No.

NATIONAL ROAD ADMINISTRATION
REPUBLIC OF MOZAMBIQUE

THE STUDY ON UPGRADING OF NAMPULA-CUAMBA ROAD IN THE REPUBLIC OF MOZAMBIQUE

FINAL REPORT
2 of 3
MAIN TEXT
APPENDIX-A to I

November 2007

JAPAN INTERNATIONAL COOPERTATION AGENCY

Oriental Consultants Company Limited

Japan Engineering Consultants Company Limited

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The following foreign exchange rate is applied in the study:

1 US dollar = 25.75Mtn = 122.62 JP Yen, or 1 MTn = 0.21 JP Yen (June 2007),

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PREFACE

In response to the request from the Government of the Republic of Mozambique, the Government of Japan decided to conduct the Study on Upgrading of Nampula – Cuamba Road and entrusted to study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Keigo KONNO of Oriental Consultants Co., Ltd. and consist of Oriental Consultants Co., Ltd. in association with Japan Engineering Consultants Co., Ltd. to Mozambique, between September 2006 and October 2007.

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

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

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

November 2007

Eiji HASHIMOTO
Vice President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

November 2007

Mr. Eiji HASHIMOTO,
Vice President
Japan International Cooperation Agency (JICA)
Tokyo, JAPAN

We are pleased to submit to you the Final Report of the Study on Upgrading of Nampula – Cuamba Road in the Republic of Mozambique.

This study was conducted by Oriental Consultants Co., Ltd. in association with Japan Engineering Consultants Co., Ltd. under a contract to JICA, during the period from September 2006 to November 2007.

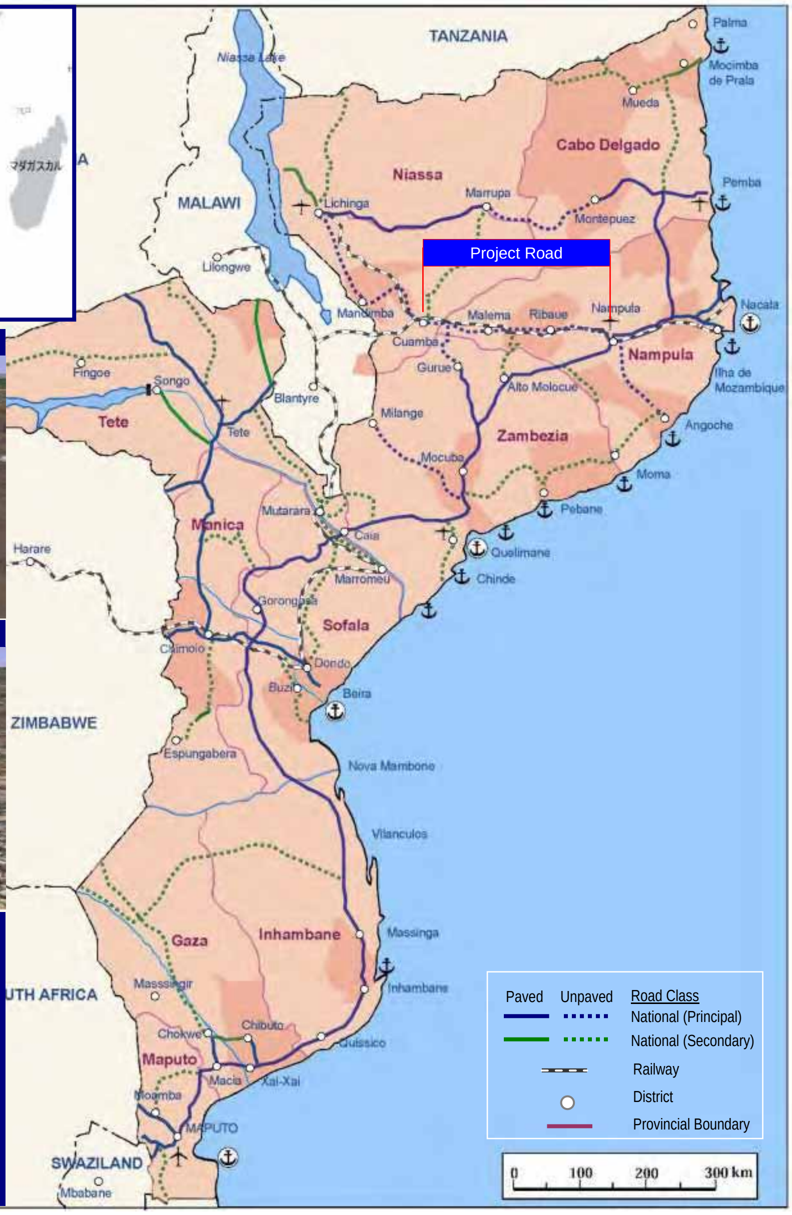
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Ministry of Foreign Affairs of Japan, Japan International Cooperation Bank, National Road Administration, JICA Mozambique Office and Embassy of Japan in Mozambique for their cooperation assistance throughout the Study.

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

Very truly yours,

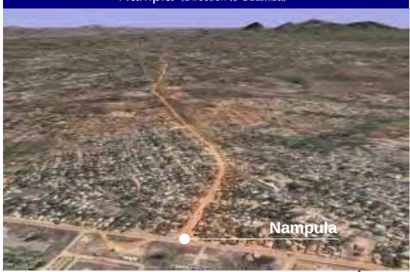
Keigo KONNO
Team Leader,
Study Team of the Study on Upgrading
Nampula – Cuamba Road

PROJECT LOCATION MAP



Cuamba (Direction to Nampula)

Nampla (Direction to Cuamba)



Typical View of the Project Road

Dry Season

Rainy Season

Satellite View of the Project Road

The Study Route Map

Project Outline

1. Country	Republic of Mozambique
2. Name of Study	The Study on Upgrading of Nampula – Cuamba Road in the Republic of Mozambique
3. Counterpart Agency	National Road Administration, Ministry of Public Works and Housing
4. Objectives of the Study	To carry out a feasibility study (the Study) on the upgrading of National Road No.13 between the cities of Nampula and Cuamba, which are a part of the Nacala Corridor, as an EPSA project with a loan from AfDB and JBIC.

1. The Study Area

- Four districts of Nampula, Mecuburi, Ribaue and Malema in Nampula province and the district of Cuamba in Niassa province
- The Study road of approximately 350km long

2. Scope of the Study

1) Feasibility Study

a) Execution of Supplementary Survey
b) Examination of Design Standards
c) Execution of Traffic Demand Forecast
d) Support for Environmental and Social Considerations
e) Execution of Preliminary Design
f) Execution of Construction Planning & Cost Estimate
g) Preparation of Project Implementation Plan
h) Examination of Economic and Financial Analysis
i) Examination of Road Maintenance and Traffic Management

2) Regional Development Plan

a) Examination of Overall Conditions and Current Regional Development Plans
b) Formulation of Regional Development Program
c) Selection of Pilot Projects
d) Execution of Pilot Projects
e) Execution of Emergency Works as Pilot Project

3. Narrative Description

Feasibility Study

Overall, the Study road width varies between 5m and over 10m and is generally lower than the surrounding ground. Furthermore the Study road has an earth/gravel surface with very poor drain. In order to design a suitable road as a part of the Nacala Corridor, traffic survey was carried out. As a result of the analysis using JICA STRADA model, the traffic demand in 2026 was forecasted that it was 1,262 vehicle/day in case of 80km/hr and 1,324 vehicle/day in case of 100km/hr. Based on the SATCC Standards, a design speed of 80km/hr was recommend in consideration of traffic safety, construction cost, social impacts, traffic management and operation. And furthermore, the selection of the suitable pavement composition was evaluated based on the initial cost and its financial viability using the EIRR indicator. As a result of the analysis, a DBST surface on a base layer of granular type was selected as the most economically viable pavement composition. Its composition was shown the lowest initial cost and the highest EIRR. Economic ratios of NPV, B/C and EIRR were US$ 50.443, 1.51 and 18.8% respectively. With regard to the concept of COI, ROW was arranged based on the environmental viewpoints, of which clearance width such as construction road and diversion was 7m from both shoulders respectively. With regard to the construction planning, the Study road was divided into 3 construction sections, which were Nampula – Ribaue, Ribaue – Malema, Malema – Cuamba. And the construction schedule was estimated at 36 months for each section.

Regional Development Plan

The northern region along the Study road area is high potential agricultural area. Various multi-sector projects and programs are on-going in the Study region. However there are some problems such as lack of transport, lack of knowledge on commercialization, lock of basic services in the remote areas, lack of traffic safety education and so on. Based on the result of a SWOT analysis, the priority strategic development programs under 3 development pillars, which were agricultural development, improvement of rural center and upgrading of basic service, was formulated. In order to examine the contents of 3 pillars, “Rural Center (Core) Project” which was one of the “Rural Development Program” as a “Pilot Project”, was planed. And for the increase of the synergic effect of the pilot project, the selected 3 pilot projects were packaged into one integrated pilot project, which was named “MICHINOEKI”. The MICHINOEKI provides the facilities such as market, parking area, public toilet, open space and bicycle center to provide functions of income generation, rest area place of information/events, and improvement of transport means for the farmer.

4. Conclusion and Recommendations

- Implementation of regional development programs together with the Study Road upgrading project. It is recommended that MICHINOEKI shall be implemented as a soft component of the project, and community roads along the study road shall be implemented together with this project.
- Support for Environmental and social consideration
  - Minimization of resettlement and stakeholder consultation
  - Support for Appropriate environmental and social consideration for other relevant activities
- Keeping the implementation schedule to start the construction work of the Study road from the beginning of 2009
- Starting the detailed design stage from the beginning of 2008
- Execution of severe site survey for quarries on the detailed design stage
- Expected shortage of cement supply for concrete structure due to the FIFA 2010 World Cup
- Execution of operation and maintenance of the upgrading road including Michinoeki Anchilo

SUMMARY OF PROJECT

[1] OVERALL APPROACH & IMPLEMENTATION PROGRAM OF THE STUDY

Mozambique's 16-year civil war, which lasted until 1992, ruined much of the nation and destroyed its key road infrastructure. After civil war, the Government of the Republic of Mozambique (hereafter referred to as the "GOM") has promoted various regional development plans in the country. As a first step, the rehabilitation of road infrastructure is not only indispensable but will stimulate economic growth and reduce poverty, which is considered important for the Action Plan for the Reduction of Absolute Poverty (hereafter referred to as "PARPA") for 2001 to 2005. Note that many donors, including the World Bank, the European Union, the African Development Bank, etc., support the road and bridge management program of PARPA and Roads III for rehabilitating Mozambique's key roads.

The Nacala Corridor, which extends to Malawi and Zambia through the Nampula and Niassa Provinces of Mozambique from Nacala Port, serves as a trucking route that connects northern agricultural areas with important provinces and/or districts and has the potential to produce benefits for these areas in the near future. However, during the rainy season from December to March, the amount of rainfall is comparatively large (ranging from 1200 to 2000 mm) and, as the Corridor is an unpaved road, it is frequently impassable during this period, adversely affecting the transportation of agricultural crops.

Given this background, the GOM wishes to draw up a road improvement plan for the Nacala Corridor that will upgrade inter-provincial connectively, and that will establish a network that will be compatible with that of the surrounding districts, provinces and counties to realize an effective international road system, with the aim of invigorating the socio-economy of northern Mozambique. In response of this request from the GOM, the Government of Japan (hereafter referred to as the "GOJ") has decided to carry out a Feasibility Study (hereafter referred to as the "F/S") for the road of northern provinces, i.e., "The Study on Upgrading of Nampula – Cuamba Road in the Republic of Mozambique" (hereafter referred to as "the Study").

Therefore, the objective of this Study is to carry out the F/S on the upgrading of National Road No.13 between Nampula and Cuamba, which is a part of the Nacala Corridor, approved by AfDB as the Enhanced Private Sector Assistance (EPSA) project, which is a co-financed scheme with the Japan Bank for International Cooperation (JBIC).

[2] GENERAL APPRECIATION

1 Road System

Mozambique's transport sector is governed by the following road sector policies and strategies:

- Road Sector Strategy 2007-2011 (RSS)
- Roads and Bridges Management and Maintenance Program (Roads III)
- PRISE 2007-2009

Mozambique has a road network of approximately 29,000 km, of which all national and regional roads classified are administrated by ANE; it has a coastline of approximately 2,700 km with the three (3) principal seaports being Maputo, Beira and Nacala. There are three (3) railway lines located around Maputo/Matola, Beira and Nacala and they constitute the Caminhos de Ferro de Mozambique (CFM) system.

2 Capacity of Road Sector Institutions

The road sector in Mozambique has been administrated by a number of government organizations, at national and provincial level. They are: the Ministry of Public Works and Housing (MOPH), the National Administration of Roads (ANE) and the Road Fund (FE) at national level, and the Provincial Delegations of ANE, the Municipal Councils and the District Administrations, at local level.

According to the ten-year Program, it requires financing of US$ 1,700 million, of which approximately 25% (US$ 432 million) is to be provided through IDA Adjustable Program Loan (APL) Credits. The Road Fund will need to contribute approximately US$ 600 million towards routine and periodic maintenance of the road network. The remainder of the program is to be financed by other donors and by the GOM's investment budget.

However, Phase 1 of the Program is behind schedule in terms of financing performance. Compared to the total US$ 703 million investment plan, only approximately US$540 million had been committed by both the GOM and donors, which accounts for only 77% of the total amount.

[3] FEASIBILITY STUDY

1 Approach & Methodology

The following approaches shall be applied to conduct the feasibility study on the Study Road.

- The Study Road should be upgraded as an all-weather road guaranteeing and all year round access.

- The most appropriate design speed for the Study Road shall be selected considering the cost-benefit aspect the capacity for transportation vs. construction costs.
- The most appropriate pavement type shall be selected considering locally available materials and its related costs.
- The necessity of bypass routes at major district centers on the Study Road shall be studied in line with forecasted traffic volumes the scale of resettlement and land acquisition.
- Future traffic demand on the Nacala Corridor shall be forecasted and shall take into account the transportation modes of road and railway.
- The improved Study road shall be operated and maintained by a suitable organization to ensure a long and useful life.

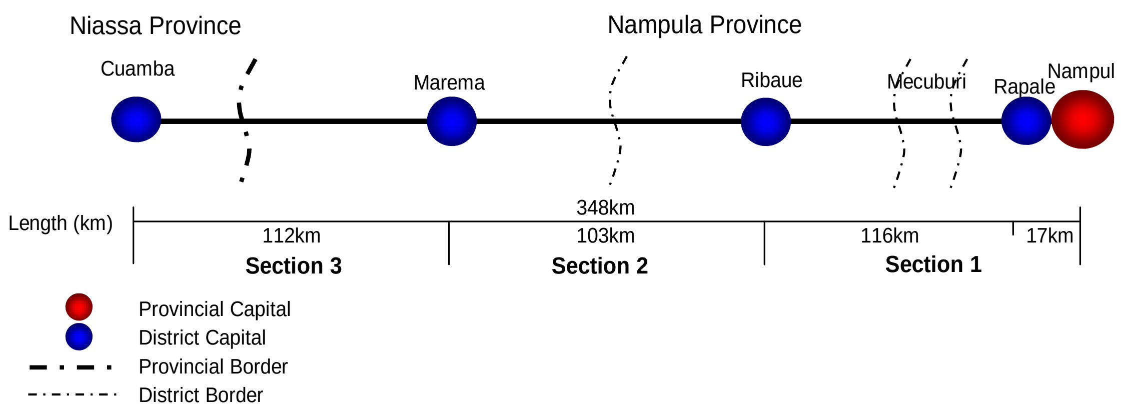
In order to implement the aforementioned approaches, the following methodology shall be applied for the feasibility study.

- JICA STRADA model is applied to forecast traffic demand and to properly assess the traffic volume on the Study Road and consider the effects on the road network.
- HDM-4/RED model is applied for the economic analysis in order to properly assess the effects on the blockage of the existing Study Road during the rainy season.

2 Existing Conditions of the Study Road & Bridges

The Study Road, with a total length of approximately 350km, passes through one city (Nampula), five districts (Nampula, Mecuburi, Ribaue and Malema in Nampula Province, and Cuamba in Niassa Province) and connects one provincial capital (Nampula) and four district capitals (Rapale, Ribaue, Malema, Cuamba), The Study Road is part of the NACALA CORRIDOR, connecting the Nacala Port with Malawi and Zambia.

The Study Road can be broadly divided into three sections as follows:



Outline of the Study Road

Overall, the Study Road width varies between 5 m and over 10m. The road is generally lower than the surrounding ground and has an earth/gravel surface with a poorly defined open drainage system. The side drains discharge surface water through irregularly positioned miter-drains. Crossing culverts on the road were observed at reasonably regular intervals. Some new culverts were recently constructed, and other culverts had headwalls repaired.

3 Natural Condition Survey for the Study Road

The natural condition Survey was carried out for the present conditions of the object road and those results of survey will be became the basic materials for the basic design. In addition, the aerial photo survey was carried out for topographical map to use for the basic design. Principal results of geological survey and hydrology survey are shown in table below.

Principal Results of the Survey

Survey Items	Survey Results
Geological Survey	• Sub-grade and sub-base of the existing study road are sufficiently strong for to use the sub-grade and the sub-base for the new road. • Laterite can not be used for material of sub-base, but when stabilized with cement or crushed stone, it can be used. • Only Cuamba Quarry can be used for surfacing and base materials. • Utilize of other quarry for above mentioned materials should be judged by other test results. • Laterite with 3% cement can be utilized for the sub-base but not for the base course. • Laterite with crushed stone can be utilized for the sub-base but depend on mix proportion.
Hydrological Survey	• Design high water level and design flood discharge were calculated by Rational Formula.

4 Traffic Demand Forecast for the Study Road

The following traffic surveys were executed: 1) traffic volume survey (24h and 12h), 2) a roadside origin-destination survey, 3) bus and train passenger survey, 4) situation survey of train operation, 5) interview survey of the major transport company. In addition to these surveys, the Study Team obtained some historical traffic data from ANE.

The overall demand for traffic movement has been formulated using a combination of data from the traffic surveys and economic growth data. The way in which traffic distributes on the road network is forecasted using the traffic assignment model JICASTRADA.

Based on the result of the analysis, average traffic demand in 2026 is 1,262 vehicle/day in case-1

(80kms/hr travel speed) and 1,324 in case-2 (100kms/hr travel speed).

Future Traffic Volume in 2026

［Case of 80kms/hr］ ［Unit：vehicles/day］

Section Name	AADT in 2006	Passenger Car	Mini-Bus	Bus	Cargo	Total
Nampula-Ribaue	335	111	324	177	767	1379
Ribaue-Malema	36	153	159	129	743	1184
Malema-Cuamba	141	138	125	127	833	1223
Sections Average	171	134	203	144	781	1262

［Case of 100kms/hr］ ［Unit：vehicles/day］

Section Name	AADT in 2006	Passenger Car	Mini-Bus	Bus	Cargo	Total
Nampula-Ribaue	335	111	367	173	795	1446
Ribaue-Malema	36	153	209	117	783	1262
Malema-Cuamba	141	138	125	127	873	1263
Sections Average	171	134	234	139	817	1324

5 Environmental & Social Considerations

The GOM has issued laws relevant to the environment, according to the EIA Law, all project's proponents must obtain have environmental certification from approval organization the Ministry of Environmental Coordination (hereinafter referred to as "MICOA"). This environmental law prescribes that rural road rehabilitation projects are is classified as "category A" projects, which is required an n EIA basically.

The IEE (pre-EIA) based on the JICA's guidelines indicated that it seems serious environmental impacts are not expected so far, however some key issues such as resettlement, elephant corridor and infection diseases items were picked up through the IEE. An EIA will be carried out based on the on procedures outlined by the of GOM's environmental law law basically. However other relevant environmental guidelines should be consulted as well referred from the view point of social considerations. Therefore JICA's has proposed a comprehensive ToR for the EIA based on the guidelines which includes all items from GOM, AfDB, JBIC and JICA. Thean environmental section in ANE, UASMA, in ANE has adopted this proposed ToR for the EIA. According to the timetable, the ESIA report will be submitted to MICOA in November 2007 and ANE will receive environmental permission by the end of 2007.

6 Applicable Design Standards

The application of a proper design standard will ensure that the following objectives are achieved:

- Ensure a safe, comfortable and high standard service level for the road users by the provision of adequate sight distance and sufficient roadway space
- Ensure that the roadway is designed economically
- Ensure uniformity in the design
- Ensure safety of the structures (bridges and culverts).

The applicable geometric design standard should adhere to the SATCC Standards. The design standards will be based on the proposed adopted design speed and take into consideration the construction cost and the environmental impacts.

7 Preliminary Design

This study aims to upgrade the Study Road, the Nampula – Cuamba Road which has a length of 350km. Through discussions with ANE and the results of field surveys by the Study Team, the concept of the Project was defined as follows:

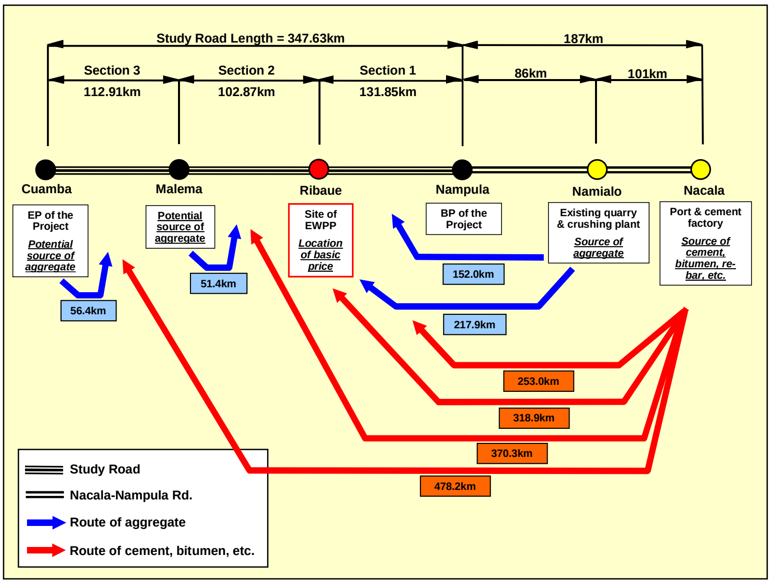
- To create an efficient primary road connection securing smooth traffic flow throughout the year corresponding to the future traffic demand
- To create a safe primary road connection by reducing the risk of accidents, especially the rate of injuries to pedestrians by motorized vehicles

The Upgrading of the Study Road will satisfy the geometric standards of SATCC for road safety. However, it is important that the impacts to the social and natural environmental are minimized. Accordingly, the following concepts of road alignment were discussed and agreed upon between ANE and the Study Team.

- The existing centerline shall be followed in the town and major villages.
- Other sections outside the towns and major villages shall satisfy the SATCC Standards taking into account the existing centerline wherever feasible.
- Bridges as evaluated in good condition by the bridge inventory survey shall be maintained in the project design to minimize initial capital costs.

8 Construction Planning & Cost Estimate

The study road will be divided into 3 construction sections as shown in following figure. Furthermore estimated project period is 36 months per each section



Locations & Functions of Important Places

Estimated project cost is summarized in following tables.

Total Project Cost (Design Speed = 80km/h; ALT-3)

(Currency: US $)

No.	Description		Section 1 Nampula to Ribaue 131.85 km	Section 2 Ribaue to Malema 102.87 km	Section 3 Malema to Cuamba 112.91 km	Total 347.63 km	% of (1-10)
0	Compensation		443,675	346,158	379,942	1,169,775	
1	Preliminary & general		11,882,980	9,776,507	11,598,963	33,258,450	28.7%
2	Earthworks		5,930,179	3,802,568	2,958,588	12,691,336	10.9%
3	Pavement		16,707,209	10,991,198	14,168,338	41,866,745	36.1%
4	Drainage		4,018,899	4,926,522	6,195,310	15,140,730	13.1%
5	Road furniture		175,198	176,688	292,253	644,139	0.6%
6	Miscellaneous		252,626	59,068	292,412	604,106	0.5%
7	Bridge		0	2,337,294	2,703,350	5,040,644	4.3%
8	Temporary construction road		1,262,692	1,028,483	1,059,032	3,350,207	2.9%
9	Dayworks		697,331	573,717	680,664	1,951,712	1.7%
10	Social issues		507,408	417,461	495,280	1,420,149	1.2%
	Total (1-10)		41,434,523	34,089,506	40,444,189	115,968,218	100%
11	Contingency	10%	4,143,452	3,408,951	4,044,419	11,596,822	
	Total construction cost (1-11)		45,577,975	37,498,457	44,488,608	127,565,039	
12	Engineering cost	8%	3,646,238	2,999,877	3,559,089	10,205,203	
	Total project cost (1-12)		49,224,213	40,498,333	48,047,697	137,770,243	
13	VAT	17%	8,368,116	6,884,717	8,168,108	23,420,941	
	Total project cost with VAT (1-13)		57,592,329	47,383,050	56,215,805	161,191,184	
14	Total(13) + (0)Compensation		58,036,004	47,729,207	56,595,747	162,360,959	

Unit Cost of the Project per kilometer (Currency: US $)

Type of unit cost	Section 1	Section 2	Section 3	Total
Unit construction cost (1-10)	$314,255 /km	$331,384 /km	$358,198 /km	$333,597 /km
Unit construction cost (1-11)	$345,681 /km	$364,523 /km	$394,018 /km	$366,956 /km
Unit project cost (1-12)	$373,335 /km	$393,685 /km	$425,540 /km	$396,313 /km
Unit project cost with VAT (1-13)	$436,802 /km	$460,611 /km	$497,882 /km	$463,686 /km
Unit project cost +VAT + Compensation. (1-14)	$440,167 /km	$463,976 /km	$501,247 /km	$467,051 /km
Unit construction cost (0-10)	$317,620 /km	$334,749 /km	$361,563 /km	$336,962 /km

9 Project Implementation

At present, AfDB and JBIC are considering to finance the Project. The Project implementation schedule should be consistent with the technical requirements and the availability of financial resources. The proposed Project implementation schedule is presented in the below.

- The detailed design stage will start from the beginning of 2008.
- The construction stage will start from the beginning of 2009 during 3 years.

10 Economic and Financial Analysis

The project scores an average level as an upgrade-to-paved intervention and its economic viability is acceptable, with an EIRR of over 12% for the optimum intervention among alternatives. Based on this result, N13 (Nampula - Cuamba) project is evaluated as one of the prioritized projects in the road sector. The particular importance of this primary road and of bringing it to all-weather transit-able condition is well established.

Result of Economic Analysis

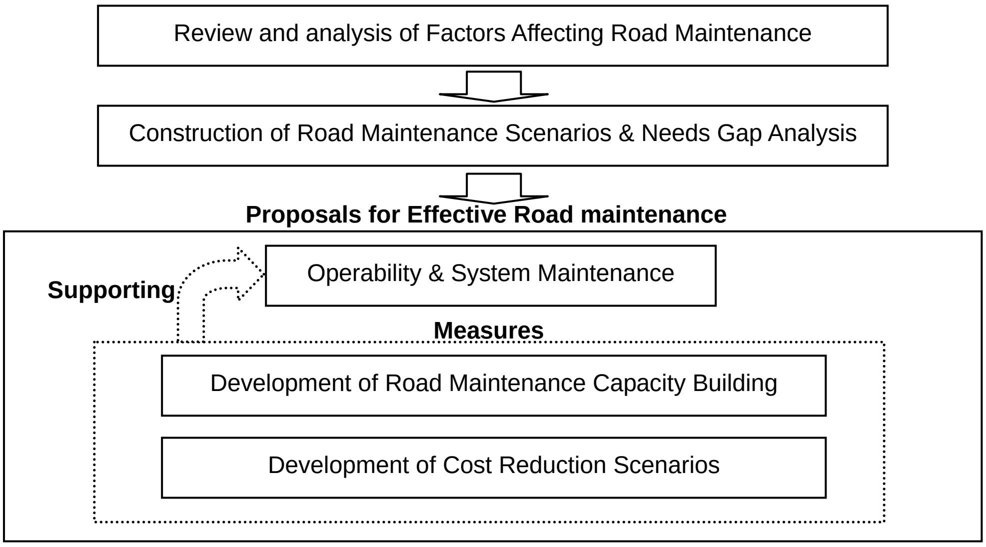
Section	Length (km)	Design	Construction Cost	Economic Ratio		
		Pavement Type	US$/km	NPV	B/C	EIRR
Nampula-Ribaue	131.6	DBST on Granular	317,620	21,094	1.59	19.8%
Ribaue-Malema	102.9	DBST on Granular	334,749	15,389	1.53	19.0%
Malema-Cuamba	112.9	DBST on Granular	361,563	13,951	1.40	17.5%
Total	347.4	DBST on Granular	336,962	50,433	1.51	18.8%

Result of Sensitive Analysis

Case	Assumptions	Section			
		N-R	R-M	M-C	Total
Base	Upgrade to paved road with DBST on Granular	19.8%	19.0%	17.5%	18.8%
1	Increase in traffic volume of +20%	23.0%	22.1%	20.5%	21.9%
2	Decrease in traffic volume of -20%	16.2%	15.5%	14.2%	15.3%
3	Decrease in investment costs of -20%	23.8%	22.8%	21.2%	22.6%
4	Increase in investment costs of +20%	16.8%	16.1%	14.8%	15.9%

11 Road Maintenance & Traffic Management

The proposals are comprehensive in order to develop the most effective road maintenance system. The workflow for this approach is shown in Figure below.



Developing an Effective Road Maintenance

Regarding to the traffic management such as overloading control and traffic safety, existing methods for overloading control rely on the use of axle-load weighing stations. Weighing stations will be an important measure to deal with the problem of overloaded vehicles. In addition to the overloading control, the following measures are recommended to reduce the level of road fatalities;

- Media campaigns on road safety
- Road safety awareness and education for rural children in communities and schools
- Strict enforcement of driver's license issuance and renewal
- Enforcement of traffic violations
- Strict vehicle inspection for registration and renewal

[4] REGIONAL DEVELOPMENT PLAN

1 Overall Conditions of the Study Area

The Study area is located in the provinces of Niassa and Nampula. The Nacala Corridor, which extends from Nacala Port to Malawi crossing the Provinces of Nampula and Niassa. The Study road is an unpaved road, it is frequently impassable during the rainy season, affecting the transportation of crops during this period. Socio-Economic Indicators of the provinces in the Study Area are shown below.

Socio-Economic Indicators in the Study Area

	Nampula	Niassa	National
Population – National Institute of Statistics (INE) projection for 2004	3,563,220	966,580	19 million
Children under age 18 (2004)	1,832,340	519,330	9,613,470
% of population that live below poverty line (2003)	52.60%	52.10%	54%
Infant mortality rate per 1000 (2003)	164	140	124
Chronic malnutrition among children 0-5 years (2003)	42%	47%	41%
Access to safe drinking water (2003)	32.20%	30.20%	35.70%
Access to sanitation (2003)	26.20%	70%	44.80%
HIV/AIDS Prevalence among 15- 49 year olds (2004)	9.20%	11.10%	13.60%
Primary School net enrolment rate (2003)	46.30%	47.30%	61%
Adult illiteracy rate (2003)	65.10%	64.40%	53.60%
Female illiteracy rate (2003)	81.40%	68%	68%
Fertility Rate (2003)	6.2	7.2	5.5
Total % of population with radios (2003)	48.30%	43%	45.50%

Source: UNICEF Moz.

2 Current Regional Development Plans and Activities

Various multi-sector projects and programs are on-going in the study region. It is noted that most of the development projects and programs are supported by donors and implemented with the assistance of NGOs.

The major NGOs and Agencies active in the region are; CARE International, CLUSA, SNV, World Vision, Save the children, Felocidade, Olipa-Odes, Ophavela, Oram, Monaso(HIV/AID) and CPI (Center for Promotion of Investment).

The major development issues of the study region are as follows;

- More than 90% of the population in the study region live in the rural areas
- Dispersed population distribution, only 25.6% of the population live within a distance of 10 km from the project road (both sides)
- The majority of the rural population engages in subsistence or family farming.
- Lack of transportation, especially in the rainy season due to impassable roads
- Lack of access to technology resulting in low agricultural productivity reliant on manpower only
- Lack of economic facilities in rural centers with respect to storage, markets, processing factories, means of transportation, etc.
- Lack of basic need services such as health, education, sanitary facilities
- Less than 10% of the farmers are members of producers association
- Many of the existing processing factories and storage facilities for agricultural products in Nampula City are deteriorated
- Vast availability of arable land and high potential to serve as a grain belt and contribute to food

security in Mozambique

- Interesting landscape and potential tourism attractions

3 Regional Development Program

Following table shows the summary of the regional development policies for each time horizon (period), and the priority strategic development program under the development pillars of 1) agricultural development, 2) Improvement of Rural Centers, and 3) Upgrading of Basic Services are proposed in the Study.

Establishment of Development Policies

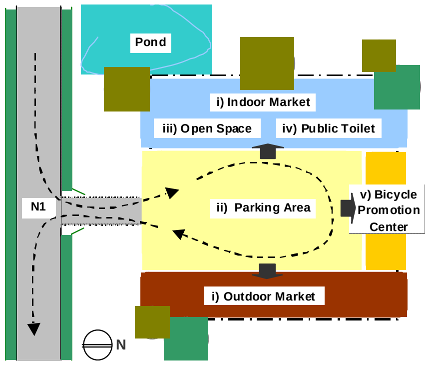
Period	Area involved	Agricultural Development	Improvement of Rural Center	Upgrading of Basic Services
Short	Half of 5 districts and 1 city (30 km radius zone)	Organization and transformation (increase of producer's associations: target=20%) and expansion of extension services, improvement of production facilities and management of natural resources	Improvement of rural center's functions, , improvement of mobility, and preventive measures for negative impacts	Improvement of medical, school and sanitary facilities
Mid	All of 5 districts and 1 city and expand area to other areas of Nacala Corridor	Organization and transformation (increase of producer's associations: target=30%), and & strengthening of producer's associations (target=30%) and continuation of above measures	Expand the above measures to the hinterland, improvement of markets, distribution and processing factories in Nampula and Nacala, and tourism development along the corridor	Improvement of medical, school, sanitary facilities, and electricity supply
Long	All of Nacala Corridor and expand to the northern 3 provinces	Increase & strengthening of producer's associations (target=50%) and continuation of above measures	Increase of jobs, improvement of public services, development of agro-processing center in the regional centers, and invitation of investments on large-scale livestock and plantation in the rural area, and integrated development of railway, airport and sea port	Improvement of medical, school, sanitary facilities, electricity supply, and settlement environment

4 Pilot Project

The objective of the Pilot Project is to grasp the development procedure, mechanism for project management and required necessary resources including human, material and financial. It will also serve to examine whether such projects are suitable to the local circumstances in Mozambique, and to identify an appropriate and achievable implementation and operation plan for the "Rural Center (Core) Project" which is the one of the main proposals of the "Regional Development Program".

To create a synergic effect between the pilot projects, the 3 selected projects are packaged into one integrated pilot project, which is called "MICHINOEKI". This pilot project will constitute of the following elements and conceptual lay-out plan for the facilities:

- For the income generation of the farmers / villagers, a market facility to sell agricultural products to the road users is provided
- For the information provision / promotion of events to villagers, an open space is provided
- For the rest area ,a refrigerator, parking area, public toilet and water supply is provided for the road users, and
- For the improvement of farmers' mobility a bicycle promotion center is provided to carry their products to the market.



The MICHINOEKI shall be implemented by PPP (Public and Private Partnership) method in cooperation with ANE, Local Government and the Project Operation Unit (POU).

The location of the proposed MICHINOEKI for pilot project is on the N1 km 19.1 from Nampula City (part of the central area of Anchilo Administrative Post). Through the experience of implementation, establishment of management and operation, monitoring and evaluation was conducted so that the recommendation and lessons leaned are following;

Recommendation

1. The contents/components of the MICHINOEKI which are i) parking lot, ii) Open Market, iii) Sales of Goods to rural people and drivers, iv) Pubic Toilet and v) Event Space are evaluated to be effective for full-scale project implementation, and should be part and parcel of future MICHINOEKI's.
2. The Administrative System (ANE: Owner of Facility, District: Owner of Operation) was confirmed to be efficient. The same system should be used for the full-scale project. The Financial recourses are expected to be provided by the soft component of the Nampula - Cuamba road improvement project.
3. The Bicycle promotion centre should be integrated into the MICHINOEKI project to promote the use of the bicycle for rural people and also to generate income for the operation of the road side station..

Lessons Learned

1. Technical assistance and capacity building is required for the operational staff of the MICHINOEKI. Most farmers are not business minded.
2. Promotion and publishment of the MICHINOEKI concept is important for the rural areas in order to have the farmers fully recognize and understand the MICHINOEKI's objectives and be involved in the outdoor market activities.
3. The staffs of MICHINOEKI have installed the community phone and started constructing another rest space under their decision. The community phone has been confirmed as a one of a useful public purpose by the results of operating records. It is recommended that the community phone should be provided into future MICHINOEKIs.

5 Roadside Station

The main objectives for the Roadside Station "MICHINOEKI" are as follows:

- **Rest:** Providing highway users with a clean, comfortable rest area
- **Market:** Providing a location for direct sale of products (and possibly for processing local products to generate added value)
- **Terminal:** Providing terminal functions for public transport.
- **Public Service:** Providing public services that are needed by local residents, as well as by highway users.

The study team identified the following proposed locations for future MICHINOEKI on the study road, and also visited each local administration and discussed the availability for each of these locations. All locations have been confirmed as being available for public facilities.

Layout arrangement considering the specific conditions in Mozambique and the site conditions are considered and the recommended layout plan for MICHINOEKI was proposed.

Through the pilot project in MICHINOEKI Anchilo, procedures for implementation, organization and operation have been tested which have provided important lessons learnt for its establishment in the Mozambican context. Especially, it is recommended that community phone should be installed through the scheme of Public Private Partnership (PPP) as a one of the MICHINOEKI's facilities. It helps much improvement for communication tools among rural people. And full scale implementation of the MICHINOEKI concept at the eight proposed locations on the study road is recommend as soft component of the main project for road improvement.

6 Emergency Works As Pilot Project

The Emergency works (hereafter described as “the Works”) is a component of the pilot projects focusing on the rehabilitation of feeder roads and/or community infrastructures, which are strongly related with the regional development program. The works mainly aims that an effectiveness of small scale rehabilitation for community infrastructures are to be experimentally examined when it is undertaken within the framework of the regional development program. And secondary, specific data & information of construction as well as procurement are to be updated and compiled to feedback to the Feasibility study.

The Works were selected from the list of the prioritized projects, which are proposed in the Short-term Regional Development Policy.

Based on a technical examination as well as a needs assessment, the rehabilitation work for the existing community roads were carried out in the center of Ribaue district, which is a hub town in the region and provides public services both for education and for medical attentions.

The Works are to rehabilitate community roads of 0.98km in length and to improve access to the hospital and the school in Ribaue, Nampula Province. The Works comprise the following tasks:

- ✓ Road Pavement with a Single Chip Seal
- ✓ Installation of the Pedestrian Way and Rehabilitation of the Central Island (Strip)
- ✓ Installation of the Drainage and Cross Culvert

The rehabilitation work had progressed as scheduled. The Works commenced on May 29th and completed on July 30th, 2007. The total construction period was about 10 weeks. The facts and lessons indicate that it is optimum that the rehabilitation for the community infrastructures is comprehensively implemented in combination with the large scale road rehabilitation in terms of the project cost efficiency, the best management on the consturuction deliver time as well as its quality.

[5] CONCLUSIONS & RECOMMENDATIONS

The economic analysis of upgrading the Study Road concluded that project implementation (between 2009 and 2011) maybe appropriate based solely on benefits to road users and would produce substantial additional economic benefits. The economic validity for the Project is acceptable with an EIRR of 18% based on the most suitable pavement structure of DBST surfacing on granular base and sub-base assuming optimum maintenance interventions and based on the design speed of 80 km/h.

Recommendations based on the Study are summarized as follows.

(1) Implementation of regional development programs together with the Study Road upgrading

project. It is recommended that MICHINOEKI shall be implemented as a soft component of the project, and community roads along the study road shall be implemented together with this project.

(2) Support for environmental and social consideration

- ✓ Minimization of resettlement and stakeholder consultation
- ✓ Support for appropriate environmental and social consideration for other relevant activities

(3) Keeping the implementation schedule to start the construction work of the Study road from the beginning of 2009

(4) Starting the detailed design stage from the beginning of 2008

(5) Execution of severe site survey for quarries on the detailed design stage

(6) Expected shortage of cement supply for concrete structure due to the FIFA 2010 World Cup

(7) Execution of operation and management on the upgrading road including MICHINOEKI Anchilo

THE STUDY ON UPGRADING OF NAMPULA – CUAMBA ROAD IN THE REPUBLIC OF MOZAMBIQUE

FINAL REPORT

Table of Contents

Figure

Table

ABBREVIATIONS

AADT	Annual Average Daily Traffic
AAQS	Ambient Air Quality Standards
ACE	Competent Authority of Road Sector
ADELNA	Local Economic Development Agency in Nampula
ADT	Average Daily Traffic
AfDB	African Development Bank
ANE	National Road Administration
APL	Adjustable Program Loan
ASNANI	Water and Sanitation Project in Nampula and Niassa Provinces
B/C	Benefit/Cost
CDN	Northern Development Corridor
CEPP	Training School for Teacher of Higher Education
CFM	Mozambique Railway Authority
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CLUSA	Cooperative League of the U.S.A.
COI	Corridor of Imact
CPI	Center for Promotion of Investment
DA	Directorate of Administration
DBST	Double Bituminous Surface Treatment
DEN	Directorate of National Roads
DEP	Department of Roads and Bridges
DER	Directorate of Regional Roads
DNEP	National Directorate of Roads and Bridges
DNPF	National Directorate for Planning and Finance
DNPO/MPF	National Directorate for Planning and Budgeting of the Ministry of Planning and Finance
DPOPH	Provincial Directorate of Public Works and Housing
ECMEP	State Enterprise for Construction and Maintenance of Roads and Bridges
EDM	Mozambique Electricity Company
EF	Equivalency Factors
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EITI	Extractive Industries Transparency Initiative
EME	Emergency Maintenance
EMP	Environmental Management Plan
EPSA	Enhanced Private Sector Assistance
ESA	Equivalent Standard Axles
ESAP	Environmental and Social Assessment Procedures
ESGI	Secondary School
ESIA	Environmental and Social Impact Assessment
EU	European Union
FDI	Direct Foreign Investment
FE	Fondo de Estrada
FIP	Preliminary Information File
FIRR	Financial Internal Rate of Return
Fls	Financial Intermediaries
FR	Forecast Reserve
GATV	Voluntary Testing and Assisting Office for HIV/AIDS
GDP	Gross Domestic Product
GHCN1	Global Historical Climatology Network ,version 1
GIS	Geographic Information System
GOJ	Government of Japan
GOM	Government of the Republic of Mozambique

GPS	Global Positioning System
H.W.L	High Water Level
HDM	Highway Design and Maintenance Standards Model
HDR	Human Development Rate
HIV/AIDS	Human Immunodeficiency Virus /Acquires Immune Deficiency Syndrome
HPR	Human Poverty Rate
I.M.F	International Monetary Fund
IDA	International Development Association
IEE	Initial Environmental Examination
IIAM	Mozambique Institute for Agricultural Research
IMAP	Training School for Primary School Teachers
INAV(I.N.A.V.)	National Institute of Road Traffic
INE	National Statistics Institute
IRI	International Roughness Index
IRMS	Integrated Road Management System
ITNs	Insecticide Treated Nets
IUCN	International Union for the Conservation of Nature and Natural Resources
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LDF	Local Development Fund
LDI	Direct Local Investment
LED	Local Economic Development
MA	Ministry of Agriculture
MCA	Multi Criteria Analysis
MCC	Millennium Challenge Corporation
MICOA	Ministry for Coordination of Environmental Affairs
MDG	Millennium Development Goals
MOPH	Ministry of Public Works and Housing
MP	Periodic Maintenance
MPF	Ministry of Planning and Finance
MSA	Ministry of State Administration
MTC	Ministry of Transport and Communications
MTFF	Medium-Term Financial Framework
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NPV	Net Present Value
OD	Origin and Destination
PAC	Environmental Action Plans
PAP	Project Affected Person(s)
PARPA	The Action Plan for the Reduction of Absolute Poverty
PGA	Environmental Management Plan
PIP	Project Implementation Plan
PPABS	Fishery Project
PRISE	Road Sector Integrate Program
RAP	Resettlement Action Plan
RF	Road Fund
RED	Roads Economic Decision Model
RISDP	Regional Indicative Strategic Development Plan
RoadⅢ	Roads and Bridge Management and Maintenance Program, phase 3
ROCS	Road and Coastal Shipping Project
ROW	Right of Way
RPF	Resettlement Policy Framework
RRIP	Rehabilitation of the Regional Roads Network
RSS	Roads Sector Strategy 2007-2011
SABS	South Africa Bureau of Standards

SADC	Southern African Development Community
SATCC	the Southern Africa Transport and Communications Commission
SBS	Sector Budget Support
SBST	Single Bituminous Surface Treatment
SEA	Strategic Environmental Assessment
ASDI	Swedish International Development Cooperation Agency
SMP	Strategic Maintenance Plan
STDs	Sexually Transmitted Diseases
SWOT	Strength, Opportunity, Weakness and Threat
TA	Technical Assistance
TOR	Terms of Reference
TOT	Training of Trainer
TRRL	Transport and Road Research Laboratory
TVE	Technical and Vocational Education
UASMA	Unit for Environmental and Social Issues
UNDP	United Nation Development Program
WB	World Bank
WHO	World Health Organization
WWF	World Wildlife Fund

The following foreign exchange rate is applied in the study:
1 US dollar = 25.75Mtn = 122.62 JP Yen, or 1 MTn = 0.21 JP Yen (June 2007),

PART 1:

OVERALL APPROACH & IMPLEMENTATION PROGRAM OF THE STUDY

PART 1: OVERALL APPROACH & IMPLEMENTATION PROGRAM OF THE STUDY

1.1 Background

Mozambique's 16-year civil war, which lasted until 1992, ruined much of the nation and destroyed its key road infrastructure. After the civil war, the Government of the Republic of Mozambique (GOM) has promoted various regional development plans in the country. As a first step, the rehabilitation of road infrastructure was indispensable in stimulating economic growth and reducing poverty. This objective remains important for the Action Plan for the Reduction of Absolute Poverty (PARPA 2001 - 2005). Note that many donors, including the World Bank (WB), the European Union (EU) and the African Development Bank (AfDB) support the road network and bridge management program of PARPA and Roads III for rehabilitating Mozambique's key roads.

