Lusaka City Council
Ministry of Local Government and Housing
The Republic of Zambia

PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR THE IMPROVEMENT OF THE LIVING ENVIRONMENT IN THE SOUTHERN AREA OF LUSAKA
IN
THE REPUBLIC OF ZAMBIA

April 2011

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)
KATAHIRA & ENGINEERS INTERNATIONAL

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Katahira & Engineers International on the Project for the Improvement of the Living Environment in the Southern Area of Lusaka in the Republic of Zambia.

The survey team held a series of discussions with the officials concerned of the Government of the republic of Zambia, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Zambia for their close cooperation extended to the survey team.

April, 2011

Kiyofumi Konishi
Director General,
Economic Infrastructure Department
Japan International Cooperation Agency

Summary

1. Outline of the Country

The Republic of Zambia (hereinafter referred to as Zambia) is a landlocked country located in the southern part of Africa, whose total land area is 752,600 km2, the total population is 12,620,000 (2008 World Bank) and national population growth rate is 2.5 % per annum (2008 World Bank). Approximately 80 % of population is Christians. The official language is English.

Lusaka City under the administration of Lusaka province is the Capital of Zambia and has been selected as the survey area of the project. It has an area of 70 km^2, a population of 1,080,000 (2000 national census) and population growth rate of 3.6 % (1990 – 2000 annual average in the national census).

The terrain of Lusaka is high plateau with some hills and its elevation is nearly 1,300m. The average maximum air temperature shows the distribution from 24 to 32 degree centigrade, the average minimum air temperature is from 7 to 18 degree centigrade and annual rainfall is around 800 mm. Lusaka has three seasons: light rainy season from October to November with high air temperature, rainy season from December to March and dry season from May to September with low air temperature.

The prime industries of Zambia are agriculture of cones, tobaccos and etc., mining industry of copper, cobalt and etc. and tourist business of natural parks. That of GNI per capita in 2009 was US$ 970 shows that Zambia is a developing country. The economic growth rate was 5.7 % (2008 World Bank) and the inflation rate was 12.9 % (2008 World Bank). The unemployment rate is almost 50 %. GDP in 2008 was US$ 14.7 billion which consists of its 21 % of the primary industry, 46 % of the secondary industry and 33% of the tertiary industry (2008 World Bank). While the economy of Zambia has been monoculture economy depending on the industry of copper whose export accounts for 60 % out of the total export amount, Zambia is working on diversification of industry such as agriculture and tourist business. However, the state of public finance remains relatively strained as it is shown that Kwacha declines 73 %, inflation rate is increasing, lending interest rate of commercial banks is increasing, trade deficit is expanding, agricultural production output is decreasing and there is an adverse impact on construction sector.

2. Background of the Project

With this background, JICA conducted "The Study on Comprehensive Urban Development Plan for The City of Lusaka (hereinafter referred to as The Lusaka Development Study)" from August 2007 to March 2009 and formulated a short-, medium- and long-term development plans for Lusaka City. To ease traffic concentration on the inner city road network in Lusaka City center caused by its radiating network, the Study recommended constructions of Inner Ring Road for a short-term project and Outer Ring Road for a med- long-term project. In parallel to these ring road developments, construction of an Access Road to the on going Lusaka South - Multi Facilities Economic Zone (LS-MFEZ) development is also suggested to contribute to a relief of traffic congestions as well as improvements of access to LS-MFEZ.

Pre-Feasibility Study of "The Lusaka Development Study" was conducted and identified the objectives of the short-term project as the constructions and improvement of the Inner Ring Road, Access Road to LS-MFEZ and other surrounding roads. With environmental and social consideration, the project was proposed to divide into 2 phases. Phase 1 development includes Inner Ring Road (South, 5.1km), link roads (6.7km) between Inner Ring Road and Chilimbulu Road, Inner Ring Road Extension (3.6km), Mini Bypass road (1.18km) linking Inner Ring Road and Kafue Road and other associated works such as pedestrian, drainage and facilities. Phase 2 project includes Inner Ring Road (West, 4.6km), Access Road to LS-MFEZ (3.2km), and other associated works such as pedestrian, drainage and facilities.

In accordance with the result of Pre-Feasibility Study, the Government of the Republic of Zambia (GRZ) requested to the Government of Japan for the project to be implemented under Japanese Grant Aid.

In the request, in addition to the developments proposed in Pre-Feasibility Study following roads were included. In Phase 1, Lulalila link Road and Shatumbu Road (3.1 km), Ben Bella Extension link (1.0 km), and seven intersections improvement, and in Phase-2 project, Katanga Road (2.1 km) and Mwapila-Great North Road rehabilitation (6.5 km). In order to review the appropriateness of phasing developments and the environmental and social considerations of implementing organization, JICA carried out a "Preparatory Survey on Program on Support for Industrial Infrastructure Development" in January 2010. Based on the Survey, prioritization was given to Phase-1 project as a Japanese Grant Aid project. This was because a greater traffic volume on Phase-1 roads was expected comparing Phase-2 roads and Zambian implementing organization was considered to be inadequate preparation against high possibility of a large-scale resettlement in Phase-2 development. This was also confirmed by the fact that earlier construction of Access Road to LS-MFEZ is crucial for promoting infrastructure development of LS-MFEZ and investments to the zone.

In response to these findings from the Survey, the Government of Japan has decided to carry out a preparatory survey with regards to a Grant Aid for Phase-1 project and Access Road to LS-MFEZ.

3. Outline Design of the Study and Contents of Project

In response to the requested from GRZ, the Government of Japan decided to conduct the preparatory survey on "the Project for the Improvement of the Living Environment in the Southern Area of Lusaka in the Republic of Zambia". JICA dispatched a survey team to the site between the period of 27th July 2010 and 20th September 2010. The survey team held a series of discussions with the concerned officials of GRZ, and conducted field investigations. Based on the results of the Survey, Outline Design was developed and summarized into Draft Final Report. Between 17th and 24th February 2011, the survey team was dispatched again to discuss the Outline Design Report and agreed after the consultations with GRZ.

Overall goal and the Project objective of the project are described as below:

Overall Goal: Improvement of living conditions for Lusaka residents and activation of local economy through improvement and construction of Inner Ring Road, LS-MFEZ Access Road and the connecting roads in Lusaka City.

Project Objective: Mitigation of traffic congestion by improvement and construction of Inner Ring Road, LS-MFEZ Access Road and the connecting roads in Lusaka City.

The project implements road construction works financed by Japanese Grant Aid Scheme in order to accomplish the above overall goal.

The original request for the project by GRZ includes road improvement works of Inner Ring Road, Kasama Rd – Mosi-Oa-Tunya Jct., Mosi-Oa-Tunya Jct. - LS-MFEZ, Mini Bypass Link, Chibwa Road, Nationalist Road, Yotam Muleya Road, Kasama Road, Shantumbu Road, Mosi-Oa-Tunya Road, Mulalila Road Link and Ben Bella Extension Link, and improvement of 7 intersections.

During the Site Survey it was revealed that improvement works for Kasama Road, the southern part of Shantumbu Road, the southern part of Mosi-Oa-Tunya Road have been on going by the Road Development Agency (RDA) of Zambia and construction works of Chibwa Road, Nationalist Road and Yotam Muleya Road had already been contracted. While, the condition of the northern part of Mosi-Oa-Tunya Road is good and expected effects by improvement works on the northern part of Shantumbu Rd and Mulalila Rosd were evaluated not significant. Therefore, it was agreed to exclude these road from the project component. It is also agreed that on going pavement work on Inner Ring Road Extension section by RDA will be improved under the project to bear heavy vehicle traffic.

It is also agreed that the original road alignments of Mini Bypass Link and Mosi-Oa-Tunya Jct. - LS-MFEZ proposed in the Lusaka Development Study were revised to minimize resettlement.

Roads selected for the project are shown in Table 1.

Table 1 Project Roads

Road Name	Road Length	Work Type
Inner Ring Road	4.875 km	New road construction
Kasama Rd – Mosi-Oa-Tunya Jct.	2.582 km	New road construction (in some parts improvement of existing road)
Mosi-Oa-Tunya Jct. - LS-MFEZ	4.952 km	New road construction (in some parts improvement of existing road)
Mini Bypass Link	1.220 km	New road construction
Ben Bella Extension Link	0.954 km	Improvement of unpaved road
Total	14.583 km	

The contents of facilities under outline design are summarized in Table 2.2-6.

Table 2 Contents of the Facilities under Outline Design

Road Name	Specifications
Mini Bypass Link (1.22km)	Road Cross Section: Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×2 Carriageway Pavement: AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement: Stone Surfacing, Interlocking Block (t=60mm), Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage: Concrete Drain (Depth = 300mm ~ 800mm), Stone Pitching Drain (Depth = 300mm ~ 800mm), RC Pipe Culvert (Pre-cast, Inner Diameter = 300mm ~ 900mm) Box Culvert: Box Culvert (2400mm x 2100mm) Slope Protection: Stone Pitching (t=150mm) Sign Board: Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead, Railway Crossing Ahead Road Marking: Center Line (w=150mm), Edge Line (w=150mm) Guardrail: Guardrail (On the Ground) Street Light: Street Light (H=8000mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections) Railway Crossing: Crossing gate and alarm device
Inner Ring Road (4.88 ㎞)	Road Cross Section: Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×1 Carriageway Pavement: AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement: Stone Surfacing, Interlocking Block (t=60mm), Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Accessway: Subbase (Crusher Run, t=100mm) Drainage: Stone Pitching Drain (Depth = 300mm ~ 800mm), Sod Drain (Depth = 300mm), RC Pipe Culvert (Pre-cast, Inner Diameter = 300mm ~ 900mm) Box Culvert: Box Culvert (1500mm×1500mm , 2400mm x 2100mm) Retaining Wall: Wet Stone Masonry Retaining Wall (H=1000mm～2000mm), Gravity Retaining Wall (H=2000mm～2500mm) Slope Protection: Stone Pitching (t=150mm, t=300mm), Sodding Sign Board: Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking: Center Line (w=150mm), Edge Line (w=150mm) Guardrail: Guardrail (On the Ground) Street Light: Street Light (H=8000mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections)
Kasama Rd – Mosi-Oa-Tunya Jct. (2.58km)	Road Cross Section: Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×1 Carriageway Pavement: AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement: Stone Surfacing, Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage: Sod Drain (Depth = 300mm) Slope Protection: Sodding Sign Board: Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking: Center Line (w=150mm), Edge Line (w=150mm) Guardrail: Guardrail (On the Ground) Street Light: Street Light (H=8000mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections)

Road Name	Specifications
Mosi-Oa-Tunya Jct. - LS-MFEZ（4.95km）	Road Cross Section:［Sections along power line］Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×1、［Section from Power line - LS-MFEZ gate］Carriageway 3.50m×2、Shoulder 1.50m×2 Carriageway Pavement:［Whole Section］AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement:［Sections along power line］Stone Surfacing, Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage:［Whole Section］Sod Drain (Depth = 300mm)、RC Pipe Culvert (Pre-cast, Inner Diameter = 300mm ~ 900mm) Slope Protection:［Whole Section］Sodding Sign Board:［Whole Section］Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking:［Whole Section］Center Line (w=150mm), Edge Line (w=150mm) Guardrail:［Sections along power line］Guardrail (On the Ground)
Ben Bella Extension Link（0.95km）	Road Cross Section:［Western Section］Carriageway 3.25m×2、Shoulder 0.50m×2、Sidewalk 2.00m×2、［Eastern Section］Carriageway 3.25m×2、Shoulder 1.50m×2、Sidewalk 2.00m×2 Carriageway Pavement:［Whole Section］AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement:［Whole Section］Stone Surfacing, Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage:［Western Section］Concrete Drain (Depth = 300mm ~ 800mm)、［Eastern Section］Stone Pitching Drain (Depth = 300mm ~ 800mm) Box Culvert:［Whole Section］Box Culvert (1500mm×1500mm) Slope Protection:［Eastern Section］Sodding Sign Board:［Whole Section］Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking:［Whole Section］Center Line (w=150mm), Edge Line (w=150mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections)

4. Implementation Schedule and Initial Cost Estimation

To implement the Project under the Japanese Grant Aid system, it is scheduled that the detail design period to be 15 months and the construction period to be 26 months. The estimated cost is approximately 9.24 Million US$ for Zambia side.

5. Project Evaluation

(1) Adequacy

- ✓ Beneficiary of the Project reaches throughout the city, particularly in the south area of Lusaka. The total population of beneficiaries in Lusaka City is1.391 Million people which is numerous.
- ✓ GRZ can operate and maintain the project roads by itself. Excessively special techniques are not necessary.
- ✓ This Project contributes to attain the overall goal of the Fifth National Development Plan 2006-2010 and the Road Sector Investment Program Phase II.

- ✓ With regards to environmental and social consideration, mitigation of traffic congestion on the road network in Lusaka City improves air pollution in the city.
- ✓ Because sanitary condition in the project area will be improved, epidemic of infectious diseases such as cholera will be reduced.
- ✓ Since the similar road improvement projects have been implemented successfully in Lusaka and the Japanese Grant Aid scheme is familiar to GRZ, it is expected that this Project will be implemented without difficulties.

(2) Effectivity

Quantitative Impact

- ✓ Vehicles going to the city centre have to use Independence Ave. or Chilimbulu Rd. or Los Angeles Rd., however the new Project Road will be a detour route of these roads and can reduce traffic congestion in Lusaka.
- ✓ Travel time by using the Project road will be shorter than now as shown below.

From Chilenje to Center of the Lusaka City (L=8.2km)	Before Implementation (Present)	After Implementation (Future)
	35min. (Ave. speed; 14km/h)	14min. (Ave. speed; 35km/h)

From Kanyama to Center of the Lusaka City (L=3.0km)	Before Implementation (Present)	After Implementation (Future)
	12min. (Ave. speed; 15km/h)	5min. (Ave. speed; 35km/h)

- ✓ The Road which is impassable during rainy season at the present will be passable after the implementation of the Project.

Qualitative Impact

- ✓ Living condition will be improved by improvement of convenience of public buses, increase of travel speed of cars, reduction of cost for commuting to offices, schools, hospitals and etc. Upon the completion of the Project, the road will be passable throughout the year. As the result, it will enhance the accessibility to the public services / facilities.
- ✓ Development of LS-MFEZ will be promoted by the Project because heavy vehicles will be able to access to LS-MFEZ by using the project roads.

