

**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**GOVERNMENT OF SOUTHERN SUDAN**

**JUBA URBAN TRANSPORT INFRASTRUCTURE AND  
CAPACITY DEVELOPMENT STUDY  
IN  
THE SOUTHERN SUDAN**

**FINAL REPORT (1)**

**PART I    GENERAL**

**PART II   URBAN TRANSPORT DEVELOPMENT  
            MASTER PLAN**

**JULY 2010**

**CTI ENGINEERING INTERNATIONAL CO., LTD.  
YACHIYO ENGINEERING CO., LTD.**

## **PREFACE**

In response to the request from the Government of Southern Sudan (GOSS), the Government of Japan decided to conduct the “Juba Urban Transport Infrastructure and Capacity Development Study” and entrusted the Study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched the Study Team headed by Mr. Tsuneo Bekki of CTI Engineering International Co., Ltd. in association with Yachiyo Engineering Co., Ltd. from August 2008 to June 2010.

The Study Team held discussions with the officials of the Ministry of Transport and Roads, the Land Commission and other concerned agencies of GOSS as well as the Ministry of Physical Infrastructure of Central Equatoria State (CES), and conducted field surveys, data gathering and analysis, formulation of the Master Plan and Pre-Feasibility Study. In addition, the stakeholders’ meetings were conducted nine times in total to solicit opinions from various actors concerning the Study. Upon returning to Japan, the team prepared this Final Report to summarize the results of the Study.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Southern Sudan and the Central Equatoria State for their close cooperation and help extended to this Study.

July 2010

**Kiyohumi KONISHI**

Director General

Economic Infrastructure Department

Japan International Cooperation Agency

**Mr. Kiyohumi KONISHI**

Director General

Economic Infrastructure Department

Japan International Cooperation Agency

Dear Sir,

### **LETTER OF TRANSMITTAL**

We are pleased to submit herewith the Final Report of the “Juba Urban Transport Infrastructure and Capacity Development Study” in Juba urban area in Southern Sudan. The report includes the advice and suggestions of the authorities concerned of the Government of Japan and your Agency, as well as the comments made by the Ministry of Transport and Roads and other concerned agencies of the Government of Southern Sudan (GOSS) and the Ministry of Physical Infrastructure of the Central Equatoria State (CES).

This report analyses the present setting and future conditions and demand of urban transport infrastructure in Juba urban area. It comprehensively covers the issues of transport including road development and policy, urban street improvement, public transport, traffic management, urban street maintenance system, capacity development throughout the pilot project, road institution and urban environment. The report established a Road Network Master Plan for Juba and surrounding areas until the year 2025 and the Capacity Development Plan for the Ministry of Physical Infrastructure of CES. The outcome of the Study concludes that the established plans are technically, economically, environmentally and socially feasible and will contribute to the development of Juba urban area.

In view of urgency of the development of transport infrastructure in Juba urban area and the needs for socio-economic development of Southern Sudan, we recommend that the GOSS implements the projects with utmost urgency.

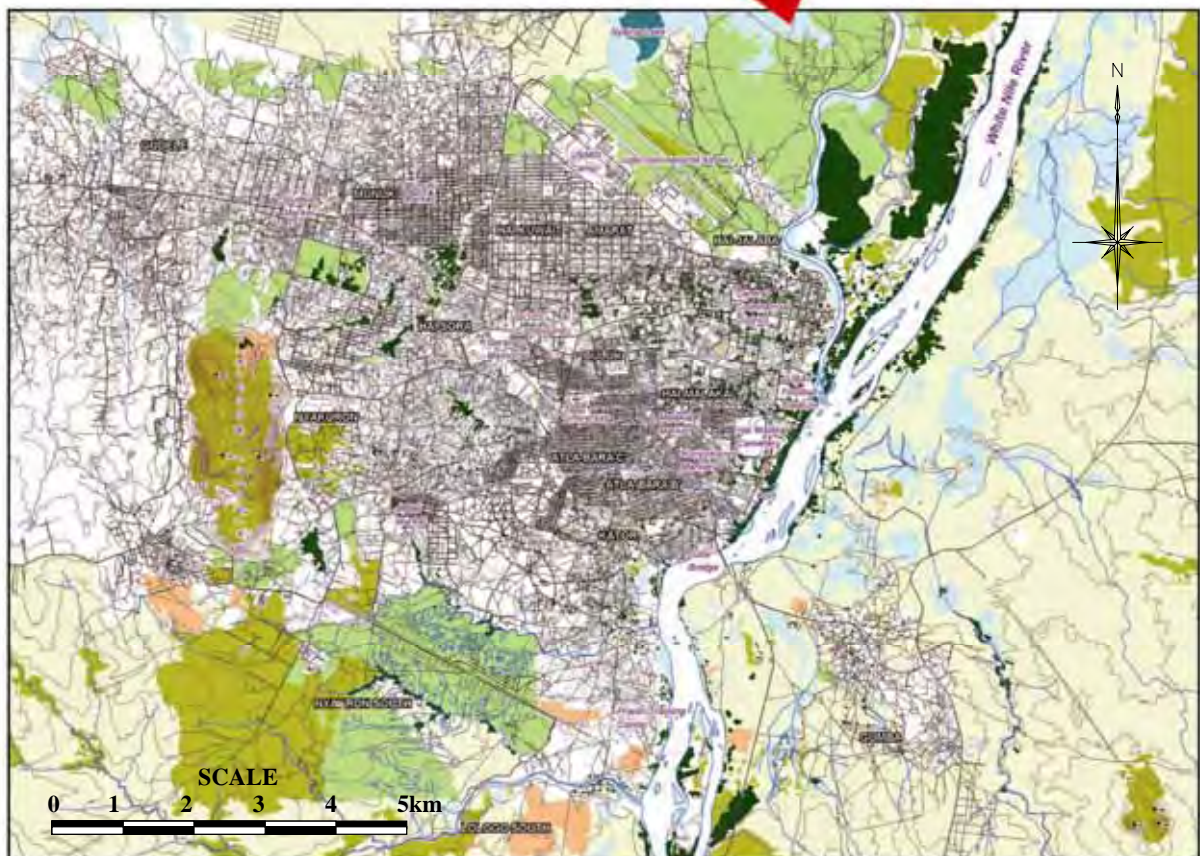
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure and Transport in the Government of Japan. Further, we wish to express our deep gratitude to the Ministry of Transport and Roads and other agencies concerned in the GOSS, and the Ministry of Physical Infrastructure of CES for their close cooperation and assistance extended to us during the course of the Study.

Very truly yours,

**Tsuneo BEKKI**

Team Leader

Juba Urban Transport Infrastructure  
and Capacity Development Study



**LOCATION MAP**

# TABLE OF CONTENTS

PREFACE	
LETTER OF TRANSMITTAL	
LOCATION MAP	
ACRONYMS AND ABBREVIATIONS	
LIST OF FIGURES	
LIST OF TABLES	

## PART I GENERAL

### CHAPTER 1 INTRODUCTION

1.1 BACKGROUND.....	1-1
1.2 OBJECTIVES OF THE STUDY .....	1-2
1.3 STUDY AREA .....	1-2
1.4 SCOPE OF THE STUDY .....	1-2
1.5 STUDY SCHEDULE AND PROGRESS .....	1-5
1.6 STAKEHOLDERS MEETING .....	1-5
1.7 ORGANIZATION OF THE STUDY .....	1-6

### CHAPTER 2 PRESENT CONDITION OF THE STUDY AREA

2.1 ADMINISTRATIVE SYSTEM .....	2-1
2.1.1 Administrative Division of Southern Sudan .....	2-1
2.1.2 Organization of GOSS and CES .....	2-3
2.2 NATURAL CONDITION .....	2-4
2.2.1 Location .....	2-4
2.2.2 Climate .....	2-4
2.2.3 Topography .....	2-5
2.2.4 Seismic Intensity .....	2-5
2.2.5 Land Type .....	2-8
2.3 SOCIO-ECONOMIC CONDITION .....	2-10
2.3.1 Population .....	2-10
2.3.2 Economy .....	2-15
2.3.3 Livelihood .....	2-16

### CHAPTER 3 PRESENT CONDITION OF URBAN TRANSPORT INFRASTRUCTURES

3.1 TRANSPORT SYSTEM .....	3-1
3.2 ROAD NETWORK AND CONDITION .....	3-3
3.2.1 Road Network .....	3-3
3.2.2 Intersection .....	3-7
3.2.3 Road Condition .....	3-9
3.2.4 Drainage Condition .....	3-12
3.2.5 Bridge and Culvert Condition .....	3-13

3.3	VEHICLE REGISTRATION .....	3-17
3.4	TRAFFIC MANAGEMENT.....	3-17
3.5	PUBLIC TRANSPORT.....	3-18

## CHAPTER 4 ON- GOING AND PLANNED TRANSPORT DEVELOPMENT PROJECTS

---

4.1	MAIN ACTIVITIES OF TRANSPORT AND ROAD DEVELOPMENT.....	4-1
4.1.1	Main Activities of Transport Development in 2008 and 2009 .....	4-1
4.1.2	On-Going and Proposed Road Projects.....	4-1
4.2	DONOR DEVELOPMENT PROGRAMS AND PROJECTS .....	4-5
4.2.1	Development Programs .....	4-5
4.2.2	Infrastructure Development Projects for 2007-2010 .....	4-6
4.3	PROJECTS RELATED TO JUBA URBAN TRANSPORT .....	4-8
4.3.1	Sudan Emergency Transport and Infrastructure Development Project .....	4-8
4.3.2	Emergency Road Rehabilitation Project (ERRP).....	4-10

## CHAPTER 5 MAJOR PROGRAMS IN TRANSPORT DEVELOPMENT

---

5.1	POLICY AND PROGRAMS IN APPROVED BUDGET 2009 OF GOSS .....	5-1
5.1.1	Goals and Expenditure Priorities.....	5-1
5.1.2	Activities and Budgets for Infrastructure Sector .....	5-3
5.1.3	Roads and Road Transport Development.....	5-4
5.2	EXPENDITURE PRIORITIES FOR ROADS FOR 2008-2011 .....	5-6
5.2.1	Six Top Priorities.....	5-6
5.2.2	Priority Roads for 2008-2011 .....	5-7
5.3	STRATEGIC PLAN FOR PHYSICAL INFRASTRUCTURE SECTOR OF CES .....	5-10
5.3.1	Development Objectives and Sector Priorities.....	5-10
5.3.2	Overall State Goals and Activities by 2011 .....	5-11
5.3.3	CES Annual Budget for 2008/2009.....	5-14
5.3.4	County Annual Work Plan for 2009 .....	5-15

## CHAPTER 6 JUBA URBAN DEVELOPMENT AND LAND USE PLAN

---

6.1	JUBA URBAN DEVELOPMENT DIRECTION .....	6-1
6.1.1	Expected Roles of Juba .....	6-1
6.1.2	Development Potential/Constraint and Direction.....	6-2
6.2	FUTURE SOCIO-ECONOMIC FRAMEWORK .....	6-4
6.2.1	Population .....	6-4
6.2.2	Economy .....	6-7
6.3	LAND USE PLAN.....	6-8
6.3.1	Present Land Use.....	6-8
6.3.2	Estimate of Future Land Demands .....	6-11
6.3.3	Proposed Land Use Plan.....	6-13