The Nacala Corridor, which extends from Nacala Port to Malawi and Zambia through the Provinces of Nampula and Niassa of Mozambique, serves as a trucking route that connects northern agricultural production areas with important hinterland provinces and/or districts and has the potential to produce benefits for these areas in the near future. However, during the rainy season from December to March, the amount of rainfall is comparatively large (ranging from 1200 to 2000 mm) and, as the Corridor is partly an unpaved road, it is frequently impassable during this period, adversely affecting the transportation of agricultural crops.

Given the above-mentioned situation, the GOM requested the Government of Japan (GOJ) to conduct a feasibility study (F/S) for upgrading the Nampula – Cuamba Road. In response to this request from the GOM, the GOJ dispatched a Project Formulation Study Team and, based on its findings, recommended the execution of "The Study on Upgrading of Cuamba – Nampula Road in the Republic of Mozambique" (hereafter referred to as 'the Study'), designating the Japan International Cooperation Agency (JICA) to conduct the Study in accordance with the Agreement on Technical Cooperation signed by the GOM and GOJ on May 31, 2005 (hereafter referred to as 'the Agreement'). Furthermore, Minutes of the Meeting (M/M) were signed and exchanged on 31 March 2006, and the Scope of Works (S/W) signed on 29 August 2006.

1.2 Objective

The objective of the Study is to carry out a F/S on the upgrading of National Road No.13 between the cities of Nampula and Cuamba, which is a part of the Nacala Corridor. The results of the Study are expected to be approved by AfDB as the Enhanced Private Sector Assistance (EPSA) project, which is a co-financed scheme with the Japan Bank for International Cooperation (JBIC).

1.3 Study Area

The Study area comprises the four districts of Nampula, Mecuburi. Ribaue and Malema in Nampula province and the district of Cuamba in Niassa province, with the total length of the Study road being approximately 350 km.

1.4 Scope of the Study

The Study covers the work items below as agreed upon in the S/W and the M/M by the National Road Administration (ANE) under the Ministry of Public Works and Housing of the Republic of Mozambique (MOPH) and the Project Formulation Study Team.

(1) Related information/data collection, review & analysis

1) National and regional development plans
2) Investment plans
3) Donor activities
4) Socio-economic data
5) Land-use and disaster data
6) Natural environment data
7) Road administration system information and budget data
8) Related laws, regulations and standards
   a) Road and bridge design standards; information on construction machines, materials, aggregates, local consultants and companies; and right of way and road inventory data
   b) Land acquisition and compensation data, environmental impact assessment plans and environmental standards
9) Maps (topography, geology, hydrology, aerial photo, satellite images, etc.)
10) Site survey data

(2) Analysis of socio-economic framework

1) Execution of socio-economic framework analysis

2) Preparation of regional development framework
3) Execution of traffic demand analysis

(3) Preliminary design

1) Execution of supplementary survey
   a) Execution of traffic volume survey
   b) Execution of hydrological survey
   c) Execution of geological survey
   d) Execution of topographical survey
2) Examination of design standards and construction methodologies
   a) Examination of required level of upgrading
   b) Examination of road and bridge design standards
   c) Examination of road safety facilities
   d) Examination of construction methodologies
3) Examination of roadside stations
   a) Description and design of components and functions
   b) Preparation of operation and management system
   c) Promotion of coordination between local government and stakeholders
   d) Preparation of preliminary design and cost estimation
4) Examination of alternatives
   a) Road alignments
   b) Bridges
   c) Road safety facilities
5) Preliminary road design
   a) Route alignment design (Horizontal and vertical alignment)
   b) Road and pavement design
   c) Bridge design
   d) Road safety facilities
   e) Environmental measures
6) Road operation and maintenance
   a) Examination of operation and maintenance methodologies
   b) Examination and recommendations on operation and maintenance entities
   c) Preparation of operation and maintenance schedule
   d) Recommendations for load control and enforcement
7) Project implementation program
   a) Preparation of construction plan (by section)
   b) Preparation of construction schedule (by section)

c) Preparation of procurement plan

d) Examination of funding sources

8) Preliminary project cost estimate

a) Calculation of project cost

b) Calculation of land acquisition and compensation costs

c) Calculation of operation and maintenance costs

(4) Preparation of regional development programs & execution of pilot projects

1) Arrangement for a place suitable for pilot project
2) Study and prepare regional development programs
3) Selection of pilot projects
4) Execution of pilot projects

(5) Economic and financial evaluations and risk analysis

1) Examination of evaluation method
2) Cost Benefit analysis
3) Risk analysis

(6) Environmental evaluation

1) Social environment
2) Natural environment
3) EIA preparation

(7) Conclusion & recommendations

1.5 Study Approach

The study approach has been been formulated based on the existing conditions that are affecting the Study Area and the Study Road. The following describes each of the main issues.

(1) Appreciation of Issues and Development Efforts

1) Although the Study Area has high socio-economic potential due to the existence of agriculture, the area has been struggling with poverty due to mainly lack of access to basic needs.

2) The Study Road and the regional roads in the Study Area are unpaved, and these roads regularly become impassable during the rainy season in spite of periodic road maintenance. This results in either increased costs for the freight and passenger transport

or impossibility of transporting goods to and from markets.

3) Under serviced operation of the railway line, which is offering one scheduled passenger return trip every two days and nonscheduled freight trips, can not enhance economic growth through carrying both freight and passenger in the Study area. In addition, there is no future investment plan for this route at present.

4) Thus, the poor conditions of the transport network including roads and railways in the Study Area undermine poverty reduction efforts and stifle economic growth.

5) Based on PARPA II, Roads III and the Road Sector Strategy 2007 – 2011 (RSS), major donors such as AfDB, EU, WB and the GOJ, have recently improved some major roads and bridges in the two provinces of the Study Area. The road network for the Study Area shall be improved taking these improvements and current improvement plans into account in order to realize maximum synergy.

6) According to the pre-feasibility study conducted by ANE, the Study Road scores very high as an upgrading project (unpaved to paved roads), and its economic viability is quite high, with and EIRR of over 70%. Based on this result, one can conclude that the Study Road is evaluated as one of the highest ranked projects.

(2) Approach of Study

Based on this analysis, the Study team established the following approach to fulfill the objective of the Study.

- The minimum requirement of the Study road should be an all-weather road capable of allowing transport throughout the year.
- A regional development program for the Study area will be formulated together with the upgrading scenario of the Study road.
- Appropriate function and structure of the Study road will be considered at each stage of the regional development program,.
- Appropriate share of the transport mode between road and railway will be considered in the future traffic demand analysis.

Based on the aforementioned approach, the Study will be conducted according to the following steps:

1) To analyze the background and present situation of the natural and socio-economic environments;

2) To analyze the present and future relevant development plans within the area of influence of the Study Road;
3) To examine and formulate suitable pilot project plans and to execute them;
4) To conduct the preliminary design of the road;
5) To examine the feasibility of high-priority road improvement projects and to prepare an implementation plan for the projects with the highest priority.

The Study flow chart is as shown in Figure 1.5.1 below.

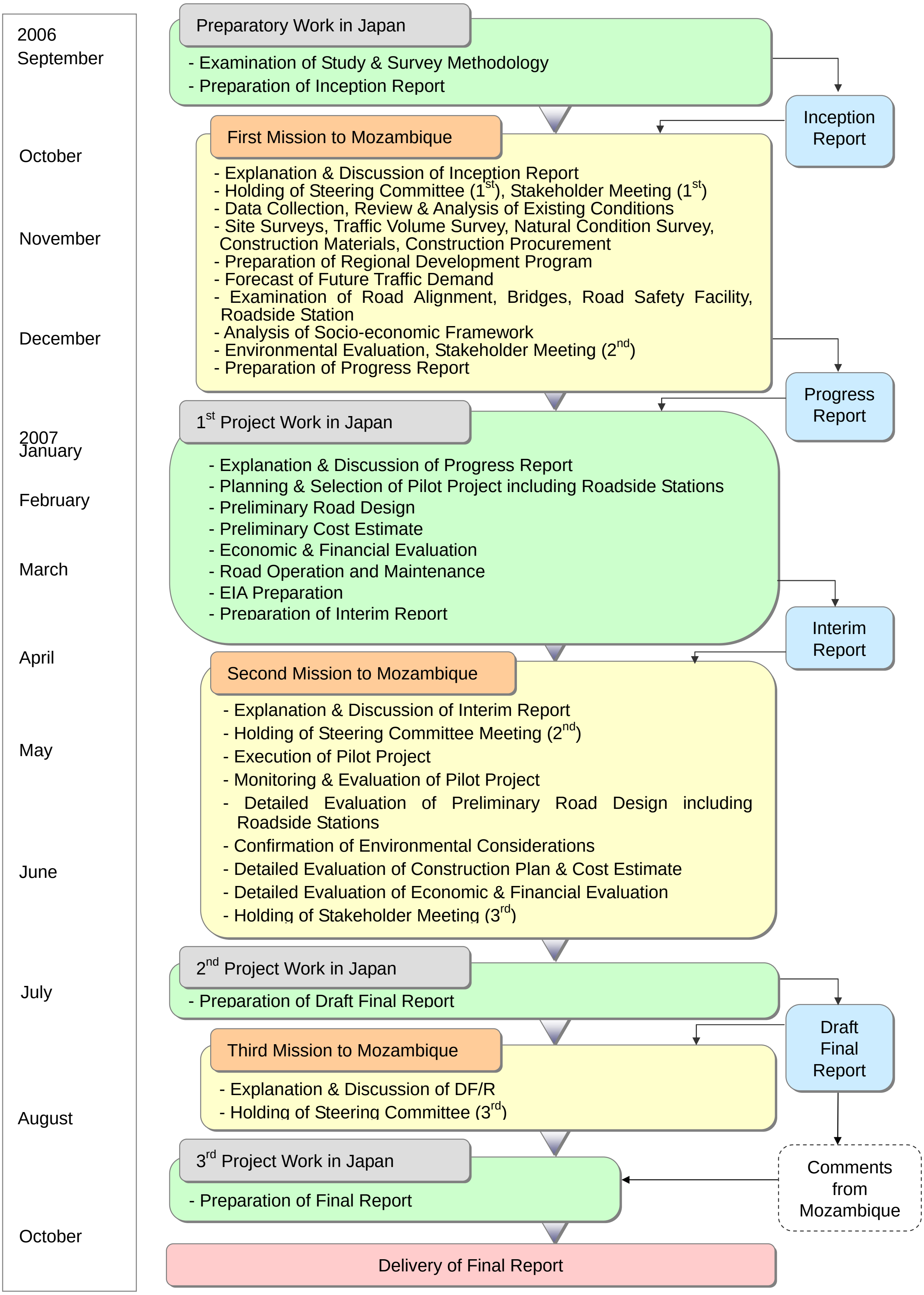


Figure 1.5.1 Study Flow

1.6 Study Implementation

(1) Study Organization

Through discussions with ANE, the Study is carried out jointly by ANE and the JICA Study Team. The relationship between these institutions is as shown in Figure 1.6.1 below.

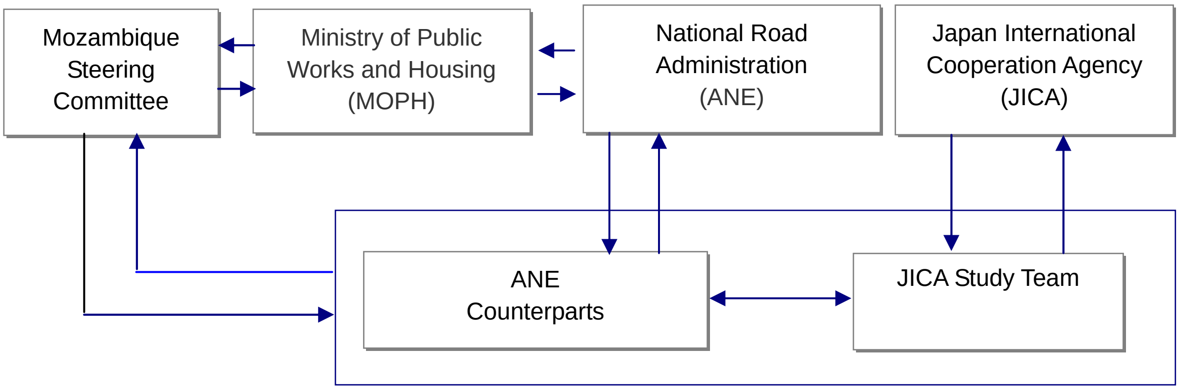


Figure 1.6.1 Organization Chart for the Study

ANE, as the agency responsible for management of the national and regional road network, acts as the counterpart agency to the Study Team and also as a coordinating body in relation to other government/non-government organizations concerned for the smooth implementation of the Study.

A Steering Committee was set up in order to conduct the Study efficiently and effectively as well as to check the appropriateness of the Study results. The committee comprises the ministries and organizations concerned listed below. The chairperson of the committee was the Director of the Road Advisory and Supervisory Office (GAS) of the Ministry of Public Works and Housing.

- Ministry of Public Works and Housing (MOPH)
- Ministry of Transport and Communications (MTC)
- Ministry for Coordination of Environmental Affairs (MICOA)
- Ministry of Agriculture (MINAG)
- Road Fund (FE)
- National Administration of Roads (ANE)

(2) Report Submission

The following is a list of the reports to be prepared and submitted by the Study Team to ANE. All reports are to be written in Portuguese and English.

1) **Inception Report (15 copies in Portuguese & 10 copies in English)**
This report was submitted at the commencement of the Study and described the overall approach and implementation program of the Study.

2) **Progress Report (15 copies in Portuguese & 10 copies in English)**
This report was submitted at the end of December 2006 and contains mainly the results of the literature review and the analysis of the data and information collected regarding the present status of the road network and regional development.

3) **Interim Report (15 copies in Portuguese & 10 copies in English)**
This report was submitted at the beginning of March 2007 and contains mainly the preliminary design results of possible road improvement alternatives for examination in the Feasibility Study together with the plans and the selection of pilot projects for regional development

4) **Draft Final Report (15 copies in Portuguese & 10 copies in English)**
This report was submitted by the end of August 2007 and contains all the Study results. Written comments from the GOM on the Draft Final Report were given to JICA Mozambique Office within one (1) month after submission of the report.

5) **Final Report (20 copies in Portuguese & 20 copies in English)**
This report took into consideration the written comments of the GOM concerning the Draft Final Report and was submitted by the end of November 2007 after receiving these comments.

PART 2:

GENERAL APPRECIATION

Chapter 1 Road System

PART 2: GENERAL APPRECIATION

Chapter 1 Road System

1.1 Overview of National Development Plan and Road Sector Development Plan

1.1.1 The Action Plan for the Reduction of Absolute Poverty (PARPA)

PARPA (2001-2005) was the first country Poverty Reduction Strategy Paper (PRSP) to combat absolute poverty in Mozambique. It contained main objectives for reducing poverty and the key actions to be implemented. The main objective of PARPA was to reduce the incident of absolute poverty from 70% in 1997 to less than 60% by 2005. This was to be achieved through economic growth (targeted an annual GDP growth of 8%), capacity development and expanding the opportunities for the poor. Based on this main strategy, PARPA focused on six areas: (i) education, (ii) health, (iii) agriculture and rural development, (iv) basic infrastructure, (v) good governance, and (vi) macro-economic and financial management.

The focus on basic infrastructure, through the road network improvement,. was expected to significantly impact on the livelihood of rural communities that make up the vast majority of the population. It aimed at achieving the following outcomes:

- ***Supporting Markets***: To contribute to the expansion of markets, in particular in the agricultural sector;
- ***District Access***: To ensure access to districts with the greatest economic potential, focusing on provinces with high population densities and high concentration of poverty;
- ***Connectivity***: To establish connectivity between the major regions of the country and to develop the main corridors;
- ***Decentralization***: To improve the capacity at the provincial and district level for the management and prioritization of roads works; and
- ***Quality of Works***: To improve the quality of the roads works, including construction, rehabilitation and maintenance. Providing more employment opportunities for the rural population.

Through the Survey of Family Units (2002-03) and the Demographic and Health Survey, it was confirmed that the main target of reducing the absolute poverty incidence to 60% by 2005 was largely achieved (54% in 2003).

1.1.2 The Action Plan for the Reduction of Absolute Poverty (PARPA II)

As a successor to PARPA (2001-2005), the GOM has started to implement PARPA II for the period 2006-2009, which is intended to reduce the incidence of absolute poverty from 54 percent in 2003 to 45 percent in 2009. It followed the same 6 priorities of interventions as defined in PARPA. However, priorities in PARPA II have shifted to greater integration of the national economy and an increase in productivity. In particular, PARPA II pays more attention to district-based development, creation of an enabling environment for the productive sector, improvement of the financial system, measures to help small and medium-size companies and the development of both the internal revenue collection system and the methods of allocating budgeted funds. Although PARPA II calls for an increase in internal revenues in real terms, it still expects to continue to rely on the contribution of foreign donors to finance about 49 percent of the State Budget every year during the period.

For these purposes, PARPA II formulated three pillars, comprising good governance, investing in human capital and economic development.

Governance: this seeks to make the apparatus of the State as a means of sparking the development of human capital and the economy. The GOM will pay special attention to improving the quality of policy analysis and design, in order to fully obtain the expected results of their implementation. Officials will be guided by the principles and laws ruled by the government to ensure transparency and accountability and to combat diversion and improper use of public funds and resources. It will also include active enforcement of the laws against criminal acts and corruption.

Human capital: this pillar provides continuity to developing work-related technical and scientific skills, good health and hygiene, and access to basic resources—especially food and water. It also aims to reduce the incidence of diseases that affect the most vulnerable population groups, focusing particularly on the battle against HIV/AIDS, malaria and tuberculosis. A special part of the resources in the state budget will be used to finance the classic social services that provide basic needs mentioned above in the area covering a huge proportion of the population including the poorest.

Economic development: this concentrates on providing the basic conditions to facilitate increased productivity. Such basic conditions refer to the improvement in infrastructure that promote the creation of wealth, ensure the availability of natural resources, a reduction in bureaucratic obstacles, and the enactment of legislation that safeguards citizen rights and encourages gains in productivity, and innovation. It will also give priority to inter-sectoral coordination in order to ensure higher productivity in agriculture and related sectors. Additional priorities are the development of the banking and financial sector so that they may fulfill their duties in retention of savings and active financing of production, particularly production by small and medium-sized companies.

The improvement of the transportation system is part of the third pillar of *economic development* through improved connections between cities and provinces. The rehabilitation and maintenance of roads and bridges will be also continued in order to improve the mobility and reduce vehicle operating costs (VOCs).

1.1.3 Road Sector Policy

Mozambique's transport sector is governed by the following road sector policies and strategies:

- Road Sector Strategy 2007-2011 (RSS)
- Roads and Bridges Management and Maintenance Program (Roads III)
- PRISE 2007-2009 (The second phase of the Roads III Program)

1) The Road Strategy 2007-2011 (RSS)

The Road Sector Strategy 2007-2011 (RSS) presents the main elements of the Government of Mozambique's (GOM's) strategy for developing and managing the classified road network. The RSS adds a level of detail to the GOM's Road Sector Policy to establish the main principles, approaches, and activities that will be followed during the 10-year long Roads-III program.

The Road Sector Policy aims at achieving the following objectives through the improvement of the road network:

- ***National Integration***: Better roads contribute to the reduction of regional differences and to the building of national unity through integration of heretofore less-favoured and more vulnerable populations.

- ***Strategic Asset***: Better roads bolster Mozambique's strategic geographical location as an essential transit corridor for its landlocked neighbours, facilitating their access to international markets.
- ***Economic Growth***: Better roads stimulate economic growth by reducing transportation costs and providing access to markets. They facilitate increased commercialisation of agricultural commodities by helping to ensure reliable delivery of inputs and timely marketing of production at competitive cost.
- ***Poverty Reduction and Social Development***: Better roads provide access to employment opportunities, schools, health-care facilities, and other social services, which are currently difficult to access for large segments of the population.

A main goal of the RSS is to serve the prioritised economic areas that have the greatest potential to contribute to economic growth such as agricultural areas, tourist sites and areas of industrial or natural-resource development.

The main objectives of the RSS are to preserve assets, enhance transitability and improve the maintenance coverage. These objectives complement the main principles elaborated in the original IRSS: sustainability, connectivity, and accessibility. ***The RSS also prioritizes roads providing access to Mozambican ports and to international border crossings, thereby contributing to investment in international transportation services***. Priority in this category include the existing corridors of Maputo, Beira, ***Nacala*** and Tete, as well as a proposed new corridor, linking Malawi to the Port of Quelimane through the border town of Milange.

Improving the secondary and tertiary road network is also a main target of the RSS. It is expected to provide economic opportunities to rural populations. Since these roads have low traffic volumes, their rehabilitation can be justified using low-cost labour-intensive construction and maintenance methods. Such methods have proved very effective under the previous Feeder Roads Programme and have the added advantage of generating employment opportunity to the rural poor. Furthermore, The upgrading of a coherent regional road network would promote decentralized decision-making through improved mobility.

The RSS is prepared for a 5-year horizon (2007-2011) and includes the strategic plans for investment, maintenance and financing mechanisms. It will be reviewed and revised in 3 years' time when preparing for the Phase 3 of the Roads-III program.

2) Road III Program (2002-2011)

The Roads and Bridges Management and Maintenance Program (Roads III) started in August 2002 as a ten-year long-term implementation program in three phases. The Roads III was formulated in light of the Government's road sector policies (e.g Road Strategy) and to achieve the above described objectives in a sustainable manner by prioritising maintenance and by ensuring the required funding for maintenance of all rehabilitated and reconstructed roads through road-user charges. The proposed program is expected to significantly improve the condition of the country's road network.

The first phase of the Program (Phase I) consisted of four project components over a four years period. Phase I focused on implementation of routine maintenance of the entire "maintainable" network funded exclusively by the Road Fund, periodic maintenance and urgent rehabilitation of paved and unpaved roads, conducting institutional and policy reforms, and completing preparations for the long-term investment program. Phases II and III (three years each) subsequently focus on periodic maintenance and rehabilitating of priority roads and bridges; strengthening road management capacity; and initiating a long-term road safety improvement program.

1.1.4 PRISE

The specific objective of the Integrated Road Sector Program (PRISE 2007-2009) is to establish a sector-wide approach for the road sector that incorporates a coherent Mozambican owned and led roads program in a comprehensive and coordinated manner. Under PRISE 2007-2009, sector planning, finance, implementation, monitoring and evaluation is fully integrated.

The program was developed to be in line with the priorities and objectives of the Government of Mozambique Road Sector Policy, PARPA, Medium Term Expenditure Framework (MTEF), and Road Sector Strategy (RSS). PRISE will enable the GOM to guide the road sector and monitor its performance to ensure that it supports the Government's main objectives of poverty reduction and balanced economic development. It will also facilitate managing sector expenditures and intersectoral balance by bringing all activities on-budget.

Under PRISE, all funding for the road sector supports a single sector policy and expenditure program under Government leadership while adopting common approaches across the sector, eventually progressing towards full reliance on GOM procedures to disburse and account for all funds.

The sector-wide approach under PRISE will foster stronger country ownership and leadership of the road sector. It will also facilitate coordinated and open policy dialogue for the entire sector, involving the key GOM agents (MOPH, ANE, Road Fund, and various stakeholders) and the sector's financial partners (RSD).

Support for PRISE 2007-2009 from donors takes the form of project financing, program funding, and sector budget support (SBS). RSD financial support for the sector will shift from parallel project and program support to increased SBS over the medium term. Donors have agreed to harmonize, to the extent possible, their own processes for appraisal, programming, review, monitoring and evaluation. All donors have agreed in principle to support the goals and priorities of PRISE.

As part of PRISE, a detailed set of plans is prepared for the period 2007 – 2009 under the Project Implementation Plan (PIP 2007-2009). The PIP includes detailed programs of works (surface type, investment and maintenance, national and provincial) and sector support activities (road sector planning and management, capacity building, road safety, and axle road control).

1.2 Road System

1.2.1 Road Classification and Current Road Conditions

1) Current Road Classification System

In recognition of the need for reclassification of the road network, the GOM approved Decree 50/2000 in December 2000, which defined a new road classification system. The decree stipulates four new road classes and gives broad classification criteria for the determination of roads in these classes. The new road classification system is summarized in Table 1.2.1. The classified roads consist of national roads (primary and secondary) and regional roads (tertiary and vicinal roads). These roads are administrated by ANE. Urban roads and unclassified roads fall under the jurisdiction of respectively the municipal councils and the district administrations.

Table 1.2.1 New Road Classification System

Categorization	Designation	Functional Definition	Numbering
National Roads	Primary Roads	Form the national trunk road network and link: • Provincial capitals • Provincial capitals and other cities • Provincial capitals and main ports • Provincial capitals and important border posts	(a): N1 to N100 (b): N101 to N199
	Secondary Roads	Form the secondary network complementing the trunk road network and link: • Primary roads • Provincial capitals and sea or river ports • Primary roads and economic poles of high importance • Primary roads and (other) border posts	N200 to N399
Regional Roads	Tertiary Roads	Tertiary roads link: • Secondary roads with primary roads or with other secondary roads • District centres • District centres and administrative posts • District centres and economic poles of high importance	R400 to R799
	Vicinal Roads	Vicinal roads link: • Tertiary roads • Administrative posts • Administrative posts and other population centres	R800 onwards

(a): Roads that constitute major routes
(b): Other primary roads

Source: Final Report on the Reclassification of the Mozambique Road Network, 2003

2) Re-classification of Road Network

In 2003, SIDA financed a study on “the Reclassification of the Mozambique Road Network” in order to apply the new classification system. This study reviewed the classification of all roads through a participatory process involving the main stakeholders. Table 1.2.2 presents the road length by road class and province as a result of the re-classification exercise.

Table 1.2.2 Reclassified Road Network

Province	Primary	Secondary	Tertiary	Vicinal	Total reclassified	Non-classified	Total
Maputo	323	169	557	547	1,596	163	1,759
Gaza	276	690	1032	529	2,527	491	3,018
Inhambane	558	265	1140	930	2,893	643	3,536
Manica	513	336	960	628	2,437	301	2,738
Sofala	584	554	847	389	2,374	207	2,581
Tete	530	1186	823	392	2,931	813	3,744
Zambezia	1,001	698	1,567	971	4,231	728	4,965
Nampula	996	165	1,982	962	4,060	788	4,893
Niassa	675	337	1,608	824	3,445	501	3,946
Cabo Delgado	414	392	1,620	371	2,797	355	3,152
Total (km)	**5,870**	**4,792**	**12,136**	**6,543**	**29,341**	**4,990**	**34,332**
Share(%)	**17.1**	**14.0**	**35.3**	**19.1**	**(85.5)**	**14.5**	**100.0**

Source: ANE (2004)

3) Current Road Conditions

Table 1.2.3 shows the surface type by road class. Although it seems that upgrading work of the primary roads has progressed well, it is noticeable that a vast majority (81.9%) of the road network is still unpaved.

Table 1.2.3 Reclassified Road Network per Surface Type (km)

Surface	Primary	Secondary	Tertiary	Vicinal	Total
Paved	3,853 (65.6%)	840 (17.5%)	581 (4.8%)	30 (0.5%)	5,304 (18.1%)
Unpaved	2,017 (34.4%)	3,952 (72.5%)	11,555 (95.2%)	6,513 (99.5%)	24,037 (81.9%)

Source: ANE (2004)

Table 1.2.4 presents the latest data on road condition of the entire network. Road surface conditions have improved in recent years due to frequent maintenance activities. For instance, the condition of the paved road has improved from 38% in 2000 to 65% in 2006.

Table 1.2.4 Latest Road Condition

Surface	Good	Fair	Poor	Total
Paved	65%	23%	12%	100%
Unpaved	17%	35%	48%	100%

Source: RSS 2007-11(2006)

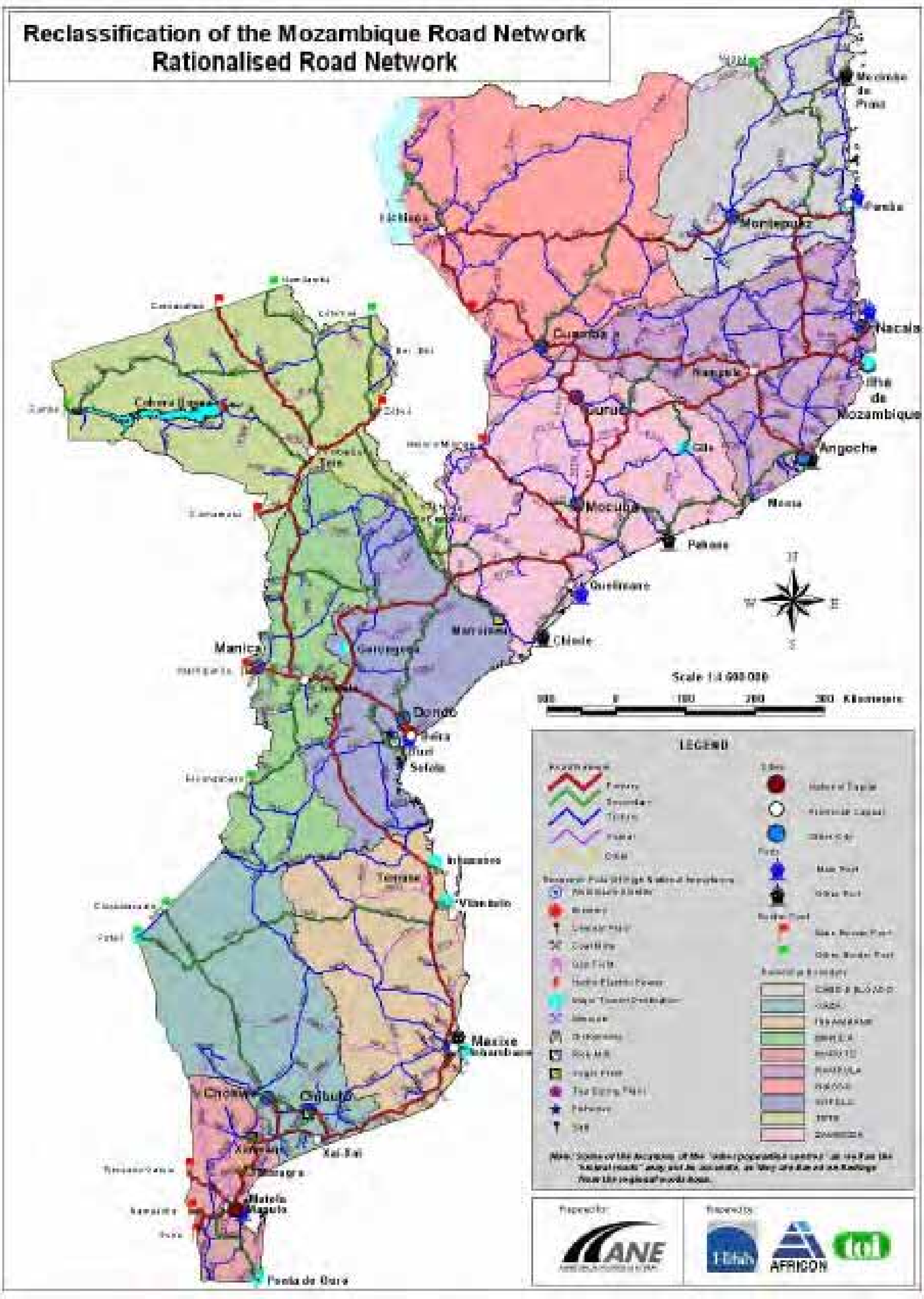


Figure 1.2.1 Mozambique Reclassified Road Network

1.2.2 Right of Way (ROW)

The Study Road (N13) is classified as a primary road. The Right of Way (ROW) for a primary road is based on the following laws:

- Relevant Law: Land Law (1 October, 1997)
- Relevant Article: Chapter II Article 8 Partial Protection Zone

The ROW for primary roads is required to be to a width of 30m outside the road shoulder on each side.

It stipulates:

The following are considered partial protection zones;

(g) The land occupied by motorways and four lane highways, aerial, surface, underground and underwater installation and conduits for electricity, telecommunication, petroleum, gas, and water, including a bordering strip of 50 meters on each side, as well as, the land occupied by roads including a bordering strip of 30 meters for primary roads and 15meters for secondary and tertiary roads;

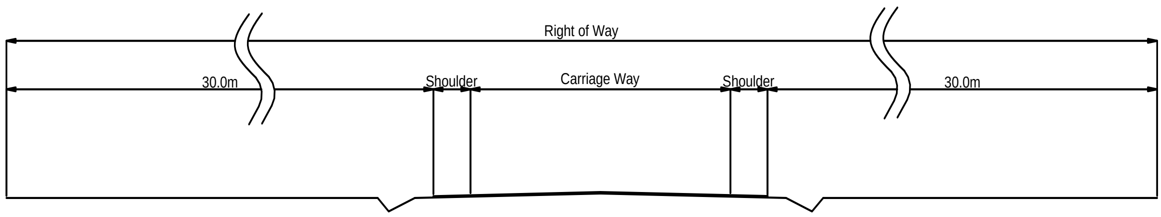


Figure 1.2.2 Standard Right of Way for a Primary Road

The details of Land Law and Land Acquisition are described in chapter 5.1.2. Land Law.

1.3 Other Transport Systems

1.3.1 Transportation Mode

Mozambique has a coastline of approximately 2,700 km with the three (3) principal seaports being Maputo, Beira and Nacala. It has thirteen (13) smaller ports for coastal shipping. There are a further three (3) railway lines located around Maputo/Matola, Beira and Nacala operated under the Mozambique Railway Authority (CFM). There are nineteen (19) airports of which seven (7) are principal.

The seven (7) principal airports are at Maputo, Beira, Nampula, Tete, Lichinga, Pemba and Quelimane. A 310-km oil pipeline links Beira to Zimbabwe through the border town of Machipanda. Mozambique also has a pipeline that links the gas exploration fields in Pande (Inhambane) to the refineries in South Africa.

However, road transport is the only mode of transport in Mozambique that reaches the most remote areas of the country and that serves the widest variety of users.

1.3.2 Traffic Modal Split

Table 1.3.1 shows the traffic modal split for both goods and passenger transportation in Mozambique. In general, the road mode occupies a large share of both freight (46.8%) and passenger transport (97.2%) among all modes, particularly for passenger transport which is almost totally reliant on the road network. On the other hand at 34.1%., contribution of the railway mode is relatively high for the freight transport The marine transportation (13.2%) also contributes towards transportation of freight. The air mode only shares low ratio for neither goods and passenger transport due to lower transport capacity.

Table 1.3.1 Traffic modal Split in Mozambique

Transportation		Road	Railway	Sea	Air	Pipeline
Goods (million TKM)	2004	950.7 (42.3%)	760.6 (33.8%)	279.1 (12.4%)	9.3 (0.4%)	248.3 (11.0%)
	2005	1,048.8 (46.8%)	762.8 (34.1%)	295.6 (13.2%)	7.4 (0.3%)	125.4 (5.6%)
Passenger (million PKM)	2004	20,906.2 (97.2%)	106.0 (0.5%)	29.8 (0.1%)	467.5 (2.2%)	-
	2005	23,909.7 (97.2%)	172.2 (0.7%)	18.5 (0.1%)	504.5 (2.1%)	-

Source: Statistical Yearbook

1.3.3 Railways (CFM)

As said before, there are three (3) railway lines operating in the Maputo/Matola area linking towards South Africa and Zimbabwe. There are a further two lines in Beira linking to Zimbabwe and the coal mines of Moatize. Finally, there is a railway line running along the Nacala corridor linking to Malawi. These railways are operating under de Mozambique Railway Authority, a semi-autonomous government organization under the Ministry of Transport and Communication. The Nacala railway, which runs through the Study area, has been operated and managed under the concession of the CFM-North and the Railroad Development Corporation (RDC).

As shown in Figure 1.3.1, the Nacala Railway connects the Central East African Railway (CEAR) at the Malawi border (Entre-Lagos) and provides a port access from landlocked states such as Malawi.

- The Nacala – Cuamba – Entre-Lagos line, 610km, to the border of Malawi, fully rehabilitated in 1996
- The Cuamba – Lichinga Line, 262km
- The Lumbo – Monapo line, 42km, and operation has been suspended, requires repair works for re-opening.

Source: www.pmaesa.org/mozambique

Figure 1.3.1 Nacala Railway Network

Table 1.3.2 shows the past trend of freight transportation by CFM North. The Nacala railway line has been mainly utilized for international transportation of goods from and to Malawi and to a much lesser extend for internal purpose (the average transport distance shows similarity to the distance between Nacala and the Malawi border). However, its trend has been stagnant in the past 5 years. It appears that demand of trade to and from Malawi through the Nacala Port has not increased. Hence, the existing capacity of the port and railway have not been sufficiently utilized.

Table 1.3.2 Past Records of Goods Transportation by the CFM North

	Y1999	Y2000	Y2001	Y2002	Y2003	Y2004	Y2005
1. by tonne							
(1)National (10^3ton)	65.0	122.7	89.4	67.0	57.0	54.8	N/A
(2) International (10^3ton)	167.0	228.0	272.5	279.4	230.0	217.0	N/A
South Africa (10^3ton)	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Zimbabwe (10^3ton)	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Suaziland (10^3ton)	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Malawi (10^3ton)	167.0	227.9	272.6	279.4	230.0	N/A	N/A
Zambia (10^3ton)	0.0	0.0	0.0	0.0	0.0	N/A	N/A
Total (10^3ton)	232.0	350.7	361.9	346.4	287.0	271.8	217.5
2. by ton-km							
(1)National (10^6ton-km)	19.8	32.4	23.8	20.8	N/A	N/A	22.3
(2)International (10^6ton-km)	96.7	116.4	162.2	161.7	N/A	N/A	100.9
Total (10^6ton-km)	116.5	148.9	186.4	182.5	162.1	172.4	123.2
Average Distance (km)	503.0	N/A	515.0	526.8	564.8	575.6	566.4

Source: Statistical Yearbook

On the one hand, Table 1.3.3 shows the trend of passenger transportation by the Nacala Railway Line. The numbers of passenger transportation has fluctuated in the past 7 years. Although the Study Team has tried to investigate the causes, it has not been possible to obtain a satisfactory explanation from the CFM North. It is assumed that this is partially due to the fact that statistical data has not been collected in a well-organized manner and that the past records were not handed over to CFM when the railway institution was transferred in 2001.

Table 1.3.3 Past Record of Passenger Transportation by the CFM North

	Y1999	Y2000	Y2001	Y2002	Y2003	Y2004	Y2005
Passenger(10^3)	976.0	885.9	972.5	812.1	676.7	839.3	560.8
Passenger-km(10^6)	61.0	60.4	64.2	56.3	45.9	69.9	79.7
Average Distance (km)	63.0	68.1	66.0	69.3	67.8	83.3	142.1

Source: Statistical Yearbook

1.3.4 Marine Transportation

Mozambique has three (3) principal seaports at Maputo, Beira and Nacala. These ports have been operated by the Caminhos de Ferro de Mozambique (CFM) system as same as applied to the railway operation under concession contract with the MOG.

The Nacala port, which is located nearest to the Study Area, is the deepest natural port on the east coast of Africa. It also serves as a terminal for the Nacala Railway Line. Table 1.3.4 shows the handling capacities of each of Nacala, Beira and Quelimane ports for various types of facilities. The Nacala Port only has general cargo and container terminals with a capacity of 1 million tones and 0.6 million tones respectively. It has no facilities for petroleum and coal. This table further shows that the Beira Port has the highest capacity of the three Ports.

Table 1.3.4 Annual Capacity of Main Northern Ports in Mozambique (tons)

Type of facility	Beira	Nacala	Quelimane*
Petroleum Product	2,000,000	Not equipped	Not equipped
Coal	300,000	Not equipped	Not equipped
General Cargo	1,700,000	1,000,000	650,000
Containers	950,000	600,000	Not equipped

Source: www.pmaesa.org/mozambique and MOTC

Table 1.3.5 shows the operation fee for container loading and unloading as well as storage fee for containers after unloading or before loading at each of the seaport in northern Mozambique. The Nacala Port is less competitive than the other two seaports in terms of usage fees (e.g. 14% higher in operation fee for a 20Ft container). This difference will be considered in the analysis on vehicle operation costs for traffic demand forecast for the Study Road.

Table 1.3.5 Usage and Operation Fee for Each Port

Items	Unit	Beira		Nacala		Quelimane*	
		Container		Container		Container	
		40Ft	20Ft	40Ft	20Ft	40Ft	20Ft
Operation Fee	Mt	8450.33	4694.63	9477.00	5265.00	8424.00	4680.00
Until 7days	Mt/day	151.67	84.26	170.10	94.50	151.20	84.00
After 7days	Mt/day	260.00	144.48	291.70	162.00	256.20	144.00

Source: Interviewed from each port by the Study Team in 2007

Table 1.3.6 indicates the past trend of “throughput” by seaport and direction. The throughput can be defined as all freight volumes to be unloaded or loaded at a seaport. The Beira Port deals with approximately 3 times more freight, particular international, than Nacala Port. This is a result of the throughput capacity of the port. Compared to the Beira Port, Nacala Port has dealt more with domestic freight, and this trend has gradually increased in the past 8 years.It implies that the underdeveloped road network in the northern area still gives an advantage to marine transport.

Table 1.3.6 Past Record of Total Throughput (10^3tons)

		Y1999	Y2000	Y2001	Y2002	Y2003	Y2004	Y2005	Y2006
Beira Port	Domestic	N/A	N/A	N/A	74.3	44.1	60.5	38.5	30.1
	International	N/A	N/A	N/A	2687.5	2464.2	2214.7	2416.8	2586.0
	Total	2143.4	2185.5	2356.1	2761.8	2508.3	2275.2	2455.3	2616.1
Nacala Port	Domestic	N/A	N/A	N/A	111.1	106.9	94.5	72.6	78.4
	International	N/A	N/A	N/A	662.9	668.3	803.5	797.6	852.5
	Total	642.0	673.0	743.3	774.0	775.2	898.0	870.2	930.9

Source: www.pmaesa.org/mozambique and MOTC

Table 1.3.7 shows the trend of transit freight in the last 8 years. "Transit freight" can be defined as the freight volume deducted from the international throughput shown in Table 1.3.6 to ones of Mozambique origin and destination. From the table, it can be observed that trade to Malawi through the Nacala Port has decreased in recent years. On the contrary, international trade from domestic origins through Nacala Port has been steadily increased

Another major characteristic in Table1.3.7 is the significant increase (approximately 700% from 1999 to 2005) in trade from Malawi through the Beira Port, particularly, in the area of import trade. This implies a potential shift in trade from Beira to Nacala port once the Nacala Corridor is upgraded as an all-weather road.

Table 1.3.7 Past Record of Transit Freight (10^3tons)

		Y1999	Y2000	Y2001	Y2002	Y2003	Y2004	Y2005	Y2006
Beira Port	**Zimbabwe**	**1514.6**	**1494.9**	**1518.0**	**1590.5**	**1120.5**	**817.7**	**937.5**	**1010.2**
	Export	208.9	405.8	540.6	420.4	343.3	335.9	242.0	256.0
	Import	1305.7	1089.1	977.4	1170.1	777.2	481.8	695.5	754.2
	Malawi	**103.9**	**132.8**	**112.2**	**401.2**	**603.6**	**690.2**	**675.4**	**591.0**
	Export	60.0	92.1	25.0	106.9	110.0	179.0	162.0	118.9
	Import	43.9	40.7	87.2	294.3	493.6	511.2	513.4	472.1
	Zambia	**65.3**	**10.4**	**37.8**	**6.3**	**25.3**	**25.3**	**62.2**	**126.9**
	Export	51.6	7.8	33.6	0.0	0.1	1.8	13.9	32.5
	Import	13.7	2.6	4.2	6.3	25.2	23.5	48.3	94.4
	Others*	**N/A**	**N/A**	**N/A**	**0.1**	**0.4**	**1.0**	**14.3**	**7.3**
Nacala Port	**Malawi**	**230.7**	**220.8**	**274.6**	**256.4**	**179.1**	**175.2**	**181.8**	**111.7**
	Export	**N/A**	68.7	117.8	85.1	58.2	76.7	63.8	36.2
	Import	**N/A**	152.1	156.8	171.3	120.9	98.5	118.0	75.5

*There is no transit traffic through Quelimane

Source: www.pmaesa.org/mozambique and MOTC

1.4 Transportation Movement at Malawi Border

The Nacala Corridor is an east-west route connecting Mozambique with Zambia via Malawi. This corridor is very important for freight transportation between the three countries. It is the shortest route and as a result, the deep-sea port at Nacala in Mozambique acts as a main port for exports and imports from both countries.

Historically, the primary transport link along the Nacala Corridor has been the railway line linking eastern Zambia, central and southern Malawi, and northern Mozambique to the Port of Nacala. In the early 1980s, as much as 95% of Malawi's trade was routed through the ports of Beira and Nacala. During the civil war in Mozambique the Beira and Nacala routes were closed in 1983 and 1984 respectively. The insurgencies within Mozambique changed the fundamentals of transport significantly. Both Zambia and Malawi made a modal shift away from rail to road transport. Distances to seaports were substantially increased for both countries. Whereas Zambian goods moved through Dar-es-Salaam and South Africa, Malawi also shifted its principal transport mode to road, and moved its supply route via Tete to Zimbabwe and subsequently to the ports of South Africa.

Thus, the Nacala Corridor became an unattractive route for both countries until the civil war was over in 1993. Even after the civil war, the Corridor was not able to attract traffic from both countries until the major bridges on the route, which were collapsed during the war, were rehabilitated in the period between 1997 and 2002.

Table 1.4.1 shows the average daily traffic at the several crossing points to Malawi in 2004. This table shows that Malawi is still using the primary road through Tete for its international trade. The Zobue-Mwanza border between Tete province and Malawi has the highest traffic volume among the cross-border points into northern Mozambique.

Table 1.4.1 ADT and Revenue at Malawi Border

Border Post		ADT (2004)	Revenue Collected July 03 - June 04	Remarks
Mozambique Side	Malawi Side			
Zobue	Mwanza	983	US$ 1,140,626	Tete Road
Mandimba	Chipode	152	US$ 39,618	Nacala Corridor
Milange	Muloza	56	US$ 30,375	
Colomue	Dedza	50	US$ 20,332	
Vila Nova de Fronteira	Marka	12	N/A	

Source: Malawi National Road Authority

Table 1.4.2 shows types of export items from Malawi by seaport, which mainly comprises agricultural products. These agricultural products are exported through South Africa, mainly from Durban. Both Beira and Nacala ports are also utilized for this purpose but their shares are lower.