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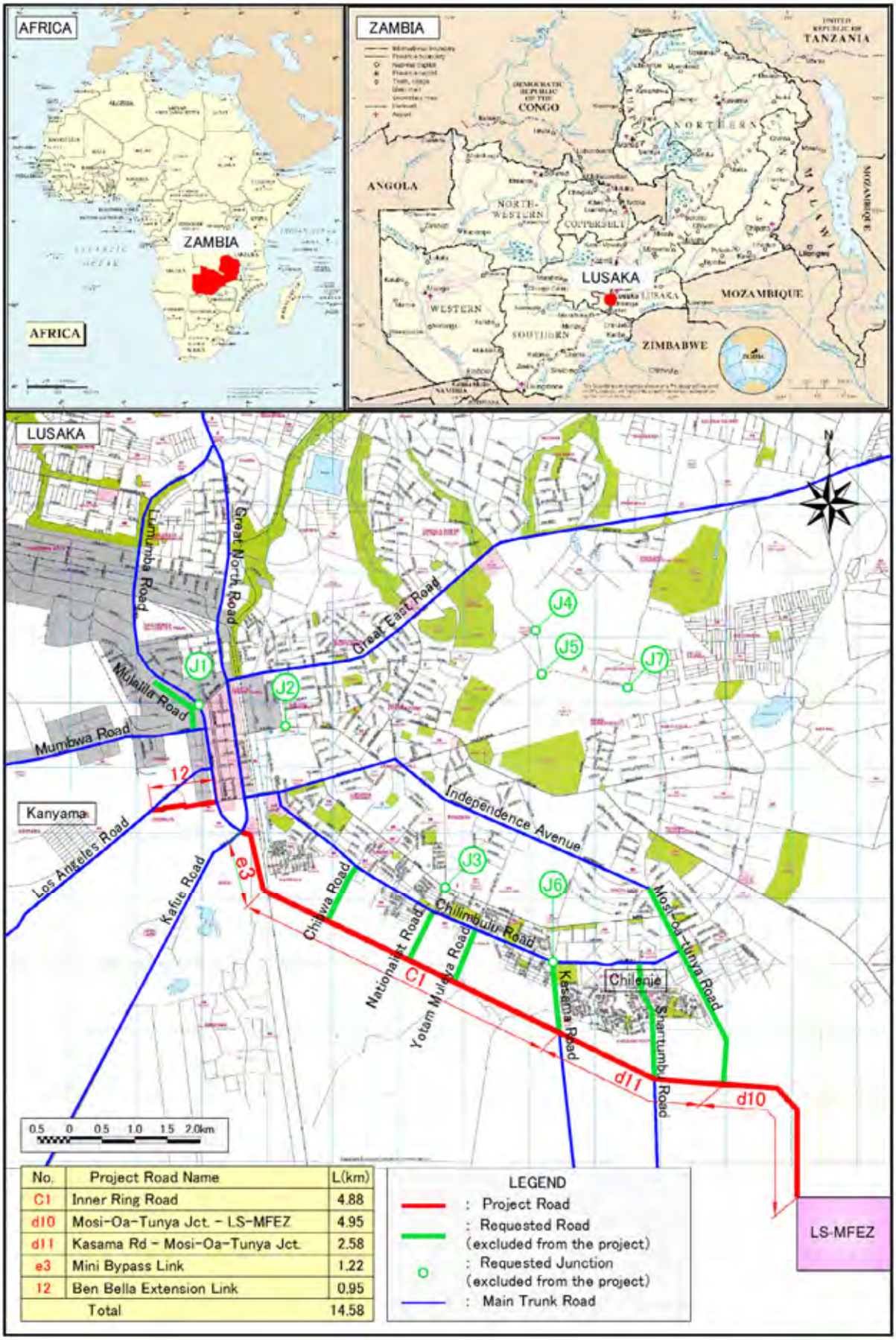
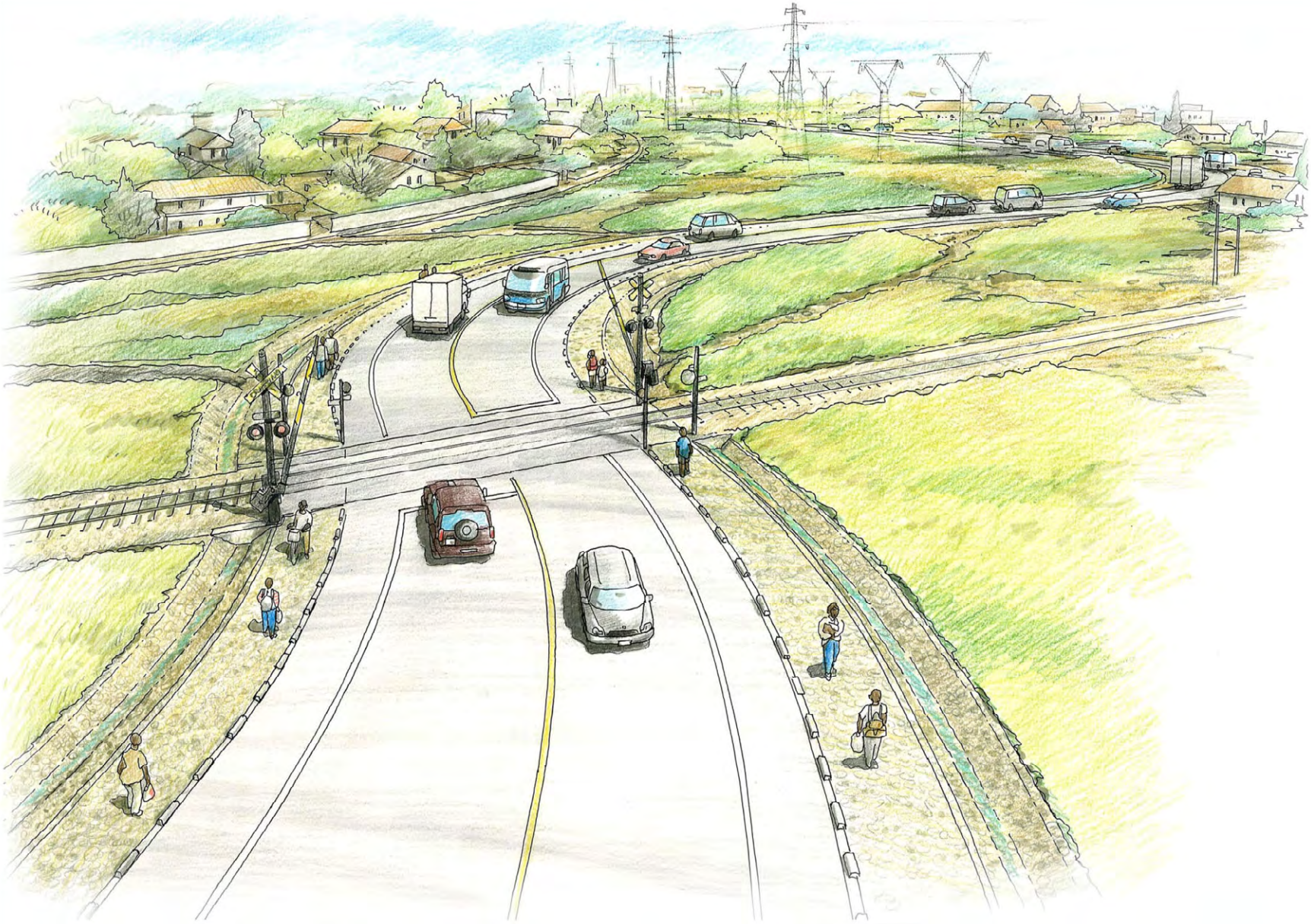


No.	Project Road Name	L(km)
C1	Inner Ring Road	4.88
d10	Mosi-Oa-Tunya Jct. – LS-MFEZ	4.95
d11	Kasama Rd – Mosi-Oa-Tunya Jct.	2.58
e3	Mini Bypass Link	1.22
12	Ben Bella Extension Link	0.95
	Total	14.58

Location Map



Perspective (Mini Bypass Link, STA0+900)

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Abbreviations

AASHTO	: American Association of State Highway and Transportation Officials
AC	: Asphalt Concrete
B/A	: Banking Arrangements
CBR	: California Bearing Ratio
E/N	: Exchange of Notes
ECZ	: Environmental Council of Zambia
EIA	: Environmental Impact Assessment
ESAL	: Equivalent Single Axle Load
G/A	: Grant Agreement
GDP	: Gross Domestic Project
GOJ	: Government of Japan
GNI	: Gross National Income
GRZ	: Government of the Republic of Zambia
JICA	: Japan International Cooperation Agency
LCC	: Lusaka City Council
LS-MFEZ	: Lusaka South Multi- Facility Economic Zone
LWSC	: Lusaka Water and Sewerage Company Limited
M/D	: Minutes of Discussions
MLGH	: Ministry of Local Government and Housing
MWS	: Ministry of Works and Supply
NRFA	: National Road Fund Agency
NHA	: National Housing Authority
ODA	: Official Development Assistance
RAP	: Resettlement Action Plan
RDA	: Road Development Agency
ROW	: Right of Way
RSZ	: Railway Systems of Zambia LTD
T/N	: Tender Notice
V/C	: Verification of Contract
WB	: World Bank
ZDA	: Zambia Development Agency
ZESCO	: Zambia Electricity Supply Corporation
ZAMTEL	: Zamnia Telecommunications Limited
ZMK	: Zambian Kwacha

CHAPTER 1 BACKGROUND OF THE PROJECT

1.1 BACKGROUND OF THE PROJECT

Zambia has been exerting its efforts to reconstruct its economy to emerge from the slumping economy. Zambia has been facing, through activating mining, agriculture, construction sector and industries promoting trade investments. As a consequence, the 6 % per annum economic growth rate has been accomplished in recent years, benefiting from the international copper price which serves as the largest income source of Zambia. However, despite its high economic growth rate, transportation cost has been higher than other countries due to an inefficient road network, structurally fragile onshore infrastructure and geographical conditions of inland country. Under these circumstances Zambia formulated the "Fifth National Development Plan (FNDP) 2006-2010" to promote organized infrastructure development including an upgrade of the road network.

In the Capital City Lusaka selected as the study area of the Project, a full transportation system adequate to cover public demands has been implemented through the Road Sector Investment Program funded by international donors etc. As a result, noticeable improvements were registered in the condition of main roads during the last ten-odd years. However the shortage of funds constrained the increase of paved road rate from around 65 %, on the other hand accelerates expansion of low-income residential area. In rainy season, poor provision of infrastructure in the area worsens their living condition. The lack of sewage system triggers a break out of infectious diseases such as choleras, and poor drainage system disturbs road conditions and limits people's access to basic public facilities such as schools and hospitals.

This unregulated expansion of low-income residential area generates frictions between the affluent and the impoverished and grows public anxiety. Taking accounts of above situations, the Government of Republic of Zambia (GRZ) has recognized the need for urban development including road maintenance and improvement.

The Lusaka City road network consists of inner city roads and three radiating roads leading to neighboring countries. Kafue Road (South-north corridor) leads to Zimbabwe and South Africa, Great North Road (Lobito corridor) leads to Congo, and Great East Road (Nacala corridor) runs through east to west of Zambia and leads to Malawi and Mozambique. These roads linking up in Lusaka City operates beyond capacity and creates inevitable traffic congestion on this road network.

The inner city road network causes conflict with international freight transport vehicles and passenger cars, and in Lusaka, only 4 roads (Great North Rd., Great East Rd., Lumumba Rd., Katima Rd.) are passable for heavy vehicles over 10t. This situation incurs not only a raise of

transportation cost but also deterioration of living environment along these unpaved and congested roads.

With this background, JICA conducted "The Study on Comprehensive Urban Development Plan for The City of Lusaka (hereinafter referred to as “The Lusaka Development Study”)" from August 2007 to March 2009 and formulated a short-, medium- and long-term development plans for Lusaka City. To ease traffic concentration on the inner city road network in Lusaka City centre caused by its radiating network, the Study recommended constructions of Inner Ring Road for a short-term project and Outer Ring Road for a med- long-term project. In parallel to these ring road developments, construction of an Access Road to the on going Lusaka South - Multi Facilities Economic Zone (LS-MFEZ) development is also suggested to contribute to a relief of traffic congestions as well as improvements of access to LS-MFEZ.

Pre-Feasibility Study of "The Lusaka Development Study" was conducted and identified the objectives of the short-term project as the constructions and improvement of the Inner Ring Road, Access Road to LS-MFEZ and other surrounding roads. With environmental and social consideration, the project is proposed to divide into 2 phases. Phase 1 development includes Inner Ring Road (South, 5.1km), link roads (6.7km) between Inner Ring Road and Chilimbulu Road, Inner Ring Road extension (3.6km), Mini Bypass road (1.18km) linking Inner Ring Road and Kafue Road and other associated works such as pedestrian, drainage and facilities. Phase 2 project includes Inner Ring Road (West, 4.6km), Access Road to LS-MFEZ (3.2km), and other associated works such as pedestrian, drainage and facilities.

In accordance with the result of Pre-Feasibility Study, GRZ requested to the Government of Japan for the Project to be implemented under Japanese Grant Aid.

In the request, in addition to the developments proposed in Pre-Feasibility Study following roads were included. In Phase 1, Lulalila link Road and Shatumbu Road (3.1 km), Ben Bella Extension link (1.0 km), and seven intersections improvement, and in Phase-2 project, Katanga Road (2.1 km) and Mwapila-Great North Road rehabilitation (6.5 km). In order to review the appropriateness of phasing developments and the environmental and social considerations of implementing organization, JICA carried out a "Preparatory Survey on Program on Support for Industrial Infrastructure Development" in January 2010. Based on the Survey, prioritization was given to Phase-1 project as a Japanese Grant Aid project. This was because a greater traffic volume on Phase-1 roads was expected comparing Phase-2 roads and Zambian implementing organization was considered to be inadequate preparation against high possibility of a large-scale resettlement inat Phase-2 development. This was also confirmed by the fact that earlier construction of Access Road to LS-MFEZ is crucial for promoting infrastructure development of LS-MFEZ and investments to the zone.

In response to these findings from the Survey, the Government of Japan has decided to carry out a preparatory survey with regards to a Grant Aid for Phase-1 project and Access Road to LS-MFEZ.

1.2 NATURAL CONDITIONS

Lusaka City belongs to steppe climate, temperature of from 15°C to 30 °C and the rainfall from 500mm to 1,250mm. Vegetation zone is savanna. The average high temperature is from 24 °C to 32 °C, the average low temperature is from 7 °C to 18 °C, and annual rainfall is 800mm. Lusaka has 3 seasons: Light rainy season (October to November), Rainy season (December to March) and Dry season (May to September).

The geology of the city is formed from a base layer of sedimentary rocks and metamorphic rocks, and a surface layer of laterite, which those rocks have been weathered. It is located in hilly landform at an altitude of 1,300m.

1.3 ENVIRONMENTAL AMD SOCIAL CONSIDERATION

GRZ has been organizing necessary documents for the verification of EIA/RAP for the project since January 2010. In this process, initial project scope was extended to only Inner Ring Road, Inner Ring Road Extension and Access Road to LS-MFEZ, and it was scheduled to be verified in August 2010. However, based on "'Master Plan (M/P) of the Lusaka Development Study" carried out from July to September 2010, it became apparent that proposed routes and road width (Inner Ring Road & Inner Ring Road Extension: 30m, Access Road to LS-MFEZ: 50m) will require a large-scale resettlement and land acquisition. Therefore the proposed project was concluded as not feasible. In addition, EIA/RAP report for Ben Bella Extension Link and Project Brief for Mulalila Rd has not yet been prepared.

In consultation with GRZ, JICA survey team agreed to implement EIA/RAP procedure including preparation and approval of Project Brief based on the alternative routes for studied roads which would minimize a scale of resettlement and land acquisition. After all, the revised project was evaluated as category B according to the Guidelines for Environmental and Social Considerations of JICA.

Table 1.3-1 Resettlement and Land Acquisition for Inner Ring Road

Residence only whose land is within ROW	Residence which needs to be resettled	Residence under construction of foundation and wall	Other property	Number of PAPs
12	19	20	13	129 + α

* α is expected to be counted because a census for No.111 house has not been taken.

Table 1.3-2 Resettlement and Land Acquisition for Mosi – Oa – Tunya Jct. – LS-MFEZ

Residence which needs to be resettled	Land Acquisition	Number of PAPs
0	18m * 510m	0

Table 1.3-3 Resettlement and Land Acquisition for Ben bella Extension Link

Residence which needs to be resettled	Other property	Land Acquisition	Number of PAPs
1	Around 10	12.5m * 600m	β

* Other property: Communal water supply, Toilet, Stand
* β will be counted in a census in RAP preparation.

The resettlement schedule after the verification of EIA/RAP is assumed as follows;

Table 1.3-4 Resettlement Schedule

Year Month	2010				2011				2012			
	1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12	1 2 3	4 5 6	7 8 9	10 11 12
Opening of relocation plan												
Setting up project committee												
Implementation of relocation plan												
Enlightenment for compensation												
Considering countermeasure of claim												
Allocation of Budget												
Contract with NGO of livelihood restoration												
Payment of compensation cost												
Relocation												
Construction												
Monitoring and Evaluation												

*Construction and monitoring will be continued to the end of the project

Ministry of Local Government and Housing (MLGH), as a leading institution of the project, administrates overall resources including mobilization, coordination and financing for implementation of resettlement

In the end of August 2010, MLGH has applied approximately US$ 7.6 million of special budget for resettlement and land acquisition to the Ministry of Finance. The requested budget was based on the worst scenario of resettlement and land acquisition and can be reduced as compensation negotiation progresses with residents.

Resettlement is scheduled to complete in June 2012, and the commencement of project construction is in October 2012. As the schedule requires to be updated according to the resettlement agreement and budget allocation, the progress of above procedures by GOZ has to be observed carefully.

Environmental items, their impacts and mitigation measures are shown in below Table 1.3-5.

Table 1.3-5 Impact and Mitigation Measure

	Item	Rank	Expected Impact	Evaluation and Measure
1	Involuntary Resettlement	B	Involuntary resettlement of legal and illegal residents counts around 20 houses and 150 PAPs.	-Provision of drawings for census survey -Assistance in counting PAPs -Confirmation of progress of RAP preparation -Assistance in holding SHM
2	Vulnerable people, Ethnic minority, Indigenous people	B	Resettlement of one resident, one plot, communal water supplies, toilets and stands along Ben Bella Extension Link will occur.	-Holding stakeholder meetings -Securement of relocation site and mediation -Most of planned sections are within existing road area.
3	Traffic congestion	B	Traffic congestion due to the construction work	-Setting detour, sign board, and allocate security guards
4	Air pollution	B	Adverse effects to residents by dust from the construction site and exhaust from vehicles during operation period	-Maintenance of equipments and water spray around work sites during construction -Maintenance of vehicles and observance of exhaust standard
5	Noise and Vibration	B	Adverse effects to residents by noise and vibration of traffic especially at the site near hospital or school	-Restriction of working hours -Consideration to residents and students if blasting rock
	Other	The minimum effects are predicted on the ecosystem because the project is proposed on existing roads or routes in every day use. Whereas compensation and securement of resettlement sites are assumed impacted by involuntary resettlement observed at the census survey.		