## PART II URBAN TRANSPORT DEVELOPMENT MASTER PLAN

### CHAPTER 7 TRANSPORT DEVELOPMENT POLICY AND TARGET

7.1	APPROACH .....	7-1
7.2	TRANSPORT DEVELOPMENT POLICY AND OBJECTIVE OF MTR .....	7-3
7.2.1	Transport Sector Policy .....	7-3
7.2.2	Transport Sector Objectives .....	7-4
7.2.3	Transport Development Projects Implementation Strategy .....	7-6
7.3	STRATEGIC PLAN FOR ROAD SECTOR OF MTR .....	7-7
7.3.1	Constraints to Road Development .....	7-7
7.3.2	Steps for Implementation of Strategic Plan .....	7-7
7.3.3	Plan Implementation Schedule .....	7-10
7.4	PROPOSED URBAN TRANSPORT DEVELOPMENT STRATEGY AND TARGET .....	7-10
7.4.1	Present Urban Transport Issues .....	7-10
7.4.2	Proposed Urban Transport Development Strategy .....	7-11
7.4.3	Proposed Transport Development Target .....	7-16

### CHAPTER 8 TRAFFIC DEMAND FORECAST

8.1	PRESENT TRAFFIC .....	8-1
8.1.1	Traffic Survey .....	8-1
8.1.2	Zoning System .....	8-2
8.1.3	Result of Traffic Survey .....	8-5
8.2	Future Traffic .....	8-22
8.2.1	Methodology .....	8-22
8.2.2	Forecast of Trip Generation and Attraction .....	8-25
8.2.3	Forecast of Trip Distribution .....	8-29
8.2.4	Forecast of Modal Split .....	8-32
8.2.5	Traffic Assignment .....	8-33
8.2.6	Assessment of Present Transport Network .....	8-36

### CHAPTER 9 ROAD NETWORK DEVELOPMENT PLAN

9.1	STUDY METHODOLOGY .....	9-1
9.2	ROAD CLASSIFICATION .....	9-2
9.3	STANDARD CROSS-SECTIONS .....	9-3
9.4	ROAD ANCILLARY FACILITIES .....	9-6
9.5	PROPOSED ROAD NETWORK DEVELOPMENT .....	9-8
9.5.1	Mapping .....	9-8
9.5.2	Proposed Road Network .....	9-9
9.5.3	Existing and Planned Road Length .....	9-11
9.6	IDENTIFICATION OF REQUIRED ROAD IMPROVEMENT .....	9-14
9.7	PROJECT COST ESTIMATE .....	9-16
9.8	PROJECT IMPLEMENTATION FRAME AND TRAFFIC CONDITION .....	9-18



## **CHAPTER 10 PUBLIC TRANSPORT DEVELOPMENT PLAN**

---

10.1	PLANNING CONCEPT .....	10-1
10.1.1	Problems with Present Bus/Taxi Services .....	10-1
10.1.2	Planning Directions for Public Transport Development.....	10-2
10.2	ADMINISTRATIVE / INSTITUTIONAL SYSTEM .....	10-3
10.3	PUBLIC TRANSPORT DEMAND ESTIMATE .....	10-4
10.4	PROPOSED BUS SYSTEM.....	10-6
10.4.1	Bus Network Improvement Plan .....	10-6
10.4.2	Bus Terminal Improvement Plan.....	10-6
10.4.3	Staging Plan.....	10-7
10.5	PROPOSED TAXI SYSTEM.....	10-10
10.6	COST ESTIMATE .....	10-12

## **CHAPTER 11 TRAFFIC MANAGEMENT SYSTEM DEVELOPMENT PLAN**

---

11.1	PLANNING CONCEPT .....	11-1
11.1.1	Present Traffic Problems .....	11-1
11.1.2	Objective of Traffic Management Plan.....	11-1
11.1.3	Basic Direction of Traffic Management Measures .....	11-2
11.2	ADMINISTRATIVE/INSTITUTIONAL SYSTEM .....	11-2
11.3	TRAFFIC ENGINEERING MEASURES .....	11-4
11.3.1	Road Improvement and Traffic Operation.....	11-4
11.3.2	Intersection Operation Plan .....	11-5
11.3.3	Traffic Management Plan in Juba.....	11-10
11.3.4	Other Traffic Management Plan – Traffic Demand Management .....	11-11
11.3.5	Special Remarks .....	11-12
11.4	TRAFFIC SAFETY EDUCATION AND TRAFFIC ENFORCEMENT .....	11-13

## **CHAPTER 12 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS**

---

12.1	ENVIRONMENTAL INSTITUTION.....	12-1
12.2	ENVIRONMENTAL RULES AND REGULATIONS .....	12-4
12.3	PRESENT PRACTICE OF ENVIRONMENTAL AND SOCIAL CONSIDERATIONS.....	12-9
12.4	NATURAL ENVIRONMENTAL CONSIDERATION OF STUDY AREA.....	12-9
12.5	LAND ACQUISITION AND RESETTLEMENT LAWS AND PROCEDURE .....	12-17
12.6	IEE FOR MAJOR PROJECTS .....	12-20
12.6.1	Road Improvement/Construction Project.....	12-20
12.6.2	Bus Terminal & Bus Parking Area Project.....	12-31

## **CHAPTER 13 PROPOSED PROJECT IMPLEMENTATION SYSTEM**

---

13.1	PRESENT IMPLEMENTATION SYSTEM .....	13-1
13.1.1	Present Procedure for Urban Transport Project Implementation.....	13-1
13.1.2	Present Organization of Agencies Responsible for Road Management .....	13-5
13.1.3	Problems and Issues in Present Implementation System.....	13-10
13.2	PROPOSED IMPLEMENTATION SYSTEM.....	13-13



13.2.1 Basic Concepts and Measures .....	13-13
13.2.2 Government Policy and Strategic Plan .....	13-14
13.2.3 Organization Structure.....	13-16
13.2.4 Organizational Function and Implementation Flow .....	13-18

## CHAPTER 14 PROPOSED ROAD MAINTENANCE SYSTEM

14.1 PRESENT MAINTENANCE SYSTEM.....	14-1
14.1.1 Demarcation of Road Maintenance Work between MTR and MOPI.....	14-1
14.1.2 Organization and Performance of MTR .....	14-2
14.1.3 Organization and Performance of the MOPI.....	14-4
14.2 REQUIRED MAINTENANCE WORKS .....	14-5
14.2.1 Road Maintenance Classification .....	14-5
14.2.2 Maintenance Management System.....	14-6
14.2.3 Road Maintenance Works.....	14-8
14.2.4 Road Maintenance Requirements.....	14-8
14.3 MAINTENANCE SYSTEM DEVELOPMENT SCENARIOS .....	14-11
14.3.1 Categorization of Maintenance Works .....	14-11
14.3.2 Type of Maintenance Contract .....	14-13
14.3.3 Proposed Development Strategy and Scenario.....	14-16
14.4 PROPOSED MAINTENANCE SYSTEM.....	14-19
14.4.1 Basic Policy in Establishing Effective Maintenance System .....	14-19
14.4.2 Role and Responsibility of Public Sector .....	14-20
14.4.3 Organizational Structure and Function.....	14-22

## CHAPTER 15 IMPLEMENTATION PLAN

15.1 IMPEMETATION FRAMEWORK AND CAPACITY .....	15-1
15.2 ASSUMPTIONS ON FUNDS AVAILABLE FOR MASTER PLAN PROJECTS.....	15-2
15.3 IMPLEMENTATION PRIORITY AND SCHEDULE.....	15-6

# PART III PRE-FEASIBILITY STUDY OF HIGH PRIORITY PROJECTS

## CHAPTER 16 FORMULATION OF URBAN STREET MAINTENANCE SYSSTEM

16.1 OBJECTIVE AND APPROACH OF THE STUDY .....	16-1
16.2 PRESUMPTION OF ROAD IMPROVEMENT PROGRESS.....	16-4
16.2.1 Improvement Type for Urban Street.....	16-4
16.2.2 Assumed Progress of Improvement and Maintenance .....	16-5
16.3 ESTIMATION FOR ROAD MAINTENANCE WORKS .....	16-9
16.3.1 Required Maintenance Works .....	16-9
16.3.2 Unit Cost for Maintenance Works .....	16-11
16.3.3 Cost Estimation for Maintenance Works.....	16-14
16.4 URBAN STREET MAINTENANCE SYSTEM .....	16-15
16.4.1 Implementation Strategy .....	16-15
16.4.2 Organization Structure of MOPI .....	16-16

16.4.3	Annual Maintenance Plan for the Years 2012, 2016 and 2026.....	16-19
--------	--	-------

## CHAPTER 17 URBAN STREET IMPROVEMENT IN CENTRAL COMMERCIAL DISTRICT

---

17.1	OBJECTIVES AND APPROACH OF THE STUDY .....	17-1
17.2	PRESENT ROAD CONDITION .....	17-4
17.2.1	Study Area and Existing Road Network.....	17-4
17.2.2	Road Inventory .....	17-5
17.2.3	Present Road Conditions .....	17-7
17.3	URBAN STREET IMPROVEMENT POLICY .....	17-10
17.3.1	Urban Characteristics .....	17-10
17.3.2	Level of Improvement.....	17-12
17.3.3	Urban Aesthetics and Environment Amenity .....	17-13
17.3.4	Major Development Area .....	17-14
17.4	BASIC PLAN.....	17-14
17.4.1	Functional Classification of Street Network .....	17-14
17.4.2	Design Criteria .....	17-16
17.4.3	Standard Cross-sections .....	17-16
17.4.4	Pavement Type and Stage Improvement .....	17-19
17.4.5	Traffic Demand Forecast and Management.....	17-19
17.5	PRELIMINARY DESIGN .....	17-22
17.5.1	General Plan .....	17-22
17.5.2	Pavement Design.....	17-24
17.5.3	Drainage Design.....	17-28
17.5.4	Intersection Design.....	17-33
17.5.5	Road Ancillary Facilities .....	17-41
17.6	COST ESTIMATE .....	17-44
17.6.1	Right-of-way Acquisition and Compensation Cost .....	17-44
17.6.2	Detailed Design Cost.....	17-44
17.6.3	Construction Cost.....	17-44
17.6.4	Construction Supervision Cost.....	17-46
17.6.5	Summary of Project Cost .....	17-46
17.7	ENVIRONMENTAL IMPACT ASSESSMENT .....	17-47
17.7.1	Natural Environment .....	17-47
17.7.2	Social Environment .....	17-47
17.7.3	Pollution .....	17-51
17.7.4	Environmental Evaluation.....	17-52
17.8	SIMPLIFIED ECONOMIC EVALUATION.....	17-54
17.8.1	Approach .....	17-54
17.8.2	Economic Cost .....	17-54
17.8.3	Economic Benefit.....	17-55
17.8.4	Economic Evaluation .....	17-58
17.9	IMPLEMENTATION PLAN.....	17-61