Table 1.4.2 Routing of Exports from Malawi in 2003 (10^3ton)

Route	Tobacco	Sugar	Tea	Cotton	Coffee	Food Crop	Other	Total	
								(10^3ton)	(%)
Dar es Salaam	-	-	-	-	-	-	-	0.0	0.0%
Beira	31.7	50.7	7.1	-	-	-	-	89.5	24.8%
Durban	77.7	-	18.1	-	3.1	-	13.4	112.3	31.2%
South Africa (Destination)	-	10.4	10.1	11.5	-	11.4	6.7	50.1	13.9%
Nacala	-	52.0	4.2	-	-	16.3	5.1	77.6	21.5%
Other Africa	-	16.9	2.5	-	-	4.9	6.7	31.0	8.6%
Total	109.4	130.0	42.0	11.5	3.1	32.6	31.9	360.5	100.0%

Source: Pre-feasibility Study for the Reopening of the Shire-Zambezi Waterway

Table 1.4.3 indicates the items imported to Malawi by seaport. The majority of import items enter through South Africa and the port of Durban. Both Beira and Nacala ports also contribute significantly to the volume imported to Malawi.

Table 1.4.3 Routing of Imports to Malawi in 2003 (10^3ton)

Route	Fuel	Fertilizer	Others	Total	
				(10^3ton)	(%)
Dar es Salaam	53.6	11.3		64.9	7.4
Beira	123.8	33.9		157.7	17.9
Durban			93.8	93.8	10.7
South Africa (Origin)		128.8	281.4	410.2	46.7
Nacala	28.8	52.0	71.5	152.3	17.3
Other Africa					0.0
Total	206.2	226.0	446.7	878.9	100.0

Source: Pre-feasibility Study for the Reopening of the Shire-Zambezi Waterway

On a summarizing note, statistical data shown in 1.3 demonstrate that the international trade of Malawi has been transported mainly through the South African ports, particularly Durban. The contribution of the Mozambican ports, comprising Beira and Nacala, is much less although still significant (30-40% at present). This would derive from the facts not only that the South African ports, especially Durban, have high standard facilities to berth ships for international trade than ones in Mozambique, but also that the Nacala Corrido has been recognized as anunstable and inefficient route to the Nacala Port.

Chapter 2 Capacity of Road Sector Institutions

Chapter 2 Capacity of Road Sector Institutions

2.1 Public Institutions Responsible for Roads and Transport

The road sector in Mozambique has been administrated by a number of government organizations, at national and provincial level. They are: the Ministry of Public Works and Housing (MOPH), the National Administration of Roads (ANE) and the Road Fund (FE) at national level, and the Municipal Councils and the District Administrations, at provincial level.

2.1.1 Ministry of Public Works and Housing

MOPH is the line Ministry to which government organizations (such as ANE and FE) connected to the road sector are subordinate. The objectives and functions of MOPH are defined in the presidential Decree no. 8/95. The relationship between MOPH and subordinate organizations is also defined in the road sector legislation. MOPH has responsibility to oversee the overall management of ANE, the development of sector policies, and the implementation of sector-programs by ANE.

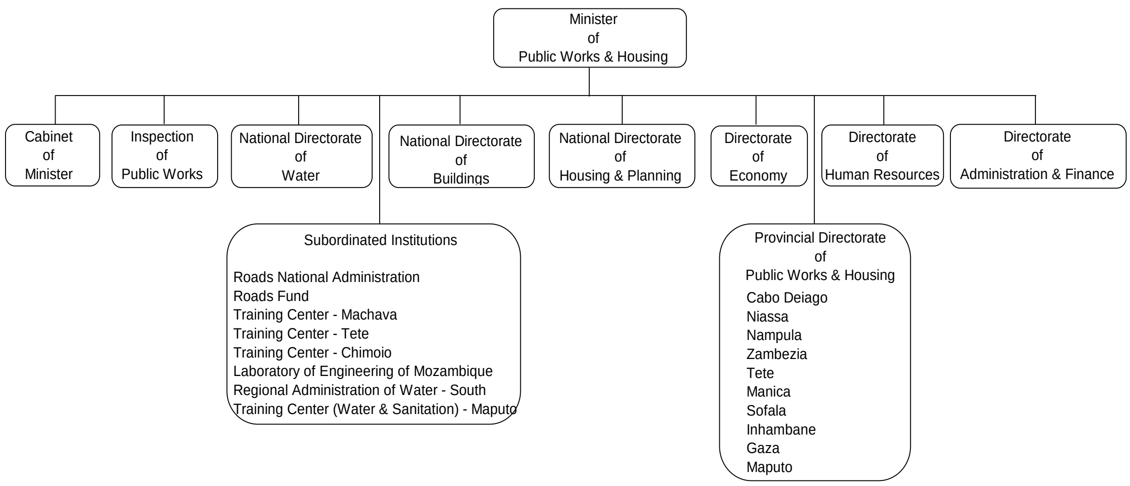


Figure 2.1.1 Organizational Chart of Ministry of Public Works and Housing

2.1.2 National Road Administration (ANE)

ANE was created at the end of 1999 by separating the former DNEP from MOPH and endowing it with an autonomous legal status. ANE is responsible to MOPH for implementation of the agreed road sector programs, including planning, design and supervision of construction, rehabilitation and maintenance of the road network. ANE is only responsible for both national and regional classified roads (primary, secondary and tertiary roads) and not for urban and district roads, which are under the jurisdiction of respectively the municipalities and district administrations. The main objectives of ANE comprises of:

- Coordinating national policies regarding the development and maintenance of the road networks at all levels.
- Executing the design, supervision, construction and maintenance works in the road sector by contracting these activities out to consulting engineering firms and contractors.
- Monitoring the execution of activities by contractors and consultants and approving payments.
- Supporting the provincial, municipal and district authorities in the management of the roads under their jurisdiction

ANE currently operates through the following three executive units as shown in Figure 2.1.2.

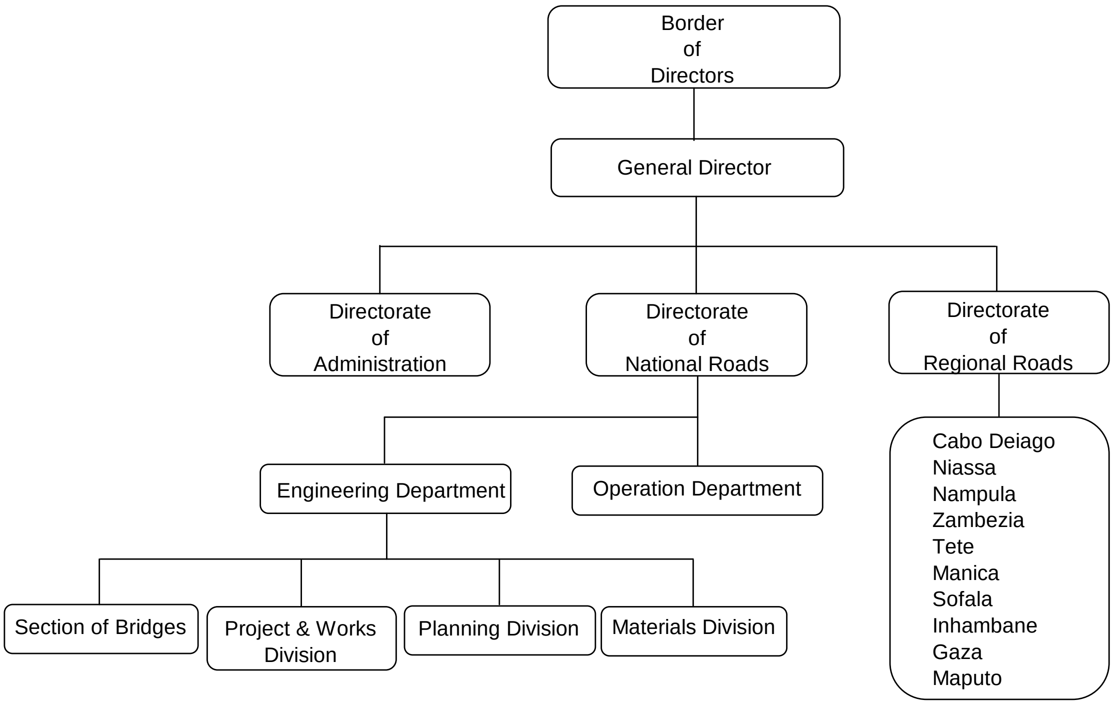


Figure 2.1.2 Organizational Chart of National Roads Administration

1) Directorate of National Roads (DEN)

DEN is the operational unit responsible for executing ANE's work program for National Roads. Under the road sector reforms, DEN is responsible for procuring and managing the contracts necessary for the execution of all major works on National Roads. Given the composition of the Roads III Program, DEN is responsible for the procurement of the majority of the design, construction and supervision services that will be required to implement the projects.

DEN's responsibilities include the planning, development, rehabilitation, construction, periodic maintenance and road-signing of national roads, for which it undertakes all necessary procurement and project management work. DEN also has responsibility for the control of the use of the road reserve, proposing updates of the classification of National Roads, budget preparation for work on National Roads and the formulation of proposals and implementation of actions for road concessions.

The functions of the Directorate of National Roads are summarized below:

- Planning — Overall network planning and reporting using the HNMS road management system, traffic and road condition data collection and budget preparation.
- Technical — Definition of design standards, procurement and management of studies, designs, construction and supervision services, monitoring of national road classification, development of new techniques for using available materials, monitoring and quality control issues.

2) Directorate of Regional Roads (DER)

The main function of DER is to implement routine maintenance of national roads, maintenance and rehabilitation of the regional road network and to assist the municipalities and districts in managing their road network The DER has a policy-making, coordinating, monitoring and advisory role for work carried by the provinces on Regional (Tertiary and Vicinal) Roads. DER coordinates and monitors planning, budget preparation and the execution of work carried out in the provinces by the ANE delegations. The DER also collates and compiles the annual budget submissions from the provinces for submission to the Road Fund. Although the responsibility for the execution of the work on Regional Roads will rest with the authorities at provincial level, it is important that the planning and management processes used at provincial level are standardized and coordinated.

All Regional Roads works will be structured within the client-consultant-contractor framework. The resulting functions of the Directorate of Regional Roads are summarized below:

- Planning — Dealing with overall planning, budget, reporting, monitoring and quality control issues

- Technical Dealing with road standards, monitoring of classification, input on contractor development issues, socio-economic issues, technology choice and current labour-based technologies for rehabilitation and maintenance

3) Directorate of Administration (DA)

The DA's functions are administration, internal resource management and procurement, personnel management and current expenses. The Directorate is also responsible for training programmes and work safety.

ANE's Social Issues Unit falls within the Directorate of Administration. This unit is responsible for providing expertise to ANE and other bodies in the road sector in the following areas:

- Initiatives to combat the spread of HIV / AIDS
- Monitoring of the impact of road projects and programs on poverty alleviation
- Promotion of equal employment opportunities for women in the road sector
- Environmental impact of roads

4) Major Issues on Capacity of ANE

The previous reports (RSS) pointed out some issues on the capacity of ANE as follows:

- Lack of strategic direction, leadership, management systems and procedures and high-level technical expertise in key areas
- Serious payment delays hindered the implementation of the project, which generally contribute to higher costs as well as would cause higher bidding prices considering its risk.
- The long procurement process causes a delay in commencement of the project.
- However, there is another view on the cause of the inefficient activities. The view described that there is insufficient delegation of authorities from MOPW to ANE and it causes a delay in decision making.
- Insufficient technical knowledge to conduct quality control on road materials and equipment particularly at the provincial level. Despite this situation, there is limited access to training facilities to promote their skills.

These issues have adversely affected both efficiency and effectiveness of the project implementation.

5) Organizational Reform of ANE

Given the preceding, the Road Sector Strategy requires further reform of ANE's institutional organization. The major objective of the reform is to separate financial and planning function and execution one, which means the separation of the Road Fund from ANE. In addition, the internal reform has been also under progress and the tentative new organization structure is shown in Figure 2.1.3. The re-organization aims at increasing organizational efficiency, ensuring timely decision making, and implementing a result-based management approach.

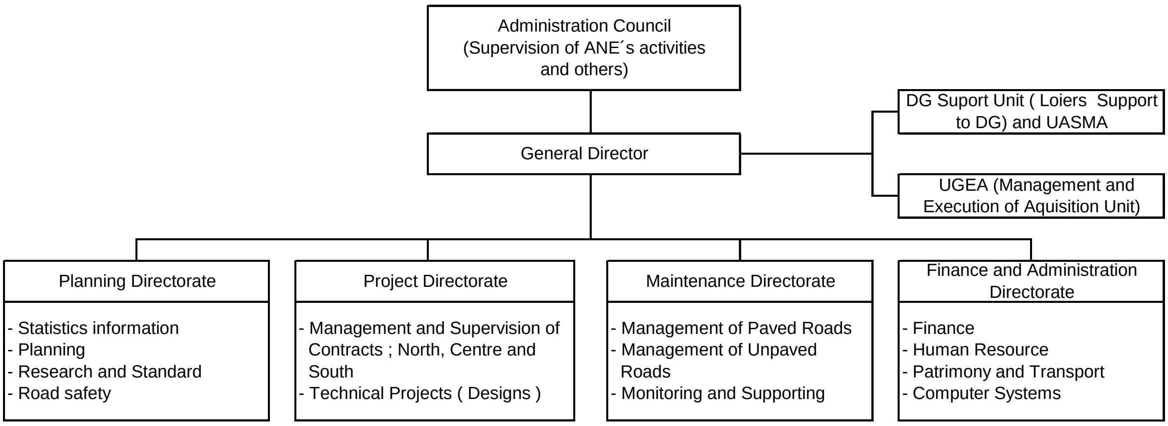


Figure 2.1.3 (1) New ANE Central Organization Chart (Tentative)

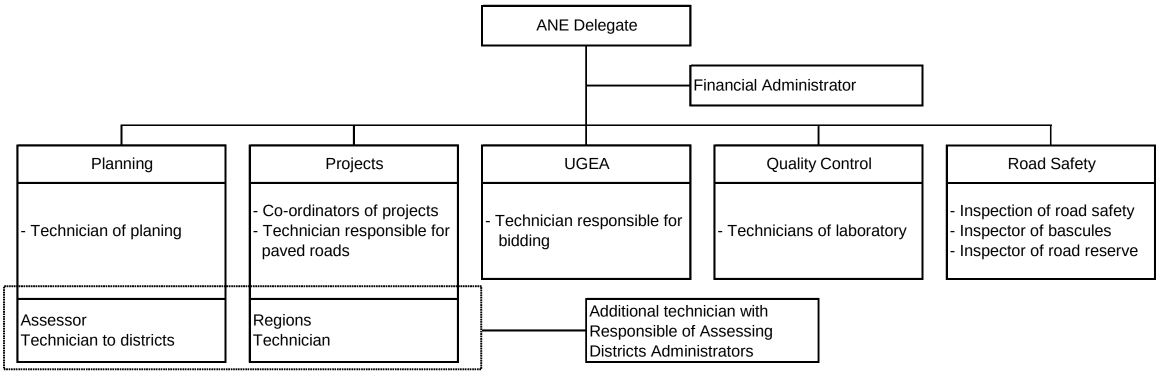


Figure 2.1.3 (2) New ANE Provincial Organization Chart (Tentative)

2.1.3 Road Fund

1) Major Activities of Road Fund

A Road Fund (formerly the Road and Bridges Maintenance Fund) was established in 1989 as an autonomous body to secure the fund of road maintenance. However, it was transferred under the supervision of the ANE Board in 1997 at the time when the road sector management reform was implemented. In the first phase of Roads III, the Road Fund was again separated from ANE as an autonomous legal entity.

The functions of the Road Fund are as follows;

- To ensure the timely collection of the funds
- To identify and propose new source of revenues
- To recommend funding for the road network development
- To recommend foreign funding for road projects
- To manage the financial resources intended for the road sector under the conditions set by the government
- To allocate resources for the maintenance of various classes of roads according to the contract plan with the government

The revenue of the Road Fund comprises three sources: the government budget; road user charges composed of traffic fines, border and other tolls, and fuel levy; and external sources. The fuel levy has still remained at the same level in 2002 (e.g. Mets 671 per little for petrol and Mets 1,460 for diesel), although Road III agreement specified. In 2004, US$ 77.3 million was allocated to the Road Fund. Table 2.1.1 shows the sources of Funds to the Road Fund in 2004. This table also indicates that the total revenue of the Fund has been rising because of an increase in both the fuel levy and donor funding. However, as mentioned before, the increase in the fuel levy derived from only the increase in the US$ value against Mets but not increase in the levy.

Table 2.1.1 Sources of Funds for the Road Fund (US$ Million)

Source	2002	2003	2004	Remarks
1. Government Investment	**Incl.below**	**Incl. below**	**4.2**	
2. Road User Charges	**27.3**	**41.9**	**47.7**	
- Fuel Levy	22.4	34.9	41.0	
- Toll Fees	4.9	7.0	6.6	
3. Donor Funding	**5.1**	**14.3**	**25.4**	
Total	**32.4**	**55.3**	**77.3**	

Source: Final Report, Review of Road Sector Strategy and Phase 2 Planning, 2005

However, the total revenue of the Road Fund is still insufficient to cover all routine and periodic road maintenance demands at present. According to the Review Report of RBMMP Implementation, it only fulfills approximately only 50% of the demand of both routine and periodic maintenance for all road network, which was proposed about US$145 million for this purpose.

The Road Sector Strategy now proposed the increase of the Road Fund revenue up to US$100 million by the end of the program, which would cover routine maintenance requirements by the user charge portion and periodic maintenance requirements by both user charge and donors funding. This increase of the revenue from the user charge is planned to seek for a rise in fuel levy.

2) Major Issues on Capacity of Road Fund

Some issues on the Road Fund have been pointed out in " Final Report on Review of Road Sector Strategy and Phase 2 Planning as follows;

- For the Road III implementation, the Road Sector Strategy anticipates that donors would fill the funding gap between the maintenance requirements and revenue from the local funding. However, donor's commitment has been insufficient and only some 50% of the planned amount were allocated from the donors. This fund shortage resulted in delay in implementation of Road IIII Phase 1.
- The revenue of the Road Fund still largely depends on support from donors for the Roads III implementation. Although the Road Sector Strategy is expected to increase the revenue from the user charge, a current upward trend of fuel prices makes it difficult to rise the fuel levy, which results in the higher fuel prices.
- The fuel levy has been paid into the Road Fund accounts via the Ministry of Finance, although this dedicated account was created by the MOF. In addition, the total amounts of the levy has not transferred to the Road Fund, which accounts for only 60% of the total.
- Funds for periodic maintenance were only paid 18% of the planned funds in2004 and this appears that the large amounts of the Road Fund monies were diverted to other purpose such as counterparts funds, payment of VAT and other emergency payments.

2.1.4 Municipalities

The numbers of cities and towns have municipal councils nationwide in Mozambique. As mentioned above, urban and district networks have been managed by those municipal councils but not ANE. They have technical departments with a wide range of capacities in terms of road management. By the government regulations, the councils receive funds from the central government for works on the road network and undertake procurement and contract management of the works. Since the municipal's technical capacities are insufficient to efficiently conduct those works, they have been receiving technical support from the Directorate of Regional Roads in ANE.

2.2 Private Sector Institutions

2.2.1 Contractors

The previous studies describe activities of both local and international contractors in the domestic markets. According to such reports, there is only wholly Mozambican contractor capable to execute road projects at the ICB basis but limiting value of 15 million per project, and other companies have capacity to undertake the project with approximately US$ 250,000 per year. Therefore, such small contractors can only participate in only minor works such as maintenance works.

Given the preceding and geographical advantages, South African contractors have been actively working in the domestic markets. In addition, international contractors from various countries, such as Portugal, Italy, Brazil, Demark, Zimbabwe, China and Japan, have been involved with road projects funded by international donors. Table 2.2.1 shows the list of major international contractors working in the Mozambique market.

Table 2.2.1 List of International Contractors Working in Domestic Market

Name of Contractor	Origin	Name of Contractor	Origin
WBHO	South Africa/Mozambique	Conduril	Portugal
Group 5	South Africa	CMC	Italy/Mozambique
Rumdel	Ditto	Astaldi	Italy
Tarcon	Zimbabwe	NCC	Demark/Swaziland
Tamega	Portugal/Mozambique	CNO	Brazil
Mota/Engil	Ditto	Syno Hydro Corp.	China
Teixeira Duarte	Portugal	CHICO	Ditto
OPCA	Ditto	Konoike Corp	Japan
Grinaker	Ditto	Dai Nippon Corp	Ditto

The previous studies (i.e. 2003 Technical Audit) indicated the weakness of local contractors as follows;

- Many contractors have limited financial capacity to procure equipment and materials and it makes difficult to expand their capacity and cause a delay of implementation.
- Staff of the local contractors have also insufficient skills and knowledge to execute the project at the required quality level.
- There is a lack of qualified experts in the domestic market including engineers and project managers.

Considering this situation, international donors recognized that the development of local contractors is a key factor in success of Road III program, the Program includes the capacity development components including strengthen the national contractor's association of EMPREMO.

2.2.2 Consulting Firms

The activities of domestic consulting firms are also in the similar situation of domestic contractors. Only several local consultants have been actively working for the road projects mainly with international consultants. Consultec, Ingerop Mocambique Lda, Projecta Lda, SEED Lda, and Tecnica Lda are major domestic consulting firms in the road sector.

Given this situation, many international consulting firms have been actively involved with road sector projects. Their origin includes South Africa, Zimbabwe, Germany, France, USA, UK, Portugal and Canada.
The domestic consulting firms have also facing to the similar issues of local contractors, a lack of human resources with qualified professional skills, and weak financial capacity of the firms. In addition, there is no institution that represents consulting firms in Mozambique at present. This fact seems to prove the weakness of domestic consulting firms in Mozambique.

2.2.3 Procurement Conditions for Material & Equipment for Road Works

(1) Materials

The availability of major materials for road works is summarized in Table 2.2.2. In general, whereas natural resources are locally available near the project sites, industrial produces shall be procured from mainly from South Africa.

Table 2.2.2 Availability of Construction Materials

Item	Locally available	To be imported	Remarks
Aggregate	○		Environment assessment will be required for new development
Sand	○		Environment assessment will be required for extraction from rivers
Borrow materials	○		Environment assessment will be required for new development
Cement	○		Cements necessary for concrete with high compressive strength shall be imported from South Africa
Bituminous materials		○	From South Africa
Reinforcement bar	○	○	Locally available but not large diameter and/or high strength
PC cable		○	From South Africa

Sand for concrete mixing is usually available from the rivers near the project sites. Borrow materials are usually available along the project roads. However, the necessity of an environmental impact assessment should be confirmed in both cases (sands and road building materials).

Only two firms, Cimentos de Mocambique and ARJ Group, have been producing cement in Mozambique. The former has three plants nationwide and its production dominant the local market (86% in 2002). However, the total production of two firms is far below the domestic demands of 800,000 tons and about a half of the demands are procured from other countries mainly South Africa.

Bituminous materials for paving and surfacing works and PC steel strand cables for bridge works are usually procured only from the international market, mainly South Africa. Although steel reinforcement bars are available both from local and international markets, re-bars with large diameters and/or high strength requirements are only procured from the international market.

(2) Construction Equipment

The number of construction equipment hire/lease companies in the local market is very limited and the capacity of such companies (e.g. type, number, spare parts accessibility and condition of equipment) is insufficient for large construction projects. Generally, international contractors import their own equipment for the projects.

2.3 Current Road Maintenance System

2.3.1 Routine Maintenance Works

Routine maintenance includes localized repairs (typically less than 150m in continuous length) of pavement and shoulder defects, and regular maintenance of road drainage, side slopes, verges and furniture. Actions include pothole patching, reshaping of side drains, repairing and cleaning of culverts and drains, vegetation control, dust control, erosion control, removal of sand from the road surface, repainting of road markings, repairing and replacing of road signs and guardrails and general roadside cleaning. Specific action for unpaved roads includes spot re-gravelling, dragging, shallow blading and dust control measures.

Routine maintenance has been implemented by the provinces, through the DPOPH (Provincial Directorate of Public Works and Housing) and provincial DEPs (Mozambique Government incorporated DEPs into ANE's Provincial delegations in April 2006). Planning for routine maintenance on the national roads will continue to be the responsibility of the Operation Department of ANE, with liaison undertaken by the ANE delegates. The ANE's delegations with assistance from DER will plan routine maintenance on the tertiary road network. Routine maintenance will increasingly be executed by contracts let out under competitive bidding. ECMEP, their labour brigades, and small contractors, are the main executing organizations. The funds for routine maintenance are recently financed entirely under the Road Fund.

2.3.2 Periodic Maintenance Works

Periodic maintenance includes full-width resurfacing or treatment of the existing pavement or roadway (including minor shape correction, surface patching and restoration of skid resistance) to maintain surface characteristics and structural integrity for continued serviceability. It includes localized repairs and reconstruction (typically less than 10 percent of total project length in sections of less than 250 meters in continuous length) and limited geometric improvements related to enhancement of traffic capacity, speed and safety but not structural strengthening. Specific actions include application of slurry seals, fog sprays, enrichment treatments, surface treatments (double or single); friction courses; thin asphalt surfacing typically 30mm or less in thickness and localised base reconstruction, vegetation control, repainting road markings, repairing and replacing road signs.

Periodic maintenance of unpaved roads includes full re-graveling to restore required surfacing thickness. It will also involve deep blading with re-profiling and/or re-compaction to reshape the road profile, reduce roughness, slow deterioration, improve riding quality and better drainage.

Whereas ANE/DEN is responsible for periodic maintenance of both primary and secondary roads, provincial DEPs has responsibility of these works for both tertiary and vicinal roads. These periodic maintenance works have been executed by local contractors under competitive bidding. Financing of periodic maintenance is in principle the responsibility of the Road Fund. However, since the local user charges can not cover the requirements of periodic maintenance, several donors has been supporting to provide funds for periodic maintenance.

2.3.3 Rehabilitation Works

Rehabilitation civil works involve full-width, full-length surfacing, with strengthening and shaping of existing pavements or roadways (including repair of minor drainage structures) to provide improved structural strength and integrity required for continued serviceability. Geometric improvements related to width, curvature of gradient of roadway, pavement, shoulders or structures, will be undertaken to increase traffic capacity, improve speed or increase safety. Where required this would include maintenance and/or provision of vehicle load control facilities. Specific actions include full base reconstruction, asphalt strengthening overlays, selective deep patching and overlays, granular base overlays and surfacing, surface treatment with major shape correction, recycling of one or more pavement layers.

Same as the periodic maintenance works, whereas ANE/DEN is responsible for rehabilitation works of both primary and secondary roads, provincial DEPs has responsibility of these works for both tertiary and vicinal roads. Since this kind of works require much project costs, contractors are usually procured at ICB basis under competitive bidding. These works are normally financed by the GOM or Donors but not the Road Fund.

2.4 Current Road Sector Investment Plan

2.4.1 Review of the Phase 1 of the Road III Program

(1) Review of Investment Plan for Phase 1 Program

The ten-year Program requires financing of US$ 1,700 million, of which approximately 25% (US$ 432 million) is to be provided through IDA Adjustable Program Loan (APL) Credits. The Road Fund will need to contribute approximately US$ 600 million towards routine and periodic maintenance of the road network. The remainder of the program is to be financed by other donors and by the GOM's investment budget.

The first phase of the Program (the Phase 1 Program) consists of three components: The first component of civil works includes routine maintenance, periodic maintenance, rehabilitation of roads and bridges, rural roads rehabilitation, emergency works, road safety and engineering services (design and supervision) for these works; The second component consists of institutional strengthening and support for policy reforms, including technical studies, technical assistance, training, and Project management support; The third component includes revisiting of the sector strategy and preparatory activities toward the next phase of the ten-year Program.

The four-year Phase 1 Program required US$ 703.6 million of financing, of which US$ 162.0 million is to be provided through an APL IDA credit (APL1). The Road Fund's contribution is US$ 197.8. Other donor financing of US$ 330.3 million and Government financing of US$ 13.5 million completes the financial plan.

Table 2.4.1 Project (Phase I) Financing

Component	Indicative Cost	GOM & Road Fund [b]	IDA	Other Donors
A. Civil Works				
1. Routine Maintenance	$50.3	$47.5	$0.0	$2.8
2. Periodic Maintenance	$224.1	$127.8	$38.1	$58.2
3. Rehabilitation	$240.0	$12.0	$55.8	$172.2
4. Rural Roads & Bridges	$69.0	$0.9	$17.3	$50.7
5. Emergency Works	$11.0	$0.3	$6.3	$4.4
6. Road Safety	$10.9	$0.3	$7.1	$3.6
7. Engineering Services	$44.6	$12.2	$12.8	$19.6
Total Civil Works	**$649.8**	**$201.0**	**$137.3**	**$311.5**
B. Institutional Strengthening				
1. Technical Studies	$11.5	$0.0	$4.8	$6.7
2. Expertise	$11.6	$0.0	$7.4	$4.2
3. Training	$5.2	$0.0	$2.7	$2.5
4. Support to Management	$1.9	$0.0	$1.9	$0.0
5. Operating Expenses	$10.3	$10.3	$0.0	$0.0
Total Institutional	**$40.5**	**$10.3**	**$16.8**	**$13.4**
C. Preparation for Phase II				
1. Strategy Formulation	$0.6	$0.0	$0.6	$0.0
2. Studies	$11.4	$0.0	$6.1	$5.3
Total Preparatory	**$12.0**	**$0.0**	**$6.7**	**$5.3**
D. PPF	$1.3	$0.0	$1.3	$0.0
Total Project	**$703.6**	**$211.3**	**$162.0**	**$330.3**

Note: All costs in million US$s.

Table 2.4.2 Phase 1 Program Components by Year

Project Cost by Component (APL-1)	2002	2003	2004	2005	Total
A. Roads & Bridges works					
1. Routine Maintenance	10.6	11.7	13.4	14.6	50.3
2. Periodic Maintenance	47.0	54.2	58.8	64.0	224.1
3. Rehabilitation	57.8	75.4	57.8	48.9	240.0
4. Rural Roads & Bridges	14.1	14.8	23.0	17.1	69.0
5. Emergency Works	2.6	2.7	2.8	2.9	11.0
6. Road Safety	1.3	4.0	4.4	1.1	10.9
7. Engineering Services	12.3	10.4	10.9	11.0	44.6
Subtotal Roads & Bridges works	**145.7**	**173.2**	**171.2**	**159.8**	**649.8**
B. Policy Reforms & Institutional Strengthening					
1. Technical Studies & Assistance	2.7	2.8	2.9	3.0	11.5
2. Expertise & Institutional Strengthening of ANE	3.1	2.9	2.7	2.8	11.6
3. Training	1.2	1.4	1.2	1.4	5.2
4. Support to Program & Project Management	0.3	0.6	0.6	0.3	1.9
5. ANE, DEPs & Road Fund Operating Expenses	2.3	2.5	2.7	2.9	10.3
Subtotal Policy Reform & Institutional Strengthening	**9.5**	**10.3**	**10.2**	**10.5**	**40.5**
C. Strategy formulation & preparatory activities					
1. Assistance for Strategy formulation			0.2	0.4	0.6
2. General and Technical Studies & Expertise				11.4	11.4
Subtotal Strategy formulation & preparatory activitiesPhase2			**0.2**	**11.8**	**12.0**
D. Project Preparation Studies (under PPF)	1.3				1.3
Total	**156.5**	**183.5**	**181.6**	**182.0**	**703.6**

Note: All costs in million US$s

However, the Phase 1 Program is behind schedule in terms of financing performance. Compared to the total US$ 703 million investment plan, only approximately US$540 million had been committed by both the GOM and donors, which accounts for only 77% of the total amount. In terms of maintenance funding, it reached approximately US$90millon in the revenue shortage on the Road Fund compared to the original plan up to the end of 2004. It was mainly derived from shortage of donor's contribution. In addition to the delay in disbursement, the Phase 1 Program had experienced several difficulties. Firstly, the considerable cost-over run has been observed on several civil works components. Secondly, there are some difficulties such as serious fund allocation delays, procurement delays and delay in administrative process.

(2) Review of Routine and Periodic Maintenance Works in Phase 1 Program

Table 2.4.3 shows the detailed plan for both routine and periodic maintenance works in the Phase 1. According to the plan, the total of 54,300km for routine maintenance and 7500 km for periodic maintenance of the road network are to be executed in four years.

During the Phase I Program, routine maintenance costs are to be entirely funded by the Road Fund. On the one hand, approximately 40% of periodic maintenance costs will be financed by donors. This share will decline to 25% and 15% during Phases II and III respectively, with the goal of increasing the Road Fund share to 100% by the end of Roads III.

Table 2.4.3 Annual Maintenance Programme: Routine and Periodic Maintenance

Year	2002	2003	2004	2005	Average Phase I	Total Phase I
Routine Maintenance Kms	12,840	13,335	13,834	14,343	13,588	54,352
Periodic Maintenance Kms	1,510	1,941	2,017	2,062	1,882	7,530
Routine Maintenance Costs [a]	$10.8	$11.6	$12.4	$13.3	$12.0	$48.2
Periodic Maintenance Costs [b]	$43.1	$55.3	$57.1	$54.9	$52.6	$210.3
Total Maintenance Costs	$53.9	$66.9	$69.5	$68.2	$64.6	$258.5

Note: Costs in US$ millions.
a. Includes physical contingencies of 8% and price contingencies of 6.2% per annum
b. Includes physical contingencies of 8% and price contingencies of 5.0% per annum

However, achievement of maintenance works shows contrast between the routine and periodic. The funds for routine maintenance equaled or exceeded the planed amounts and the reported total length for routine maintenance is slightly shorter than the targeted. By contrast, the targets of periodic maintenance could not achieve. It only reached 18% of the planned funds and 9% of the targeted road length by 2003. The Review of Road Sector Strategy and Phase 2 Planning analyzed that shortage of the actual funding from donors for the first three years maybe a major cause of it.

The said report also summarized technical issues on maintenance activities as follows;

- The repair of potholes have not been included in many routine maintenance contracts in several provinces due to considerably increase in contract costs and lack of good quality materials.
- Delays in periodic maintenance works have caused more expensive interventions earlier than necessary as well have resulted in costly routine maintenance works.
- At provincial level, there were the unavailability of good materials, constrains on the budget and the poor planning of maintenance due to the lack of routine maintenance management system.

2.4.2 Roads and Bridges Rehabilitation

There are 17 rehabilitation road works (excluding the rural roads component) that are planned for Phase I, as shown in Table 2.4.4. Sixteen of the road works are road rehabilitation and one project involves the rehabilitation of 14 bridges. Almost 2,500 kilometres of road are included with a total base cost of US$ 231 million. All but two of the road works are on the paved road network, with 10 primary roads and 6 secondary roads included. Regional distribution is assured since there is at least one project planned for each province, with only Sofala having as many as three projects. Nine of the road works, accounting for over 50% of the total length, are on the current or future EN1, demonstrating the importance given to this trunk road in the road sector strategy.

All rehabilitation road works in Phase I have secure financing, being jointly financed by donors and the GOM, with counterpart funds made available to the Road Fund from the Investment Budget. In addition to IDA, eight other donors are supporting rehabilitation road works. The counterpart share ranges from 0–20% depending on the donor, with average being around 4%.

Table 2.4.4 Rehabilitation Road Works for Phase 1

Road	Class	Surface	Length	Cost	Donor	Province
EN 231 Nampevo - Gurué	S	P	127	12.3	IDB	Zambezia
EN 8 Nampula - Nacala	P	P	199	19.3	EU	Nampula
EN 1 Maputo - Marracuene	P	P	30	8.2	IDA	Maputo
EN 242/106 Pemba - Montepuez	S	P	200	7.8	ADB	Cabo Delgado
EN 1 Maxixe - Cr. ER520/EN1	P	P	123	20.3	IDA	Inhambane
EN 206 Chissano - Chibuto	S	U	39	4.9	BADEA	Gaza
EN 223 Cr. EN 223/103 - Calomué	S	P	127	18.0	ADB	Tete
EN 7/104/232 Namacurra - Rio Ligonha	P	P	317	40.0	EU	Zambezia
EN 1 Cr. EN1/ER520 - Vilankulo	P	P	109	13.1	IDA	Inhambane
EN 102 Vanduzi - Changara	P	P	232	13.1	ADB	Manica
EN 1 Manhica - Incoluane	P	P	52	12.8	IDA	Maputo
EN 256/205 Chokwe - Lagoa Nova	S	P	128	6.9	OPEC	Gaza
EN 1 Inchope - Gorongosa	P	P	74	6.9	USAID	Sofala
EN 242 Litunde - Fr. Cabo Delgado	S	U	322	20.0	ASDI	Niassa
14 Bridges				14.0	JICA	National
EN 1 Rio Save - Muxungue	P	P	107	2.4	EU	Sofala
EN 1 Gorongosa - Caia	P	P	240	11.3	USAID	Sofala

Rural roads rehabilitation is actually part of an integrated program for supporting the improvement of regional roads, including civil works (routine and periodic maintenance in addition to the rehabilitation described here) and institutional strengthening at the provincial level, described later. The integrated strategy for regional roads elaborated by the Directorate of Regional Roads, DER. Support for rural roads is consistent with the road sector strategy of giving priority to roads that integrate zones of agricultural production to the national network. To that end, almost 60% of the rural roads rehabilitation funding is earmarked for road works to be identified at the provincial level.

Over 2,000 km of road are included with a total base cost of US$ 63 million planned for Phase I. All of the road works are on the unpaved road network. There are fifteen road works projects, covering nine provinces and involving 12 different donors, as shown in Table 2.4.5. Thirteen of the road works are road rehabilitation and two road works involve the rehabilitation of rural bridges.

All rural rehabilitation road works in Phase I have secure financing. In all cases, except for the five IDA supported road works, donor funding is 100% and in the form of grants.

Table 2.4.5 Rural Roads Rehabilitation Road Works

Road	Class	Surface	Length	Cost	IRR	Donor	Province
ER 405 Fr. Maputo - Chokwe	T	U	31	0.6	58%	IDA	Gaza
ER 555 Estima - Magoe	T	U	123	2.4	47%	IDA	Tete
EN 239 Nametil - Cr. EN239/260	S	U	76	4.9	43%	IDA	Nampula
ER 572 Meconta - Corrane	S/T	U	68	3.4	30%	IDA	Nampula
EN208 Guiga Bridge				10.0	12%	NDF	Gaza
Rural Roads (Niassa e Maputo)	T	U	445	8.6	12%	IFAD	Niassa, Maputo
Rural Roads (Niassa)	T	U	126	1.2	12%	Irish Aid	Niassa
Rural Bridges (Zambezia)	T			4.5	12%	EU	Zambezia
Rural Roads (National)	T	U	80	1.6	12%	SIDA/DFID	National
Rural Roads (Zambezia)	T	U	452	9.9	12%	KFW	Zambezia
Rural Roads (Cabo Delgado)	T	U	325	4.4	12%	NORAD	Cabo Delgado
EN 221 Bene - Fingoe	S	U	114	5.6	17%	IDA	Tete
Rural Roads (Tete, Manica)	T	U	140	4.0	12%	DANIDA	Tete, Manica
Rural Roads (Nampula e Zambézia)	T	U	87	1.7	12%	USAID	Nampula, Zambezia
District Roads Nampula	T	U		0.5	12%	UNCDF	Nampula

There is no description about the detailed progress of rehabilitation works within the Phase 1 Program. However, it is assumed that this rehabilitation works are also behind the schedule according to a delay disbursement of investment.

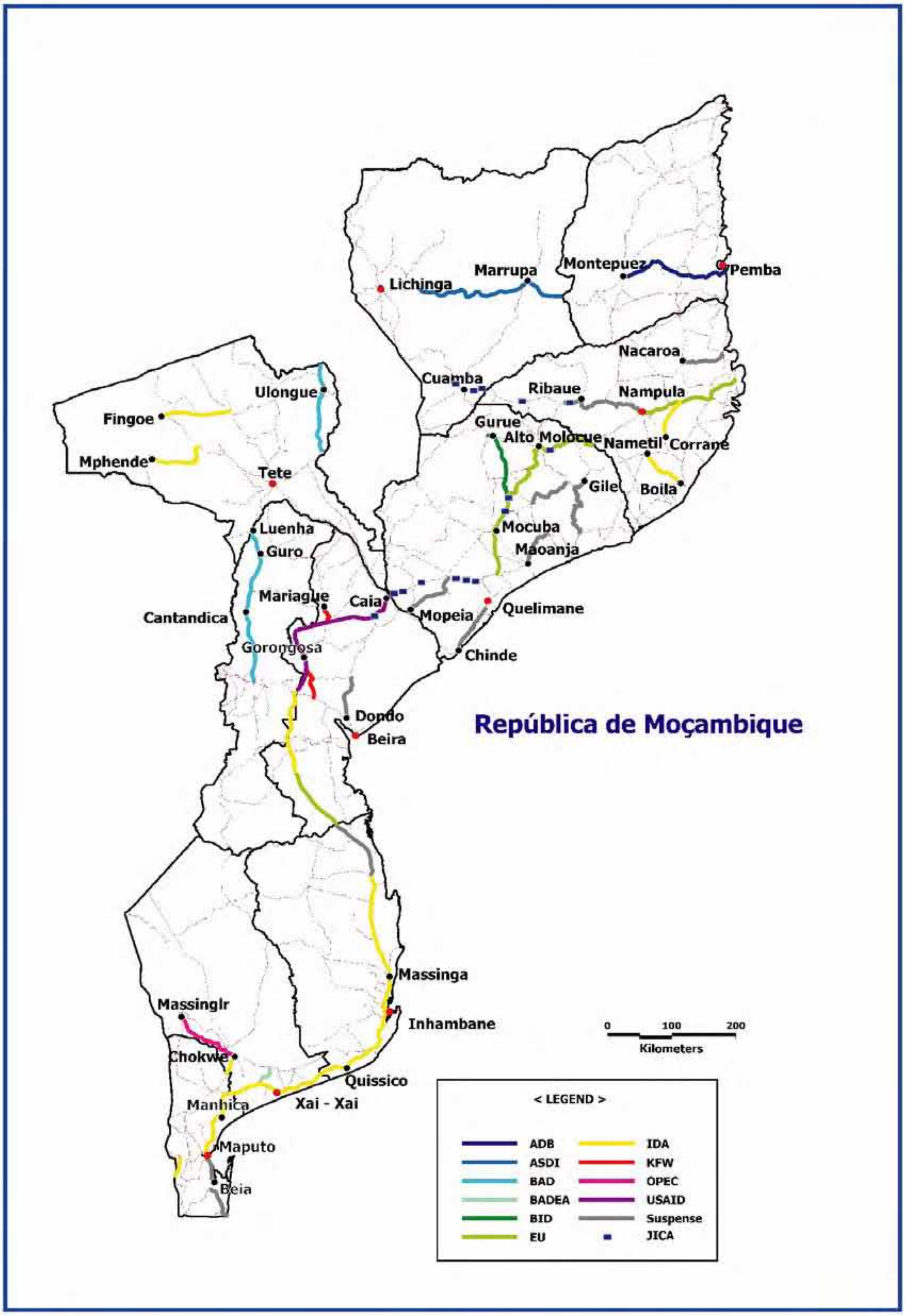


Figure 2.4.1 Phase 1 Project Map

2.4.3 Emergency Repair Works & Traffic Safety Component

The Phase 1 Program includes a component to finance emergency repair works to roads and bridges following heavy rains and flooding. This component is projected at US$ 33 million for Roads III with US$ 11 million projected for Phase I. The importance of foreseeing the need for emergency works funding separate from planned civil works is to maintain the integrity of the planned programme.

The road safety program is implemented by ANE but in collaboration with other agencies responsible for road and traffic safety, including the Road Safety Council, INAV, the Ministry of Transport and Communications, and the Ministry of the Interior (Road Traffic Police). Implementation of road safety measures, including improved collection of traffic accident statistics for identification of black spots, safety audits on the major trunk roads, incorporation of additional safety features and requirements in road design, and installation and maintenance of road structures designed for safety, such as guard rails.
ANE will appoint a senior staff member (Department Head) to oversee the programme and develop a Safety Action Plan, to be prepared by March 2007. The road safety programme will consist of 5 programme elements.

According to the review report on the Road III Phase 1, there was little progress in the areas of road safety in Phase 1. Whereas procurement of consulting services conducting safety audits and assisting in the management of the road safety program was quite, almost no budget was allocated for road safety activities.

2.4.4 Institutional Development Component

This component is essential to the success of the Roads III Program, since it ensures the concomitant measures to develop and reinforce the institutional capacity required for the road sector. This support has the following objectives:

- Establishment of an institutional framework for the sector, which ensures effective, transparent and accountable roads management and administration. This includes clear separation of the financing and allocation functions (under the Road Fund) from the management of contracts and supervision of construction and maintenance, and creation of an independent Road Board responsible for overseeing and monitoring performance in the overall sector. ANE and the Road Fund is supported and strengthened in their respective roles.

- Establishment of the most appropriate financial management framework for ANE, the Road Fund and Programme and projects management, to ensure the sufficient, timely, stable and secure flow of funds to cover roads maintenance needs.
- Establishment of a system of technical and financial auditing and performance monitoring for the Road Fund.
- Preparation and implementation of a strategy for human resources development, focusing on procurement, disbursement, accounting, financial management and project management in government road and transport management institutions, based on best practice in the public and private sectors. Strengthening of the Programme started under ROCS2 to help prevent the spread of HIV/AIDS.
- Promotion of local contractors through training (including labour-based methods) and other activities.
- Strengthening of the unit at ANE responsible for addressing issues of AIDS, the environment poverty alleviation and gender. A socio-economic impact assessment of ROCS2 currently underway will provide the baseline data against which future progress can be measured.
- Establishment of a unit responsible for monitoring and evaluation of Programme implementation progress and impact.

There are 5 subcomponents: 1) technical studies and support (supporting ANE’s social unit, the Road Fund, implementation of works, and axle load monitoring); 2) expertise and institutional strengthening (including technical assistance and support for key departments and staff); 3) training (including support for private-sector strengthening and development of ANE and Road Fund staff capabilities); 4) support to programme management entailing assistance to senior key staff in advance planning and prioritisation of projects and the implementation thereof ; and 5) operating expenses of the implementing agencies (ANE, Road Fund, and support to the DEPs).