A: Serious Impact, B: Considerable Impact, C: Further examination is not required.

With a support of Environmental Council of Zambia (ECZ), Lusaka City Council (LCC) is responsible for monitoring and reporting JICA about the result of natural and social environment before, during and after construction of the project using a monitoring form attached in the Minutes of Discussion. Monitoring items assumed to impact natural environments are such as Air quality, Noise/Vibration and social environment are such as Public Consultation, Grievance Redress, Progress control of Land Acquisition and Resettlement, Livelihood Restoration Assistance, Increase and Decrease of Incomes related to land acquisition and resettlement.

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 BASIC CONSEPT OF THE PROJECT

2.1.1 Over Goal and Project Purpose

Overall Goal: Improvement of living conditions for Lusaka residents and activation of local economy through improvement and construction of Inner Ring Road, LS-MFEZ Access Road and connection roads in Lusaka City.

Project Objective: Minimization of traffic congestion by improvement and construction of Inner Ring Road, LS-MFEZ Access Road and connection roads in Lusaka City.

2.1.2 Basic Concept of The Project

The project implements road construction works financed by Japanese Grant Aid Scheme in order to accomplish the above overall goal.

The original request for the project by GRZ includes road improvement works of Inner Ring Road, Kasama Rd – Mosi-Oa-Tunya Jct., Mosi-Oa-Tunya Jct. - LS-MFEZ, Mini Bypass Link, Chibwa Road, Nationalist Road, Yotam Muleya Road, Kasama Road, Shantumbu Road, Mosi-Oa-Tunya Road, Mulalila Road Link and Ben Bella Extension Link, and improvement of 7 intersections.

During the Site Survey it was revealed that improvement works for Kasama Road, the southern part of Shantumbu Road, the southern part of Mosi-Oa-Tunya Road have been on going by the Road Development Agency (RDA) of Zambia and construction works of Chibwa Road, Nationalist Road and Yotam Muleya Road had already been contracted. While, the condition of the northern part of Mosi-Oa-Tunya Road is good and expected effects by improvement works on the northern part of Shantumbu Rd and Mulalila Rosd were evaluated not significant. Therefore, it was agreed to exclude these road from the project component. It is also agreed that on going pavement work on Inner Ring Road Extension section by RDA will be improved under the project to bear heavy vehicle traffic.

It is also agreed that the original road alignments of Mini Bypass Link and Mosi-Oa-Tunya Jct. - LS-MFEZ proposed in the Lusaka Development Study were revised to minimize resettlement.

Roads selected for the project are shown in the Table 2.1-1.

Table 2.1-1 Project Roads

Road Name	Road Length	Work Type
Inner Ring Road	4.875 km	New road construction
Kasama Rd – Mosi-Oa-Tunya Jct.	2.582 km	New road construction (in some parts improvement of existing road)
Mosi-Oa-Tunya Jct. - LS-MFEZ	4.952 km	New road construction (in some parts improvement of existing road)
Mini Bypass Link	1.220 km	New road construction
Ben Bella Extension Link	0.954 km	Improvement of unpaved road
Total	14.583 km	

2.2 OUTLINE DESIGN OF THE JAPANESE ASSISTANCE

2.2.1 Design Policy

2.2.1.1 Project Scope

Roads selected on Table 2.1-1 were assessed as reasonable for the project scope,, according to the evaluation of expected effects on reduction of traffic congestions, improvement of living environment and poverty alleviation by the implementation of requested roads and intersections,

On the other hand, roads listed in Table 2.2-1 were excluded from the project component requested based on the site survey, due to their limited effects by improvement or decision to implement works by GOZ. The detailed reasons for exclusion from the Project are explained in below Table 2.2-1.

Table 2.2-1 List of Roads Excluded from the Project

Road Name	Reason of exclusion from the Project
Mulalila Road	-Existing road is unpaved, however, expected effects on improvement of living condition and poverty alleviation are not significant since the roadsides are mostly occupied by factories and storages and residences are limited. -Expected effect on traffic congestion mitigation is limited. Rather, traffic congestion at the intersection at Lumumba Rd. may become heavier because the type of the intersection will be changed from T intersection to Cross intersection.
Shantumbu Road	-Existing road is unpaved, however, the expected effect on living condition improvement and poverty alleviation is not significant since the living condition of the roadside area is already improved with roads, drains, water supply and others. -Expected effect on traffic congestion mitigation is limited since the road will not be used as a detour of major road.
Improvement of 7 Intersections	-The expected effect on living condition improvement and poverty alleviation by the intersections improvement is not significant.

Road Name	Reason of exclusion from the Project
	-The urgency of intersection improvements is not high, since waiting durations to pass those intersections are less than 10 minutes. -The traffic congestions at 2 intersections (J3, J6) in the southern Lusaka will be mitigated after the construction of Inner Ring Road.
Chibwa Road Nationalist Road Yotam Muleya Road	Zambian side decided to construct the roads by itself.

2.2.1.2 Design Policy

(1) Basic Policy

The project scope is described in Table 2.1-1 as explained in the previous section. Design is to be developed referring to study results and proposals of The Lusaka Development Study including M/P and Pre-F/S, and design conditions and technical specifications adopted in the Project for Improvement and Maintenance of Lusaka City Roads (Phase I to III). The present conditions of the roads should also be reviewed.

The content of the Project is formulated to attain the objectives of the Project such as congestion mitigation, living condition improvement, and poverty alleviation.

(2) Policy for Natural Environmental Conditions

The principal of road structure is an embankment considering the large area of hard rock covered ground surface on the site as well as a partial flooded area during rainy season.

(3) Policy for Socio-Economic Conditions

Ben Bella Extension Link is designed to provide direct improvement of living conditions along the road, addressing such as improvement of traffic safety, comfort of driving and walking, sanitation condition with drainage and others.

The surface structure for the section of Mini Bypass Link to LS-MFEZ (Mini Bypass Link ~ Inner Ring Rd. ~ Kasama Rd – Mosi-Oa-Tun Jct. ~ Mosi-Oa-Tunya Jct. – LS-MFEZ) is planned for heavy vehicles. Bus bays are also provided at convenient places for students and working people.

(4) Policy for Construction & Procurement Conditions

Construction materials are specified with consideration to quality, cost and procurement condition. Especially stone is utilized as much as possible as it is abundantly available at reasonable prices near the site.

(5) Policy for Utilization of Local Contractor & Consultant

Local contractors with sufficient equipment and technical capabilities are utilized in construction planning. Construction methods commonly used in Zambia is adopted considering their capacity.

(6) Policy for Operation and Maintenance

Open channel is adopted as basis of drainage system for its easy operation and maintenance. Asphalt concrete, typically used in Zambia, is specified for the surface structure considering general maintenance capability of locals.

(7) Grade Setting Policy for Facilities

The appropriate road specification is proposed referring to the proposal provided at The Lusaka Development Study including M/P and Pre-F/S, and, design condition, specification, grade and structure set in the Project for Improvement and Maintenance of Lusaka City Roads (Phase I to III).

(8) Policy for Construction/Procurement Method & Construction Schedule

Given above mentioned policies (1) ~ (7), design, construction and procurement method are proposed. Further, construction schedule requires a consideration of rainy season, and construction methods require reflecting a consideration of minimum influences on residents along project sites as well as present traffic flow during construction works.

2.2.2 Basic Plan

2.2.2.1 Design Condition

(1) Design Specifications

In principal, the design is developed in accordance with the road design specifications of South African Transport Communications Commission (SATCC) adopted by RDA. Road design specifications of American Association of State Highway and Transportation Officials (AASHTO) and Japanese Road Association (JRA) are referred as supplementary. Design specifications adopted are shown below.

Road Geometric Standard Specification

- Code of Practice for the Geometric Design of Trunk Roads, SATCC
- Road Structure Ordinance 2004, JRA

Pavement Structural Design Specification

- Guide for Design of Pavement Structures 1993, AASHTO

(2) Road Classification

To formulate the basic specifications of the Project roads, the Project roads are classified as shown in Table 2.2-2, according to road functions in the road network and forecasted vehicle types and volumes.

Table 2.2-2 Classification of the Project Road

Road Class	Project Roads
Arterial	Inner Ring Road, Kasama Rd – Mosi-Oa-Tunya Jct., Mosi-Oa-Tunya Jct. - LS-MFEZ
Collector	Mini Bypass Link, Ben Bella Extension Link

(3) Road Geometric Standards

The geometric standards by road class of the Project are established in accordance with the design specifications of SATCC and JRA as shown in Table 2.2-3.

Table 2.2-3 Geometric Standards by Road Class

Item	Geometric Standards	
	Arterial	Collector
Design speed (km/h)	60	50 (40)
Maximum grade (%)	4.0	6.0
Minimum horizontal curve radius (m)	100	60
Stopping sight distance (m)	85	65 (50)
Minimum vertical curve radius (凸) (m)	1100	700 (400)
Minimum vertical curve radius (凹) (m)	1800	1300 (400)
Maximum super-elevation (%)	4.0	6.0
Carriageway width (m)	3.50	3.25

Note: Figure in ( ) can be adopted where the standard is difficult to be applied due to the site condition.

2.2.2.2 Road Planning

(1) Planning of Inner Ring Road, Kasama Rd – Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. – LS-MFEZ (section along the power lines)

The section of Inner Ring Road, Kasama Rd. - Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ (section along the power lines) forms a single arterial road and linking to International Ring road of Kafue Road and LS-MFEZ. Located along power lines as well as under similar design conditions, same specifications are planned for the roads.

Road Route

Approximately 7.7km of these roads are proposed to be newly constructed except approximately 1.8km of existing road sections of Kasama Rd. - Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ. In the Lusaka Development Study, the roads have been proposed to develop on land along power lines, which is about 120m wide and owned by state. There are 3 lines of high voltage pylons paralleling to power poles supporting 33KV and 11KV

power lines in some places. Proposed Inner Ring Road is on the south side of these power lines.

Because of existing houses on proposed road site, the route is proposed to locate near to power lines to minimize the impact of resettlement. Under this condition, the safety distance between power lines and proposed roads needs to be secured. After the discussions with local power company ZESCO, it is agreed to secure distance of 25m from the high voltage line and road shoulder, and 5m from the 11KV power line and road shoulder. Additionally, guardrails are installed to protect power poles from accidental vehicle damages.

Road Right-of-Way (ROW)

Considering the standard road width of 13m with embankment slopes and drains, total of 18m wide ROW is necessary for the construction of roads. Houses located within ROW are required to be demolished for the road construction.

Road Cross Section

Carriageway width is 3.5m in accordance with the geometric standard of arterial road. 1.5m width of road shoulder for vehicle's emergency stopping and bicycle path, and 2 m width of sidewalk as the standard considering low demand of usage are also set. Sidewalk is installed at the south side (residential area side) of the road only. Typical cross section is shown in Figure 2.2-1.

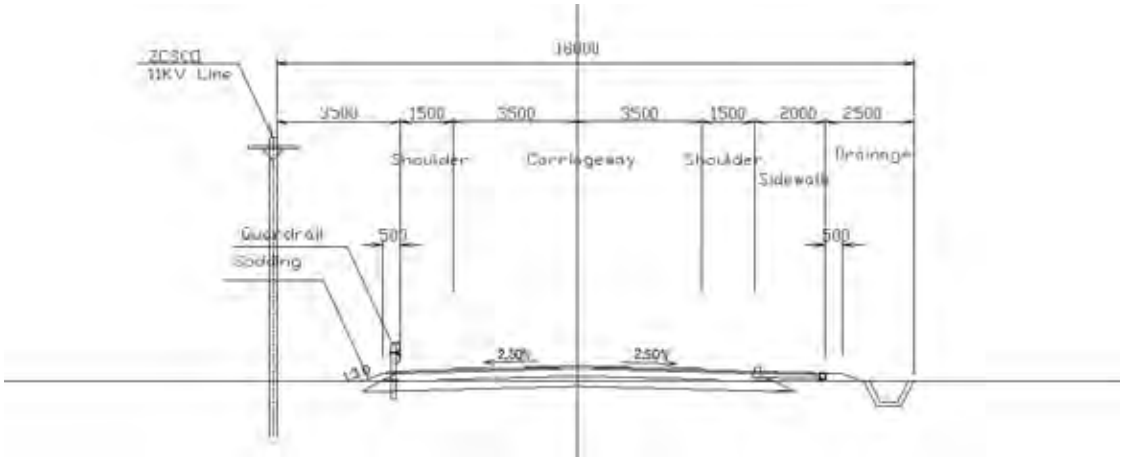


Figure 2.2-1 Typical Cross Section of Inner Ring Road, Kasama Rd – Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ (Section along power lines)

Number of Lanes

2-lane road (1-lane for 1 direction) is proposed as requested by Zambia with a provision of .widening to 4-lane road by 2030 as described in The Lusaka Development Study. However, difficulty of land acquisition for widening of roads is anticipated because of proximity to residences and power lines. Thus it is evaluated that current road condition is not feasible for expansion in the future.

To accommodate increasing demand of future traffic, Middle Ring Road and Outer Ring Road are proposed. The Lusaka Development Study proposes the construction of the Middle Ring Road by 2020 and Outer Ring Road by 2030. The traffic analysis in the Study forecasts that the traffic volume along Inner Ring Road in 2025 to be approximately 18,000 veh. /day (it is converted about 2,200 pcu/h in a peak hour).This is within the traffic capacity of a 2-lane road (about 2,300 pcu/h), and proposed number of lanes is considered sufficient for Project roads. Please refer to Appendix 5 for detail data.

Road Elevation

The lower elevation of ground at the starting section of Inner Ring Road is vulnerable to flooding during rainy seasons. This is because existing discharge capacity of waterway leading to the downstream river is in adequate being too small in section and too gentle in gradient. The roadside ground of about 1 km from beginning of Inner Ring road gets flooded for several months in rainy seasons. The highest water level of the inundation reaches to the bottom of the railway sleepers. Proposed road elevation is set to be 1 m higher than the highest water level to avoid weakening of the surface by water saturation. Sections without inundation is to be about 0.5 m (about pavement thickness) higher than the existing ground level considering the easy access from access roads and residences, and avoiding rock excavation work for the construction of subgrade and basecourse.

Road Ditch

The north side (the power line side) of roads is wasteland, therefore, no ditch installation is proposed. While the south side of residential area is planned to install ditch, except the section of wasteland between the junctions of Chibwa Road and Yotam Muleya Road planned without ditch. For the remaining flat south side section from the junction with Yotam Muleya Road to Mosi-Oa-Tunya Jct. - LS-MFEZ (section along the power line), sod type ditch is proposed to store rainwater and permeate into the ground and evaporate into the air.

(2) Planning of Mosi-Oa-Tunya Jct. - LS-MFEZ (section from the power line to LS-MFEZ gate)

Road Route

To extend Mosi-Oa-Tunya Road to the southeastern direction to construct Mosi-Oa-Tunya Jct. - LS-MFEZ was proposed in The Lusaka Development Study. Since this route runs through residential area, a large scale resettlement is inevitable. An alternative route along power lines and along the existing earth road is suggested to avoid resettlement and land acquisition. Most of land use on roadside is farm and grassland and residences are limited.

Road Cross Section

The width of carriageway and shoulders is set same as Mosi-Oa-Tunya Jct. - LS-MFEZ (section along the power lines). A road shoulder is proposed for sidewalk due to few existing houses and expected small volume of traffic and pedestrian for the foreseeable future. Typical cross section of the road is shown in Figure 2.2-2.

