be increased. In addition, the new residents in the three wards (Kamwala, Kabwata, and Libata) should be involved in formulating the local land use plan to protect their living environment. Currently, the capacity development project for ward planning is ongoing as a SIDA (Swedish International Development Cooperation Agency) project. Land use control in this area should be considered.

6) Use of Local Resources

The Contractor should utilize a local construction company as subcontractor so that the local company can develop their technical capability as well as maintenance capability for new structures constructed under the project.

CHAPTER-2

OUTER RING ROAD

CHAPTER-2 OUTER RING ROAD

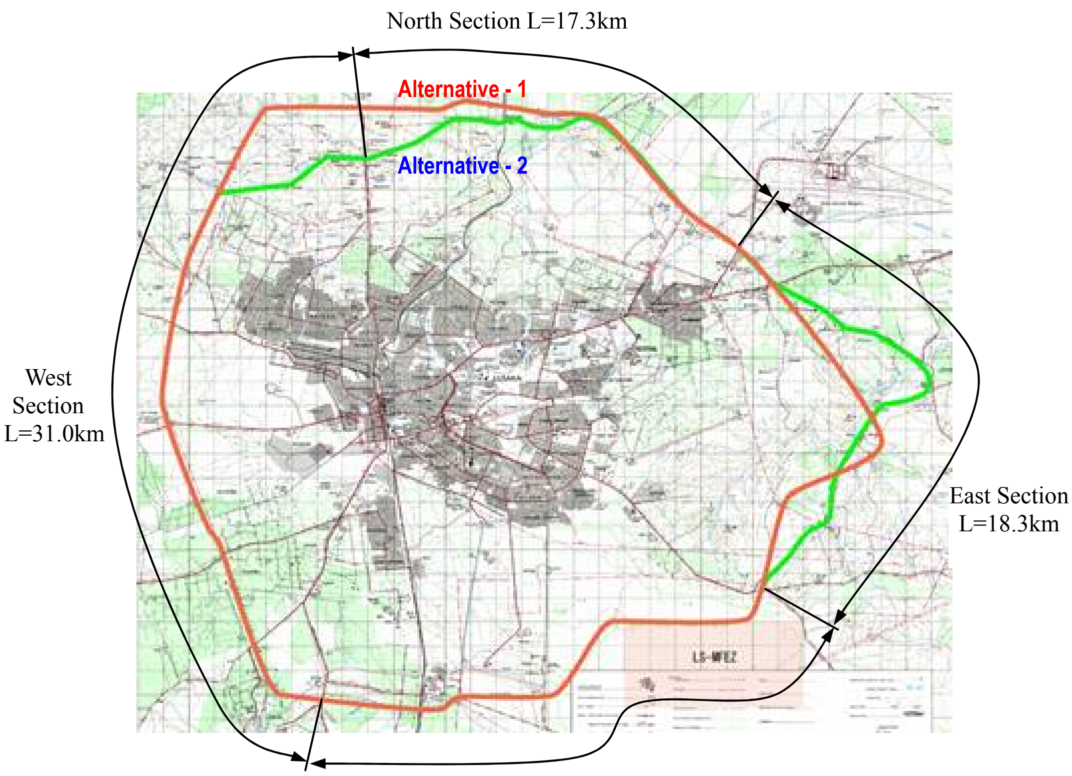
2.1 Introduction

The Outer Ring Road was selected as a priority project which is subject to a pre-F/S through the evaluation process described in Section 1.6.5 of the Volume II as well as through continuous discussions with the counterpart and relevant stakeholders.

The Outer Ring Road is proposed in the Comprehensive Urban Development Plan as one of the most important roads comprising the basic urban structure of Lusaka. In the land use plan, the ring road determines the Urban Growth Boundary (UGB) between the Urban Development Promotion Zone and the Urban Development Control Zone. Another important function of the ring road is to connect the industrial zones in Lusaka. In addition, the ring road functions as a bypass road of the Lusaka road network for inter-regional and international transportation.

The development of the Outer Ring Road is not a short-term project. However, it is necessary to construct the southern part of the ring road in the short-term period because the access road for the Lusaka South MFEZ (Multi Facility Economic Zone) is an urgent need. To support the MFEZ development, the access section of the Outer Ring Road is selected as a priority project in the master plan.

This chapter is a preliminary study for the Outer Ring Road. Although the construction of the road will be a medium-term and long-term project, the JICA Study Team carried out this study because of the significant impact of the ring road.



Source: JICA Study Team

Figure 2.1.1 Location of Outer Ring Road

2.2 Traffic Volume Forecast

Traffic volume on the project roads was forecasted for the year 2015, 2020, and 2030. The same traffic forecast model in the master plan was applied to this feasibility study. The important assumption for the demand forecast of the Outer Ring Road is industrial development. The table below shows the industrial development projection in the master plan. The total industrial park area in 2015 will be 180 ha. The area in 2020 will be more than four times that of 2015, and the area in 2030 will be more than 10 times that of 2015. Since these industrial parks are located along the Outer Ring Road, it is expected that most of the trucks for these industrial parks will use the road.

Table 2.2.1 Area of Industrial Parks

Unit: ha

	2015	2020	2030
Lusaka South MFEZ	30	240	400
Lusaka North MFEZ	150	213	355
Chibombo	0	50	141
South of Lusaka	0	135	307
West of Lusaka	0	340	737
Total	180	998	1,940

Source: JICA Study Team

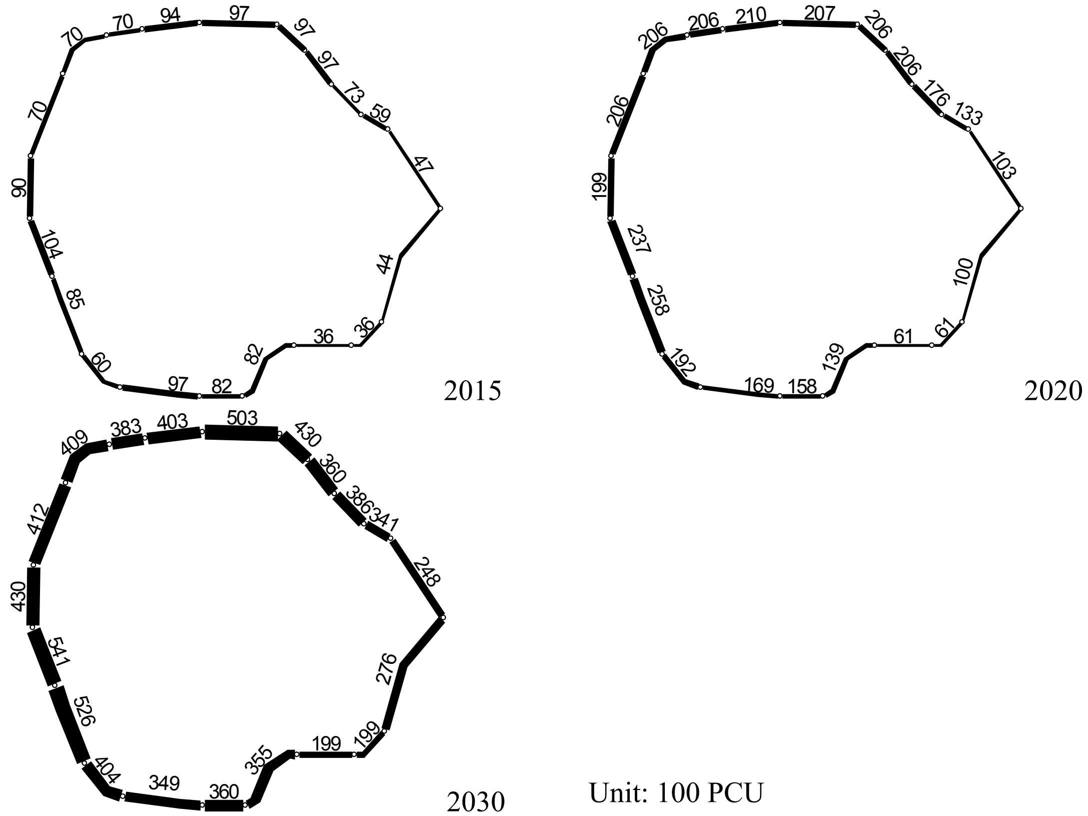
It was assumed that the trip generation rate of an industrial area is 0.038 ton per square meters per day, which was estimated from the result of the freight interview survey conducted by the JICA Study Team in 2007. The same OD pattern taken from the Cordon Line survey in 2007 was applied for the travel pattern of trucks. The ratio of net area to gross area in the industrial park was assumed to be 0.65. Passenger Car Unit (PCU) of a truck for traffic assignment is 2.5 PCU per truck with a 15-ton loading.

It was also assumed that the future road network will be developed according to the master plan schedule. Figure 2.2.1 illustrates the result of the traffic volume forecast of the Outer Ring Road with 4-lane for 2015, 2020, and 2030. The maximum speed is set to 80 km/hr in the forecast.

The result shows that the traffic volume demand for the Outer Ring Road is high. In 2015, the west and north parts have 6,000 to 10,000 PCUs traffic demand, and it will be between 18,000 and 26,000 PCUs in 2020. In 2030, traffic demand of these parts will be 34,000 to 54,000 PCUs. The south and east parts will have smaller traffic demand but it will be 20,000 to 36,000 in 2030. On the other hand, the result also shows that the 4-lane road has enough capacity to deal with the traffic by 2030.

From the result of the traffic volume forecast only, it can be said that demand for the Outer Ring Road is very high and the road should be 4-lane road for all sections.

However, the project also needs to be evaluated from the economic view point.



Source: JICA Study Team

Figure 2.2.1 Traffic Volume Forecast of Outer Ring Road

2.3 Project Alternatives

The project alternatives, including a “zero option”, are evaluated as follows:

Since the Lusaka South MFEZ development is the almost committed project, the south part of the Outer Ring Road is regarded as a part of the “zero option”. In addition, all other projects in the master plan are included in “zero option” because the purpose of this evaluation is for the Outer Ring Road. If other projects are not included, the benefits from the road will be overestimated.

Additionally, in this section, the project alternatives are considered in terms of the road design, and the route alternatives are discussed in terms of environmental and social aspects in Section 2.4.1.

For the project alternatives, the Outer Ring Road is divided into four sections: i) Western (Kafue Road – Great North Road), ii) Northern (Great North Road – Great East Road), iii) Eastern (Great East Road – Leopard Hill Road), and iv) Southern (Leopard Hill Road – Kafue Road). The Southern part is regarded as the base for all alternatives as a 4-lane road (maximum speed=80 kph). Each section has three alternatives: i) 4-lane road, ii) 2-lane road, and iii) no-project. The number of alternatives is 3 x 3 x 3 – 1 = 26.

These alternatives were evaluated by applying the traffic demand in 2030. The same land use pattern (the same OD) is used for all alternatives, whether of not the section along industrial parks exists.

The evaluation criteria include: i) vehicle–kilometers, ii) vehicle–hours, iii) vehicle operating cost (VOC), iv) travel time cost (TTC), v) fuel consumption (or CO_2

emission), vi) first year return (FYR), and vii) maximum volume to capacity ratio(V/C) on the Outer Ring Road. The method of calculation for these items is described in Section 2.7.

Table 2.3.1 shows the result of the calculations.

The total benefit is highest in case all sections are constructed as 4-lane road. The savings of travel time cost is lowest in case only the Eastern part is constructed as 2-lane road. In view of cost efficiency, No. 2 (only Northern part is constructed as 4-lane) shows the highest FYR. However, the benefit of the case is very small. In case that only the Eastern part is constructed as 2-lane road, FYR is lowest.

As a whole, the FYR is high in case that the Eastern part is not constructed. However, the Eastern part is important for Lusaka South MFEZ because it will be the access route from the airport and Nacala corridor.

The JICA Study Team recommends that all sections should be 4-lane because the advantage of cost-efficiency of other cases does not necessarily be clear. Since trucks are the major traffic on the Outer Ring Road, it is preferable to provide multi lanes for overtaking. The FYR of 34.6% is high although it is not in the top group of alternatives. Preliminary engineering study was carried out for this case.

It should be noted that the FYR is calculated for the year 2030, when a large scale of demand is expected. The Economic Internal Rate of Return (EIRR) for the case of all 4-lanes is calculated in Section 2.7.

Table 2.3.1 Evaluation of Alternatives

No. of Lanes				No.	Cost	Saving (per day)						First Year Return	Maximum VCR on ORR
South	West	East	North		Million (USD)	Veh-km ('000)	CO2 (Ton)	Veh-hour ('000)	VOC ('000USD)	TTC ('000USD)	Total ('000USD)		
			0	BASE									
		0	2	1	33	27	10	12	3	45	48	53.3%	1.1
			4	2	50	60	19	17	9	65	74	53.6%	0.8
			0	3	53	32	18	9	9	32	41	28.6%	0.9
	0	2	2	4	85	70	25	21	10	79	89	38.1%	1.2
			4	5	103	110	25	27	10	100	111	39.3%	1.1
			0	6	81	55	20	12	11	44	56	25.1%	0.6
		4	2	7	114	97	28	25	13	93	106	34.2%	1.2
			4	8	131	144	33	32	16	118	134	37.4%	0.9
			0	9	77	47	30	16	14	60	74	35.0%	1.3
		0	2	10	110	71	37	27	15	102	118	39.1%	1.3
			4	11	127	101	43	32	19	120	139	39.7%	1.3
			0	12	130	80	49	25	23	92	115	32.5%	1.3
4	2	2	2	13	162	97	71	35	35	131	166	37.2%	1.2
			4	14	180	136	71	40	35	150	185	37.5%	1.2
			0	15	158	102	51	28	26	103	129	29.8%	1.3
		4	2	16	191	120	71	38	35	141	177	33.8%	1.2
			4	17	208	168	70	44	35	162	197	34.6%	1.2
			0	18	119	127	44	26	23	96	119	36.7%	1.0
		0	2	19	151	159	60	37	28	139	168	40.5%	1.2
			4	20	169	210	56	42	26	159	184	39.8%	1.1
			0	21	171	161	67	35	35	128	162	34.6%	1.1
	4	2	2	22	204	179	80	44	39	164	203	36.3%	1.1
			4	23	222	217	82	49	41	183	224	36.9%	1.0
			0	24	200	187	64	38	34	140	174	31.8%	1.1
		4	2	25	232	197	80	46	41	172	213	33.4%	1.1
			4	26	250	231	86	52	45	192	237	34.6%	1.0

South Kafue Road - Lepoard Hill Road
West Kafue Road - Great North Road
East Leopard Hill Road - Great East Road
North Great East Road - Great North Road

Best (yellow)
Worst (blue)

Source: JICA Study Team

2.4 Preliminary Design

2.4.1 Route Alternative

(1) Alternative Setting

Construction of the Outer Ring Road requires a large scale land acquisition of agricultural lands and relatively small number of resettlement. On the other hand, there are existing roads along the proposed route although these roads are not connected to each other and the alignments are not suitable for the ring road. The alternative route was prepared with the view of minimizing land acquisition by using existing roads as much as possible. The following areas for each section were considered as conditions for the preparation of the alternative routes:

South Section: Game Reserve, Police Academy, LS-MFEZ, Lilayi Airport
West Section: Western Industrial Area

East Section: Lusaka East Forest Reserve, Eastern Housing Area, President Facilities

North Section: Northern Industrial Zone, Airport commercial plan, LN-MFEZ, Extension of International Airport

Figure 2.4.1 shows the proposed route of each alternative.

(2) Evaluation of Alternative Routes

The same cross-section was applied for the alternative routes, using existing roads as lower class of road as discussed in the recommendations. The costs of the alternative routes were estimated as presented below.

Table 2.4.1 Construction Cost of Route Alternatives

ZMK Unit: Million

Section	Alternative 1	Alternative 2
South Section	228,940	228,940
West Section	446,558	430,430
East Section	341,755	381,551
North Section	191,441	191,790
Total	1,208,694	1,232,711

Source: JICA Study Team

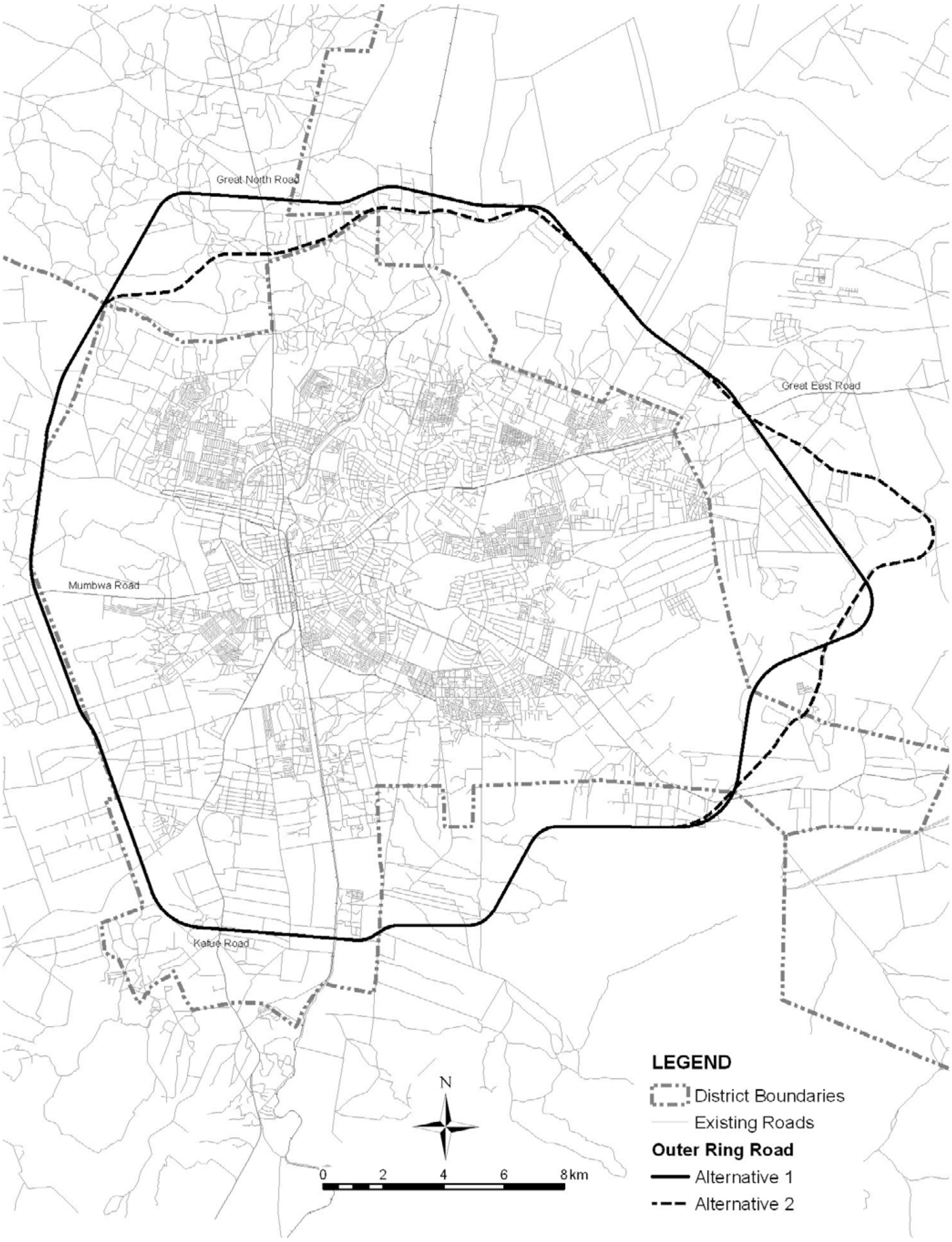
The construction cost of Alternative-2 is higher than that of Alternative-1 by 24 billion ZMK. On the other hand, the estimated savings in the land acquisition cost (less than ZMK 80 billion) would be larger than the difference of the construction costs. This implies that the total project cost of Alternatvie-2 would be lower than that of Alternative-1. However, the alignment of Alternative-2 is winding as shown in Figure 2.4.1. Since Alternative-2 uses the existing roads as much as possible, the road of Alternative-2 will divide the existing communities.

Moreover, the route alternatives were also considered in terms of the environmental and social impacts. However, since there are no significant differences in the environmental impacts identified with the exsting data in this study, the social impact of potential resettlement, namely the number of resettlers' structures, was identified with the satellite imanges as shown in Table 2.4.2. As a result, Alternative 1 is considered the better option than Alternative 2.

Table 2.4.2 Number of Displaced Structures by Route Alternative

Section	Alternative 1	Alternative 2
South Section	4	4
West Section	21	32
East Section	10	20
North Section	14	22
Total	49	78

Source: JICA Study Team



Source: JICA Study Team

Figure 2.4.1 Alternative Route

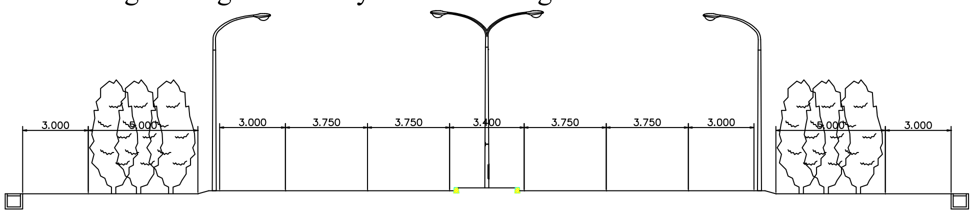
2.4.2 Horizontal and Vertical Alignment

The horizontal and vertical alignment was drawn by using computer-aided design (CAD) system. The design was done using available satellite images (Quick Bird, 2007 – 2008) and contour lines in existing topographic maps.

The plan and profile as results of the design is attached in the Supplemental Data Book and Design Drawings.

2.4.3 Road Cross Section

The cross section of the road was prepared by referring to the Southern Africa Transport and Communications Commission (SATCC) standard, the Zambia geometric standard and the Road Re-classification Study being carried out by RDA. Figure 2.4.2 illustrates the typical cross section of the road, with width of 45 m. The median width is 3.4m, and 3.0m shoulder spaces are provided. There are 5 m green belts and 3.0 m service roads for both sides. A sidewalk is not included because the Outer Ring Road runs along the edge of the city where walking demand is small.



Source: JICA Study Team

Figure 2.4.2 Typical Cross Section

2.4.4 Intersections

Preliminary intersections design was made based on the number of lanes of the intersecting roads and the projected traffic volume in 2030. As a result of preliminary intersection analysis, at-grade type intersection is selected for all intersections in the Outer Ring Road.

The result of intersection capacity analysis based on the Highway Capacity Manual, Transportation Research Board, 1985 and the preliminary lane arrangements for the intersections are shown in Table 2.4.2.