Based on the Phase 1 Program, several institutional reform plans have executed, particularly separation of the Road Fund from ANE, establishment of separate of Directors and a national roads council are notable. However, performance of the road sector institution have not achieved to the targeted level. Issues on the capacity of the road sector institutions are described in 2.1.

2.5 Roads III Phase 2 Program

2.5.1 Financial Plan for 2007 - 2009

A detailed set of plans for the period 2007 – 2009 are being prepared for inclusion in the Roads-III Phase 2 Project Implementation Plan (PIP 2007 - 2009) based on the review results of Phase 1 implementation. PIP 2007 - 2009 includes detailed programs of works (paved and unpaved, investment and maintenance, national and provincial) and sector support activities (road sector planning and management, capacity building, road safety, and axle load control). Procurement, implementation and disbursement schedules are also included in PIP 2007 - 2009, as are the performance indicators that will be used to measure accomplishments and performance.

PIP 2007 - 2009 is to be reviewed and adjusted annually to take into account changes in needs and resource availability. Toward the end of Roads III Phase 2, the program for Phase 3 (PIP 3) will be prepared based upon a revised Strategy and rolling 5-year plan.

Table 2.5.1 Summary Sources and Uses of Funds, PRISE 2007 – 2009 (USD million)

Component	Planned Uses	Funding				Total Funding
		Road Fund	GOM	SBS	Donors	
Overhead	$69.6	$29.9		$0.6	$24.4	$69.6
Maintenance	$263.9	$165.1		$79.2	$0.5	$263.9
Rehabilitation and Upgrade	$709.8		$139.1		$570.5	$709.8
SBS					$113.5	
Total	**$1043.3**	**$195.0**	**$139.1**	**$113.5**	**$709.1**	**$1043.3**

Source: PRISE

2.5.2 Rehabilitation and Upgrading Projects for Phase 2

The full Investment Plan for Phase 2 is formulated based on PIP 2007 – 2009. The principle of sustainability dictates that new investments (rehabilitation, upgrading, and new construction) will only be undertaken where there is a demonstrated capacity to maintain those investments. At the same time, RSS establishes a priority for upgrading, rehabilitating, and maintaining the entire core primary road network at a level of “good paved condition”. Further, the goal of accessibility points towards the importance of allocating investment resources toward regional roads. These three factors point towards the importance of a balanced approach to investment decision.

The investment plan followed a process of identification and evaluation of candidate projects. For the purposes of the prioritization exercise, projects were divided into three categories:

- **National roads projects**: It includes upgrade, rehabilitation and periodic maintenance of paved roads. The full list of National Roads candidate projects was discussed with stakeholders and following revisions, a total of 59 were included in the prioritization exercise. The selected projects are listed up in Table 2.5.2.
- **Regional roads projects** : A total of 69 provincial roads were initially identified. These projects were not prioritized as regional roads rehabilitation priorities will be established in cooperation with the Provinces. An expanded list of regional roads candidate projects are included in PIP 2007 - 2009.
- **Bridge projects**: The GOM has established a priority program of 13 bridges for rehabilitation and construction in Phase 2 among 32 candidate projects.

As shown in Table 2.5.2, the upgrading of the Study Roads (Cuamba-Nampula Road) shows economic feasibility of the project with 71.1% of EIRR.

Table 2.5.2 National Roads Investment Projects

Road	Province	Length (km)	Projected Works a	Est. EIRR (%)	Estimated Cost (USD m)	
					Total	Phase 2
Rehabilitation						
N1: Maputo (Jardim - Benfica)	Maputo	7	Rehabilitation & upgrade	414.0	$4.5	$4.5
N1: Xai - Xai – Zandamela – Chissibuca	Gaza, Inhambane	96	Rehabilitation	80.1	$22.0	$22.0
N1: Massinga - Nhachengue	Inhambane	57	Rehabilitation	34.4	$15.0	$15.0
N7: Vanduzi – Changara (km 60-106, 161-270)	Manica	154	Rehabilitation	65.8	$46.0	$46.0
R445: Macarretane – Massingir	Gaza	106	Rehabilitation	na	$8.5	$8.5
Upgrading						
N14: Montepuez - Ruaça	Cabo Delgado	136	Upgrade to Paved	5.2	$42.8	$33.2
N14: Marrupa - Ruaça	Niassa	87	Upgrade to Paved	6.0	$19.9	$19.9
N380: Macomia – Oasse	Cabo-Delgado	28	Upgrade to Paved	na	$8.5	$8.5
N13: Lichinga - Litunde	Niassa	67	Widen and Reseal	20.5	$15.7	$15.1
N13: Bridges and Structures	Cabo Delgado, Niassa		Repair and Construct	na	$4.8	$4.5
N13: Cuamba - Lichinga	Niassa	286	Upgrade to Paved	12.3	$72.9	$24.3
N13: Cuamba - Nampula	Nampula	335	Upgrade to Paved	71.1	$120.5	$60.3
N103: Gurué – Magige	Zambezia	35	Upgrade to Paved	na	$11.5	$11.5
N11: Mocuba – Milange	Zambezia	171	Upgrade to Paved	na	$36.1	$27.1
Total		**1,565**			**$428.7**	**$300.2**

2.5.3 Other Road Projects Implemented by MCC

The Millennium Challenge Corporation (MCC), which is a United States Government corporation designed to work with some of the poorest developing countries, proposed road rehabilitation program (Proposal for Road Sector Investment in the North) apart from Road III Phase 2 Program as a part of investment program for economic growth and the poverty reduction in Mozambique's four northern provinces: Cabo del Gado, Niassa, Nampula, and Zambézia in 2007.

This road sector investment proposal picked up the number of sections along the National Route 1(L=490km), and a section of the N104 (L=47km) as a first priority project. As a second priority, it picked up some road sections including the Lichinga-Cuamba section of the N13 in Niassa Province, totaling 864 km of the road length. However, only N1 rehabilitation project is recently determined to be financed by MCC. Table 2.5.3 shows the results of the economic analysis on the sections of the N1.

Table 2.5.3 Priority Investment Package for MCC

Province	Road	Road Section	Length km	Capital Cost USD m	Capital Cost km USD m	EIRR	NPV
Cabo Delgado	N1	Rio Lurio - Metoro	74	22	0.294	10.50%	2.4
Nampula	N1	Nampula - Rio Ligonha	102	34	0.339	9.10%	0.6
Nampula	N1	Namialo - Rio Lurio	148	47	0.317	8.70%	-0.8
Zambezia	N1	Nicoadala - Chimuara	167	55	0.330	15.20%	24
Total			490	158		11.40%	26

PART 3:

FEASIBILITY STUDY

Chapter 1 Approach and Methodology

PART 3: FEASIBILITY STUDY

Chapter 1 Approach and Methodology

1.1 Introduction

Part 3 describes the approach, methodology and procedure of the feasibility study on the Study Road as well as its results, which comprises 10 chapters. Firstly the Study Team grasped the existing conditions of the Study Road including topography, geology, hydrology, natural and social environment and traffic, and established the upgrading concepts based on the understanding of characteristics of the Study Road. Secondly the preliminary design of road and bridges was conducted in order to formulate the upgrading concepts on the basis of design standards and specifications applied. This was followed by construction planning, cost estimate and implementation planning, and an economic analysis was executed in order to confirm the economic feasibility of the Study Road. In parallel to this process, an initial environmental examination (IEE) was also conducted to identify further check points in the EIA, which is now being undertaken by the GOM.

According to the contents of Part 3, Chapter 1 presents the approach and methodology for the feasibility study, considering the major issues of the Study Road.

1.2 Appreciation of Issues on Study Road

The following issues should be considered in order to conduct the feasibility study on the Study Road.

- **Function as an International Corridor (Nacala Corridor):** The neighboring countries of Malawi and Zambia as landlocked countries are paying a very large premium (estimated at 5-10 per cent for Malawi) on all imports and exports as a result of tremendously high transportation costs, as well as the unreliable and inefficient transport system (this applies to a somewhat lesser extent in the case of Zambia). There are two key problems that have been identified as critical in causing these inefficiencies. Firstly, the very poor quality of the physical infrastructure (particularly transport related), and secondly, the very unsatisfactory operation (including management, institutional, policy and procedural matters) of the existing infrastructure networks. The upgrading of the Study Road to all-weather road is expected to provide Malawi and Zambia with an alternative route to access an international port as well as secure a reliable international transportation route to Nacala.

- **Function as a Corridor for Regional Development in Mozambique:** Although the Northern area of Mozambique (the Study Area) has high economic potential due to the existence of agricultural resources, the area has been struggling with poverty due to mainly lack of access to basic needs. Particularly, the Study road and its access roads are unpaved and in poor condition. These roads regularly become impassable by heavy rain during the rainy season. This results in increased costs for the freight and passenger transport, frequent impossibility of transporting of goods to and from markets, and limiting access to market, school, hospital and other public facilities. The upgrading of the Study Road is expected to improve the access to district and province centers from the Study Area, which would promote socio-economic activities and social development of the rural poor.

1.3 Approaches and Methodology for the Feasibility Study

Within this context, the following approaches shall be applied to conduct the feasibility study on the Study Road.

- The Study Road should be upgraded as an all-weather road guaranteeing all year round.access
- The most appropriate design speed for the Study Road shall be selected considering the cost-benefit aspect the capacity for transportation vs. construction costs.
- The most appropriate pavement type shall be selected considering locally available materials and its related costs.
- The necessity of bypass routes at major district centers on the Study Road shall be studied in line with forecasted traffic volumes the scale of resettlement and land acquisition.
- Future traffic demand on the Nacala Corridor shall be forecasted and shall take into account the transportation modes of road and railway.
- The improved Study road shall be operated and maintained by a suitable organization to ensure a long and useful life.

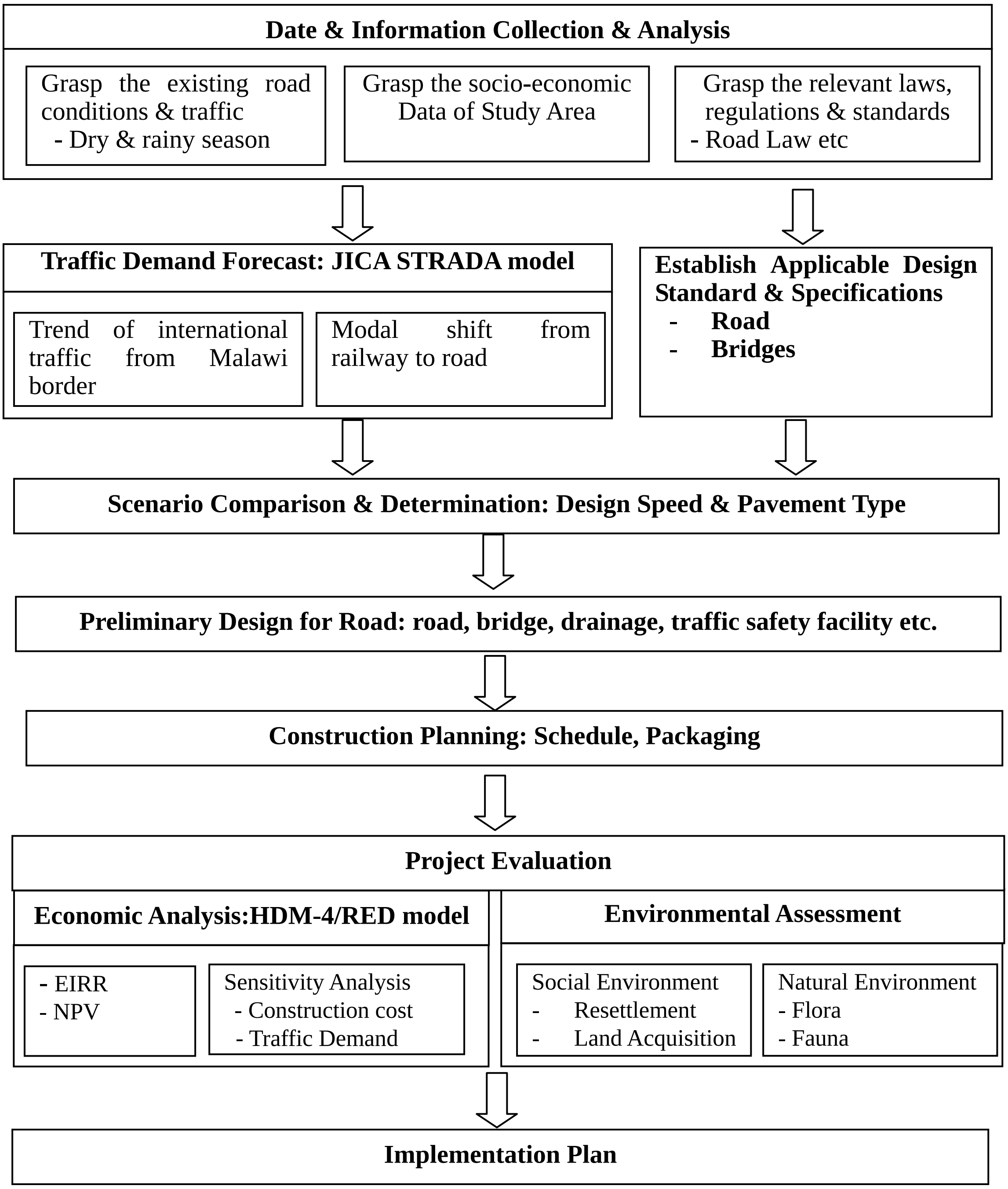
In order to implement the aforementioned approaches, the following methodology shall be applied for the feasibility study.

- JICA STRADA model is applied to forecast traffic demand and to properly assess the traffic volume on the Study Road and consider the effects on the road network.
- HDM-4/RED model is applied for the economic analysis in order to properly assess

the effects on the blockageof the existing Study Road during the rainy season.

1.4 Work Procedure of the Feasibility Study

The following procedure shall be followed for the feasibility study.



Chapter 2 Existing Conditions of the Study Road & Bridges

Chapter 2 Existing Conditions of the Study Road & Bridges

2.1 Outline of Inventory Survey for Study Road

2.1.1 General Description of the Study Road

As shown in Figure 2.1.1, the Study Road, with a total length of approximately 350km, passes through one city (Nampula), five districts (Nampula, Mecuburi, Ribaue and Malema in Nampula Province, and Cuamba in Niassa Province) and connects one provincial capital (Nampula) and four district capitals (Rapale, Ribaue, Malema, Cuamba), The Study Road is part of the NACALA CORRIDOR, connecting the Nacala Port with Malawi and Zambia.

The referencing system for the Study Road used in this report is based on discussions between ANE and the Study Team, and is as follows;

- Chainage increase from Nampula towards Cuamba.
- The starting point of the Study Road is at the N1/ N13 junction in Nampula city
- The end point is at the intersection of the N13 and the railway bridge in Cuamba town

The Study Road can be broadly divided into three sections and the road length of each section is indicated in Figure 2.1.1.

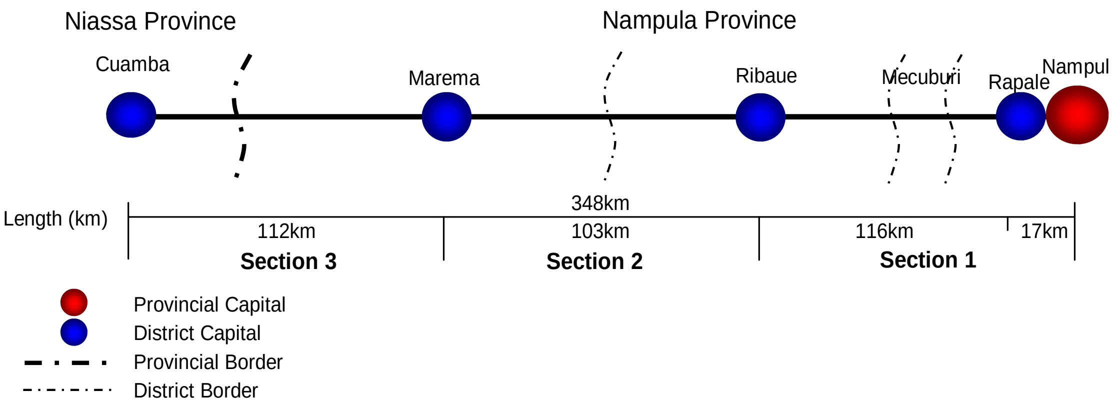


Figure 2.1.1 Outline of the Study Road

2.1.2 Methodology of Inventory Survey

A road inventory survey was carried out to assess the present conditions of the Study Road and to determine upgrading concepts. The road inventory survey included:

- ***Road Condition Assessment***: terrain, geometry, road surface type and conditions, and drainage type.
- ***Road features and furniture (major and minor junctions, cuttings, embankments, cities, towns, villages, road signs, pedestrian crossings, bus stops)***: for each feature description, chainage and coordinates.
- ***Culvert Condition Assessment***: coordinates, culvert type, culvert shape, number, width and condition of the carriageway, and general condition of the culvert.

The results of the inventory survey are summarized in the following sub-chapter.

2.1.3 Existing Conditions of the Study Road

(1) Summary of Existing Conditions of the Study Road

Table 2.1.1 summarizes the results of the inventory survey for the Study Road.

Table 2.1.1 Summary of Existing Road Conditions

Route	N13 (former N8)	**Length**	348km
Origin	Nampula (Nampula Province)	**Destination**	Cuamba (Niassa Province)
Terrain Conditions: From Nampula to Cuamba, the Study Road passes through flat and rolling terrain. The road steadily climbs, the altitude starts from 400MASL and reaches up to nearly 600MASL at Namina. Thereafter the road follows ups and downs around 500 – 600 MASL, across rolling terrain.			
Road Conditions: Overall, the Study Road width varies between 5 m and over 10m. The road is generally lower than the surrounding ground and has an earth/gravel surface with a poorly defined open drainage system. The side drains discharge surface water through irregularly positioned miter-drains. Crossing culverts on the road were observed at reasonably regular intervals. Some new culverts were recently constructed, and other culverts had headwalls repaired.			
Crossing Conditions: A total of 37 rivers or streams on the Study Road were identified. All waterways identified had crossing structures, including multi-cell pipe culverts, box culverts and bridges. Most of the rivers and streams have almost no discharge in the dry season and only one-third of the rivers have perennial but very slow water flow. The river gradients are gentle.			
Roadside Conditions: The Study Road passes through numerous villages. Although lots of pedestrians and cyclists were observed within or near the towns and villages, their numbers are reduced to very few outside the towns and villages. Along the Study Road, cultivated lands are observed mostly near the villages with the remainder part being bush land			

Traffic Conditions: Traffic on the Study Road is mainly observed in the morning. Although traffic volumes near towns like Nampula and Cuamba is relatively high, little traffic is observed on the sections 2 between Ribaue and Malema. Traffic counts are as follows; Section-1: 648 ADT, Section-2: 38 ADT, Section-3: 117 ADT Whereas mini-busses are most common on Section-1,heavy trucks account for the highest percentage on Section-3.
Socio-economic Conditions: The population figures (2005) for Nampula and Niassa Province are 3,643,739 and 992,764 respectively. These numbers account for respectively.19% and 5% of the national population. The GDPs (2004) of Nampula and Niassa Province are 8,212 and 1,908 billion Meticais, these account for 13% and 3% of the Mozambique's GDP, respectively. On average, the Mozambique's GDP grew by 9.2 percent annually between 2000 and 2004. whereas Nampula and Niassa are 6.9 percent and 9.7 percent. The major economic activity of both provinces is agriculture.

(2) Existing Road Conditions by Section

Nampula – Ribaue Section (Section 1)

The road passes three major towns, namely Rapale, Namina, and Namigonha. The road steadily climbs in elevation, up to nearly 600MASL at Namina and crosses flat and rolling terrain. The road has an earth surface and its condition is fair because of recent emergency maintenance works, including surface gravelling, drainage improvement and installation of new culverts. The road runs parallel with the railway line all along this section.

Ribaué and Malema (Section2)

This section does not cross any major town. The road climbs and falls from nearly 500 – 600 MASL, across rolling terrain. The road has an earth surface and is significantly deteriorated by lack of maintenance activities and heavy rains. Road surface erosion is frequently observed which is causing a problem to traffic. The erosion results from the road being aligned below the surrounding area and the steep gradients. This situation concentrates rainfall down on the carriageway for long distances due to lack of suitable outlets.

Malema and Cuamba (Section3)

This section passes through only one major town of Mutuali. The road repeats the ups and downs at nearly 600MASL, across rolling terrain. The road condition is assessed as fair because of rehabilitation works completed in 2003 with IDA funding and recent emergency maintenance work including surface gravelling and drainage improvement. The road runs parallel to the railway line all along the section. Between Rio Lurio (District border of

Malema and Cuamba) and Cuamba town the road crosses the railway line on seven occasions within a short length. This situation is dangerous from the viewpoint of traffic safety and geometrically unacceptable.

(3) Maintenance Activities on the Study Road

The recent periodic maintenance and emergency maintenance works carried out on the Study Road (except between Ribaue and Malema) is clearly visible. In these sections, vehicles can run through at more than 60km/h. Although emergency maintenance between Ribaue and Malema have started, it could not accomplish the entire section due to shortfall in budget. Now, ANE is looking for funds for the remaining section. This maintenance work consists of the road surface grading, earth drainage, installation of new culverts, culvert headwall repairs, grass cutting and widening of the carriageway to the required minimum width.

Table 2.1.2 Current Maintenance Work for N13

Section	Type	Period	Financing source
Nampula – Namina	MP	Under Negotiation	GoM
Malema – Lurio	MP	Completed in Oct, 2006	GoM
Namina – Ribaue	EM	Completed in May, 2007	EU
Ribaue – Malema	EM	Partially completed	EU

Note: MP: Periodic Maintenance, EM: Emergency Maintenance

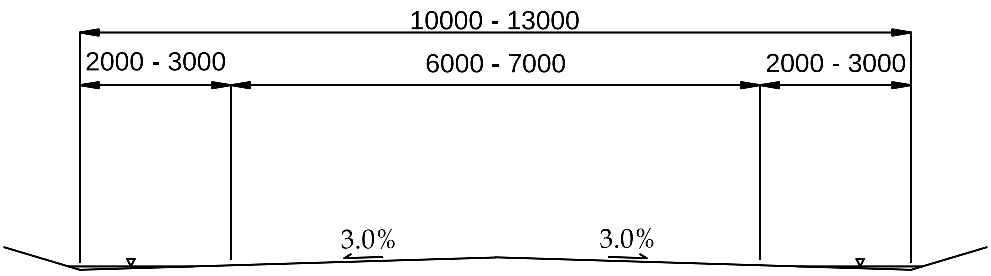


Figure 2.1.2 Typical Cross Section of N13 for Emergency Maintenance

2.1.4 Findings from Road Inventory Survey

(1) Alignment

Table 2.1.3 and Figure 2.1.4 summarize the existing conditions of both horizontal and vertical alignment. In general, the alignment of the Study Road runs along the rolling terrain.

The inventory survey clarified that the existing alignments particular the horizontal, at many points could not accommodate traffic to follow the design speed of 80km/h. Curves with a radius of less than 20m are frequently observed and vehicles can not safely drive the designated speed. In addition, the following improvements should be incorporated into the upgrading concepts.

Connection with Town Roads

The horizontal alignment of the Study Road meets connecting roads at right angles at three distinct points. These points not only prevent from smooth driving but also become black spots from a traffic safety viewpoint. The locations are:

- Rapale Intersection
- Malema Intersection (in front of the railway station)
- Cuamba Intersection

Skew Crossing over Railway

There are 16 crossing points with the railway line on the entire section of the Study Road. At the crossing points, the existing alignment of the Study Roads usually crosses over the railway line at a skewed angle. These type of crossings are dangerous in terms of traffic safety because firstly it is difficult for drivers to confirm whether or not a train is coming, and secondly, the sharp crossing of vehicles sometimes causes slippage particularly on rainy days.

Regarding the vertical alignment, it also does not comply with the required geometry standards. This vertical gradient does not facilitate traffic safety from the following viewpoints;

- Vertical sight distance necessary for a 80/100 km/h design speed can not be secured
- Heavy vehicles can not negotiate the steep climbs with the designated design speed. It causes traffic congestion or dangerous overtaking by other vehicles

However, the improvement of the vertical alignment will not be of a large magnitude.

Table 2.1.3 Review of Existing Horizontal Alignment

Curve No.	Existing Curve Data				Required Curve Length (m)	Design Speed						Remarks
	Beginning Sta.	Radius (m)	Curve Length (m)	Deflection Angle		80kph			100kph			
						Radius	Length	Spiral	Radius	Length	Spiral	
1	0+204.1941	500	288.28	33	150	OK	OK	OUT	OK	OK	OUT	Nampula
2	1+390.5113	1000	296.97	17	150	OK	OK	OK	OK	OK	OUT	
3	1+999.3749	5000	217.88	3	210	OK	OK	OK	OK	OK	OK	
4	2+653.6633	1500	238.94	9	150	OK	OK	OK	OK	OK	OK	
5	3+276.6456	1000	713.49	41	150	OK	OK	OK	OK	OK	OUT	Railway Cross
6	5+382.322	1000	636.49	36	150	OK	OK	OK	OK	OK	OUT	
7	6+708.1833	1000	109.41	6	150	OK	OUT	OK	OK	OUT	OUT	
8	6+860.6885	20	13.99	40	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
9	6+892.6864	20	12.10	35	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
10	7+390.4757	500	739.09	85	150	OK	OK	OUT	OK	OK	OUT	
11	8+207.8622	2000	192.50	5	150	OK	OK	OK	OK	OK	OK	
12	8+438.9165	3000	152.58	3	210	OK	OUT	OK	OK	OUT	OK	
13	9+327.8859	350	438.18	72	150	OK	OK	OUT	OUT	OK	OUT	
14	10+217.5289	1000	411.56	23	150	OK	OK	OK	OK	OK	OUT	
15	11+131.1501	1000	433.23	24	150	OK	OK	OK	OK	OK	OUT	
16	12+146.4785	1000	222.37	12	150	OK	OK	OK	OK	OK	OUT	
17	12+420.6232	1000	138.52	8	150	OK	OUT	OK	OK	OUT	OUT	
18	12+563.9673	500	37.35	5	150	OK	OUT	OUT	OK	OUT	OUT	
19	13+365.8865	1000	64.57	3	210	OK	OUT	OK	OK	OUT	OUT	
20	13+518.3183	430	485.94	64	150	OK	OK	OUT	OK	OK	OUT	
21	14+249.0693	400	435.31	62	150	OK	OK	OUT	OUT	OK	OUT	
22	15+261.4574	200	50.91	15	150	OUT	OUT	OUT	OUT	OUT	OUT	
23	15+345.8211	200	62.04	18	150	OUT	OUT	OUT	OUT	OUT	OUT	
24	15+586.5963	2000	125.57	3	210	OK	OUT	OK	OK	OUT	OK	Rapale
25	15+874.6007	550	1041.71	252	150	OK	OK	OUT	OK	OK	OUT	Rapale
26	17+894.9997	350	268.42	44	150	OK	OK	OUT	OUT	OK	OUT	Rapale
27	18+244.6391	180	223.28	289	150	OUT	OK	OUT	OUT	OK	OUT	Rapale
28	18+611.3745	80	112.52	279	150	OUT	OUT	OUT	OUT	OUT	OUT	Rapale, Railway
29	18+736.1158	40	50.50	287	150	OUT	OUT	OUT	OUT	OUT	OUT	Rapale
30	19+679.4802	1000	440.71	25	150	OK	OK	OK	OK	OK	OUT	
31	22+364.9546	900	327.14	21	150	OK	OK	OK	OK	OK	OUT	
32	23+535.0686	1000	603.70	35	150	OK	OK	OK	OK	OK	OUT	
33	26+372.7521	1000	148.02	8	150	OK	OUT	OK	OK	OUT	OUT	
34	26+535.3996	800	137.79	9	150	OK	OUT	OK	OK	OUT	OUT	
35	26+998.2021	1200	363.06	18	150	OK	OK	OK	OK	OK	OUT	
36	29+78.4231	1000	569.98	33	150	OK	OK	OK	OK	OK	OUT	
37	30+593.4356	420	500.31	68	150	OK	OK	OUT	OK	OK	OUT	
38	31+912.2641	580	584.29	57	150	OK	OK	OUT	OK	OK	OUT	
39	33+476.5986	620	314.35	29	150	OK	OK	OUT	OK	OK	OUT	
40	34+204.5293	750	140.78	10	150	OK	OUT	OUT	OK	OUT	OUT	
41	34+382.0027	1000	51.46	2	240	OK	OUT	OK	OK	OUT	OUT	
42	34+441.1853	400	162.89	23	150	OK	OK	OUT	OUT	OK	OUT	
43	34+685.1098	300	274.90	53	150	OK	OK	OUT	OUT	OK	OUT	
44	34+985.079	1000	110.00	7	150	OK	OUT	OK	OK	OUT	OUT	
45	37+603.9078	1000	314.24	18	150	OK	OK	OK	OK	OK	OUT	
46	39+453.8097	420	503.31	68	150	OK	OK	OUT	OK	OK	OUT	
47	40+54.7623	350	476.37	78	150	OK	OK	OUT	OUT	OK	OUT	
48	40+999.2863	820	323.49	22	150	OK	OK	OK	OK	OK	OUT	
49	41+627.9905	720	462.71	37	150	OK	OK	OUT	OK	OK	OUT	
50	43+279.5325	1000	168.15	10	150	OK	OK	OK	OK	OK	OUT	
51	43+529.731	1200	426.20	20	150	OK	OK	OK	OK	OK	OUT	
52	45+47.8298	150	129.77	50	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
53	45+299.4747	120	104.79	50	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
54	45+530.8798	500	93.69	11	150	OK	OUT	OUT	OK	OUT	OUT	
55	45+626.789	1000	60.14	4	180	OK	OUT	OK	OK	OUT	OUT	
56	45+825.111	180	129.45	41	150	OUT	OUT	OUT	OUT	OUT	OUT	
57	46+199.7431	350	146.40	24	150	OK	OUT	OUT	OUT	OUT	OUT	
58	46+444.2299	400	110.29	16	150	OK	OUT	OUT	OUT	OUT	OUT	
59	46+557.9759	2000	85.23	3	210	OK	OUT	OK	OK	OUT	OK	
60	46+939.2027	1000	102.23	6	150	OK	OUT	OK	OK	OUT	OUT	
61	47+117.4473	200	134.70	39	150	OUT	OUT	OUT	OUT	OUT	OUT	
62	47+263.483	800	106.90	7	150	OK	OUT	OUT	OK	OUT	OUT	
63	47+634.5718	1000	82.20	5	150	OK	OUT	OK	OK	OUT	OUT	
64	47+725.3143	150	120.80	46	150	OUT	OUT	OUT	OUT	OUT	OUT	
65	47+919.3506	400	162.77	23	150	OK	OK	OUT	OUT	OK	OUT	
66	48+205.5827	400	118.05	16	150	OK	OUT	OUT	OUT	OUT	OUT	
67	48+651.345	2000	85.05	2	240	OK	OUT	OK	OK	OUT	OK	
68	48+902.4029	5000	181.51	2	240	OK	OUT	OK	OK	OUT	OK	
69	49+383.8991	550	193.19	20	150	OK	OK	OUT	OK	OK	OUT	
70	49+741.765	800	75.40	6	150	OK	OUT	OUT	OK	OUT	OUT	
71	50+131.0735	2000	353.09	10	150	OK	OK	OK	OK	OK	OK	
72	50+584.3405	300	181.98	35	150	OK	OK	OUT	OUT	OK	OUT	
73	50+768.2987	950	279.42	17	150	OK	OK	OK	OK	OK	OUT	
74	51+569.5236	900	175.00	11	150	OK	OK	OK	OK	OK	OUT	
75	51+874.8555	750	136.94	10	150	OK	OUT	OUT	OK	OUT	OUT	
76	52+194.1789	500	140.65	16	150	OK	OUT	OUT	OK	OUT	OUT	
77	52+406.1557	550	76.04	8	150	OK	OUT	OUT	OK	OUT	OUT	
78	52+525.225	600	152.70	14	150	OK	OK	OUT	OK	OK	OUT	
79	52+807.0485	1000	23.87	2	240	OK	OUT	OK	OK	OUT	OUT	
80	52+981.9913	600	121.86	12	150	OK	OUT	OUT	OK	OUT	OUT	
81	53+325.9567	800	169.10	12	150	OK	OK	OK	OK	OK	OUT	
82	53+612.9251	600	139.80	13	150	OK	OUT	OUT	OK	OUT	OUT	
83	53+781.1042	1700	554.15	18	150	OK	OK	OK	OK	OK	OK	
84	54+531.6335	1000	153.78	8	150	OK	OK	OK	OK	OK	OUT	
85	54+807.7724	4200	376.43	5	150	OK	OK	OK	OK	OK	OK	
86	55+845.4638	4000	111.04	2	240	OK	OUT	OK	OK	OUT	OK	
87	56+175.3583	360	259.84	41	150	OK	OK	OUT	OUT	OK	OUT	
88	57+148.6523	500	123.64	14	150	OK	OUT	OUT	OK	OUT	OUT	
89	57+463.3084	300	104.31	20	150	OK	OUT	OUT	OUT	OUT	OUT	
90	58+0.5938	200	109.28	32	150	OUT	OUT	OUT	OUT	OUT	OUT	
91	58+174.8412	350	138.71	22	150	OK	OUT	OUT	OUT	OUT	OUT	
92	58+511.569	2000	196.03	5	150	OK	OK	OK	OK	OK	OK	
93	58+912.4745	2000	112.22	3	210	OK	OUT	OK	OK	OUT	OK	
94	59+132.2344	1000	247.83	14	150	OK	OK	OK	OK	OK	OUT	
95	59+936.0662	1000	143.15	8	150	OK	OUT	OK	OK	OUT	OUT	
96	60+272.5511	1000	305.88	18	150	OK	OK	OK	OK	OK	OUT	
97	60+838.3431	350	133.99	22	150	OK	OUT	OUT	OUT	OUT	OUT	
98	61+144.0045	100	141.00	279	150	OUT	OUT	OUT	OUT	OUT	OUT	
99	61+313.758	1000	82.72	5	150	OK	OUT	OK	OK	OUT	OUT	
100	61+439.7653	1000	126.02	7	150	OK	OUT	OK	OK	OUT	OUT	
101	61+602.2876	600	386.98	323	150	OK	OK	OUT	OK	OK	OUT	
102	62+154.8808	450	151.46	20	150	OK	OK	OUT	OK	OK	OUT	
103	62+420.1603	700	475.73	39	150	OK	OK	OUT	OK	OK	OUT	
104	63+71.525	250	311.73	72	150	OUT	OK	OUT	OUT	OK	OUT	
105	63+950.4047	5000	138.74	2	240	OK	OUT	OK	OK	OUT	OK	
106	64+233.5185	400	184.36	26	150	OK	OK	OUT	OUT	OK	OUT	
107	64+595.6434	500	159.21	19	150	OK	OK	OUT	OK	OK	OUT	
108	64+912.5607	800	165.59	11	150	OK	OK	OK	OK	OK	OUT	
109	65+953.3498	700	189.48	15	150	OK	OK	OUT	OK	OK	OUT	
110	66+143.1065	5000	98.55	1	270	OK	OUT	OK	OK	OUT	OK	
111	66+757.3127	1500	189.59	7	150	OK	OK	OK	OK	OK	OK	
112	67+8.7955	1500	165.06	6	150	OK	OK	OK	OK	OK	OK	
113	67+212.1805	550	375.27	39	150	OK	OK	OUT	OK	OK	OUT	
114	67+895.3866	2000	89.20	3	210	OK	OUT	OK	OK	OUT	OK	
115	68+48.0328	1000	129.71	8	150	OK	OUT	OK	OK	OUT	OUT	
116	68+389.8195	680	171.26	15	150	OK	OK	OUT	OK	OK	OUT	
117	68+622.1771	800	144.65	10	150	OK	OUT	OUT	OK	OUT	OUT	
118	68+949.2816	10000	356.87	2	240	OK	OK	OK	OK	OK	OK	
119	70+223.6679	5000	331.91	4	180	OK	OK	OK	OK	OK	OK	
120	70+746.9005	10000	273.18	2	240	OK	OK	OK	OK	OK	OK	

121	71+761.0815	2000	136.88	4	180	OK	OUT	OK	OK	OUT	OK	
122	72+48.3704	1000	166.90	10	150	OK	OK	OK	OK	OK	OUT	
123	72+295.8416	1000	131.14	8	150	OK	OUT	OK	OK	OUT	OUT	
124	72+486.2614	1500	172.81	6	150	OK	OK	OK	OK	OK	OK	
125	72+758.4843	1000	148.48	8	150	OK	OUT	OK	OK	OUT	OUT	
126	73+95.3328	1000	64.74	3	210	OK	OUT	OK	OK	OUT	OUT	
127	73+333.5574	650	166.42	14	150	OK	OK	OUT	OK	OK	OUT	
128	73+656.7012	700	103.43	8	150	OK	OUT	OUT	OK	OUT	OUT	Namina
129	74+51.9937	5000	248.83	3	210	OK	OK	OK	OK	OK	OK	Namina
130	74+511.872	8000	229.02	2	240	OK	OUT	OK	OK	OUT	OK	
131	75+300.8449	520	620.08	69	150	OK	OK	OUT	OK	OK	OUT	
132	76+346.4427	2000	168.07	5	150	OK	OK	OK	OK	OK	OK	
133	77+43.1598	380	337.73	51	150	OK	OK	OUT	OUT	OK	OUT	
134	77+490.8993	1000	117.96	7	150	OK	OUT	OK	OK	OUT	OUT	
135	78+581.4263	550	259.19	27	150	OK	OK	OUT	OK	OK	OUT	
136	78+982.386	1000	123.08	7	150	OK	OUT	OK	OK	OUT	OUT	
137	79+840.172	150	191.47	73	150	OUT	OK	OUT	OUT	OK	OUT	
138	80+281.1054	1000	47.98	3	210	OK	OUT	OK	OK	OUT	OUT	
139	80+429.1108	1000	47.77	3	210	OK	OUT	OK	OK	OUT	OUT	
140	80+554.4098	250	165.01	38	150	OK	OK	OUT	OUT	OK	OUT	
141	80+762.6899	800	218.28	16	150	OK	OK	OK	OK	OK	OUT	
142	81+131.8	600	132.13	13	150	OK	OUT	OUT	OK	OUT	OUT	
143	81+436.101	2000	112.92	3	210	OK	OUT	OK	OK	OUT	OK	
144	81+789.246	200	171.44	49	150	OUT	OK	OUT	OUT	OK	OUT	
145	81+986.7364	500	33.52	4	180	OK	OUT	OUT	OK	OUT	OUT	
146	82+153.8733	500	148.51	17	150	OK	OUT	OUT	OK	OUT	OUT	
147	82+329.7018	1200	629.11	30	150	OK	OK	OK	OK	OK	OUT	
148	83+249.567	1200	224.63	11	150	OK	OK	OK	OK	OK	OUT	
149	83+831.9902	5000	340.40	4	180	OK	OK	OK	OK	OK	OK	
150	84+248.3296	380	190.38	28	150	OK	OK	OUT	OUT	OK	OUT	
151	84+609.7747	10000	221.76	2	240	OK	OUT	OK	OK	OUT	OK	
152	84+910.8759	280	186.40	38	150	OK	OK	OUT	OUT	OK	OUT	
153	85+122.4555	300	93.03	18	150	OK	OUT	OUT	OUT	OUT	OUT	
154	85+345.4132	500	203.94	24	150	OK	OK	OUT	OK	OK	OUT	
155	85+607.9873	300	163.58	31	150	OK	OK	OUT	OUT	OK	OUT	
156	86+112.7268	1500	231.22	9	150	OK	OK	OK	OK	OK	OK	
157	86+497.4342	260	177.23	39	150	OK	OK	OUT	OUT	OK	OUT	
158	87+48.2791	260	128.86	28	150	OK	OUT	OUT	OUT	OUT	OUT	
159	87+723.9806	500	98.75	12	150	OK	OUT	OUT	OK	OUT	OUT	
160	87+927.6899	500	118.86	14	150	OK	OUT	OUT	OK	OUT	OUT	
161	88+274.2352	1000	376.52	22	150	OK	OK	OK	OK	OK	OUT	
162	89+537.7867	10000	437.54	2	240	OK	OK	OK	OK	OK	OK	
163	90+179.4008	2000	51.85	1	270	OK	OUT	OK	OK	OUT	OK	
164	90+367.6825	1200	289.33	14	150	OK	OK	OK	OK	OK	OUT	
165	90+852.3226	2500	168.21	3	210	OK	OUT	OK	OK	OUT	OK	
166	91+102.9115	1000	122.37	7	150	OK	OUT	OK	OK	OUT	OUT	
167	91+336.7315	3000	257.33	5	150	OK	OK	OK	OK	OK	OK	
168	91+803.6237	1200	366.12	17	150	OK	OK	OK	OK	OK	OUT	
169	92+883.6119	3000	192.95	4	180	OK	OK	OK	OK	OK	OK	
170	93+183.2196	2500	260.35	6	150	OK	OK	OK	OK	OK	OK	
171	93+758.9791	1000	327.85	19	150	OK	OK	OK	OK	OK	OUT	
172	94+286.8454	600	324.76	31	150	OK	OK	OUT	OK	OK	OUT	
173	95+501.7302	600	338.65	32	150	OK	OK	OUT	OK	OK	OUT	
174	96+638.6157	2000	366.18	11	150	OK	OK	OK	OK	OK	OK	
175	97+581.6494	650	368.62	33	150	OK	OK	OUT	OK	OK	OUT	
176	97+982.1308	800	70.62	5	150	OK	OUT	OK	OK	OUT	OUT	
177	98+60.2237	2000	155.92	5	150	OK	OK	OK	OK	OK	OK	
178	98+241.6172	1000	134.65	8	150	OK	OUT	OK	OK	OUT	OUT	
179	98+592.5737	1000	471.02	27	150	OK	OK	OK	OK	OK	OUT	
180	99+532.3693	980	297.95	18	150	OK	OK	OK	OK	OK	OUT	
181	100+40.6336	2500	648.38	14	150	OK	OK	OK	OK	OK	OK	
182	100+807.1577	2500	109.50	2	240	OK	OUT	OK	OK	OUT	OK	
183	100+953.4188	300	118.95	23	150	OK	OUT	OUT	OUT	OUT	OUT	
184	101+133.7323	3000	137.54	2	240	OK	OUT	OK	OK	OUT	OK	
185	103+850.3626	3000	244.00	4	180	OK	OK	OK	OK	OK	OK	
186	104+270.8781	850	205.71	14	150	OK	OK	OK	OK	OK	OUT	
187	105+498.0146	300	146.49	28	150	OK	OUT	OUT	OUT	OUT	OUT	
188	106+112.3857	1000	172.60	10	150	OK	OK	OK	OK	OK	OUT	
189	106+630.6636	1000	121.18	7	150	OK	OUT	OK	OK	OUT	OUT	
190	107+146.0696	620	251.80	23	150	OK	OK	OUT	OK	OK	OUT	
191	107+490.992	700	301.59	25	150	OK	OK	OUT	OK	OK	OUT	
192	109+829.5441	220	132.42	34	150	OUT	OUT	OUT	OUT	OUT	OUT	
193	111+10.5412	1500	159.85	7	150	OK	OK	OK	OK	OK	OK	
194	111+275.1779	4500	311.52	4	180	OK	OK	OK	OK	OK	OK	
195	111+589.728	280	121.04	24	150	OK	OUT	OUT	OUT	OUT	OUT	
196	111+767.7322	350	187.42	31	150	OK	OK	OUT	OUT	OK	OUT	
197	114+954.5492	420	304.56	42	150	OK	OK	OUT	OK	OK	OUT	Railway Cross
198	117+43.7459	440	210.30	28	150	OK	OK	OUT	OK	OK	OUT	
199	117+520.7211	20000	178.08	1	270	OK	OUT	OK	OK	OUT	OK	
200	118+164.7262	10000	200.47	1	270	OK	OUT	OK	OK	OUT	OK	
201	118+605.9945	10000	87.33	0	300	OK	OUT	OK	OK	OUT	OK	
202	119+429.565	350	216.20	35	150	OK	OK	OUT	OUT	OK	OUT	Namigonha
203	120+48.8949	2000	132.89	4	180	OK	OUT	OK	OK	OUT	OK	Namigonha
204	120+356.2721	50	56.25	64	150	OUT	OUT	OUT	OUT	OUT	OUT	Namigonha
205	120+413.8911	210	97.74	27	150	OUT	OUT	OUT	OUT	OUT	OUT	Namigonha
206	120+571.1553	500	268.84	329	150	OK	OK	OUT	OK	OK	OUT	Namigonha
207	125+604.6436	1000	502.19	331	150	OK	OK	OK	OK	OK	OUT	
208	126+124.3476	800	162.43	12	150	OK	OK	OK	OK	OK	OUT	
209	128+858.4681	1000	731.55	318	150	OK	OK	OK	OK	OK	OUT	
210	131+826.8311	450	337.11	317	150	OK	OK	OUT	OK	OK	OUT	Ribaue
211	132+760.6992	100	98.75	56	150	OUT	OUT	OUT	OUT	OUT	OUT	Ribaue
212	133+222.1918	400	143.60	21	150	OK	OUT	OUT	OUT	OUT	OUT	Ribaue
213	134+213.2242	200	75.64	22	150	OUT	OUT	OUT	OUT	OUT	OUT	
214	134+406.6598	300	63.64	12	150	OK	OUT	OUT	OUT	OUT	OUT	
215	134+542.0326	300	139.18	27	150	OK	OUT	OUT	OUT	OUT	OUT	
216	135+41.0664	3000	126.67	3	210	OK	OUT	OK	OK	OUT	OK	
217	135+179.8427	3000	228.16	5	150	OK	OK	OK	OK	OK	OK	
218	135+415.5426	3000	112.53	3	210	OK	OUT	OK	OK	OUT	OK	
219	135+541.4467	1800	178.64	6	150	OK	OK	OK	OK	OK	OK	
220	135+918.7104	2000	143.52	4	180	OK	OUT	OK	OK	OUT	OK	
221	136+62.4065	2000	146.56	4	180	OK	OUT	OK	OK	OUT	OK	
222	136+235.4083	2500	194.99	5	150	OK	OK	OK	OK	OK	OK	
223	136+456.4444	1500	118.21	5	150	OK	OUT	OK	OK	OUT	OK	
224	136+585.561	1500	195.61	8	150	OK	OK	OK	OK	OK	OK	
225	136+910.8806	3000	366.96	7	150	OK	OK	OK	OK	OK	OK	
226	137+294.5171	800	137.18	9	150	OK	OUT	OUT	OK	OUT	OUT	
227	137+486.9624	450	101.97	13	150	OK	OUT	OUT	OK	OUT	OUT	
228	137+704.0564	5000	174.08	2	240	OK	OUT	OK	OK	OUT	OK	
229	138+738.296	2000	395.88	12	150	OK	OK	OK	OK	OK	OK	
230	139+419.4707	500	111.47	13	150	OK	OUT	OUT	OK	OUT	OUT	
231	139+720.4919	1500	82.28	4	180	OK	OUT	OK	OK	OUT	OK	
232	140+7.7716	1500	56.17	3	210	OK	OUT	OK	OK	OUT	OK	
233	140+113.6047	1500	79.52	3	210	OK	OUT	OK	OK	OUT	OK	
234	140+421.9246	2500	328.20	8	150	OK	OK	OK	OK	OK	OK	
235	140+969.4644	5000	235.04	3	210	OK	OK	OK	OK	OK	OK	
236	141+617.8396	3000	142.18	3	210	OK	OUT	OK	OK	OUT	OK	
237	141+809.8798	2000	298.81	9	150	OK	OK	OK	OK	OK	OK	
238	142+131.8029	600	127.34	13	150	OK	OUT	OUT	OK	OUT	OUT	
239	142+356.0109	2000	89.72	3	210	OK	OUT	OK	OK	OUT	OK	
240	142+508.4276	1800	140.10	5	150	OK	OUT	OK	OK	OUT	OK	
241	142+810.7358	1000	57.88	3	210	OK	OUT	OK	OK	OUT	OUT	
242	142+874.4019	1000	55.82	3	210	OK	OUT	OK	OK	OUT	OUT	
243	143+147.4022	5000	219.84	3	210	OK	OK	OK	OK	OK	OK	