## CHAPTER 18 ROUTE LOCATION STUDY OF MAJOR ARTERIALS

---

18.1	OBJECTIVES AND APPROACH OF THE STUDY .....	18-1
18.1.1	Objectives of Route Location Study .....	18-1
18.1.2	Process of Route Location Selection .....	18-3
18.1.3	Policy on Route Location Selection .....	18-5
18.2	ESTABLISHMENT OF ROUTE REQUIREMENTS .....	18-5
18.2.1	Engineering Requirements .....	18-5
18.2.2	Land Access Requirements .....	18-6
18.2.3	Environmental and Social Requirements .....	18-7
18.3	EXAMINATION OF ALTERNATIVE ROUTES .....	18-11
18.3.1	Site Reconnaissance .....	18-11
18.3.2	Identification of Control Points .....	18-14
18.3.3	Comparison of Alternative Routes .....	18-15
18.3.4	Nile River Crossing .....	18-19
18.4	PROPOSED OPTIMUM ROUTES .....	18-22
18.5	PREPARATORY WORKS .....	18-24

## CHAPTER 19 URBAN STREET NETWORK DEVELOPMENT IN SOUTHERN JUBA

---

19.1	OBJECTIVES AND APPROACH OF THE STUDY .....	19-1
19.1.1	Objectives of the Study .....	19-1
19.1.2	Study Methodology .....	19-1
19.2	PRESENT CONDITION OF SOUTHERN JUBA AND SELECTION OF STUDY ROADS.....	19-4
19.2.1	Present Condition of Southern Juba .....	19-4
19.2.2	Selection of the Study Roads.....	19-6
19.3	BASIC PLAN.....	19-8
19.3.1	Design Policy .....	19-8
19.3.2	Route Location .....	19-8
19.3.3	Future Traffic Demand .....	19-12
19.3.4	Standard Cross-sections .....	19-14
19.3.5	Stage Construction .....	19-16
19.4	PRELIMINARY DESIGN .....	19-18
19.4.1	Alignment.....	19-18
19.4.2	Pavement Design.....	19-21
19.4.3	Drainage Design.....	19-24
19.4.4	Intersection Design.....	19-25
19.4.5	Structure Design.....	19-30
19.4.6	Nile River Bridge Design.....	19-43
19.4.7	Ancillary Facilities Design .....	19-56
19.4.8	Preliminary Design Drawings .....	19-60
19.5	CONSTRUCTION PLAN AND COST ESTIMATE.....	19-61
19.5.1	Construction Method.....	19-61
19.5.2	Construction Schedule.....	19-62
19.5.3	Procurement Plan .....	19-63
19.5.4	Project Cost Estimate .....	19-65

19.6	INITIAL ENVIRONMENTAL EXAMINATION .....	19-70
19.6.1	Natural Environment .....	19-70
19.6.2	Social Environment .....	19-71
19.6.3	Environmental Evaluation .....	19-73
19.7	SIMPLIFIED ECONOMIC EVALUATION.....	19-75
19.7.1	Economic Cost .....	19-75
19.7.2	Economic Benefit.....	19-76
19.7.3	Economic Evaluation .....	19-77
19.8	IMPLEMENTATION PLAN.....	19-84
19.8.1	Implementation Organization.....	19-84
19.8.2	Project Implementation Activities and Schedule.....	19-84

## **PART IV BRIDGES AND CULVERTS RECONSTRUCTION PROJECT**

### **CHAPTER 20 SELECTION OF BRIDGES AND CULVERTS**

20.1	BACKGROUND AND PROJECT OBJECTIVES .....	20-1
20.2	EXISTING CONDITIONS OF THE PROPOSED BRIDGES AND CULVERTS LOCATIONS..	20-4
20.2.1	River/Streams and Bridge Opening.....	20-4
20.2.2	Road and Bridge Geometry .....	20-7
20.2.3	Bridge and Culverts Structures.....	20-7
20.3	OVERALL ASSESSMENT OF EXISTING CONDITIONS .....	20-7

### **CHAPTER 21 NATURAL CONDITION SURVEY**

21.1	TOPOGRAPHIC SURVEY AT BRIDGES AND CULVERTS SITES .....	21-1
21.2	GEOTECHNICAL SURVEY FOR BRIDGES AND CULVERTS.....	21-3
21.3	RIVER CONDITION AND FLOOD DISCHARGE .....	21-5

### **CHAPTER 22 PRELIMINARY PLAN AND DESIGN**

22.1	CONSIDERATION FOR BRIDGE PLANNING .....	22-1
22.2	BRIDGE/CULVERT OPENING , SPAN LENGTH AND BRIDGE LENGTH.....	22-2
22.3	BRIDGE CROSS-SECTION .....	22-2
22.4	BRIDGE TYPE .....	22-5
22.5	PROPOSED BRIDGES AND CULVERTS .....	22-5
22.6	BRIDGE AND CULVERT PRIORITIZATION.....	22-7
22.7	CONSTRCUTION COST ESTIMATE.....	22-10
22.7.1	Concept of Cost Estimate .....	22-10
22.7.2	Basic Flow of Cost Estimate .....	22-10
22.7.3	Estimates Costs of Bridges and Culverts.....	22-11

### **CHAPTER 23 INITIAL ENVIRONMENTAL EXAMINATION (IEE) FOR BRIDGE AND CULVERT RECONSTRUCTION PROJECT**

23.1	GENERAL .....	23-1
23.2	EVALUATION RESULTS FOR ENVIRONMENTAL ELEMENTS .....	23-3

## **PART V CAPACITY DEVELOPMENT THRU PILOT PROJECT**

### **CHAPTER 24 1st PILOT PROJECT IMPLEMENTATION**

24.1	OBJECTIVES AND POLICY OF PILOT PROJECT.....	24-1
24.2	WORKING GROUP ACTIVITIES.....	24-2
24.2.1	The Working Group (W/G) .....	24-2
24.2.2	Issues of Road Infrastructure in Munuki .....	24-4
24.3	IMPLEMENTATION PLAN OF PILOT PROJECT .....	24-6
24.3.1	Proposed Site.....	24-6
24.3.2	Implementation Scheme .....	24-7
24.3.3	Design and Cost Estimation .....	24-9
24.3.4	Construction Management and Supervision.....	24-11
24.4	CONSTRUCTION WORKS.....	24-12
24.4.1	Contract .....	24-12
24.4.2	Construction .....	24-14
24.4.3	Supervision and Construction Management.....	24-14
24.5	EVALUATION OF PILOT PROJECT AND FEEDBACK .....	24-21
24.5.1	Evaluation Method and Matrix Design .....	24-21
24.5.2	Evaluation of Capacity Development (C/D) Items and Impact for Users .....	24-24
24.5.3	Evaluation of Construction.....	24-29
24.5.4	Recommendation for Capacity Development.....	24-31
24.5.5	Recommendation for Road Maintenance Plan .....	24-32
24.6	PROPOSED MAINTENANCE PLAN FOR MUNUKI.....	24-33
24.6.1	Existing Road Conditions.....	24-33
24.6.2	Estimation of Road Maintenance Cost.....	24-38
24.6.3	Annual Road Maintenance Plan .....	24-39

### **CHAPTER 25 2nd PILOT PROJECT IMPLEMENTATION**

25.1	OBJECTIVES AND APPROACH OF 2 <sup>nd</sup> PILOT PROJECT .....	25-1
25.1.1	Background of 2 <sup>nd</sup> Pilot Project.....	25-1
25.1.2	Project Objectives .....	25-2
25.1.3	Issues on Road Maintenance for Collector and Local Roads .....	25-2
25.1.4	Project Implementation Approach and Methodology.....	25-3
25.2	PROJECT SITE SELECTION AND JUSTIFICATION .....	25-7
25.2.1	Existing Conditions of Collector and Local Roads .....	25-7
25.2.2	Inspection of Candidate Sites and Site Selection .....	25-8
25.3	PLANNING AND ENGINEERING STAGE.....	25-11
25.3.1	Inspection and Condition Evaluation of 2 <sup>nd</sup> Pilot Project Site .....	25-11
25.3.2	Design for Gravel Road Maintenance/Rehabilitation .....	25-12
25.3.3	Project Scope and Budget.....	25-13
25.3.4	Construction Planning .....	25-16
25.4	PROJECT EXECUTION .....	25-18
25.4.1	Project Organization and Administration .....	25-18
25.4.2	Project Execution and Supervision.....	25-19
25.4.3	Project Monitoring and Control .....	25-20

25.4.4 Completion and Reporting .....	25-26
25.5 PROJECT EVALUATION AND FEEDBACK.....	25-28
25.5.1 Evaluation Method for 2 <sup>nd</sup> Pilot Project .....	25-28
25.5.2 Project Relevance .....	25-29
25.5.3 Project Achievement and Effectiveness .....	25-29
25.5.4 Project Efficiency .....	25-38
25.5.5 Project Impact .....	25-43
25.5.6 Project Sustainability.....	25-46
25.6 RECOMMENDATIONS.....	25-49

## CHAPTER 26 CAPACITY DEVELOPMENT PLAN

26.1 CAPACITY DEVELOPMENT THRU PILOT PROJECT .....	26-1
26.1.1 Objectives of Capacity Development for MOPI thru Pilot Project .....	26-1
26.1.2 Outline of the MOPI.....	26-1
26.1.3 Training Need Analysis .....	26-3
26.2 PROJECT CYCLE MANAGEMENT FOR CAPACITY DEVELOPMENT PLAN .....	26-4
26.3 LESSONS LEARNED FROM PILOT PROJECTS .....	26-13
26.3.1 Relationship Between Capacity Development and the Pilot Project.....	26-13
26.3.2 Lessons Learned from 1 <sup>st</sup> Pilot Project.....	26-15
26.4 CAPACITY DEVELOPMENT CONDITION .....	26-19
26.5 CAPACITY DEVELOPMENT PROGRAM .....	26-21
26.5.1 Targets of Capacity Development .....	26-21
26.5.2 Proposed Curriculum and Development Methods.....	26-26
26.5.3 Proposed Progress and Action Plan.....	26-29
26.6 STRENGTHNING OF THE PRIVATE SECTOR .....	26-33
26.6.1 Roles of Private Sector .....	26-33
26.6.2 Government's Support to Private Sector .....	26-34

## PART VI CONCLUSIONS AND RECOMMENDATIONS

### CHAPTER 27 CONCLUSIONS AND RECOMMENDATIONS

27.1 CONCLUSIONS .....	27-1
27.1.1 Urban Transport Development Master Plan .....	27-1
27.1.2 Pre-Feasibility Study Projects .....	27-3
27.1.3 Bridges and Culverts Reconstruction Project.....	27-5
27.1.4 Capacity Development Thru Pilot Project.....	27-6
27.2 RECOMMENDATIONS.....	27-8