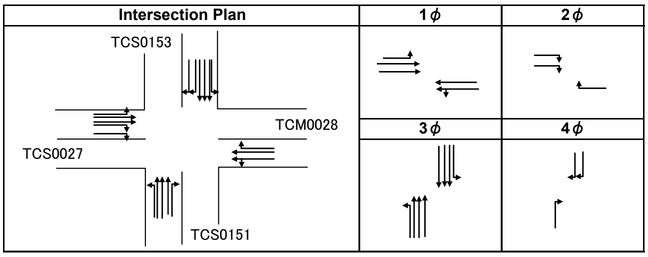
Source: JICA Study Team

Figure 2.4.3 Intersections Location Map

Table 2.4.3 Intersection Capacity Analysis and Intersection Plan

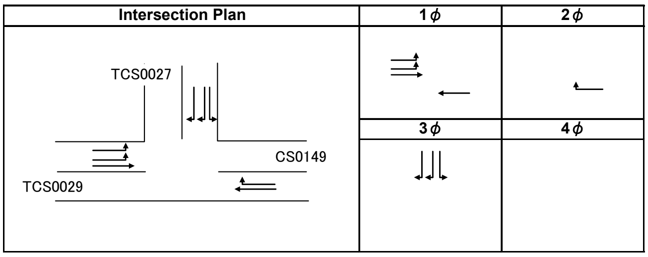
Intersection No.01

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCM0028	Left	0	0	0	0.000	60	0.904
(ORR)	Straight	2,451	272	2,948	0.092		
	Right	1,137	126	1,400	0.090		
TCS0151	Left	4,336	482	1,113	0.433		
	Straight	21,532	2392	4,423	0.541		
	Right	0	0	1,400	0.000		
TCS0027	Left	2,462	274	1,113	0.246		
(ORR)	Straight	2,302	256	2,948	0.087		
	Right	4,303	478	2,801	0.171		
TCS0153	Left	1,173	130	1,113	0.117		
(MFEZ Access	Straight	21,565	2396	4,423	0.542		
Road)	Right	2,495	277	2,801	0.099		



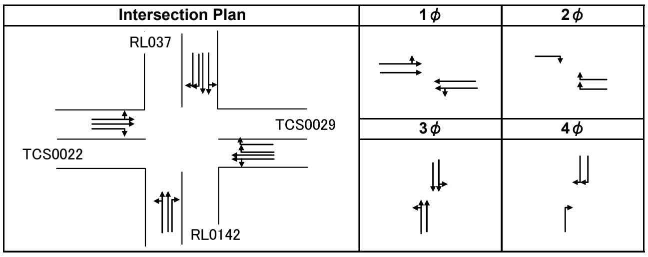
Intersection No.02

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
CS0149	Left	0	0	0	0.000	50	0.812
	Straight	812	90	1,490	0.060		
	Right	0	0	1,416	0.000		
TCS0029	Left	9,067	1007	2,250	0.448		
(ORR)	Straight	740	82	1,490	0.055		
	Right	0	0	0	0.000		
TCS0027	Left	0	0	1,125	0.000		
(ORR)	Straight	0	0	0	0.000		
	Right	9,282	1031	2,832	0.364		
	Left	0	0	0	0.000		
	Straight	0	0	0	0.000		
	Right	0	0	0	0.000		



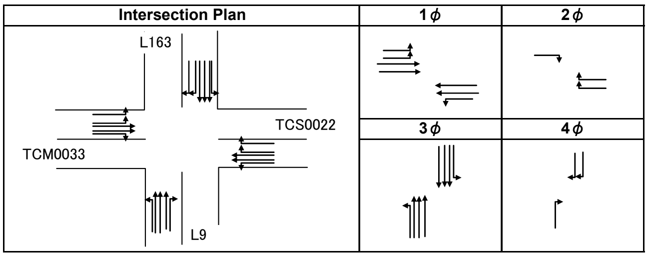
Intersection No.03

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0029	Left	2,812	0	0	0.000		
(ORR)	Straight	3,736	727	2,696	0.270		
	Right	3,470	386	2,863	0.135		
RL0142	Left	0	0	0	0.000		
	Straight	754	84	3,013	0.028		
	Right	2,624	292	1,431	0.204	60	0.857
TCS0022	Left	4,290	0	0	0.000		
(ORR)	Straight	3,721	890	2,617	0.340		
	Right	0	0	1,431	0.000		
RL037	Left	3,616	0	0	0.000		
	Straight	784	489	2,406	0.203		
	Right	4,595	511	2,863	0.179		



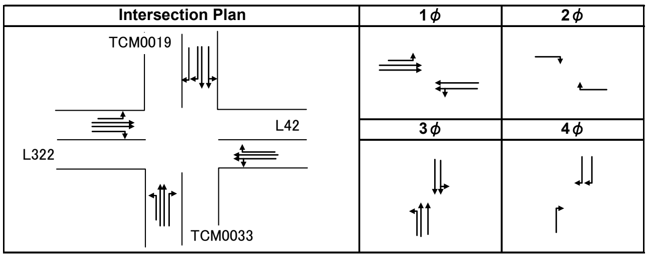
Intersection No.04

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCS0022	Left	1,405	156	1,088	0.143		
(ORR)	Straight	2,180	242	2,884	0.084		
	Right	4,572	508	2,739	0.185		
L9	Left	5,826	647	1,088	0.595		
(Great North	Straight	12,261	1362	4,325	0.315		
Road)	Right	1,373	153	1,370	0.112	60	0.812
TCM0033	Left	4,248	472	1,088	0.434		
(ORR)	Straight	2,215	246	2,884	0.085		
	Right	5,613	624	2,739	0.228		
L163	Left	4,423	491	1,088	0.451		
(Great North	Straight	12,815	1424	4,325	0.329		
Road)	Right	4,176	464	2,739	0.169		



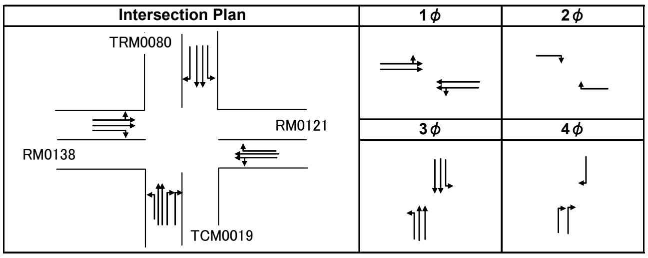
Intersection No.05

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L42	Left	0	0	0	0.000		
	Straight	3,245	361	3,013	0.120		
	Right	0	0	1,431	0.000		
TCM0033	Left	2,167	241	1,137	0.212		
(ORR)	Straight	10,015	1113	3,013	0.369		
	Right	0	0	1,431	0.000	60	0.891
L322	Left	6,051	672	1,137	0.591		
	Straight	2,799	311	3,013	0.103		
	Right	2,173	241	1,431	0.168		
TCM0019	Left	0	0	0	0.000		
(ORR)	Straight	9,903	1100	3,013	0.365		
	Right	6,015	668	2,863	0.233		



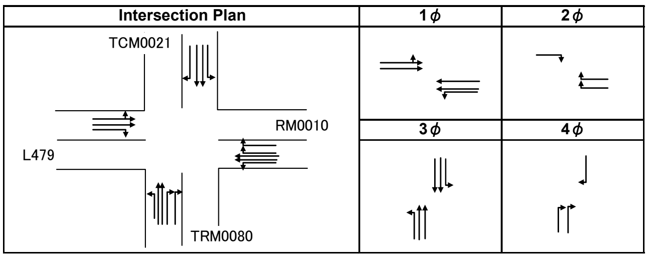
Intersection No.06

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RM0121	Left	2,981	0	0	0.000		
	Straight	1,412	488	2,350	0.208		
	Right	1,164	129	1,339	0.096		
TCM0019	Left	738	82	1,064	0.077		
(ORR)	Straight	12,236	1360	2,819	0.482		
	Right	3,091	343	2,678	0.128	60	0.915
RM0138	Left	1,369	0	0	0.000		
	Straight	1,414	309	2,479	0.125		
	Right	746	83	1,339	0.062		
TRM0080	Left	1,151	128	1,064	0.120		
(ORR)	Straight	12,191	1355	2,819	0.481		
	Right	1,380	153	1,339	0.114		



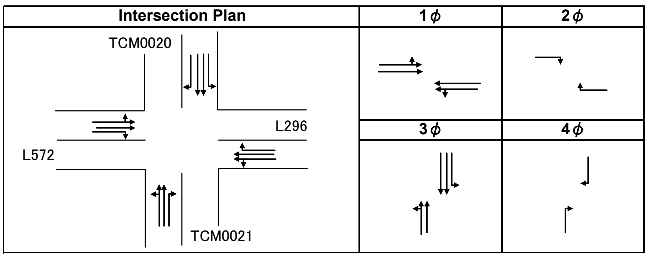
Intersection No.07

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RM0010	Left	5,430	603	1,064	0.567		
(Mumbwa	Straight	1,125	125	2,819	0.044		
Road)	Right	3,621	402	2,678	0.150		
TRM0080	Left	1,724	192	1,064	0.180		
(ORR)	Straight	7,910	879	2,819	0.312		
	Right	5,136	571	2,678	0.213	40	0.758
L479	Left	704	0	0	0.000		
(Mumbwa	Straight	1,201	211	2,563	0.082		
Road)	Right	1,771	197	1,339	0.147		
TCM0021	Left	3,618	402	1,064	0.378		
(ORR)	Straight	7,522	836	2,819	0.297		
	Right	716	80	1,339	0.060		



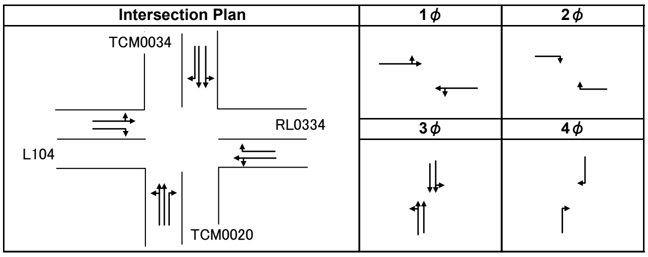
Intersection No.08

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L296	Left	3,050	0	0	0.000		
	Straight	0	339	2,128	0.159		
	Right	1,885	209	1,339	0.156		
TCM0021	Left	223	0	0	0.000		
(ORR)	Straight	8,947	1019	2,802	0.364		
	Right	3,064	340	1,339	0.254	60	0.933
L572	Left	179	0	0	0.000		
	Straight	0	20	2,128	0.009		
	Right	299	33	1,339	0.025		
TCM0020	Left	1,885	209	1,064	0.196		
(ORR)	Straight	8,587	954	2,819	0.338		
	Right	99	11	1,339	0.008		



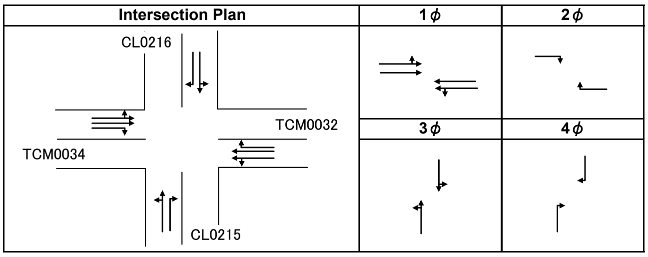
Intersection No.09

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RL0334	Left	734	0	0	0.000	40	0.549
	Straight	0	82	1,125	0.073		
	Right	71	8	1,416	0.006		
TCM0020	Left	0	0	0	0.000		
(ORR)	Straight	11,452	1272	2,981	0.427		
	Right	559	62	1,416	0.044		
L104	Left	0	0	0	0.000		
	Straight	0	0	1,490	0.000		
	Right	0	0	1,416	0.000		
TCM0034	Left	55	0	0	0.000		
(ORR)	Straight	11,082	1237	2,977	0.415		
	Right	0	0	1,416	0.000		



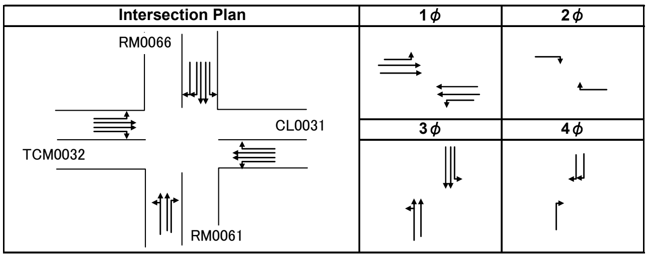
Intersection No.10

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCM0032	Left	1,154	0	0	0.000	50	0.804
(ORR)	Straight	9,266	1158	2,805	0.413		
	Right	0	0	1,370	0.000		
CL0215	Left	0	0	0	0.000		
	Straight	2,474	275	1,442	0.191		
	Right	1,293	144	1,370	0.105		
TCM0034	Left	1,842	0	0	0.000		
(ORR)	Straight	9,665	1279	2,770	0.462		
	Right	0	0	1,370	0.000		
CL0216	Left	0	0	0	0.000		
	Straight	1,914	213	1,442	0.148		
	Right	1,871	208	1,370	0.152		



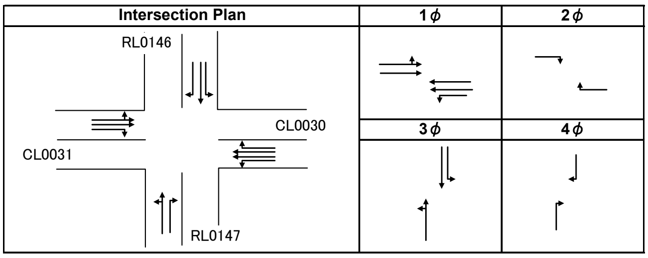
Intersection No.11

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
CL0031	Left	3,869	430	1,064	0.404	60	0.941
(ORR)	Straight	3,134	348	2,819	0.123		
	Right	2,551	283	2,678	0.106		
RM0061	Left	239	0	0	0.000		
(Great North	Straight	7,608	872	2,797	0.312		
Road)	Right	4,070	452	2,678	0.169		
TCM0032	Left	7,338	815	1,064	0.766		
(ORR)	Straight	3,242	360	2,819	0.128		
	Right	239	27	1,339	0.020		
RM0066	Left	2,482	276	1,064	0.259		
(Great North	Straight	8,038	1169	2,819	0.415		
Road)	Right	7,048	783	2,678	0.292		



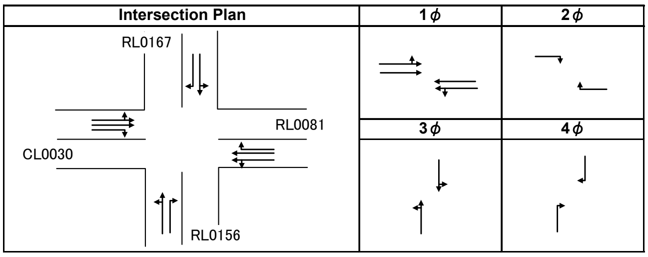
Intersection No.12

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
CL0030	Left	2,395	266	1,137	0.234	70	0.894
(ORR)	Straight	8,352	928	3,013	0.308		
	Right	2,907	323	1,431	0.226		
RL0147	Left	1,172	0	0	0.000		
	Straight	1,995	352	1,370	0.257		
	Right	2,775	308	1,431	0.215		
CL0031	Left	122	0	0	0.000		
(ORR)	Straight	8,585	968	3,003	0.322		
	Right	1,087	121	1,431	0.085		
RL0146	Left	3,120	347	1,137	0.305		
	Straight	1,973	219	1,507	0.145		
	Right	130	14	1,431	0.010		



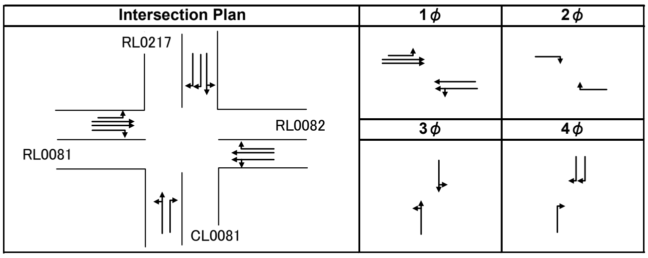
Intersection No.13

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RL0081	Left	968	0	0	0.000	50	0.818
(ORR)	Straight	11,046	1335	2,953	0.452		
	Right	187	21	1,431	0.015		
RL0156	Left	0	0	0	0.000		
	Straight	681	76	1,507	0.050		
	Right	1,280	142	1,431	0.099		
CL0030	Left	2,679	0	0	0.000		
(ORR)	Straight	11,346	1559	2,872	0.543		
	Right	0	0	1,431	0.000		
RL0167	Left	184	0	0	0.000		
	Straight	561	82	1,416	0.058		
	Right	2,607	290	1,431	0.203		



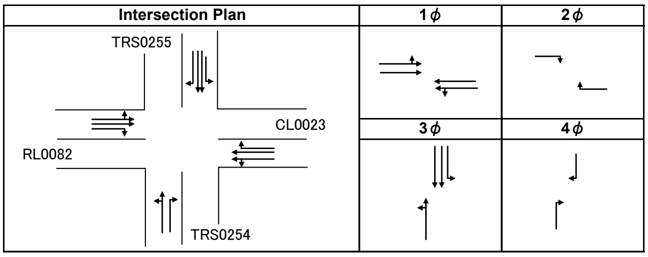
Intersection No.14

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RL0082	Left	862	0	0	0.000	60	0.862
	Straight	7,671	948	2,938	0.323		
	Right	0	0	1,431	0.000		
CL0081	Left	818	0	0	0.000		
(ORR)	Straight	3,521	482	1,437	0.335		
	Right	1,115	124	1,431	0.087		
RL0081	Left	3,812	424	1,137	0.373		
	Straight	7,964	885	3,013	0.294		
	Right	720	80	1,431	0.056		
RL0217	Left	0	0	0	0.000		
(ORR)	Straight	3,063	340	1,507	0.226		
	Right	3,806	423	2,863	0.148		



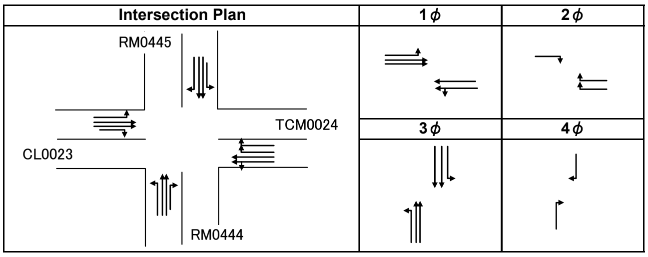
Intersection No.15

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
CL0023	Left	284	0	0	0.000	60	0.859
(ORR)	Straight	7,470	862	2,986	0.289		
	Right	3,257	362	1,431	0.253		
TRS0254	Left	730	0	0	0.000		
	Straight	7,338	896	1,473	0.608		
	Right	274	30	1,431	0.021		
RL0082	Left	426	0	0	0.000		
(ORR)	Straight	7,778	911	2,975	0.306		
	Right	746	83	1,431	0.058		
TRS0255	Left	3,267	363	1,137	0.319		
	Straight	7,439	827	3,013	0.274		
	Right	337	37	1,431	0.026		



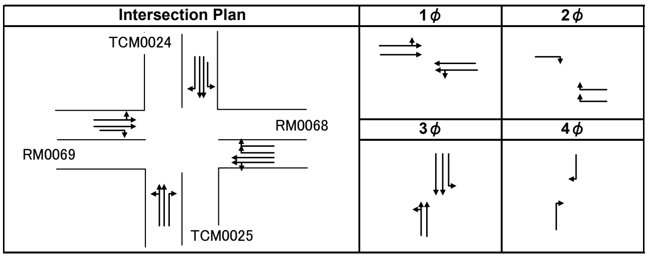
Intersection No.16

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
TCM0024	Left	553	0	0	0.000	60	0.824
(ORR)	Straight	5,390	660	2,755	0.240		
	Right	4,004	445	2,678	0.166		
RM0444	Left	3,577	397	1,064	0.373		
(Airport Road)	Straight	6,318	702	2,819	0.249		
	Right	720	80	1,339	0.060		
CL0023	Left	2,086	232	1,064	0.218		
(ORR)	Straight	5,598	622	2,819	0.221		
	Right	3,634	404	1,339	0.302		
RM0445	Left	4,058	451	1,064	0.424		
(Airport Road)	Straight	6,181	687	2,819	0.244		
	Right	2,044	227	1,339	0.170		



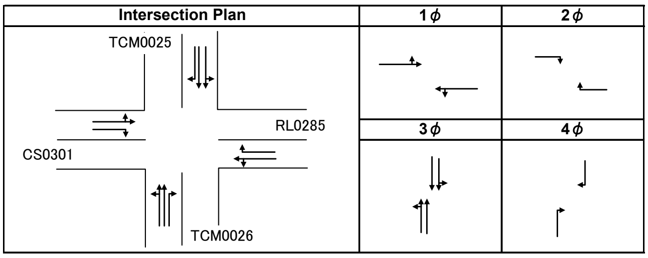
Intersection No.17

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RM0068	Left	1,090	0	0	0.000	40	0.708
(Great East	Straight	5,371	718	2,920	0.246		
Road)	Right	6,652	739	2,893	0.255		
TCM0025	Left	572	0	0	0.000		
(ORR)	Straight	3,294	430	2,934	0.147		
	Right	1,090	121	1,447	0.084		
RM0069	Left	0	0	0	0.000		
(Great East	Straight	5,691	632	3,046	0.208		
Road)	Right	567	63	1,447	0.044		
TCM0024	Left	6,988	776	1,149	0.675		
(ORR)	Straight	3,388	376	3,046	0.123		
	Right	0	0	1,447	0.000		



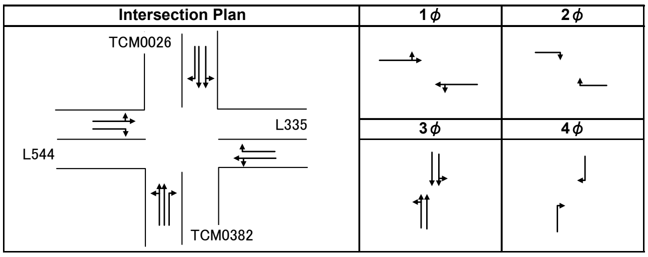
Intersection No.18

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
RL0285	Left	1,536	0	0	0.000	40	0.583
	Straight	1	171	1,137	0.150		
	Right	0	0	1,431	0.000		
TCM0026	Left	983	0	0	0.000		
(ORR)	Straight	4,518	611	2,881	0.212		
	Right	1,575	175	1,431	0.122		
CS0301	Left	502	0	0	0.000		
	Straight	0	56	1,137	0.049		
	Right	1,256	140	1,431	0.098		
TCM0025	Left	0	0	0	0.000		
(ORR)	Straight	4,611	512	3,013	0.170		
	Right	423	47	1,431	0.033		



Intersection No.19

From Leg	Direction	TV/day	v	s	v/s	C	Σv/s
L335	Left	551	0	0	0.000	40	0.428
	Straight	133	76	1,171	0.065		
	Right	155	17	1,385	0.012		
TCM0382	Left	49	0	0	0.000		
(ORR)	Straight	2,903	328	2,905	0.113		
	Right	523	58	1,385	0.042		
L544	Left	1,682	0	0	0.000		
	Straight	163	205	1,132	0.181		
	Right	49	5	1,385	0.004		
TCM0026	Left	153	0	0	0.000		
(ORR)	Straight	2,996	350	2,881	0.121		
	Right	1,410	157	1,385	0.113		



where,
TV/day = Directional daily traffic volume
V = Adjusted flow rate (h)
S = Adjusted saturation flow rate
v/s = Degree of saturation
C = Cycle time
$\sum w/s$ = Total degree of saturation
Source: JICA Study Team

2.4.5 Pavement Component

The pavement was designed according to the Pavement Design Guide, Roads Department, Ministry of Works and Supply 1994.

The subsoil condition (CBR value) was set up referring to the available data in "Pavement Evaluation of Great East Road, May 2008", where subsoil is assumed to be of similar condition.

Table 2.4.4 shows the proposed pavement design.

Table 2.4.4 Proposed Pavement Design

Component	Material	Thickness (cm)
Wearing Course	Hot mixed asphalt concrete	5
Binder Course	Hot mixed asphalt concrete	5
Base Course	Mechanical stabilized crushed aggregate	30
Sub-base Course	Granular material	45

Source: JICA Study Team

2.4.6 Drainage System

Side channels for surface drainage are installed on both sides of the road in order to protect the road structures from rainwater and ensure the road is open in all weather.

2.4.7 Road Facilities

(1) Traffic Signal

All intersections which are shown in Figure 2.4.3 need traffic signals due to their saturation level. Flexible signal phasing system is proposed to be adopted for the operation of the traffic signals in order for it to function according to traffic capacity.

(2) Traffic Safety Devices

Traffic safety devices include road markings, traffic signs, and median islands. These facilities are planned to be installed for the entire sections.

(3) Street Light

Street lights are planned to be installed in major intersections and along service roads which have frequent traffic access.

2.4.8 Summary of Cross Section Design

The result of the preliminary design and design quantities of the project roads are summarized as follows:

Table 2.4.5 Summary of the Cross Section Design

Type of Project		New Construction
Road Length		86.015 km
Median		3.40 m
Carriageway (Lane) width		3.75 m x 4 (paved)
Shoulder		3.00 m x 2 (paved)
Service Road		3.00 m (both sides)
Buffer Zone		5.00 m (both sides)
Total Road Width		45.00 m
Earthwork	Excavation:	1,925,337 m^3
	Embankment:	825,255 m^3
	Subgrade:	1,734,062 m^3
Pavement Component and Extent of Work		
Carriageway	Surface Course:	10 cm

	Base Course:	30 cm
	Subbase Course:	45 cm
	Pavement Area:	1,290,225 m^2
Shoulder	Surface Course:	10 cm
	Base Course:	30 cm
	Subbase Course:	45 cm
	Pavement Area	516,090 m^2
Service Road	Surface Course:	10 cm
	Base Course:	30 cm
	Subbase Course:	45 cm
	Pavement Area:	516,090 m^2
Cross Drainage	Box Culverts:	85 locations, 3,825 m
	Pipe Culverts:	287 locations, 12,915 m
Surface Drainage		Drainage Channel: 172,030 m
Traffic Signals		80 locations
Traffic Safety Devices	Markings:	516,090 m
	Traffic Signs:	343 locations
Traffic Light		80 Nos.
Planting		21,505 Nos.

Source: JICA Study Team

2.5 Preliminary Cost Estimation

2.5.1 Condition of Cost Estimation

The construction cost was estimated based on the recent information and updated data from local consultants and the LCC.

Cost items of the preliminary cost estimate are:

Table 2.5.1 Cost Items of the Preliminary Cost Estimate

Component / Element	Particular Conditions
Project Cost	
a. Construction Cost	
Direct Cost	Estimated by unit costs and quantities
Indirect Cost	
Overhead and Profit	10 % of the direct cost
Field Expenses	1 % of the direct cost
Temporary Works	10 % of the direct cost
Employer's Site Requirements	Cost for supply of site office and the required expenses Estimated as 2 % of the direct cost
b. Land Acquisition	Land acquisition cost was estimated as 50,000 ZMK /m^2 based on the Government Valuation Department Bulletin and LCC Main Valuation Roll 2007
c. Relocation Compensation	30,000,000 ZMK/house
d. Relocation/Removal of Utilities	10 % of the construction cost Including power lines, telecom lines and water main pipes
e. Taxes	VAT, etc. 16 % of the construction cost
f. Administration Cost	2 % of the construction cost
g. Engineering Cost	10 % of the construction cost
h. Contingency	10 % of the construction cost

Note: Since actual extent of utilities relocation/removal has several unknown factors at present stage, possible amount was estimated for magnitude of the construction.