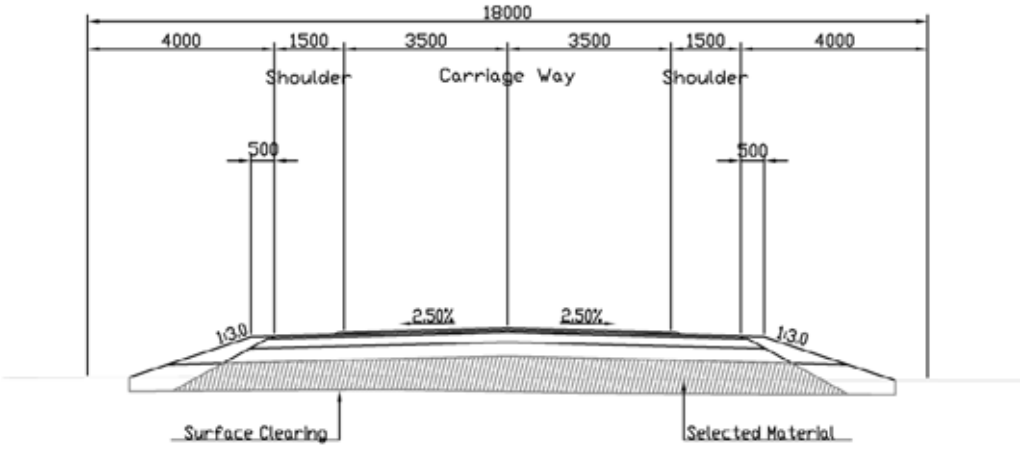


Figure 2.2-2 Typical Cross Section of Mosi-Oa-Tunya Jct. - LS-MFEZ (Section from the power lines to LS-MFEZ gate) without road ditch

Road Elevation

Since subgrade soil along the road is not strong (the design CBR = 2), improvement of subgrade by embanking with about 65 cm thick of selected soil (CBR>8) is specified. Road elevation will be about 1m higher than the ground level accordingly.

Road Ditch

Since the ground is flat with no drain way, a sod ditch is planned at the section with houses along the road. The section without houses along the road is planned without ditch, and rainwater permeates into the roadside ground to evaporate into the air. However, the about 200 m interval of road cross pipes (60 cm diameter) are to be installed to prevent unpredictable interruption of surface water flow.

End Point of LS-MFEZ Access Road

The Mosi-Oa-Tunya Jct. - LS-MFEZ is planned to be terminated at the fence of LS-MFEZ area. The exact location of end point of Mosi-Oa-Tunya Jct. - LS-MFEZ is shown in

Figure 2.2-3. The photograph of the northwestern corner of LS-MFEZ area is shown in Figure 2.2-4.

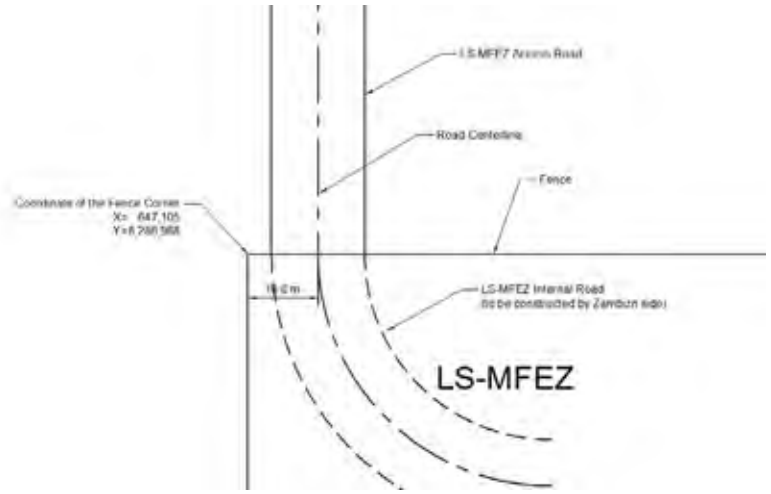


Figure 2.2-3 Location of the End of Mosi-Oa-Tunya Jct. - LS-MFEZ

Figure 2.2-4 Northwestern Corner of LS-MFEZ Area

(3) Planning of Sections Already Constructed by the Zambian Side of Kasama Rd. – Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ

A part of the Kasama Rd. – Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ from at the junction with Shantumbu Road to about 1.8 km to the east has been constructed by the Zambian side. The road section was paved with bituminous treatment over 15 cm thick of cement stabilized base course and 15 cm thick of granular sub-base course. Since this surface was assessed as not adequate to carry the future heavy traffic along Kasama Rd. – Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ, it is proposed to overlay with base course and asphalt concrete over this existing surface. The overlay thickness is designed based

on the forecasted future traffic volume. Typical cross section of road section is shown in Figure 2.2-5.

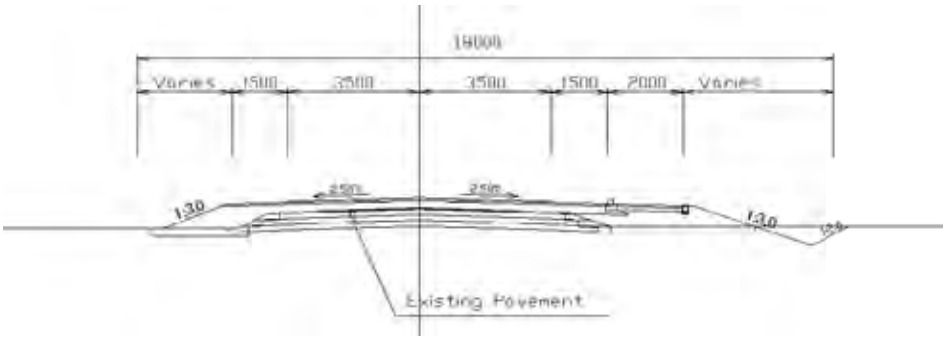


Figure 2.2-5 Typical Cross Section of Overlay on Existing Pavement of Kasama Rd. – Mosi-Oa-Tunya Jct. and Mosi-Oa-Tunya Jct. - LS-MFEZ

(4) Planning of Mini Bypass Link

Road Route

The Mini Bypass Link is to be newly constructed. Alternative road routes are examined in order to select the best route with minimum impacts on resettlement and smooth connection to Kafue Road. The land along the road route is state owned.

Road Cross Section

The function of Mini Bypass Link is to connect Kafue Road and Inner Ring Road temporarily until Inner Ring Road is extended to intersect with Kafue Road and Mumbwa Road. Although the road standard is classified as collector road, arterial road class standard is applied for the carriageway width to allow smooth access by large trucks. Since the pedestrian traffic is predicted as significant, 2 m wide sidewalks are planned for both sides of the road. Typical cross section is shown in Figure 2.2-6.

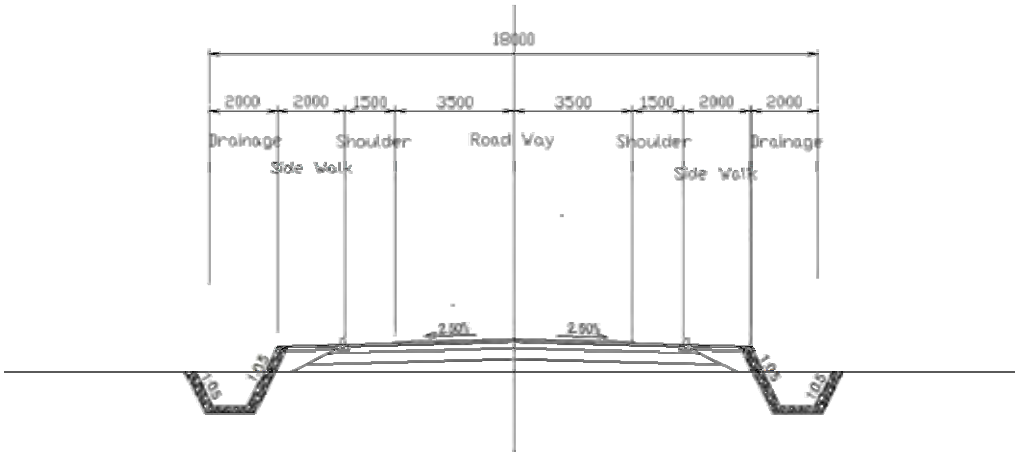


Figure 2.2-6 Typical Cross Section of Mini Bypass Link

Road Elevation

Mini Bypass Link intersects with railway, Chongwe Road and Kafue Road. The elevation of road has to meet with the elevation of the existing roads and railways. The road sections with roadsides inundated during rainy season should be planned 1 m higher than the highest water level, otherwise the upper subgrade of the road is specified to be made of crushed stones to avoid the surface becoming weak due to the saturation with water.

Road Ditch

Ditches are planned on the both sides of the road. Installation of drain ditches and pipes from road ditches to the existing downstream drain are planned.

Railway Crossing

With regard to the railway and Mini Bypass link crossing, the following were confirmed at discussions with Railway Systems of Zambia (RSZ), LCC and RDA. The confirmations are to be reflected into design.

- Mini Bypass Link crosses the railway with a level crossing.
- Crossing gate and alarm devises are installed.
- Mini Bypass Link intersects with the railway at angle of 75 degree or more.
- Mini Bypass Link should be distant from the railway as far as possible (minimum 2.9 m from the railway center).
- Train stop signal will be relocated to avoid stopping a train on Mini Bypass Link (to be relocated by the Zambian side).

(5) Planning of Ben Bella Extension Link

Ben Bella Extension Link is un-surfaced road connecting Lumumba Road and Los Angeles Road. The road runs through Chibolya, which is a dense low-income class residential area. Los Angeles Road is connected directly with Lumumba Road, however, the section of Los Angeles Road near to Lumumba Road suffers from ongoing congestion by the roadside public markets and a entrance to the mini-bus terminal. Once the improvement projects is implemented most of current traffic on Los Angeles Road is predicted to shift to Ben Bella Extension Link. Ben Bella Extension Link is classified as collector road.

Road Route

The Existing road runs through residential areas. The narrow sharply curved existing road need to be widened and its alignment to be readjusted into straight to avoid resettlement of many existing residences by the road upgrade.

Road Cross Section

The eastern half of the total length of ROW is about 28 m wide, and requires to be designed with future provision for widening. While, the western section of the road is about 13m wide with buildup area, therefore the proposed road has to consider minimizing impacts on resettlement.

Carriageway width is standard 3.25 m in consist. Road shoulder width of the eastern section is 1.5 m for vehicle's emergency stopping and bicycle's pass, while the western section is a minimum required width of 0.5 m. Installation of 2 m wide sidewalk for both sections is proposed to absorb significant volume of future pedestrian traffic. The eastern section of sidewalk will be placed next to roadside walls to reserve the space for the future widening. Typical cross sections are shown in Figure 2.2-7.

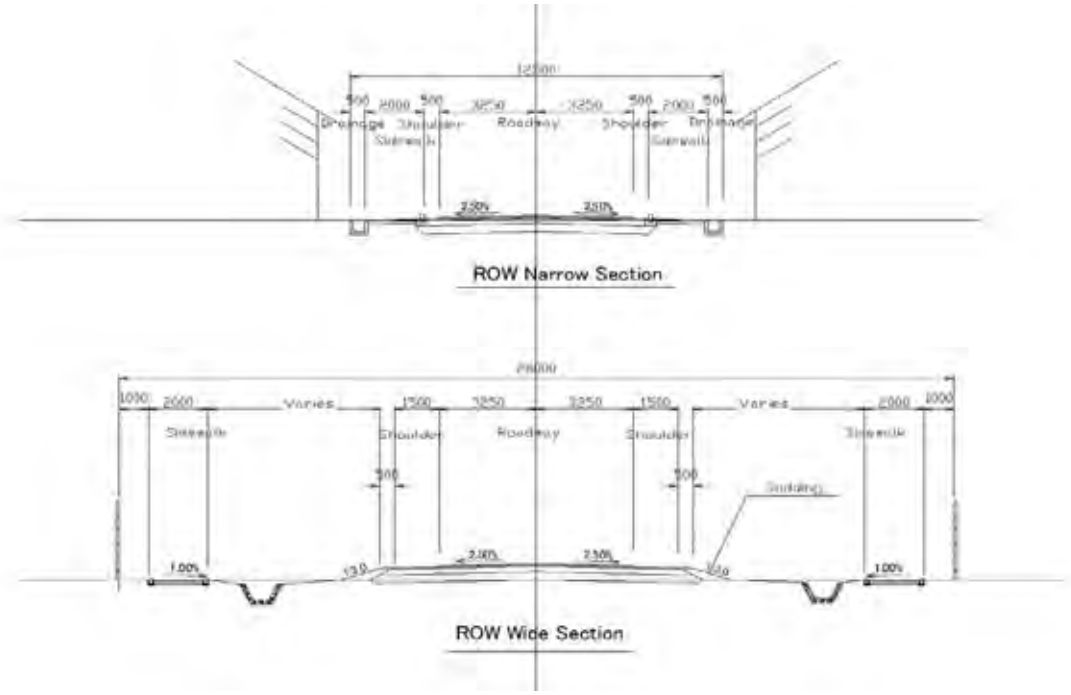


Figure 2.2-7 Typical Cross Sections of Ben Bella Extension Link

Road Elevation

The road elevation of the eastern section is planned to be a pavement thickness higher than the existing ground level to avoid excavation works. The western section is set to be almost same as the existing ground level to make it accessible for roadside houses.

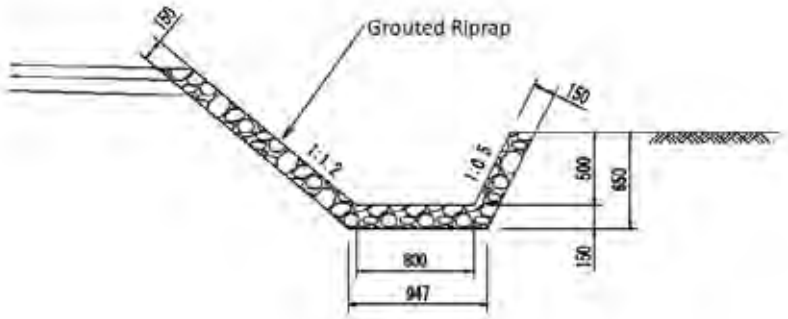
Road Ditch

It is planned to install ditches on the both sides of the road. Considering the road width, standard type: grouted riprap ditch is adopted for the eastern section, and narrow type: concrete ditch for the western section. Drainage water from Ben Bella Road will be merged into ditches of Los Angeles Road and Lumumba Road.

2.2.2.3 Drainage Planning

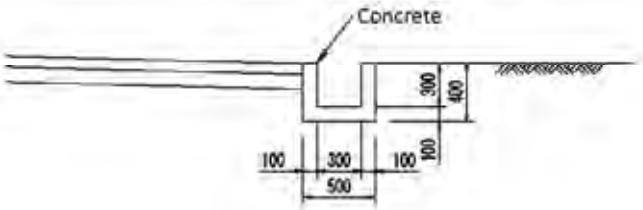
Grouted riprap ditch is adopted as the standard ditch to utilize abundantly available stones at the project area. Types of ditch structures are shown in Figure 2.2-8. The plan of the drainage route form Mosi-Oa-Tunya Jct. - LS-MFEZ to Inner Ring Road is shown in Figure 2.2-9. The drainage route plan of Mini Bypass Link is shown in Figure 2.2-10.

Installation of 3 pipe culverts at Mini Bypass Link and Existing Railway Embankment are planned to drain the inundating water smoothly around the starting section of Inner Ring Road and MiniBypass Link during rainy reason.