# ACRONYMS AND ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AC	:	Asphalt Concrete
AIDS	:	Acquired Immunodeficiency Syndrome
ASTM	:	American Society for Testing and Materials
B/C	:	Benefit/Cost Ratio
BCRP	:	Bridges and Culverts Reconstruction Project
CAI	:	Clean Air Initiative
CBD	:	Central Business District
CBR	:	California Bearing Ratio
CCD	:	Central Commercial District
CCG	:	Community Construction Group
C/D	:	Capacity Development
CES	:	Central Equatoria State
CPA	:	Comprehensive Peace Agreement
DBST	:	Double Bituminous Surface Treatment
DEM	:	Digital Elevation Model
DMR	:	Department of Road Maintenance
EB	:	Equipment Based
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
ERRP	:	Emergency Road Rehabilitation Project
ESAL	:	Equivalent Single Axle Load
GDP	:	Gross Domestic Product
GIS	:	Geographic Information System
GNI	:	Gross National Income
GOJ	:	Government of Japan
GONU	:	Government of National Unity
GOSS	:	Government of Southern Sudan
GRDP	:	Gross Regional Domestic Product
HCM	:	Highway Capacity Manual
HIV	:	Human Immunodeficiency Virus
HR	:	Human Resources



ICAO	:	International Civil Aviation Organization
IDA	:	International Development Association
IDP	:	Internally Displaced Person
IEE	:	Initial Environmental Examination
IMCT	:	Inter-Ministry Committee for Transport
IOM	:	International Organization for Migration
I/S	:	Intersection
JAM	:	Joint Assessment Mission
JICA	:	Japan International Cooperation Agency
JRA	:	Japan Road Association
LB	:	Labor Based
LOS	:	Level of Service
MAD	:	Mean Absolute Difference
MBA	:	Maintenance by Administration
MBC	:	Maintenance by Contract
MDTF	:	Multi Donor Trust Fund
M&E	:	Monitoring and Evaluation
MEWCT	:	Ministry of Environment, Wildlife, Conservation and Tourism
MFEHR	:	Ministry of Finance, Economy and Human Resources
MFEP	:	Ministry of Finance and Economic Planning
MHPPE	:	Ministry of Housing, Physical Planning and Environment
MHLPU	:	Ministry of Housing, Land and Public Utilities
MOH	:	Ministry of Health
MOPI	:	Ministry of Physical Infrastructure
MSL	:	Mean Sea Level
MTR	:	Ministry of Transport and Roads
MWRI	:	Ministry of Water Resources and Irrigation
NGO	:	Non-Governmental Organization
NMIMT	:	Non-Motorized and Intermediate Means of Transport
NMT	:	Non-Motorized Transport
NPV	:	Net Present Value
NSCSE	:	New Sudan Centre for Statistics and Evaluation
OD	:	Origin-Destination
OJT	:	On-the-Job Training
PCM	:	Project Cycle Management
PCP	:	Physically Challenged People

PCU	:	Passenger Car Unit
PDM	:	Project Design Matrix
PM	:	Periodic Maintenance
PMT	:	Project Management Team
P/P	:	Pilot Project
PSI	:	Present Serviceability Index
QCBS	:	Quality- and Cost-Based Selection
R/A	:	Roundabout
RCPC	:	Reinforced Concrete Pipe Culvert
RM	:	Routine Maintenance
ROW	:	Right of Way
RR	:	Road Rehabilitation
RTC	:	River Transport Corporation
RTSMU	:	Road Traffic and Safety Management Unit
SARPS	:	Standards and Recommendation Practices
SDG	:	Sudani Pounds (Monetary Unit)
SETIDP	:	Sudan Emergency Transport and Infrastructure Development Project
SN	:	Structural Number
SNAP	:	Sudanese National AIDS Control Programme
SOSUS	:	Southern Sudan SPLM Areas
SPLA	:	Sudan Peoples Liberation Army
SPLM	:	Sudan Peoples Liberation Movement
SRA	:	State Road Agency
SSAC	:	Southern Sudan AIDS Commission
SSCCSE	:	Southern Sudan Commission for Census, Statistics and Evaluation
SSCRA	:	Southern Sudan County Road Agency
SSEC	:	Southern Sudan Electricity Corporation
SSRA	:	Southern Sudan Road Agency
SSRB	:	Southern Sudan Road Board
SSURA	:	Southern Sudan Urban Road Agency
SSUWC	:	Southern Sudan Urban Water Corporation
STD	:	Sexually Transmitted Disease
TA	:	Technical Assistance
TAST	:	Technical Assistance Team
TNA	:	Training Needs Analysis
TRL	:	Transport Research Laboratory
UN	:	United Nations
UNDP	:	United Nations Development Program

UNICEF	:	United Nations International Children's Fund
UNOPS	:	United Nations Office for Project Services
USAID	:	United States Agency for International Development
USD	:	US Dollar
USGS	:	United States Geological Survey
UTM	:	Universal Transverse Mercator
VCR (V/C)	:	Volume-Capacity Ratio
WB	:	World Bank
WFP	:	World Food Programme
WG	:	Working Group
WGS	:	World Geodetic System

# LIST OF FIGURES

Figure 1.4-1	Study Flow Diagram .....	1-4
Figure 2.1.1-1	Administrative Structure of Southern Sudan .....	2-1
Figure 2.1.1-2	Administrative Divisions .....	2-2
Figure 2.1.2-1	Organization of the Government of the Southern Sudan .....	2-3
Figure 2.1.2-2	Organization of Central Equatoria State .....	2-3
Figure 2.2.2-1	Monthly Rainfall in JUBA .....	2-5
Figure 2.2.4-1	Earthquake Occurrence Position in Juba and Environs .....	2-7
Figure 2.2.4-2	Earthquake Occurrence Position in Juba Wide Area .....	2-7
Figure 2.2.5-1	Land Type in Juba .....	2-9
Figure 2.3.1-1	Population of Sudan for the Years 1973 – 2008 .....	2-10
Figure 2.3.3-1	Livelihood Zones of Southern Sudan .....	2-17
Figure 3.2.1-1	International Road Network .....	3-4
Figure 3.2.1-2	Interstate Road Network .....	3-5
Figure 3.2.1-3	Present Road Network in Juba .....	3-6
Figure 3.2.1-4	Present Road Network in Juba and Surrounding Area .....	3-6
Figure 3.2.2-1	Location of Major Intersections in Juba .....	3-8
Figure 3.2.3-1	Road Condition (as of October 2008) .....	3-9
Figure 3.2.3-2	Route of Road Inventory Survey .....	3-10
Figure 3.2.4-1	Image of Rainwater Flow on May Street .....	3-12
Figure 3.2.5-1	Existing Bridges/Culverts in Juba .....	3-13
Figure 3.4-1	Existing Traffic Management in Juba .....	3-18
Figure 3.5-1	Location of Bus Terminal .....	3-18
Figure 4.2.1-1	Road Projects Progress .....	4-7
Figure 4.3.2-1	Status of Emergency Road Rehabilitation Project (ERRP) .....	4-11
Figure 5.2.2-1	Priority Roads for Year 2011 .....	5-9
Figure 5.3.2-1	CES Physical Infrastructure Sector Activities by Year 2011, Roads and Airstrips .....	5-13
Figure 6.2.1-1	Population of Sudan .....	6-5
Figure 6.3.1-1	Land Type in Juba .....	6-8
Figure 6.3.1-2	Present Land Use .....	6-10
Figure 6.3.3-1	Proposed New Residential Areas by 2015/2025 .....	6-15
Figure 6.3.3-2	Proposed Land Use for 2015 .....	6-18
Figure 6.3.3-3	Proposed Land Use for 2025 .....	6-19
Figure 7.1-1	Procedure of Transport Master Plan Formulation .....	7-2
Figure 8.1.1-1	Traffic Survey Locations .....	8-2
Figure 8.1.2-1	Zoning System of the Study Area .....	8-2
Figure 8.1.3-1	Daily Traffic Volume .....	8-5
Figure 8.1.3-2(1)	Traffic Composition by Road (Sta. A1~A8) .....	8-6
Figure 8.1.3-2(2)	Traffic Composition by Road (Sta. B1~B5) .....	8-7
Figure 8.1.3-3(1)	16hr. Hourly Traffic Volume .....	8-8
Figure 8.1.3-3(2)	16hr. Hourly Traffic Volume .....	8-9
Figure 8.1.3-3(3)	16hr. Hourly Traffic Volume .....	8-10
Figure 8.1.3-3(4)	16hr. Hourly Traffic Volume .....	8-11

Figure 8.1.3-4(1)	24hr. Hourly Traffic Volume .....	8-12
Figure 8.1.3-4(2)	24hr. Hourly Traffic Volume .....	8-13
Figure 8.1.3-4(3)	24hr. Hourly Traffic Volume .....	8-14
Figure 8.1.3-5	Trip Purpose .....	8-15
Figure 8.1.3-6	Travel Speed and Congestion .....	8-18
Figure 8.1.3-7	Sex .....	8-19
Figure 8.1.3-8	Age .....	8-19
Figure 8.1.3-9	Education Background .....	8-19
Figure 8.1.3-10	Working Status .....	8-19
Figure 8.1.3-11	Income Level .....	8-20
Figure 8.1.3-12	Trip Purpose .....	8-20
Figure 8.1.3-13	Frequency of Bus Usage .....	8-20
Figure 8.1.3-14	Assessment of Present Bus Service .....	8-21
Figure 8.1.3-15	Opinion on Improvement of the Bus Service .....	8-21
Figure 8.2.1-1	Flow of Transport Demand Forecast .....	8-23
Figure 8.2.2-1	Verification of Trip Generation and Attraction Model .....	8-25
Figure 8.2.2-2	Trip Generation in 2008, 2015 and 2025 .....	8-28
Figure 8.2.3-1	Verification of Trip Distribution Model .....	8-30
Figure 8.2.3-2	Desire Line of Total Trips in 2008,2015 and 2025 .....	8-31
Figure 8.2.4-1	Future Modal Share .....	8-32
Figure 8.2.5-1	Traffic Assignment Procedure .....	8-33
Figure 8.2.5-2	Volume-Speed Relationship .....	8-34
Figure 8.2.5-3	Comparison between Observed and Assigned Traffic at Individual Sites .....	8-35
Figure 8.2.6-1	Traffic Assignment Result In Existing Case in 2008 .....	8-37
Figure 8.2.6-2	Traffic Assignment Result in Do-Nothing Case in 2015 .....	8-37
Figure 8.2.6-3	Traffic Assignment Result in Do-Nothing Case in 2025 .....	8-37
Figure 9.1-1	Study Procedure .....	9-1
Figure 9.2-1	Schematic Illustration of a Portion of a Suburban Street Network .....	9-3
Figure 9.5.2-1	Proposed Road Network in Juba Urban Area .....	9-10
Figure 9.5.3-1	Sectioning of Arterial Streets .....	9-13
Figure 9.5.3-2	Blocks of Collector/Local Streets .....	9-13
Figure 9.8-1	Traffic Assignment Result in Existing Case – Year 2008 .....	9-20
Figure 9.8-2	Traffic Assignment Result in With-Project Case – Year 2015 .....	9-20
Figure 9.8-3	Traffic Assignment Result in With-Project Case – Year 2025 .....	9-20
Figure 10.1.2-1	Proposed Future Public Transport System in Juba .....	10-3
Figure 10.3-1	Estimated Bus Volume (2008) .....	10-4
Figure 10.3-2	Future Bus Volume (2015) .....	10-5
Figure 10.4.1-1	Proposed Future Bus Network Plan .....	10-6
Figure 10.4.2-1	Location of Proposed Bus Terminals and Bus Parking Areas .....	10-7
Figure 10.4.3-1	Staging Plan of Public Transport .....	10-8
Figure 10.4.3-2	Various Bus Services.....	10-9
Figure 10.4.3-3	Bus/Minivan Fleet Size and Type .....	10-9
Figure 11.3.1-1	Intersection with Exclusive Left-turn Lanes .....	11-4
Figure 11.3.2-1	Study Approach .....	11-6
Figure 11.3.2-2	Major Intersection Improvement Types .....	11-6