244	143+490.9459	1250	190.56	9	150	OK	OK	OK	OK	OK	OUT	
245	143+685.911	1250	101.77	5	150	OK	OUT	OK	OK	OUT	OUT	
246	143+926.302	1250	120.35	6	150	OK	OUT	OK	OK	OUT	OUT	
247	144+295.5643	10000	520.19	3	210	OK	OK	OK	OK	OK	OK	
248	144+920.2573	2500	250.33	5	150	OK	OK	OK	OK	OK	OK	
249	145+599.465	550	107.23	12	150	OK	OUT	OUT	OK	OUT	OUT	
250	145+959.9958	1500	90.70	3	210	OK	OUT	OK	OK	OUT	OK	
251	146+58.8109	1300	183.76	8	150	OK	OK	OK	OK	OK	OK	
252	146+300.555	4500	452.00	6	150	OK	OK	OK	OK	OK	OK	
253	146+754.0809	5000	122.56	1	270	OK	OUT	OK	OK	OUT	OK	
254	147+203.2464	700	198.42	16	150	OK	OK	OUT	OK	OK	OUT	
255	147+461.4031	3000	206.20	4	180	OK	OK	OK	OK	OK	OK	
256	147+703.387	3000	203.37	4	180	OK	OK	OK	OK	OK	OK	
257	147+930.8066	1500	148.43	6	150	OK	OUT	OK	OK	OUT	OK	
258	148+220.1703	2500	311.51	7	150	OK	OK	OK	OK	OK	OK	
259	148+888.0092	750	239.91	19	150	OK	OK	OUT	OK	OK	OUT	
260	149+139.5666	400	117.49	17	150	OK	OUT	OUT	OUT	OUT	OUT	
261	149+760.8395	1200	134.90	7	150	OK	OUT	OK	OK	OUT	OUT	
262	150+5.7197	3000	263.66	5	150	OK	OK	OK	OK	OK	OK	
263	150+279.7707	1000	74.80	4	180	OK	OUT	OK	OK	OUT	OUT	
264	150+416.8371	10000	199.92	1	270	OK	OUT	OK	OK	OUT	OK	
265	151+88.1814	10000	309.64	2	240	OK	OK	OK	OK	OK	OK	
266	151+411.7096	1000	78.92	4	180	OK	OUT	OK	OK	OUT	OUT	
267	151+497.504	2000	123.07	3	210	OK	OUT	OK	OK	OUT	OK	
268	151+896.1836	3000	80.19	1	270	OK	OUT	OK	OK	OUT	OK	
269	151+996.5055	2000	110.15	3	210	OK	OUT	OK	OK	OUT	OK	
270	152+152.1092	1500	95.65	3	210	OK	OUT	OK	OK	OUT	OK	
271	152+253.8644	1500	180.90	7	150	OK	OK	OK	OK	OK	OK	
272	152+541.3849	800	204.68	15	150	OK	OK	OK	OK	OK	OUT	
273	152+963.8685	3000	169.23	3	210	OK	OUT	OK	OK	OUT	OK	
274	153+253.1372	3000	214.56	4	180	OK	OK	OK	OK	OK	OK	
275	153+820.1507	3500	248.51	4	180	OK	OK	OK	OK	OK	OK	
276	154+159.5226	10000	371.47	2	240	OK	OK	OK	OK	OK	OK	
277	154+676.5691	800	99.76	7	150	OK	OUT	OK	OK	OUT	OUT	
278	155+711.4818	1500	174.19	6	150	OK	OK	OK	OK	OK	OK	
279	155+985.0533	1000	71.59	4	180	OK	OUT	OK	OK	OUT	OUT	
280	156+467.3967	1000	92.80	6	150	OK	OUT	OK	OK	OUT	OUT	
281	156+566.0699	600	63.62	6	150	OK	OUT	OUT	OK	OUT	OUT	
282	156+753.6906	10000	201.16	1	270	OK	OUT	OK	OK	OUT	OK	
283	157+471.7161	6500	276.42	3	210	OK	OK	OK	OK	OK	OK	
284	157+834.7202	3000	408.66	7	150	OK	OK	OK	OK	OK	OK	
285	158+301.3009	1000	69.72	4	180	OK	OUT	OK	OK	OUT	OUT	
286	158+385.8661	1000	97.01	5	150	OK	OUT	OK	OK	OUT	OUT	
287	158+594.7765	5000	127.94	1	270	OK	OUT	OK	OK	OUT	OK	
288	158+997.0418	1500	168.63	7	150	OK	OK	OK	OK	OK	OK	
289	159+250.5856	250	108.70	25	150	OK	OUT	OUT	OUT	OUT	OUT	
290	159+441.6657	180	72.77	23	150	OUT	OUT	OUT	OUT	OUT	OUT	
291	159+791.2272	400	86.35	12	150	OK	OUT	OUT	OUT	OUT	OUT	
292	159+998.1979	500	61.89	7	150	OK	OUT	OUT	OK	OUT	OUT	
293	160+140.2744	500	22.02	3	210	OK	OUT	OUT	OK	OUT	OUT	
294	160+255.7983	200	63.59	18	150	OUT	OUT	OUT	OUT	OUT	OUT	
295	160+469.0409	500	127.00	14	150	OK	OUT	OUT	OK	OUT	OUT	
296	160+826.4562	1000	120.69	7	150	OK	OUT	OK	OK	OUT	OUT	
297	161+302.3295	1250	64.15	3	210	OK	OUT	OK	OK	OUT	OK	
298	161+378.2855	1250	78.39	3	210	OK	OUT	OK	OK	OUT	OK	
299	161+495.9374	350	49.34	8	150	OK	OUT	OUT	OUT	OUT	OUT	
300	161+558.5844	500	35.62	4	180	OK	OUT	OUT	OK	OUT	OUT	
301	162+71.4327	7000	413.20	4	180	OK	OK	OK	OK	OK	OK	
302	162+533.3673	7000	126.47	1	270	OK	OUT	OK	OK	OUT	OK	
303	163+94.7921	10000	327.55	2	240	OK	OK	OK	OK	OK	OK	
304	163+945.8106	2500	192.81	4	180	OK	OK	OK	OK	OK	OK	
305	164+360.6146	20000	539.58	1	270	OK	OK	OK	OK	OK	OK	
306	164+964.835	800	119.36	9	150	OK	OUT	OK	OK	OUT	OUT	
307	165+188.5122	150	24.65	9	150	OUT	OUT	OUT	OUT	OUT	OUT	
308	165+247.5846	100	66.24	38	150	OUT	OUT	OUT	OUT	OUT	OUT	
309	165+482.3322	500	46.79	5	150	OK	OUT	OUT	OK	OUT	OUT	
310	165+635.2078	900	251.52	16	150	OK	OK	OK	OK	OK	OUT	
311	166+28.6996	5000	464.06	5	150	OK	OK	OK	OK	OK	OK	
312	166+601.745	10000	241.87	1	270	OK	OUT	OK	OK	OUT	OK	
313	166+856.2876	1300	270.93	12	150	OK	OK	OK	OK	OK	OK	
314	167+172.7189	5000	184.82	2	240	OK	OUT	OK	OK	OUT	OK	
315	167+357.5407	5000	87.11	1	270	OK	OUT	OK	OK	OUT	OK	
316	167+534.004	3000	239.78	5	150	OK	OK	OK	OK	OK	OK	
317	167+789.5261	1250	88.42	4	180	OK	OUT	OK	OK	OUT	OUT	
318	167+906.4365	1250	45.81	2	240	OK	OUT	OK	OK	OUT	OK	
319	168+51.2076	100	39.70	23	150	OUT	OUT	OUT	OUT	OUT	OUT	
320	168+108.94	150	57.38	22	150	OUT	OUT	OUT	OUT	OUT	OUT	
321	168+188.9596	500	38.82	5	150	OK	OUT	OUT	OK	OUT	OUT	
322	168+250.1019	350	135.73	23	150	OK	OUT	OUT	OUT	OUT	OUT	
323	168+469.6888	800	162.02	11	150	OK	OK	OK	OK	OK	OUT	
324	168+801.389	1300	292.08	13	150	OK	OK	OK	OK	OK	OK	
325	169+288.995	600	90.56	8	150	OK	OUT	OUT	OK	OUT	OUT	
326	169+403.1066	220	93.62	24	150	OUT	OUT	OUT	OUT	OUT	OUT	
327	170+590.411	5000	254.21	3	210	OK	OK	OK	OK	OK	OK	
328	171+141.9958	700	191.64	16	150	OK	OK	OUT	OK	OK	OUT	
329	171+916.7449	2500	160.97	4	180	OK	OUT	OK	OK	OUT	OK	
330	172+647.8943	3000	183.46	4	180	OK	OK	OK	OK	OK	OK	
331	173+1.5411	1200	324.40	16	150	OK	OK	OK	OK	OK	OUT	
332	173+387.7738	2000	107.75	3	210	OK	OUT	OK	OK	OUT	OK	
333	173+584.8814	1000	176.73	10	150	OK	OK	OK	OK	OK	OUT	
334	173+794.7133	600	74.13	7	150	OK	OUT	OUT	OK	OUT	OUT	
335	173+875.85	500	136.68	16	150	OK	OUT	OUT	OK	OUT	OUT	
336	174+263.1292	1000	147.34	9	150	OK	OUT	OK	OK	OUT	OUT	
337	174+694.8978	1500	73.66	3	210	OK	OUT	OK	OK	OUT	OK	
338	174+777.0045	1500	59.63	3	210	OK	OUT	OK	OK	OUT	OK	
339	175+111.3522	800	140.76	10	150	OK	OUT	OK	OK	OUT	OUT	
340	176+197.4151	300	62.77	11	150	OK	OUT	OUT	OUT	OUT	OUT	
341	176+386.9256	1000	96.03	5	150	OK	OUT	OK	OK	OUT	OUT	
342	176+515.0344	800	124.33	9	150	OK	OUT	OK	OK	OUT	OUT	
343	176+733.213	1000	70.72	4	180	OK	OUT	OK	OK	OUT	OUT	
344	176+998.4393	3000	172.60	3	210	OK	OUT	OK	OK	OUT	OK	
345	177+202.5764	2000	131.66	4	180	OK	OUT	OK	OK	OUT	OK	
346	177+942.8707	300	105.30	20	150	OK	OUT	OUT	OUT	OUT	OUT	
347	178+313.8483	1000	60.50	3	210	OK	OUT	OK	OK	OUT	OUT	
348	178+415.559	1000	80.59	4	180	OK	OUT	OK	OK	OUT	OUT	
349	178+573.1302	150	69.27	26	150	OUT	OUT	OUT	OUT	OUT	OUT	
350	178+678.7342	100	79.98	46	150	OUT	OUT	OUT	OUT	OUT	OUT	
351	178+876.0069	1500	192.80	7	150	OK	OK	OK	OK	OK	OK	
352	179+112.2023	130	101.76	45	150	OUT	OUT	OUT	OUT	OUT	OUT	
353	180+200.0445	800	162.81	12	150	OK	OK	OUT	OK	OK	OUT	
354	180+508.0675	300	92.05	18	150	OK	OUT	OUT	OUT	OUT	OUT	
355	180+672.7033	250	80.51	19	150	OUT	OUT	OUT	OUT	OUT	OUT	
356	180+779.6952	1200	267.99	13	150	OK	OK	OK	OK	OK	OUT	
357	181+299.0904	800	244.60	17	150	OK	OK	OUT	OK	OK	OUT	
358	182+145.2089	2000	243.48	6	150	OK	OK	OK	OK	OK	OK	
359	182+876.1556	3500	115.49	1	270	OK	OUT	OK	OK	OUT	OK	
360	183+93.1817	3500	121.33	2	240	OK	OUT	OK	OK	OUT	OK	
361	183+472.6947	150	123.08	47	150	OUT	OUT	OUT	OUT	OUT	OUT	
362	183+631.2094	170	79.97	27	150	OUT	OUT	OUT	OUT	OUT	OUT	
363	183+776.648	75	70.10	53	150	OUT	OUT	OUT	OUT	OUT	OUT	
364	184+15.4246	150	91.46	35	150	OUT	OUT	OUT	OUT	OUT	OUT	
365	184+687.3864	1000	51.66	3	210	OK	OUT	OK	OK	OUT	OUT	
366	184+739.7612	800	77.90	5	150	OK	OUT	OK	OK	OUT	OUT	

367	184+846.6538	1000	94.36	5	150	OK	OUT	OK	OK	OUT	OUT	
368	184+958.7773	1000	32.85	2	240	OK	OUT	OK	OK	OUT	OUT	
369	185+130.0451	100	38.60	22	150	OUT	OUT	OUT	OUT	OUT	OUT	
370	185+191.1205	1000	89.58	5	150	OK	OUT	OK	OK	OUT	OUT	
371	185+358.9892	180	82.26	26	150	OUT	OUT	OUT	OUT	OUT	OUT	
372	185+606.4011	180	49.57	16	150	OUT	OUT	OUT	OUT	OUT	OUT	
373	185+758.9344	2000	62.09	1	270	OK	OUT	OK	OK	OUT	OK	
374	186+522.9814	2000	265.71	8	150	OK	OK	OK	OK	OK	OK	
375	186+961.2073	200	75.90	22	150	OUT	OUT	OUT	OUT	OUT	OUT	
376	187+208.419	500	107.65	12	150	OK	OUT	OUT	OK	OUT	OUT	
377	187+405.3395	1000	195.81	11	150	OK	OK	OK	OK	OK	OUT	
378	187+891.8544	500	83.47	10	150	OK	OUT	OUT	OK	OUT	OUT	
379	188+283.6484	300	57.09	11	150	OK	OUT	OUT	OUT	OUT	OUT	
380	188+369.6063	300	59.98	11	150	OK	OUT	OUT	OUT	OUT	OUT	
381	188+524.8991	130	106.74	47	150	OUT	OUT	OUT	OUT	OUT	OUT	
382	188+812.5253	280	106.56	22	150	OK	OUT	OUT	OUT	OUT	OUT	
383	188+977.195	2500	324.13	7	150	OK	OK	OK	OK	OK	OK	
384	190+51.5966	600	302.94	29	150	OK	OK	OUT	OK	OK	OUT	
385	190+494.0625	1000	106.24	6	150	OK	OUT	OK	OK	OUT	OUT	
386	190+718.4351	500	162.44	18	150	OK	OK	OUT	OK	OK	OUT	
387	191+26.3748	1500	183.62	7	150	OK	OK	OK	OK	OK	OK	
388	191+255.476	1500	101.44	4	180	OK	OUT	OK	OK	OUT	OK	
389	191+447.8252	1500	57.89	2	240	OK	OUT	OK	OK	OUT	OK	
390	191+539.5161	300	62.10	11	150	OK	OUT	OUT	OUT	OUT	OUT	
391	191+724.9703	600	58.67	5	150	OK	OUT	OUT	OK	OUT	OUT	
392	191+827.8247	1000	77.11	4	180	OK	OUT	OK	OK	OUT	OUT	
393	191+934.3671	1000	47.32	2	240	OK	OUT	OK	OK	OUT	OUT	
394	192+8.6861	1000	83.81	4	180	OK	OUT	OK	OK	OUT	OUT	
395	192+128.0983	200	96.33	27	150	OUT	OUT	OUT	OUT	OUT	OUT	
396	193+239.2982	30000	652.59	1	270	OK	OK	OK	OK	OK	OK	
397	194+663.2942	400	207.01	30	150	OK	OK	OUT	OUT	OK	OUT	
398	196+122.7702	10000	157.37	1	270	OK	OUT	OK	OK	OUT	OK	
399	196+335.704	1200	215.65	11	150	OK	OK	OK	OK	OK	OUT	
400	197+280.9276	10	9.57	55	150	OUT	OUT	OUT	OUT	OUT	OUT	
401	197+290.8696	10	9.18	53	150	OUT	OUT	OUT	OUT	OUT	OUT	
402	197+423.2241	10	5.98	34	150	OUT	OUT	OUT	OUT	OUT	OUT	
403	197+448.2365	10	5.60	32	150	OUT	OUT	OUT	OUT	OUT	OUT	
404	199+484.7268	800	208.91	15	150	OK	OK	OUT	OK	OK	OUT	
405	199+694.2656	1500	225.34	9	150	OK	OK	OK	OK	OK	OK	
406	200+849.7844	5000	124.55	2	240	OK	OUT	OK	OK	OUT	OK	
407	201+17.0809	1000	225.03	13	150	OK	OK	OK	OK	OK	OUT	
408	204+412.9391	10000	197.04	1	270	OK	OUT	OK	OK	OUT	OK	
409	204+682.7043	1100	318.16	16	150	OK	OK	OK	OK	OK	OUT	
410	205+31.529	2000	150.52	4	180	OK	OUT	OK	OK	OUT	OK	
411	205+556.7828	10000	165.58	1	270	OK	OUT	OK	OK	OUT	OK	
412	206+148.251	10000	338.68	2	240	OK	OK	OK	OK	OK	OK	
413	206+716.7275	800	122.27	9	150	OK	OUT	OUT	OK	OUT	OUT	
414	206+843.1118	1000	124.15	7	150	OK	OUT	OK	OK	OUT	OUT	
415	207+466.9335	1000	96.31	5	150	OK	OUT	OK	OK	OUT	OUT	
416	207+621.6679	1000	64.50	4	180	OK	OUT	OK	OK	OUT	OUT	
417	207+820.968	800	106.62	7	150	OK	OUT	OK	OK	OUT	OUT	
418	207+966.4625	800	86.54	6	150	OK	OUT	OK	OK	OUT	OUT	
419	208+672.1592	10000	233.54	1	270	OK	OUT	OK	OK	OUT	OK	
420	208+909.7331	5000	194.49	2	240	OK	OUT	OK	OK	OUT	OK	
421	209+170.2241	10000	209.52	1	270	OK	OUT	OK	OK	OUT	OK	
422	209+676.2655	400	239.66	35	150	OK	OK	OUT	OUT	OK	OUT	
423	210+485.1946	500	196.89	22	150	OK	OK	OUT	OK	OK	OUT	
424	210+773.6586	250	141.50	32	150	OK	OUT	OUT	OUT	OUT	OUT	Railway Cross
425	211+231.0255	3000	161.94	3	210	OK	OUT	OK	OK	OUT	OK	
426	211+634.8938	200	106.24	31	150	OUT	OUT	OUT	OUT	OUT	OUT	
427	211+978.9579	500	132.62	16	150	OK	OUT	OUT	OK	OUT	OUT	
428	212+306.6205	1000	54.41	4	180	OK	OUT	OK	OK	OUT	OUT	
429	212+366.124	300	59.46	12	150	OK	OUT	OUT	OUT	OUT	OUT	
430	212+522.2602	1500	162.87	6	150	OK	OK	OK	OK	OK	OK	
431	212+804.3591	1100	260.37	14	150	OK	OK	OK	OK	OK	OUT	
432	213+155.7072	3000	61.48	1	270	OK	OUT	OK	OK	OUT	OK	
433	213+231.5722	1500	87.07	3	210	OK	OUT	OK	OK	OUT	OK	
434	213+804.2665	5000	123.50	2	240	OK	OUT	OK	OK	OUT	OK	
435	213+932.3897	2000	42.39	2	240	OK	OUT	OK	OK	OUT	OK	
436	214+385.5431	700	196.43	16	150	OK	OK	OUT	OK	OK	OUT	
437	214+657.7061	50000	221.00	1	270	OK	OUT	OK	OK	OUT	OK	
438	215+202.081	15000	186.16	1	270	OK	OUT	OK	OK	OUT	OK	
439	215+725.5942	500	66.75	8	150	OK	OUT	OUT	OK	OUT	OUT	
440	215+897.5667	200	79.83	22	150	OUT	OUT	OUT	OUT	OUT	OUT	
441	215+999.025	200	33.96	9	150	OUT	OUT	OUT	OUT	OUT	OUT	
442	216+118.7833	200	31.01	9	150	OUT	OUT	OUT	OUT	OUT	OUT	
443	216+345.5507	1000	231.58	14	150	OK	OK	OK	OK	OK	OUT	
444	216+753.8593	3000	127.03	3	210	OK	OUT	OK	OK	OUT	OK	
445	216+890.0402	2000	205.92	6	150	OK	OK	OK	OK	OK	OK	
446	218+53.7598	5000	233.90	3	210	OK	OK	OK	OK	OK	OK	
447	218+406.6123	3000	128.66	3	210	OK	OUT	OK	OK	OUT	OK	
448	219+220.2365	6000	531.51	5	150	OK	OK	OK	OK	OK	OK	
449	220+37.4774	3000	74.23	2	240	OK	OUT	OK	OK	OUT	OK	
450	220+577.12	1500	87.47	3	210	OK	OUT	OK	OK	OUT	OK	
451	220+665.9466	1500	77.34	3	210	OK	OUT	OK	OK	OUT	OK	
452	221+422.4961	800	122.89	9	150	OK	OUT	OK	OK	OUT	OUT	
453	221+553.5716	3000	86.69	2	240	OK	OUT	OK	OK	OUT	OK	
454	221+660.0116	2000	85.50	3	210	OK	OUT	OK	OK	OUT	OK	
455	222+25.4826	1500	148.87	6	150	OK	OUT	OK	OK	OUT	OK	
456	222+814.5875	800	277.79	20	150	OK	OK	OK	OK	OK	OUT	
457	223+238.2934	2000	347.95	10	150	OK	OK	OK	OK	OK	OK	
458	223+618.6475	1500	83.33	3	210	OK	OUT	OK	OK	OUT	OK	
459	223+763.2835	1500	63.41	3	210	OK	OUT	OK	OK	OUT	OK	
460	224+362.737	175	194.27	64	150	OUT	OK	OUT	OUT	OK	OUT	
461	225+52.4618	220	242.41	63	150	OUT	OK	OUT	OUT	OK	OUT	
462	227+1.1345	800	160.26	12	150	OK	OK	OUT	OK	OK	OUT	
463	227+886.0505	1200	168.64	9	150	OK	OK	OK	OK	OK	OUT	
464	228+392.4454	1800	306.89	10	150	OK	OK	OK	OK	OK	OK	
465	228+974.6169	10000	281.87	1	270	OK	OK	OK	OK	OK	OK	
466	229+342.4612	2000	69.16	2	240	OK	OUT	OK	OK	OUT	OK	
467	229+521.3025	5000	81.06	1	270	OK	OUT	OK	OK	OUT	OK	
468	229+718.1832	180	105.40	34	150	OUT	OUT	OUT	OUT	OUT	OUT	
469	230+61.1775	220	100.68	26	150	OUT	OUT	OUT	OUT	OUT	OUT	
470	230+172.2804	2000	281.03	8	150	OK	OK	OK	OK	OK	OK	
471	230+550.9712	2000	296.69	9	150	OK	OK	OK	OK	OK	OK	
472	230+943.7675	160	52.10	19	150	OUT	OUT	OUT	OUT	OUT	OUT	
473	231+219.0499	500	68.61	8	150	OK	OUT	OUT	OK	OUT	OUT	
474	231+399.1183	300	126.81	24	150	OK	OUT	OUT	OUT	OUT	OUT	
475	231+556.4354	300	83.43	16	150	OK	OUT	OUT	OUT	OUT	OUT	
476	231+737.9347	1000	144.06	8	150	OK	OUT	OK	OK	OUT	OUT	
477	231+954.5512	280	171.85	35	150	OK	OK	OUT	OUT	OK	OUT	
478	232+512.819	50	32.78	38	150	OUT	OUT	OUT	OUT	OUT	OUT	
479	232+684.9614	200	110.05	32	150	OUT	OUT	OUT	OUT	OUT	OUT	
480	233+171.0271	2500	82.38	2	240	OK	OUT	OK	OK	OUT	OK	
481	233+256.0636	800	75.41	5	150	OK	OUT	OUT	OK	OUT	OUT	
482	233+556.6355	800	67.33	5	150	OK	OUT	OK	OK	OUT	OUT	
483	233+642.6243	800	44.44	3	210	OK	OUT	OK	OK	OUT	OUT	
484	233+797.7373	1000	117.95	7	150	OK	OUT	OK	OK	OUT	OUT	
485	234+10.7804	700	136.17	11	150	OK	OUT	OUT	OK	OUT	OUT	
486	234+283.5237	7500	136.69	1	270	OK	OUT	OK	OK	OUT	OK	
487	234+444.5563	5000	126.67	1	270	OK	OUT	OK	OK	OUT	OK	
488	234+874.1625	200	124.61	36	150	OUT	OUT	OUT	OUT	OUT	OUT	
489	235+131.3164	200	146.51	42	150	OUT	OUT	OUT	OUT	OUT	OUT	Malema

490	235+442.9179	200	71.66	21	150	OUT	OUT	OUT	OUT	OUT	OUT	Malema
491	235+739.515	10	17.55	100	150	OUT	OUT	OUT	OUT	OUT	OUT	Malema
492	235+813.1081	2000	111.30	4	180	OK	OUT	OK	OK	OUT	OK	Malema
493	236+2.678	5000	109.83	1	270	OK	OUT	OK	OK	OUT	OK	Malema
494	236+966.036	25	11.39	26	150	OUT	OUT	OUT	OUT	OUT	OUT	Malema
495	237+29.5687	20000	182.89	0	300	OK	OUT	OK	OK	OUT	OK	
496	237+452.9457	300	127.32	24	150	OK	OUT	OUT	OUT	OUT	OUT	
497	237+995.3875	50000	296.76	0	300	OK	OUT	OK	OK	OUT	OK	
498	238+577.461	50000	387.49	0	300	OK	OK	OK	OK	OK	OK	
499	239+498.8785	10000	142.37	1	270	OK	OUT	OK	OK	OUT	OK	
500	239+910.0969	800	114.25	8	150	OK	OUT	OK	OK	OUT	OUT	
501	240+674.1249	500	130.33	15	150	OK	OUT	OUT	OK	OUT	OUT	
502	240+820.6337	600	137.14	13	150	OK	OUT	OUT	OK	OUT	OUT	
503	241+121.1869	140	160.00	66	150	OUT	OK	OUT	OUT	OK	OUT	
504	241+467.9093	260	244.73	54	150	OK	OK	OUT	OUT	OK	OUT	
505	241+739.5352	20000	291.13	1	270	OK	OK	OK	OK	OK	OK	
506	242+127.4638	8000	306.94	2	240	OK	OK	OK	OK	OK	OK	
507	242+448.8361	5500	337.04	3	210	OK	OK	OK	OK	OK	OK	
508	243+214.7595	50000	297.06	0	300	OK	OUT	OK	OK	OUT	OK	
509	243+855.0115	1250	97.33	5	150	OK	OUT	OK	OK	OUT	OK	
510	243+961.5203	1250	66.93	4	180	OK	OUT	OK	OK	OUT	OUT	
511	244+361.581	4000	205.61	2	240	OK	OUT	OK	OK	OUT	OK	
512	244+926.8712	10000	447.61	3	210	OK	OK	OK	OK	OK	OK	
513	245+503.0914	3000	110.31	2	240	OK	OUT	OK	OK	OUT	OK	
514	245+902.8192	10000	218.93	1	270	OK	OUT	OK	OK	OUT	OK	
515	246+275.8467	20000	160.67	0	300	OK	OUT	OK	OK	OUT	OK	
516	246+709.029	20000	284.46	1	270	OK	OK	OK	OK	OK	OK	
517	247+907.2202	10000	282.81	2	240	OK	OK	OK	OK	OK	OK	
518	248+390.3124	3500	272.93	4	180	OK	OK	OK	OK	OK	OK	
519	248+786.1907	500	199.14	23	150	OK	OK	OUT	OK	OK	OUT	
520	249+118.3142	500	123.24	14	150	OK	OUT	OUT	OK	OUT	OUT	
521	249+251.0938	5000	138.38	1	270	OK	OUT	OK	OK	OUT	OK	
522	249+555.7893	400	111.08	16	150	OK	OUT	OUT	OUT	OUT	OUT	
523	250+98.0354	10000	237.03	2	240	OK	OUT	OK	OK	OUT	OK	
524	250+586.0321	1800	129.22	4	180	OK	OUT	OK	OK	OUT	OK	
525	251+455.4885	10000	469.16	3	210	OK	OK	OK	OK	OK	OK	
526	252+32.7193	1500	114.75	4	180	OK	OUT	OK	OK	OUT	OK	
527	252+431.6525	5000	207.61	3	210	OK	OUT	OK	OK	OUT	OK	
528	253+376.0148	4500	167.85	2	240	OK	OUT	OK	OK	OUT	OK	
529	254+172.2581	3000	44.04	1	270	OK	OUT	OK	OK	OUT	OK	
530	254+338.0131	20000	313.93	1	270	OK	OK	OK	OK	OK	OK	
531	255+861.0178	50000	511.24	1	270	OK	OK	OK	OK	OK	OK	
532	256+375.4103	10000	492.76	3	210	OK	OK	OK	OK	OK	OK	
533	256+884.0452	10000	96.14	1	270	OK	OUT	OK	OK	OUT	OK	
534	257+678.6014	300	141.15	26	150	OK	OUT	OUT	OUT	OUT	OUT	
535	258+120.9544	400	150.16	21	150	OK	OK	OUT	OUT	OK	OUT	
536	258+376.734	900	89.74	6	150	OK	OUT	OK	OK	OUT	OUT	
537	258+742.8475	5000	229.29	2	240	OK	OUT	OK	OK	OUT	OK	
538	259+29.6043	8000	220.62	2	240	OK	OUT	OK	OK	OUT	OK	
539	259+411.2851	10000	237.38	1	270	OK	OUT	OK	OK	OUT	OK	
540	259+718.1111	3000	244.25	4	180	OK	OK	OK	OK	OK	OK	
541	260+6.7191	10000	86.63	1	270	OK	OUT	OK	OK	OUT	OK	
542	260+664.9755	6000	554.47	5	150	OK	OK	OK	OK	OK	OK	
543	261+366.1871	20000	229.71	0	300	OK	OUT	OK	OK	OUT	OK	
544	261+748.6722	10000	215.36	1	270	OK	OUT	OK	OK	OUT	OK	
545	262+33.4677	10000	373.69	2	240	OK	OK	OK	OK	OK	OK	
546	262+484.4459	5000	191.71	2	240	OK	OUT	OK	OK	OUT	OK	
547	262+960.6902	10000	76.44	0	300	OK	OUT	OK	OK	OUT	OK	
548	263+552.3975	10000	261.97	2	240	OK	OK	OK	OK	OK	OK	
549	263+949.5382	8000	492.16	4	180	OK	OK	OK	OK	OK	OK	
550	264+585.6523	6000	375.89	4	180	OK	OK	OK	OK	OK	OK	
551	265+716.4877	10000	69.99	0	300	OK	OUT	OK	OK	OUT	OK	
552	266+255.6198	20000	248.77	1	270	OK	OUT	OK	OK	OUT	OK	
553	266+561.6294	2000	112.40	3	210	OK	OUT	OK	OK	OUT	OK	
554	266+806.9072	5000	515.65	6	150	OK	OK	OK	OK	OK	OK	
555	267+599.1559	1500	249.28	9	150	OK	OK	OK	OK	OK	OK	
556	268+365.9749	2500	89.95	2	240	OK	OUT	OK	OK	OUT	OK	
557	268+475.3684	2500	111.20	3	210	OK	OUT	OK	OK	OUT	OK	
558	270+741.8715	1000	235.85	13	150	OK	OK	OK	OK	OK	OUT	
559	271+80.2827	300	142.21	27	150	OK	OUT	OUT	OUT	OUT	OUT	
560	271+350.2394	450	105.93	14	150	OK	OUT	OUT	OK	OUT	OUT	
561	272+596.4503	20000	141.92	0	300	OK	OUT	OK	OK	OUT	OK	
562	273+723.0153	50000	472.21	1	270	OK	OK	OK	OK	OK	OK	
563	274+319.9367	50000	280.62	1	270	OK	OK	OK	OK	OK	OK	
564	275+481.5236	50000	253.86	1	270	OK	OUT	OK	OK	OUT	OK	
565	275+908.681	50000	317.01	1	270	OK	OK	OK	OK	OK	OK	
566	278+137.5603	50000	581.81	0	300	OK	OK	OK	OK	OK	OK	
567	279+301.5502	1500	253.01	9	150	OK	OK	OK	OK	OK	OK	
568	280+536.8016	380	212.30	32	150	OK	OK	OUT	OUT	OK	OUT	
569	281+124.617	250	98.68	23	150	OUT	OUT	OUT	OUT	OUT	OUT	Mutuali
570	281+444.7371	450	93.58	12	150	OK	OUT	OUT	OK	OUT	OUT	Mutuali
571	281+948.8471	450	149.93	19	150	OK	OUT	OUT	OK	OUT	OUT	Mutuali
572	282+432.7951	130	131.07	58	150	OUT	OUT	OUT	OUT	OUT	OUT	Mutuali
573	282+615.1849	100	82.69	312	150	OUT	OUT	OUT	OUT	OUT	OUT	Mutuali
574	283+0.3144	2000	182.79	5	150	OK	OK	OK	OK	OK	OK	
575	283+469.8007	450	623.94	280	150	OK	OK	OUT	OK	OK	OUT	
576	284+381.4141	3000	264.08	5	150	OK	OK	OK	OK	OK	OK	
577	284+700.2996	3000	364.61	7	150	OK	OK	OK	OK	OK	OK	
578	285+735.6538	1500	101.10	4	180	OK	OUT	OK	OK	OUT	OK	
579	286+26.9913	2000	268.75	8	150	OK	OK	OK	OK	OK	OK	
580	286+506.9716	3000	170.73	3	210	OK	OUT	OK	OK	OUT	OK	
581	286+986.43	1450	439.45	17	150	OK	OK	OK	OK	OK	OK	
582	287+697.1059	1500	236.60	9	150	OK	OK	OK	OK	OK	OK	
583	288+62.6787	1500	123.30	5	150	OK	OUT	OK	OK	OUT	OK	
584	288+362.6788	1500	64.52	2	240	OK	OUT	OK	OK	OUT	OK	
585	288+495.8409	550	151.33	16	150	OK	OK	OUT	OK	OK	OUT	
586	288+974.4501	950	313.89	19	150	OK	OK	OK	OK	OK	OUT	
587	289+515.5225	2000	364.11	11	150	OK	OK	OK	OK	OK	OK	
588	290+41.1418	2000	200.29	6	150	OK	OK	OK	OK	OK	OK	
589	290+463.6944	2000	168.72	5	150	OK	OK	OK	OK	OK	OK	
590	290+758.6229	1000	275.02	16	150	OK	OK	OK	OK	OK	OUT	
591	291+135.6912	1000	103.98	6	150	OK	OUT	OK	OK	OUT	OUT	
592	291+303.5437	300	33.83	6	150	OK	OUT	OUT	OUT	OUT	OUT	
593	291+340.2589	300	84.29	16	150	OK	OUT	OUT	OUT	OUT	OUT	
594	291+428.5015	300	56.67	11	150	OK	OUT	OUT	OUT	OUT	OUT	
595	291+570.6057	1500	179.79	7	150	OK	OK	OK	OK	OK	OK	
596	291+851.8076	1300	143.43	6	150	OK	OUT	OK	OK	OUT	OK	
597	292+178.362	3000	407.21	8	150	OK	OK	OK	OK	OK	OK	
598	292+644.2353	500	180.18	20	150	OK	OK	OUT	OK	OK	OUT	
599	293+47.0294	2000	127.22	3	210	OK	OUT	OK	OK	OUT	OK	
600	293+355.6809	2000	91.12	2	240	OK	OUT	OK	OK	OUT	OK	
601	293+814.4014	5000	126.89	1	270	OK	OUT	OK	OK	OUT	OK	
602	293+955.2178	5000	163.63	2	240	OK	OUT	OK	OK	OUT	OK	
603	294+146.1317	1500	408.24	16	150	OK	OK	OK	OK	OK	OK	
604	294+829.1014	500	239.64	28	150	OK	OK	OUT	OK	OK	OUT	
605	295+161.969	800	164.91	12	150	OK	OK	OK	OK	OK	OUT	
606	295+496.8693	650	152.23	13	150	OK	OK	OUT	OK	OK	OUT	
607	295+951.5692	300	77.57	15	150	OK	OUT	OUT	OUT	OUT	OUT	
608	296+70.1119	350	152.57	25	150	OK	OK	OUT	OUT	OK	OUT	
609	296+235.702	1750	357.67	12	150	OK	OK	OK	OK	OK	OK	
610	296+635.8622	2000	216.46	6	150	OK	OK	OK	OK	OK	OK	
611	296+910.264	1200	299.16	14	150	OK	OK	OK	OK	OK	OUT	
612	297+845.7396	4000	245.76	3	210	OK	OK	OK	OK	OK	OK	

613	298+166.6922	800	195.26	14	150	OK	OK	OUT	OK	OK	OUT	
614	298+508.7344	800	321.50	23	150	OK	OK	OUT	OK	OK	OUT	
615	299+24.3535	700	273.08	22	150	OK	OK	OUT	OK	OK	OUT	
616	299+475.8919	300	139.63	26	150	OK	OUT	OUT	OUT	OUT	OUT	
617	300+80.4104	800	142.93	10	150	OK	OUT	OK	OK	OUT	OUT	
618	300+266.5388	100	71.60	41	150	OUT	OUT	OUT	OUT	OUT	OUT	
619	300+398.5077	500	32.44	4	180	OK	OUT	OUT	OK	OUT	OUT	
620	300+645.6852	100	128.53	74	150	OUT	OUT	OUT	OUT	OUT	OUT	
621	300+821.1055	500	101.27	12	150	OK	OUT	OUT	OK	OUT	OUT	
622	301+219.7938	800	146.72	10	150	OK	OUT	OUT	OK	OUT	OUT	
623	301+671.8447	1500	267.51	10	150	OK	OK	OK	OK	OK	OK	
624	302+135.6507	2000	220.00	6	150	OK	OK	OK	OK	OK	OK	
625	302+414.0711	1100	356.34	18	150	OK	OK	OK	OK	OK	OUT	
626	302+867.2704	2000	211.42	7	150	OK	OK	OK	OK	OK	OK	
627	303+245.8865	600	226.12	22	150	OK	OK	OUT	OK	OK	OUT	
628	303+538.5489	2000	268.23	8	150	OK	OK	OK	OK	OK	OK	
629	303+939.3644	2000	154.81	5	150	OK	OK	OK	OK	OK	OK	
630	304+243.7498	250	201.51	46	150	OK	OK	OUT	OUT	OK	OUT	
631	304+521.6866	500	56.00	7	150	OK	OUT	OUT	OK	OUT	OUT	
632	304+652.3642	2000	193.36	6	150	OK	OK	OK	OK	OK	OK	
633	305+65.576	2000	141.26	4	180	OK	OUT	OK	OK	OUT	OK	
634	305+313.1199	2200	215.67	5	150	OK	OK	OK	OK	OK	OK	
635	305+659.1559	1800	188.09	6	150	OK	OK	OK	OK	OK	OK	
636	305+922.7197	600	98.99	9	150	OK	OUT	OUT	OK	OUT	OUT	
637	306+54.4154	250	56.30	13	150	OK	OUT	OUT	OUT	OUT	OUT	
638	306+134.2326	400	224.01	32	150	OK	OK	OUT	OUT	OK	OUT	
639	306+419.3998	10000	299.15	2	240	OK	OK	OK	OK	OK	OK	
640	306+788.4673	1200	428.88	20	150	OK	OK	OK	OK	OK	OUT	
641	307+386.2814	120	84.56	40	150	OUT	OUT	OUT	OUT	OUT	OUT	
642	307+582.1737	200	112.21	32	150	OUT	OUT	OUT	OUT	OUT	OUT	
643	307+738.9875	150	90.14	35	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
644	307+840.7907	130	87.52	39	150	OUT	OUT	OUT	OUT	OUT	OUT	
645	307+984.4197	700	88.81	7	150	OK	OUT	OUT	OK	OUT	OUT	
646	308+221.7832	800	46.44	3	210	OK	OUT	OK	OK	OUT	OUT	
647	308+329.0183	550	117.56	12	150	OK	OUT	OUT	OK	OUT	OUT	
648	308+473.0585	1200	260.79	12	150	OK	OK	OK	OK	OK	OUT	
649	308+938.2995	1200	94.68	4	180	OK	OUT	OK	OK	OUT	OUT	
650	309+230.9541	250	79.73	18	150	OK	OUT	OUT	OUT	OUT	OUT	
651	309+427.8672	200	102.10	29	150	OUT	OUT	OUT	OUT	OUT	OUT	
652	309+535.902	450	207.11	27	150	OK	OK	OUT	OK	OK	OUT	
653	310+75.8712	400	360.31	52	150	OK	OK	OUT	OUT	OK	OUT	
654	310+633.991	75	55.48	42	150	OUT	OUT	OUT	OUT	OUT	OUT	Lurio
655	310+778.3916	1000	123.15	7	150	OK	OUT	OK	OK	OUT	OUT	
656	310+936.0782	800	271.37	20	150	OK	OK	OK	OK	OK	OUT	
657	311+296.4438	600	162.94	16	150	OK	OK	OUT	OK	OK	OUT	
658	311+540.2698	1000	137.94	8	150	OK	OUT	OK	OK	OUT	OUT	
659	311+787.2579	500	222.93	25	150	OK	OK	OUT	OK	OK	OUT	
660	312+58.4143	2000	314.35	10	150	OK	OK	OK	OK	OK	OK	
661	312+639.7785	2000	76.80	3	210	OK	OUT	OK	OK	OUT	OK	
662	312+861.3063	800	160.12	12	150	OK	OK	OK	OK	OK	OUT	
663	313+245.8551	500	127.49	15	150	OK	OUT	OUT	OK	OUT	OUT	
664	313+459.6135	3500	534.69	9	150	OK	OK	OK	OK	OK	OK	
665	314+381.7718	1000	140.85	8	150	OK	OUT	OK	OK	OUT	OUT	
666	315+10.2956	1000	64.67	3	210	OK	OUT	OK	OK	OUT	OUT	
667	315+158.1897	850	209.67	14	150	OK	OK	OK	OK	OK	OUT	
668	315+627.7334	2000	131.54	4	180	OK	OUT	OK	OK	OUT	OK	
669	315+830.7407	1000	371.89	21	150	OK	OK	OK	OK	OK	OUT	
670	316+509.7367	2500	466.77	11	150	OK	OK	OK	OK	OK	OK	
671	317+106.43	1700	359.05	12	150	OK	OK	OK	OK	OK	OK	
672	317+765.3204	3000	174.69	3	210	OK	OUT	OK	OK	OUT	OK	
673	318+109.0314	600	173.91	17	150	OK	OK	OUT	OK	OK	OUT	
674	318+374.7005	2000	236.38	7	150	OK	OK	OK	OK	OK	OK	
675	318+827.6976	2500	137.05	4	180	OK	OUT	OK	OK	OUT	OK	
676	319+344.6806	2000	313.87	9	150	OK	OK	OK	OK	OK	OK	
677	319+757.6999	800	144.74	11	150	OK	OUT	OUT	OK	OUT	OUT	
678	320+376.8182	180	88.97	28	150	OUT	OUT	OUT	OUT	OUT	OUT	
679	320+505.6401	350	122.57	20	150	OK	OUT	OUT	OUT	OUT	OUT	
680	320+701.2023	320	270.56	48	150	OK	OK	OUT	OUT	OK	OUT	
681	321+399.8477	550	309.75	32	150	OK	OK	OUT	OK	OK	OUT	
682	323+26.0321	450	273.55	35	150	OK	OK	OUT	OK	OK	OUT	
683	324+540.6306	800	96.46	7	150	OK	OUT	OK	OK	OUT	OUT	
684	324+808.8601	2000	132.88	3	210	OK	OUT	OK	OK	OUT	OK	
685	325+114.1514	800	276.08	19	150	OK	OK	OUT	OK	OK	OUT	
686	325+473.3985	4000	288.16	4	180	OK	OK	OK	OK	OK	OK	
687	325+782.6163	1050	442.32	24	150	OK	OK	OK	OK	OK	OUT	
688	326+324.5988	3000	150.83	3	210	OK	OUT	OK	OK	OUT	OK	
689	326+606.6138	10000	238.28	1	270	OK	OUT	OK	OK	OUT	OK	
690	327+1.5821	250	96.49	22	150	OK	OUT	OUT	OUT	OUT	OUT	
691	327+568.5828	300	100.07	19	150	OK	OUT	OUT	OUT	OUT	OUT	
692	327+959.9671	2000	189.98	5	150	OK	OK	OK	OK	OK	OK	
693	328+446.3753	2000	101.99	3	210	OK	OUT	OK	OK	OUT	OK	
694	328+624.6576	500	88.14	10	150	OK	OUT	OUT	OK	OUT	OUT	
695	328+754.9967	300	84.52	16	150	OK	OUT	OUT	OUT	OUT	OUT	
696	328+892.9654	90	76.93	49	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
697	328+990.1029	170	86.48	29	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
698	329+573.1096	500	56.92	7	150	OK	OUT	OUT	OK	OUT	OUT	
699	329+755.0719	300	73.97	15	150	OK	OUT	OUT	OUT	OUT	OUT	
700	330+266.1773	500	174.71	21	150	OK	OK	OUT	OK	OK	OUT	
701	330+778.3711	550	221.16	24	150	OK	OK	OUT	OK	OK	OUT	
702	331+412.1414	150	74.65	29	150	OUT	OUT	OUT	OUT	OUT	OUT	
703	331+619.9938	120	94.23	45	150	OUT	OUT	OUT	OUT	OUT	OUT	
704	331+755.7343	250	50.81	12	150	OUT	OUT	OUT	OUT	OUT	OUT	
705	331+834.2038	150	77.70	30	150	OUT	OUT	OUT	OUT	OUT	OUT	
706	331+944.7433	100	47.02	27	150	OUT	OUT	OUT	OUT	OUT	OUT	
707	332+141.6039	20	19.23	55	150	OUT	OUT	OUT	OUT	OUT	OUT	
708	332+162.0823	20	16.74	48	150	OUT	OUT	OUT	OUT	OUT	OUT	
709	332+246.608	500	188.98	22	150	OK	OK	OUT	OK	OK	OUT	
710	332+484.0629	300	115.22	22	150	OK	OUT	OUT	OUT	OUT	OUT	
711	332+652.2905	1500	125.70	4	180	OK	OUT	OK	OK	OUT	OK	
712	333+55.5803	2000	442.12	13	150	OK	OK	OK	OK	OK	OK	
713	333+588.1337	500	58.51	7	150	OK	OUT	OUT	OK	OUT	OUT	
714	333+665.2017	500	44.55	5	150	OK	OUT	OUT	OK	OUT	OUT	
715	333+897.2921	400	194.88	28	150	OK	OK	OUT	OUT	OK	OUT	
716	334+112.7421	3000	296.42	6	150	OK	OK	OK	OK	OK	OK	
717	334+432.7014	5000	363.80	4	180	OK	OK	OK	OK	OK	OK	
718	334+820.4222	800	117.92	9	150	OK	OUT	OUT	OK	OUT	OUT	
719	335+462.4316	800	269.28	20	150	OK	OK	OK	OK	OK	OUT	
720	336+3.3707	800	127.73	9	150	OK	OUT	OK	OK	OUT	OUT	
721	336+314.0047	40	42.38	60	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
722	336+426.8634	75	78.23	59	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
723	336+577.5832	100	31.03	17	150	OUT	OUT	OUT	OUT	OUT	OUT	
724	336+635.2287	70	71.13	58	150	OUT	OUT	OUT	OUT	OUT	OUT	
725	336+842.2109	130	116.46	51	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
726	337+65.751	200	64.97	18	150	OUT	OUT	OUT	OUT	OUT	OUT	
727	337+326.0529	2000	59.77	2	240	OK	OUT	OK	OK	OUT	OK	
728	337+712.5936	1200	250.75	12	150	OK	OK	OK	OK	OK	OUT	
729	338+1.2039	5000	252.10	3	210	OK	OK	OK	OK	OK	OK	
730	338+354.8942	5000	56.27	1	270	OK	OUT	OK	OK	OUT	OK	
731	338+590.3635	5000	221.06	3	210	OK	OK	OK	OK	OK	OK	
732	338+931.7143	1800	253.62	8	150	OK	OK	OK	OK	OK	OK	
733	339+424.986	1200	237.16	12	150	OK	OK	OK	OK	OK	OUT	
734	339+844.5694	700	252.47	21	150	OK	OK	OUT	OK	OK	OUT	
735	340+153.6126	800	159.02	11	150	OK	OK	OUT	OK	OK	OUT	

736	340+469.0256	10	15.04	86	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
737	340+484.7415	15	22.82	87	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
738	340+575.6715	1000	85.48	4	180	OK	OUT	OK	OK	OUT	OUT	
739	340+940.0681	1000	333.72	20	150	OK	OK	OK	OK	OK	OUT	
740	341+415.6499	5000	91.61	1	270	OK	OUT	OK	OK	OUT	OK	
741	342+133.9134	3000	206.57	4	180	OK	OK	OK	OK	OK	OK	
742	342+544.8733	40	22.30	32	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
743	342+567.4031	40	20.44	29	150	OUT	OUT	OUT	OUT	OUT	OUT	Railway Cross
744	343+467.8677	300	144.09	28	150	OK	OUT	OUT	OUT	OUT	OUT	
745	344+37.5327	3000	105.58	2	240	OK	OUT	OK	OK	OUT	OK	
746	344+218.3309	2000	130.52	4	180	OK	OUT	OK	OK	OUT	OK	Cuamba
747	345+77.0643	400	195.53	28	150	OK	OK	OUT	OUT	OK	OUT	Cuamba
748	346+319.8028	50	76.23	87	150	OUT	OUT	OUT	OUT	OUT	OUT	Cuamba
749	346+485.2233	10	9.96	58	150	OUT	OUT	OUT	OUT	OUT	OUT	Cuamba
750	346+584.5285	10	18.39	106	150	OUT	OUT	OUT	OUT	OUT	OUT	Cuamba
751	346+639.482	100	43.48	25	150	OUT	OUT	OUT	OUT	OUT	OUT	Cuamba
752	346+755.9703	120	104.61	50	150	OUT	OUT	OUT	OUT	OUT	OUT	Cuamba
753	347+142.8425	800	212.31	15	150	OK	OK	OK	OK	OK	OUT	Cuamba
754	347+465.502	20000	371.53	1	270	OK	OK	OK	OK	OK	OK	Cuamba
755	347+874.4109	390	226.17	33	150	OK	OK	OUT	OUT	OK	OUT	Cuamba
756	348+125.5508	300	111.66	22	150	OK	OUT	OUT	OUT	OUT	OUT	Cuamba

(2) Cross Section

Typically, the existing width of the Study Road ranges from 5m to more than 10m. After completion of the emergency maintenance, the road width (except for the urban sections) will be maintained as per Figure 2.1.2 mentioned above. The existing road cross sections in the major towns are as shown in Figures 2.1.3 (1) to (3).