Source: JICA Study Team

2.5.2 Construction Cost

The construction cost was estimated for each road section, using the unit cost shown in Table 2.5.2. The unit costs were obtained from local consultant companies as most recent information.

Table 2.5.2 Unit Cost by Work Item

	Unit Cost	Remarks
EARTHWORK		
Embankment (Gravel)	144,000 ZMK/m^3	Including 1km hauling from Borrow Pit, formation
Embankment (Common Soil)	45,000 ZMK/m^3	Including 1km hauling from Borrow Pit, formation
Hard Rock Excavation	160,000 ZMK/m^3	Including embankment, formation
Soft Rock Excavation	24,000 ZMK/m^3	Including embankment, formation
Removal of Top Soil	20,000 ZMK/m^3	Remove surface on existing road as unsuitable material, less than 20cm in thickness
Subgrade Preparation	25,000 ZMK/m^2	Compact 90% of maximum dry density
PAVEMENT WORK		
Subgrade	45,000 ZMK/m^3	15cm in thickness, Compact 93% of maximum dry density
Granular Subbase	55,000 ZMK/m^3	15cm in thickness, Compact 95% of maximum dry density
Granular Base	65,000 ZMK/m^3	15cm in thickness, Compact 97% of maximum dry density
Cement Stabilized Base	20,000 ZMK/m^3	15cm in thickness, contain 4% cement
- Portland Cement	1,250,000 ZMK/ton	for cement stabilized base
Prime Coat	3,400 ZMK/m^2	MC-30, 1l/m^2
Tack Coat	1,500 ZMK/m^2	1l/m^2
Asphalt Wearing Course	80,000 ZMK/m^2	5cm in thickness
Multiple Bituminous Surface Dressing	30,000 ZMK/m^2	
- Bitumen	9,500 ZMK/litre	
- Aggregate 19.0mm	165,000 ZMK/m^3	
- Aggregate 9.5mm	165,000 ZMK/m^3	
- Fog Spray	4,200 ZMK/litre	
Concrete Work	1,150,000 ZMK/m^3	
Structural Excavation	48,000 ZMK/m^3	
DRAINAGE STRUCTURES		
RC Bridge	16,000,000 ZMK/m^2	Including substructure, foundation (4,000 USD/^{m2} x 4,000)
PC Bridge	20,000,000 ZMK/m^2	Including substructure, foundation (5,000 USD/m^2 x 4,000)
Box Culvert	7,500,000 ZMK/m	1.0m x 1.0m, Double
Pipe Culvert	1,750,000 ZMK/m	Diameter: 500mm
Side Channel	517,500 ZMK/m	0.5m x 0.5m (0.45m^3/m x 1150000 K/m^3)
ANCILLARY WORKS		
Traffic Signal	67,500,000 ZMK/each	Including electric work
Marking	2,000 ZMK/m	
Delineator		
Traffic Sign	3,500,000 ZMK/each	
Guard Rail	320,000 ZMK/m	
Traffic Light	8,000,000 ZMK/each	
Planting	370,000 ZMK/each	18,500 K/m^3 x 20m^3/each
EARTHWORK (additional)		
Clearing and Grubbing	1,200 ZMK/m^2	
Excavation of Surplus Material	38,000 ZMK/m^3	from borrow pit
Spreading surplus material	7,500,000 ZMK/ha	from borrow pit

Source: JICA Study Team (unit costs from local consultant companies)

The quantities of the work items and the estimated costs by section are shown in the following tables.

Table 2.5.3 Construction Cost of South Section

Item	Description		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	871,830	1,046,196,000
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	0	0
Soft Rock Excavation			m^3	24,000	435,915	10,461,960,000
Subgrade Preparation			m^2	25,000	503,724	12,593,100,000
Subgrade		80 cm	m^3	45,000	390,579	17,576,092,800
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	290,610	23,248,800,000
Binder Course	As	5 cm	m^2	80,000	290,610	23,248,800,000
Base	Granular	30 cm	m^3	65,000	87,183	5,666,895,000
Sub-Base	Granular	45 cm	m^3	55,000	130,774	7,192,597,500
Prime Coat			m^2	3,400	290,610	988,074,000
Tack Coat			m^2	1,500	290,610	435,915,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	116,244	9,299,520,000
Binder Course	As	5 cm	m^2	80,000	116,244	9,299,520,000
Base	Granular	30 cm	m^3	65,000	34,873	2,266,758,000
Sub-Base	Granular	45 cm	m^3	55,000	52,310	2,877,039,000
Prime Coat			m^2	3,400	116,244	395,229,600
Tack Coat			m^2	1,500	116,244	174,366,000
PAVEMENT (Service Road)						
Wearing Course	As	5 cm	m^2	80,000	116,244	9,299,520,000
Binder Course	As	5 cm	m^2	80,000	116,244	9,299,520,000
Base	Granular	30 cm	m^3	65,000	34,873	2,266,758,000
Sub-Base	Granular	45 cm	m^3	55,000	52,310	2,877,039,000
Prime Coat			m^2	3,400	116,244	395,229,600
Tack Coat			m^2	1,500	116,244	174,366,000
BRIDGE						
RC Bridge			m^2	16,000,000	0	0
PC Bridge			m^2	20,000,000	0	0
DRAINAGE						
Box Culvert			m	7,500,000	855	6,412,500,000
Pipe Culvert			m	1,750,000	2,925	5,118,750,000
Side Channel			m	517,500	38,748	20,052,090,000
ANCILLARY WORKS						
Traffic Signal			each	67,500,000	20	1,350,000,000
Marking			m	2,000	116,244	232,488,000
Delineator			m	0	0	0
Traffic Sign			each	3,500,000	77	269,500,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	20	160,000,000
Planting			each	370,000	4,844	1,792,280,000
Sub-total						186,470,903,500
INDIRECT COST						
Overhead and Profit			%	186,470,903,500	10	18,647,090,350
Field Expenses			%	186,470,903,500	1	1,864,709,035
Temporary Works			%	186,470,903,500	10	18,647,090,350
Employer's Site Requirements			%	186,470,903,500	2	3,729,418,070
Sub-Total						42,888,307,805
Total						229,359,211,305

Source: JICA Study Team

Table 2.5.4 Construction Cost of East Section

Item	Description		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	825,255	990,306,000
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	825,255	37,136,475,000
Hard Rock Excavation			m^3	160,000	0	0
Soft Rock Excavation			m^3	24,000	412,627	9,903,060,000
Subgrade Preparation			m^2	25,000	476,814	11,920,350,000
Subgrade			m^3	45,000	369,714	16,637,140,800
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	275,085	22,006,800,000
Binder Course	As	5 cm	m^2	80,000	275,085	22,006,800,000
Base	Granular	30 cm	m^3	65,000	82,526	5,364,157,500
Sub-Base	Granular	45 cm	m^3	55,000	123,788	6,808,353,750
Prime Coat			m^2	3,400	275,085	935,289,000
Tack Coat			m^2	1,500	275,085	412,627,500
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	110,034	8,802,720,000
Binder Course	As	5 cm	m^2	80,000	110,034	8,802,720,000
Base	Granular	30 cm	m^3	65,000	33,010	2,145,663,000
Sub-Base	Granular	45 cm	m^3	55,000	49,515	2,723,341,500
Prime Coat			m^2	3,400	110,034	374,115,600
Tack Coat			m^2	1,500	110,034	165,051,000
PAVEMENT (Service Road)						
Wearing Course	As	5 cm	m^2	80,000	110,034	8,802,720,000
Binder Course	As	5 cm	m^2	80,000	110,034	8,802,720,000
Base	Granular	30 cm	m^3	65,000	33,010	2,145,663,000
Sub-Base	Granular	45 cm	m^3	55,000	49,515	2,723,341,500
Prime Coat			m^2	3,400	110,034	374,115,600
Tack Coat			m^2	1,500	110,034	165,051,000
BRIDGE						
RC Bridge			m^2	16,000,000	675	10,800,000,000
PC Bridge			m^2	20,000,000	2,700	54,000,000,000
DRAINAGE						
Box Culvert			m	7,500,000	810	6,075,000,000
Pipe Culvert			m	1,750,000	2,745	4,803,750,000
Side Channel			m	517,500	36,678	18,980,865,000
ANCILLARY WORKS						
Traffic Signal			each	67,500,000	20	1,350,000,000
Marking			m	2,000	110,034	220,068,000
Delineator			m	0	0	0
Traffic Sign			each	3,500,000	73	255,500,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	20	160,000,000
Planting			each	370,000	4,585	1,696,450,000
Sub-total						278,490,214,750
INDIRECT COST						
Overhead and Profit			%	278,490,214,750	10	27,849,021,475
Field Expenses			%	278,490,214,750	1	2,784,902,148
Temporary Works			%	278,490,214,750	10	27,849,021,475
Employer's Site Requirements			%	278,490,214,750	2	5,569,804,295
Sub-Total						64,052,749,393
Total						342,542,964,143

Source: JICA Study Team

Table 2.5.5 Construction Cost of North Section

Item	Description		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	777,960	933,552,000
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	0	0
Soft Rock Excavation			m^3	24,000	388,980	9,335,520,000
Subgrade Preparation			m^2	25,000	449,488	11,237,200,000
Subgrade			m^3	45,000	348,526	15,683,673,600
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	259,320	20,745,600,000
Binder Course	As	5 cm	m^2	80,000	259,320	20,745,600,000
Base	Granular	30 cm	m^3	65,000	77,796	5,056,740,000
Sub-Base	Granular	45 cm	m^3	55,000	116,694	6,418,170,000
Prime Coat			m^2	3,400	259,320	881,688,000
Tack Coat			m^2	1,500	259,320	388,980,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	103,728	8,298,240,000
Binder Course	As	5 cm	m^2	80,000	103,728	8,298,240,000
Base	Granular	30 cm	m^3	65,000	31,118	2,022,696,000
Sub-Base	Granular	45 cm	m^3	55,000	46,678	2,567,268,000
Prime Coat			m^2	3,400	103,728	352,675,200
Tack Coat			m^2	1,500	103,728	155,592,000
PAVEMENT (Service Road)						
Wearing Course	As	5 cm	m^2	0	103,728	0
Binder Course	As	5 cm	m^2	0	103,728	0
Base	Granular	30 cm	m^3	0	31,118	0
Sub-Base	Granular	45 cm	m^3	0	46,678	0
Prime Coat			m^2	0	103,728	0
Tack Coat			m^2	0	103,728	0
BRIDGE						
RC Bridge			m^2	16,000,000	675	10,800,000,000
PC Bridge			m^2	20,000,000	0	0
DRAINAGE						
Box Culvert			m	7,500,000	765	5,737,500,000
Pipe Culvert			m	1,750,000	2,610	4,567,500,000
Side Channel			m	517,500	34,576	17,893,080,000
ANCILLARY WORKS						
Traffic Signal			each	67,500,000	20	1,350,000,000
Marking			m	2,000	103,728	207,456,000
Delineator			m	0	0	0
Traffic Sign			each	3,500,000	69	241,500,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	20	160,000,000
Planting			each	370,000	4,322	1,599,140,000
Sub-total						155,677,610,800
INDIRECT COST						
Overhead and Profit			%	155,677,610,800	10	15,567,761,080
Field Expenses			%	155,677,610,800	1	1,556,776,108
Temporary Works			%	155,677,610,800	10	15,567,761,080
Employer's Site Requirements			%	155,677,610,800	2	3,113,552,216
Sub-Total						35,805,850,484
Total						191,483,461,284

Source: JICA Study Team

Table 2.5.6 Construction Cost of West Section

Item	Description		Unit	Unit Cost (ZMK)	Quantity	Amount (ZMK)
EARTHWORK						
Clearing and Grubbing			m^2	1,200	1,395,630	1,674,756,000
Removal of Top Soil	less than 20cm		m^3	20,000	0	0
Embankment	Granular		m^3	144,000	0	0
Embankment	Earth & Sand		m^3	45,000	0	0
Hard Rock Excavation			m^3	160,000	0	0
Soft Rock Excavation			m^3	24,000	697,815	16,747,560,000
Subgrade Preparation			m^2	25,000	806,364	20,159,100,000
Subgrade			m^3	45,000	625,242	28,135,900,800
PAVEMENT (Carriage Way)						
Wearing Course	As	5 cm	m^2	80,000	465,210	37,216,800,000
Binder Course	As	5 cm	m^2	80,000	465,210	37,216,800,000
Base	Granular	30 cm	m^3	65,000	139,563	9,071,595,000
Sub-Base	Granular	45 cm	m^3	55,000	209,345	11,513,947,500
Prime Coat			m^2	3,400	465,210	1,581,714,000
Tack Coat			m^2	1,500	465,210	697,815,000
PAVEMENT (Shoulder)						
Wearing Course	As	5 cm	m^2	80,000	186,084	14,886,720,000
Binder Course	As	5 cm	m^2	80,000	186,084	14,886,720,000
Base	Granular	30 cm	m^3	65,000	55,825	3,628,638,000
Sub-Base	Granular	45 cm	m^3	55,000	83,738	4,605,579,000
Prime Coat			m^2	3,400	186,084	632,685,600
Tack Coat			m^2	1,500	186,084	279,126,000
PAVEMENT (Service Road)						
Wearing Course	As	5 cm	m^2	80,000	186,084	14,886,720,000
Binder Course	As	5 cm	m^2	80,000	186,084	14,886,720,000
Base	Granular	30 cm	m^3	65,000	55,825	3,628,638,000
Sub-Base	Granular	45 cm	m^3	55,000	83,738	4,605,579,000
Prime Coat			m^2	3,400	186,084	632,685,600
Tack Coat			m^2	1,500	186,084	279,126,000
BRIDGE						
RC Bridge			m^2	16,000,000	4,050	64,800,000,000
PC Bridge			m^2	20,000,000	0	0
DRAINAGE						
Box Culvert			m	7,500,000	1,395	10,462,500,000
Pipe Culvert			m	1,750,000	4,635	8,111,250,000
Side Channel			m	517,500	62,028	32,099,490,000
ANCILLARY WORKS						
Traffic Signal			each	67,500,000	20	1,350,000,000
Marking			m	2,000	186,084	372,168,000
Delineator			m	0	0	0
Traffic Sign			each	3,500,000	124	434,000,000
Guard Rail			m	320,000	0	0
Traffic Light			each	8,000,000	20	160,000,000
Planting			each	370,000	7,754	2,868,980,000
Sub-total						362,513,313,500
INDIRECT COST						
Overhead and Profit			%	362,513,313,500	10	36,251,331,350
Field Expenses			%	362,513,313,500	1	3,625,133,135
Temporary Works			%	362,513,313,500	10	36,251,331,350
Employer's Site Requirements			%	362,513,313,500	2	7,250,266,270
Sub-Total						83,378,062,105
Total						445,891,375,605

Source: JICA Study Team

2.5.3 Project Cost

The estimated project cost is summarized as follows.

Table 2.5.7 Summary of Project Cost

Unit: USD million

Cost Item	South	East	North	West	Total
Construction	64.0	95.6	53.5	124.5	337.6
Land Acquisition	12.2	11.5	10.9	19.5	54.0
Building Relocation/ Compensation	0.0	0.1	0.1	0.2	0.4
Relocation/ Removal of Utilities	6.4	9.6	5.3	12.4	33.8
Taxes	10.2	15.3	8.6	19.9	54.0
Administration	1.3	1.9	1.1	2.5	6.8
Engineering	6.4	9.6	5.3	12.4	33.8
Contingency	6.4	9.6	5.3	12.4	33.8
Total	107.0	153.1	90.1	203.9	554.1
Total - Taxes	96.7	137.8	81.5	184.0	500.1

Source: JICA Study Team

2.5.4 Construction Period

Table 2.5.3 shows the estimation of the construction period for the Outer Ring Road. It was estimated that the construction period of the south, east, and north sections would be 3–4 years while the west section needs five years of construction.

Table 2.5.8 Estimation of Construction Period

	Work Period per km	South Section		East Section		North Section		West Section	
		Length (km)	Work Period	Length (km)	Work Period Month	Length (km)	Work Period Month	Length (km)	Work Period Month
New Construction									
Flat Terrain									
Embankment	0.56	19.374	10.8			8.892	5.0	18.000	10.1
Base Course	0.31	19.374	6.0			8.892	2.8	18.000	5.6
Surface Course	0.71	19.374	13.8			8.892	6.3	18.000	12.8
Hilliy Terrain									
Embankment	0.47			18.339	8.6	8.396	3.9	13.014	6.1
Base Course	0.31			18.339	5.7	8.396	2.6	13.014	4.0
Surface Course	0.71			18.339	13.0	8.396	6.0	13.014	9.2
Others			9.0		9.0		9.0		9.0
TOTAL			39.6		36.3		35.6		56.8

Source: JICA Study Team

2.6 Operation and Maintenance

2.6.1 Operation and Maintenance Program

Road and drainage cleaning is the minimum requirement of maintenance work after the completion of the project. It is recommended that the cleaning work should be carried out at least once a month as routine maintenance. Routine maintenance should be scheduled and organized based on daily inspection.

Since the traffic on the project road is expected to increase in the near future, periodic maintenance and rehabilitation should be programmed to ensure the good riding quality of the road.

The following routine and periodic inspection activities are proposed.

Table 2.6.1 Proposed Inspection Program

Level of Inspection	Frequency	Methodology
Routine Inspection	- Once a day for inspection on the roadway - Two to four times a year for outside the roadway	On-vehicle inspection
Periodic Inspection	- Once a year	On-foot inspection by a group of engineers and technicians
Special Inspection	- Once in every five years	On-foot inspection of a specific site or section by a team of professional engineers and technicians for specific purposes, such as acquisition of actual data needed to establish a rehabilitation program

Source: JICA Study Team

Based on these inspections, a proper annual maintenance program should be formulated.

2.6.2 Operation and Maintenance Costs

1) Routine Maintenance

Routine maintenance will consist of road cleaning and drainage cleaning.

It is assumed that the routine maintenance cost is 5% of the maintenance and rehabilitation cost.

2) Periodic/Preventive Maintenance and Minor/Major Rehabilitation

Typical methods of periodic maintenance and minor/major rehabilitation are presented below:

Table 2.6.2 Proposed Rehabilitation Method by Damage Type

Type of Damage	Periodic/Preventive Maintenance	Minor Rehabilitation	Major Rehabilitation
Raveling	Seal		
Potholes	Patching	Overlaying	Replacement of Base / Sub-base Course
Block Cracking	Seal, Patching		Resurfacing
Longitudinal Cracking	Crack Seal		

Source: JICA Study Team

The five year maintenance program is proposed as:

- Routine maintenance and inspection will be done every year.
- Pothole patching will be done on the third year of the maintenance program as the periodic maintenance work.
- Overlaying will be done on the fifth year of the maintenance program as the minor rehabilitation work.
- The five year maintenance program will be repeated up to 2030.

3) Maintenance Costs

The unit costs of maintenance works were assumed as shown in the table below:

Table 2.6.3 Unit Cost of Maintenance Works

Level of Requirement	Major Work	Unit Cost	Remarks
Periodic Maintenance	Patching	740,000 ZMK/m^3	Refer to data in the recent maintenance report
Minor Rehabilitation	Overlaying	1,600,000 ZMK/m^3	Estimated based on recent information from local consultants

Source: JICA Study Team (Unit cost was obtained from local consultant companies.)

The results of the estimates for all maintenance costs are shown in the table below.

Table 2.6.4 Estimated Maintenance Costs of the Outer Ring Road

Item	Unit Cost ZMK	Quantity	Frequency	Cost for five years ZMK
Periodic Maintenance	740,000	103m^3	Third Year	76,220,000
Minor Rehabilitation	1,600,000	69,411m^3	Fifth Year	111,057,600,000
Total				548,420,127,500

Source: JICA Study Team

2.7 Economic Evaluation

2.7.1 Methodology

Economic evaluation was carried out by calculating the Economic Internal Rate of Return (EIRR) and Net Present Value (NPV) of this project. For the NPV, a discount rate of 10% was used.

The major economic benefits from the Outer Ring Road are: i) formulation of a good urban structure, ii) benefit from the industrial park development, and iii) benefit from the satellite town development. However, it is difficult to estimate these benefits in monetary terms, since it is necessary to estimate how much the benefit from the industrial park and satellite towns will reduce unless the Outer Ring Road exists. Economic loss from the failure of the urban structure formulation is also difficult to be evaluated in terms of money.

In this report, the economic benefits were evaluated in view of traffic. Savings in vehicle operating cost (VOC) and travel time cost (TTC) were considered as economic benefits of the Outer Ring Road. These are the traditional items for the economic analysis in the roads sector.

Since the Outer Ring Road is a long-term project, the benefits are reflected in the latter stage of the cash flow analysis. To evaluate this project based on the maser plan schedule, the evaluation period should be long enough to consider the benefits after 2030. However, the far future benefits and costs are negligible due to the discount rate applied in the analysis. Therefore, this project was evaluated based on the case that the full sections are constructed as 4-lane roads by 2015. The applicable implementation schedule is discussed in 2.9.

For traffic volume calculation, the road network data of the “with project” and “without Project” cases are prepared for years 2015, 2020, and 2030. The network in the “with project” case consists of the master plan network and the full Outer Ring Road network. The network in the “without project” case consists of the master plan network, excluding the Outer Ring Road sections. In other words, it was assumed that all master plan projects will be carried out except for the Outer Ring Road.

The same OD data as in the master plan analysis was used. This means that all the industrial parks and satellite towns were assumed to be developed even if the Outer Ring Road would not be developed.

2.7.2 Vehicle Operating Cost

Vehicle operating cost (VOC) is calculated for car, bus, and truck by applying HDM-4, which is a popular model on VOC calculation for economic evaluation. Table 2.7.1 shows the unit prices used in the HDM-4 analysis. Carbon dioxide (CO_2) emission is also estimated by using fuel consumption calculated in HDM-4. The conversion rate for CO_2 is 2.36 ton/ liter for petroleum, and 2.738 for diesel. Since the recent wholesale price of fuel has been fluctuating, the average price in 2006 was used.

Table 2.7.1 Unit Prices for HDM-4 Analysis

	Fuel USD/litter	Lubricant USD/litter	Vehicle USD/vehicle	Tire USD/no.	Maintenance USD/hour	Crew USD/hour
Car	0.6	4.5	5,000	100	2.9	0.0
Minibus	0.6	4.5	8,000	188	2.9	2.2
Truck	0.7	4.5	12,500	850	2.9	2.2

Source: JICA Study Team

Table 2.7.2 shows the calculated VOC by speed. As analyzed from the table, the most economical speed is 60 km/h, thus, the VOC on the Outer Ring Road becomes higher than the other roads because the maximum speed in the ring road is 80 km/h.

Table 2.7.2 Vehicle Operating Cost

VOC per vehicle-1000km Unit: USD

Speed	Paved			Unpaved		
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK
10	290.9	254.1	586.8	323.9	275.3	648.9
20	186.8	154.0	367.0	219.5	175.1	428.8
30	153.9	122.5	298.9	186.9	143.8	361.2
40	139.8	107.8	269.6	173.1	129.9	332.7
50	133.7	100.5	256.4	168.0	122.8	320.5
60	131.8	96.3	249.7	166.5	119.0	312.8
70	133.6	95.3	251.7	170.0	118.8	316.1
80	137.9	96.7	259.6	177.4	121.8	326.2
90	146.5	98.9	271.5	188.2	125.6	341.4
100	157.1	102.7	287.6	202.7	131.2	360.8

Source: JICA Study Team

VOC savings is estimated as USD 3.5 million per year in 2015, USD 7.3 million in 2020, and USD 22.6 million in 2030.

2.7.3 Travel Time Cost

Passenger travel time cost is calculated from time values, which is estimated from the result of household interview survey conducted by the JICA Study Team in 2007. The future time values are estimated from the assumption of per capita GDP growth. Time cost for goods is not estimated due to difficulty of the estimation. Table 2.7.3 shows the estimated time values.

Table 2.7.3 Time Values

Unit: USD

Year	Time Value per passenger		Time Value per vehicle		Ratio to 2007	
	Bus	Car	Bus	Car	Bus	Car
2007	0.300	2.25	3.00	2.70	1.00	1.00
2015	0.420	2.41	4.20	2.89	1.40	1.07
2020	0.528	2.75	5.28	3.29	1.76	1.22
2030	0.840	3.47	8.40	4.16	2.80	1.54

Source: JICA Study Team

Travel time cost saving per year is estimated at USD 4.7 million in 2015, USD 12.8 million in 2020, and USD 77.1 million in 2030.