Figure 11.3.2-3	Junctions to be Improved in Phase I to Phase III .....	11-10
Figure 12.1-1	Organization of Former Ministry of Environment, Wildlife, Conservation and Tourism (GOSS) .....	12-1
Figure 12.1-2	Organization of Directorate of Environmental Affairs of MHPPE, GOSS .....	12-2
Figure 12.1-3	Organization of Ministry of Transport and Roads, GOSS .....	12-3
Figure 12.2-1	Procedure of Environmental and Social Consideration in JICA (Case of Concerned Project of the GOSS) .....	12-7
Figure 12.2-2	EIA Procedure (MHPPE & MTR) .....	12-8
Figure 12.6.1-1	Subject Roads .....	12-20
Figure 12.6.2-1	Location of Proposed Bus Terminals and Bus Parking Areas .....	12-31
Figure 13.1.1-1	Procedure for Implementation of Juba Urban Roads Projects (in case of National Roads) .....	13-4
Figure 13.1.2-1	Organization of Ministry of Transport and Roads (MTR) .....	13-6
Figure 13.1.2-2	Organization of Directorate of Roads and Bridges in the MTR .....	13-5
Figure 13.1.2-3	Organization of Ministry of Physical Infrastructure (MOPI), CES .....	13-8
Figure 13.1.2-4	Organization of Directorate of Roads and Bridges in the MOPI .....	13-8
Figure 13.1.2-5	Structure Recommended by Strategic Plan .....	13-10
Figure 13.2.3-1	Proposed Overall Organizational Structure for Implementation of Urban Transport Development .....	13-17
Figure 13.2.4.-1	Project Implementation Flow of Juba Urban Transport Infrastructure (JUTI) .....	13-19
Figure 14.2.2-1	Basic Flow of Pavement Maintenance Management System .....	14-7
Figure 14.4.2-1	Vicious Circle of Road Network Deterioration .....	14-20
Figure 14.4.3-1	Administrative Road Classification .....	14-22
Figure 14.4.3-2	Proposed Structure of Directorate of Roads and Bridges, the MTR .....	14-23
Figure 14.4.3-3	Proposed Structure of Directorate of Roads and Bridges, MOPI .....	14-25
Figure 15.2-1	Assumed Budget for Transport and Road .....	15-5
Figure 15.3-1	Proposed Projects at Different Term Periods .....	15-9
Figure 16.1-1	Flow Chart of Approach to the Study.....	16-2
Figure 16.4.2-1	Implementation Cycle and Proposed Function of MOPI .....	16-16
Figure 16.4.2-2	Proposed Organizational Set-up of MOPI .....	16-18
Figure 16.4.3-1	Location Map of Improved Streets.....	16-27
Figure 17.1-1	Study Flow of Urban Street Improvement .....	17-3
Figure 17.2.1-1	Location of CCD .....	17-4
Figure 17.2.1-2	Road Network in CCD .....	17-5
Figure 17.2.3-1	Present ROW Width .....	17-7
Figure 17.2.3-2	Present Road Conditions in CCD (as of May 2009) .....	17-9
Figure 17.2.3-3	Present Drainage Type (as of May 2009) .....	17-10
Figure 17.3.1-1	Existing Land Use in CCD .....	17-11
Figure 17.4.1-1	Functional Classification of Streets in CCD .....	17-15
Figure 17.5.1-1	Adopted Standard Cross-sections .....	17-22
Figure 17.5.1-2	Layout Plan of Road Facilities .....	17-23
Figure 17.5.3-1	Procedural Flow of Road Drainage Design .....	17-28
Figure 17.5.3-2	Road Drainage Layout Plan in CCD .....	17-29
Figure 17.5.3-3	Design Example: Plan & Profile .....	17-32
Figure 17.5.4-1	Design Intersections .....	17-33

Figure 17.5.4-2	Intersection Design Example (Intersection-1) .....	17-40
Figure 17.5.4-3	Typical Traffic Signal .....	17-41
Figure 17.5.5-1	Example of Traffic Signs and Sign Post .....	17-42
Figure 17.5.5-2	Plan of Typical Bus Bay .....	17-43
Figure 17.5.5-3	Typical Pedestrian Crossing .....	17-43
Figure 17.7.2-1	Electric Wires and Poles .....	17-48
Figure 17.7.2-2	Roadside Facilities .....	17-48
Figure 17.7.2-3	Water Pipe Facility .....	17-49
Figure 17.9-1	Streets Covered by On-going Project and Others .....	17-62
Figure 18.1.1-1	Proposed Road Network and Standard Cross-Sections for Arterial Streets .....	18-2
Figure 18.1.2-1	Route Location Study Procedure for Major Arterials .....	18-3
Figure 18.2.2-1	Proposed Land Use for Juba (Year 2025) .....	18-6
Figure 18.3.1-1	Delineation of the Proposed Routes by Satellite Image .....	18-11
Figure 18.3.1-2(a)	Existing Conditions of C2 Proposed Route .....	18-12
Figure 18.3.1-2(b)	Existing Conditions of C3 Proposed Route .....	18-13
Figure 18.3.1-2(c)	Existing Conditions of R5 Proposed Route .....	18-14
Figure 18.3.2-1	Control Points for Route Location Alternatives .....	18-15
Figure 18.3.3-1	C2 Nile River Bridge Crossings .....	18-19
Figure 18.3.3-2	C3 Nile River Bridge No.2 - North .....	18-21
Figure 18.3.3-3	R5 Nile River Bridge Crossing .....	18-21
Figure 18.4-1	Proposed Route Locations for Juba Urban Road Network .....	18-22
Figure 18.4-2	Work Improvement for the Proposed Juba Urban Road Network .....	18-24
Figure 19.1.1-1	Study Flow on Urban Street Network Development in Southern Juba .....	19-3
Figure 19.2.1-1	Geographic Condition in Southern Juba .....	19-4
Figure 19.2.1-2	Present Land Use in the Southern Juba .....	19-5
Figure 19.2.1-3	Land Use Plan in Southern Juba (2025) .....	19-5
Figure 19.2.1-4	Present Road Network in Southern Juba .....	19-6
Figure 19.3.2-1	Route Location Control Points .....	19-9
Figure 19.3.2-2	Alternative Alignments of Lologo and Nyakuron Radial Streets .....	19-10
Figure 19.3.2-3(a)	Existing Conditions of CSA (Lologo Radial Street) .....	19-10
Figure 19.3.2-3(b)	Existing Conditions of CSB (Nyakuron Radial Street) .....	19-11
Figure 19.3.3-1	Segment of the Study Roads .....	19-12
Figure 19.3.3-2	Estimated Traffic Volume and Traffic Capacity .....	19-13
Figure 19.3.4-1(a)	Typical Cross Section of Circumferential Streets (C2, Outside CCD and C3) ....	19-14
Figure 19.3.4-1(b)	Typical Cross Section of Circumferential Streets C2 (Inside CCD) .....	19-14
Figure 19.3.4-1(c)	Typical Cross Section of Lologo and Nyakuron Radial Streets .....	19-15
Figure 19.4.1-1	Pre-FS Streets Proposed Alignments .....	19-19
Figure 19.4.3-1	Road Side Drainage .....	19-24
Figure 19.4.4-1	Location of Major Intersections to be Studied .....	19-25
Figure 19.4.4-2	Typical Plan of Proposed Signalized Intersection .....	19-29
Figure 19.4.5-1	Locations and Basic Scales of Structures along the Study Roads .....	19-30
Figure 19.4.5-2(1)	Typical Cross-Sections of Bridges on Circumferential Streets .....	19-33
Figure 19.4.5-2(2)	Typical Cross-Sections of Culverts on Circumferential Streets .....	19-34
Figure 19.4.5-3	Typical Cross-Sections of Bridge/Culverts on Collector Streets .....	19-34
Figure 19.4.5-4	Existing Conditions of Study Roads at Bridge/Culverts Sites .....	19-35



Figure 19.4.5-5	Proposed Structures Along C2 .....	19-40
Figure 19.4.5-6	Proposed Structures Along C3 .....	19-41
Figure 19.4.5-7	Proposed Structures Along CSA (in Lologo) and CSB (in Nyakuron) .....	19-42
Figure 19.4.6-1	Study Flow for the Nile River Bridge Design .....	19-43
Figure 19.4.6-2	The Nile River .....	19-44
Figure 19.4.6-3	Location of C3 Nile River Crossing Bridge No.1 .....	19-45
Figure 19.4.6-4	River Section at Proposed Site .....	19-46
Figure 19.4.6-5	River Condition at the Proposed Site .....	19-47
Figure 19.4.6-6	Existing Juba Bridge .....	19-48
Figure 19.4.6-7	General View of Existing Juba Bridge .....	19-48
Figure 19.4.6-8	Applicable Bridge Types for Intermediate Span Bridges .....	19-50
Figure 19.4.6-9	Cost of Different Bridge Superstructure Types .....	19-51
Figure 19.4.6-10	Candidate Bridges for Nile River Crossing .....	19-52
Figure 19.4.6-11	Proposed Nile River Crossing .....	19-55
Figure 19.4.7-1	General Plan of Green Belt and Sidewalk .....	19-57
Figure 19.4.7-2	Typical Pedestrian Crossing .....	19-57
Figure 19.4.7-3	Plan of Typical Bus Bay .....	19-58
Figure 19.4.7-4	Example of Traffic Signs and Sign Post .....	19-59
Figure 19.4.7-5	Typical Traffic Signal .....	19-59
Figure 19.6.1-1	Route Locations of C2, C3, CSA and CSB .....	19-70
Figure 20.1-1	On-Going Emergency Road Rehabilitation Project and Proposed Bridges and Culverts Locations .....	20-1
Figure 20.1-2	Existing Bridges and Culverts Proposed for Bridges and Culverts Reconstruction Project .....	20-2
Figure 20.2.1-1	Bridge Openings and River Conditions .....	20-5
Figure 21.1-1	Typical Topographic Survey Results .....	21-2
Figure 21.2-1	Borehole Locations .....	21-4
Figure 21.2-2	Typical Borehole Log (BH-1, Bridge No.6) .....	21-4
Figure 21.3-1	River Basin and Flood Discharges .....	21-5
Figure 21.3-2	Estimated Flood Discharges .....	21-6
Figure 22.2-1	Bridge Opening and Bridge Length .....	22-2
Figure 22.3-1(a)	Proposed Bridge Cross-Sections .....	22-3
Figure 22.3-1(b)	Proposed Bridge Cross-Sections .....	22-4
Figure 22.7-1	Basic Flow of Cost Estimate Procedure .....	22-10
Figure 24.1-1	Area Division and Informal Areas .....	24-2
Figure 24.2.1-1	Working Group and Workshop in the 1st Pilot Project .....	24-3
Figure 24.2.2-1	Proposed Sites in Munuki Payam .....	24-5
Figure 24.3.1-1	Project Location in Munuki .....	24-6
Figure 24.3.2-1	Pilot Project Organization .....	24-7
Figure 24.3.3-1	Road Alignment .....	24-9
Figure 24.3.3-2	Typical Cross Section.....	24-9
Figure 24.3.3-3	Cross Section of Culvert .....	24-10
Figure 24.4.3-1	Construction Progress of Survey and Clearance Works.....	24-15
Figure 24.4.3-2	Comparison Before and After of Construction .....	24-16
Figure 24.4.3-3	Camber Check and Material Test.....	24-18