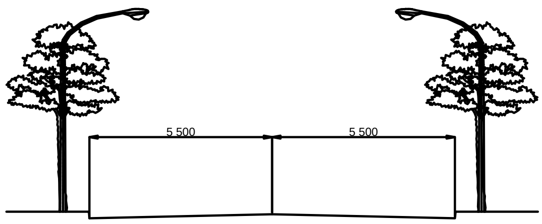


Figure 2.1.3 (1) Existing Cross Section at Ribaue Town

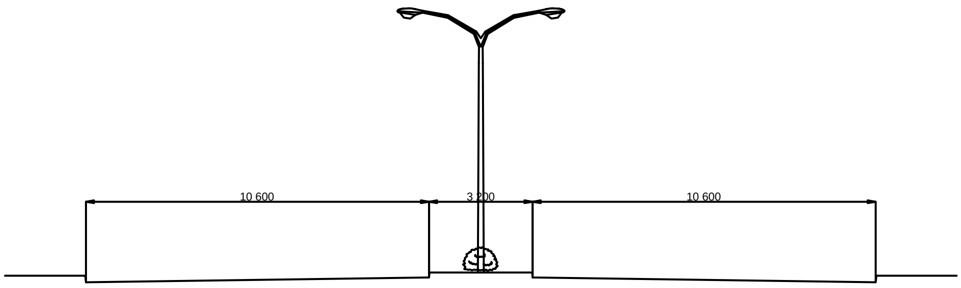


Figure 2.1.3 (2) Existing Cross Section at Malema Town

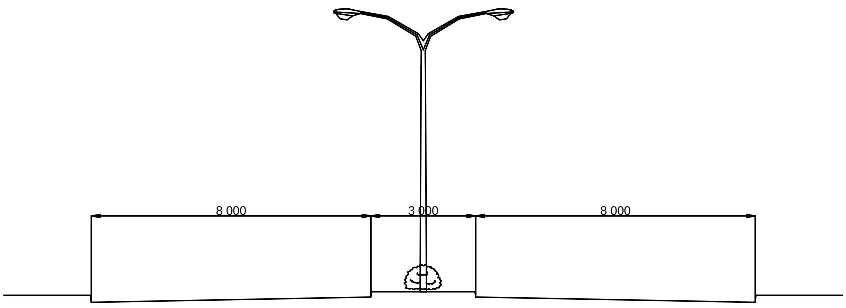


Figure 2.1.3 (3) Existing Cross Section at Cuamba Town

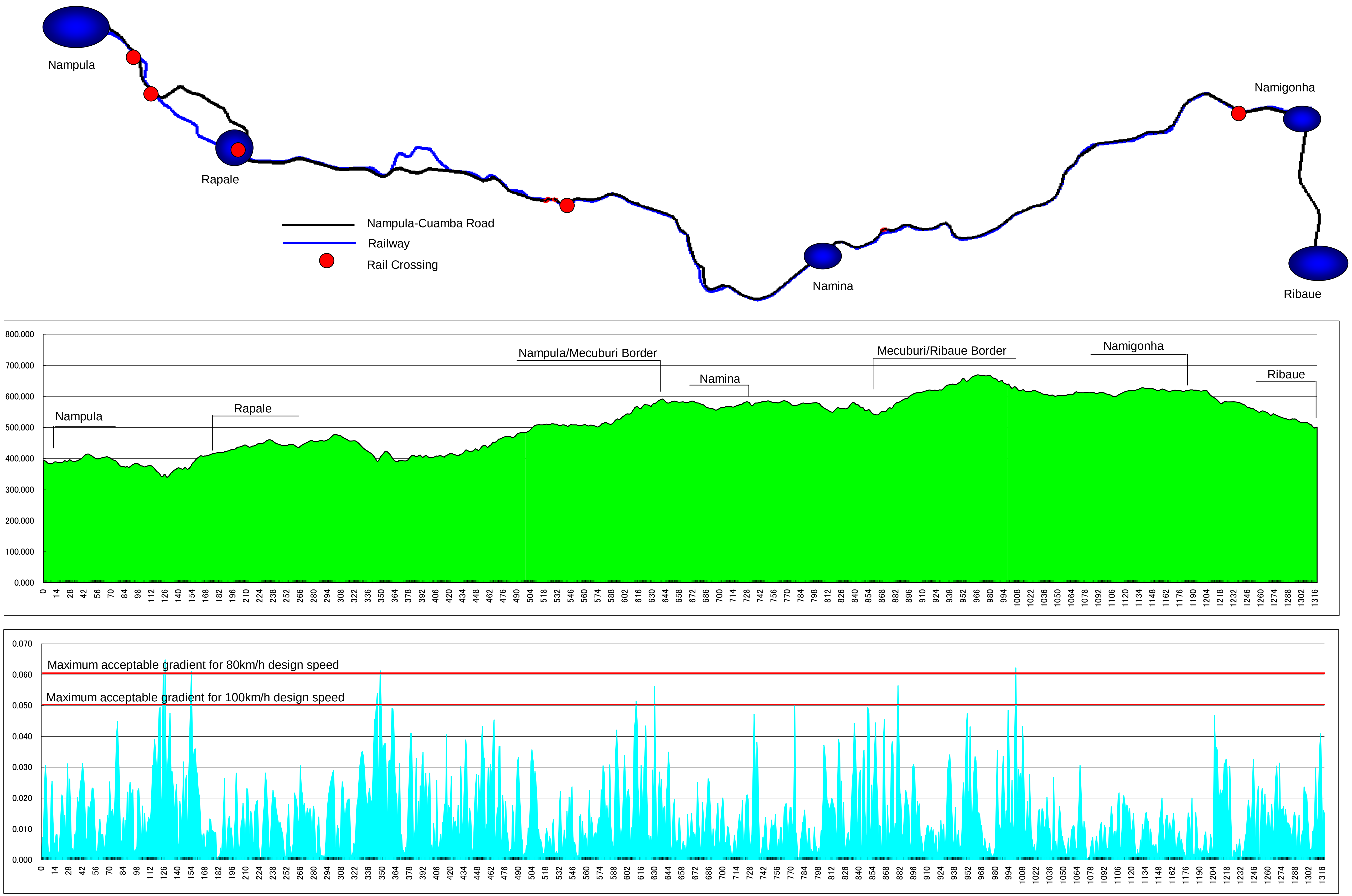


Figure 2.1.4 (1) Existing Horizontal and Vertical Alignment (Nampula – Ribare)

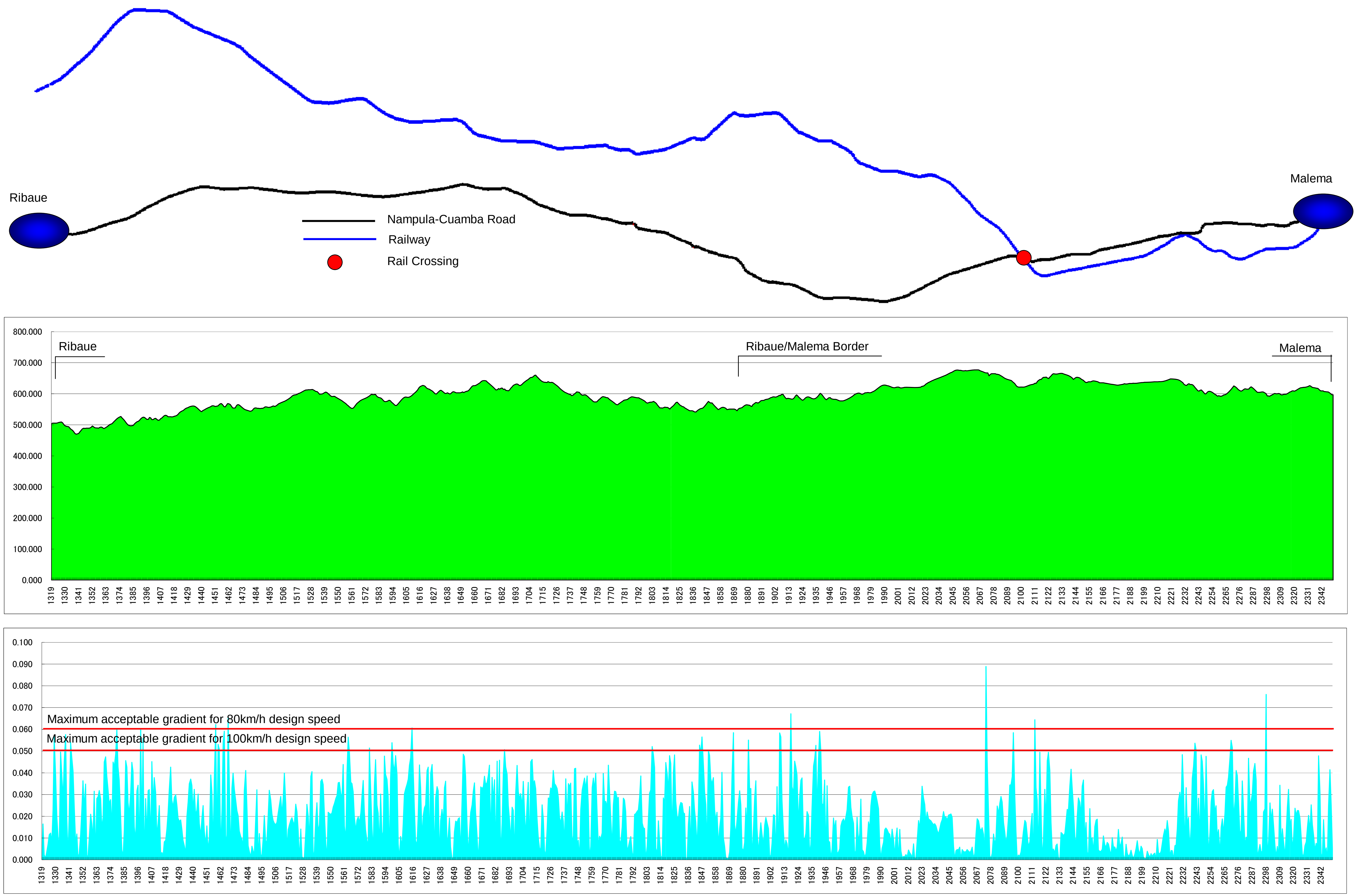


Figure 2.1.4 (2) Existing Horizontal and Vertical Alignment (Ribare - Malema)

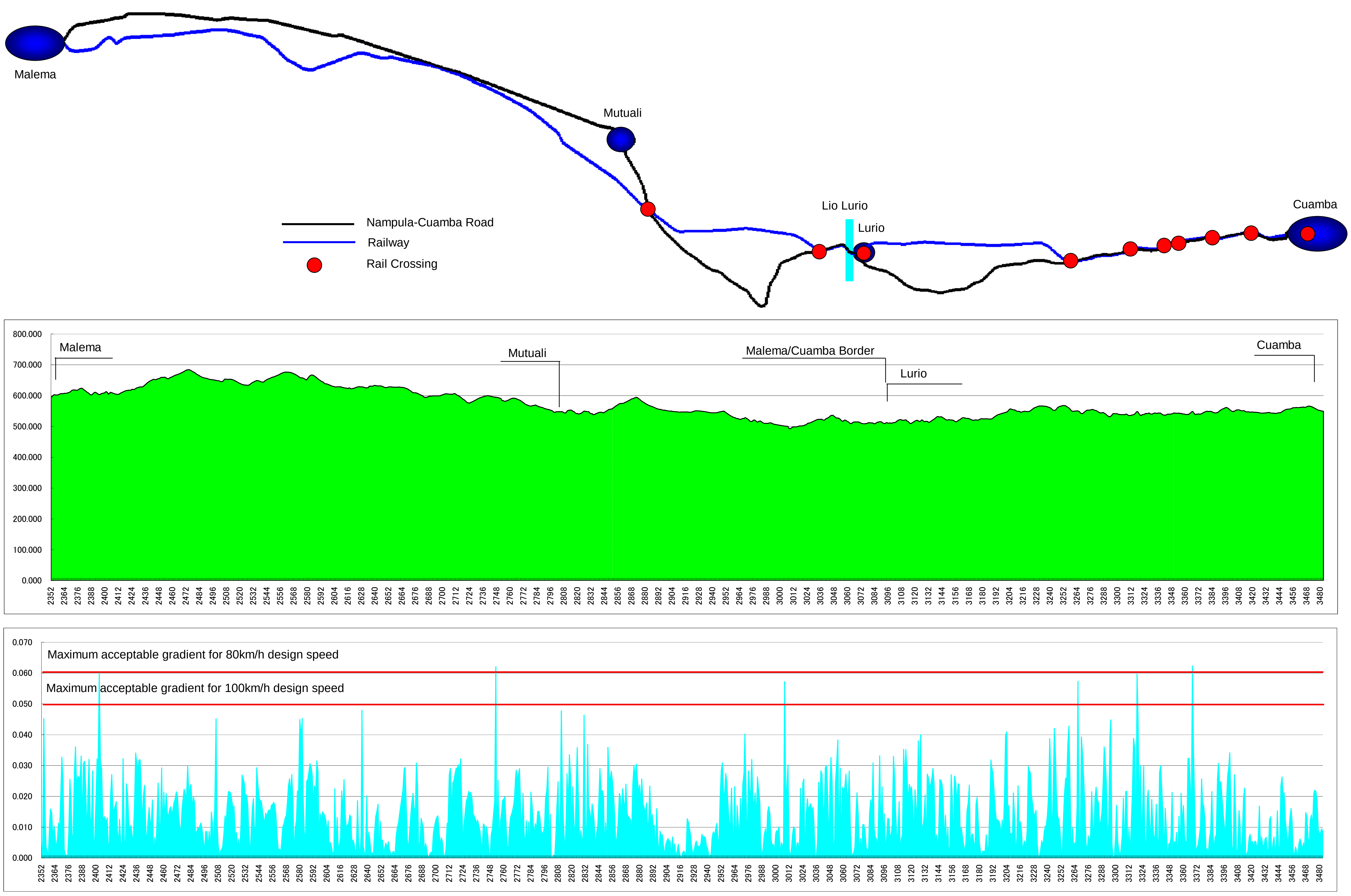


Figure 2.1.4 (3) Existing Horizontal and Vertical Alignment (Malema - Cuamba)

(3) Drainage

Generally, the elevation of the existing Study Road is lower than the surrounding ground. It has an earth/gravel surface with a poorly defined open drainage system. The side-ditches drain surface water through irregularly positioned mitre drains causing concentration of run-off water on the carriageway. Crossing culverts on the Study Road were observed to be located at reasonably regular intervals. Recently, some improvement works for culverts have been executed; including new culvert installation and repair of headwalls on old box culverts. The culverts including their inlets and outlets are generally in a good condition. However the width between culvert headwalls varies according to the existing road width, the terrain. All information for culverts collected for the road inventory survey is summarized in Table 2.1.4 below.

Table 2.1.4 Location of Existing Bridges and Culverts

List of Exisiting Brdiges and Cross Culverts (Nampula - Ribaue)

No.	Ref. No.	Bridge Name	Station	Position	Structure Type	ϕ (m)	Width (m)	Size		Remarks
								B (m)	H (m)	
1	C-1		45	S15 06.640 E39 13.643	Corgate Pipe	1.0	11.0			
2	C-2		846	S15 06.355 E39 13.358	Box Culvert		11.0	0.80	0.60	
3	C-3		1697	S15 06.067 E39 12.990	Corgate Pipe	0.8	11.0			
4	C-4		2430	S15 05.758 E39 12.733	Corgate Pipe	1.4	10.0			Half
5	C-5		3124	S15 05.488 E39 12.463	Corgate Pipe	1.0	10.0			
6	C-6		3410	S15 05.387 E39 12.340	Corgate Pipe	1.0	10.0			
7	C-7		3722	S15 05.242 E39 12.255	Corgate Pipe	1.0	10.0			
8	C-8		4939	S15 04.595 E39 12.135	Corgate Pipe	1.0	10.0			
9	C-9		5970	S15 04.072 E39 11.960	Corgate Pipe	1.0	10.0			
10	C-10		7390	S15 03.527 E39 11.402	Corgate Pipe	1.0	7.0			
11	C-11		7726	S15 03.448 E39 11.237	Corgate Pipe	1.0	7.0			
12	C-12		8042	S15 03.478 E39 11.068	Corgate Pipe	1.0	7.0			
13	C-13		8221	S15 03.537 E39 10.988	Box Culvert		7.0	1.10	0.90	
14	C-14		8439	S15 03.603 E39 10.888	Box Culvert		7.0	1.10	0.90	
15	C-15		8494	S15 03.620 E39 10.862	Corgate Pipe	0.8	11.0			
16	C-16		8845	S15 03.730 E39 10.703	Corgate Pipe	0.8	11.0			
17	C-17		9570	S15 03.922 E39 10.357	Corgate Pipe	1.0	11.0			
18	C-18		10123	S15 03.772 E39 10.095	Corgate Pipe	1.0	6.0			
19	C-19		10481	S15 03.675 E39 09.922	Corgate Pipe	0.8	7.0			
20	C-20		10722	S15 03.642 E39 09.792	Corgate Pipe	0.8	10.0			
21	C-21		11808	S15 03.632 E39 09.745	Corgate Pipe	0.8	8.0			
22	C-22		11697	S15 03.453 E39 09.295	Corgate Pipe	0.8	10.0			
23	C-23		12127	S15 03.318 E39 09.105	Corgate Pipe	1.0	7.0			
24	C-24		12256	S15 03.277 E39 09.040	Corgate Pipe	1.0	8.0			
25	C-25		12695	S15 03.167 E39 08.823	Box Culvert		11.0	0.60	0.80	
26	C-26		12787	S15 03.143 E39 08.778	Corgate Pipe	1.0	7.0			
27	C-27		13119	S15 03.057 E39 08.615	Box Culvert		10.0	0.60	0.80	
28	C-28		13236	S15 03.028 E39 08.557	Corgate Pipe	1.0	11.0			
29	C-29		13448	S15 02.977 E39 08.450	Corgate Pipe	1.0	9.0			
30	C-30		13635	S15 02.930 E39 08.358	Corgate Pipe	0.8	7.0			
31	C-31		13970	S15 02.773 E39 08.275	Corgate Pipe	0.8	11.0			
32	C-32		14029	S15 02.740 E39 08.275	Box Culvert		11.0	1.60	0.70	
33	C-33		14800	S15 02.403 E39 08.088	Box Culvert		11.0	0.50	0.40	
34	C-34		14888	S15 02.382 E39 08.045	Box Culvert		10.0	0.60	1.00	
35	C-35		15606	S15 02.352 E39 07.987	Corgate Pipe	1.0	10.0			
36	C-36		15161	S15 02.315 E39 07.908	Corgate Pipe	1.0	8.0			
37	C-37		15300	S15 02.282 E39 07.838	Box Culvert		9.0	1.90	2.00	
38	C-38		15410	S15 02.263 E39 07.780	Corgate Pipe	1.0	11.0			
39	C-39		15559	S15 02.225 E39 07.708	Corgate Pipe	0.8	11.0			
40	C-40		16040	S15 02.100 E39 07.472	Corgate Pipe	0.8	10.0			
41	C-41		17015	S15 01.632 E39 07.507	Corgate Pipe	0.8	10.0			
42	C-42		18053	S15 01.220 E39 07.897	Corgate Pipe	1.2	8.0			
43	C-43		18373	S15 01.050 E39 07.888	Corgate Pipe	1.0	11.0			
44	C-44		18448	S15 01.028 E39 07.852	Corgate Pipe	1.0	7.0			
45	C-45		19045	S15 00.865 E39 07.592	Corgate Pipe	1.0	7.0			
46	C-46		19773	S15 00.673 E39 07.238	Corgate Pipe	0.6	8.0			
47	C-47		19959	S15 00.642 E39 07.140	Corgate Pipe	0.8	7.0			
48	C-48		21347	S15 00.602 E39 06.367	Corgate Pipe	0.8	7.0			
49	C-49		22340	S15 00.577 E39 05.813	Corgate Pipe	0.6	9.0			
50	C-50		24953	S15 00.622 E39 04.405	Corgate Pipe	0.6	9.0			
51	C-51		26398	S15 00.398 E39 03.633	Corgate Pipe	1.0	10.0			
52	C-52		28230	S15 00.300 E39 02.627	Corgate Pipe	0.8	9.0			
53	C-53		29010	S15 00.315 E39 02.193	Corgate Pipe	0.8	8.0			
54	B-1	Intephe	34608	S15 00.240 E38 59.340	RC T-shaped					
55	B-2	Namuca	36590	S15 00.210 E38 58.260	RC T-shaped					

56	C-54		31796	S15 00.177 E38 57.923	Corgate Pipe	1.0	7.0			
57	C-55		37459	S15 00.162 E38 57.777	Corgate Pipe	1.0	7.0			
58	C-56		38529	S14 59.975 E38 57.217	Corgate Pipe	1.0	7.0			
59	C-57		39260	S14 59.812 E38 56.845	Corgate Pipe	0.8	7.0			
60	B-3	Mutivaze1	40016	S14 59.840 E38 56.460	RC Hollow Slab					Built in 1998 under Japan's Grant Aid
61	C-58		40450	S14 59.900 E38 56.242	Corgate Pipe	0.6	7.0			
62	C-59		40824	S14 59.795 E38 56.063	Corgate Pipe	0.8	7.0			
63	C-60		41460	S14 59.557 E38 55.812	Corgate Pipe	0.6	7.0			
64	C-61		42892	S14 59.190 E38 55.135	Box Culvert		9.0	2.90	1.15	
65	C-62		44230	S14 58.973 E38 54.428	Box Culvert		11.0	1.00	1.00	
66	C-63		45020	S14 58.925 E38 53.988	Corgate Pipe	1.0	7.0			
67	C-64		45925	S14 58.957 E38 53.515	Corgate Pipe	0.6	7.0			
68	C-65		46675	S14 58.780 E38 53.155	Corgate Pipe	1.2	6.0			
69	C-66		48584	S14 58.972 E38 52.192	Corgate Pipe	0.6	6.0			
70	C-67		50003	S14 59.052 E38 51.420	Corgate Pipe	1.0	7.0			
71	C-68		53380	S14 58.697 E38 49.707	Corgate Pipe	0.8	7.0			
72	C-69		54278	S14 58.538 E38 49.235	Corgate Pipe	0.8	7.0			
73	C-70		54879	S14 58.462 E38 48.910	Box Culvert		7.0	1.00	1.00	New
74	C-71		55520	S14 58.333 E38 48.578	Corgate Pipe	0.8	6.0			
75	C-72		56625	S14 57.998 E38 48.102	Corgate Pipe	0.8	6.0			
76	C-73		57307	S14 57.663 E38 47.938	Corgate Pipe	0.8	7.0			
77	C-74		58739	S14 57.063 E38 47.532	Corgate Pipe	0.8	7.0			
78	C-75		60140	S14 56.343 E38 47.300	Corgate Pipe	0.8	7.0			
79	C-76		60664	S14 56.112 E38 47.133	Box Culvert		9.0	1.50	1.00	
80	C-77		60784	S14 56.060 E38 47.092	Box Culvert		7.0	1.00	1.00	New
81	C-78		60784	S14 56.060 E38 47.092	Box Culvert		7.0	1.00	1.00	New
82	C-79		60996	S14 56.000 E38 46.988	Box Culvert		7.0	1.00	1.00	New
83	C-80		61710	S14 55.688 E38 46.920	Corgate Pipe	0.8	9.0			
84	C-81		61818	S14 55.630 E38 46.913	Box Culvert		8.0	1.50	1.00	
85	C-82		62369	S14 55.343 E38 46.848	Box Culvert		7.0	1.00	1.00	New
86	C-83		62875	S14 55.088 E38 46.750	Box Culvert		6.0	2.00	0.90	
87	C-84		64722	S14 55.155 E38 45.800	Corgate Pipe	0.8	7.0			
88	C-85		65889	S14 54.812 E38 45.260	Corgate Pipe	0.8	7.0			
89	C-86		66480	S14 54.677 E38 44.963	Corgate Pipe	0.8	7.0			
90	C-87		67472	S14 54.540 E38 44.430	Corgate Pipe	0.8	7.0			
91	C-88		67897	S14 54.613 E38 44.205	Corgate Pipe	0.8	7.0			
92	C-89		68900	S14 54.832 E38 43.700	Corgate Pipe	0.8	7.0			
93	C-90		69542	S14 55.060 E38 43.428	Corgate Pipe	0.8	7.0			
94	C-91		70278	S14 55.323 E38 43.120	Corgate Pipe	0.8	7.0			
95	C-92		71331	S14 55.682 E38 42.663	Corgate Pipe	0.8	7.0			
96	C-93		73323	S14 56.387 E38 41.823	Corgate Pipe	0.8	7.0			
97	C-94		73782	S14 56.518 E38 41.605	Corgate Pipe	0.8	7.0			
98	C-95		73896	S14 56.557 E38 41.557	Corgate Pipe	0.8	7.0			
99	C-96		74070	S14 56.612 E38 41.478	Corgate Pipe	0.8	7.0			
100	C-97		75571	S14 57.108 E38 40.820	Corgate Pipe	0.8	7.0			
101	C-98		76110	S14 57.035 E38 40.537	Corgate Pipe	0.8	7.0			
102	C-99		76110	S14 57.035 E38 40.537	Corgate Pipe	0.8	7.0			
103	C-100		77467	S14 56.860 E38 39.837	Corgate Pipe	0.8	7.0			
104	C-101		77672	S14 56.907 E38 39.733	Corgate Pipe	0.8	7.0			
105	C-102		78920	S14 57.205 E38 39.117	Corgate Pipe	0.8	7.0			
106	C-103		79183	S14 57.317 E38 39.027	Box Culvert		11.0	1.25	2.90	
107	C-104		81649	S14 57.800 E38 37.900	Corgate Pipe	0.8	7.0			
108	C-105		82485	S14 57.710 E38 37.480	Corgate Pipe	0.8	6.0			
109	C-106		83095	S14 57.632 E38 37.150	Corgate Pipe	0.6	7.0			
110	C-107		84180	S14 57.668 E38 36.547	Corgate Pipe	0.8	7.0			
111	C-108		84648	S14 57.783 E38 36.320	Corgate Pipe	0.8	8.0			
112	C-109		85090	S14 57.905 E38 36.115	Corgate Pipe	0.8	7.0			
113	C-110		86019	S14 57.607 E38 35.760	Corgate Pipe	0.8	6.0			
114	B-4	Mecuburi	86367	S14 57.430 E38 35.690	RC Hollow Slab					Built in 1998 under Japan's Grant Aid
115	C-111		86818	S14 57.272 E38 35.508	Corgate Pipe	0.8	7.0			
116	C-112		87028	S14 57.228 E38 35.400	Corgate Pipe	0.9	7.0			
117	C-113		87189	S14 57.212 E38 35.312	Corgate Pipe	0.9	7.0			
118	B-5	Namialo	87806	S14 57.250 E38 34.970	RC Slab					
119	C-114		89298	S14 57.472 E38 34.180	Corgate Pipe	0.9	6.0			
120	C-115		89535	S14 57.522 E38 34.058	Corgate Pipe	0.9	6.0			
121	C-116		92943	S14 58.468 E38 32.440	Corgate Pipe	1.0	6.0			
122	C-117		93645	S14 58.622 E38 32.082	Corgate Pipe	0.6	6.0			
123	C-118		94252	S14 58.682 E38 31.752	Corgate Pipe	0.8	6.0			
124	C-119		94475	S14 58.703 E38 31.630	Corgate Pipe	0.8	6.0			
125	C-120		95000	S14 58.818 E38 31.360	Corgate Pipe	1.0	6.0			
126	C-121		95618	S14 59.037 E38 31.093	Corgate Pipe	1.0	6.0			
127	C-122		98284	S15 00.313 E38 30.453	Corgate Pipe	1.2	6.0			
128	C-123		98900	S15 00.527 E38 30.192	Corgate Pipe	1.2	6.0			
129	C-124		99722	S15 00.913 E38 29.963	Corgate Pipe	1.2	6.0			
130	C-125		100195	S15 01.095 E38 29.777	Corgate Pipe	1.2	6.0			
131	C-126		101018	S15 01.337 E38 29.393	Corgate Pipe	1.2	6.0			
132	C-127		101709	S15 01.390 E38 29.012	Corgate Pipe	0.8	6.0			
133	C-128		101900	S15 01.402 E38 28.905	Corgate Pipe	0.8	6.0			
134	C-129		103638	S15 01.520 E38 27.943	Corgate Pipe	0.8	6.0			
135	C-130		104069	S15 01.553 E38 27.705	Corgate Pipe	0.8	6.0			
136	C-131		104729	S15 01.670 E38 27.360	Corgate Pipe	0.8	6.0			
137	C-132		105625	S15 01.865 E38 26.903	Corgate Pipe	1.2	6.0			
138	C-133		106467	S15 01.873 E38 26.435	Corgate Pipe	0.8	6.0			
139	C-134		108872	S15 02.685 E38 25.512	Corgate Pipe	0.8	6.0			
140	C-135		110792	S15 03.405 E38 24.803	Corgate Pipe	1.2	6.0			
141	C-136		112900	S15 03.325 E38 23.745	Corgate Pipe	0.8	6.0			
142	C-137		114129	S15 02.993 E38 23.150	Corgate Pipe	0.8	6.0			
143	C-138		115339	S15 02.755 E38 22.540	Corgate Pipe	0.8	6.0			
144	C-139		116460	S15 02.880 E38 21.928	Corgate Pipe	0.8	6.0			
145	C-140		117975	S15 02.842 E38 21.115	Corgate Pipe	0.8	6.0			
146	C-141		118395	S15 02.778 E38 20.880	Corgate Pipe	0.8	6.0			
147	C-142		120381	S15 02.770 E38 19.820	Box Culvert		11.0	1.20	1.50	
148	C-143		120885	S15 02.525 E38 19.745	Corgate Pipe	0.8	8.0			
149	C-144		121059	S15 02.432 E38 19.760	Corgate Pipe	1.0	6.0			
150	C-145		121873	S15 01.995 E38 19.828	Corgate Pipe	1.2	6.0			
151	C-146		122399	S15 01.713 E38 19.870	Corgate Pipe	1.2	6.0			Damp Ground
152	C-147		125795	S14 59.890 E38 20.143	Box Culvert		14.0	1.00	1.00	Damp Ground
153	C-148		128861	S14 58.452 E38 19.297	Corgate Pipe	0.6	9.0			
154	C-149		130301	S14 57.692 E38 19.288	Corgate Pipe	0.8	6.0			
155	C-150		131500	S14 57.053 E38 19.405	Corgate Pipe	0.8	6.0			
156	C-151		131650	S14 56.972 E38 19.420	Corgate Pipe	1.5	9.0			

List of Exisiting Brdiges and Cross Culverts (Ribaue - Malema)

No.	Ref. No.	Bridge Name	Station	Position	Structure Type	ϕ (m)	Width (m)	Size		Remarks
								B (m)	H (m)	
1	C-152		133132	S14 56.403 E38 19.019	Corgate Pipe	0.8	9.0			
2	B-6	Muco	134005	S14 56.541 E38 18.556	RC Slab					Continuous girder
3	C-153		134615	S14 56.568 E38 18.225	Corgate Pipe	1.2	6.0			
4	C-154		134869	S14 56.592 E38 18.087	Corgate Pipe	0.8	6.0			
5	C-155		135438	S14 56.658 E38 17.777	Corgate Pipe	0.8	6.0			
6	C-156		135670	S14 56.687 E38 17.651	Corgate Pipe	0.8	6.0			
7	C-157		136159	S14 56.768 E38 17.391	Corgate Pipe	0.8	6.0			
8	C-158		136808	S14 56.894 E38 17.053	Corgate Pipe	0.8	6.0			
9	C-159		137296	S14 56.996 E38 16.805	Corgate Pipe	0.8	6.0			
10	B-7	Namicuti	138318	S14 57.156 E38 16.259	RC Slab					Continuous girder
11	C-160		139388	S14 57.342 E38 15.696	Corgate Pipe	0.8	6.0			
12	C-161		139645	S14 57.420 E38 15.577	Corgate Pipe	0.8	6.0			
13	C-162		140037	S14 57.545 E38 15.401	Corgate Pipe	1.2	6.0			
14	C-163		140539	S14 57.697 E38 15.168	Corgate Pipe	0.8	6.0			
15	C-164		141320	S14 57.896 E38 14.782	Corgate Pipe	1.0	6.0			
16	C-165		141492	S14 57.939 E38 14.698	Corgate Pipe	0.8	6.0			
17	C-166		141575	S14 57.961 E38 14.657	Corgate Pipe	1.2	6.0			
18	C-167		141780	S14 58.013 E38 14.557	Corgate Pipe	1.2	6.0			
19	C-168		142084	S14 58.094 E38 14.408	Corgate Pipe	1.2	6.0			
20	C-169		144000	S14 58.478 E38 13.417	Corgate Pipe	1.2	5.0			
21	C-170		145185	S14 58.604 E38 12.767	Corgate Pipe	0.8	6.0			
22	C-171		145873	S14 58.612 E38 12.387	Corgate Pipe	0.8	6.0			
23	C-172		146200	S14 58.593 E38 12.207	Corgate Pipe	0.8	6.0			
24	C-173		146550	S14 58.583 E38 12.011	Box Culvert		5.0	0.80	0.80	
25	C-174		146657	S14 58.576 E38 11.952	Box Culvert		5.0	0.80	1.00	
26	B-8	Nepuipui	147993	S14 58.581 E38 11.214	RC Slab					
27	C-175		148567	S14 58.579 E38 10.894	Corgate Pipe	0.8	6.0			
28	C-176		148747	S14 58.571 E38 10.794	Corgate Pipe	0.8	6.0			
29	C-177		148980	S14 58.559 E38 10.665	Box Culvert		5.0	0.60	0.80	
30	B-9	Napala	149320	S14 58.573 E38 10.477	RC Slab					
31	C-178		149930	S14 58.544 E38 10.139	Corgate Pipe	0.9	8.0			
32	C-179		151560	S14 58.429 E38 09.235	Corgate Pipe	1.2	6.0			
33	C-180		151635	S14 58.416 E38 09.196	Corgate Pipe	0.8	6.0			
34	C-181		152002	S14 58.389 E38 08.992	Corgate Pipe	0.8	9.0			
35	C-182		152718	S14 58.345 E38 08.597	Corgate Pipe	0.8	6.0			
36	C-183		153253	S14 58.381 E38 08.300	Corgate Pipe	1.2	6.0			
37	C-184		153339	S14 58.387 E38 08.253	Corgate Pipe	0.8	6.0			
38	C-185		153539	S14 58.395 E38 08.142	Corgate Pipe	1.2	6.0			
39	B-10	Mutololoua	153717	S14 58.406 E38 08.043	RC Slab					
40	C-186		154400	S14 58.414 E38 07.663	Corgate Pipe	0.8	6.0			
41	C-187		154531	S14 58.420 E38 07.589	Corgate Pipe	0.8	5.0			
42	B-11	Natete	156147	S14 58.345 E38 06.692	RC Hollow Slab					Built in 2002 under Japan's Grant Aid
43	C-188		157811	S14 58.232 E38 05.771	Corgate Pipe	0.8	7.0			
44	C-189		158370	S14 58.232 E38 05.460	Corgate Pipe	0.8	7.0			
45	C-190		158672	S14 58.238 E38 05.291	Corgate Pipe	0.6	7.0			
46	C-191		158855	S14 58.243 E38 05.190	Corgate Pipe	0.8	6.0			
47	B-12	Monapo	159640	S14 58.255 E38 04.756	RC Slab					Damp Ground
48	C-192		160392	S14 58.276 E38 04.339	Corgate Pipe	0.8	6.0			
49	C-193		160612	S14 58.304 E38 04.220	Corgate Pipe	1.2	6.0			
50	C-194		160779	S14 58.309 E38 04.128	Corgate Pipe	1.2	6.0			
51	C-195		161527	S14 58.371 E38 03.716	Box Culvert		22.0	0.60	0.80	
52	C-196		162256	S14 58.414 E38 03.311	Corgate Pipe	1.2	6.0			
53	C-197		162862	S14 58.467 E38 02.977	Corgate Pipe	1.2	6.0			Damp Ground
54	C-198		163641	S14 58.542 E38 02.549	Corgate Pipe	0.8	10.0			Damp Ground
55	C-199		163988	S14 58.577 E38 02.360	Corgate Pipe	1.0	6.0			Damp Ground
56	C-200		164590	S14 58.663 E38 02.036	Corgate Pipe	1.2	5.0			Damp Ground
57	C-201		164750	S14 58.684 E38 01.949	Corgate Pipe	0.6	9.0			Damp Ground
58	C-202		165128	S14 58.725 E38 01.743	Corgate Pipe	1.2	6.0			Damp Ground
59	B-13	ThiThi	165348	S14 58.726 E38 01.622	RC Hollow Slab					Built in 1998 under Japan's Grant Aid
60	C-203		165958	S14 58.599 E38 01.310	Corgate Pipe	0.8	6.0			
61	C-204		167710	S14 58.525 E38 00.339	Box Culvert		6.0	1.20	1.50	
62	C-205		168020	S14 58.521 E38 00.166	Corgate Pipe	0.8	9.0			
63	C-206		168178	S14 58.536 E38 00.080	Corgate Pipe	0.8	6.0			
64	C-207		168338	S14 58.536 E37 59.996	Corgate Pipe	1.2	6.0			
65	C-208		168470	S14 58.516 E37 59.921	Corgate Pipe	1.0	6.0			
66	C-209		168670	S14 58.472 E37 59.819	Corgate Pipe	1.0	9.0			
67	C-210		169635	S14 58.280 E37 59.323	Box Culvert		9.0	1.20	1.50	
68	C-211		171745	S14 57.717 E37 58.304	Corgate Pipe	1.2	6.0			
69	C-212		173352	S14 57.392 E37 57.473	Corgate Pipe	0.6	8.0			
70	C-213		173591	S14 57.365 E37 57.343	Box Culvert		9.0	1.00	1.00	
71	C-214		173809	S14 57.349 E37 57.223	Corgate Pipe	1.0	6.0			
72	C-215		173842	S14 57.347 E37 57.204	Corgate Pipe	0.8	8.0			
73	C-216		174675	S14 57.342 E37 56.741	Box Culvert		6.0	3.25	2.00	
74	B-14	Naiua	175700	S14 57.251 E37 56.180	RC T-shaped					
75	B-15	Nampaua	177420	S14 57.028 E37 55.252	RC T-shaped					Damp Ground
76	C-217		179890	S14 56.668 E37 54.023	Corgate Pipe	1.2	6.0			
77	C-218		180181	S14 56.634 E37 53.864	Corgate Pipe	0.8	6.0			
78	B-16	Iuhapua	181013	S14 56.581 E37 53.405	RC T-shaped					
79	C-219		181372	S14 56.538 E37 53.210	Corgate Pipe	0.8	7.0			
80	C-220		181698	S14 56.460 E37 53.048	Corgate Pipe	1.0	4.0			
81	C-221		183381	S14 56.057 E37 52.206	Corgate Pipe	1.0	6.0			
82	C-222		183480	S14 56.036 E37 52.157	Corgate Pipe	1.0	6.0			
83	B-17		183785	S14 55.911 E37 52.052	RC T-shaped					
84	C-223		185036	S14 55.706 E37 51.405	Corgate Pipe	1.0	9.0			
85	B-18		185603	S14 55.606 E37 51.113	RC Slab					
86	C-224		186340	S14 55.496 E37 50.717	Box Culvert		9.0	3.25	2.00	
87	B-19	Lalaua	187090	S14 55.400 E37 50.313	RC Slab					
88	C-225		188270	S14 54.916 E37 49.903	Corgate Pipe	1.0	5.0			
89	C-226		188787	S14 54.744 E37 49.704	Corgate Pipe	1.2	5.0			
90	C-227		190155	S14 54.362 E37 49.045	Corgate Pipe	0.8	8.0			