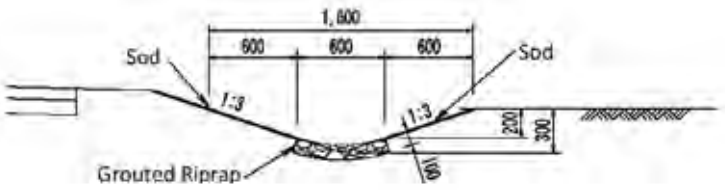
Grouted Riprap Ditch

(Standard Type)



Concrete Ditch

(For narrow road)



Sod Ditch

(For flat road)

Figure 2.2-8 Ditch Types

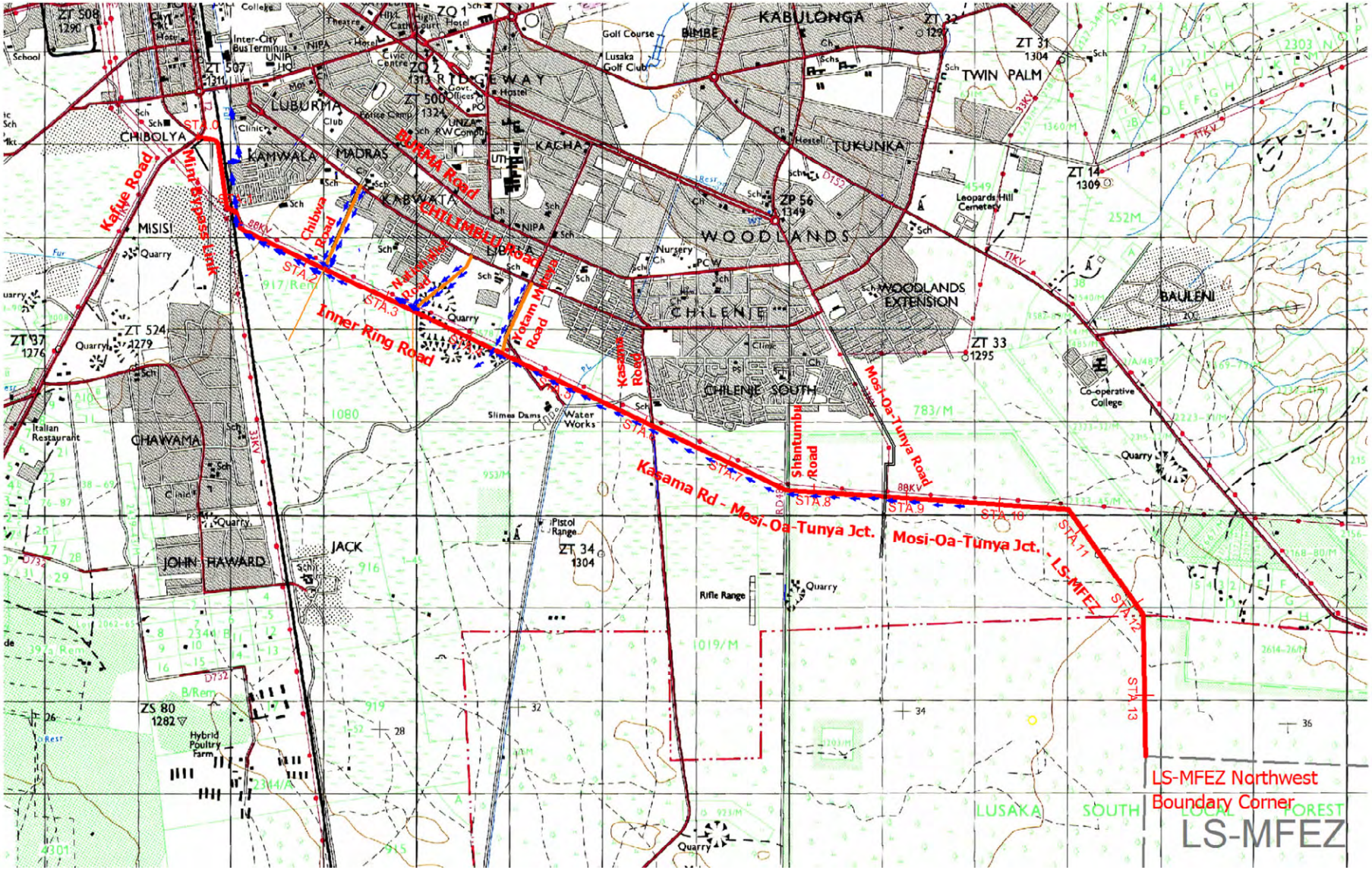


Figure 2.2-9 Plan of Drainage Route from Mosi-Oa-Tunya Jct. - LS-MFEZ to Inner Ring Road

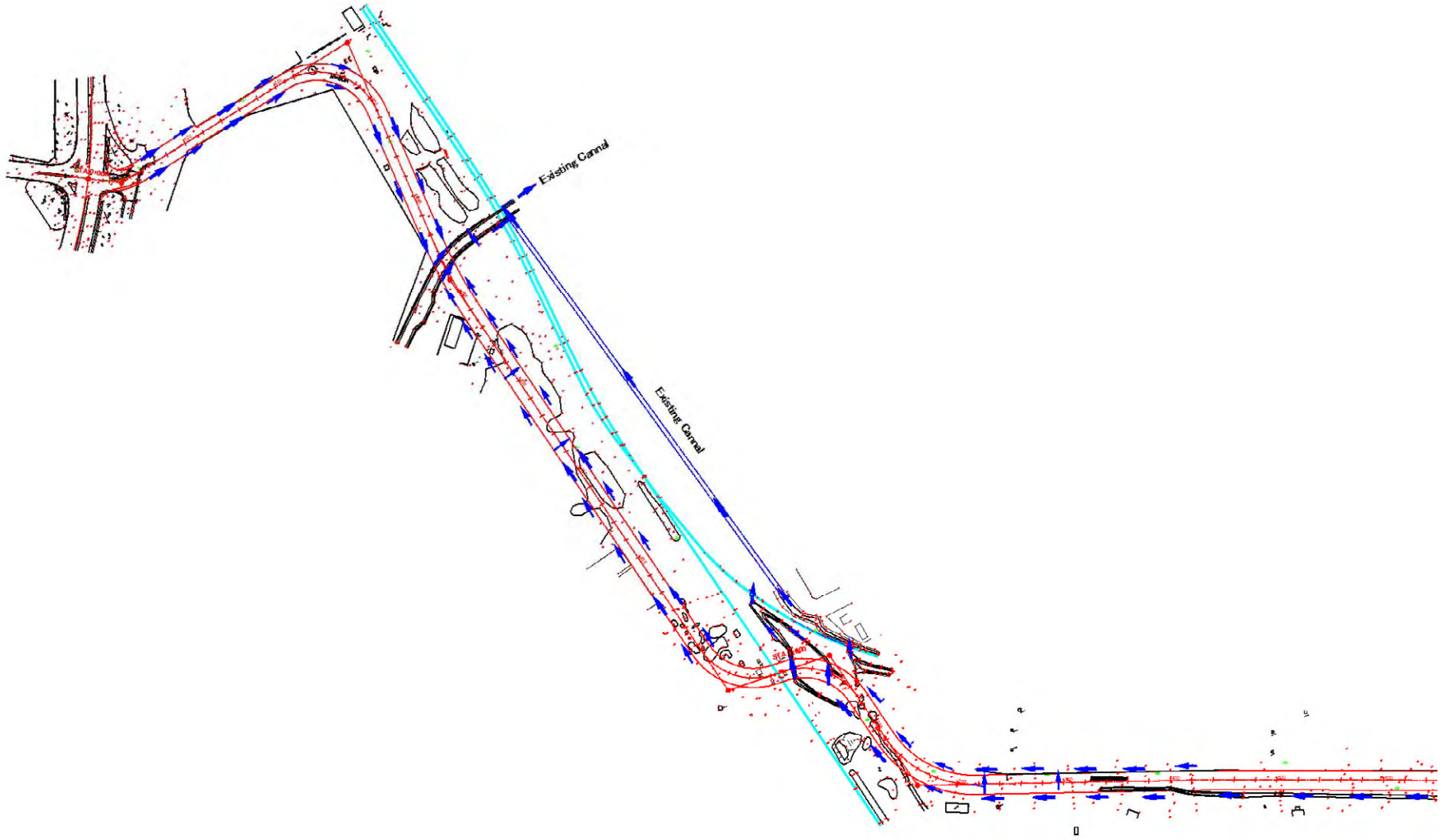


Figure 2.2-10 Plan of Drainage Route of Mini Bypass Link

2.2.2.4 Ancillary Facility Planning

(1) Traffic Lights

Installation of traffic lights at the following intersections is planned for the foreseen large traffic volumes of vehicles and pedestrians.

- 7 intersections along Inner Ring Road and Mini Bypass Link (intersections with Chibwa Road, Nationalist Road, Yotam Muleya Road, Kasama Road, Shantumbu Road, Mosi-Oa-Tunya Road and Chongwe Road)
- The intersection of Ben Bella Road with Los Angeles Road

(2) Bus Bays

For the proposed bus operation service, bus bays will be allocated at every major intersection along the Inner Ring Road, Kasama Rd – Mosi-Oa-Tunya Jct. and Mini Bypass Link. Typical dimension of proposed 11 bus bays in total is shown in Figure 2.2-11. Additional bus stops are planned for sections where the distance between intersections is more than 1 km. Typical layout of the bus bay along the roads is shown in Figure Figure 2.2-12.

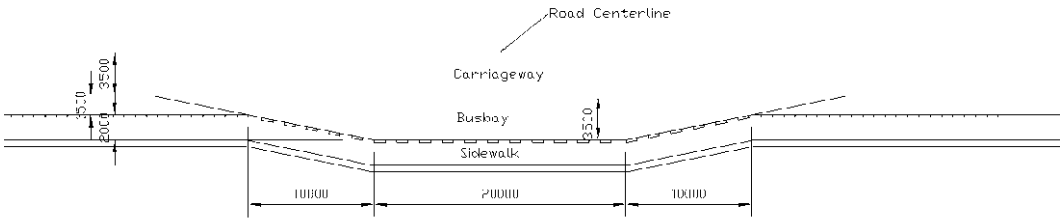


Figure 2.2-11 Dimension of Bus Bay

(3) Street Lights

Street lights along Mini Bypass Link will be installed for the safety of pedestrian at night and the winding road. Street lights are also installed at bus bays and cross walks along Inner Ring Road.

- Mini Bypass Link: 25 units at an interval of 50 m
- Inner Ring Road: 22 units at bus bays and 16 units at crosswalks

(4) Sign Boards

Sign boards are installed to secure traffic safety. Required sign boards are as follows.

- Speed limit, Stop, Crosswalk ahead, Intersection ahead, School zone, Sharp curve ahead, Railway crossing ahead

(5) Railway Crossing and Alarm

A crossing gate and alarm at the railway crossing on Mini Bypass Link is planned.

(6) Road Marking

Following road markings are essential to secure the traffic safety.

- Road centerline, edge line, lane separator, crosswalk, stop line, direction arrow

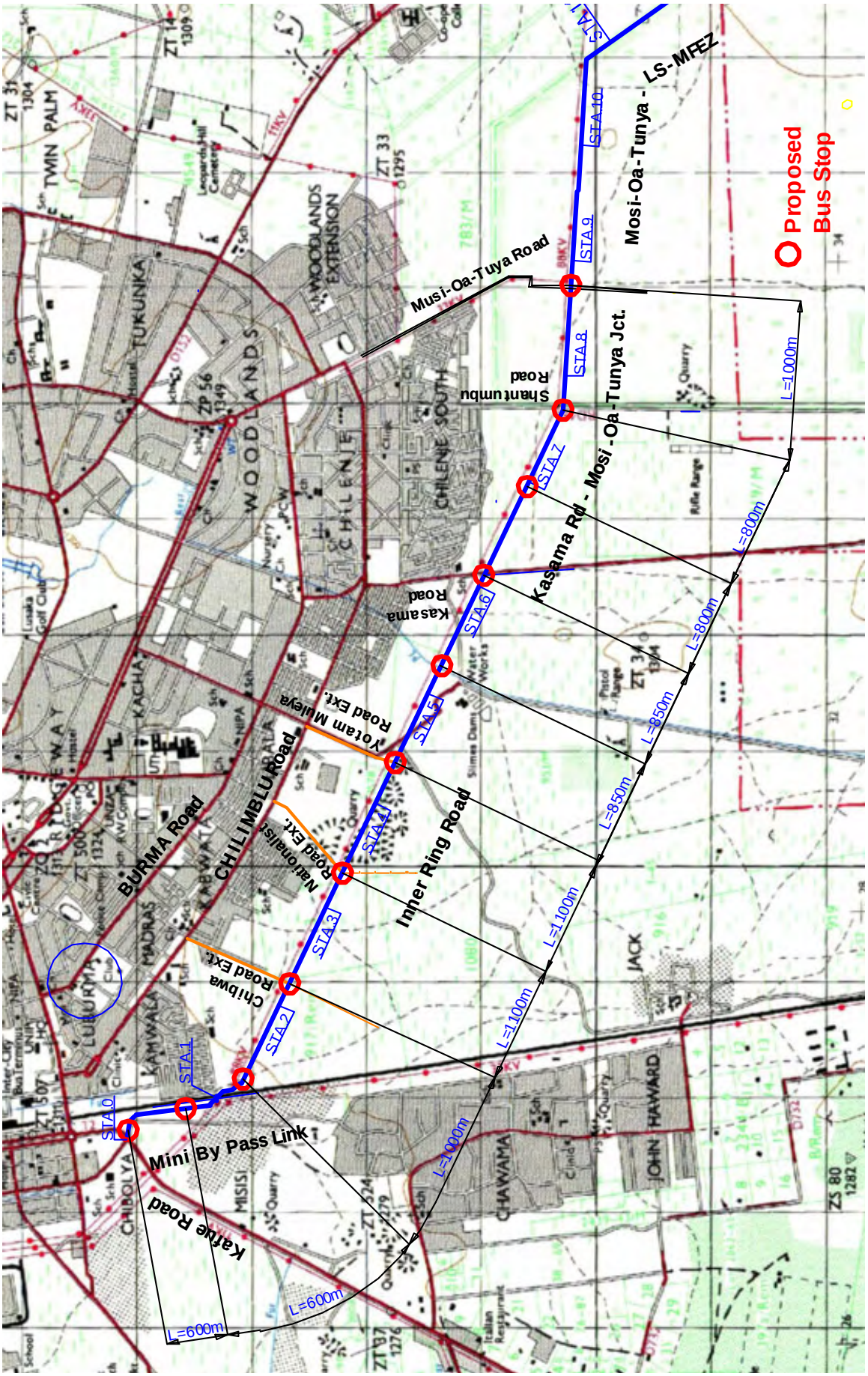


Figure 2.2-12 Layout of Bus Bay

2.2.2.5 Pavement Structure Design

(1) Pavement Structure Design Criteria

- Pavement structure design standard: Guide for Pavement Structures 1993, AASHTO.
- Design Period: 15 years (from 2015 to 2030)

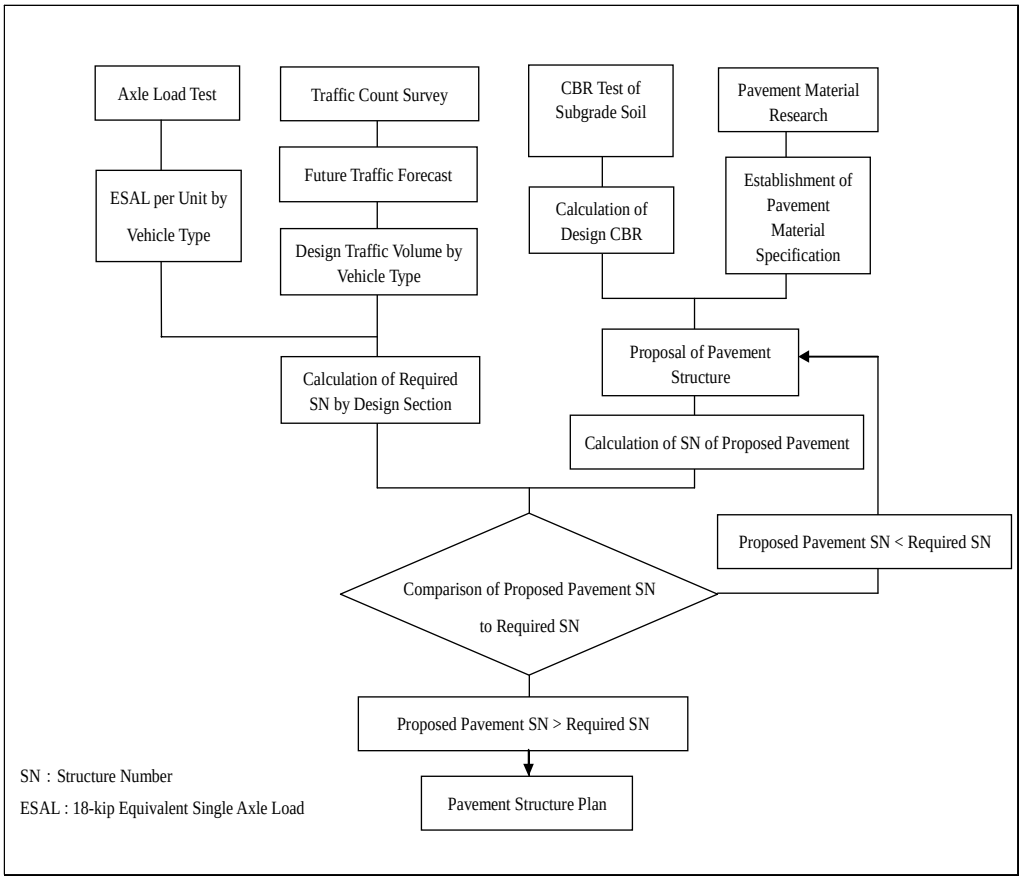


Figure 2.2-13 Pavement Structure Design Procedure

(2) Pavement Structure Design Section

The Project roads are segregated into the following 5 pavement structure design sections in accordance with traffic and geological condition.

Table 2.2-4 Pavement Structure Design Section

Section No.	Pavement Structure Design Section
1	Mini Bypass Link – Inner Ring Road – Kasama Rd – Mosi-Oa-Tunya Jct. – Mosi-Oa-Tunya Jct. - LS-MFEZ (sections along power line)
2	Kasama Rd – Mosi-Oa-Tunya Jct. - Mosi-Oa-Tunya Jct. - LS-MFEZ (section constructed by Zambian side)
3	Mosi-Oa-Tunya Jct. - LS-MFEZ (section from Power line - LS-MFEZ gate)
4	Ben Bella Extension Link

(3) Pavement design load

Pavement design loads by design section are calculated by the total ESAL (18-kip Equivalent Single Axle Load) which is drawn from the traffic volume (2015 – 2030) by vehicle type multiplied by ESAL per vehicle by vehicle type. ESAL per vehicle by vehicle type is adopted to the survey results of the axle loading test conducted in JICA Basic Design Study on the Project for Improvement and Maintenance of Ndola and Kitwe City Roads. Traffic demand analysis and design load for pavement design are shown in Appendix 5.