Figure 24.4.3-4	Sand Cone Replacement Test at Site.....	24-18
Figure 24.5.2-1	Achievement of Planning and Construction Works .....	24-25
Figure 24.5.2-2	Effectiveness of C/D on Planning and Construction Works.....	24-25
Figure 24.5.2-3	Sustainability of C/D on Planning and Construction Works .....	24-27
Figure 24.5.2-4	Impacts to Community Along the Street.....	24-28
Figure 24.6.1-1	Roads in Munuki Area .....	24-34
Figure 24.6.1-2	Target Road Network for Database .....	24-35
Figure 24.6.1-3	Share of Length by Road Surface Condition in Munuki.....	24-36
Figure 24.6.1-4	Range of Width for Roads in Munuki .....	24-37
Figure 24.6.1-5	Range of ROW in Munuki .....	24-38
Figure 24.6.3-1	Model Case of Maintenance Cost of MTR and MOPI.....	24-40
Figure 25.1.1-1	Road Structures for the Pilot Projects .....	25-2
Figure 25.1.4-1	Flow of Road Maintenance Implementation (Force Account).....	25-4
Figure 25.1.4-2	Project Implementation Scheme .....	25-5
Figure 25.1.4-3	Pilot Project Organization .....	25-6
Figure 25.1.4-4	Pilot Project Implementation Schedule.....	25-6
Figure 25.2.2-1	Candidate Sites for 2nd Pilot Project .....	25-8
Figure 25.3.1-1	2nd Pilot Project Site Condition.....	25-12
Figure 25.3.3-1	Gravel Pavement Structure .....	25-14
Figure 25.3.3-2	General Plan and Cross-Sections .....	25-15
Figure 25.3.4-1	Original Planned Schedule.....	25-16
Figure 25.3.4-2	Traffic Control During Ditch Excavation .....	25-17
Figure 25.3.4-3	Traffic Control During Culvert and Black Cotton Soil Excavation .....	25-17
Figure 25.4.1-1	CCG Organization.....	25-18
Figure 25.4.3-1	Planned and Actual Schedule .....	25-21
Figure 25.4.3-2	Road Cross-Section During Initial Inspection and Proposed Correction.....	25-23
Figure 25.4.3-3	Heights of Pipe Culverts and Ditches .....	25-24
Figure 25.5.3-1	Results of 2nd Pilot Project Inspection (15 May 2010) .....	25-33
Figure 25.5.3-2	Completion of 2nd Pilot Project.....	25-37
Figure 25.5.4-1	Typical Road Cross-Section.....	25-40
Figure 25.5.5-1	Completion of the 1st and 2nd Pilot Projects.....	25-44
Figure 26.2-1	Problem Analysis .....	26-5
Figure 26.2-2	Object Analysis .....	26-6
Figure 26.4-1	Level of Capacity Development.....	26-19
Figure 26.5.1-1	Implementation Cycle of Road Maintenance.....	26-24

# LIST OF TABLES

Table 1.5-1	Study Schedule and Progress .....	1-5
Table 2.2.2-1	Monthly Rainfall in JUBA .....	2-4
Table 2.2.4-1	Seismic Intensity List .....	2-6
Table 2.3.1-1	Population of Sudan for the Years 1973 – 2008 .....	2-10
Table 2.3.1-2	Average Annual Population Growth Rate .....	2-11
Table 2.3.1-3	2008 Population .....	2-12
Table 2.3.1-4	2008 Population of Juba Urban Area .....	2-13
Table 2.3.1-5	Cumulative Number of Returnees up to June 2008 .....	2-14
Table 2.3.2-1	Gross Domestic Product at Current Market Prices .....	2-15
Table 2.3.2-2	Economic Indicators .....	2-16
Table 3.2.1-1	Road Type and Responsible Organization .....	3-3
Table 3.2.1-2	Proposed Institution and Function .....	3-3
Table 3.2.1-3	Road List in Central Equatoria .....	3-5
Table 3.2.1-4	Summary of Arterial Radial Roads .....	3-7
Table 3.2.1-5	Summary of Arterial Circumferential Roads .....	3-7
Table 3.2.2-1	Major Intersection Conditions .....	3-7
Table 3.2.3-1	Road Inventory Data in Juba .....	3-11
Table 3.2.5-1	Summary of Existing Bridges and Culverts Conditions .....	3-14
Table 3.3-1	Vehicle Registration System and Number of Registered Vehicles .....	3-17
Table 3.5-1	Interstate/International Bus Operation from/to Juba .....	3-19
Table 4.1.1-1	Main Activities of Transport Development in 2008 Budget.....	4-2
Table 4.1.1-2	Main Activities of Transport Development in 2009 Budget.....	4-3
Table 4.1.2-1	Summary of Road Contracts under MTR .....	4-4
Table 4.2.2-1	Summary of Donor Infrastructure Development Projects .....	4-8
Table 5.1.1-1	GOSS Revenues and Expenditures: 2006 - 2009 .....	5-2
Table 5.1.1-2	2009 Budget Allocation by Sector .....	5-2
Table 5.1.2-1	GOSS 2009 Budget Estimates for Infrastructure Sector .....	5-3
Table 5.1.2-2	2009 Budget Estimates for Transport and Roads by Program Area .....	5-4
Table 5.1.2-3	Capital Details for Transport and Roads in 2009 Budget .....	5-4
Table 5.1.3-1	Major Projects Listed in Capital Details .....	5-6
Table 5.2.2-1	Proposed Roads for Year 2011 .....	5-8
Table 5.2.2-2	Total Cost of the Priority Roads Development (US\$ Millions) .....	5-9
Table 5.3.2-1	CES Physical Infrastructure Sector Activities by Year 2011 .....	5-12
Table 5.3.3-1	CES Annual Budget for 2008/2009 .....	5-14
Table 5.3.3-2	CES Annual Budget Allocation for 2009 .....	5-15
Table 5.3.3-3	Details of 2009 Budget of Physical Infrastructure Sector .....	5-15
Table 5.3.4-1	Activities in Road Transport in County Annual Work Plan 2009 .....	5-16
Table 6.1.2-1	Factors Related to Development Potential .....	6-2
Table 6.2.1-1	Past Population of Sudan .....	6-4
Table 6.2.1-2	Future Population of Sudan .....	6-4

Table 6.2.1-3	Urban Population of Northern Sudan .....	6-5
Table 6.2.1-4	Future Population .....	6-6
Table 6.2.2-1	Roughly Estimated Future GRDP of Juba Urban Area .....	6-7
Table 6.3.1-1	Residential Land Classification .....	6-8
Table 6.3.1-2	Present Land Use by Category .....	6-10
Table 6.3.2-1	Required Future Urban Area .....	6-11
Table 6.3.2-2	Assumptions in Estimation of Land Demands by Category .....	6-12
Table 6.3.2-3	Estimated Future Working Population .....	6-12
Table 6.3.2-4	Estimated Future Land Demands by Land Use Category .....	6-13
Table 7.3.3-1	Costs of Road Projects .....	7-10
Table 7.4.2-1	Proposed Urban Transport Development Strategy .....	7-13
Table 7.4.3-1	Urban Street Class Based on Functional and Design Categories .....	7-16
Table 7.4.3-2	Level of Service by Class .....	7-17
Table 7.4.3-3	Definitions of Levels of Service .....	7-17
Table 7.4.3-4	Proposed Targets by Street Class .....	7-17
Table 8.1.1-1	Contents of Traffic Survey .....	8-1
Table 8.1.2-1	Zoning System Inside the Study Area .....	8-3
Table 8.1.2-2	Zoning System Outside of the Study Area .....	8-4
Table 8.1.3-1	Conversion Rate (24h/12h rate) .....	8-14
Table 8.1.3-2	Vehicle Occupancy .....	8-15
Table 8.1.3-3	Average Number of Passengers on Board by Vehicle Category .....	8-16
Table 8.1.3-4	Traffic by Commodity Type .....	8-16
Table 8.1.3-5	Average Loading by Type of Truck .....	8-17
Table 8.1.3-6	Routes of Travel Speed Survey .....	8-17
Table 8.1.3-7	Respondents .....	8-19
Table 8.2.1-1	Travel Mode Category in Demand Forecasting .....	8-24
Table 8.2.2-1	Trip Generation and Attraction Model Parameters .....	8-25
Table 8.2.2-2	Future Framework .....	8-26
Table 8.2.2-3	Future Total Trip Generation .....	8-26
Table 8.2.2-4	Trip Generation and Attraction in 2008, 2015 and 2025 .....	8-27
Table 8.2.3-1	Inter-Zone Trip Distribution Model Parameters .....	8-29
Table 8.2.4-1	Future Modal Share .....	8-32
Table 8.2.5-1	Occupancy Rate and Passenger Car Unit (pcu) .....	8-34
Table 8.2.5-2	Free Flow Speed (Vmax) and Capacity (Q) by Road Type .....	8-35
Table 8.2.6-1	Vehicle Assignment Results in Do-Nothing Case .....	8-36
Table 9.2-1	Administrative Road Classification .....	9-2
Table 9.2-2	Definition of Urban Road Classification in AASHTO .....	9-2
Table 9.2-3	Functional Classification Proposed for this Study .....	9-3
Table 9.3-1	Proposed Road Functional Classification and Design Criteria .....	9-4
Table 9.3-2	Proposed Standard Cross Sections .....	9-5
Table 9.5.1-1	Specifications of the Satellite Image .....	9-8
Table 9.5.1-2	Specifications of Mapping .....	9-8
Table 9.5.1-3	Produced Maps .....	9-9