91	C-228		190600	S14 54.332 E37 48.800	Corgate Pipe	1.2	6.0			
92	C-229		191100	S14 54.302 E37 48.527	Corgate Pipe	0.4	5.0			
93	C-230		191341	S14 54.286 E37 48.393	Corgate Pipe	0.4	7.0			
94	C-231		191587	S14 54.262 E37 48.258	Box Culvert		9.0	0.80	0.80	
95	C-232		192428	S14 54.182 E37 47.805	Corgate Pipe	1.0	8.0			
96	C-233		193230	S14 53.978 E37 47.410	Corgate Pipe	1.0	7.0			
97	C-234		193378	S14 53.940 E37 47.338	Corgate Pipe	1.0	7.0			
98	C-235		193440	S14 53.924 E37 47.306	Corgate Pipe	1.0	7.0			
99	C-236		194307	S14 53.709 E37 46.877	Box Culvert		12.0	3.25	2.00	
100	C-237		194810	S14 53.591 E37 46.621	Corgate Pipe	0.4	11.0			
101	C-238		195179	S14 53.606 E37 46.415	Corgate Pipe	1.0	11.0			Damp Ground
102	B-20		195519	S14 53.617 E37 46.225	RC T-shaped					
103	C-239		196100	S14 53.632 E37 45.901	Box Culvert		6.0	0.80	0.60	
104	C-240		197241	S14 53.592 E37 45.263	Corgate Pipe	1.0	6.0			
105	C-241		197849	S14 53.559 E37 44.935	Box Culvert		14.0	3.25	2.00	
106	C-242		198108	S14 53.545 E37 44.791	Box Culvert		14.0	1.20	1.50	
107	C-243		199781	S14 53.466 E37 43.864	Corgate Pipe	1.2	9.0			
108	C-244		200318	S14 53.546 E37 43.577	Corgate Pipe	1.0	6.0			
109	C-245		201258	S14 53.705 E37 43.079	Corgate Pipe	1.0	14.0			
110	C-246		201765	S14 53.838 E37 42.831	Box Culvert		14.0	3.25	2.00	Damp Ground
111	C-247		203793	S14 54.361 E37 41.836	Corgate Pipe	1.0	8.0			
112	C-248		204797	S14 54.622 E37 41.345	Corgate Pipe	1.0	6.0			
113	C-249		205479	S14 54.730 E37 40.981	Corgate Pipe	1.0	6.0			
114	C-250		207440	S14 55.063 E37 39.943	Box Culvert		14.0	3.25	2.00	
115	C-251		209010	S14 55.324 E37 39.110	Corgate Pipe	1.2	16.0			
116	C-252		209515	S14 55.413 E37 38.844	Corgate Pipe	1.0	9.0			
117	C-253		209715	S14 55.447 E37 38.738	Corgate Pipe	1.2	6.0			
118	C-254		209847	S14 55.449 E37 38.663	Corgate Pipe	0.8	8.0			
119	B-21	Niose	210022	S14 55.425 E37 38.569	RC Slab					Repired in 2002 under Japan's Grant Aid
120	C-255		210776	S14 55.274 E37 38.181	Corgate Pipe	1.0	6.0			
121	C-256		211430	S14 55.205 E37 37.829	Box Culvert		7.0	0.80	1.20	
122	C-257		211602	S14 55.190 E37 37.733	Box Culvert		5.0	1.00	1.00	
123	C-258		211919	S14 55.230 E37 37.566	Corgate Pipe	1.2	6.0			
124	C-259		212199	S14 55.262 E37 37.414	Corgate Pipe	1.2	5.0			
125	B-22	Tiwa	212811	S14 55.276 E37 37.073	RC T-shaped					bridge with angle
126	B-23		214188	S14 55.460 E37 36.330	RC Slab					
127	C-260		215268	S14 55.487 E37 35.733	Box Culvert		14.0	3.25	2.00	Damp Ground
128	C-261		215530	S14 55.485 E37 35.586	Corgate Pipe	0.8	6.0			Damp Ground
129	C-262		216492	S14 55.630 E37 35.082	Corgate Pipe	0.8	8.0			Damp Ground
130	C-263		217588	S14 55.774 E37 34.490	Corgate Pipe	1.2	6.0			Damp Ground
131	C-264		217830	S14 55.802 E37 34.357	Corgate Pipe	1.0	6.0			
132	C-265		217838	S14 55.804 E37 34.354	Corgate Pipe	1.2	6.0			
133	C-266		217867	S14 55.808 E37 34.338	Corgate Pipe	1.0	6.0			
134	C-267		219009	S14 55.924 E37 33.712	Corgate Pipe	1.2	7.0			
135	C-268		219350	S14 55.961 E37 33.526	Corgate Pipe	1.2	6.0			
136	C-269		220170	S14 56.083 E37 33.086	Corgate Pipe	0.4	6.0			
137	C-270		220670	S14 56.156 E37 32.817	Corgate Pipe	1.2	7.0			
138	C-271		221130	S14 56.216 E37 32.567	Corgate Pipe	1.2	7.0			
139	C-272		223043	S14 56.402 E37 31.521	Corgate Pipe	2.0	7.0			
140	C-273		224265	S14 56.406 E37 30.842	Corgate Pipe	1.2	7.0			
141	C-274		224790	S14 56.583 E37 30.646	Corgate Pipe	2.0	7.0			Damp Ground
142	C-275		225704	S14 56.803 E37 30.264	Corgate Pipe	1.0	7.0			Damp Ground
143	B-24	Nataleia	226032	S14 56.817 E37 30.082	RC Slab					
144	B-25	Maposo	226590	S14 56.838 E37 29.771	RC Slab					Damp Ground
145	C-276		228243	S14 56.795 E37 28.854	Corgate Pipe	1.2	7.0			Damp Ground
146	C-277		229038	S14 56.756 E37 28.414	Corgate Pipe	1.2	7.0			
147	B-26	Mupari	229940	S14 56.733 E37 27.921	RC Slab					
148	C-278		230610	S14 56.747 E37 27.558	Corgate Pipe	0.4	6.0			
149	C-279		230951	S14 56.698 E37 27.375	Corgate Pipe	1.2	6.0			
150	C-280		231308	S14 56.692 E37 27.177	Corgate Pipe	2.0	7.0			
151	C-281		232000	S14 56.829 E37 26.831	Corgate Pipe	2.0	8.0			
152	C-282		232521	S14 56.879 E37 26.552	Corgate Pipe	2.0	8.0			
153	C-283		232783	S14 56.964 E37 26.437	Corgate Pipe	0.8	7.0			
154	C-284		234237	S14 57.083 E37 25.638	Corgate Pipe	2.0	7.0			
155	C-285		234595	S14 57.123 E37 25.443	Box Culvert		9.0	0.80	1.20	
156	C-286		235065	S14 57.132 E37 25.186	Box Culvert		5.0	1.00	1.50	

List of Exisiting Brdiges and Cross Culverts (Malema - Cuamba)

No.	Ref. No.	Bridge Name	Station	Position	Structure Type	ϕ (m)	Width (m)	Size		Remarks
								B (m)	H (m)	
1	B-27	Mutivaze2	235260	S14 57.068 E37 25.103	RC Slab					
2	C-287		237510	S14 57.574 E37 24.335	Corgate Pipe	0.4	8.0			
3	C-288		238900	S14 57.696 E37 23.571	Box Culvert		5.0	3.25	2.00	Damp Ground
4	C-289		239304	S14 57.729 E37 23.348	Corgate Pipe	2.0	8.0			Damp Ground
5	C-290		240370	S14 57.856 E37 22.769	Corgate Pipe	2.0	8.0			
6	B-28	Malema	241018	S14 57.890 E37 22.415	PC T-shaped					Variable depth girder
7	C-291		242572	S14 58.050 E37 21.621	Corgate Pipe	1.0	6.0			
8	C-292		243300	S14 58.037 E37 21.215	Corgate Pipe	1.0	6.0			Damp Ground
9	C-293		244445	S14 58.025 E37 20.577	Corgate Pipe	1.0	6.0			
10	C-294		245095	S14 58.005 E37 20.216	Corgate Pipe	1.0	6.0			
11	C-295		245623	S14 57.977 E37 19.922	Corgate Pipe	2.0	8.0			
12	C-296		245795	S14 57.963 E37 19.828	Corgate Pipe	2.0	8.0			
13	C-297		246022	S14 57.944 E37 19.702	Corgate Pipe	2.0	8.0			
14	C-298		249535	S14 57.827 E37 17.766	Corgate Pipe	2.0	7.0			
15	C-299		250360	S14 57.786 E37 17.310	Corgate Pipe	2.0	8.0			
16	C-300		252310	S14 57.722 E37 16.223	Corgate Pipe	2.0	8.0			Damp Ground
17	C-301		252681	S14 57.677 E37 16.022	3-Corgate Pipe Culvert	2.0	6.0			
18	C-302		253969	S14 57.526 E37 15.322	Corgate Pipe	1.2	5.0			
19	C-303		257520	S14 57.054 E37 13.401	Corgate Pipe	0.6	6.0			
20	B-29		257855	S14 57.037 E37 13.218	RC Slab					Damp Ground
21	C-304		259548	S14 56.867 E37 12.308	Corgate Pipe	2.0	8.0			
22	C-305		260526	S14 56.702 E37 11.790	Corgate Pipe	2.0	88.0			
23	C-306		260856	S14 56.650 E37 11.614	Corgate Pipe	1.2	6.0			
24	C-307		261085	S14 56.611 E37 11.493	Corgate Pipe	0.8	6.0			Damp Ground
25	C-308		261115	S14 56.605 E37 11.477	Corgate Pipe	2.0	8.0			Damp Ground
26	C-309		161385	S14 56.551 E37 11.337	Corgate Pipe	2.0	8.0			
27	C-310		261581	S14 56.513 E37 11.235	Corgate Pipe	1.2	6.0			
28	C-311		261891	S14 56.453 E37 11.074	Corgate Pipe	1.2	6.0			
29	C-312		262821	S14 56.280 E37 10.587	Corgate Pipe	1.2	6.0			
30	C-313		263278	S14 56.204 E37 10.345	Corgate Pipe	0.8	7.0			
31	B-30	Namuela	263365	S14 56.190 E37 10.298	Bailey					
32	C-314		263700	S14 56.132 E37 10.121	Corgate Pipe	2.0	7.0			
33	C-315		264829	S14 55.944 E37 09.522	Corgate Pipe	1.2	7.0			
34	C-316		264953	S14 55.922 E37 09.456	Corgate Pipe	1.2	6.0			
35	C-317		265755	S14 55.776 E37 09.035	Corgate Pipe	1.2	6.0			
36	C-318		267540	S14 55.487 E37 08.088	Corgate Pipe	1.2	6.0			
37	C-319		268400	S14 55.336 E37 07.634	Corgate Pipe	1.2	6.0			
38	C-320		269551	S14 55.108 E37 07.036	Corgate Pipe	1.2	7.0			
39	C-321		270770	S14 54.861 E37 06.406	Corgate Pipe	1.2	6.0			
40	C-322		272238	S14 54.569 E37 05.652	Corgate Pipe	1.2	6.0			
41	C-323		272321	S14 54.553 E37 05.608	Corgate Pipe	1.2	6.0			
42	C-324		275490	S14 53.918 E37 03.967	Corgate Pipe	1.2	6.0			
43	C-325		277748	S14 53.463 E37 02.798	Corgate Pipe	1.2	6.0			
44	C-326		277822	S14 53.448 E37 02.759	Corgate Pipe	1.2	6.0			
45	C-327		279994	S14 53.051 E37 01.623	Corgate Pipe	1.2	6.0			
46	C-328		280379	S14 53.004 E37 01.414	Corgate Pipe	1.2	6.0			
47	B-31	Malume	280836	S14 52.898 E37 01.190	PC T-shaped					Variable depth girder
48	C-329		281810	S14 52.671 E37 00.718	Corgate Pipe	1.2	6.0			
49	C-330		281910	S14 52.662 E37 00.663	Corgate Pipe	1.2	7.0			
50	B-32	Nuail	282188	S14 52.607 E37 00.520	PC T-shaped +RC Slab					Variable depth girder+eaqual one
51	C-331		282738	S14 52.400 E37 00.394	Corgate Pipe	1.2	7.0			
52	C-332		283150	S14 52.242 E37 00.556	Corgate Pipe	1.2	9.0			
53	C-333		283420	S14 52.147 E37 00.671	Corgate Pipe	1.2	9.0			
54	C-334		284300	S14 51.726 E37 00.693	Corgate Pipe	0.8	7.0			
55	C-335		284872	S14 51.450 E37 00.548	Corgate Pipe	0.8	7.0			
56	C-336		285015	S14 51.382 E37 00.510	Corgate Pipe	1.0	7.0			
57	C-337		286030	S14 50.910 E37 00.219	Corgate Pipe	1.0	7.0			
58	C-338		286361	S14 50.745 E37 00.146	Corgate Pipe	2.0	7.0			
59	C-339		287220	S14 50.310 E36 59.978	Corgate Pipe	1.2	6.0			
60	C-340		287920	S14 49.935 E36 59.927	Corgate Pipe	1.2	6.0			
61	C-341		288341	S14 49.713 E36 59.868	Corgate Pipe	1.2	6.0			
62	C-342		288502	S14 49.626 E36 59.854	Corgate Pipe	0.8	6.0			
63	C-343		288748	S14 49.502 E36 59.809	Corgate Pipe	0.8	6.0			
64	C-344		289680	S14 49.087 E36 59.520	Box Culvert		7.0	1.00	1.00	
65	C-345		290255	S14 48.830 E36 59.339	Corgate Pipe	1.0	6.0			
66	C-346		290350	S14 48.788 E36 59.307	Corgate Pipe	0.8	6.0			
67	C-347		290500	S14 48.725 E36 59.256	Corgate Pipe	0.8	6.0			
68	C-348		290788	S14 48.596 E36 59.167	Corgate Pipe	1.2	6.0			
69	C-349		290987	S14 48.513 E36 59.095	Corgate Pipe	1.0	6.0			
70	C-350		292092	S14 48.097 E36 58.653	Corgate Pipe	1.2	6.0			
71	C-351		294035	S14 47.436 E36 57.822	Corgate Pipe	0.8	6.0			
72	C-352		295816	S14 46.892 E36 57.019	Corgate Pipe	0.8	6.0			
73	C-353		296252	S14 46.824 E36 56.788	Corgate Pipe	0.8	7.0			
74	C-354		296414	S14 46.777 E36 56.713	Corgate Pipe	1.2	7.0			
75	C-355		296740	S14 46.663 E36 56.573	Corgate Pipe	1.2	7.0			
76	C-356		297426	S14 46.424 E36 56.283	Corgate Pipe	1.2	6.0			
77	C-357		298005	S14 46.250 E36 56.014	Corgate Pipe	0.8	6.0			
78	C-358		298730	S14 46.053 E36 55.666	Corgate Pipe	0.8	6.0			
79	B-33		300835	S14 45.410 E36 54.843	Steel Truss					
80	C-359		301180	S14 45.588 E36 54.778	Corgate Pipe	0.8	6.0			
81	C-360		301328	S14 45.665 E36 54.755	Corgate Pipe	0.8	7.0			
82	C-361		301388	S14 45.697 E36 54.750	Corgate Pipe	0.8	6.0			
83	C-362		301459	S14 45.735 E36 54.745	Corgate Pipe	0.8	6.0			
84	C-363		301840	S14 45.939 E36 54.707	Corgate Pipe	0.8	6.0			
85	C-364		302066	S14 46.055 E36 54.667	Corgate Pipe	0.8	6.0			
86	C-365		302335	S14 46.193 E36 54.622	Corgate Pipe	0.8	6.0			
87	C-366		302590	S14 46.327 E36 54.583	Corgate Pipe	1.2	6.0			
88	C-367		303628	S14 46.815 E36 54.307	Corgate Pipe	1.2	6.0			
89	C-368		303998	S14 46.950 E36 54.250	Corgate Pipe	1.2	6.0			
90	C-369		305040	S14 47.324 E36 53.800	Corgate Pipe	1.2	6.0			

91	C-370		305560	S14 47.429 E36 53.531	Corgate Pipe	1.2	6.0			
92	C-371		306300	S14 47.611 E36 53.166	Corgate Pipe	1.2	6.0			
93	C-372		307311	S14 47.683 E36 52.610	Corgate Pipe	0.4	6.0			
94	C-373		307455	S14 47.702 E36 52.535	Corgate Pipe	1.2	6.0			
95	C-374		307521	S14 47.690 E36 52.499	Corgate Pipe	1.0	6.0			
96	C-375		308439	S14 47.805 E36 52.019	Corgate Pipe	1.2	6.0			
97	C-376		309327	S14 47.942 E36 51.542	Corgate Pipe	1.2	7.0			
98	C-377		309660	S14 47.875 E36 51.377	Corgate Pipe	1.2	6.0			
99	B-34	Lurio	309860	S14 47.788 E36 51.311	RC T-shaped					Only road section
100	C-378		311100	S14 47.417 E36 50.774	Corgate Pipe	1.2	7.0			
101	C-379		311322	S14 47.311 E36 50.714	Corgate Pipe	1.2	7.0			
102	C-380		311610	S14 47.197 E36 50.607	Corgate Pipe	1.2	7.0			
103	C-381		312450	S14 46.953 E36 50.224	Corgate Pipe	1.2	7.0			
104	C-382		312815	S14 46.894 E36 50.030	Corgate Pipe	2.0	7.0			
105	C-383		313257	S14 46.846 E36 49.790	Corgate Pipe	2.0	7.0			
106	C-384		314265	S14 46.601 E36 49.290	Corgate Pipe	1.2	7.0			
107	C-385		314848	S14 46.410 E36 49.033	Corgate Pipe	2.0	7.0			
108	C-386		315310	S14 46.243 E36 48.842	Corgate Pipe	1.2	7.0			
109	C-387		315695	S14 46.147 E36 48.648	4-Corgate Pipe Culvert	2.0	7.0			
110	C-388		317140	S14 45.965 E36 47.877	Corgate Pipe	1.2	7.0			
111	C-389		317590	S14 45.926 E36 47.631	Corgate Pipe	1.2	7.0			
112	C-390		318072	S14 45.874 E36 47.368	Corgate Pipe	1.2	7.0			
113	C-391		318719	S14 45.906 E36 47.012	Corgate Pipe	2.0	7.0			
114	C-392		320000	S14 46.016 E36 46.307	Corgate Pipe	1.2	7.0			
115	C-393		320730	S14 46.187 E36 45.966	Corgate Pipe	1.2	7.0			
116	C-394		321154	S14 46.281 E36 45.760	Corgate Pipe	1.2	7.0			
117	C-395		321199	S14 46.286 E36 45.737	Corgate Pipe	1.2	7.0			
118	C-396		321438	S14 46.314 E36 45.607	Corgate Pipe	1.2	7.0			
119	C-397		322020	S14 46.502 E36 45.351	Corgate Pipe	1.2	7.0			
120	C-398		322182	S14 46.563 E36 45.286	Corgate Pipe	1.2	7.0			
121	C-399		324362	S14 47.038 E36 44.229	Corgate Pipe	1.2	7.0			
122	C-400		324422	S14 47.044 E36 44.196	Corgate Pipe	2.0	7.0			
123	C-401		326019	S14 47.191 E36 43.330	Corgate Pipe	1.2	7.0			
124	C-402		326910	S14 47.198 E36 42.833	2-Corgate Pipe Culvert	2.0	7.0			
125	C-403		327586	S14 47.084 E36 42.478	Corgate Pipe	1.2	7.0			
126	C-404		327962	S14 47.067 E36 42.269	Corgate Pipe	1.2	7.0			
127	C-405		328539	S14 47.074 E36 41.949	Corgate Pipe	1.2	7.0			
128	C-406		328970	S14 47.089 E36 41.710	Corgate Pipe	1.2	7.0			
129	B-35	Murusso	329230	S14 47.138 E36 41.579	RC Hollow Slab					Built in 2002 under Japan's Grant Aid
130	C-407		329990	S14 47.238 E36 41.167	Corgate Pipe	0.8	7.0			
131	C-408		330122	S14 47.238 E36 41.093	Corgate Pipe	1.2	7.0			
132	C-409		330321	S14 47.248 E36 40.983	Corgate Pipe	1.2	7.0			
133	C-410		330595	S14 47.302 E36 40.844	Corgate Pipe	1.2	7.0			
134	C-411		330665	S14 47.320 E36 40.808	Corgate Pipe	1.2	7.0			
135	C-412		331053	S14 47.377 E36 40.602	Corgate Pipe	2.0	7.0			
136	C-413		331275	S14 47.381 E36 40.479	Corgate Pipe	0.8	7.0			
137	C-414		331425	S14 47.383 E36 40.394	Corgate Pipe	2.0	7.0			
138	C-415		332134	S14 47.393 E36 40.023	Corgate Pipe	1.2	7.0			
139	C-416		332268	S14 47.401 E36 39.951	Corgate Pipe	0.8	7.0			
140	C-417		332630	S14 47.455 E36 39.756	Corgate Pipe	1.2	7.0			
141	C-418		332972	S14 47.466 E36 39.567	Corgate Pipe	1.2	7.0			
142	C-419		333459	S14 47.513 E36 39.301	Corgate Pipe	1.2	7.0			
143	C-420		333718	S14 47.566 E36 39.167	Corgate Pipe	1.2	7.0			
144	C-421		334100	S14 47.616 E36 38.960	2-Corgate Pipe Culvert	2.0	7.0			
145	C-422		334640	S14 47.596 E36 38.662	Corgate Pipe	1.2	7.0			
146	C-423		334822	S14 47.601 E36 38.559	Corgate Pipe	1.2	7.0			
147	C-424		334885	S14 47.600 E36 38.525	Corgate Pipe	0.8	7.0			
148	C-425		335348	S14 47.574 E36 38.269	Corgate Pipe	1.2	7.0			
149	C-426		335620	S14 47.569 E36 38.117	Corgate Pipe	1.2	7.0			
150	C-427		335820	S14 47.590 E36 38.009	Corgate Pipe	1.2	7.0			
151	C-428		336072	S14 47.623 E36 37.872	Corgate Pipe	1.2	7.0			
152	C-429		336285	S14 47.669 E36 37.763	Corgate Pipe	1.2	7.0			
153	C-430		336360	S14 47.692 E36 37.733	Corgate Pipe	0.6	7.0			
154	C-431		336845	S14 47.781 E36 37.530	Corgate Pipe	1.2	7.0			
155	C-432		336890	S14 47.779 E36 37.505	Corgate Pipe	1.2	7.0			
156	C-433		337130	S14 47.841 E36 37.388	Corgate Pipe	2.0	7.0			
157	C-434		337330	S14 47.868 E36 37.282	2-Corgate Pipe Culvert	1.2	7.0			
158	C-435		337399	S14 47.877 E36 37.245	Corgate Pipe	2.0	7.0			
159	C-436		338070	S14 47.942 E36 36.877	Corgate Pipe	1.2	7.0			
160	C-437		338568	S14 47.963 E36 36.602	Corgate Pipe	1.2	7.0			
161	C-438		338704	S14 47.969 E36 36.523	4-Corgate Pipe Culvert	2.0	7.0			
162	C-439		338708	S14 47.971 E36 36.526	Corgate Pipe	1.2	7.0			
163	C-440		340160	S14 48.124 E36 35.736	Corgate Pipe	1.2	7.0			
164	C-441		340490	S14 48.108 E36 35.556	Corgate Pipe	1.2	7.0			
165	C-442		341039	S14 48.083 E36 35.255	Corgate Pipe	1.2	7.0			
166	C-443		341448	S14 48.119 E36 35.031	Corgate Pipe	1.2	7.0			
167	C-444		341617	S14 48.138 E36 34.939	Corgate Pipe	0.8	7.0			
168	C-445		341921	S14 48.175 E36 34.773	Corgate Pipe	1.2	7.0			
169	C-446		342250	S14 48.213 E36 34.595	Corgate Pipe	1.2	7.0			
170	C-447		342567	S14 48.238 E36 34.418	Corgate Pipe	1.2	7.0			
171	C-448		342729	S14 48.241 E36 34.331	3-Corgate Pipe Culvert	1.2	7.0			
172	C-449		342895	S14 48.250 E36 34.239	Corgate Pipe	0.8	7.0			
173	B-36	Namutimbua	343920	S14 48.215 E36 33.680	RC Hollow Slab					Built in 2003 under Japan's Grant Aid
174	C-450		344155	S14 48.161 E36 33.561	Corgate Pipe	0.8	7.0			
175	C-451		344411	S14 48.108 E36 33.429	Corgate Pipe	1.2	7.0			
176	C-452		345122	S14 47.973 E36 33.057	Corgate Pipe	0.8	7.0			
177	C-453		346580	S14 48.158 E36 32.419	Corgate Pipe	0.8	7.0			
178	C-454		346636	S14 48.180 E36 32.415	Corgate Pipe	0.8	7.0			
179	C-455		346683	S14 48.201 E36 32.402	Corgate Pipe	1.2	7.0			
180	C-456		347800	S14 48.395 E36 31.843	Corgate Pipe	0.8	7.0			
181	C-457		347990	S14 48.401 E36 31.737	2-Corgate Pipe Culvert	1.2	7.0			
182	C-458		348240	S14 48.339 E36 31.614	Corgate Pipe	0.8	7.0			

2.1.5 Analysis of Findings for Formulating Up-grading Concepts

(1) Introduction

The following chart describes the relationship between the factors to be considered for formulating the upgrading concepts (and its particular items) for the Study Road. These factors will be discussed in more detail in Chapter 7. Based on these relationships, findings from the road inventory survey are further analyzed and its results will form a basis defining the upgrading concepts.

【Factors to be considered】	【Items of Upgrading Concepts】
A) Design Speed as National Trunk Road	Road Alignment and Road Width Road Surface
B) Securing all-year passage for transport route	Drainage Facilities Road Surface
C) Securing traffic safety for road users	Road Safety Facilities Bypass Route
D) Minimizing negative impacts by increased traffic	Bypass Route

(2) Analysis Results

1) Necessity of Improvement of Road Alignment

<u>Horizontal Alignment</u>

The existing horizontal alignment is not appropriate for "high" speed driving. In particular the length and radius of curves, and sharp angled crossings of railway lines in the section between Mutuali and Cuamba are unacceptable with a view to road safety standards. At some intersections the Study Road meets other access roads at right angles along the horizontal alignment. These aspects should be improved.

<u>Vertical Alignment</u>

The vertical alignment poses less of a problem for "high" speed driving and road safety standards. Road surface erosion, the existence of damp/wet areas and the elevation gap between the road alignment and the railway crossing need to be addressed in the upgrading concepts. In some problematic sections, the vertical alignment should be improved by establishing a gentle gradient and elevating the road surface.

2) Necessity of Improvement of Road Surface

During the rainy season, most sections of the Study Road suffer from erosion by heavy rainfall and uncontrolled surface run off. The erosion makes driving conditions difficult.

The erosion issue is a result of various problems such as the road being lower than the surrounding area, steep gradients, improper or defected drainage, and the use of road materials with high Plasticity Index (PI).

In addition, during the dry season, the road surface is corrugated as a result of substandard material characteristics and car driving forces. Driving on corrugated road is very uncomfortable for drivers and passengers.

Based on the issues presented on alignment and road surface condition, the Study Team recommends to surface the road, with for instance a bituminous surface treatment to allow for comfortable trafficking all year long.

3) Necessity to Improve Drainage Facility

The culverts and their respective inlets and outlets are generally in good condition. However the width between culvert headwalls is very narrow. In addition, it is reported that a fair amount of earth and sand accumulate inside the culverts during the rainy season probably due to the use of corrugated steel-pipes and flat gradients. Therefore, existing culverts should be replaced with concrete box culverts with sufficient capacity and appropriate gradients to prevent silting up.

Existing earth drains are not functional due to accumulated earth and soil and eroded road surfaces. These problems are particularly notable on sections with steep gradient, in “cut and fill” and those that are lower than the surrounding ground level. On such sections, an appropriate drainage system should be designed. Furthermore, drainage structures should be connected and discharged through suitable and regular outlets.

4) Necessity to Consider Bypasses in Town Section

Most of the towns and villages have expanded along the existing road alignment. As a result, the Study Road passes through many of the town and village centers. On such sections, stores , vendors, religious facilities and public facilities such as schools, hospitals and town halls are located adjacent to the road. Therefore, the following measures should be considered in the short, medium and long term respectively.

<u>Short Term (Low Traffic Volume)</u>

In areas with high population densities along the road, measures such as speed humps and well visible road signs should be employed to reduce traffic speed through villages. Where a bituminous road crosses through a village, combined speed hump / pedestrian crossings will be used to emphasize the priority given to pedestrian traffic. Elevating footpaths along the road in order to separate it from the carriageway will be also be an effective alternative within town sections.

Medium and Long Term (High Traffic Volume)

Increased traffic volumes are expected in the medium and long term after improvement of the Study Road. In such cases, traffic accidents and air pollution will increase. Bypass routes that detour the town centers should be considered in the medium and long term. This measure will also secure maintaining the design speed as there will be no need to slow down in town sections.

2.2 Existing Bridge Conditions

2.2.1 Introduction

A bridge inventory survey was executed to assess the present conditions of bridges. The information obtained will be utilized for diagnosing damage of the existing bridges as well as propose improvements to those bridges.

A list of bridges was obtained from the local authority, but only for the road sections in Nampula Province. No list was obtained for the sections in Niassa Province. Accordingly, the bridge inventory survey in Nampula Province was executed based on these lists, and all bridges in Niassa Province were identified through the site visit.

2.2.2 Survey Scope

1) General

All waterways with approximately more than 5m in width on the Study Road were the subject of investigation as part of the bridge inventory survey. As a result, 36 rivers or streams were identified. All waterways had structures, including some multi-cell pipe culverts., The survey mainly focused on gathering general information about the bridge and waterway, including flood records, and in assessing any damage to the bridge.

2) Survey Items

The following information was gathered at the bridge sites:

- Bridge Location: Route name, Road section, Station
- Bridge General Information: Total length, span arrangement, carriageway &

pedestrian width, superstructure type, load capacity, girder information (depth, arrangements), substructure type (pier and abutment), protection work

- Damage Conditions: Girder, slab, substructure, bank protection, others (ancillary facilities)
- River Conditions: Yearly Low Water Level, Yearly High Water Level, Highest Water Level (HWL), river width, riverbed material, river gradient, river depth
- Surrounding Conditions: Land use, potential number of houses to be affected by a new bridge
- Other Information: Observation at the site, information from project documents
- Engineer’s Comments: Necessity of replacement, points to be considered in a new bridge plan

2.2.3 Survey Work Method

The bridge inventory and relevant information were collected mainly by on-site investigations, and checked with the topographical survey. In addition, flood record information including the flood H.W.L. was gathered from the Department of Water Resources and Control as well as by interviewing local people living near the existing bridge.

2.2.4 Survey Results

1) General

All information collected by the bridge inventory survey is summarized in the survey sheets in Table 2.2.1.

Table 2.2.1 Summary of Bridge Inventory Survey Results

Bridge No.	Bridge Name	Section	Station	Bridge Length (m)	Span (m)	Inner Width (m)	Superstructure: Structure Type	Superstructure: Girder Depth (m)	Superstructure: No. of Girder	Superstructure: Design Load (ton)	Substructure: Abut. Type	Substructure: Height (m)	Substructure: Pier Type	Substructure: Height (m)	Foundation Type	H.W.L. (m)	Clearance against HWL	Adopted Improve-ment Category	Remarks
1	Intephe	NP-RB	34+900	6.2	6.2	5.7	RC T-shaped	1.10	3	-	Gravity	4.0	-	-	Spread	1.5	OK	Replace	
2	Namuca	NP-RB	37+000	4.5	4.5	5.7	RC T-shaped	0.70	3	-	Gravity	4.7	-	-	Spread	1.5	OK	Replace	
3	Mutivaze1	NP-RB	40+300	45.0	15.0x3	0.8+7.2+0.8	RC Hollow Slab	0.85	1	25	Reversed T	9.0	Wall	8.0	Spread	6.5	OK	Restore	Built in 1998 under Japan's Grant Aid
4	Mecuburi	NP-RB	87+100	30.0	15.0x2	0.8+7.2+0.8	RC Hollow Slab	0.85	1	25	Reversed T	8.5	Wall	7.0	Spread	5.7	OK	Restore	Built in 1998 under Japan's Grant Aid
5	Namialo	NP-RB	88+500	6.4	6.4	4.2	RC Slab	0.25	1	-	-	-	-	-	-	2.5	No	Replace	
6	Muco	RB-ML	135+000	22.7	7.5x3	7.4	RC Slab	0.45	1	-	Gravity	6.0	Wall	6.0	Unknown	2.5	OK	Restore	Continuous girder
7	Namicuti	RB-ML	139+300	23.0	7.7x3	7.4	RC Slab	0.45	1	-	Gravity	5.5	Wall	5.5	Unknown	1.5	OK	Restore	Continuous girder
8	Nepuipui	RB-ML	149+000	13.0	13.0	7.4	RC Slab	0.45	1	-	Gravity	8.0	-	-	Unknown	2.5	OK	Restore	
9	Napala	RB-ML	150+500	13.6	13.6	7.4	RC Slab	0.45	1	-	Gravity	6.0	-	-	Unknown	1.5	OK	Restore	
10	Mutololoua	RB-ML	154+800	7.9	7.9	3.7	RC Slab	0.50	1	-	Gravity	6.0	-	-	Spread	2.0	OK	Replace	
11	Natete	RB-ML	157+400	30.0	15.0x2	0.8+7.2+0.8	RC Hollow Slab	0.90	1	25	Reversed T	8.0	Wall	6.5	Spread	3.5	OK	Restore	Built in 2002 under Japan's Grant Aid
12	Monapo	RB-ML	160+900	11.5	11.5	7.3	RC Slab	0.50	1	-							No		
13	ThiThi	RB-ML	166+600	30.0	15.0x2	7.3	RC Hollow Slab	0.85	1	25	Reversed T	9.5	Wall	9.0	Spread	6.3	OK	Restore	Built in 1998 under Japan's Grant Aid
14	Naiua	RB-ML	177+100	8.9	8.9	3.7	RC T-shaped	0.90	2	-	Gravity	5.5	-	-	Unknown	1.5	OK	Replace	
15	Nampaua	RB-ML	178+800	10.9	10.9	3.7	RC T-shaped	1.00	2	-	Gravity	6.0	-	-	Unknown	2.0	OK	Replace	
16	Iuhapua	RB-ML	182+400	10.9	10.9	3.6	RC T-shaped	1.00	2	-	Gravity	5.5	-	-	Unknown	1.5	OK	Replace	
17		RB-ML	185+200	9.1	9.1	3.7	RC T-shaped	1.00	2	-	Gravity	4.0	-	-	Unknown	2.0	No	Replace	
18		RB-ML	187+100	5.6	5.6	3.7	RC Slab	0.50	1	-	Gravity	4.0	-	-	Unknown	1.0	OK	Replace	
19	Lalaua	RB-ML	188+600	28.0	8.6+9.0+10.4	3.6	RC Slab	0.50	1	-	Gravity	5.5	Wall	5.0	Spread	1.5	OK		
20		RB-ML	197+100	9.0	9.0	3.6	RC T-shaped	0.90	2	-	Gravity	4.5	-	-	Unknown	1.5	OK	Replace	
21	Niose	RB-ML	211+700	22.9	7.6x3	7.4	RC Slab	0.40	1	-	L-shaped	6.0	Wall	9.5	Spread	5.0	OK	Restore	Repired in 2002 under Japan's Grant Aid
22	Tiwa	RB-ML	214+500	3.9	3.9	5.6	RC T-shaped	0.60	5	-	Gravity	4.5	-	-	Unknown	1.5	OK	Replace	bridge with angle
23		RB-ML	215+900	8.9	8.9	3.6	RC Slab	0.50	1	-	Gravity								
24	Nataleia	RB-ML	227+900	22.6	7.5x3	7.3	RC Slab	0.40	1	-							No		
25	Maposo	RB-ML	229+700	4.8	4.8	5.1	RC Slab	0.30	1	-									
26	Mupari	RB-ML	231+900	9.0	9.0	4.0	RC Slab	0.50	1										
27	Mutivaze2	RB-ML	237+300	24.3	6.3x4	3.4	RC Slab	0.40	1								No		
28	Malema	ML-CA	243+200	61.5	20.5x3	0.8+7.1+0.8	PC T-shaped	Max. 1.40	4	-									Variable depth girder
29		ML-CA		5.0	5.0	4.0	RC Slab												
30	Namuela	ML-CA	265+600	30.6	30.6	4.2	Bailey	2.20	-	-							OK		
31	Malume	ML-CA	283+300	82.4	20.6x4	0.8+7.2+0.8	PC T-shaped	Max. 1.40	4	-									Variable depth girder
32	Nuail	ML-CA	284+600	31.7	10.6+20.5+10.6	0.8+7.2+0.8	PC T-shaped +RC Slab	Max. 1.40 0.50	4 1	-									Variable depth girder+eaqual one
33		ML-CA	303+400	6.6	3.3x2	5.4	Steel Truss	1.00	5	-									
34	Lurio	ML-CA	312+500	94.2	15.7x6	1.1+3.2+0.7	RC T-shaped	2.30	2	-							OK		Only road section
35	Murusso	ML-CA	331+900	20.0	10.0x2	0.8+7.2+0.8	RC Hollow Slab	0.75	1	25	Reversed T	6.0	Wall	6.0	Spread	4.7			Built in 2002 under Japan's Grant Aid
36	Namutimbua	ML-CA	346+600	30.0	15.0x2	0.8+7.2+0.8	RC Hollow Slab	0.90	1	25	Reversed T	5.5	Wall	6.0	Pile □400	3.5			Built in 2003 under Japan's Grant Aid

2) Characteristics of Existing Bridges

Small and medium sized bridges (with up to 60m in length) are most common . Only Malume Bridge and Lurio Bridge have a superior length of 82.4 m and 94.2m respectively. Regarding the bridge formation width, it was noted that 16 bridges (43%), have sufficient to allow a 2-lane carriageway width. The remaining bridges can only accommodate one-way traffic, with lane widths ranging from 3.6 m to 5.7m. The reinforced concrete slab or T-shaped girder is the most prominent type of structure amongst the existing bridges. A pre-stressed concrete T-shaped girder has been applied for three bridges that have relatively long span length of 20m, and a Bailey type bridge was installed at one crossing point.

Accurate information, with regard to the dates of construction of the existing bridges, could not be obtained, neither from interviews with local engineers nor from site observations, with the exception of 6 bridges constructed under the Japan’s Grant Aid scheme. Although the site survey found that dates were indicated on the wing wall at some bridges, it was difficult to judge whether or not such dates indicated the year of construction. However, from the information obtained from local engineers, it is assumed that small bridges with narrow widths would have been constructed during the 1930-40s, and the medium sized bridges with 2-lane carriageways would have been built in the 1960s-70s. The bridges constructed with the Japanese funds were completed in either 1998 or 2002.

The inventory survey could not establish the live load applied in the designs of the existing bridges due to the lack of design reports or drawings. The new bridges funded by the Japanese Government are an exception. Those Japanese bridges were designed with a live load responding to 25ton vehicles, which has now become the international standard.

Regarding the condition of the existing bridges, it was observed that most of the bridges have been kept in a good condition (including superstructure and substructure). Significant damage was not observed during the site investigations. Surface cracks on substructures, abrasion of the deck surface, and missing railings are the only damage observed on the existing bridges, and those defects will not seriously affect the structural condition.

3) Characteristics of Rivers and Streams

Small and medium sized rivers with relatively short lengths and small catchment areas are predominant on the Study Road. Those rivers have a relatively narrow river width, ranging from 5m to 60m, with approximately a 1m to 6.5m water depth. Their riverbeds consist of mainly silty or sand soils. Most of rivers and streams have no water in the dry season and only one-third of the rivers have perennial water flow. In the Namicuti, Nataleia, Malema, Malume and Lurio rivers, permanent water flows, with gentle velocity, were observed at the crossing points.

The catchment area of these rivers have a relatively high run-off coefficient caused by low vegetation growth. Severe rainfall intensity will cause flooding at some crossing points. At some crossing points, flood damage has been reported by local residents and engineers. This flood damage is described in Table 2.2.2.

Table 2.2.2 Flood Damage at Crossing Points on the Study Road

River Name	Station	Flood HWL	Damage Description	Remarks
No.5 Namialo	88+500	0.5m+ bridge surface	Inundation at surrounding area	
No12 Monapa	160+900	0.8m+ bridge surface	Flood washed away a part of approach roads in 2005 and the closure of the road continued for one month	
No17	185+200	0.5m+ approach road	Flood inundates sometimes at the approach road at right bank but no overflow on the bridge.	
No24 Nataleia	227+900	0.8m+ bridge surface	Flood overflowed not only bridge but also approach road up to 30-50m from the bridge in 2005.	
No27 Mutivasse	237+300	Bottom of girder	Floodwater sometimes rises to the girder bottom but no overflow occurred so far.	
No29	254+800	Flood record could not be available	Flood would overflow the surface because this seems a submersed type	Repaired the surface in 2002

2.2.5 Analysis of Findings

The following are the results of the analysis of the bridge inventory survey

1) Necessity of Improvement of Existing Narrow and Old Crossing Structure

A total of 18 bridges have insufficient bridge formation width for a 2-lane carriage way. Those bridges have been in service for approximately 60-70 years, and one can consider that their lifespan will soon come to an end from a functional point of view, although the structures are still relatively sound. Consequently, it is recommended that they be replaced with new structures allowing for 2-lane traffic operation. However, if replacement costs are excessive and would affect the project's feasibility, other alternative should be explored. This issue will be further discussed in "Chapter 7.2 Upgrading Concept for the Study Road".

2) Necessity to Improve Existing Bridges that have Insufficient Discharge Capacity against Flood

It is reported that floods overflowed and caused damage to both the bridge decks and the approach roads at 5 bridges on the Study Road. In addition, at the Mutivasse Bridge the flood at times reaches the bottom of the girder, These six bridges seem to have insufficient capacity to withstand floods based return periods appropriate for trunk roads. Accordingly, the present discharge capacity for those bridges should be improved. As replacement with new bridges will require high initial capital costs which will affect the Project feasibility, alternatives should be examined. This issue will be discussed in Chapter 7.2.

3) Necessity to Consider Retaining the Existing Bridges that have Sufficient Bridge Width for 2-lane Traffic as well as Sufficient Discharge Capacity against Flood

In addition to the bridges rehabilitated under the Japan's Grant Aid Scheme, eight bridges have been identified as having a sufficient width for 2-lane traffic operation and a sufficient discharge capacity against the appropriate design flood. Since these bridges are still in relatively good condition, their continued utilization should be considered in the upgrading scenarios for the Study Road. Their capacity to carry the design live load will be a major factor on the decision to retain them. These bridges were constructed in the 1960s-70s, when lower live loads were applied during design. This issue will be further discussed in Chapter 7.2.

Even if a decision to retain these bridges is taken, minor repair works including railings, overlay of the deck surface, and repair of expansion joints should be incorporated into the Project.

Chapter 3 Natural Condition Surveys for the Study Road

Chapter 3 Natural Condition Surveys for the Study Road

3.1 Introduction

Natural condition surveys were executed not only to grasp the existing conditions along the Study Road but also to utilize the results for the preliminary design for both road and bridges. These comprise the topographic and geological surveys and those were carried out by local consultants on a contract basis. The following describes the contents and results of the surveys.

3.2 Topographic Survey

3.2.1 Scope of Work

A topographic survey was conducted to assess existing topographic conditions for the Study road. The work items were as follows:

(1) Plan Survey for River Crossing Points using a Total Station
(2) Road Alignment Survey
- Centerline survey
- Longitudinal survey
- Cross section survey

3.2.2 Specifications for Survey

The survey area and survey intervals were as follows:

(1) Plan Survey for River Crossing Points
- Location: Six rivers including the Rio Lurio River (see Figure 3.2.1)
- Survey Length: In addition to the length of existing bridges 20m of approach section on either side is added
- Survey Width: 50m on either side of the road centerline for a total of 100m.

(2) Centerline Survey for the Road
- 5 km intervals (identification of national coordinates).

(3) Longitudinal Survey for the Road
- 5 km intervals.

(4) Cross Section Survey for the Road
- 5 km intervals.
- Survey width was 30m on either side of the centerline for a total width of 60m.

All survey data was processed and presented in drawings together with digital files. Details are as follows:

- River Plan using a Total Station: Scale: 1/1,000
- Profile based on Center Line Survey: Scale: V1/1,000, H1/10,000
- Cross section based on Cross Section Survey: Scale: V1/200, H1/200
- Digital data [3-dimensional coordinates are tabulated in MS Excel format, drawing data in Auto CAD R14/LT 2000 format, Word and Excel data, etc] is presented on a CD-ROM

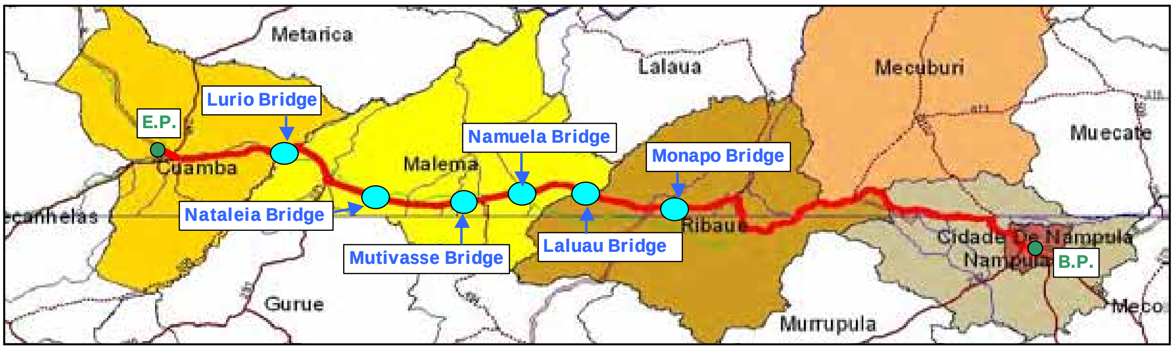


Figure 3.2.1 Location Map of Plan Survey for River Crossing Points

3.2.3 Survey Method

The survey was executed using the WGS 84 UTM Zone 37 System, and the Leica System 1200 and 500 RTK-GPS were utilized to locate the position and elevation of the fixed point at km 0 (City of Nampula). The method used to establish such a point is called the “Single Point Fix Method”, and the results for point elevation consisted of ellipsoidal height. Unfortunately, there are no trigonometric beacons with coordinates in Mozambique so ellipsoidal height had to be used. The rest of the survey was then based on the location of the other points in relation to the fixed point.

Benchmarks were built and surveyed every 5km as well as for cross sections. This was done via real-time GPS. Note that six bridge sites were surveyed with the Leica T1000 total station.