(4) Pavement Materials

The following universally common pavement materials are specified to consider availability in local area. .

- Surface Course: Asphalt Concrete
- Base Course: Mechanically stabilized granular material (CBR>80)
- Sub base Course: Crushed stones (CBR>30)
- Embankment: Selected soil from road excavation or borrow pits (CBR>6)

(5) Sub grade Design CBR

The sub grade soil along the project roads were sampled and tested in the laboratory. The design CBRs by design section are obtained by the CBR laboratory tests. Calculation of CBR is shown in Appendix 5.

(6) Calculation of Required Pavement Thickness

Methodology

The equation and constants given in AASHTO are referred to as follows:

$$Log_{10}(W_{18})=Z_R\times S_0+9.36\times Log_{10}(SN+1)-0.20+\{Log_{10}[\triangle PSI/(4.2-1.5)]/[0.40+1094/(SN+1)^{5.19}]\}+2.32\times Log_{10}(M_r)-8.07$$

Where,

W18: Total ESAL (2015 – 2030)

ZR: Standard Deviation (= -1.037 in case reliability = 85%)

S0: Combined standard error (= 0.45 in case flexible pavement)

SN: Structural number = a1 x D1+ a2 x m2 x D2 + a3 x m3 x D3 (a: Layer coefficient, m: Drainage coefficient, D: Layer thickness)

⊿PSI: Po - Pt

P0: Initial serviceability index (= 4.2 in case flexible pavement)

Pt: Terminal serviceability index (= 2.5 in case arterial road / = 2.0 in case not arterial road)

MR: Resilient modulus (= 1500 x CBR)

Layer coefficient:

a1=0.44 (asphalt concrete surface course)

a2=0.14 (granular base course)

a3=0.11 (granular subbase course)

Drainage coefficient：

m2: drainage coefficient of base course (= 0.9 in case average condition)

m3: drainage coefficient of subbase course (=0.8 in case average condition)

Pavement Thickness Plan

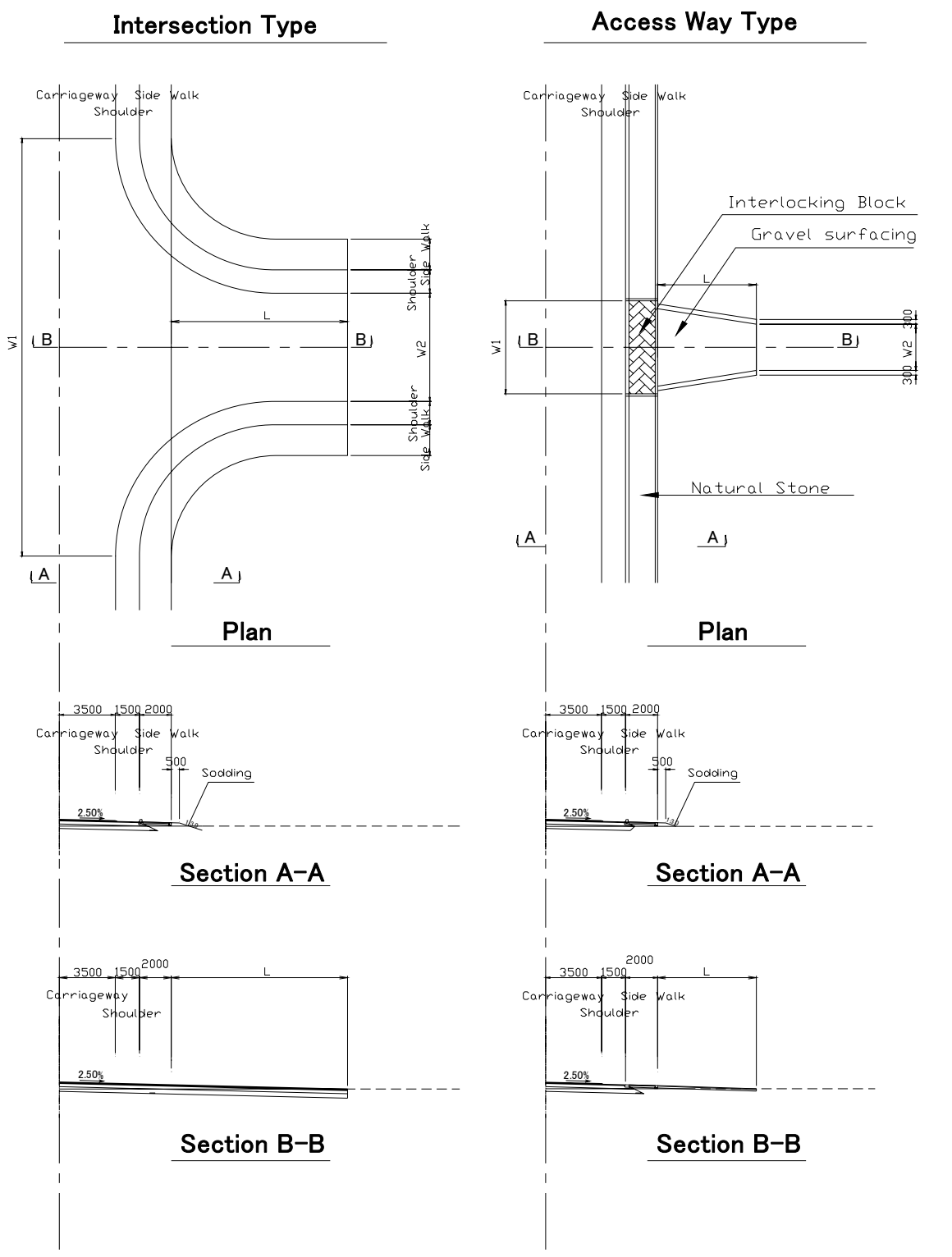
As the result of the calculation referred to in Appendix 5, the pavement thicknesses are planned as shown in Table 2.2-5.

Table 2.2-5 Proposed Thickness Plan (cm)

Design Section	1	2	3	4
	Mini Bypass Link Inner Ring Road Kasama Rd. – Mosi-Oa-Tunya Jct. Mosi-Oa-Tunya Jct. - LS-MFEZ	Section constructed by Zambian side of Kasama Rd. – Mosi-Oa-Tunya Jct. & Mosi-Oa-Tunya Jct. - LS-MFEZ	From Power line to LS-MFEZ gate in Mosi-Oa-Tunya Jct. - LS-MFEZ	Ben Bella Extension Link
Asphalt Concrete	10	10	10	10
Base Course	20	15	20	20
Subbase Course	35	(Exist.Pavement)	25	25

2.2.2.6 Roadside Facility Access Way

Access ways between roads and existing access roads, factories, storages, stores and other roadside facilities are planned to allow vehicles. Roadside houses with cars will be provided access ways, where a part of access ways is paved with interlocking blocks to allow vehicles to cross is to over. Typical design of access ways are shown in Figure 2.2-14.



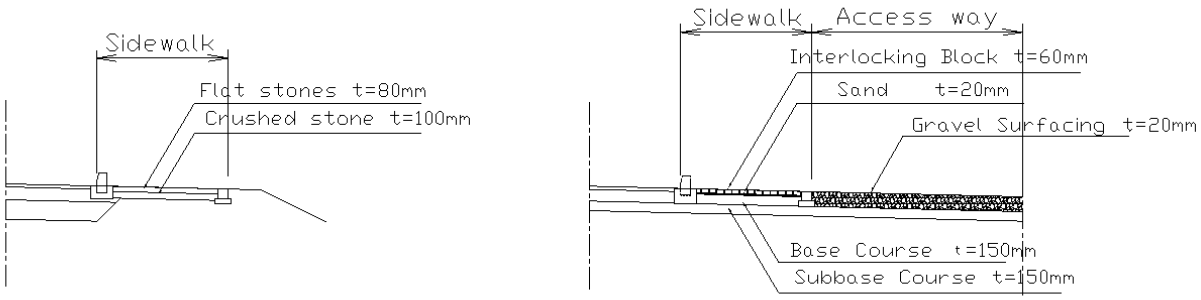
Access way to be used by vehicles frequently,
Existing Access Road
(Access to factory, storage, store and facilities)

Access way to be used by vehicles not frequently
(Access to houses)

Figure 2.2-14 Roadside Facility Access Ways

2.2.2.7 Sidewalk Pavement

Typical structure of sidewalk pavement is shown in Figure 2.2-15. The surface is specified as flat stones which are abundantly available around the project site. Parts of sidewalk with vehicles access are to be paved with interlocking block.



Typical Section

Access Way Section

Figure 2.2-15 Sidewalk Pavements

Figure 2.2-16 Sample of a Stone Surfacing Sidewalk

2.2.3 Outline Design Drawing

Contents of facilities under outline design are summarized in Table 2.2-6.

Table 2.2-6 Contents of the Facilities under Outline Design Scheme

Road Name	Specifications
Mini Bypass Link (1.22km)	Road Cross Section: Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×2 Carriageway Pavement: AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement: Stone Surfacing, Interlocking Block (t=60mm), Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage: Concrete Drain (Depth = 300mm ~ 800mm), Stone Pitching Drain (Depth = 300mm ~ 800mm), RC Pipe Culvert (Pre-cast, Inner Diameter = 300mm ~ 900mm) Box Culvert: Box Culvert (2400mm x 2100mm) Slope Protection: Stone Pitching (t=150mm) Sign Board: Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead, Railway Crossing Ahead Road Marking: Center Line (w=150mm), Edge Line (w=150mm) Guardrail: Guardrail (On the Ground) Street Light: Street Light (H=8000mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections) Railway Crossing: Crossing gate and alarm device
Inner Ring Road (4.88 ㎞)	Road Cross Section: Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×1 Carriageway Pavement: AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement: Stone Surfacing, Interlocking Block (t=60mm), Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Accessway: Subbase (Crusher Run, t=100mm) Drainage: Stone Pitching Drain (Depth = 300mm ~ 800mm), Sod Drain (Depth = 300mm), RC Pipe Culvert (Pre-cast, Inner Diameter = 300mm ~ 900mm) Box Culvert: Box Culvert (1500mm×1500mm , 2400mm x 2100mm) Retaining Wall: Wet Stone Masonry Retaining Wall (H=1000mm～2000mm), Gravity Retaining Wall (H=2000mm～2500mm) Slope Protection: Stone Pitching (t=150mm, t=300mm), Sodding Sign Board: Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking: Center Line (w=150mm), Edge Line (w=150mm) Guardrail: Guardrail (On the Ground) Street Light: Street Light (H=8000mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections)
Kasama Rd – Mosi-Oa-Tunya Jct. (2.58km)	Road Cross Section: Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×1 Carriageway Pavement: AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement: Stone Surfacing, Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage: Sod Drain (Depth = 300mm) Slope Protection: Sodding Sign Board: Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking: Center Line (w=150mm), Edge Line (w=150mm) Guardrail: Guardrail (On the Ground) Street Light: Street Light (H=8000mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections)

Road Name	Specifications
Mosi-Oa-Tunya Jct. - LS-MFEZ（4.95km）	Road Cross Section:［Sections along power line］Carriageway 3.50m×2、Shoulder 1.50m×2、Sidewalk 2.00m×1、［Section from Power line - LS-MFEZ gate］Carriageway 3.50m×2、Shoulder 1.50m×2 Carriageway Pavement:［Whole Section］AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement:［Sections along power line］Stone Surfacing, Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage:［Whole Section］Sod Drain (Depth = 300mm)、RC Pipe Culvert (Pre-cast, Inner Diameter = 300mm ~ 900mm) Slope Protection:［Whole Section］Sodding Sign Board:［Whole Section］Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking:［Whole Section］Center Line (w=150mm), Edge Line (w=150mm) Guardrail:［Sections along power line］Guardrail (On the Ground)
Ben Bella Extension Link（0.95km）	Road Cross Section:［Western Section］Carriageway 3.25m×2、Shoulder 0.50m×2、Sidewalk 2.00m×2、［Eastern Section］Carriageway 3.25m×2、Shoulder 1.50m×2、Sidewalk 2.00m×2 Carriageway Pavement:［Whole Section］AC Surface Course (t=50mm), AC Binder Course (t=50mm), Basecourse (Mechanically Stabilized Aggregate t=150mm~200mm), Subbase (Crusher run t=150mm～400mm) Kurb Stone: Between Carriageway and Sidewalk Sidewalk Pavement:［Whole Section］Stone Surfacing, Basecourse (Crusher Run (t=100mm), Mechanically Stabilized Aggregate (t=120～170mm)) Drainage:［Western Section］Concrete Drain (Depth = 300mm ~ 800mm)、［Eastern Section］Stone Pitching Drain (Depth = 300mm ~ 800mm) Box Culvert:［Whole Section］Box Culvert (1500mm×1500mm) Slope Protection:［Eastern Section］Sodding Sign Board:［Whole Section］Speed limit, Stop, Crosswalk Ahead, Intersection Ahead, School Ahead, Sharp Curve Ahead Road Marking:［Whole Section］Center Line (w=150mm), Edge Line (w=150mm) Traffic Light: Traffic Light (At Large Cross Intersections, Small Cross Intersections, Small T Intersections)

Outline Design Drawings are presented from next page, and contents of drawings are summarized in Table 2.2-7.

Table 2.2-7 Contents of the Outline Design Drawings

Title of the Drawings	Number of the Drawings
Abbreviation	AB-01
Location Map	LM-01
Typical Cross Sections	TC-01~07
Plan (Mini Bypass Link~Inner-Ring Rd~ Kasama Rd – Mosi-Oa-Tunya Jct.~ LS-MFEZ)	PL-I01～41
Plan (Ben Bella Extension Link)	PL-B01～03
Intersection Plan	IS-01～03
Access Way	AC-01
Kerb Stone	KS-01
Drainage	DS-01~05
Slope Protection	SP-01
Bus Stop	BS-01
Guardrail	GR-01
Road Marking	RM-01
Road Sign	RS-01
Box Culvert	BC-01~02

ABBREVIATION LIST

CLASSIFICATION		ABBREVIATION	DESCRIPTION	DRAWING NO.
KERB STONE		KS300A	For boundary between carriage way and side walk	KS-01
		KS300B	For boundary between carriage way and side walk	
		KS150A	For boundary between stone pitching and interlocking block	
		KS150B	For boundary between stone pitching and interlocking block	
		KL350A	For boundary between side walk and pedestrian crossing	
		KL350B	For boundary between side walk and pedestrian crossing	
DRAINAGE	LINE DITCH	DSC300	Concrete ditch	DS-01
		DSC300C	Concrete ditch with concrete cover	
		DSC600	Concrete ditch	
		DSC(r)600	Reinforced concrete ditch	
		DSC(r)600c	Reinforced concrete ditch with concrete cover	DS-03
		DM500	Grouted riprap ditch	DS-02
		DM500C	Grouted riprap ditch with concrete cover	
		DM600	Grouted riprap ditch	
		DM600C	Grouted riprap ditch with concrete cover	
		DM1000	Grouted riprap ditch	DS-03
		DML500	Grouted riprap ditch	
		DS	Sod ditch	
	CONCRETE PIPE CULVERT	DP300ac	Concrete pipe with 360 degree concrete base, Diameter=300mm	DS-4
		DP450ac	Concrete pipe with 360 degree concrete base, Diameter=450mm	
		DP600ac	Concrete pipe with 360 degree concrete base, Diameter=600mm	
		DP900ac	Concrete pipe with 360 degree concrete base, Diameter=900mm	
		DP2x900ac	2-barrel concrete pipe with 360 degree concrete base, Diameter=900mm x 2	
	CATCH BASIN	DB(C) 500-500-700	Concrete catch basin with concrete cover	DS-05
		DB(C) 700-700-1200	Concrete catch basin with concrete cover	

CLASSIFICATION		ABBREVIATION	DESCRIPTION	DRAWING NO.
SLOP PROTECTION	STONE MASONRY	SM300A	Grouted riprap masonry t=300mm	SP-01
		SM200	Grouted riprap masonry t=200mm	
	RETAINING WALL	RW300A	Grouted riprap retaining wall	
SIDE WALK		SW(Sp)-W	Stone surfacing side walk	AC-01
		SW(Ib)-W	Interlocking block surfacing side walk	
GUARD RAIL		Gr-B-E	Earth type guard rail	GR-01
		Gr-B-C	Structural type guard rail	
CONCRETE BOX CULVERT		C-Bx.2.40x2.10	Concrete box culvert, width = 2.40m, height = 2.10m	BC-01
		C-Bx.1.50x1.50	Concrete box culvert, width = 1.50m, height = 1.50m	BC-02