Table 2.7.4 Calculation of VOC and TTC (2015)

Vehicle-km (per day) With Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	25,137	125,136	45,663	11,644	50,526	20,476	36,781	175,663	66,139	278,582
20	54,626	260,746	90,520	7,319	27,511	8,894	61,945	288,257	99,414	449,616
30	19,809	113,288	58,246	0	0	0	19,809	113,288	58,246	191,343
40	9,705	66,424	43,880	0	0	0	9,705	66,424	43,880	120,009
50	971	6,225	3,337	0	0	0	971	6,225	3,337	10,534
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	12,494	73,876	34,562	0	0	0	12,494	73,876	34,562	120,932

Vehicle-km (per day) Without Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	172,037	842,875	306,602	66,070	286,504	113,592	238,107	1,129,379	420,194	1,787,680
20	264,386	1,287,109	437,281	38,798	158,852	51,224	303,184	1,445,961	488,505	2,237,650
30	105,791	633,128	311,608	0	0	0	105,791	633,128	311,608	1,050,527
40	32,234	239,252	192,029	0	0	0	32,234	239,252	192,029	463,515
50	6,369	36,647	19,035	0	0	0	6,369	36,647	19,035	62,051
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0

Vehicle-km Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	146,900	717,739	260,939	54,426	235,978	93,116	201,326	953,716	354,055	1,509,098
20	209,760	1,026,363	346,761	31,479	131,341	42,330	241,239	1,157,704	389,091	1,788,034
30	85,982	519,840	253,362	0	0	0	85,982	519,840	253,362	859,184
40	22,529	172,828	148,149	0	0	0	22,529	172,828	148,149	343,506
50	5,398	30,422	15,698	0	0	0	5,398	30,422	15,698	51,517
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	-12,494	-73,876	-34,562	0	0	0	-12,494	-73,876	-34,562	-120,932

VOC Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	75,580	182,403	153,126	29,783	64,964	60,425	105,364	247,367	213,551	566,282
20	62,505	158,106	127,264	10,400	23,003	18,150	72,906	181,109	145,413	399,428
30	19,576	63,699	75,737	0	0	0	19,576	63,699	75,737	159,012
40	4,397	18,628	39,943	0	0	0	4,397	18,628	39,943	62,968
50	960	3,059	4,026	0	0	0	960	3,059	4,026	8,044
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	-2,062	-7,145	-8,972	0	0	0	-2,062	-7,145	-8,972	-18,180
										1,177,555

Fuel Saving (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	33,875	167,448	66,644	13,367	57,956	27,749	47,242	225,405	94,392	367,039
20	26,702	130,040	55,412	4,454	18,230	8,542	31,157	148,270	63,955	243,382
30	8,211	48,917	34,280	0	0	0	8,211	48,917	34,280	91,408
40	1,863	13,792	19,082	0	0	0	1,863	13,792	19,082	34,736
50	423	2,230	2,056	0	0	0	423	2,230	2,056	4,709
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	-1,123	-5,504	-5,654	0	0	0	-1,123	-5,504	-5,654	-12,281

CO2 Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	79,945	395,178	182,471	31,546	136,776	75,975	111,492	531,955	258,446	901,893
20	63,018	306,895	151,719	10,512	43,023	23,388	73,530	349,918	175,108	598,555
30	19,379	115,444	93,858	0	0	0	19,379	115,444	93,858	228,681
40	4,397	32,548	52,245	0	0	0	4,397	32,548	52,245	89,191
50	999	5,263	5,630	0	0	0	999	5,263	5,630	11,892
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	-2,651	-12,989	-15,482	0	0	0	-2,651	-12,989	-15,482	-31,121
										1,799,091

Travel Time (per day)

Speed	With Case			Without Case			Time Saving			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
Hours	6,099	30,212	11,955	6,739	33,717	12,995	640	3,505	1,040	5,185
USD							2,686	10,125	0	12,811

Source: JICA Study Team

Table 2.7.5 Calculation of VOC and TTC (2020)

Vehicle-km (per day) — With Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	56,936	332,044	110,913	15,310	71,773	26,052	72,246	403,817	136,964	613,027
20	52,621	268,354	94,805	6,630	26,057	7,758	59,252	294,410	102,563	456,226
30	23,293	123,850	73,571	0	0	0	23,293	123,850	73,571	220,714
40	9,807	58,870	43,333	0	0	0	9,807	58,870	43,333	112,010
50	3,748	46,179	94,090	0	0	0	3,748	46,179	94,090	144,017
60	2,176	14,909	12,412	0	0	0	2,176	14,909	12,412	29,496
70	12,997	83,217	90,881	0	0	0	12,997	83,217	90,881	187,095
80	5,262	34,034	26,817	0	0	0	5,262	34,034	26,817	66,113

Vehicle-km (per day) — Without Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	400,898	2,282,735	786,646	95,004	450,896	164,907	495,902	2,733,631	951,553	4,181,086
20	232,978	1,245,228	472,970	31,001	128,844	50,206	263,979	1,374,072	523,176	2,161,227
30	92,252	492,647	362,611	0	0	0	92,252	492,647	362,611	947,510
40	25,771	158,431	164,939	0	0	0	25,771	158,431	164,939	349,141
50	21,754	248,762	494,601	0	0	0	21,754	248,762	494,601	765,117
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0

Vehicle-km Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	343,962	1,950,691	675,733	79,694	379,123	138,855	423,656	2,329,814	814,589	3,568,059
20	180,357	976,874	378,165	24,371	102,787	42,448	204,727	1,079,662	420,613	1,705,001
30	68,959	368,797	289,040	0	0	0	68,959	368,797	289,040	726,796
40	15,964	99,561	121,606	0	0	0	15,964	99,561	121,606	237,131
50	18,006	202,583	400,511	0	0	0	18,006	202,583	400,511	621,100
60	-2,176	-14,909	-12,412	0	0	0	-2,176	-14,909	-12,412	-29,496
70	-12,997	-83,217	-90,881	0	0	0	-12,997	-83,217	-90,881	-187,095
80	-5,262	-34,034	-26,817	0	0	0	-5,262	-34,034	-26,817	-66,113

VOC Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	176,969	495,740	396,538	43,610	104,372	90,107	220,579	600,112	486,645	1,307,336
20	53,743	150,483	138,789	8,052	18,002	18,200	61,795	168,485	156,989	387,270
30	15,700	45,191	86,402	0	0	0	15,700	45,191	86,402	147,293
40	3,116	10,731	32,786	0	0	0	3,116	10,731	32,786	46,633
50	3,202	20,369	102,708	0	0	0	3,202	20,369	102,708	126,278
60	-366	-1,436	-3,099	0	0	0	-366	-1,436	-3,099	-4,902
70	-2,141	-7,929	-22,873	0	0	0	-2,141	-7,929	-22,873	-32,943
80	-868	-3,292	-6,962	0	0	0	-868	-3,292	-6,962	-11,122
										1,965,844

Fuel Saving (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	79,318	455,096	172,582	19,573	93,113	41,379	98,890	548,209	213,961	861,061
20	22,959	123,770	60,431	3,448	14,267	8,566	26,408	138,037	68,997	233,441
30	6,586	34,704	39,107	0	0	0	6,586	34,704	39,107	80,396
40	1,320	7,945	15,663	0	0	0	1,320	7,945	15,663	24,928
50	1,412	14,849	52,467	0	0	0	1,412	14,849	52,467	68,728
60	-171	-1,042	-1,674	0	0	0	-171	-1,042	-1,674	-2,887
70	-1,077	-5,875	-13,323	0	0	0	-1,077	-5,875	-13,323	-20,276
80	-473	-2,536	-4,387	0	0	0	-473	-2,536	-4,387	-7,396

CO2 Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	187,190	1,074,027	472,530	46,192	219,746	113,295	233,382	1,293,773	585,826	2,112,980
20	54,184	292,097	165,459	8,138	33,670	23,454	62,322	325,767	188,913	577,002
30	15,542	81,901	107,075	0	0	0	15,542	81,901	107,075	204,518
40	3,116	18,750	42,885	0	0	0	3,116	18,750	42,885	64,751
50	3,332	35,044	143,654	0	0	0	3,332	35,044	143,654	182,030
60	-403	-2,459	-4,584	0	0	0	-403	-2,459	-4,584	-7,446
70	-2,543	-13,865	-36,479	0	0	0	-2,543	-13,865	-36,479	-52,887
80	-1,116	-5,984	-12,012	0	0	0	-1,116	-5,984	-12,012	-19,113
										3,061,836

Travel Time (per day)

Speed	With Case			Without Case			Time Saving			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
Hours	9,237	51,312	21,750	10,702	59,650	24,244	1,465	8,337	2,494	12,297
USD							7,736	27,463	0	35,200

Source: JICA Study Team

Table 2.7.6 Calculation of VOC and TTC (2030)

Vehicle-km (per day) With Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	128,040	783,119	215,593	14,233	71,822	25,852	142,272	854,940	241,445	1,238,658
20	87,266	451,863	143,421	7,503	29,773	8,618	94,770	481,637	152,039	728,445
30	51,916	271,880	104,913	0	0	0	51,916	271,880	104,913	428,710
40	36,874	218,573	144,705	0	0	0	36,874	218,573	144,705	400,151
50	11,621	110,735	252,494	0	0	0	11,621	110,735	252,494	374,850
60	19,651	118,515	139,378	0	0	0	19,651	118,515	139,378	277,544
70	9,772	54,899	21,622	0	0	0	9,772	54,899	21,622	86,293
80	9,876	63,030	36,228	0	0	0	9,876	63,030	36,228	109,135

Vehicle-km (per day) Without Case

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	868,183	5,146,645	1,628,545	106,003	552,713	200,993	974,186	5,699,358	1,829,538	8,503,082
20	431,482	2,238,101	811,944	38,726	169,961	74,539	470,208	2,408,062	886,483	3,764,753
30	224,838	1,232,497	562,779	0	0	0	224,838	1,232,497	562,779	2,020,114
40	95,822	568,732	456,927	0	0	0	95,822	568,732	456,927	1,121,481
50	26,599	371,557	1,131,495	0	0	0	26,599	371,557	1,131,495	1,529,651
60	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0

Vehicle-km Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	740,143	4,363,526	1,412,952	91,770	480,891	175,141	831,914	4,844,418	1,588,093	7,264,424
20	344,216	1,786,238	668,523	31,223	140,188	65,921	375,438	1,926,425	734,444	3,036,308
30	172,922	960,617	457,866	0	0	0	172,922	960,617	457,866	1,591,404
40	58,948	350,159	312,222	0	0	0	58,948	350,159	312,222	721,330
50	14,978	260,822	879,001	0	0	0	14,978	260,822	879,001	1,154,801
60	-19,651	-118,515	-139,378	0	0	0	-19,651	-118,515	-139,378	-277,544
70	-9,772	-54,899	-21,622	0	0	0	-9,772	-54,899	-21,622	-86,293
80	-9,876	-63,030	-36,228	0	0	0	-9,876	-63,030	-36,228	-109,135

VOC Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	380,805	1,108,927	829,158	50,219	132,388	113,653	431,024	1,241,315	942,811	2,615,150
20	102,571	275,162	245,353	10,316	24,552	28,265	112,887	299,714	273,617	686,218
30	39,371	117,710	136,868	0	0	0	39,371	117,710	136,868	293,949
40	11,504	37,742	84,179	0	0	0	11,504	37,742	84,179	133,425
50	2,663	26,224	225,413	0	0	0	2,663	26,224	225,413	254,300
60	-3,309	-11,414	-34,803	0	0	0	-3,309	-11,414	-34,803	-49,527
70	-1,610	-5,231	-5,442	0	0	0	-1,610	-5,231	-5,442	-12,282
80	-1,630	-6,096	-9,405	0	0	0	-1,630	-6,096	-9,405	-17,131
										3,904,102

Fuel Saving (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	170,677	1,018,011	360,868	22,539	118,107	52,192	193,216	1,136,118	413,060	1,742,393
20	43,819	226,316	106,830	4,418	19,458	13,303	48,237	245,774	120,133	414,144
30	16,514	90,394	61,949	0	0	0	16,514	90,394	61,949	168,857
40	4,875	27,943	40,214	0	0	0	4,875	27,943	40,214	73,032
50	1,174	19,118	115,149	0	0	0	1,174	19,118	115,149	135,442
60	-1,541	-8,284	-18,802	0	0	0	-1,541	-8,284	-18,802	-28,627
70	-810	-3,876	-3,170	0	0	0	-810	-3,876	-3,170	-7,856
80	-888	-4,696	-5,927	0	0	0	-888	-4,696	-5,927	-11,511

CO2 Reduction (per day)

Speed	Paved			Unpaved			Total			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
10	402,798	2,402,505	988,056	53,192	278,732	142,902	455,989	2,681,238	1,130,958	4,268,185
20	103,412	534,107	292,501	10,426	45,921	36,423	113,838	580,028	328,924	1,022,790
30	38,973	213,330	169,617	0	0	0	38,973	213,330	169,617	421,920
40	11,505	65,945	110,107	0	0	0	11,505	65,945	110,107	187,556
50	2,771	45,119	315,278	0	0	0	2,771	45,119	315,278	363,169
60	-3,636	-19,551	-51,480	0	0	0	-3,636	-19,551	-51,480	-74,667
70	-1,912	-9,147	-8,679	0	0	0	-1,912	-9,147	-8,679	-19,738
80	-2,095	-11,082	-16,228	0	0	0	-2,095	-11,082	-16,228	-29,405
										6,139,810

Travel Time (per day)

Speed	With Case			Without Case			Time Saving			Total
km/h	BUS	CAR	TRUCK	BUS	CAR	TRUCK	BUS	CAR	TRUCK	
Hours	19,724	115,723	42,417	26,288	153,297	55,196	6,564	37,574	12,779	56,917
USD							55,134	156,234	0	211,369

Source: JICA Study Team

2.7.4 CO_2 Reduction

CO_2 reduction is part of the economic benefits of the project. It is a quantifiable benefit and its reduction through the project was calculated as shown in Tables 2.7.4 to 2.7.6. The yearly reduction was estimated as 0.7 billion ton in 2015, 1.1 billion ton in 2020 and 2.2 billion ton in 2030. However, the assumption for the calculation is not stable because the estimated fuel consumption for CO_2 emission was based on typical vehicle models in HDM-4. It is expected that vehicles will be replaced with more energy efficient types. In addition, the method to convert CO_2-ton to USD is not stable yet. Therefore, the benefit from CO_2 reduction was not considered in the economic analysis.

2.7.5 Project Cost

The total project cost in terms of economic cost was estimated as USD 432.5 million as shown in Table 2.7.5. The cost was evenly allocated over five years from year 2010. The opening was assumed to be in 2015.

The routine and periodic maintenance cost was estimated as USD 0.334 million per year. Minor rehabilitation of the road was planned for every five years and the cost was estimated at USD 31 million. Since the traffic volume forecast shows that a 2-lane road would be adequate by 2020, the cost of the first rehabilitation was assumed to be half of the estimated maintenance cost.

Table 2.7.7 Economic Cost of the Outer Ring Road

Unit: USD million

Cost Item	Project Cost	Conversion Factor	Economic Cost
Construction	337.6	0.8	270.1
Land Acquisition	54.0	1.0	54.0
Building Relocation/ Compensation	0.4	1.0	0.4
Relocation/ Removal of Utilities	33.8	1.0	33.8
Taxes	54.0	0.0	0.0
Administration	6.8	1.0	6.8
Engineering	33.8	1.0	33.8
Contingency	33.8	1.0	33.8
Total	554.1		432.5

Source: JICA Study Team

2.7.6 EIRR and NPV

The EIRR was calculated to be 6.6%, and Net Present Value (NPV) is negative value of -107 million USD. Cash flow analysis is shown in Table 2.7.8. The resulting EIRR is relatively low and the negative NPV means that the project is not feasible in case that all sections are constructed as 4-lane roads by 2015.

Table 2.7.8 Benefit and Cost Flow of Outer Ring Road Project

Unit: USD thousand

Year	Capital Cost	O&M Cost	Total Cost	VOC Saving	Time Saving	Total Benefit	Cash Flow
2009			0				0
2010	86,500		86,500				-86,500
2011	86,500		86,500				-86,500
2012	86,500		86,500				-86,500
2013	86,500		86,500				-86,500
2014	86,500		86,500				-86,500
2015		334	334	3,993	5,063	9,056	8,722
2016		334	334	5,511	6,999	12,510	12,176
2017		334	334	7,028	8,936	15,964	15,630
2018		334	334	8,546	10,873	19,419	19,085
2019		334	334	10,064	12,809	22,873	22,539
2020		15,834	15,834	11,581	14,746	26,327	10,493
2021		334	334	12,815	21,234	34,049	33,715
2022		334	334	14,049	27,722	41,771	41,437
2023		334	334	15,284	34,210	49,493	49,159
2024		334	334	16,518	40,698	57,215	56,881
2025		15,834	15,834	17,752	47,186	64,938	49,104
2026		334	334	18,986	53,674	72,660	72,326
2027		334	334	20,220	60,162	80,382	80,048
2028		334	334	21,454	66,650	88,104	87,770
2029		334	334	22,688	73,138	95,826	95,492
2030		31,335	31,335	23,922	79,626	103,548	72,213
2031		334	334	23,922	79,626	103,548	103,214
2032		334	334	23,922	79,626	103,548	103,214
2033		334	334	23,922	79,626	103,548	103,214
2034		334	334	23,922	79,626	103,548	103,214

Source: JICA Study Team

2.7.7 Sensitivity Analysis

The EIRR at 6.6% is lower than the discount rate of 10%. Any increase in cost and decrease in benefit results in lower EIRR and negative NPV. Table 2.7.9 shows the sensitivity analysis for the positive scenario. If the benefit is 30% higher and cost is 20% lower, EIRR exceeds 10%.

Table 2.7.9 Sensitivity Analysis of EIRR of the Project

		Benefit		
		+10%	+20%	+30%
Cost	-10%	8.9%	9.6%	10.3%
	-15%	9.3%	10.1%	10.7%
	-20%	9.8%	10.6%	11.3%

Source: JICA Study Team

2.7.8 Scenario Analysis

(1) 2-lane Road – full opening

This is the case when all sections of the Outer Ring Road are constructed as 2-lane road. The cost was estimated at 65% of the cost of the 4-lane road. Table 2.7.10 shows the benefit and cost flow. EIRR was calculated at 8.8%. The result shows that a 2-lane road is better than the 4-lane road if the project is implemented in the short term. This does not necessarily mean that the 2-lane road is a better alternative than the 4-lane.

The result shows that opening of all sections in the short term is not feasible whether the number of lanes is two or four.

Table 2.7.10 Benefit and Cost Flow (2-Lane Case)

Unit: USD thousand

Year	Capital Cost	O&M Cost	Total Cost	VOC Saving	Time Saving	Total Benefit	Cash Flow
2009			0				0
2010	45,318		45,318				-45,318
2011	45,318		45,318				-45,318
2012	45,318		45,318				-45,318
2013	45,318		45,318				-45,318
2014	45,318		45,318				-45,318
2015		168	168	3,616	4,607	8,223	8,055
2016		168	168	3,999	5,816	9,815	9,647
2017		168	168	4,383	7,025	11,407	11,239
2018		168	168	4,766	8,234	13,000	12,831
2019		168	168	5,149	9,442	14,592	14,424
2020		7,970	7,970	5,533	10,651	16,184	8,213
2021		168	168	6,394	15,467	21,861	21,693
2022		168	168	7,255	20,284	27,539	27,371
2023		168	168	8,117	25,100	33,216	33,048
2024		168	168	8,978	29,916	38,894	38,726
2025		7,970	7,970	9,839	34,732	44,572	36,601
2026		168	168	10,701	39,549	50,249	50,081
2027		168	168	11,562	44,365	55,927	55,759
2028		168	168	12,423	49,181	61,604	61,436
2029		168	168	13,285	53,997	67,282	67,114
2030		15,773	15,773	14,146	58,813	72,960	57,186
2031		168	168	14,146	58,813	72,960	72,791
2032		168	168	14,146	58,813	72,960	72,791
2033		168	168	14,146	58,813	72,960	72,791
2034		168	168	14,146	58,813	72,960	72,791

Source: JICA Study Team

(2) 2-lane Road – Western Section and MFEZ approach

This case aims to analyze the feasibility of the Western Section of the Outer Ring Road. It was assumed that part of the South Section for the MFEZ approach would be constructed together because it is an essential infrastructure for MFEZ development. The project cost of the Western Section was estimated as USD 119.6 million and its economic cost was estimated as USD 103.4 million. Table 2.7.11 shows the benefit and cost flow of this case. EIRR was calculated as 10.5%, which is a little higher than the discount rate of 10%. The EIRR itself implies that this case would be feasible but just a 5% cost increase and 5% benefit decrease will result with the EIRR decreasing to 9.6%. It can not be said that the case is feasible because of the result of the sensitivity analysis.

Table 2.7.11 Benefit and Cost Flow (Western Section 2-lane)

Unit: USD thousand

Year	Capital Cost	O&M Cost	Total Cost	VOC Saving	Time Saving	Total Benefit	Cash Flow
2009			0				0
2010	20,683		20,683				-20,683
2011	20,683		20,683				-20,683
2012	20,683		20,683				-20,683
2013	20,683		20,683				-20,683
2014	20,683		20,683				-20,683
2015		78	78	1,597	2,172	3,770	3,691
2016		78	78	2,247	2,978	5,225	5,146
2017		78	78	2,897	3,783	6,680	6,602
2018		78	78	3,546	4,589	8,135	8,057
2019		78	78	4,196	5,394	9,590	9,512
2020		3,710	3,710	4,846	6,200	11,045	7,335
2021		78	78	5,160	8,598	13,757	13,679
2022		78	78	5,474	10,996	16,469	16,391
2023		78	78	5,788	13,393	19,181	19,103
2024		78	78	6,102	15,791	21,893	21,815
2025		3,710	3,710	6,416	18,189	24,605	20,895
2026		78	78	6,730	20,587	27,317	27,239
2027		78	78	7,044	22,985	30,029	29,951
2028		78	78	7,357	25,383	32,741	32,662
2029		78	78	7,671	27,781	35,453	35,374
2030		7,342	7,342	7,985	30,179	38,165	30,823
2031		78	78	7,985	30,179	38,165	38,086
2032		78	78	7,985	30,179	38,165	38,086
2033		78	78	7,985	30,179	38,165	38,086
2034		78	78	7,985	30,179	38,165	38,086

Source: JICA Study Team

(3) Western Section (International Traffic Growth at 10% p.a.)

In the demand forecast in this report, the growth rate of international transit traffic was assumed as 3%. Since the number of this traffic is quite small, it does not affect the project feasibility so much. However, in case that the international transit traffic will increase at a high growth rate like 10% per year, the traffic will become 6.7 times in 20 years. Demand forecast was carried out for this case and the benefit flow was calculated as shown in Table 2.7.12. EIRR was calculated at 12.9%. The sensitivity analysis of this case shows that the project is still feasible with the EIRR at 11.0% even if there would be a 10% cost increase and 10% of benefit decrease. This means that the Western Section would be feasible if the international transit traffic increase at the growth rate of 10% or higher per year. This case can be considered only if high growth in international transit traffic is expected.

Table 2.7.12 Benefit and Cost Flow (Western Section 2-lane, High Growth in International Transit Traffic)

Unit: USD thousand

Year	Capital Cost	O&M Cost	Total Cost	VOC Saving	Time Saving	Total Benefit	Cash Flow
2009			0				0
2010	20,683		20,683				-20,683
2011	20,683		20,683				-20,683
2012	20,683		20,683				-20,683
2013	20,683		20,683				-20,683
2014	20,683		20,683				-20,683
2015		78	78	1,852	2,511	4,363	4,285
2016		78	78	3,148	3,611	6,759	6,681
2017		78	78	4,444	4,711	9,155	9,077
2018		78	78	5,740	5,811	11,551	11,473
2019		78	78	7,036	6,911	13,947	13,869
2020		3,710	3,710	8,332	8,011	16,343	12,633
2021		78	78	8,661	10,740	19,401	19,323
2022		78	78	8,991	13,468	22,459	22,381
2023		78	78	9,320	16,196	25,517	25,438
2024		78	78	9,650	18,925	28,575	28,496
2025		3,710	3,710	9,979	21,653	31,632	27,922
2026		78	78	10,309	24,382	34,690	34,612
2027		78	78	10,638	27,110	37,748	37,670
2028		78	78	10,967	29,838	40,806	40,727
2029		78	78	11,297	32,567	43,863	43,785
2030		7,342	7,342	11,626	35,295	46,921	39,579
2031		78	78	11,626	35,295	46,921	46,843
2032		78	78	11,626	35,295	46,921	46,843
2033		78	78	11,626	35,295	46,921	46,843
2034		78	78	11,626	35,295	46,921	46,843

Source: JICA Study Team

(4) Master Plan Case

In the master plan, the target years of the Outer Ring Road project are 2015, 2020, and 2030, and the construction schedule is proposed as i) 2-lane road in the South section by 2015, ii) 2-lane road in the West and East sections by 2020, and iii) 4-lane road in the North section and widening of 2-lane sections to 4-lane. To evaluate this case, the economic benefit after 2030 up to 2049 was taken into consideration because the benefit from the entire project will still be obtained after the target year of 2030. The cost allocation was assumed as follows:

Short-term (2015) South Section	Mid-term (2020) West & East Sections	Long-term (2030) North Section & 4-lane
2011: 10.0% 2012: 33.3% 2013: 33.3% 2014: 33.3%	2015: 10% 2016: 15% 2017: 25% 2018: 25% 2019: 25%	2025: 10% 2026: 15% 2027: 25% 2028: 25% 2029: 25%

Source: JICA Study Team

Table 2.7.13 shows the flow of economic benefit and cost. EIRR and NPV were calculated as 11.2% and USD 16.3 million. EIRR shows that the master plan case is economically feasible. The sensitivity analysis shows that EIRR exceeds 10% in case that the cost increase is less than 11.2% with the same benefit, or in case that the decrease in benefit is less than 11.2% with the same cost.