Table 9.5.3-1	Road Length (Arterial Streets) .....	9-11
Table 9.5.3-2	Road Length (Collector and Local Streets) .....	9-12
Table 9.6-1	Proposed Staging Improvement Scheme .....	9-14
Table 9.6-2	Necessary Improvement Works .....	9-15
Table 9.7-1	Unit Construction Cost by Type of Work .....	9-16
Table 9.7-2	Estimated Construction Cost .....	9-17
Table 9.8-1	Project Implementation Frame .....	9-19
Table 9.8-2	Summary of Traffic Assignment in With-Project Case .....	9-19
Table 10.3-1	Future Minibus Demand in Juba .....	10-5
Table 10.5-1	Selection of Public Transport Mode Other than Bus .....	10-10
Table 10.5-2	Service Limitation for Public Transport Mode Other than Bus .....	10-11
Table 10.6-1	Cost Estimate of Bus Terminals and Bus Parking Areas Construction Project .....	10-12
Table 11.3.2-1	Advantages and Disadvantages of Intersection Improvement Type .....	11-7
Table 11.3.2-2	Present Traffic of 11 Selected Junctions .....	11-8
Table 11.3.2-3	Result of Evaluation for 11 Selected Junction Based on Present Traffic .....	11-8
Table 11.3.2-4	Result of Evaluation for 11 Selected Junction Based on Future Traffic (2015) .....	11-9
Table 11.3.2-5	Countermeasures for Intersection Improvement .....	11-9
Table 11.3.2-6	Proposed Implementation Phase .....	11-10
Table 12.2-1	Contents of the Practices in Environmental Guideline .....	12-4
Table 12.4-1	National Parks and Game Reserves .....	12-11
Table 12.4-2	Completely Protected Species of Mammalia (Mammals) & AVES (Birds) .....	12-11
Table 12.5-1	Contents of SOUTHERN SUDAN PROPOSED LAND BILL 2007( 2 <sup>nd</sup> Draft) .....	12-17
Table 12.6.1-1	Roadside Condition for Existing Roads and New Roads .....	12-25
Table 12.6.1-2	Evaluation Results for Environmental Elements .....	12-30
Table 12.6.2-1	Land Use Condition of the Area Related to Bus Terminal & Parking Area Project ..	12-32
Table 13.1.1-1	Administrative Road Classification .....	13-1
Table 13.1.2-1	Major Duties and Number of Staff of Directorate of Roads and Bridges in the MTR	13-7
Table 13.1.2-2	Major Duties and Number of Staff of Directorate of Roads and Bridges in the MOPI	13-9
Table 14.1.1-1	MTR's Idea on Demarcation of Road Improvement/Maintenance Works .....	14-1
Table 14.1.2-1	Major Duties and Number of Staff in MTR .....	14-2
Table 14.1.2-2	List of Equipment Owned by MTR .....	14-2
Table 14.1.2-3	Major Works Undertaken by MTR .....	14-2
Table 14.1.2-4	2008 Expenditure and 2009 Budget of MTR .....	14-3
Table 14.1.2-5	Cost Estimates for Construction & Civil Works (2009) .....	14-3
Table 14.1.3-1	Major Duties and Number of Staff in MOPI .....	14-4
Table 14.1.3-2	List of Equipment Owned by MOPI .....	14-4
Table 14.1.3-3	Annual Budget of MOPI for 2008 .....	14-5
Table 14.2.3-1	Classification of Maintenance Works .....	14-8
Table 14.2.4-1	Identification of Distress Types (AASHTO Guide) .....	14-9
Table 14.2.4-2	Identification of Distress Types (JRA) .....	14-10
Table 14.2.4-3	Surface Defects – Road with Asphalt Surfacing .....	14-10
Table 14.3.1-1	Categorization of Maintenance Works .....	14-13
Table 14.3.2-1	Contract Type and Major Application .....	14-14

Table 14.3.3-1	Proposed Development Scenario of Road Maintenance System .....	14-18
Table 14.4.3-1	Proposed Jurisdiction of Road Improvement/Maintenance Work .....	14-22
Table 14.4.3-2	Demarcation of Roles and Functions between Central and Regional Office .....	14-25
Table 15.2-1	Overall GOSS Financial Needs and Gap .....	15-3
Table 15.3-1	Overall Implementation Schedule .....	15-8
Table 16.2.1-1	Road Improvement Types.....	16-4
Table 16.2.1-2	Application of Road Improvement Types for Urban Streets .....	16-5
Table 16.2.2-1	Assumed Stages of Road Improvement.....	16-6
Table 16.2.2-2	Application of Road Improvement Options for Urban Streets .....	16-6
Table 16.2.2-3	Assumed Progress of Road Improvement and Maintenance .....	16-7
Table 16.2.2-4	Required Length to be Maintained in Target Years 2012 and 2016.....	16-8
Table 16.3.1-1	Basic Maintenance Works by Road Classification .....	16-10
Table 16.3.2-1	Unit Cost of Labor, Equipment, and Materials.....	16-11
Table 16.3.2-2	Road Maintenance Cost per Kilometer .....	16-12
Table 16.3.2-3	Comparison of Road Maintenance and Improvement Cost per Kilometer .....	16-12
Table 16.3.2-4	Assumed Annual Cost and Resources (Equipment/Tools, Materials, Man-power) on Road Maintenance Works.....	16-13
Table 16.3.3-1	Maintenance Cost Required in 2012 and 2016(Collector and Local Streets).....	16-14
Table 16.3.3-2	Maintenance and Construction Costs Required in 2012 and 2016 (Collector and Local Streets).....	16-14
Table 16.4.2-1	Proposed Function of the MTR and MOPI .....	16-17
Table 16.4.2-2	Proposed Management and Maintenance Responsibilities for the MOPI .....	16-19
Table 16.4.3-1	Annually Required Days of Maintenance Works (2012, 2016 and 2026).....	16-19
Table 16.4.3-2 (1)	Required Days of Maintenance Works for Year 2012 .....	16-20
Table 16.4.3-2 (2)	Required Days of Maintenance Works for Year 2016 .....	16-21
Table 16.4.3-2 (3)	Required Days of Maintenance Works for Year 2026 .....	16-22
Table 16.4.3-3	Annually Required Number of Man-power (2012, 2016 and 2026) .....	16-23
Table 16.4.3-4	Number of Labor and Equipment Required for One Maintenance Team.....	16-23
Table 16.4.3-5	Number of Personnel in the Directorate of Roads & Bridges .....	16-24
Table 16.4.3-6	Required Number of Engineers for the Road Maintenance (per 10 km long).....	16-24
Table 16.4.3-7	Required Number of Engineers for the Road Maintenance (2012, 2016 and 2026) .....	16-25
Table 16.4.3-8	Annual Number of Major Equipment Required for Maintenance Works.....	16-25
Table 16.4.3-9	Major Equipment Owned by the MTR.....	16-26
Table 16.4.3-10	Major Materials Required for Road Maintenance.....	16-26
Table 16.4.3-11	Annual Budget for Year 2009, Central Equatorial State Government.....	16-27
Table 16.4.3-12	Proposed Annual Budget for Maintenance Work in 2012, 2016 and 2026.....	16-28
Table 16.4.3-13	Assumed Maintenance Cost for Temporary Leveling in 2012, 2016 and 2026 .....	16-28
Table 16.4.3-14	Required Equipment for Maintenance Work in 2012, 2016 and 2026 .....	16-29
Table 16.4.3-15(1)	Summary of Budget Requirement for Street Maintenance Work (Years 2012 and 2016).....	16-30
Table 16.4.3-15(2)	Summary of Budget Requirement for Street Maintenance Work (Year 2026) .....	16-31
Table 17.2.3-1	Road Length in CCD .....	17-7
Table 17.2.3-2	Range of Roadway and ROW Width .....	17-7

Table 17.2.3-3	Road Length by Surface Type and Road Classification (as of May 2009)	17-8
Table 17.2.3-4	Present Condition of Road Surface (as of May 2009)	17-8
Table 17.3.1-1	Percentage of Land Use in CCD	17-11
Table 17.3.2-1	Improvement Level	17-13
Table 17.4.1-1	Definition of Urban Street Classification in CCD	17-15
Table 17.4.2-1	Proposed Design Criteria	17-16
Table 17.4.3-1(1)	Standard Cross-sections of Streets in CCD (1/2)	17-17
Table 17.4.3-1(2)	Standard Cross-sections of Streets in CCD (2/2)	17-18
Table 17.4.5-1	Assumed Traffic Growth Rate of Collector and Major Local Streets	17-19
Table 17.4.5-2	Estimated Traffic Volume of the Streets in CCD	17-20
Table 17.5.1-1	Road Facilities Plan	17-23
Table 17.5.2-1	Design Sections and Proposed Pavement Type	17-24
Table 17.5.2-2	Design Inputs	17-26
Table 17.5.2-3	Required Structural Number	17-27
Table 17.5.2-4	Layer Thicknesses Selected	17-27
Table 17.5.3-1	Design Storm Frequency and Rainfall Intensity for Design of Road Drainage	17-29
Table 17.5.3-2	Run-off/Discharge on Arterial Streets	17-30
Table 17.5.3-3	Run-off/Discharge on Collector Streets	17-31
Table 17.5.3-4	Run-off/Discharge on Major Local Street	17-31
Table 17.5.3-5	Design Example: Design Computation	17-32
Table 17.5.4-1	Critical Gap and Follow-up Times for Roundabouts	17-34
Table 17.5.4-2	Adjustment Factors	17-34
Table 17.5.4-3	Traffic Volume by Direction	17-35
Table 17.5.4-3	Traffic Volume by Direction (Continued)	17-36
Table 17.5.4-4	Intersection Capacity Analysis (Intersection-1, Roundabout, 2015 Traffic)	17-36
Table 17.5.4-5	Intersection Capacity Analysis (Intersection-1, Signalized, 2015 Traffic)	17-37
Table 17.5.4-6	Intersection Capacity Analysis (Intersection-2, Roundabout, 2015 Traffic)	17-38
Table 17.5.4-7	Intersection Capacity Analysis (Intersection-3, Roundabout, 2015 Traffic)	17-38
Table 17.5.4-9	Summary of Intersection Design	17-38
Table 17.5.4-8	Intersection Capacity Analysis (Intersection-4, Signalized, 2015 Traffic)	17-39
Table 17.6.3-1	Unit Construction Costs	17-45
Table 17.6.3-2	Construction Costs per Kilometer	17-45
Table 17.6.3-3	Construction Costs by Road Class	17-46
Table 17.6.5-1	Summary of Project Costs	17-46
Table 17.4.4-1	Evaluation Results for Environmental Elements	17-53
Table 17.8.2-1	Financial and Economic Cost of the Project	17-55
Table 17.8.3-1	Assumed Traffic Volume	17-55
Table 17.8.3-2	Basic Vehicle Operating Cost and Passenger Time Cost	17-56
Table 17.8.3-3	Traffic Cost	17-57
Table 17.8.3-4	Estimated Benefits	17-57
Table 17.8.4-1	Implementation Schedule	17-58
Table 17.8.4-2(1)	Benefit-Cost Stream (1/2)	17-58
Table 17.8.4-2(2)	Benefit-Cost Stream (2/2)	17-59