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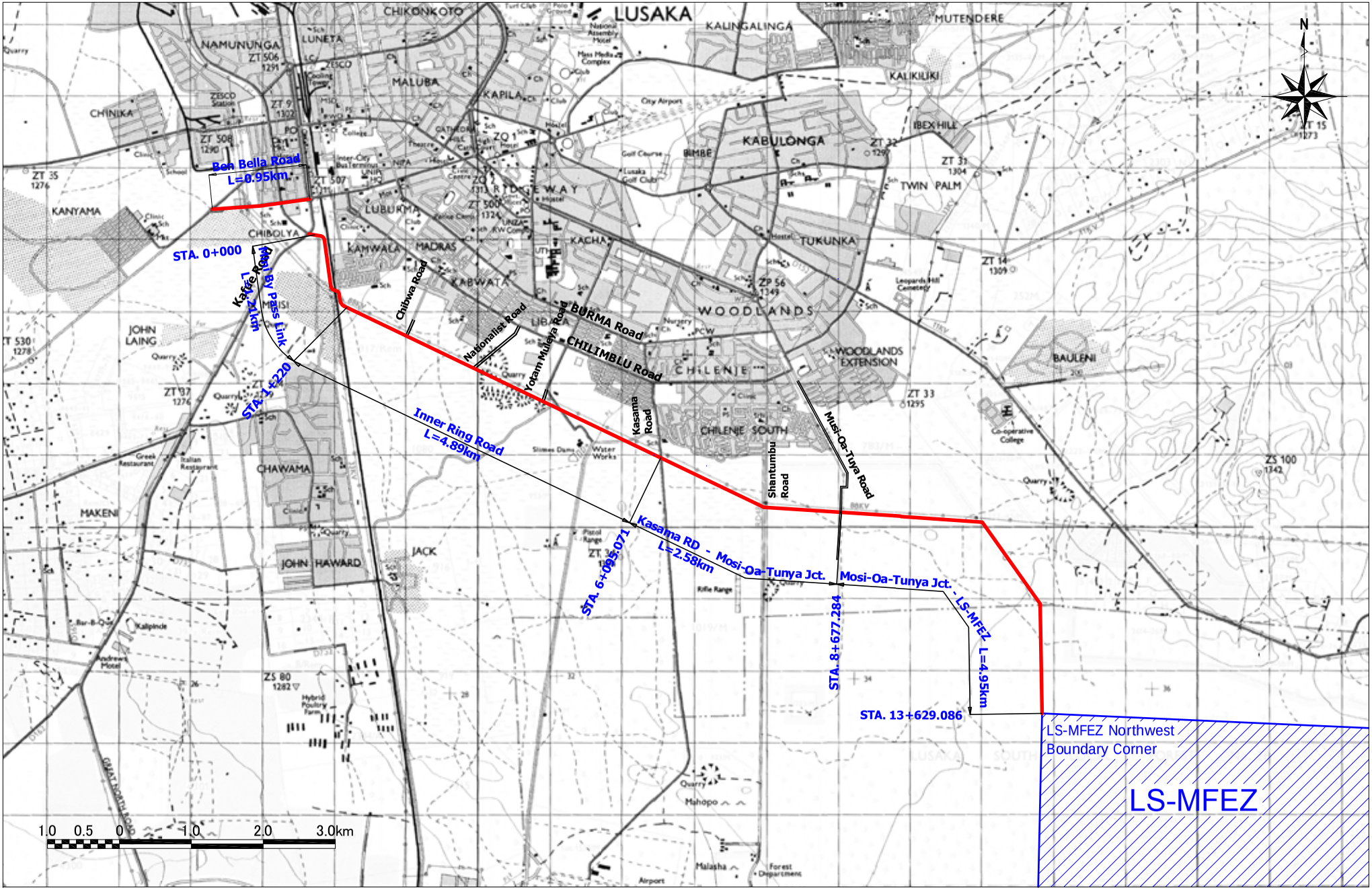
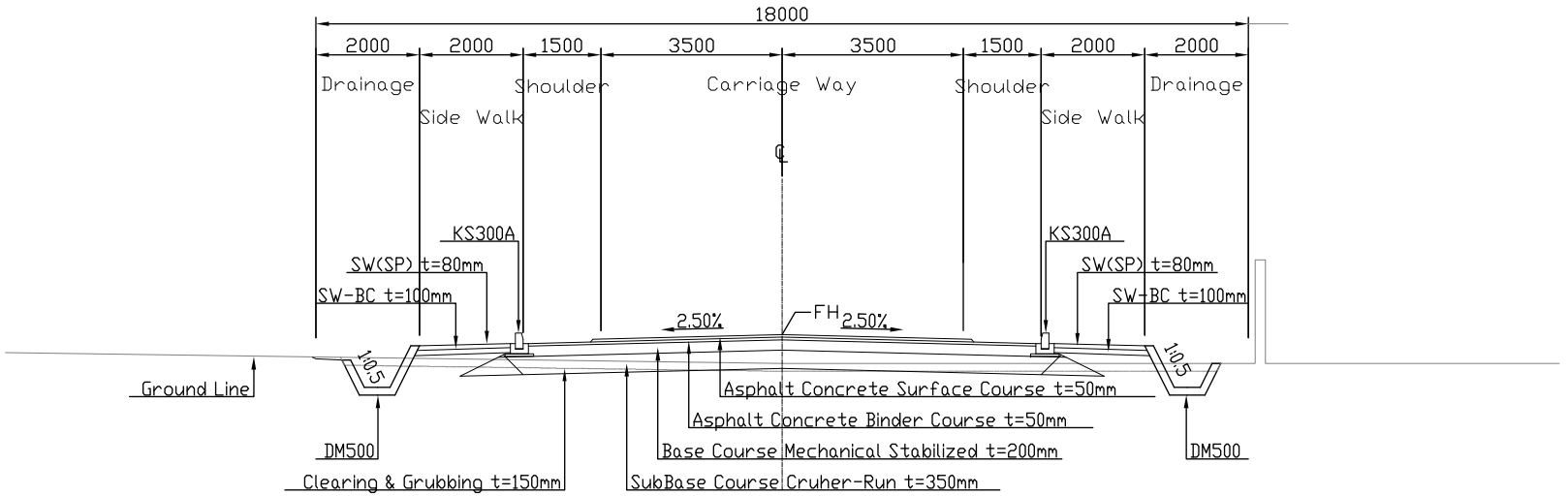
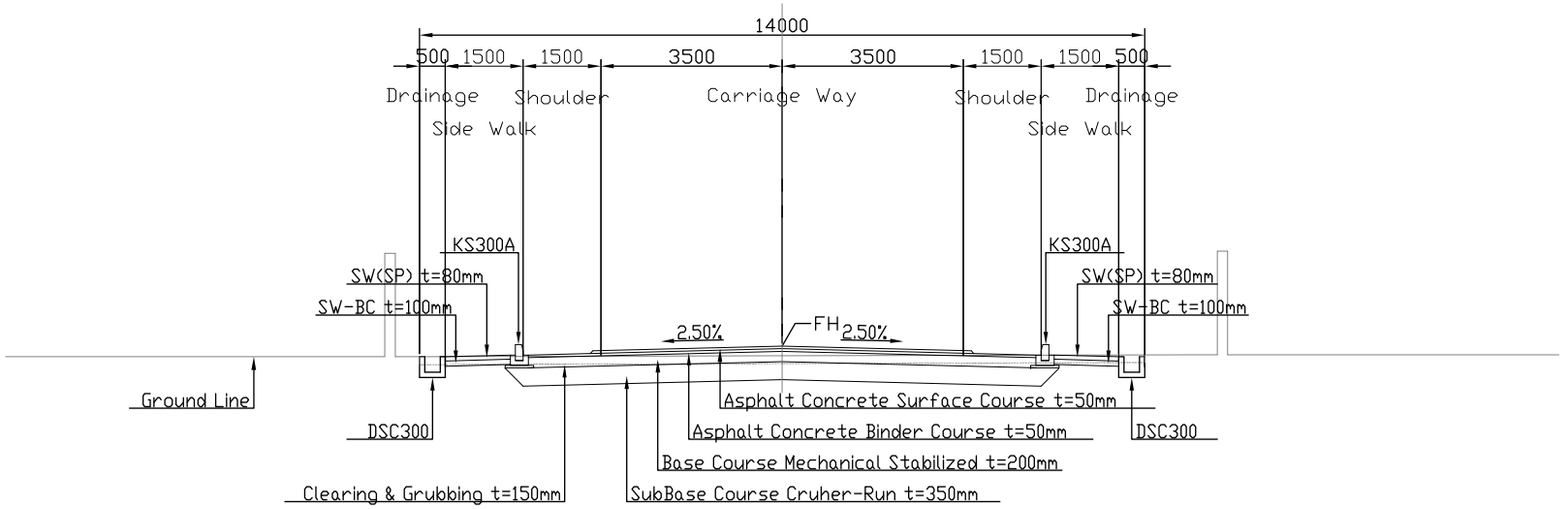


MINISTRY OF LOCAL GOVERNMENT AND HOUSING LUSAKA CITY COUNCIL	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE IMPROVEMENT OF THE LIVING ENVIRONMENT IN THE SOUTHERN AREA OF LUSAKA IN THE REPUBLIC OF ZAMBIA	TITLE: LOCATION MAP	Drawing No.	LM-01
				SCALE	1/50,000
				DATE	Jan. 2011

Mini Bypass Link Section
STA.0+260-STA.0+580
STA.0+760-STA.0+860



Mini Bypass Link Section
STA.0+000-STA.0+240



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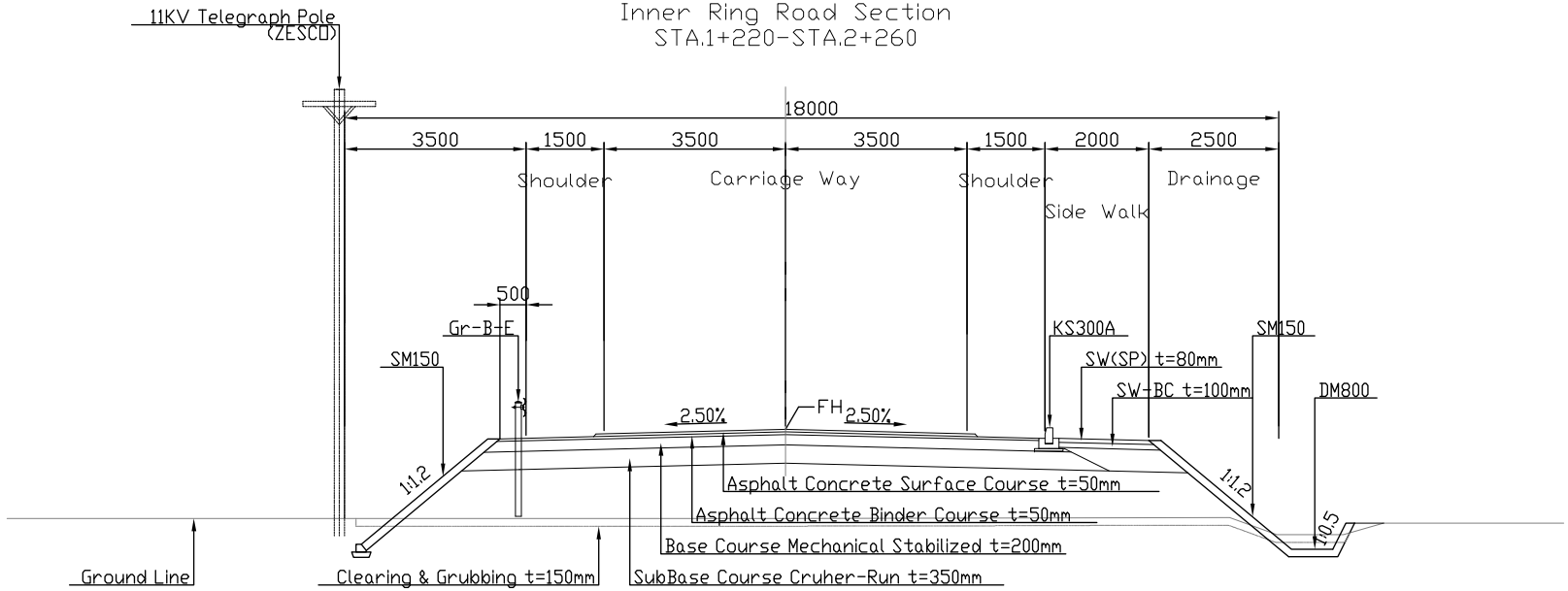
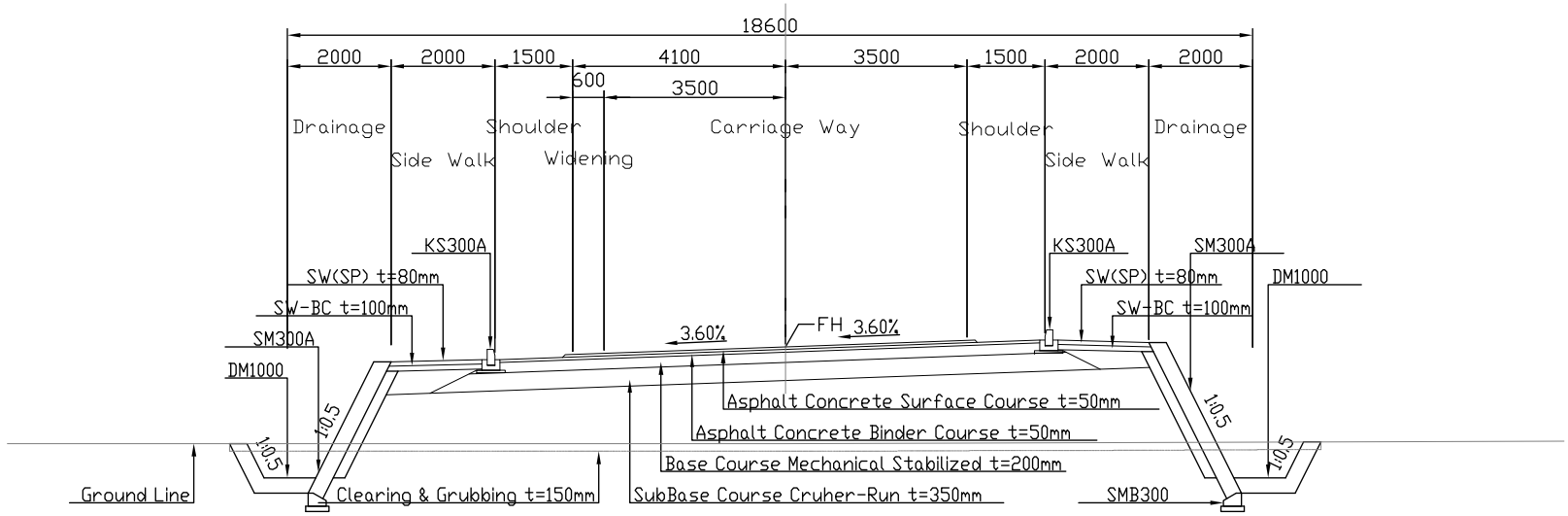
				SCALE	1/100
				DATE	Jan. 2011