2.8 Environmental and Social Considerations Study for the Outer Ring Road Project

2.8.1 Current Environmental and Social Conditions of the Project Site

In addition to the general environmental and social conditions of the city of Lusaka which is described in Chapter 7 of Volume I, the project site-specific information collected through the public hearings and site visits is provided in following section.

(1) Land Use and Local Economy

The land use and local economic status of the project site varies since it covers approximately 85 km. The planned alignment passes through 11 wards, namely Mwembesh, Kanyama, Munkold, Lilay, Kamulanga and Kabulonga Wards of Lusaka City, Namalombwe and Chilongolo, Wards of Kafue District, Ntandabale and Chinkuli Wards of Chongwe District, Chamuka Ward of Chibombo District.

The project site is in the suburbs and consists of large-scale farms with worker's communities in Lilay Ward, an existing industrial/commercial area in Chilanga Ward, a newly planned industrial/commercial area in Chisankane Ward, and green fields.

North Side of a Hill at Great North Road in North Section

Existing Road in Chilanga Ward connecting to Kafue Road

Residential & Commercial Area in Mwembesh Ward

Farmland in Lilayi Ward

(2) Air Quality

As mentioned in Section 1.6.1 for the inner ring road, overall air pollution level in Lusaka is considered insignificant compared to other industrial areas. However, according to the Lusaka Environment Outlook Report, an emerging problem due to the increase in vehicle traffic is expected.

Moreover, the project site of the outer ring road mainly consists of suburbs in and around Lusaka City, and dispersion of air pollutants is expected. Therefore, the overall air quality in the outer ring project site is considered in good condition.

(3) Noise and Vibration

The alignment of the outer ring road runs through less populated areas, thus overall noise and vibration levels are observed to be relatively low. In the existing roads, there are some localized impacts of noise and vibration from vehicles.

(4) Hydrological Situation

Based on the official map of Greater Lusaka, there are eight rivers in the project sites, namely Munkolo River, Mukamunya River, Chalimbana River, Kapwelyamba River, Chingomoti River, Ngwerere River and Kawangi River. However, these are not major rivers.

Chingamati River in Chongwe District

(5) Fauna, Flora and Biodiversity

There is one forest reserve in the project area and another forest reserve near the project site, namely the Lusaka South Local Forest No.26 and Lusaka East Forest Reserve, respectively. In the South Section, an approximately 4-km stretch passes through the Lusaka South Local Forest No. 26, which was partially allocated to be a MFEZ in 2007. In the East Section, the Lusaka East Forest Reserve is located on the west side of the planned alignment.

In the Lusaka South Local Forest No. 26, there is no officially recognized endangered and precious fauna and flora, according to hearings with the Forest Department of the MoTENR. Additionally, the legal status of the rest of the local forest is not yet cleared and its delineated boundary needs to be clarified by further study.

According to hearings conducted with the Forest Department, the Lusaka East Forest Reserve is intact and in good condition.

Alignment outside & along Lusaka East Local Forest

Greenfield along the Existing Road in Chongwe District

(6) Involuntary Resettlement

Major involuntary resettlement is expected in the West Section. The number of the residential and non-residential structures in the Right of Way (ROW) is identified to be about 49 households, using available satellite images. The breakdown of the structures is as shown in Table 2.8.1. However, due to the rapid expansion of housing construction in some areas of the project site and the inclusion of abandoned structures, it is expected that the number of affected structures is subject to change and shall be identified by the future field survey.

Table 2.8.1 Approx. Number of Residential and Non-residential Structures in the ROW

Section Name	South Section	West Section	East Section	North Section	Total
No of Structures to be Resettled.	4	21	10	14	49

Note: Identified by available satellite images taken between July 2008 and July 2009

Source: JICA Study Team

(7) Indigenous and Ethnic People

Zambia consists of 73 tribes and no conflict among the tribes is observed due to its National Policy. The alignment passes through 2 compounds, namely Lilayi and Barlaston Park Compounds.

2.8.2 Considerations of the Alternative Alignments including the Zero Option

Considerations of 2 alternative alignments in the North and East Sections and the zero option were conducted in terms of technical, economic and environmental and social considerations. The details are described in Section 2.3.

2.8.3 Environmental and Social Impacts by the Outer Ring Road Project

The Environmental and Social Considerations study for the outer ring road was conducted. The results of the impact assessment, proposed mitigation measures, Environmental Management Plan (EMP) and proposed Environmental Monitoring Plan (EMoP) will be described briefly in the following section.

(1) Approach for the Impact Assessment

The Environmental and Social Considerations Study was conducted to assess environmental and social impacts of the project referring to the relevant laws, regulations and standards of Zambia and the JICA Guidelines for Environmental and Social Considerations. The relevant laws and regulations in Zambia are listed in Section 2.3.4 of Volume I of this report. For the Pre-EIA, There are 31 environmental impact items that were ranked from A to D (both positive/negative) depending on its environmental and social significance in accordance with rating criteria listed below.

Rating Criteria

- A+/-: Significant positive/negative impact is expected.
- B+/-: Positive/negative impact is expected to some extent.
- C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
- Blank: No impact is expected.

(2) Summary of the Environmental and Social Impacts of the Outer Ring Road Project

The summary of environmental and social impacts of the outer ring road project is shown in Table 2.8.2. The significant impacts will be discussed in following section.

Table 2.8.2 Summary of Environmental and Social Impacts of the Outer Ring Road Project

Env. Impacts / Impact Phase	Social Environment														Natural Environment									Pollution							
	1.Involuntary Resettlement	2.Local Economy such as Employment & Livelihood, etc.	3.Land Use & Utilization of Local Resources	4. Social Institutions such as Split of Communities	5.Existing Social Infrastructures & Services	6.The poor, indigenous & ethnic people	7.Misdistribution of Benefit & Damage	8.Cultural Heritage	9.Local Conflict of Interest	10.Water Usage or Water Rights & Rights of Common	11.Sanitation	12.Hazards (Risk), Infectious Diseases such as HIV/AIDS	13.Accidents	14.Traffic Jam & Congestion	15.Topography & Geographical Features	16.Soil Erosion	17.Groundwater	18.Hydrological Situation & Rainwater	19.Coastal Zone	20.Fauna, Flora & Biodiversity	21.Meteorology	22.Landscape	23.Global Warming	24.Air Pollution	25.Water Pollution	26.Soil Contamination	27.Waste	**28.Noise & Vibration**	29.Ground Subsidence	30.Offensive Odor	31.Bottom Sediment
Design Phase	A-					B-																									
Construction Phase		B+	B+	B-	B-									B-						C-				B-			B-	B-		B-	
Operation Phase		A+	B+	B-			B-		B-				B+/-	A+				B+/-		C-		B-	B+	B-				A-		B-	

Source: JICA Study Team

(3) Expected Negative Environmental amd Social Impacts of the Outer Ring Road Project

The description of environmental and social impacts of the outer ring road project for each stage is shown in Table 2.8.3.

Table 2.8.3 Description of Environmental and Social Impacts of the Outer Ring Road Project

	No.	Likely Impacts	Ranking			Description
			Design	Construction	Operation	
Social Environment	1	Involuntary Resettlement	A-	-	-	Forty-nine affected households are identified from the satellite images, although it has been minimized as much as possible by considering the alternative routes. However, the affected households are relatively scattered along the alignment, 21 affected households are identified in the West Section.
	2	Local Economy such as Employment & Livelihood, etc.	-	B+	A+	Economic activities would be facilitated due to improved access (1) along the city border and (2) to the planned economic zone in Chisankane, Multi-facility Economic Zone (MFEZ) provided by the outer ring road. People would be benefited by reduced traffic congestion and improved direct access to wider area of the City of Lusaka in the long run. Additionally, the local people would be benefited by employment as casual laborers during construction.
	3	Land Use & Utilization of Local Resources	-	B+	B+	Existing land use would be changed in some areas by the planned road since the outer ring road is expected to bring more vehicles and commercial business along the road. Overall, utilization of local resources will be also improved by the project which is planned to be part of the urban development master plan.
	4	Social Institutions such as Split of Communities	-	B-	B-	Split of existing communities is expected where a road is newly constructed in populated areas, such as the West Section of the outer ring road during construction and operation. The impact is expected to be relatively significant because the project site is in the suburbs and not heavily populated.
	5	Existing Social Infrastructures & Services such as Traffic / Existing Public Facilities	-	B-	-	Access to existing social infrastructure such as the existing roads, schools, churches, police posts and other public facilities could be disturbed during construction.
	6	The poor, indigenous and ethnic people	B-	-	-	Resettlement would occur along the outer ring road dispersedly but not concentrated in the Unplanned Urban Settlement (UUS). Therefore, the impact on the poor shall be insignificant.
	7	Misdistribution of Benefit & Damage	-	-	B-	Inequality between beneficiaries of the project and the Project Affected Persons (PAPs) would occur to some extent.
	8	Cultural Heritage	-	-	-	Cultural heritages are not identified by the list of the cultural heritage site obtained from the National Heritage Conservation Commission (NHCC) and observations during the site visits.
	9	Local Conflict of Interests	-	-	B-	Conflicts of interests related to the road development could occur among beneficiaries and the PAPs.
	10	Water Usage or Water Rights & Rights of Common	-	-	-	No significant impact on water use is expected. Water use would be slightly increased to sprinkle water on the surface of roads regularly only during construction to prevent dusts.
	11	Sanitation	-	-	-	Deterioration of sanitary conditions would not occur due to the project. The construction of the work camps is not expected since most construction workers are locally hired in and around Lusaka, the capital city with adequate labor supply.

	No.	Likely Impacts	Ranking			Description
			Design	Construction	Operation	
	12	Hazards (Risk) Infectious Diseases such as HIV/AIDS	-	-	-	Influx of laborers would not be expected during construction since most of the workers would be employed in and near Lusaka, which has enough labor supply. The probability to spread infectious HIV/AIDS due to the project is considered low.
	13	Accidents	-	-	B+/-	Traffic accidents could be increased by purely the increased number of the vehicles. On the other hand, it could also be decreased especially around the road will be newly constructed in an appropriate design so that present people's driving behaviors would be improved.
	14	Traffic Jam and Congestion	-	B-	A+	During construction, the access to the existing roads would be disturbed in the short-term. Some traffic jam would be expected due to the construction in the short-term. During operations, the overall traffic jam would be improved not only in the outer ring road network as well as the other major network around the town.
Natural Environment	15	Topography & Geographical Features	-	-	-	No significant impact is identified since (1) the planned alignment passes through mostly flat areas except some hilly parts of the West and East Sections and (2) the planned cut slope is not steep.
	16	Soil Erosion	-	-	-	No significant impact is identified since (1) the planned alignment passes through mostly flat areas except some hilly parts of the West and East Sections and (2) the planned cut slope is not steep. Soil erosion could be caused at the borrow pits if not managed in an appropriate way; however, it is unlikely to happen for the project which is subject to the EIA since appropriate management of borrow pits is required for the EIA's approval by the ECZ.
	17	Groundwater	-	-	-	No significant impact is identified since the impact on groundwater is not relevant to the outer ring road project.
	18	Hydrological Situation and Rainwater	-	-	B+/-	The outer ring road is planned to pass through eight minor rivers, such as Munkolo River, Mukamunya River, Chalimbana River, Kapwelyaamba River, Chingomoti River, Ngwerere River, Kawangi River and Chunga River. The road will be designed not to disturb the river flow, and the impact expected is insignificant. Rainwater was identified as one of the urban problems during rainy season according to the existing data and hearings with LCC staff. Lined rainwater drainage has been originally included in the project and will mitigate inundation in/near the project site.
	19	Coastal Zone (Mangroves, Coral Reefs, Tidal Flats, etc.)	-	-	-	There is no coastal zone in Zambia.
	20	Fauna, Flora and Biodiversity	-	C-	C -	In the South Section, there is approximately a 4-km stretch passing the Lusaka South Local Forest No. 26, which was partially allocated to a MFEZ in 2007. However, the impact is considered insignificant because in the Lusaka South Local Forest No. 26, there is no endangered and precious fauna and flora and encroached by local residents according to hearings with Forest Department of MoTENR. Additionally it is not cleared the legal status of the rest of the Local Forest and its clear boundary, which need to be clarified by the further study to confirm the impacts... As for the Lusaka East Forest Reserve, the impact on the forest reserve is considered insignificant since the alignment is designed to avoid the Forest Reserve. However, the exact boundary needs to be confirmed by the further study.
	21	Meteorology	-	-	-	No significant impact is identified because it is not relevant to the outer ring road project.
	22	Landscape	-	-	B-	In some rural areas such as the South Section and the North Section, the road design does not fit in well with its surrounding landscape.
	23	Global Warming	-	-	B+	The overall CO_2 emission would be decreased due to smooth traffic flow in the outer ring road.

	No.	Likely Impacts	Ranking			Description
			Design	Construction	Operation	
	24	Air Pollution	-	B-	B-	Deterioration of ambient air quality would temporarily occur from emissions of construction machineries during construction. Moreover, deterioration of ambient air quality would be caused by the increase in vehicle traffic during operation. On the other hand, dust would be minimized due to the change from unpaved roads to paved roads. Overall, the impact on air quality is expected to be less significant since the road is planned to pass the rural areas where air quality is good.
Pollution	25	Water Pollution	-	-	-	No impact on water quality is expected since water use/waste water would be very limited only at the construction site.
	26	Soil Contamination	-	-	-	It would be adversely affected by inappropriate wastewater and waste disposal during construction.
	27	Waste	-	B-	-	Disposal of the construction residue of the project would be expected during construction.
	28	Noise and Vibration	-	B-	A-	Noise (B- in construction; A- in operation): Noise level would be higher due to construction machinery temporarily during construction. Moreover, noise level would worsen due to the increased number of vehicle traffic in operation. Especially, the noise impact is considered significant in the quiet rural communities without the existing road. Vibration (B- in construction; no impact in operation): At present, perception of vibration as a pollution problem in Zambia is very low. Additionally, vibration impact is often localized and less direct compared to the noise impact. Therefore, impact on the vibration level from the project is minor and negligible.
	29	Ground Subsidence	-	-	-	No impact is identified because the planned road project does not involve dense structures, although the bedrock in some areas of Lusaka City is considered fragile.
	30	Offensive Odor	-	B-	B-	Offensive odors could be caused by construction waste and machinery during construction. Offensive odors from vehicle emission gases are expected to worsen locally, but with less significant impact.
	31	Bottom Sediment	-	-	-	No significant impact is identified in the outer ring road project because the planned road crosses no major rivers or any major part of a river.

Source: JICA Study Team

2.8.4 Outline of the Environmental Management Plan for the Outer Ring Road Project

The outline of Environmental Management Plan (EMP) for the Outer Ring Road Project is proposed as described in Table 2.8.4.

Table 2.8.4 Outline of the EMP for the Outer Ring Road Project

Impact No.	Significant Negative Impacts	Proposed EMP	Implementing Organization	Responsible Organization
1	Involuntary Resettlement	Public Consultation with the Project Affected Persons (PAPs) and adequate Resettlement Action Plan shall be prepared in accordance with international standards such as the World Bank's Operational Policy 4.12. The RAP shall include consideration of appropriate relocation site(s), information disclosure to, and discussions with, resettlers, appropriate infrastructure in a new relocation site(s), and compensations and livelihood assistance. Special attention shall be made to vulnerable sectors, such as the lower-income residents, the illegal occupants without the Occupancy License, the elderly, the disabled, women and children.	LCC/MLGH	LCC/MLGH
4	Social Institutions (Split of communities)	Sufficient consultation on relocation with the PAPs shall be conducted to minimize impacts of split of communities by considering alternative relocation site(s) and alternative crossings.	LCC/MLGH	LCC/MLGH
5	Existing Social Infrastructures & Services such as Traffic / Existing Public Facilities	Provide sufficient staff to control traffic and detours for access to existing social infrastructures such as schools, churches and hospitals during construction.	Contractor	LCC/MLGH
14	Traffic Jam & Congestion			
6	The poor, Indigenous & Ethnic People	Adequate public consultation and agreement between the government and residents are needed. Special attention shall be made to the vulnerable sectors, such as the lower-income residents, the illegal occupants without the Occupancy License, the elderly, the disabled, women and children.	LCC/MLGH	LCC/MLGH
7	Misdistribution of Benefit & Damage			
9	Conflicts of Interest,			
13	Accidents	Safety design in accordance with regulations and provide pedestrian ways and crossings with signals During construction, the contractor needs to comply with Zambian and international laws and regulations on working conditions. Oil or any other chemical spillage shall be avoided to prevent any accidents as well as groundwater/soil contamination by providing information and education to workers on their appropriate handling.	Contractor	LCC
18	Hydrological Situation & Rainwater	The road shall be designed not to disturb the river flow even though the rivers to be crossed by the outer ring road are minor. Rainwater drainage shall be provided for the outer ring road.	Contractor	LCC
20	Fauna, Flora & Biodiversity	Consultation with Forestry Department of MoTENR is required to confirm the legal status of the Lusaka South Local Forest No. 26 as well as the official boundaries of the Lusaka South Local Forest No. 26, and the Lusaka East Forest Reserve. A license needs to be obtained for construction in accordance with the Forest Act of 1999 if the legal status of the forest reserve is valid and the project involves the forest reserves.	Contractor	LCC
22	Landscape	Provide roadside planting to mitigate impacts on landscape in green fields with an aesthetic value if any.	Contractor	LCC

Impact No.	Significant Negative Impacts	Proposed EMP	Implementing Organization	Responsible Organization
24	Air Pollution	Periodically sprinkle water to mitigate dusts during construction on the line, earth mixing sites and temporary roads where these are close to the communities. Adopt low air pollution emitting equipment, vehicles and methodology for construction, if available. Provide temporary barriers or screens during construction, if necessary. Vehicles delivering materials shall be covered to reduce spillage. Provide roadside planting to mitigate air pollution. Equipment and vehicles shall be well-maintained to keep air pollution at a minimum.	Contractor	LCC
27	Waste	Secure appropriate disposal sites for construction residue in advance. Consult with the local authorities on the use of excess soil, if necessary.	Contractor	LCC
28	Noise & Vibration	Provide roadside planting to mitigate noise. Adopt low noise and vibration emitting equipment, vehicles and methodology for construction if available. Avoid nighttime construction activities near communities. Provide temporary barriers or screens during construction, if necessary. Noise and vibration standards of industrial enterprises shall be enforced to protect construction workers. If there will be strong noise, earplugs shall be worn, and working time shall be limited. Equipment and vehicles shall be well-maintained to keep their noise/vibration at a minimum.	Contractor	MLGH/LCC
30	Offensive Odor	Keep equipment and vehicles well-maintained to minimize offensive odor. Provide roadside planting to mitigate offensive odor.	Contractor	MLGH/LCC

Source: JICA Study Team

2.8.5 Outline of the Environmental Monitoring Plan for the Outer Ring Road Project

The outline of the Environmental Monitoring Plan (EmoP) for the Outer Ring Road Project is proposed as described in Table 2.8.5.

Table 2.8.5 Outline of the EmoP for the Outer Ring Road Project

Impact No.	Significant Negative Impacts	Proposed EmoP	
		Internal Monitoring	Auditing (External Monitoring)
1	Involuntary Resettlement	The internal and external Monitoring Plan for resettlement and compensation shall be formulated separately in the RAP, in accordance with international standards such as the World Bank.	• Environmental Auditing is required by the EPPC (EIA) Regulations, 1997 for the developer to conduct a post-assessment environmental audit within 12-16 months after the completion of the project or the commencement of the project, whichever is earlier. • Monitoring shall be conducted by at least 2 persons of the EIA Team or any qualified persons appointed by the developer and approved by the ECZ. • The monitoring report shall be prepared by the developer and submitted to the ECZ.
24	Air Pollution	**During Construction:** Monitor dust on regular basis at least once every month by a site visit of the person in charge of the LCC. Monitor air quality (e.g. SO_2, PM_{10}, Nox, CO, Pb & dust) in consultation with ECZ, if necessary and/or when any complaints are received from local residents. **During Operation:** Monitor air quality (e.g. SO_2, PM_{10}, Nox, CO, Pb & dust) in consultation with ECZ. Monitoring at least twice a year (dry season & rainy season) is suggested.	
28	Noise	**During Construction:** Monitor roadside noise level (Laeq) in consultation with ECZ, if necessary, and/or when any complaints are received from local residents. **During Operation:** Monitor roadside noise level (Laeq) in consultation with ECZ, if necessary, and/or when any complaints are received from local residents. Monitoring at least once a year is suggested.	

Source: JICA Study Team

2.8.6 Further Study Procedure and Draft TOR of EIA for the Outer Ring Road Project

The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations of 1997 requires a full EIA for the Outer Ring Road Project under the second schedule of the regulations which states as follows.

All major roads outside urban areas, the construction of new roads and major improvements over 10 km in length or over 1 km in length if the road passes though a National Park or Game Management Area.

The step-wise official EIA procedure is mentioned in Section 2.3.4 of Volume I. The Proposed TOR of the EIA for the outer ring road is described below.

Table 2.8.6 Proposed TOR of the EIA for the Outer Ring Road Project

Item	Description	Remarks (Standards and References)
Alternative Consideration	Consideration of Alignments including Zero Option.	Minimize the number of households to be resettled and the magnitude of the split of communities, as well as maximize the project benefits.
Air Quality	Measurement of CO, Nox, SO_2, PM10, Pb and Dust is suggested.	Evaluate impacts referring to the Zambian Ambient Air Standard and other international standards.
Noise	Measurement of Laeq at a roadside is suggested.	Evaluate roadside noise impacts referring to international standards.
Fauna & Flora	Confirm the legal status and official boundaries of the Lusaka South Local Forest No. 26, and the Lusaka East Forest Reserve.	If applicable, the liscence to construct in the forest reserve shall be obtained in accordance with the Forest Act of 1999.
Socio-economic Survey and Census Survey for RAP	**Socio-economic Survey:** Target respondents will be 20 to 25% of the total number of households to be resettled. **Census Survey:** To be conducted for 100% of the total number of households to be resettled.	Application of the sampling rate of the Asian Development Bank's Good Practice Handbook is suggested. Census survey at 100% is required for the RAP as common practice in Zambia.
RAP Formulation	Preparation of the RAP based on the results of the socio-economic survey, the census survey and stakeholder meetings.	To be prepared in accordance with the 1) Zambian Practice based on the Zambian Lands Acquisition Act, Town and Country Planning Act, and 2) World Bank's Operational Policy 4.12, which is commonly used for RAP preparation in Zambia.
Stakeholder Meetings	Conduct of stakeholder meetings are suggested for at least two stages, one for scoping and the other for feedback of the survey results to PAPs.	Two stages of the stakeholder meetings are required by the Zambian EIA regulation. If necessary, consider to organize more stakeholder meetings in the various project stages, as required by international standards.

Source: JICA Study Team

2.9 Project Implementation

The National Road Fund Agency (NRFA) received ZMK 232 billion from fuel levy and road user charges, and ZMK 135 billion from the Government in 2007. The total of these domestic funding was ZMK 367 billion, or USD 102 million. NRFA also received funds from donor countries, thus the total income in 2007 amounted to ZMK 451 billion (USD 126 million). The project cost of the Outer Ring Road was estimated to be five times the yearly domestic budget for the road sector in Zambia. This means that the project can not be a short-term project, and its funding and implementation are the future key issues to be resolved. On the other hand, it is necessary to consider its alignment as soon as possible to prevent land development along the route. It is desirable to designate the road alignment as a public road according to the Public Road Act. However, designating the Outer Ring Road route as a public road should be carefully justified due to stipulated restrictions in the legislated act. In the early stages, the proposed route should be designated as agricultural or forest area according the land use along the route to discourage any urban development. The road should be designated as a public road only by section based on the actual progress of the road development.

Since the road runs through four districts, the Outer Ring Road should be a District Road or other higher class road under the Road Development Authority (RDA). The section in Lusaka District is very short but it will be an essential urban infrastructure for Lusaka. If the road route were within the Lusaka boundary, it is natural that the road was an Urban Road which should be constructed and maintained by Lusaka. Therefore, involvement of Lusaka for the implementation of the project is important. The coordination body should be established for the project implementation among the RDA, MLGH, Lusaka District, Chibombo District, Chongwe District, and Kafue District.

2.10 Conclusions and Recommendations

2.10.1 Conclusion

The Outer Ring Road is expected to promote industrial development. The road is an essential infrastructure of the master plan because it will complete the future urban structure. In addition, the road will play an important role for international transportation. Without the road, heavy trucks will go into the center of the city and will choke the traffic in Lusaka. The Outer Ring Road, therefore, is a very necessary infrastructure for the master plan. The project alternative study shows that providing four lanes for all sections as a complete circular road is the best option to provide for the traffic demand in 2030.

However, the Outer Ring Road should be a long-term project. Its full opening as a 4-lane road in the short-term is not feasible with the EIRR of 7.2%. The total length of the Outer Ring Road is 85.7km, with the total cost estimated at 414 million USD. It is thus financially difficult to implement this project in the short term.

Initially, the road should be a 2-lane road. In this case, it is necessary to acquire enough ROW for the future widening to a 4-lane road. The road should be constructed by stages. In the short term, the priority section for the access to Lusaka South MFEZ should be constructed. For the next stage, the western part of the road will be given higher priority than the other sections because of industrial development west of Lusaka and the increase in international traffic for the north and south corridor.