The centre line of the Study Road was surveyed with the Leica System 500 RTK GPS mounted on a car. However, there were areas with big trees and unfortunately GPS does not work properly under such circumstances.. In other areas, culverts were being repaired and detour roads had to be used in such cases. Hence, there are some gaps between some of the points.

3.2.4 Survey Results

Topographic survey results are utilized in the preliminary design drawings for bridges indicated in Volume III Drawings.

3.3 Aerial Photo Survey

3.3.1 Purpose of the Survey

During the first phase of the Study, it was found that topographical maps offered to the Study Team are not appropriate for conducting a preliminary design. Firstly, since it was produced in 1970, the existing Study Road and railway route differed from the latest routes at some sections due to improvement work done. Secondly, since the maps were not produced with digital formats, it is impossible to reflect the topographical survey results on the topographical map obtained. Consequently, the execution of the Aerial Photo Survey was recommended and it was carried out to produce the base topographical map for the preliminary design of the road.

3.3.2 Scope of Work

The Scope of Work is composed of the following:

- Photography (length: 350km, Width: 5km)
- Making of Photo (S=1/10,000)
- Making of Base Map for Design (S=1/10,000)

3.3.3 Survey Method and Results

(1) Aerial Photo Survey

The photographic mission was executed by an aircraft flown in from South Africa in accordance with the air law in Mozambique. Actual photography was conducted on 15 lines for three days in the beginning of June 2007 when clear skies were available.

(2) Photo Ground Control

After the flights for the aerial photo survey, a series of ground control points were measured in three dimensions (XYZ coordinate) with a precision GPS system at major intersections and bridges to produce a contour line for the base map of the preliminary design. The ground control points were carefully selected because they must be clearly visible on the aerial photo.

(3) Producing the Base Topographical Map for the Preliminary Design

The base topographical map with contour lines was produced by using the three dimensional coordinates (XYZ) collected by the ground control survey (See Volume III Drawings). Its coordinates were matched to the road centerline survey of the first phase of the Study.

3.4 Geological Survey

3.4.1 Scope of Work

The Scope of Work for the Geological Survey was composed of the following items:

(1) Mechanical Boring Survey

- Mechanical Boring
- Standard Penetration Test (SPT)
- Laboratory Test (Unconfined Compression Test)

(2) Sub-grade Survey

- Dynamic Cone Penetration (DCP) Test

(3) Laboratory Test

- California Bearing Ration (CBR) Test for Sub-grade with sampling
- Laterite Test with sampling
- Quarry Test with sampling
- Material Mixture Test

3.4.2 Testing and Investigation Purposes and Methods

(1) Mechanical Boring Survey

Mechanical boring was conducted at 11 locations as described below. These results will be utilized to determine the type of foundation for the bridges and its details are:

- Monapo Bridge 2 boreholes

- Laluau Bridge 2 boreholes
- Namuela Bridge 2 boreholes
- Mutivasse Bridge 1 borehole
- Nataleia Bridge 1 borehole
- Luio Bridge 3 boreholes

The survey locations are as shown in Figure 3.4.1.

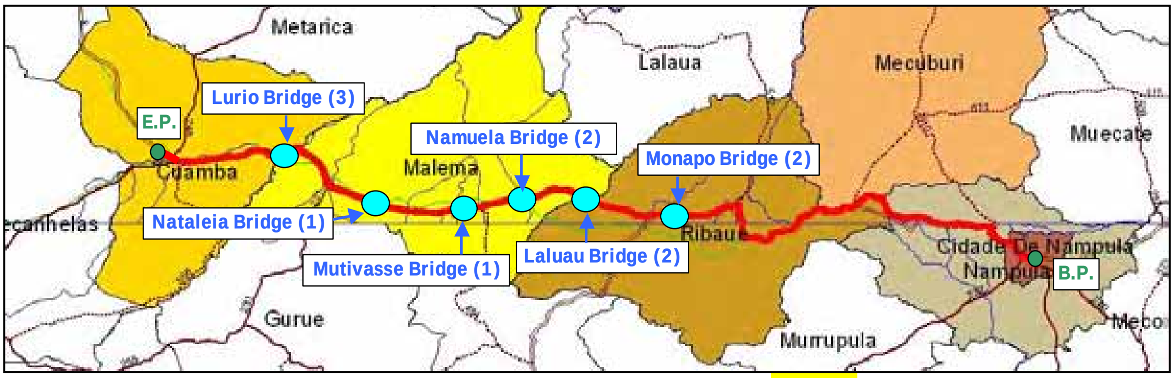


Figure 3.4.1 Location Map for Mechanical Boring Survey

(2) Dynamic Cone Penetration (DCP) test

According to the scope of works for this Study, the DCP test was conducted every 10,000m in order to measure the strength and stiffness of the sub-grade (roadbed), which is a basis for the pavement design.

(3) California Bearing Ratio (CBR) test

Five samples were taken from the existing sub-grade layer in order to measure the strength and stiffness of the roadbed, which will also form a basis for designing the pavement, referring to the ASTM (American Society for Testing and Materials), BS (British Standard) or equivalent standard. Sampling locations are as shown in Figure 3.4.2.

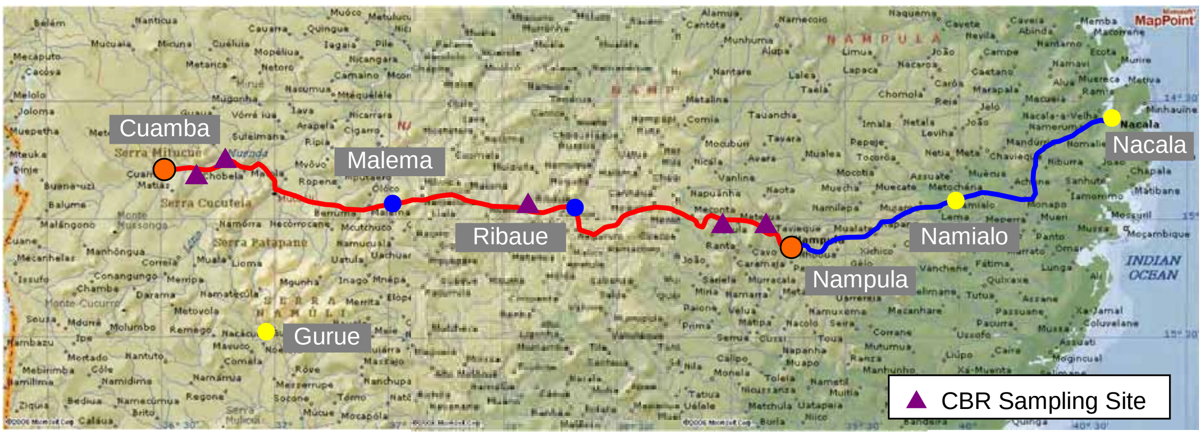


Figure 3.4.2 Locations for CBR Test

(4) Laboratory Testing for Laterite

Five samples of laterite were taken from borrow pits along the Study Road as shown in Figure 3.4.3 in order to check their appropriateness as sub-base material. Those samples were tested in accordance with the ASTM (American Society for Testing and Materials), BS (British Standard) or equivalent standards taking into account the following tests:

- Liquid and Plasticity Limit
- Moisture Contents
- Granulometry (Grain Size) Test

Figure 3.4.3 Location of Laterite Sampling Site

5) Laboratory Testing for Quarries

Five samples were taken from quarry sites or existing crushed stone plants in the Study Area in order to check their appropriateness as pavement materials. Sampling locations are shown in Figure 3.4.4. Quarry testing was carried out for material properties in line with ASTM (the American Society for Testing and Materials), BS (British Standard) or equivalent standards and the following test was executed:

- Aggregate Fracture Test (ACV)

Figure 3.4.4 Locations of Quarry Sampling Sites

6) Laboratory Testing for Material Mixture

Material testing of the laterite (5 samples) was carried out for the following mixtures to seek cost-effective sub-base materials:

- Three samples of laterite mixed with Cement at OPC 3 %, 4%, 5% (3 cases)
- One sample of laterite mixed with Crushed stone (60 %) (1 case)
- One sample of laterite mixed with Crushed stone (40 %) (1 case)

3.4.3 Survey Results

(1) Mechanical Boring Survey

Eleven boreholes were drilled at positions indicated by the Study Team using a rotary core drilling rig (D900 Atlas-Copco). During drilling, Standard Penetration Tests (SPT) were carried out at intervals of approximately 1.0m. Samples recovered during the drilling process were logged and some samples were selected for further laboratory testing. These samples were tested for Unconfined Compressive Strength Test (UCS) at the LEM (Laboratório de Engenharia de Moçambique) laboratory in Maputo. Samples from upper layers of rock were left to soak for 24 hours prior to crush testing. This procedure was adopted to check rock sensitivity against water.

A summary of the results for the mechanical boring survey is shown in Table 3.4.1. Locations of borehole positions at each bridge sites and copies of recorded drilling logs are contained in Appendix B-1. The UCS results for rock samples are shown in Appendix B-2.

Table 3.4.1 Summary of Mechanical Boring Survey

Bridge Name	Boring Number	Depth to Rock Layer	Bearing Stratum	Applicable Foundation Type
Monapo Bridge	BH01	11.25m	Slightly weathered granite rock	Pile foundation
	BH02	7.25m	Slightly weathered granite rock	Pile foundation
Lalaua Bridge	BH03	2.50m	Un-weathered granite rock	Spread foundation
	BH04	6.00m	Weathered granite rock	Spread foundation
Namuela Bridge	BH05	3.50 m	Un-weathered granite rock	Spread foundation
	BH06	0.75 m	Sound granite rock	Spread foundation
Mutivasse Bridge	BH07	6.50 m	Sound granite rock	Spread foundation
Nataleia Bridge	BH08	11.25 m	Sound granite rock	Pile foundation
Lurio Bridge	BH09	9.00 m	Sound granite rock	Pile foundation
	BH10	2.50 m	Sound granite rock	Spread foundation
	BH11	4.25 m	Sound granite rock	Spread foundation

(2) Dynamic Cone Penetration (DCP) Test

DCP tests were carried out every 10km along the Study Road, and penetration data was converted to in-situ CBR values. These values are as shown in Appendix B-3 along with a graphical presentation of the penetration profiles of the DCP. Due to the existence of hard layers at shallow depths at most of the test sites, the DCP test did not penetrate more than 200mm. For the CBR calculations, the CICTRAN DCP/CBR relationship was used, and based on the DCP (Nr. of blows) the DN (mm/blow) was calculated (dividing the number of blows by the depth of penetration, see Appendix B-3). According to the DCP test results, the sub-grade of the existing Study road is sufficiently strong for the construction of a new road (see Table 3.4.2 for details).

Table 3.4.2 Summary of DCP Test

Number	Location	CBR in-situ	Number	Location	CBR in-situ
1	0+000	29	19	180+000	134
2	10+000	62	20	190+000	210
3	20+000	63	21	200+000	210
4	30+000	204	22	210+000	170
5	40+000	51	23	220+000	79
6	50+000	42	24	230+000	151
7	60+000	53	25	240+000	70
8	70+000	70	26	250+000	14
9	80+000	62	27	260+000	24
10	90+000	135	28	270+000	12
11	100+000	62	29	280+000	17
12	110+000	42	30	290+000	29
13	120+000	59	31	300+000	37
14	130+000	53	32	310+000	40
15	140+000	151	33	320+000	102
16	150+000	75	34	330+000	111
17	160+000	148	35	340+000	86
18	170+000	59	--	--	--

(3) California Bearing Ratio (CBR) Test

CBR tests were performed for 5 samples collected at several locations as described in Table 3.4.3. These tests were performed according to the TMH1 Test A8 procedures. The samples were collected at the sub-base layer of the existing road. A summary of the CBR testing is shown in Table 3.4.4, and the results are shown in Appendix B-4.

Table 3.4.3 Samples Collected for CBR

Sample Number	Distance from Nampula (km)	UTM Coordinates		Layer of collected sample
		X	Y	
1	15.00	0514255	8337352	Sub-base
2	35.10	0498842	8341240	Sub-base
3	148.00	0415361	8344108	Sub-base
4	199.30	0367713	8353077	Sub-base
5	351.00	0237300	8362071	Sub-base

Table 3.4.4 Summary of CBR Test

Sample Number	1	2	3	4	5
CBR at 100 % Mod. AASHTO	35	19	52	84	20
95 % Mod. AASHTO	23	18	46	40	16
90 % Mod. AASHTO	14	14	24	28	8

From the test results, the existing sub-base materials have sufficient strength and stiffness to act as a supporting sub-grade for the future pavement structure for upgrading, without the necessity to replace the material .

(4) Laboratory Testing for Laterite

The laterite testing comprise several tests and its specifications are given below. Table 3.4.5 shows the location of each sample collected for the Laterite testing.

- Grading: according to TMH1 A1 standard procedure
- Atterberg Limits: according to TMH1 A2 standard procedure
- Moisture content: according to TMH1 A7 standard procedure

Table 3.4.5 Samples Collected for CBR

Sample Number	Distance from Nampula (km)	UTM Coordinates		Distance from Road to Borrow Pit (km)
		X	Y	
1	79.00	0463426	8347197	0.20 ― Left
2	124.20	0428805	8338009	0.18 ― Right
3	204.30	0362870	8350012	0.09 ― Left
4	256.50	0314658	8345284	0.10 ― Right
5	332.00	0237300	8362071	0.07 ― Right

The results for these tests are shown in Appendix B-5. A summary of the properties are shown in Table 3.4.6, including an AASHTO classification for the soils tested.

Table 3.4.6 Laterite Test Results

Sample Number (Location: Km)	1 (79+00)	2 (124+00)	3 (204+00)	4 (256+50)	5 (332+10)
% Passing 2.00 mm	82.50	63.40	77.30	53.0	34.30
0.425 mm	59.70	33.7	52.0	26.30	20.50
0.075 mm	45.60	16.40	35.10	17.40	17.70
Grading Modulus	1.11	1.87	1.36	2.03	2.27
Moisture Content (%)	5.7	1.7	2.0	2.0	2.9
Plasticity Index	20	12	18	15	19
AASHTO Classification	A-7-6	A-2-6	A-6	A-2-6	A-2-6

From the test results, it is concluded that these materials by its self can not be used as sub-base materials mainly due to high plasticity index (recommended to be lower than 12 for subtropical areas). Accordingly, it is necessary to consider improving the properties of these laterites using cement stabilization or mixing with crushed stones.

(5) Laboratory Testing for Quarries

For the quarry tests, the Aggregate Crushing Value (ACV) was obtained at the following quarries:

- Pedreira de Namialo;
- Pedreira do Km 60+300 (Right Hand Side);
- Pedreira Ribaué – Cuamba;
- Pedreira de Malema, and
- Pedreira Cuamba/Lichinga.

A summary of the test results is shown in Table 3.4.8. According to ANE standards, the maximum ACV required for surfacing and base-course are 25% and 28%, respectively. However, Table 3.4.8 demonstrates that only the Cuamba Quarry satisfies the ANE standard for surfacing material. On the other hand, if the results for the Crushing strength, the Atterberg limits, the Flakiness index, the Abrasion loss test, Absorption test, etc within limits , then it is permissible to accept an ACV of up to 32% for the wearing course and base course. It is therefore recommended that these tests be carried out. The ANE standards are shown in Table 3.4.7, with the results for this test confirmed in Appendix B-6.

Table 3.4.7 ANE Standard Values for the Quality of the Crushed Stone

Utilization	Wearing Course	Base Course	Concrete
ACV (%)	25 (32) or below	28 (32) or below	45 or below

Note: ( ); Exceptional Values

Table 3.4.8 Summary of Quarry Test Results

Sampling Location		Namialo	Km60+300	Ribaue	Malema	Cuamba
Abrasion Loss (%)		28.1	39.0	38.0	28.2	22.7
Wearing Course	<32%	Pass	Fail	Fail	Pass	Pass
Base Course	<32%	Pass	Fail	Fail	Pass	Pass
Aggregate for concrete	<45%	Pass	Pass	Pass	Pass	Pass

(6) Laboratory Testing for Material Mixture

1) Soil - Cement Mixtures

Based on the laterite testing results as mentioned above, which indicated that these materials are unacceptable as sub-base materials, further laboratory testing for material mixtures was carried out. Samples from borrow pits were collected to mix with cement in various proportions (i.e., ranging from 3 to 5%). These samples were tested as described under point 6) of 3.4.2. The samples were prepared in Nampula and tested at the LEM laboratory in Maputo. A summary of the test results is shown in Table 3.4.9 (see Appendix B-7 for details).

According to the Japanese Asphalt Pavement Manual (Japan Road Association), the standard for minimum strength of cement stabilized material in sub-base and base course layers are as shown in Table 3.4.10. Based on these tables, it can therefore be concluded that the 3 soil samples tested with 3% cement can be utilized for the sub-base layer but not for the base course.

Table 3.4.9 Summary of Soil – Cement Mixture Test

Composition		Compressive Strength			
Laterite	Cement	Unit	Km 204+300	Km 256+500	Km 322+100
95%	5%	kPa	1,923	2,451	1,947
		MPa	1.9	2.5	1.9
		Kgf/cm^2	19.6	25.0	19.8
96%	4%	kPa	1,440	2,443	799
		MPa	1.4	2.4	0.8
		Kgf/cm^2	14.7	24.9	8.1
97%	3%	kPa	995	2,039	1,211
		MPa	1.0	2.0	1.2
		Kgf/cm^2	10.1	20.8	12.3

Table 3.4.10 Quality Standard for Sub-base and Base Courses

	Unconfined Compression Strength	
Stabilization with Cement Material	Sub-base course material	Base course material
	10 kgf/cm2 (0.98MPa) or over	30 kgf/cm2 (2.9MPa) or over

On a conclusive remark, the three tested mixtures are acceptable as sub-base materials but not as base-course because the obtained compressive strengths could not meet the minimum requirement of less than 30 kgf/cm^2 (2.9 MPa)

2) Material Mixture Test

CBR tests were performed on material mixtures comprising laterites and crushed stone from the Namialo quarry in two different mix proportions. These tests were undertaken as part of the work described under point 6) of 3.4.2. A summary of the test results is shown in Table 3.4.11. For the material obtained at the borrow pit located at chainage 79+000, the mix proportion used was 70% laterite and 30% crushed stone. For the material from the borrow pit at 124+200, the proportion used was 60% laterite plus 40% crushed stone. The nominal dimension of the aggregate used was 19/25 mm. Details of the results are presented in Appendix B-8.

Table 3.4.11 Results for Material Mixture Test

Sample Location	Km 79+000	km 124+200
Mix Proportion	Laterite = 70% Crushed stone = 30%	Laterite = 60% Crushed stone = 40%
Before soaking		
CBR at 100 % Mod. AASHTO	8	83
95 % Mod. AASHTO	5	53
90 % Mod. AASHTO	2	25
After 72 hours soaking		
CBR at 100 % Mod. AASHTO	13	132
95 % Mod. AASHTO	9	28
90 % Mod. AASHTO	8	27

From these test results it was found that the 70% (laterite) and 30% (crushed stone) mixture from the borrow pit at 79+000 is unacceptable neither as a sub-base material nor as a a base-course, and the 60% (laterite) and 40% (crushed stone) mixture from the borrow pit at 124+200 is acceptable as a sub-base material but not as a base course layer (the CBR value at 95% Mod. AASHTO is lower than 80, which is the minimum required strength of base-course materials). Accordingly, further investigation of mix proportions should be carried out in the detailed design stage in order to explore possible cost-effective materials for road pavement layers

3.5 Hydrology Survey

3.5.1 High Water Level

The high water level of rivers crossing as determined through interviews with local habitants is as shown in Table 3.5.1.

Table 3.5.1 High Water Level

River Name	Monapo	Laluau	Nataleia	Mutivasse	Namuela	Lurio
High Water Level (m)	561.7	545.7	592.9	596.6	623.9	505.3

3.5.2 Discharge

The discharge figures of the Rivers as obtained from DNA Maputo is shown in Table 3.5.2.

Table 3.5.2 Discharge

River Name	Maximum Discharge (m^3/s)	Month Year	Average of Maximum Discharge (m^3/s)	Period of Data Collection	Remarks
Meluli	273.86	Mar. 1998	27.78	May/1959 - Sep/2001	Not subjected river Close of Monapo River
Lalaua	17.04	Dec. 1971	3.45	Dec/1970 - Aug/1977	
Natalei1a	39.51	Aug. 1976	8.00	Oct/1960 - Mar/1985	
Mutivaze	8.57	Jan. 1965	3.07	Oct/1960 - Sep/1984	
Lurio	65.61	Jan. 1981	47.12	Apr/1959 - Apr/1961 Oct/1980 - Sep/1981	1)

1): Data available is insufficient, it seems that the actual discharge is more than 500m^3/s.

3.6 Hydrological Analysis

3.6.1 Introduction

This sub-chapter describes the hydrological analysis for the preliminary design stage and for elaborating the construction plan of the bridges and culverts. The basic data for the analysis comprises the water level of waterways and meteorological data including precipitation, rainy days, at representative points along the Study Road.

The probability discharge is estimated from the catchment area and rainfall data at each bridge site. The design high water level and velocity are also determined based on this data. In order to confirm the results, an interview about the estimated High Water Level (HWL) was undertaken with local people at each bridge site and compared to the calculations.

3.6.2 Characteristics of Waterways on the Study Road

A total of 37 waterways, assumed to have a width of more than 5m, are identified on the Study Road during the bridge and road inventory survey. All waterways generally run from south to north and most have a relative short length with small catchment areas. Only the Nataleia & Lurio Rivers are longer rivers with larger catchment areas. Table 3.6.1 summarizes the major characteristics of waterways across the Study Road.

Table 3.6.1 Major Characteristics of Waterway on the Study Road

No.	Name	Station	Lenth (km)	Catichment Area (km2)	Average Gradient
1	Intephe	34+900	7.7	23.0	0.012
2	Namuca	37+000	7.3	22.2	0.014
3	Mutivaze	40+300			
4	Mecuburi	87+100			
5	Namiali	88+500	8.4	18.0	0.012
6	Muco	135+000			
7	Namicute	139+300			
8	Nepuipui	149+000			
9	Napala	150+500			
10	Mutoloua	154+800	1.2	2.1	0.267
11	Natete	157+400			
12	Monapo	160+900	10.5	31.9	0.015
13	ThiThi	166+600			
14	Naiua	177+100	7.0	17.1	0.013
15	Nampaua	178+800	6.1	15.2	0.012
16	Iuhapua	182+400	7.7	19.1	0.014
17	Lagua	185+200	15.7	65.2	0.010
18		187+100	0.8	2.0	0.043

No.	Name	Station	Lenth (km)	Catchment Area (km2)	Average Gradient
19	Lalaua	188+600	26.7	58.8	0.004
20		197+100	0.8	0.6	0.023
21	Niose	211+700			
22	Tiwa	214+500	2.2	2.5	0.04
23	Naenca	215+900	2.0	4.6	0.048
24	Nataleia	227+900	47.7	332.6	0.018
25	Maposo	229+700	2.7	2.4	0.014
26	Mupari	231+900	9.4	21.7	0.017
27	Mutivasse	237+300	26.0	89.9	0.03
28	Malema	243+200			
29		254+800	30.9	156.6	0.009
30	Namuela	265+600	8.2	20.9	0.063
31	Malume	283+300			
32	Nuail	284+600			
33	Mulacatihe	303+400	18.9	68.8	0.046
34	Lurio	312+500	41.9	453.1	0.001
35	Nicaua	318+300			
36	Murusso	331+900			
37	Namutimbua	346+600			

Note: Waterways with no detailed information (empty boxes) were not part of the study because existing drainage structure are in good condition and have sufficient discharge capacity

3.6.3 Hydrological Analysis Approach

The hydrological analysis is undertaken to determine the design water level, discharge and velocity at the proposed bridge sites. The procedure of the analysis is shown in Figure 3.6.1

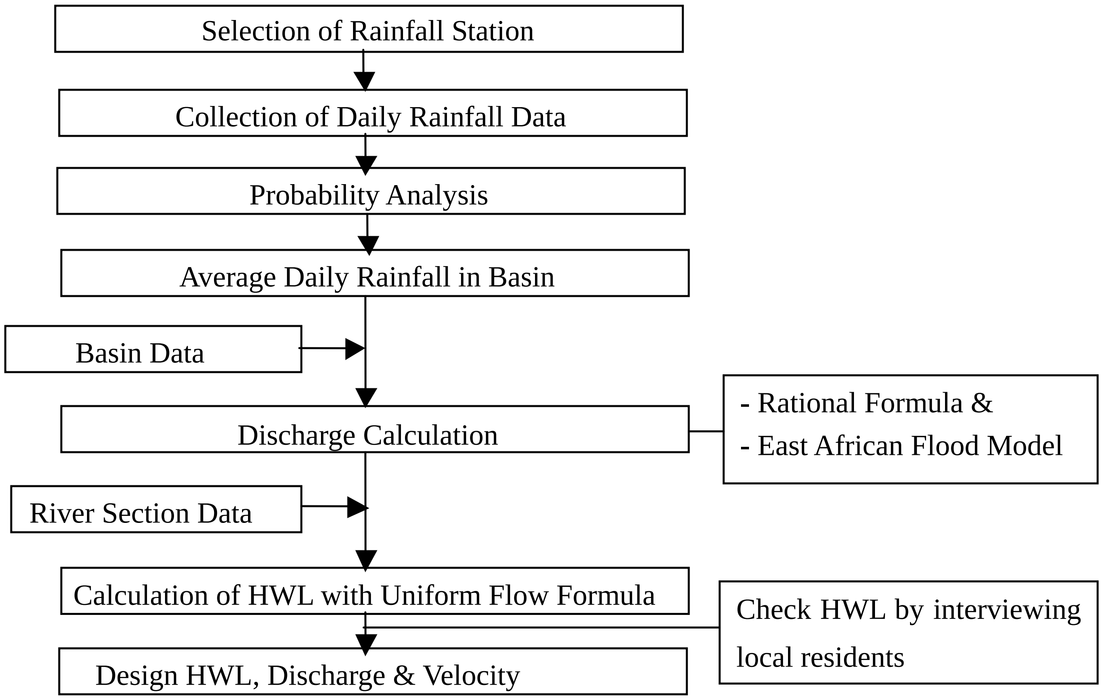


Figure 3.6.1 Procedure of Hydrological Analysis

3.6.4 Selection of Hydrological Station

There are only four hydrological stations in the study area, which regularly measure temperature, precipitation, and humidity near the Study road. These stations are located at Nampula, Ribaue, Malema, and Cuamba, which are all major cities and towns on the Study Road. Table 3.6.2 indicates the period for which the rainfall data has been measured at each station. Thia period should be statistically acceptable to estimate the average rainfall at a 50 year return period level (to be used as a design parameter for the preliminary design of bridges and culvert).

Table 3.6.2 Available Rainfall Data at Each Station

Station	Rainfall Data Available
Nampula	1986-2005(20 years)
Ribaue	1990-2003(14 years)
Malema	1951-1970(20 years)
Cuamba	1986-2005(20 years)

As mentioned in 3.4.2, although some rivers had data about water level and discharge, those were considered insufficient to carry out a probability analysis.

3.6.5 Probability Analysis on Daily Rainfall

The daily rainfall used as a design parameter is estimated on the basis of the rainfall station located nearest to the respective catchment area. In order to estimate average rainfall at each return period, the "Weibull or Hazen" plotting method will be applied. In this method, the values of data will be plotted on a log-graphic paper that corresponds to the shape of frequency of rainfall occurrence. After plotting all data, a bisecting curve is determined visually and based on this, the value for each return period is read out on the graph.

3.6.6 Average Daily Rainfall of Each River Basin at Each Return Period

The average daily rainfall of each river basin for each return period is indicated in Table 3.6.3.

Table 3.6.3 Average Daily Rainfall at Each Return Period

Observatory	Return Period	Daily Rainfall (mm)	Observatory	Return Period	Daily Rainfall (mm)
Nampla	1/10	127	Malema	1/10	88
	1/20	138		1/20	94
	1/50	150		1/50	102
	1/100	160		1/100	108
Ribaue	1/10	109	Cuamba	1/10	103
	1/20	116		1/20	114
	1/50	125		1/50	132
	1/100	132		1/100	146

3.6.7 Flood Discharge and High Water Level Estimation for Rivers

(1) Estimation Method

Several estimation methods for flood discharge have been applied in the past for road improvement projects in Mozambique. Such methods are the East African Flood Model (EAFM), which was developed by TRRL in1976, Rational Formula, and the method of US Soil Conservation Service. After discussion with ANE, the first two methods were selected for this study. Whereas EAFM has a strong similarity to the Mozambican conditions, the Rational Method has been widely used in the world. However, there are limitations as to the application of both methods. Whereas the EAFM model should not be used for catchment areas of more than 200km^2, the rational formula is not recommend for catchment areas of more than 250 km^2 or for catchment areas with a time of concentration of more than 2 hours. For such cases, the methods have a tendency to overestimate the flood discharge. For this purpose, the flood discharge estimated with both models will be compared to the actual HWL as indicated through interviews with local residents. The appropriateness of the estimation will be checked after converting the high water levels to a flood discharge using a uniform flow equation.

(2) Discharge Estimation with EAFM

1) Estimation Method and Procedure

Although the detailed method and procedure is described in "The TRRL East African Flood Model, TRRL Laboratory Report 706", the basic steps of the design method are as follows;

(a) Measurement of catchment area, catchment slope and channel slopes from the topographical maps. The average catchment slope is estimated by superimposing a grid over the catchment area and measuring the minimum distance between contour lines and each grid point. From these values the gradient will be calculated and averaged out to give the mean catchment value. The channel slope is the average slope from the bridge site to the uppermost part of the stream. Where information is sparse this maybe taken as 85% of the distance to the watershed.

(b) From site observation, select the catchment type and define the catchment lag time (K).

(c) From site observation, select the type of soils and topography
and determine the standard run off coefficient (Cs)

(d) Determine the appropriate rainfall zone: wet, dry or semi-arid

(e) Estimate catchment wetness factor (Cw)

(f) From site observation, decide on type of vegetation cover, paying particular attention to areas close to the stream, and estimate the land use factor (C_L)

(g) Calculate the total contributing area coefficient (C_A), given by

$$C_A = Cs \times Cw \times C_L$$

(h) If the rainfall zone (see d above) is semi-arid, West Uganda, initial retention (Y) is 5mm. For all other zones, Y is assumed 0.

(i) Use the following formula to calculate the design storm rainfall to be allowed for during time interval T_B in hours (P mm)

$$T_B = Tp + 2.3\ K + T_A$$

Where

$$T_A = 0.028L / (Qave^{1/4} \times S^{1/2})$$

L= length of main stream (km)

Qave =average flow during base time (m^3/h)

S= average slope of the main stream

Tp = Rainfall time (h)

(k) The volume of runoff discharge is given by the following formula;

$$RO = C_A \times (P\text{-}Y) \times A \times 100^3 \ (m^3)$$

(l) The average flow is given by

$$Qave = (0.93 \times RO) / (3600 \times T_B)$$

(m) Recalculate base time

$$T_B = Tp + 2.3\,K + T_A$$

Where

$$T_A = 0.028L/(Qave^{1/4} \times S^{1/2})$$

(n) Repeat steps (j) to (m) until Qave is within 5 % of previous estimate.

(o) Design peak flow (Q) is given by

$$Q = F \times Qave$$

Where peak flood factor (F) is;

F = 2.8 (K less than 0.5 hour)

F = 2.3 (K more than 1 hour).

2) Assumption of Coefficients

From site observation, topographical maps and aerial photos, the following coefficients necessary for design peak flow estimation are assumed.

Table 3.6.4 Assumed Coefficients for Design Peak Flow Estimation with EAFM Model

Coefficient	Description	Values Applied
Catchment area, land slope, channel slope	Measured by topographical map (1:50,000)	-
Standard contributing area coefficient	- Catchment slope: moderate to hilly depending on topography - Soil type: slightly impeded drainage from boring data (Clayey sand)	0.38-0.50
Cw: Catchment wetness factor	- Rain fall zone: semi-arid zone - Stream characteristics: mainly ephemeral streams	1.0
C_L: Land use factor	- Vegetation: Mixture of grass cover with dense vegetation	0.75
Catchment lag times	- Good pasture	1.5
Rainfall time (Tp) for East Africa 10 years storms	- Inland zone	n=0.96 Tp=0.75 h

3) Estimation Results

Discharges of each river at the design return period are calculated based on the procedures mentioned above. The calculation results of the discharges are shown in Table 3.6.5.

Since this EAFM method can not accommodate a catchment area of more than 200km^2, it is impossible to estimate the peak flow discharge for the rivers of Natalia and Lurio, with this method.

Table 3.6.5 Discharge at Each Return Period for Each Waterway (EAFM method)

River Name	A (m^2)	L (km)	S (m/m)	R24 (mm)	Design Peak Flow at Each Return Period			
					10yr (m^3/s)	20yr (m^3/s)	50yr (m^3/s)	100yr (m^3/s)
1 Intephe	23.0	7.7	0.012	127	59	64	69	74
2 Namuca	22.2	7.3	0.014	127	58	63	69	74
5 Namiali	18.0	8.4	0.012	109	40	43	46	49
10 Mutoloua	2.1	1.2	0.267	109	7	8	8	9
12 Monapo	31.9	10.5	0.015	109	61	65	70	74
14 Naiua	17.1	7.0	0.013	109	40	43	46	48
15 Nampaua	15.2	6.1	0.012	109	37	39	42	45
16 Iuhapua	19.1	7.7	0.014	109	44	46	50	53
17 Lagua	62.5	15.7	0.010	109	74	79	85	90
18 -	2.0	0.8	0.043	109	7	7	8	8
19 Lalaua	58.8	26.7	0.004	109	36	38	41	43
20 -	0.6	0.8	0.023	88	2	2	2	2
22 Tiwa	2.5	2.2	0.040	88	7	7	8	8
23 Naenca	4.6	2.0	0.048	88	12	13	14	15
24 Nataleia	332.6	47.7	0.018	88	-	-	-	-
25 Maposo	2.4	2.7	0.014	88	6	7	7	7
26 Mupari	21.7	9.4	0.017	88	38	40	44	46
27 Mutivasse	89.9	26.0	0.030	88	76	82	89	94
29 -	156.6	30.9	0.009	88	41	44	47	50
30 Namuela	20.9	8.2	0.063	88	31	33	36	38
33 Mulacatihe	68.8	18.9	0.046	103	89	98	113	126
34 Lurio	453.1	41.9	0.001	103	-	-	-	-

Note: A: Catchment Area, L: River Length, S: Average Waterway Slope, R24: Max. Daily Rainfall

(3) Discharge Estimation with Rational Formula

1) Rational Formula

The water discharge is calculated with the rational formula, as commonly applied. This formula can ensure its accuracy when the catchment area is small enough, i.e. less than approximately 200 km^2. This is applicable for all of the rivers on the Study road , except for the Natalea and Lurio River.

The formula is:

$$Q = 1 / 3.6 * f * I\ A$$

Where

Q : Maximum Flood Discharge (m^3/s)

f : Runoff Coefficient: applied as 0.37 apply except for some rivers, see under point 4)

R : Hourly Rainfall Intensity for a duration equal to the Time of Concentration (mm/h)

A : Catchment Area (km^2)

2) Time of Flood Concentration

Although several formulas are proposed to calculate the time of flood concentration, the Study Team adopts the USBR method as follows,

$$Tc = (0.87 L^2 / 1000 \times S)^{0.385}$$

Where :

Tc :Time of flood concentration (h)

L: River length (km)

S: Average gradient of main stream

3) Rainfall Intensity for Time Period Corresponding to "T"

The Monobe formula is applied to calculate the rainfall intensity for the time of concentration , corresponding to T, as follows.

$$Rt = R_{24} (Tav / 24)^{K}$$

Where :

Rt : Rainfall Intensity for time period corresponding to "T"

R_{24} : Daily rainfall in Average basin (mm)

Tav : Time of Concentration (h)

K : Coefficient = 0.37 applied to the existing rainfall intensity curve at the suburban area

$$R = Rt / Tav \quad (mm/h)$$

4) Applicable Runoff Coefficient

It is important for the accurate estimation of flood discharge to apply an appropriate runoff coefficient representing the situation of the catchment area. The runoff coefficient "f" is an integrated value representing many factors influencing the rainfall runoff relationship, i.e. topography, soil permeability, vegetation cover and land use. In addition, from the past experience, the application of the values seems to be different depending on the region. Whereas in Japan, high values (i.e. 0.6-0.7) are commonly applied for rural areas, relatively lower values are indicated in both hydraulic design manuals and FS reports in other countries. Accordingly, determination of the appropriate runoff coefficient requires careful observation of the catchment area from the site visit, and information from topographical map and aerial photos. In this analysis, a value of 0.37 ((ft+fs+fv=0.08+0.08+0.21) will be applied for the flood discharge estimation presented in Table 3.6.6. Some waterways (e.g the Nataleia river, the Namuela River) have catchment areas with different characteristics such as steep slope and deep vegetation in the hilly part and meandering features in the plain area.

Table 3.6.6 Runoff Coefficient for the Rational Method

Runoff Coefficient f = ft + fs + fv					
ft: topography		fs:soils		fv: vegetation	
Very flat(<1%)	0.03	Sand & gravel	0.04	Forest	0.04
Undulating(1-10%)	0.08	Sandy clays	0.08	Farmland	0.11
Hilly(10-20%)	0.16	Clay & loam	0.16	Grassland	0.21
Mountanious(>20%)	0.26	Sheet rock	0.26	No vegetation	0.28

Source: Highway & Traffic Engineering in Developing Countries, 1996, E& FN SPON

5) Discharge Calculation Results for Each Return Period

Discharges of each waterway at the designated return period are calculated based on the procedures mentioned above. The calculation results of discharges for each waterway are shown in Table 3.6.7.

Table 3.6.7 Discharge at Each Return Period for Each Waterway (Rational Formula)

Br.No	Bridge Name	Return Perido	Flood Concentration Time (T) (h)	Average Rainfall Intensity (R_{24}) (mm)	Rainfall Intensity within T (mm/t)	Rainfall Intensity (I) (mm/h)	Run-off Coefficient (f)	Catchment Area (A) (km^2)	Design Discharge (Df) (m^3/s)	Name of Obsevatory
1	Intephe	1/20	1.753	138	58.2	33.2	0.37	23.0	79	Nampla
		1/50	1.753	150	63.3	36.11	0.37	23.0	85	
		1/100	1.753	160	67.5	38.51	0.37	23.0	91	
2	Namuca	1/20	1.586	138	56.3	35.5	0.37	22.2	81	Nampla
		1/50	1.586	150	61.2	38.59	0.37	22.2	88	
		1/100	1.586	160	65.3	41.17	0.37	22.2	94	
5	Namiali	1/20	1.875	116	50	26.67	0.37	18.0	49	Ribaue
		1/50	1.875	125	53.9	28.75	0.37	18.0	53	
		1/100	1.875	132	56.9	30.35	0.37	18.0	56	
10	Mutoloua	1/20	0.127	116	20.6	162.2	0.37	2.1	35	Ribaue
		1/50	0.127	125	22.2	174.8	0.37	2.1	38	
		1/100	0.127	132	23.4	184.25	0.37	2.1	40	
12	Monapo	1/20	2.043	116	51.4	25.16	0.37	31.9	83	Ribaue
		1/50	2.043	125	55.4	27.12	0.37	31.9	89	
		1/100	2.043	132	58.5	28.63	0.37	31.9	94	
14	Naiua	1/20	1.58	116	47.3	29.94	0.37	17.1	53	Ribaue
		1/50	1.58	125	50.9	32.22	0.37	17.1	57	
		1/100	1.58	132	53.8	34.05	0.37	17.1	60	
15	Nampaua	1/20	1.465	116	46.1	31.47	0.37	15.2	49	Ribaue
		1/50	1.465	125	49.7	33.92	0.37	15.2	53	
		1/100	1.465	132	52.5	35.84	0.37	15.2	56	
16	Iuhapua	1/20	1.652	116	48	29.06	0.37	19.1	57	Ribaue
		1/50	1.652	125	51.7	31.3	0.37	19.1	62	
		1/100	1.652	132	54.6	33.05	0.37	19.1	65	
17	Lagua	1/20	3.255	116	60	18.43	0.37	62.5	119	Ribaue
		1/50	3.255	125	64.7	19.88	0.37	62.5	128	
		1/100	3.255	132	68.3	20.98	0.37	62.5	135	
18		1/20	0.188	116	23.4	124.47	0.37	2.0	26	Ribaue
		1/50	0.188	125	25.2	134.04	0.37	2.0	28	
		1/100	0.188	132	26.6	141.49	0.37	2.0	29	
19	Lalaua	1/20	6.972	116	77.1	11.06	0.37	58.8	67	Ribaue
		1/50	6.972	125	83.1	11.92	0.37	58.8	72	
		1/100	6.972	132	87.8	12.59	0.37	58.8	76	
20		1/20	0.239	94	20.5	85.77	0.37	0.6	5	Malema
		1/50	0.239	102	22.3	93.31	0.37	0.6	6	
		1/100	0.239	108	23.6	98.74	0.37	0.6	6	
22	Tiwa	1/20	0.42	94	24.7	58.81	0.37	2.5	15	Malema
		1/50	0.42	102	26.8	63.81	0.37	2.5	16	
		1/100	0.42	108	28.4	67.62	0.37	2.5	17	
23	Naenca	1/20	0.364	94	23.6	64.84	0.37	4.6	31	Malema
		1/50	0.364	102	25.6	70.33	0.37	4.6	33	
		1/100	0.364	108	27.1	74.45	0.37	4.6	35	
24	Nataleia	1/20	6.728	94	61.8	9.19	0.28	332.6	238	Malema
		1/50	6.728	102	67	9.96	0.28	332.6	258	
		1/100	6.728	108	71	10.55	0.28	332.6	273	
25	Maposo	1/20	0.737	94	29.8	40.43	0.37	2.4	10	Malema
		1/50	0.737	102	32.3	43.83	0.37	2.4	11	
		1/100	0.737	108	34.2	46.4	0.37	2.4	12	
26	Mupari	1/20	1.788	94	39.9	22.32	0.37	21.7	50	Malema
		1/50	1.788	102	43.3	24.22	0.37	21.7	54	
		1/100	1.788	108	45.8	25.62	0.37	21.7	57	
27	Mutivasse	1/20	3.145	94	48.1	15.29	0.37	89.9	141	Malema
		1/50	3.145	102	52.2	16.6	0.37	89.9	154	
		1/100	3.145	108	55.2	17.55	0.37	89.9	162	
29		1/20	5.71	94	58.5	10.25	0.37	156.6	165	Malema
		1/50	5.71	102	63.5	11.12	0.37	156.6	179	
		1/100	5.71	108	67.2	11.77	0.37	156.6	190	
30	Namuela	1/20	0.972	94	32.6	33.54	0.30	20.9	59	Malema
		1/50	0.972	102	35.4	36.42	0.30	20.9	64	
		1/100	0.972	108	37.5	38.58	0.30	20.9	67	
33	Mulacatihe	1/20	2.087	114	50.9	24.39	0.37	68.8	173	Cuamba
		1/50	2.087	132	59	28.27	0.37	68.8	200	
		1/100	2.087	146	65.2	31.24	0.37	68.8	221	
34	Lurio	1/20	16.82	114	101.4	6.03	0.37	453.1	281	Cuamba
		1/50	16.82	132	117.4	6.98	0.37	453.1	325	
		1/100	16.82	146	129.8	7.72	0.37	453.1	360	

(3) Determination of Design Discharge & Design Water Level for New Bridges

1) Calculation Method of Design Water Level for Bridge

The water level estimation shall be made using the Manning Formula, which assumes that the flow of the waterway is a uniform one. The major assumptions of the formula are as follows;

- Roughness coefficient: 0.05 (Clean, winding, some pools and shoals but some weeds and stones)

2) Estimation Results of Design Water Level for Bridge

Table 3.6.8 shows the calculation results of water level based on flood discharge estimated with both EAFM and Rational Formula. Those water levels are compared to HWL indicated by interviews with several local residents, and the design water levels at designated return period are determined.

Table 3.6.8 Design Water Levels for Bridges to be Improved

Br. No.	Bridge Name	River Length	River Slope	Catch-ment Area	Return Period	Rationa Formula			EAFM Method			HWL Interviewed	Design HWL	Remarks
						Design Discharge	Water Depth	Design HWL	Design Discharge	Water Depth	Design HWL			
		(km)	(m/m)	(km^2)		(m^3/s)	(m)	(m)	(m^3/s)	(m)	(m)	(m)	(m)	
12	Monapo	10.5	0.015	31.9	1/20	83	-	-	65	-	-	561.7*		
					1/50	89	3.5	561.5	70	3.1	561.1		561.5	
					1/100	94	-	-	74	-	-			
19	Lalaua	26.7	0.004	58.8	1/20	67	-	-	38	-	-	545.7		
					1/50	72	2.7	545.7	41	2.1	545.1		545.7	
					1/100	76	-	-	43	-	-			
24	Nataleia	47.7	0.014	332.6	1/20	195	-	-	-	-	-	592.9*		*1:HWL after opening widened
					1/50	212	3.1	592.1*1	-	-	-		592.1	
					1/100	224			-	-	-			
27	Mutivasse	26.0	0.030	89.9	1/20	141	-	-	82	-	-	596.0		*2:In case the Br. extends to 30m
					1/50	154	3.5	595.5*2	89	2.6	594.6		595.5	
					1/100	162	-	-	94	-	-			
30	Namuela	8.2	0.063	20.9	1/20	59	-	-	33	-	-	623.9		
					1/50	64	3.8	625.8	36	3.0	625.0		625.8	
					1/100	67	-	-	38	-	-			
34	Lurio	41.9	0.001	453.1	1/20	281	-	-	-	-	-	505.3		
					1/50	325	4.8	505.9	-	-	-		505.9	
					1/100	360	5.0	506.0	-	-	-		506.0	

*: Due to the narrow opeing, flood sometimes overflow at the bridge point.

3) Conclusion of Estimation Results for Flood Discharge

As a result of the water level estimation, the flood discharge calculated with Rational Method appears to better represent the actual hydraulic situations of the studies rivers because the flood water levels obtained from the local residents or flood traces at the crossing points are match the water levels calculated with the flood discharge of the Rational Formula. The results of the EAFM gave lower values than the HWL indicated by interviews. It may imply that some coefficients in the EAFM do not sufficiently represent the actual situation of the Study Area. Consequently, the water levels calculated with the Rational Formula will be applied as the design HWL for the new bridge design.

(4) Design Discharge for New Culverts

As mentioned above, the flood discharges calculated with Rational Formula will be applied for the new culvert design.