Inner Ring Road Section
STA.1+220-STA.2+260



Mini Bypass Link Section
STA.0+600-STA.0+740
STA.0+880-STA.1+220



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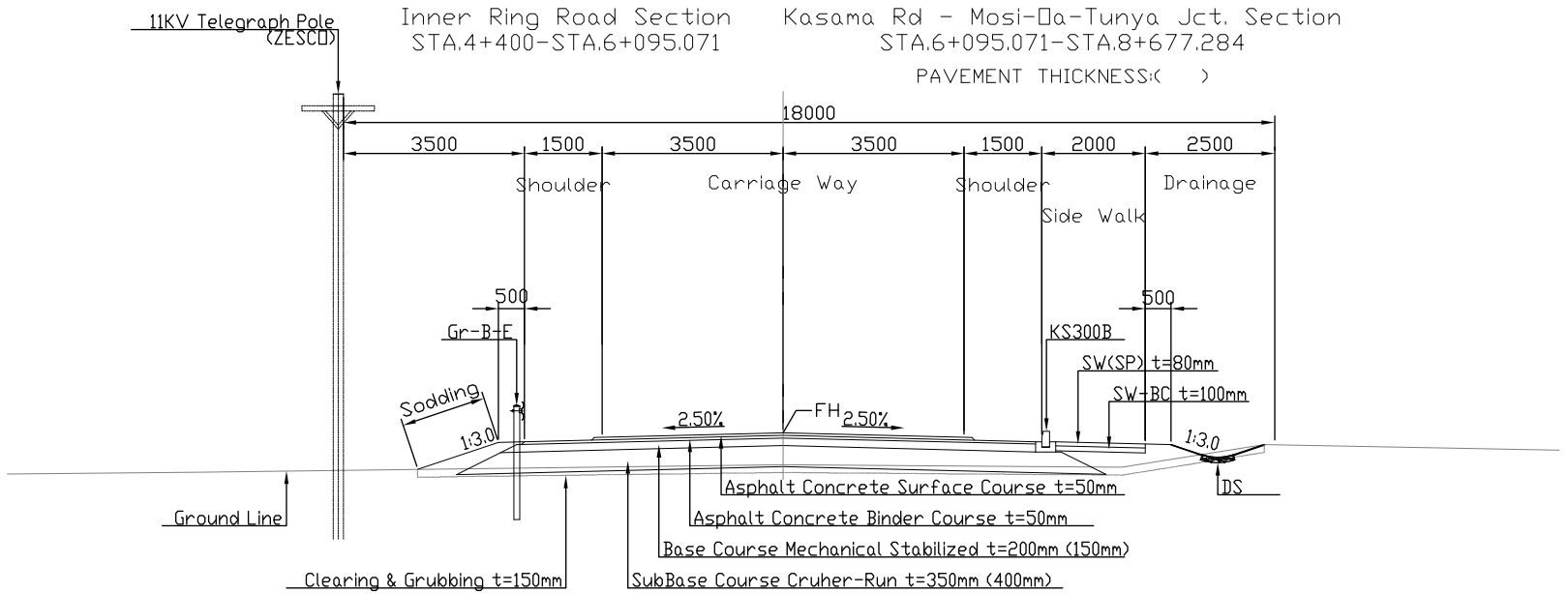
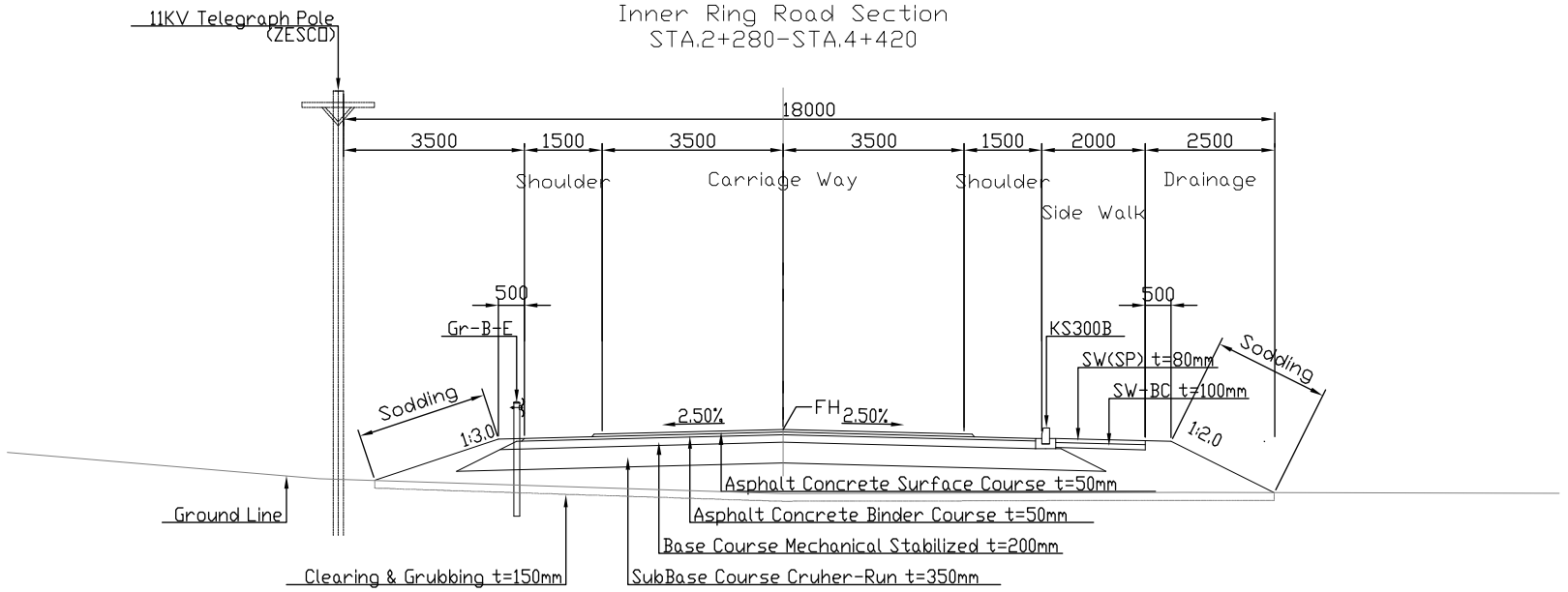
				SCALE	1/100
				DATE	Jan. 2011





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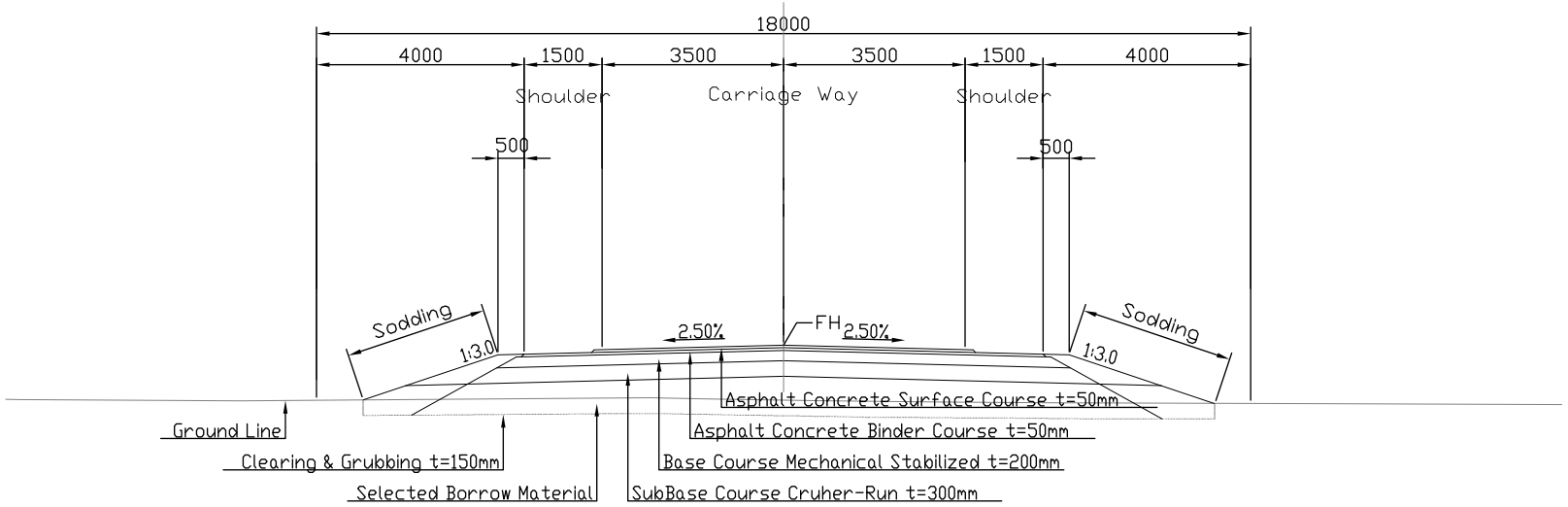
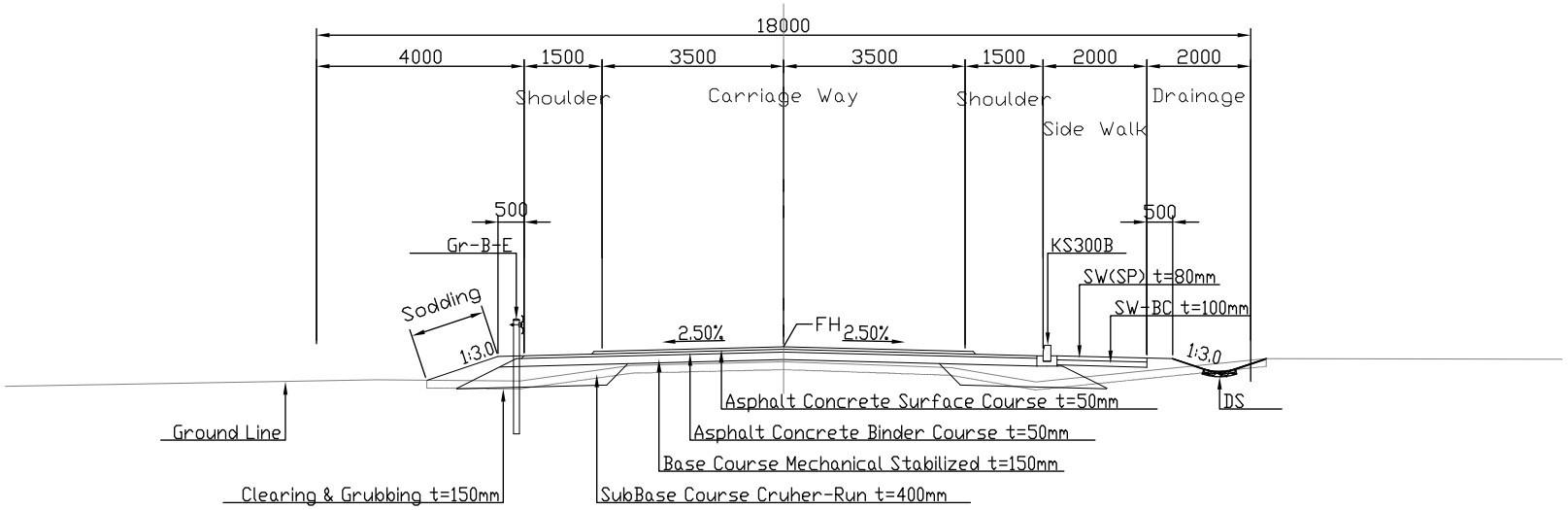
				SCALE	1/100
				DATE	Jan. 2011

Mosi-Oa-Tunya Jct. - LS-MFEZ Section
STA.9+460-STA.13+620



Mosi-Oa-Tunya Jct. - LS-MFEZ Section
STA.8+686.3-STA.9+460



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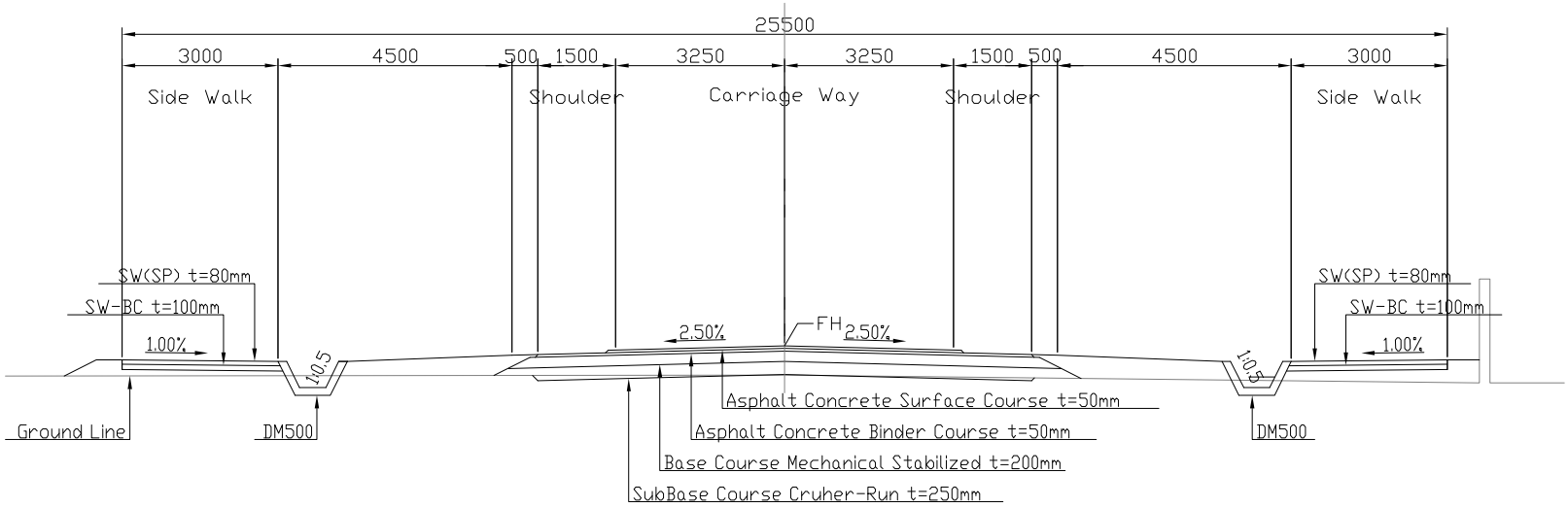
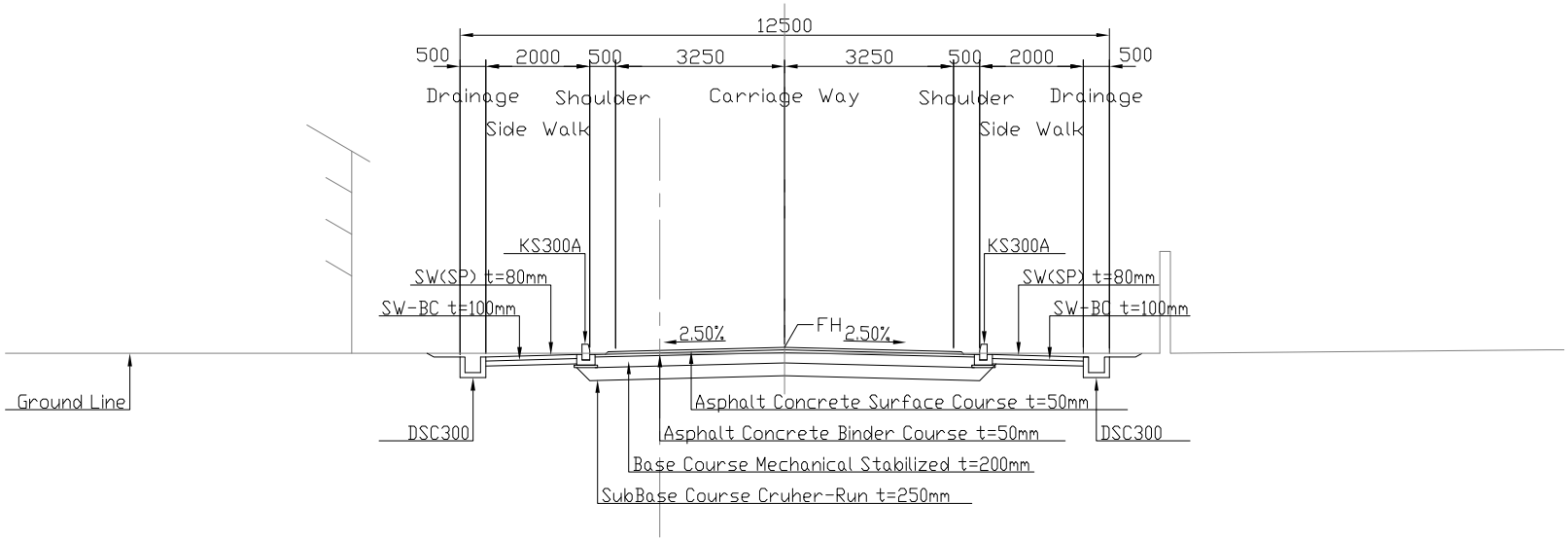
				SCALE	1/100
				DATE	Jan. 2011

Ben Bella Road Section
STA.0+620-STA.0+954.099



Ben Bella Road Section
STA.0+000-STA.0+620



MINISTRY OF LOCAL GOVERNMENT AND HOUSING LUSAKA CITY COUNCIL	JAPAN INTERNATIONAL COOPERATION AGENCY KATAHIRA & ENGINEERS INTERNATIONAL	THE PREPARATORY SURVEY ON THE PROJECT FOR THE IMPROVEMENT OF THE LIVING ENVIRONMENT IN THE SOUTHERN AREA OF LUSAKA IN THE REPUBLIC OF ZAMBIA	TITLE: TYPICAL CROSS SECTION (5)	Drawing No.	TC-05
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				DATE	Jan. 2011