The alignment of the Outer Ring Road shall be designed to minimize environmental and social impacts; however, there would be some unavoidable impacts: resettlement, impacts of construction in minor sections of the forest reserve(s), and acquisition of agricultural land. The resettlement and land acquisition shall be appropriately mitigated and compensated through the RAP. Additionally, the detailed impacts on the forest reserves shall be clarified in the further study. Since the local forests are protected by the Forest Act of 1999 to conserve forest resources, ecosystem and social, cultural and economic needs for communities, the liscence to clear trees in the forest for the construction shall be obtained by the project proponent in accordance with the Act.

There are a few problems about the engineering aspect: the Outer Ring Road crosses the railway line at the north and south sections. The railroad crossing should be a flyover in the future but it is initially designed as an at-grade crossing.

On the implementation arrangement, Lusaka City cannot carry out this project by itself because the Outer Ring Road goes through three districts – Chongwe, Kafue, Chibombo and Lusaka. Coordination among these districts is necessary.

2.10.2 Recommendations

1) Stage-wise Construction

As described in the conclusion, the full opening of the Outer Ring Road in the early stage is not feasible. In view of economic costs and benefits, a 2-lane road is more feasible in the initial stages but should be 4-lane all throughout in 2030. On the other hand, providing access to MFEZ is an urgent need. From this, the following stage-wise construction is recommended.

Table 2.10.1 Proposed Stage-wise Road Expansion Plan

	Short Term (2015)	Medium Term (2020)	Long Term (2030)
South Section	2-lane		4-lane
West Section		2-lane	4-lane
East Section		2-lane	4-lane
North Section			4-lane

Source: JICA Study Team

The cost allocation of the stage-wise development is summarized as follows.

Table 2.10.2 Cost Allocation of Outer Ring Road

Unit: USD million

	South	East	North	West	Total
Short-term	28.3				28.3
Mid-term	62.9	89.6		119.6	272.0
Long-term	5.6	48.2	81.5	64.4	199.7
Total	96.7	137.8	81.5	184.0	500.1

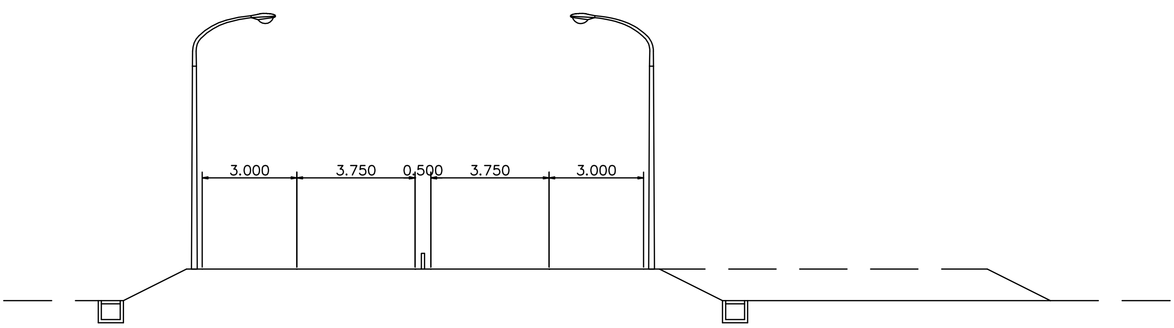
Note: Cost excludes TAX
Source: JICA Study Team

There are three alternatives of the cross section of Outer Ring Road for the stage construction: 1) Outer Ring Road is constructed as a 2-lane road in a side of the ROW (Option-1). 2) Service roads are constructed as 1-lane roads in both sides of the ROW (Option-2). 3) A service road is constructed in a side of ROW (Optioin-3).

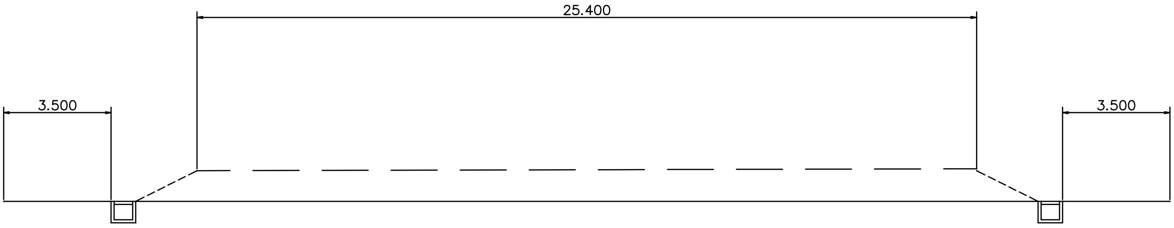
Option-1 can save the initial land acquisition cost, while Option-2 and Option-3 can avoid the future risk of land acquisition. In case of Option-1, a part of road needs to be reconstructed and this increase the total construction cost. There is no need to reconstruct the initial investment in case of Opetion-2, while Option-3 needs some reconstruction although the work is smaller than the case of Option-1.

Although Option-1 requires the additional investment is the future, it can avoid the risk of traffic demand in the year 2030. It is recommended to construct Outer Ring Road as Option-1, and reserve the future right of way by regulation.

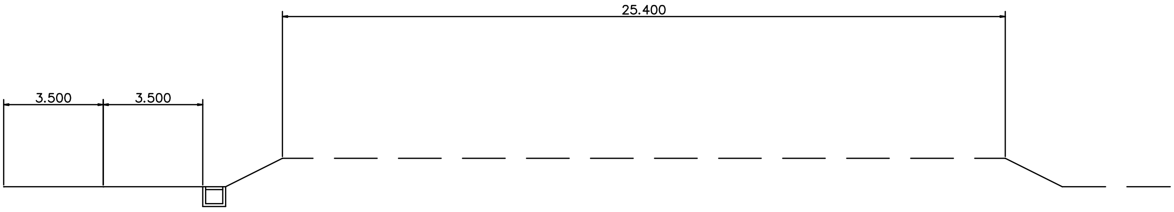
Option 1: Partial Opening / Construction of Outer Ring Road



Option 2: Advanced Opening / Construction of the Service Road



Option 3: Tentative Construction of 2-lane Road



Source: JICA Study Team

Figure 2.10.1 Alternatives of Partial Opening of Outer Ring Road

2) MFEZ support

The purpose of Outer Ring Road in short-term is providing access route to LS- MFEZ. The beneficiary of the road is LS-MFEZ and the success of the project depends on the implementation of MFEZ. Therefore, it is desirable to include this project in a part of MFEZ project so that quick implementation is possible.

3) Early Coordination among Districts

Outer Ring Road crosses Lusaka, Chibombo, Kafue, and Chongwe District. As mentioned in the conclusion, close cooperation among these districts is needed. The pre-feasibility study prepared the preliminary drawing of the alignment of Outer Ring Road. Although it is long-term project, it is necessary that all related districts know the proposed alignment so that the future implementation is possible. Therefore, it is recommended to have meetings for the discussion of the alignment of Outer Ring Road in early stage.

4) Temporary Use of Existing Road

A route alternative using the ROW of the existing road was studied in 2.4.1. The conclusion is that the original route is better than the alternative. Instead of constructing the ring road on the existing ROW, upgrading the existing road is another alternative. Although the road would not suitable for heavy vehicle, it would be able to function as the ring road when traffic demand, especially track, is small.

CHAPTER-3

WATER SUPPLY AND SANITATION IMPROVEMENT PROJECT

CHAPTER 3 WATER SUPPLY AND SANITATION IMPROVEMENT PROJECT

3.1 Outline of Water Supply and Sanitation Improvement Project

The project has two components, as shown below. The first component, the Development of Iolanda II Water Works, has two phases, but only Phase-1 is included in the project.

(1) Development of Iolanda II Water Works

<u>Phase-1:</u>

1) Intake facility on Kafue River	150,000 m^3/day
2) Pumping system for intake facility	50,000 m^3/day
3) Raw water main pipeline	2.0 km
4) Water treatment plant	50,000 m^3/day
5) Booster pumping station	50,000 m^3/day
6) Transmission main pipeline	66.5 km

Phase-2:

1) Pumping system for intake facility	100,000 m^3/day
2) Raw water main pipeline	2.0 km
3) Water treatment plant	100,000 m^3/day
4) Booster pumping station	100,000 m^3/day
5) Transmission main pipeline	66.5 km

(2) Wastewater Treatment (Sanitation) — Sanitation pilot plant

3.2 Design Conditions

3.2.1 Water Quality Standards

The following water quality standards shall be used for the project:

1) The water quality guidelines being used by Lusaka Water and Sewage Company (LWSC); and
2) WHO Drinking Water Standard.

3.2.2 Site Conditions

The site conditions essential for the project are summarized below:

1) Intake facility in Kafue River

The proposed intake facility is located in Kafue River, next to the existing intake facility. The approval of permit for the construction of the structure in the river, and the acquisition of water right for the intake of water from the river are critical requirements prior to the construction of the facility.

2) Raw Water Main Pipeline

The proposed raw water main pipeline shall be installed parallel to the existing raw water main pipeline inside the property of LWSC.

3) Iolanda II Water Treatment Plant

The proposed water treatment plant shall also be constructed beside the existing treatment plant inside the property of LWSC. The land also has sufficient space for the construction of the temporary yard.

4) Chilanga Booster Pumping Station

The proposed pumping station will be constructed in the site of the existing Chilanga Booster Pumping Station. However, the power requirement in the facility will increase and would require upgrading of the existing 12 kVA power substation. But the area of the existing site is too small for the construction of a new 36 kVA substation. Therefore, a new site beside the existing facility has to be acquired.

5) Transmission Main Pipeline

The proposed pipeline route shall be installed mainly under the road or road shoulder; generally beside the existing pipeline which are public land.

3.2.3 Design Criteria

The design criteria applied for the pre-feasibility study are shown below:

1) Treatment and Transmission Capacity

The treatment and transmission capacities for the project are set out to be 1.1 times of the projected demand taking into consideration of water for maintenance.

2) Pipe Hydraulics

The Hazen-Williams Formula is used to determine the pipe dimensions taking into consideration of higher pump efficiency to sustain the economic aspects of operation.

$$V = 0.35464 \times C \times D^{0.63} \times I^{0.54}$$

Where V: average flow velocity (m/s)
C: velocity coefficient (110)
D: inner diameter of pipeline (m)
I: hydraulic gradient

3) Pump Capacity and Arrangement

The intake and booster pumps are selected, in accordance with the above-mentioned treatment and transmission capacities, as well as the required pump heads, using higher pump efficiencies. The number of pumps is determined, taking into account of the variation of minimum, average, and maximum required flows. In addition, each pumping site should have a standby pump with the same capacity.

The power for pump operation is calculated as shown in the following formula:

$$P = (0.163 \times Q \times H) \times (1 + a) / \eta_p$$

Where P: power (kW)
Q: pump flow (m^3/min)
H: pump head (m)
a: margin (0.15 is applied)
ηp: pump efficiency (0.85 is applied)

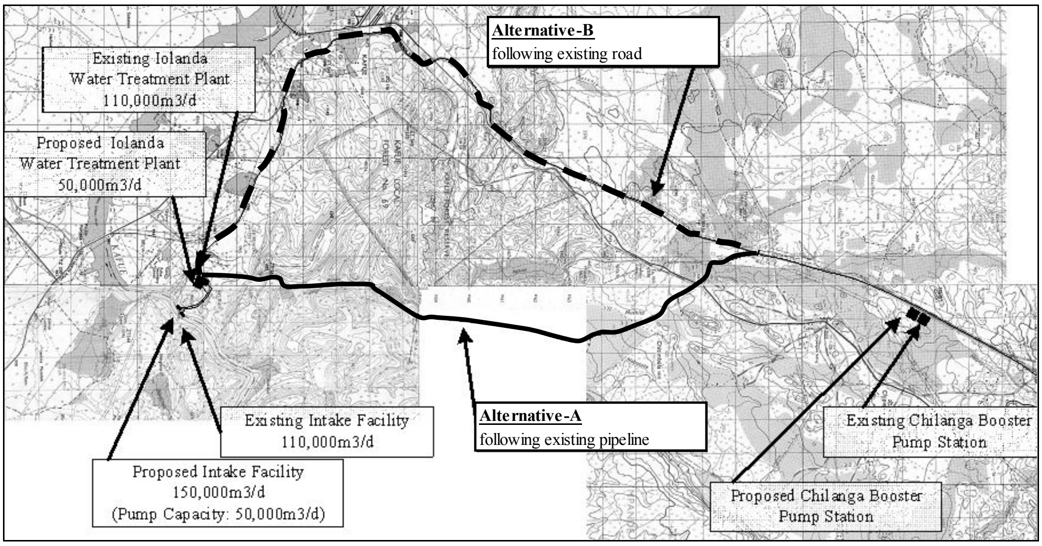
3.3 Design Alternatives

Considering the existing facilities and availability of the land, the proposed Water Works (WW; Iolanda II), the Chilanga Booster Pumping Station (BPS; Chilanga), and the transmission main pipeline from BPS to the city, the project has no other alternative for their location and system components. However, since the existing pipeline is passing through a valley and laid beside the river with concrete protective structure (see the following photo), it is necessary to consider the alignment of the transmission main pipeline from the WW to BPS.

Existing Transmission Main Pipeline beside Muchito River

3.3.1 Alternative Routes for Transmission Main Pipeline

The transmission main pipeline is a major component of the project, and it has significant environmental and economic impacts. Therefore, possible alternatives for the pipeline route are considered in this study.



Source: JICA Study Team

Figure 3.3.1 Alternative Routes for Transmission Main Pipeline

Alternative-A: Along existing pipeline

The existing pipeline, which passes along the narrow valley of Muchito River, is located about 1.5 km north of the water treatment plant and has a length of about 30 km, 1.5 km of which are encased with protective concrete. This is shown as solid line in Figure 3.3.1 above. The structure (pipeline with concrete protection), which shall be constructed along the valley, will create a huge environmental impact. Also, the construction cost for this alternative will be much higher than the ordinary installation along the road.

Alternative-B: Along existing road

The second alternative route is following the existing road (Kafue Road) and has a length of about 36 km. This is shown as dashed line in the figure above.

3.3.2 Evaluation and Selection of Alternatives

The two alternatives explained above and zero option which is without this project construction, were evaluated on the basis of technical, environmental, social and economic aspects. Based on the comparison of alternatives as shown in the following table, Alternative-B is perceived to be the more viable option.

Table 3.3.1 Comparison of Alternatives

Impact	Alternative-A	Alternative-B	Zero Option
Component	- About 30.0km pipeline - Concrete protection for1.5km	- About 36.5km pipeline	none
Cost	Slightly High - Pipeline cost is lower compared to Alt-B - Construction work cost will be very high	Ordinary	none
Technical Difficulties	Difficult - Far from access road - Requires diversion of water during construction	Ordinary - Close to major road - No special works	none
Environmental Impact	Bad - Dust and noise during construction - Effects during construction works due to far distance from access road	Almost None - Dust and noise during construction - Traffic inconvenience during construction	Very Bad - Promote uncontrolled private groundwater well development - Accelerate groundwater exhaustion and water quality degradation
Social and Economic Impacts	Good - Sustain water demand of the people (better sanitation), industries, and commercial establishments - Accelerate urban development and economic activities, which can provide livelihood to the people	Good - Sustain water demand of the people (better sanitation), industries, and commercial establishments - Accelerate urban development and economic activities, which can provide livelihood to the people	Very Bad - Deteriorate sanitary conditions due to water shortage - Restrain urban development and economic activities
Evaluation	Not recommended	**Recommended**	Not recommended

Source: JICA Study Team

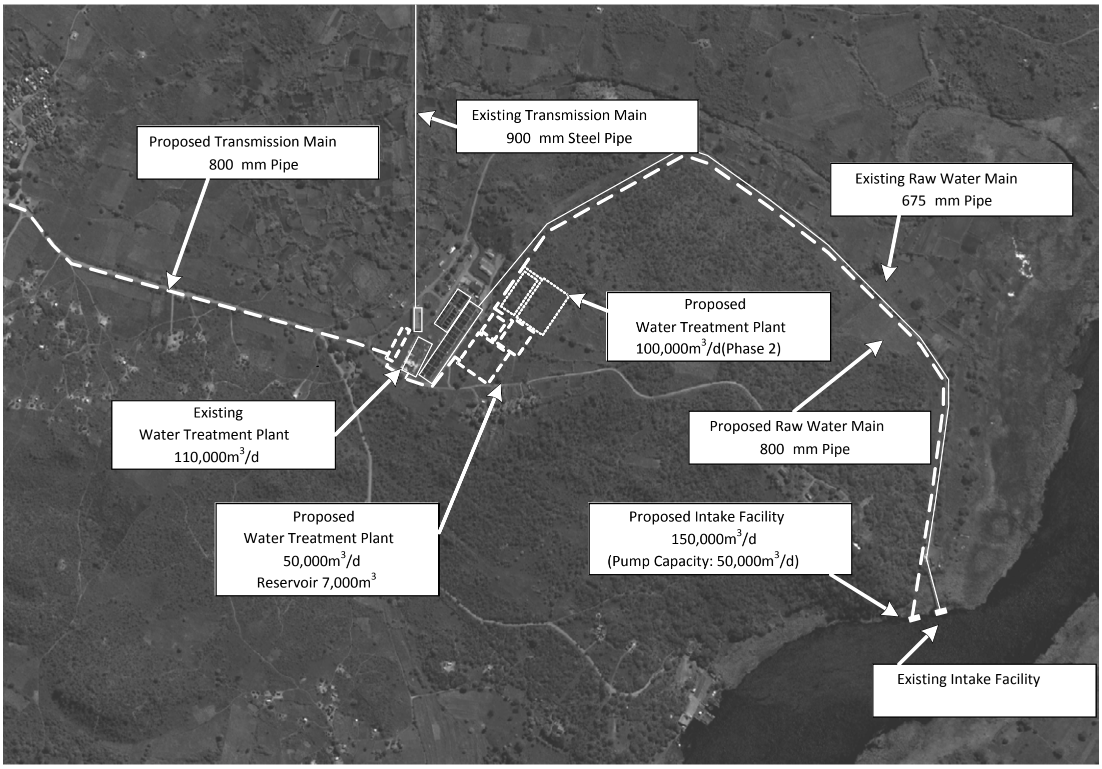
3.4 Preliminary Design

3.4.1 Intake Structure and Raw Water Main

Since the capacity of existing Iolanda Water Treatment Plant is 110,000 m^3/day (after rehabilitation works under Word Bank fund), the total water volume taken from Kafue River is projected to be 160,000 m^3/day by year 2015, which is still below the current water right.

The Iolanda II Water Treatment Plant will have a total capacity of 150,000m^3/d (Phase-1: 50,000 m^3/d, Phase-2: 100,000 m^3/d) by year 2020. Taking into account of the environmental and economic effects during construction of the intake structure inside the Kafue River, it is imperative to accelerate the completion of the civil structure during the implementation of Phase-1 project. The pumps and other mechanical equipment will be installed to meet the planned capacity in each phase.

To minimize the effects of construction to the river flow, the new intake structure shall be constructed at the upstream of the existing intake structure, and shall be kept as much as possible within the land of LWSC. For easy maintenance, the proposed raw water main pipeline shall be installed beside the existing raw water main pipeline. The proposed locations of these facilities are shown in the following figure.



Source: JICA Study Team

Figure 3.4.1 Proposed Locations of the Intake Facility and Raw Water Main Pipeline

Outline of the proposed structures is summarized in Table 3.4.1 below.

Table 3.4.1 Outline of the Proposed Structures

Intake	Raw Water Main
- Intake tower inside the Kafue River with size for pumps with total capacity of 150,000 m^3/d - Pump facilities with total capacity of 50,000 m^3/d, which is assumed 0.20 m^3/sec. x 5 pumps (including 1 stand-by) with H=40 m - Power transformer 33/3.3 kV	- About 2.0 km steel pipe with diameter of 800 mm - Pipe bridge for 800 mm x 2 lines with length of approx. 200 m - Accessories including thrust block

Source: JICA Study Team

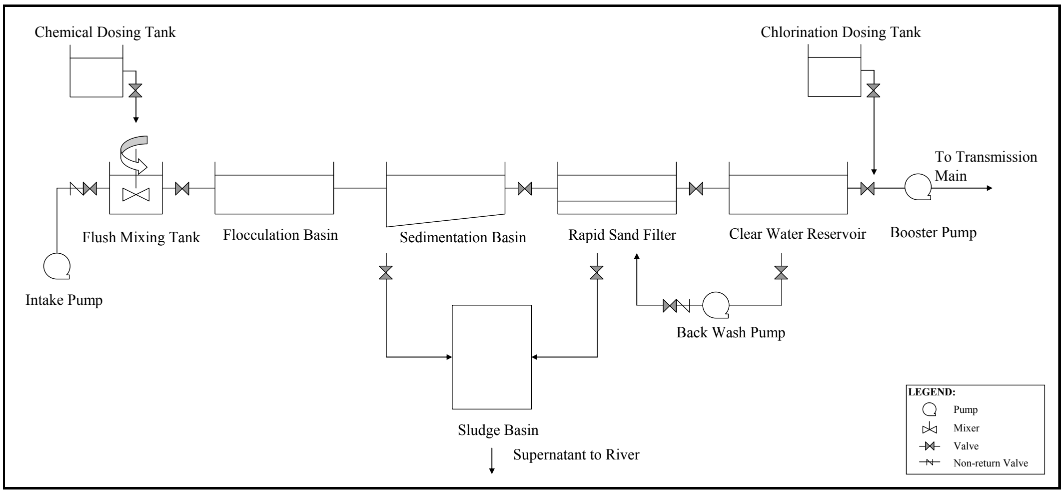
The intake water pump capacity was estimated based on 1.1 times the treatment capacity with an average of 23 hours per day operation.

3.4.2 Water Treatment Plant

The technical review and evaluation of the existing facilities unveiled that the current treatment system basically meets the standard requirements and produces water with acceptable quality. Subsequently, the new treatment system is patterned from the current system.

The proposed water treatment plant consists of the following components: i) chemical dosing system and flush mixing tank, ii) flocculation basin, iii) sedimentation basin, iv) rapid sand filter, v) clear water reservoir, vi) chlorine dosing system, vii) distribution pump), and viii) sludge basin.

The process flow diagram is shown in the following figure.



Source: JICA Study Team

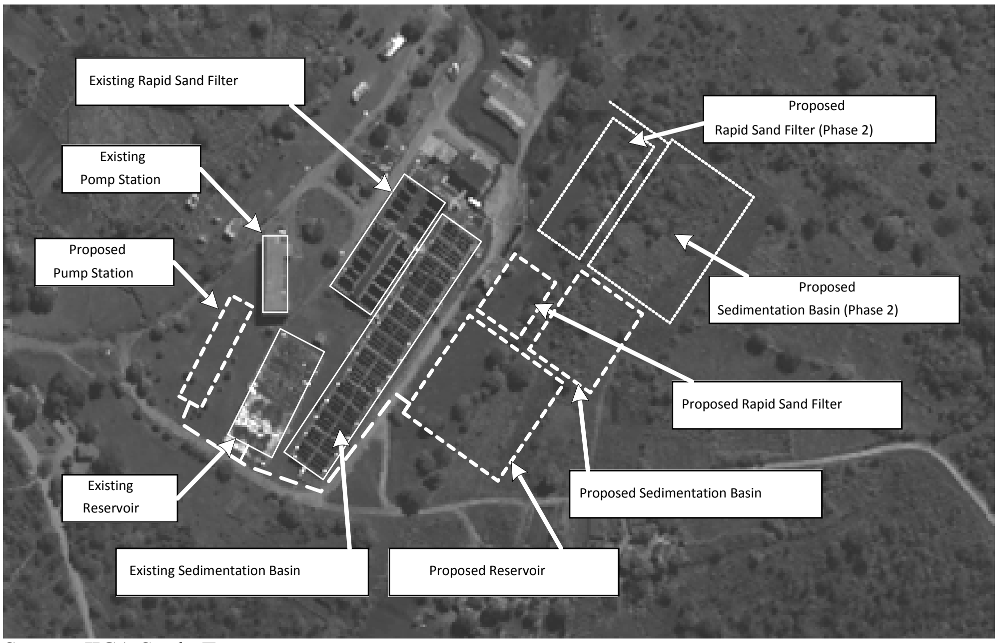
Figure 3.4.2 Proposed Treatment Process Diagram

For easy maintenance and to save on construction costs, the chlorine contact tank was omitted from the proposed system since the length of the transmission main pipeline is substantial to generate enough contact time during transmission to the distribution reservoir.

The development capacity of Iolanda II Water Treatment Plant Phase-1 is 50,000 m^3/day (2015) while Phase-2 is 100,000 m^3/day (2020) for a total of 150,000 m^3/day by 2020. The proposed plant will be located inside the LWSC site as shown in Figure 3.4.3 below.

The pump facility consists of four pumps and one standby pump, each with a capacity of 0.18 m^3/sec. A total head of 150 m is required to pump water to the Chilanga Booster Pumping Station.

A power substation, 33/3.3 kV with a capacity of 36 kVA, is also required to supply electricity for both Phase-1 and Phase-2.

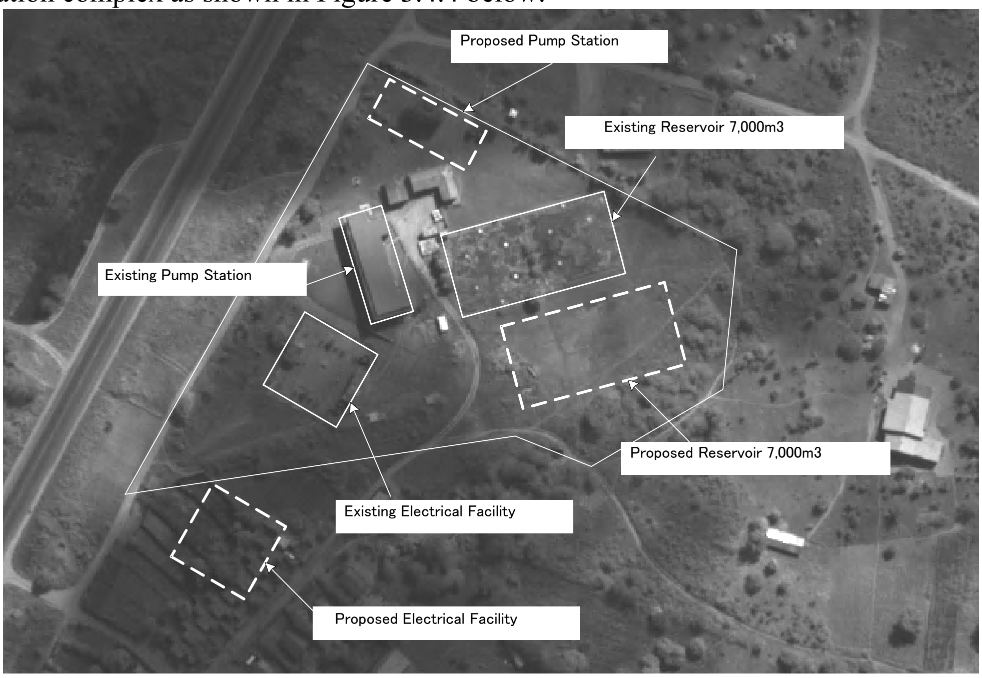


Source: JICA Study Team

Figure 3.4.3 Proposed Layout Plan of Water Treatment Plant

3.4.3 Expansion of Chilanga Booster Pumping Station

The proposed pumping station will be located inside the Chilanga Booster Pumping Station complex as shown in Figure 3.4.4 below.



Source: JICA Study Team

Figure 3.4.4 Proposed Layout Plan of Booster Pumping Station

There is insufficient space within the LWSC property to construct the proposed 36 kVA power substation. For operational and maintenance considerations, the new substation should be constructed adjacent to the existing 12 kVA power substation. A tract of land beside the LWSC property should be acquired for the proposed electrical facility as shown also in the figure above. However, the proposal should be discussed and agreed with Zambia Electricity Supply Company (ZESCO) during the feasibility study.

The proposed layout plan should consider the future expansion plan for Phase-2 with a capacity of 100,000 m^3/d. The reservoir capacity should consider the minimum requirement of 1 hour treatment capacity. Also, the specifications of the proposed pump facilities should have same specifications as the treatment plant required to boost water up to Stuart Park Reservoir.

3.4.4 Transmission Main Pipeline

The proposed transmission main pipeline is divided into two parts, as follows:

1) Transmission Main Pipeline-1: From Iolanda II Water Treatment Plant to Chilanga Booster Pumping Station with a total length of approximately 36.5 km; and
2) Transmission Main Pipeline-2: From Chilanga Booster Pumping Station to Stuart Park Reservoir with a total length of approximately 30.0 km.

The recommended size of pipe, required to transmit water at the rate of 50,000 m^3/d with economical pressure, is 800 mm diameter.

One of the major components of the construction cost for the project is the cost of the pipes. Therefore, the type of pipe to be used for the new pipelines should be carefully selected taking into account several aspects, i.e., strength, durability, workability, corrosion resistance, installation, etc. The following materials are recommended:
1) Ductile Iron Pipe (DI Pipe);
2) Steel Pipe; and
3) High Density Polyethylene Pipe (HDPE Pipe).

The comparative features of these pipes are shown in Table 3.4.2 below.

Table 3.4.2 Comparison of Pipe Features by Material

Material	Advantages	Disadvantages
Ductile Iron Pipe	1) High strength and durability 2) High toughness and impact resistance 3) Expandable and flexible at joints, allowing pipes to follow ground variations at some extent 4) Easy jointing work compared to steel pipe 5) Variety of joint types depending on construction conditions 6) Less corrosive compared to CI pipe and steel pipe 7) Installation without sand bedding is possible	1) Relatively heavy, heavy equipment is required for loading/unloading and installation on site 2) Likely to be corroded if damaged on inner and outer corrosion preventive surfaces
Steel Pipe	1) High strength and durability 2) High toughness and impact resistance 3) Can be integrated by welded joints long line 4) Good in processability	1) Skilled worker and special tools are required for welding on site in order to keep the welded joint in good quality 2) Electrolytic corrosion must be taken into account 3) Easy to be corroded if damaged on inner and outer corrosion preventive surfaces

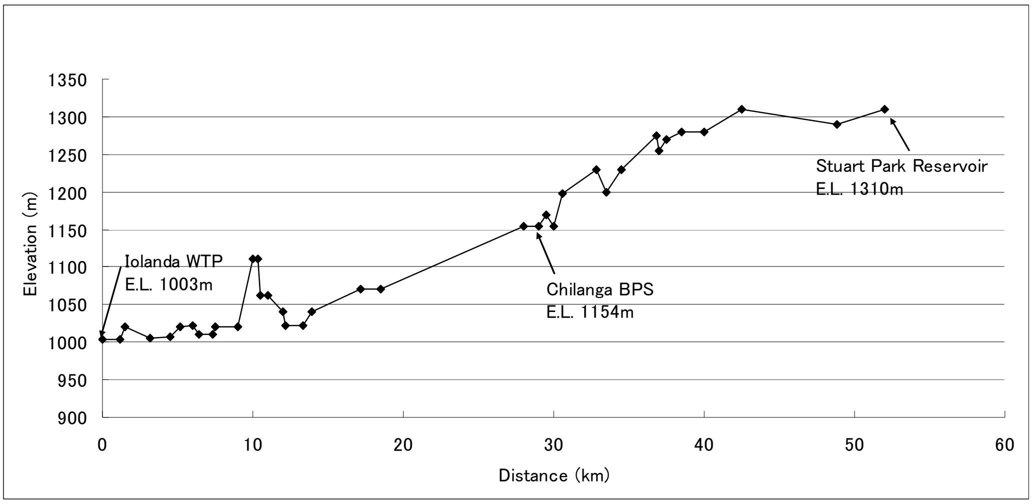
Material	Advantages	Disadvantages
Poly-ethylene pipe	1) Excellent corrosion resistance 2) Light weight and easy installation 3) Can be integrated by fusion joints 4) Flexible 5) Good in processability 6) The small roughness coefficient of inner surface lasts longer than ferrous pipes	1) Sensitive to heat and ultraviolet rays 2) Penetration with organic solvents must be taken into account 3) Difficulty in fusion jointing work when wet 4) Fusion joints require special controller and tools

Source: JICA Study Team

Since the existing transmission main pipeline uses steel pipe, cost data for this material are used in this study. However, cost effectiveness and material availability should be considered in the selection of pipe material in the feasibility study.

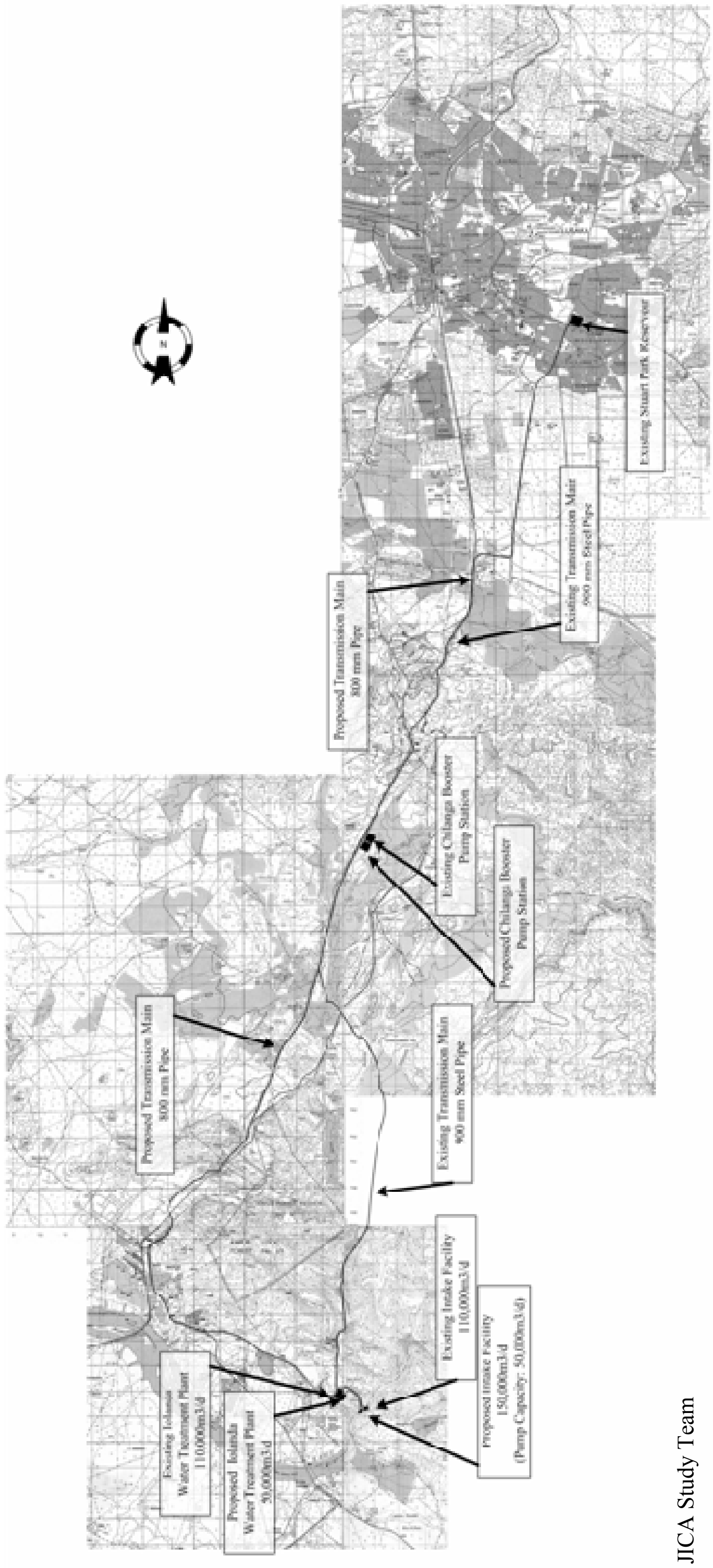
Generally, the new pipeline will be installed beside and/or under the road, or beside the existing pipelines within the road right-of-way, thus, avoiding costly and tedious acquisition of right-of-way from private landowners.

The profile and plan of the proposed pipeline are shown in Figures 3.4.5 and 3.4.6, respectively.



Source: Feasibility Study 1993

Figure 3.4.5 Profile of the Proposed Transmission Main Pipeline



Source: JICA Study Team

Figure 3.4.6 Plan of the Proposed Transmission Main Pipeline

3.5 Preliminary Cost Estimates

The preliminary cost estimates for Phase-1 are summarized in Table 3.5.1. The cost estimates are based on costs of similar projects in Zambia and other countries with similar conditions.

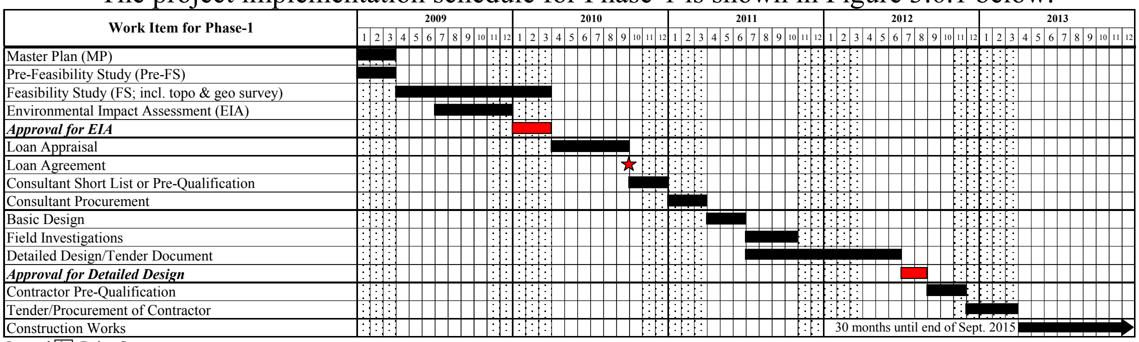
Table 3.5.1 Project Cost Estimates for Phase-1

Project Component	Cost (USD million)
1. Intake structure, 150,000 m^3/d; pump, 50,000 m^3/d	**3.19**
2. Raw Water Main (steel, dia.=800 mm, length=2,000 m)	**1.40**
3. Water Treatment Plant, 50,000 m^3/d	**29.02**
Coagulation and Sedimentation Basin	*1.06*
Rapid Sand Filters	*20.02*
Chlorination dousing system	*1.84*
Reservoir, 7,000 m^3	*2.06*
Pump unit for 50,000 m^3/d, 300 L/s x (2+1)	*4.05*
4. Transmission Main-1 (WTP - Booster Pump Station)	**21.00**
5. Booster Pump Station	**6.10**
6. Transmission Main-2 (Booster Pump Station - Reservoir)	**22.40**
7. Sanitation Pilot Plant (2 units)	**1.85**
Sub-Total (Project Direct Cost)	**84.96**
8. Engineering Services (8%)	**7.39**
TOTAL	**92.35**

Source: JICA Study Team

3.6 Project Implementation

The project implementation schedule for Phase-1 is shown in Figure 3.6.1 below.



Legend: Rainy Season
note: the implementation period will be longer if late start, due to the affects of rainy season to the survey works.

Source: JICA Study Team

Figure 3.6.1 Implementation Schedule

3.7 Preliminary Financial and Economic Evaluation

3.7.1 General Assumptions

The financial and economic analyses for the project to determine its viability are preliminary only.

The investment in sanitation pilot plant is minimal compared to the water treatment plant component; thus, its derived benefit is excluded from these analyses.

The project implementation will start in 2011 and will be completed by 2015. The commercial operation of the water supply system will commence on October 2015 with additional water treatment capacity of 50,000 m^3/day.

The project lifetime is 30 years, including 5-year construction period.

3.7.2 Financial Evaluation

(1) Financial Costs

Financial costs of the project are summarized in Table 3.7.1, consisting of: i) capital investment cost; ii) operation and maintenance cost; and iii) major rehabilitation cost.

Table 3.7.1 Financial Costs

Particulars	Cost	Remarks
Capital Investment Cost	USD 92.35 million	See Section 3.5 for detailed cost estimates
Operation and Maintenance Cost	USD 1.01/m^3 water production	Estimated based on average operation and maintenance costs (2003-2007) of the existing system
Major Rehabilitation Cost	15% of the capital investment cost in every 15 years of operation	Residual value of rehabilitation is entered as negative capital cost in the last year of project lifetime

Source: JICA Study Team

Disbursement schedule of the capital investment cost is assumed based on the implementation schedule shown in the table below.

Table 3.7.2 Disbursement Schedule of Capital Investment Cost

2011	2012	2013	2014	2015	Total
2.5%	2.5%	25.0%	40.0%	30.0%	100.0%

Source: JICA Study Team

(2) Financial Benefit

The revenue from incremental sales of water derived from the project is calculated as the financial benefit. The average tariff level of USD 0.593/m^3 in 2008 is applied as unit selling price. The water sales volume is computed (see Table 3.7.3) based on the production capacity of 50,000 m^3/day and gradual improvement in unaccounted-for-water (UFW) as presented in the master plan. Since the commencement of the operation is planned in October 2015, the production rate of 20% is assumed for the same year. Revenue collection rate of 95% is applied over the whole operational period.

Table 3.7.3 Water Sales Volume

	2015	2020	2030 - 2040
Production volume (m^3/day)	50,000	50,000	50,000
Production rate	20%	100%	100%
UFW	35%	25%	20%
Real Loss	*25%*	*20%*	*17%*
Administration/Commercial Loss	*10%*	*5%*	*3%*
Sales Volume (m^3/day)	6,500	37,500	40,000

Source: JICA Study Team

Based on the above, financial benefit (revenue) of the project is estimated to be USD 1.34 million from year 2015 up to about USD 8.23 million on the succeeding years. (Please refer to Table 3.7.5 below.)

(3) Average Cost of Capital

It is assumed that 85% of the total capital investment cost will be funded with long-term concessional loan, while the rest with commercial borrowing. The weighted average cost of capital is 1.92% per annum. This is used as the benchmark (hurdle rate) for the computation of FIRR.

Table 3.7.4 Assumed Funding Structure and Weighted Average Cost of Capital

	Concessional Loan	**Commercial Loan**
Funding proportion	85%	15%
Nominal interest rate	2.75% (0.75% plus 2% on-lending spread)	18.3%
Real interest rate after inflation adjustment	0.5%	10.0%
Weighted Average Cost of Capital	1.92%	
Payment terms	- 40 years repayment period including 10-year grace period - Interest during construction is capitalized and added to the principal	- 10 years repayment period including 2-year grace period

Source: JICA Study Team

(4) Results of Financial Analysis

The cash flow projection based on the above assumptions is presented in Table 3.7.5 below.

The computed Financial Internal Rate of Return (FIRR) for the project is 3.33%. The large capital investment requirement of over USD 90 million for the project contributed to the relatively low FIRR. However, this is fairly above the hurdle rate of 1.92%.

The computed Net Present Value (NPV) of the project, using discount rate of 1.92% (i.e., average cost of capital), is USD 16.97 million.

Furthermore, an analysis using different UFW rates and capital costs is shown in Table 3.7.6 below. Compared to the benchmark of 1.92%, the project would be viable only in those cases shaded in the table. This indicates that the UFW reduction measures mentioned in the master plan are crucial to ensure the project's financial viability.

Table 3.7.5 Financial Internal Rate of Return

(USD Million)

Year		Costs			Revenue	Net Cash Flow
		Capital Cost	O&M Cost	Total		
1	2011	2.31	0.00	2.31	0.00	-2.31
2	2012	2.31	0.00	2.31	0.00	-2.31
3	2013	23.09	0.00	23.09	0.00	-23.09
4	2014	36.94	0.00	36.94	0.00	-36.94
5	2015	27.71	0.37	28.07	1.34	-26.74
6	2016	0.00	1.84	1.84	6.89	5.05
7	2017	0.00	1.84	1.84	7.10	5.26
8	2018	0.00	1.84	1.84	7.30	5.46
9	2019	0.00	1.84	1.84	7.51	5.67
10	2020	0.00	1.84	1.84	7.71	5.87
11	2021	0.00	1.84	1.84	7.76	5.92
12	2022	0.00	1.84	1.84	7.81	5.98
13	2023	0.00	1.84	1.84	7.87	6.03
14	2024	0.00	1.84	1.84	7.92	6.08
15	2025	0.00	1.84	1.84	7.97	6.13
16	2026	0.00	1.84	1.84	8.02	6.18
17	2027	0.00	1.84	1.84	8.07	6.23
18	2028	0.00	1.84	1.84	8.12	6.28
19	2029	0.00	1.84	1.84	8.17	6.34
20	2030	13.85	1.84	15.69	8.23	-7.47
21	2031	0.00	1.84	1.84	8.23	6.39
22	2032	0.00	1.84	1.84	8.23	6.39
23	2033	0.00	1.84	1.84	8.23	6.39
24	2034	0.00	1.84	1.84	8.23	6.39
25	2035	0.00	1.84	1.84	8.23	6.39
26	2036	0.00	1.84	1.84	8.23	6.39
27	2037	0.00	1.84	1.84	8.23	6.39
28	2038	0.00	1.84	1.84	8.23	6.39
29	2039	0.00	1.84	1.84	8.23	6.39
30	2040	-4.62	1.84	-2.78	8.23	11.00

Financial Internal Rate of Return (FIRR) = 3.33%

Source: JICA Study Team

Table 3.7.6 FIRRs with different UFW Rates and Capital Costs

UFW	Capital Cost	
	Base Case (USD 92.35 million)	10% increase (USD 101.59 million)
Base Case (2015: 35%, 2020: 25%, 2030-2040: 20%)	**3.33%**	**2.52%**
+5 percentage point (2015: 40%, 2020: 30%, 2030-2040: 25%)	**2.58%**	1.79%
+10 percentage point (2015: 45%, 2020: 35%, 2030-2040: 30%)	1.78%	1.02%

Source: JICA Study Team

3.7.3 Economic Evaluation

(1) Assumptions

The capital cost and operation and maintenance costs, excluding taxes and price escalation, are adopted applying standard conversion factor of 1.0.

The projected real loss is deducted from the water production volume to estimate the real water consumption volume for the project as shown in Table 3.7.7 below.

Table 3.7.7 Estimated Water Consumption Volume

	2015	2020	2030 -2040
Production volume (m^3/day)	50,000	50,000	50,000
Production rate	20%	100%	100%
Real loss rate	25%	20%	17%
Consumption Volume (m^3/day)	7,500	40,000	41,500

Source: JICA Study Team

Economic benefits derived from the project are calculated by estimating: (i) cost saving in the existing water consumption from other sources to be met by the project, and (ii) incremental water consumption from the project.

It is assumed that the increased water supply will reach the consumers of Lusaka based on the proportion for each user category indicated in the demand forecast of the master plan.

(2) Estimated Consumption Volume and Unit Costs

Based on the above assumptions, the estimated consumption volume for with- and without-project situations are shown in Table 3.7.8 below.

Table 3.7.8 Estimated Consumption Volume (2020)

Consumption Group	With Project (m^3/day)	Without Project (m^3/day)	Remarks
Domestic Consumers	18,340	6,222	Water supply from communal taps of boreholes is assumed without project
Non-domestic Consumers	21,660	8,664	Water supply from private boreholes is assumed without project
Total	40,000	14,886	

Source: JICA Study Team

For without-project situation, it is assumed that the substitute water is supplied by communal boreholes for domestic, and by privately constructed boreholes for non-domestic users. The current tariff rates of LWSC are used for with-project situation. The unit costs of water for the different situations and consumers are tabulated in Table 3.7.9.

Table 3.7.9 Estimated Unit Cost of Water

	Domestic Consumers	Non-domestic Consumers
With Project	0.523 USD/m^3 (Current LWSC average tariff)	0.753 USD/m^3 (Current LWSC average tariff)
Without Project	1.396 USD/m^3 (Water price from communal taps of Water Trusts: ZMK100/20 litter)	1.767 USD/m^3 (Water cost estimated for private borehole construction and operation[1])

Source: JICA Study Team

(3) Results of Economic Analysis

The cash flow projection based on the above assumptions is presented in Table 3.7.10 below.

[1] Construction cost (USD 1.0 million) and operation and maintenance cost (USD 1.3/m^3) for a borehole with 200m^3/day capacity are assumed for without-project situation. The computed average water price is USD 1.767 USD/m^3 using 10% discount rate and 15-year life period per borehole.

Table 3.7.10 Economic Internal Rate of Return

(USD Million)

Year		Cost			Benefit			Net Cash Flow
		Capital Cost	O&M Cost	Total	Domestic	Non-domestic	Total	
1	2011	2.31	0.00	2.31	0.00	0.00	0.00	-2.31
2	2012	2.31	0.00	2.31	0.00	0.00	0.00	-2.31
3	2013	23.09	0.00	23.09	0.00	0.00	0.00	-23.09
4	2014	36.94	0.00	36.94	0.00	0.00	0.00	-36.94
5	2015	27.71	0.37	28.07	1.31	2.30	3.61	-24.47
6	2016	0.00	1.84	1.84	6.72	11.50	18.21	16.37
7	2017	0.00	1.84	1.84	6.89	11.51	18.40	16.56
8	2018	0.00	1.84	1.84	7.07	11.53	18.59	16.75
9	2019	0.00	1.84	1.84	7.24	11.55	18.79	16.95
10	2020	0.00	1.84	1.84	7.41	11.57	18.98	17.14
11	2021	0.00	1.84	1.84	7.68	11.28	18.96	17.12
12	2022	0.00	1.84	1.84	7.93	11.01	18.94	17.10
13	2023	0.00	1.84	1.84	8.16	10.76	18.93	17.09
14	2024	0.00	1.84	1.84	8.39	10.53	18.92	17.08
15	2025	0.00	1.84	1.84	8.61	10.31	18.92	17.08
16	2026	0.00	1.84	1.84	8.82	10.11	18.92	17.09
17	2027	0.00	1.84	1.84	9.02	9.91	18.93	17.09
18	2028	0.00	1.84	1.84	9.21	9.73	18.94	17.10
19	2029	0.00	1.84	1.84	9.40	9.56	18.96	17.12
20	2030	13.85	1.84	15.69	9.58	9.39	18.97	3.28
21	2031	0.00	1.84	1.84	9.58	9.39	18.97	17.13
22	2032	0.00	1.84	1.84	9.58	9.39	18.97	17.13
23	2033	0.00	1.84	1.84	9.58	9.39	18.97	17.13
24	2034	0.00	1.84	1.84	9.58	9.39	18.97	17.13
25	2035	0.00	1.84	1.84	9.58	9.39	18.97	17.13
26	2036	0.00	1.84	1.84	9.58	9.39	18.97	17.13
27	2037	0.00	1.84	1.84	9.58	9.39	18.97	17.13
28	2038	0.00	1.84	1.84	9.58	9.39	18.97	17.13
29	2039	0.00	1.84	1.84	9.58	9.39	18.97	17.13
30	2040	-4.62	1.84	-2.78	9.58	9.39	18.97	21.75

Economic Internal Rate of Return (EIRR) = 15.35%

Source: JICA Study Team

The Economic Internal Rate of Return (EIRR) of the project is 15.35% which is above the hurdle rate of 12.0%. The computed Net Present Values (NPVs) for the project using 10% and 12% discount rates are USD 31.94 million and USD 16.35 million, respectively.

(4) Non-quantifiable Benefits

Aside from the quantifiable financial and economic benefits, the project will generate a number of benefits that are non-quantifiable. These are as follows:

1) Service Improvement

Depending on the development of future distribution network by LWSC, the increased water supply capacity will directly benefit the consumers through more efficient and more reliable service. In areas where residents have to fetch water from remote communal taps, time to spend for fetching water will be saved by increased connections[2].

2) Better Sanitation

Increase in connection coverage, expected especially in the low-cost and peri-urban areas, will improve the hygienic situation of the residents with more access to safe water.

[2] Appraisal document for *Water Sector Improvement Project by World Bank (2006)* has indicated that the average distance for water source in peri-urban areas is 25.7 minutes and the average time to fill a 20 L container is 35.8 minutes.

3) Industrial Development

Following the Comprehensive Urban Development Plan, it is expected that manufacturing and commercial establishments will increase 1.5 times by 2015 and about 1.8 times by 2020 resulting to an economic growth of 7.6% during the period 2016-2020. A reliable water supply system will be required to meet the increasing demand for the industrial development in the area.

4) Groundwater Resource Saving

The increase in capacity of water supply sourced from surface water may save the groundwater resource in Greater Lusaka Area which is currently being exploited without sufficient regulation and monitoring.

3.8 Environmental and Social Considerations Study for the Water Supply and Sanitation Improvement Project

3.8.1 Current Environmental and Social Conditions of the Project Site

The proposed project will be located in both Lusaka and Kafue districts. The general environmental and social conditions of Lusaka City are summarized below.

(1) Geographical Feature

Nearly half of the land is used for residential purpose in Lusaka district while most of the project sites in Kafue district are agricultural and natural green fields (forest, grass and shrub, etc.). The existing transmission pipeline passes through Forest Reserve No.69, some hills, and along a valley.

(2) Hydrological Situation and Water Quality

Water for the proposed project will be taken from the Kafue Flats Sub-basin which has a surface water potential of 11,228,789 m^3/day. Due to insufficient wastewater treatment plant, a number of coliforms have been identified in the river water. Pollutants from the industries and agriculture have not been detected at the time of the study.

(3) Local Economy

The proposed project would contribute to a certain extent in promoting economic activities in the area by supplying more water to meet these demands. Some sites along Kafue River are being utilized for boating and camping, but no fishing. It was observed from one of these sites that some residents are illegally cultivating the land over the existing pipeline, about 800 m downstream of the existing intake structure.

3.8.2 Environmental and Social Impacts by the Project

The preliminary environmental and social considerations study for the Water Supply and Sanitation Improvement Project was conducted considering three design alternatives.

(1) Approach of the Impact Assessment

The Environmental and Social Considerations Study was conducted to assess the environmental and social impacts of the project referring to the relevant laws, regulations and standards of Zambia and the JICA Guideline for Environmental and Social Considerations. Following the JICA guideline on the impact assessment, 30 environmental impact items were ranked from A to D (both positive/negative) depending on its environmental and social significance, in accordance with the rating criteria listed below.

Rating Criteria
A+/-: Significant positive/negative impact is expected.
B+/-: Some extent positive/negative impact is expected.
C+/-: Unknown of positive/negative impact. (A further examination is required in the next study stage)
Blank: No impact is expected.

(2) Summary of the Environmental and Social Impacts

The summary of environmental and social impacts of the proposed project is shown in Table 3.8.1. The significant impacts will be discussed in the following section.

Table 3.8.1 Summary of Environmental and Social Impacts of the Project

Env. Impacts / Impact Phase	Social Environment												Natural Environment									Pollution								
	1.Involuntary Resettlement	2.Local Economy such as Employment & Livelihood, etc.	3.Land Use & Utilization of Local Resources	4. Social Institutions such as Split of Communities	5.Existing Social Infrastructures & Services	6.The poor, indigenous & ethnic people	7.Misdistribution of Benefit & Damage	8.Cultural Heritage	9.Local Conflict of Interest	10.Water Usage or Water Rights & Rights of Common	11.Sanitation	12.Hazards (Risk), Infectious Diseases such as HIV/AIDS	13.Topography & Geographical Features	14.Soil Erosion	15.Groundwater	16.Hydrological Situation	17.Coastal Zone	18.Fauna, Flora & Biodiversity	19.Meteorology	20.Landscape	21.Global Warming	22.Air Pollution	23.Water Pollution	24.Soil Contamination	25.Waste	26.Noise & Vibration	27.Ground Subsidence	28.Offensive Odor	29.Bottom Sediment	30.Accidents
Planning Phase																														
Construction Phase		B+/B-			B-													B-				B-	B-			B-				
Operation Phase		A+				A+					A+	B+			B+															

Source: JICA Study Team

(3) Expected Environmental and Social Impacts

The description of environmental and social impacts of the proposed project for each stage is shown below. The outline of the proposed EMP and the proposed TOR of the EIA are described in Section 3.9.2 of Recommendations for Further Stage.

Table 3.8.2 Description of Environmental and Social Impacts of the Project

	No.	Likely Impacts	Ranking: Design	Ranking: Const-ruction	Ranking: Ope-ration	Description
Social Environment	1	Involuntary Resettlement	-	-	-	・ No Involuntary Resettlement (based on hearing, satellite image, and site visit). ・ Intake facility: will be constructed in the available space of LWSC-owned property. ・ Water treatment plant (WTP): will be constructed in the available space of LWSC-owned property. ・ Booster pumping station (BPS): Part of the facilities will be constructed in its adjacent land where no residential houses are located. ・ Transmission main pipeline (WTP-BPS- Stuart Park Water Terminal): will be constructed under/along the existing road or along the existing pipeline.

	No.	Likely Impacts	Ranking			Description
			Design	Const-ruction	Ope-ration	
	2	Local Economy such as Employment & Livelihood, etc.	-	B+/B-	A+	・ B+ (Construction): Some employment opportunities as manual laborers would be provided. ・ B- (Construction): Some residents illegally cultivate land over the existing pipeline. There would be negative impacts on those residents during construction of the pipeline. ・ A+ (Operation): Future water demand in Greater Lusaka is estimated at 125,600 m^3/d for domestic use, 24,700 m^3/d for public, 5,600 m^3/d for commercial, and 135,000 m^3/d for industrial in 2015. The proposed project would contribute to a certain extent in promoting economic activities by supplying more water to meet these demands.
	3	Land Use & Utilization of Local Resources	-	-	-	・ No impact. ・ Since a new pipeline will be constructed under/along the existing road or along the existing pipeline, land use would not be changed.
	4	Social Institutions such as Split of Communities	-	-	-	・ No impact. ・ Since a new pipeline will be constructed under/along the existing road or along the existing pipeline, it would not cause split of the existing communities.
	5	Existing Social Infrastructures & Services	-	B-	-	・ B- (Construction): Since a new pipeline will be installed under/along the existing road, some road sections occur impassable and inconvenient during construction works.
	6	The poor, indigenous and ethnic people	-	-	A+	・ A+ (Operation): The proposed project will enhance water supply capacity of the LWSC. There would be positive impact on the poor in terms of their accessibility to clean water.
	7	Misdistributio n of Benefit & Damage	-	-	-	・ No relation to this issue.
	8	Cultural Heritage	-	-	-	・ No impact. ・ Transmission pipeline and road already exist in the proposed project site, therefore the probability that there are archaeological sites and monuments in that site is very low.
	9	Local Conflict of Interests	-	-	-	・ No relation to this issue.
	10	Water Usage or Water Rights & Rights of Common	-	-	-	・ No impact. ・ Existing water rights on Kafue Flats Subbasin for irrigation and municipal use, and those for ZESCO are 2,986,132m^3/d and 18,576,000m^3/d in average year, respectively. ・ Surface water potential of this Sub-basin is 11,228,789m^3/d. It is still sufficient to cover the water rights of additional 50,000m^3/d for Phase I of Iolanda II (up to 2015) and 100,000m^3/d for Phase II of Iolanda II (up to 2020), and 250,000m^3/d for Iolanda III (up to 2030). These water rights are under applying for the Water Board.
	11	Sanitation	-	-	A+	・ A+ (Operation): The urban poor in Lusaka face difficulties in accessing clean water, which deteriorates their sanitary conditions. The proposed project would make those people to be able to easily access to clean water, and accordingly their sanitary conditions would be improved.

	No.	Likely Impacts	Ranking			Description
			Design	Const-ruction	Ope-ration	
	12	Hazards (Risk) Infectious Diseases such as HIV/AIDS	-	-	B+	▪ No impact (Construction): No need to set work camps for construction workers, since those workers would be employed from Kafue, and influx of laborers from other areas is not expected. ▪ B+ (Operation): People's accessibility to clean water would be improved and accordingly water-borne infectious diseases (e.g. diarrhea, cholera, skin infection, etc.) would be decreased.
Natural Environment	13	Topography & Geographical Features	-	-	-	▪ No impact. ▪ The proposed project would not cause changes in topography and geographical features in the area since a new pipeline will be constructed under/along the existing road or along the existing pipeline.
	14	Soil Erosion	-	-	-	▪ No impact. ▪ The proposed project will not construct large-scale structures which might cause soil erosion.
	15	Groundwater	-	-	B+	▪ B+ (Operation): Currently, more than half of water production of the LWSC relies on groundwater. The proposed project of supplying water from surface water would decrease degree of reliance on groundwater.
	16	Hydrological Situation	-	-	-	▪ No impact. ▪ Surface water potential of Kafue Flats Subbasin is 11,228,789 m^3/d in average year. The volume of water (50,000 m^3/d) to be taken for Iolanda II Phase-1 (up to 2015) remains very small (about 0.44%) in relation to the surface potential water.
	17	Coastal Zone	-	-	-	▪ No relation to this issue. ▪ Zambia, as a landlocked country, does not have costal zone.
	18	Fauna, Flora and Biodiversity	-	B-	-	▪ B- (Construction): Part of a new pipeline will be constructed in the Forest Reserve No.69 in Kafue district. Although its construction would not have significant negative impacts on this Forest Reserve as it will be done under/along the existing road, and rare species are not identified, it requires obtaining a license for development in accordance with Forest Act of 1999.
	19	Meteorology	-	-	-	▪ No impact. ▪ No activities/facilities affecting meteorological phenomena in the area.
	20	Landscape	-	-	-	▪ No impact. ▪ Most of the structures will be constructed in large LWSC-owned property. ▪ Most part of the new transmission pipeline will be buried in the ground, which will have no negative effects on landscape.
	21	Global Warming	-	-	-	▪ No impact. ▪ No activities/facilities affecting global warming.
Pollution	22	Air Pollution	-	B-	-	▪ B- (Construction): There is likely to be an increase in dust due to earth excavation work and exhaust gas from construction machines and vehicles. ▪ No impact (Operation): No facility generating air pollution on the proposed project.
	23	Water Pollution	-	B-	-	▪ B- (Construction): There would be minor negative effects on water quality such as increase of suspended solid in Kafue River during construction of a new intake facility.
	24	Soil Contamination	-	-	-	▪ No impact. ▪ The proposed project does not have construction work and facilities which would cause soil contamination.

	No.	Likely Impacts	Ranking			Description
			Design	Const-ruction	Ope-ration	
	25	Waste	-	-	-	▪ No impact. ▪ Waste generated from operation of water treatment plant is planned to be treated with appropriate manner following the Zambian and/or international sufficient design/construction standard.
	26	Noise and Vibration	-	B-	-	▪ B- (Construction): Noise and vibration will be generated by excavation work during construction. ▪ No impact (Operation): Noise will be emitted from Booster Pumping Station. However, as there is no residential house near the station, there would be no significant effects.
	27	Ground Subsidence	-	-	-	▪ No impact. ▪ The proposed project does not have construction work and facilities which would cause ground subsidence.
	28	Offensive Odor	-	-	-	▪ No impact. ▪ The proposed project does not have construction work and facilities which would emit offensive odor.
	29	Bottom Sediment	-	-	-	▪ No impact. ▪ The proposed project does not have construction work and facilities which would affect bottom sediment.
	30	Accidents	-	-	-	▪ No impact. ▪ The proposed project does not have difficult construction work and operation of facilities which might cause accidents.

Source: JICA Study Team

3.9 Conclusion and Recommendation for Further Stage

3.9.1 Conclusion

The conclusions of the pre-feasibility for Water Supply and Sanitation Improvement Project are summarized below.

1) Development of water transmission system from the Kafue River to the city through the proposed priority project is the sole solution to meet the future water demand for both domestic and industrial purposes.
2) Development of Iolanda II Water Works is proposed to be carried out in two phases, of which the first phase development plan is proposed to be completed in 2015 with a 50,000 m^3/day capacity taking into account of fund allocation.
3) In order to increase the benefit derived from the development of Iolanda II Water Works, it is very important to conduct a UFW reduction program parallel with the project's implementation.

3.9.2 Recommendations for Further Stage

(1) Development Approach

In order to realize a sustainable urban water supply infrastructure, it is recommended to take a comprehensive approach with stepwise development program consisting of: i) UFW Reduction Program; ii) Development of Iolanda II Water Works Phase-1 (50,000 m^3/day by 2015); and iii) Extension of Iolanda II Water Works with another 100,000 m^3/day capacity.

(2) UFW Improvement Program

The UFW Improvement Program should have an activity for capacity development by way of training of trainers (TOT) method. It is recommended that the LWSC takes charge of extending their knowledge and technology to other local water utilities to solve one of Zambia's nonprolific water problems.

(3) Necessary Study for Implementation of the Project

Prior to its implementation, a feasibility study and design works of the project should be conducted. The following work components are recommended to be included in the further feasibility study:

i) Topographic survey
ii) Geographic survey
iii) Water quality test
iv) Approval from relevant authorities for land acquisition and construction
v) Study on design alternatives
vi) Cost estimation
vii) Environmental impact assessment (EIA)
viii) Proposed implementation schedule for the feasibility study
ix) Preparation of detailed project implementation schedule

The detailed work items for the proposed feasibility study are shown below.

1) Topographic Survey

To minimize the total survey cost and time, it is recommended to conduct the topographic survey with scale of 1:500 to avoid re-do survey work at the detailed design stage.

For intake site, river cross section survey also required.

2) Geographic Survey

To increase the accuracy of feasibility study and shorten the detailed design work period, it is recommended to conduct sufficient geographic survey for the items below:

i) 20m – 30m depth survey with soil laboratory test for all major structures (intake tower, water retaining structure, power sub-station and booster pumping station), to assume the form of substructure and required cost.
ii) 5m depth survey for pipeline alignment with average distance of 2km, to understand the ground condition and necessary excavation work contents.

3) Raw Water Quality Data

Raw water quality and water level data currently measured by LWSC should be utilized to minimize the cost and works of the Study.

4) Necessary Confirmation and Approval from Related Authority

To implement the construction works for the Project are necessary to confirm and acquire approval or agreement for the work items which disturb the current structure and/or atmosphere as listed below.

i) Construction inside the river (intake structure): Ministry of Energy and Water Development.
ii) Land acquisition (Chilanga booster pumping station): Ministry of Local Government and Housing and provincial governments.
iii) Road crossing (transmission main pipeline): Road Development Agency.
iv) Railway crossing (transmission main pipeline): Zambian Railway.
v) Power supply (sub-stations for Iolanda II water works and Chilanga booster pumping station): Zambia Electricity Supply Company Limited.

Relevant authorities above are subject to confirm during the feasibility study.

5) Alternative Study

To minimize the overall construction cost and time for the Iolanda II development, alternative study to install transmission pipeline both for Phase-1 and Phase-2 is recommended. The advantage and disadvantage to install overall pipeline in the Phase-1 is shown in the table below.

Table 3.9.1 Advantage and Disadvantage of the One Time Pipeline Installation

Advantage	Disadvantage
1. Reduce the construction period for the Phase-2 development.	1. High initial investment cost.
2. Reduce the Phase-2 construction cost for pipeline installation works.	
3. Reduce the environmental impacts occurred during pipeline construction.	
4. Surplus pipeline can be utilized to divert present transmission line and conduct the rehabilitation for the current pipes.	

Source: JICA Study Team

6) Cost Estimation Basis

Currently there is lack of the sufficient cost data for Zambia price, only the old cost data is available, therefore actual (bidding) cost for the similar project in other country was adopted in this study. However, during the implementation period of the feasibility study, the actual cost for similar projects, such as World Bank funded project (Lusaka) and African Development Bank funded project (Kitwe), are may available.

7) Necessity of Environmental Impact Assessment (EIA)

The Environmental Protection and Pollution Control Regulations (1997) requires a full EIA for the water supply/sewerage related project consists of; (i) pipelines with diameter over 0.5 m and length over 10 km, and (ii) water supply reservoir surface area more than 50 m^2.

Proposed TOR for the EIA is summarizing in table below.

Table 3.9.2 Proposed TOR for the EIA

Items	Contents
1. Alternative Consideration	• Consider alternative plans (e.g. pipeline) to mitigate environmental/social impacts.
2. Social, economic and cultural considerations	• Field reconnaissance on illegal cultivation in the project site. • Conduct consultation with those affected people.
3. Ecological considerations	• Hearing from Forest Department on the status of the Forest Reserve No.69 in Kafue district. • Field reconnaissance by ecological experts to examine baseline conditions on fauna/flora in the Forest Reserve No.69, if necessary. • Assess impacts on the Forest Reserve.
4. Water	• Assess impacts on surface water quality and quantity based on the latest existing data and information.
5. Environmental Management and Monitoring Plans	• Prepare Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP).
6. Public consultation	• Conduct public consultation for information disclosure at least 2 stages in accordance with Zambia's EIA Regulation.

Source: JICA Study Team

Approval of the EIA will be given by Environmental Council of Zambia (ECZ) which requires approximately 65 working days.

The outline of Environmental Management Plan (EMP) for the Project is proposed below.

Table 3.9.3 Outline of the Proposed EMP for the Project

Impact No.	Negative Impacts	Proposed EMP	Implementing Organization	Responsible Organization
2	Local Economy such as Employment & Livelihood, etc.	Project owner (LWSC) with those engaged in illegal cultivation and compensation for crop losses based on the current practice.	LWSC	LWSC
5	Existing Social Infrastructures & Services	Countermeasures for impassable and inconvenience of the existing road (e.g. construction at the time of low traffic density, detouring arrangement, etc.).	Contractor	LWSC
18	Fauna, Flora and Biodiversity	Measures to mitigate negative impacts on Forest Reserve will be examined in consultation with Forest Department. Educate construction workers not to harm fauna and flora in Forest Reserve during construction if necessary.	LWSC/ Consultant/ Contractor	LWSC
22	Air Pollution	Adequate countermeasures to decrease dust and exhaust gas during construction (e.g. watering, use of machines/vehicles adhere to standards during construction).	Contractor	LWSC
23	Water Pollution	Simplify and minimize the construction works inside and nearby the river.	Contractor	LWSC
26	Noise & Vibration	Consideration of construction work time (e.g. avoid night time construction near communities).	Contractor	LWSC

Source: JICA Study Team

As mentioned above, no significant environmental and social impacts are expected for the proposed project. Moreover, the LWSC are undertaking monitoring on water quality of Kafue Flats Sub-basin. Thus, additional monitoring for the proposed project is not necessary.

However, Post EIA Auditing is required to be conducted within 12-16 months after the completion of the proposed project, in accordance with the EPPC (EIA) Regulations, 1997.

8) Proposed Implementation Schedule for the Feasibility Study

Considering the survey works which only can be conducted during dry season, the study suggested to be implemented from early stage of the dry season.

Work Item and Assignment Schedule	2009									2010		
	4	5	6	7	8	9	10	11	12	1	2	3
[Feasibility Study]												
01. Topographic Survey	■	■	■	■	■	■	■	■				
02. Geographic Survey		■	■	■	■							
03. Past Study Review Works		■										
04. Development and Design Concept			■									
05. Infrastructure FS Design				■	■	■	■	■	■	■	■	
- Intake including temporary works				□	□	□	□					
- Treatment Plant					□	□	□	□				
- Transmission Line-1 (Iolanda to Chilanga)						□	□	□				
- Chilanga Booster Pumping Station							□	□	□			
- Transmission Line-2 (Chilanga to Stuart Park)									□	□	□	
06. Construction Plan										■	■	
07. Cost Estimation/Financia Evaluation										■	■	■
[Environmental Impact Assessment]												
11. Field Investigation				■								
12. Environmental Assessment					■	■	■	■	■			
13. Public Consultation					■		■		■			
EIA Approval by ECZ										▨	▨	▨
[Sublet Works]												
21. Topographic Survey (incl. river section survey)	■	■	■	■	■	■	■	■				
22. Geographic Survey		■	■	■	■							
- Structures (intake, plant, pump station)		□	□	□	□							
- Pipeline (raw water, transmission 1 &2)		□	□	□	□							
23. EIA Preparation				■	■	■	■	■	■			
24. Raw Water Quality Analysis	(Utilizing the LCC survey results)											

Legend: ░ Rainy Season

Note: The implementation period will be longer if late start, due to the affects of rainy season to the survey wo

Source: JICA Study Team

Figure 3.9.1 Proposed Implementation Schedule

9) Required Experts Input

To conduct the feasibility study proposed above, the experts input shown below will be required.

Assignment Schedule	2009									2010			Total MM
	4	5	6	7	8	9	10	11	12	1	2	3	
[Engineers]													
01. Team Leader	■	■	■	■	■	■	■	■	■	■	■	■	12.0
02. Civil Engineer (incl. land preparation and temporary works)	■	■	■	■	■	■	■	■	■	■	■	■	12.0
03. Treatment Plant Engineer (incl. mechanical works)					■	■	■	■	■				5.0
04. Pipeline Engineer (incl. structures)						■	■	■	■	■	■		6.0
05. Power Supply Engineer							■	■	■	■			4.0
06. Construction Planner/Cost Estimator										■	■	■	3.0
07. Financial Expert											■	■	2.0
08. Environmenta Expert				■	■	■	■	■	■				6.0
	Total												**50.0**
[Supporting Staff]													
11. Assistant Engineer (1)	■	■	■	■	■	■	■	■	■	■	■	■	12.0
12. Assistant Engineer (2)	■	■	■	■	■	■	■	■	■	■	■	■	12.0
13. Field/Environmental Surveyor	■	■	■	■	■	■	■	■	■				9.0
14. Field Surveyor	■	■	■	■	■	■	■	■					8.0
	Total												**41.0**

Source: JICA Study Team

Figure 3.9.2 Proposed Inputs for the Feasibility Study

10) Assumed Cost for the Feasibility Study

Based on the work items and expert inputs above, the total cost required to conduct feasibility study by the local consultant is assumed as below.

Table 3.9.4 Cost Estimate for Feasibility Study

Assignment Schedule	Estimated Budget		
	Quantity	Unit@	Amount (USD Thousand)
[Engineers]			
01. Team Leader	12.0	20,000	240
02. Civil Engineer (incl. land preparation and temporary wor	12.0	18,000	216
03. Treatment Plant Engineer (incl. mechanical works)	5.0	18,000	90
04. Pipeline Engineer (incl. structures)	6.0	18,000	108
05. Power Supply Engineer	4.0	18,000	72
06. Construction Planner/Cost Estimator	3.0	16,000	48
07. Financial Expert	2.0	16,000	32
08. Environmental Expert	6.0	20,000	120
	50.0	**Sub-total**	**926**
[Supporting Staff]			
11. Assistant Engineer (1)	12.0	8,000	96
12. Assistant Engineer (2)	12.0	8,000	96
13. Field/Environmental Surveyor	9.0	8,000	72
14. Field Surveyor	8.0	8,000	64
	41.0	**Sub-total**	**328**
[Sublet Works]			
21. Topographic Survey (incl. river section survey)	204 ha	8,000	1,632
22. Geographic Survey			
- Structures (intake, plant, pump station)	460 m	250	115
- Pipeline (raw water, transmission 1&2)	330 m	250	83
23. EIA Preparation	1 L.S.		120
		Sub-total	**1,950**
TOTAL			**3,204**

Note: The expert billing rate and sublet work costs are based on local rates.

Source: JICA Study Team