Table 17.8.4-3	Economic Indicators .....	17-60
Table 17.9-1	Proposed Implementation System .....	17-61
Table 17.9-2	Streets Covered by On-going Project and Others .....	17-62
Table 17.9-3	Proposed Project Implementation Schedule .....	17-63
Table 18.2.1-1	Engineering Requirements for Route Location of C2, C3 and R5 .....	18-6
Table 18.2.3-1	Property and Land Cost (Juba Town) .....	18-9
Table 18.3.2-1	Route Location Control Points .....	18-14
Table 18.3.3-1	Alternative Section 1 : C2 Alignment at CCD .....	18-16
Table 18.3.3-2	Alternative Section 2 : C2 Alignment at South Military Area .....	18-16
Table 18.3.3-3	Alternative Section 3 : C2 Alignment at Munuki Area .....	18-17
Table 18.3.3-4	Alternative Section 1 : C3 Alignment at Gudele Area .....	18-18
Table 18.3.3-5	Alternative Section 3 : C3 Alignment at Jebel Kujur Area .....	18-18
Table 18.3.3-6	Alternative Bridge Locations for C3 Nile Bridge No.1 – South Section .....	18-20
Table 18.4-1	Proposed Circumferential Streets .....	18-22
Table 18.4-2	Proposed Radial Streets .....	18-23
Table 19.2.2-1	Major Role of the Selected Roads .....	19-7
Table 19.3.2-1	Route Location Control Points .....	19-9
Table 19.3.2-2	Alternative Routes of CSA (Lologo Radial Street) .....	19-11
Table 19.3.2-3	Alternative Routes of CSB (Nyakuron Radial Street) .....	19-11
Table 19.3.3-1	Estimated Traffic Volume and Volume/Capacity Ratio .....	19-12
Table 19.3.3-2	The Year When Traffic Demand Exceeds 2-Lane Road Capacity .....	19-13
Table 19.3.5-1	Comparison of Stage Construction Schemes .....	19-17
Table 19.4.1-1(a)	Geometric Standards for Arterial Streets (C2, C3) .....	19-18
Table 19.4.1-1(b)	Geometric Standards for Collector Streets (Lologo/Nyakuron Radial Streets) ....	19-18
Table 19.4.2-1	Design Inputs .....	19-22
Table 19.4.2-2	Required Structural Number .....	19-23
Table 19.4.2-3	Layer Thicknesses Selected .....	19-23
Table 19.4.4-1	Uses of Roundabouts According to Road Class .....	19-26
Table 19.4.4-2	Traffic Capacity of Roundabout by its Size .....	19-27
Table 19.4.4-3	Future Traffic Volume .....	19-27
Table 19.4.4-4	Simplified Analysis of Traffic Capacity at Intersections .....	19-28
Table 19.4.4-5	Determination of Intersection Type .....	19-29
Table 19.4.5-1	Structures Along the Study Roads .....	19-30
Table 19.4.5-2	Cross-Section Elements for Bridge and Culvert .....	19-32
Table 19.4.5-3	Vertical Clearance According to Flood Discharge .....	19-36
Table 19.4.5-4	Assumed Concrete Strength .....	19-37
Table 19.4.5-5	Schedule of Structures Along C2 .....	19-38
Table 19.4.5-6	Schedule of Structures Along C3 .....	19-38
Table 19.4.5-7	Schedule of Structures Along CSA .....	19-38
Table 19.4.5-8	Schedule of Structures Along CSB .....	19-39
Table 19.4.6-1	Comparison of Bridge Alternatives for Nile River Crossing .....	19-53
Table 19.4.6-2	Proposed Nile Bridge River Crossing .....	19-54
Table 19.4.8-1	List of Preliminary Design Drawings .....	19-60

Table 19.5.1-1	Major Components of the Project.....	19-61
Table 19.5.2-1	Estimated Construction Schedule.....	19-63
Table 19.5.4-1	Unit Costs.....	19-66
Table 19.5.4-2	Major Work Quantities .....	19-67
Table 19.5.4-3(a)	Cost of Circumferential Street C2.....	19-68
Table 19.5.4-3(b)	Cost of Circumferential Street C3 .....	19-68
Table 19.5.4-3(c)	Cost of Radial Street CSA (in Lologo) .....	19-68
Table 19.5.4-3(d)	Cost of Radial Street CSB (in Nyakuron).....	19-69
Table 19.5.4-4	Project Costs.....	19-69
Table 19.6.2-1	Roadside Land Use.....	19-71
Table 19.6.3-1	Evaluation Results for Environmental Elements.....	19-74
Table 19.7.1-1	Economic Cost Estimate .....	19-75
Table 19.7.2-1	Total Vehicle-Kilometers.....	19-76
Table 19.7.2-2	Total Vehicle-Hours.....	19-76
Table 19.7.2-3	Basic Vehicle Operating Cost.....	19-77
Table 19.7.2-4	Estimation of Benefit.....	19-77
Table 19.7.3-1	Assumed Implementation Schedule .....	19-77
Table 19.7.3-2	Economic Indications of Benefit Cost Analysis .....	19-78
Table 19.7.3-3 (1/4)	Benefit-Cost Stream (C2 Project).....	19-79
Table 19.7.3-3 (2/4)	Benefit-Cost Stream (C3 Project).....	19-80
Table 19.7.3-3 (3/4)	Benefit-Cost Stream (Lologo Radial Street Project) .....	19-81
Table 19.7.3-3 (4/4)	Benefit-Cost Stream (Nyakuron Radial Street Project).....	19-82
Table 19.7.3-4	Sensitivity Analysis Results .....	19-83
Table 19.8.2-1	Proposed Implementation Schedule .....	19-86
Table 20.1-1	Summary of Existing Bridge and Culverts Conditions .....	20-3
Table 20.3-1	Overall Assessment of Existing Conditions .....	20-10
Table 22.5-1	Proposed Bridges and Culverts .....	22-6
Table 22.6-1	Prioritization Criteria.....	22-7
Table 22.6-2	Results of Bridge and Culvert Prioritization .....	22-9
Table 22.7-1(a)	Budgetary Construction Costs of Bridges and Culverts.....	22-12
Table 22.7-1(b)	Budgetary Construction Costs of Bridges and Culverts.....	22-12
Table 23.1-1	Locations of Bridges .....	23-1
Table 23.1-2	Conditions of Surrounding Areas for Bridges/Culverts.....	23-2
Table 23.2-1	Evaluation Results for Environmental Elements.....	23-3
Table 24.2.1-1	Responsibilities of W/G and W/S.....	24-3
Table 24.2.1-2	Schedule of Pilot Project .....	24-4
Table 24.2.2-1	Priority Considerations.....	24-6
Table 24.3.2-1	Role of Management Staff of Community Construction Group.....	24-8
Table 24.3.3-1	Design Catalog for Gravel Roads.....	24-10
Table 24.3.3-2	Estimated Cost of Pilot Project.....	24-11
Table 24.3.4-1	Items of Management and Supervision .....	24-11
Table 24.3.4-2	Discussion in Community Workshop .....	24-12
Table 24.4.3-1	Schedule Gap Between Plan and Actual.....	24-17

Table 24.4.3-2	Camber Check at Final Inspection .....	24-17
Table 24.4.3-3	Compaction Check at Final Inspection.....	24-18
Table 24.4.3-4	W/G Meeting List.....	24-20
Table 24.4.3-5	Summary of Actual 1st Pilot Project Cost.....	24-21
Table 24.5.1-1	Points for 1st Pilot Project Evaluation.....	24-21
Table 24.5.1-2	Evaluation Items and Target Authority .....	24-22
Table 24.5.1-3	Activities for Each C/D Item.....	24-23
Table 24.5.2-1	Comparison of C/D Items Achievement by Organization .....	24-24
Table 24.5.2-2	Comparison of Effectiveness of C/D Items by Organization .....	24-25
Table 24.5.2-3	C/D Items with Large Gap Between Achievement and Effectiveness .....	24-26
Table 24.5.2-4	Comparison of Sustainability of C/D Items .....	24-26
Table 24.5.2-5	Impacts for Inhabitants Along the Street .....	24-27
Table 24.5.2-6	Degree of Impact to Community Along the Street .....	24-28
Table 24.5.3-1	Unit Price of 1st Pilot Project and Terms of Input.....	24-29
Table 24.5.3-2	Summary of 1st Pilot Project Cost .....	24-29
Table 24.5.3-3	Investment Fund for 1st Pilot Project for Munuki Area .....	24-30
Table 24.5.3-4	Road Maintenance Works.....	24-30
Table 24.5.3-5	Estimated Cost Based on 1st Pilot Project Results.....	24-30
Table 24.5.5-1	Desired Maintenance Works.....	24-32
Table 24.5.5-2	Scheme of Maintenance Work of MOPI from Force Account to Contract Out.....	24-33
Table 24.6.1-1	Road Length by Classification in Munuki.....	24-34
Table 24.6.1-2	Drainage Length by Classification and Damage in Munuki .....	24-35
Table 24.6.1-3	Sidewalk Length by Classification and Damage in Munuki .....	24-36
Table 24.6.1-4	Summary of Surface Condition in Munuki .....	24-36
Table 24.6.1-5	Range of Width for Roads in Munuki .....	24-37
Table 24.6.1-6	Range of ROW in Munuki .....	24-37
Table 24.6.2-1	Maintenance Policy Based on Surface Condition and Road Classification .....	24-38
Table 24.6.2-2	Summary of Road Maintenance Volume .....	24-38
Table 24.6.3-1	Annual Required Length for Maintenance of MTR and MOPI .....	24-39
Table 24.6.3-2	Summary of Annual Required Cost for Maintenance of MTR and MOPI.....	24-39
Table 25.3.3-1	Pilot Project Budget.....	25-14
Table 25.4.3-1	Project Cost (Expenses).....	25-25
Table 25.4.3-2	CBR Test Results.....	25-25
Table 25.4.3-3	Grain Size Analysis of Gravel .....	25-26
Table 25.5.1-1	2nd Pilot Project Evaluation Criteria and Method.....	25-28
Table 25.5.3-1	Evaluation of Pilot Project Effectiveness by MOPI and MTR (Self Evaluation).....	25-30
Table 25.5.3-2	Inspection Results for 2nd Pilot Project .....	25-32
Table 25.5.4-1	Summary of Budget and Expenses.....	25-38
Table 25.5.4-2	Item Cost Comparison for 2nd Pilot Project Cost Performance.....	25-42
Table 25.5.5-1	Cost Benefit of 2nd Pilot Project.....	25-45
Table 26.1.2-1	Staffs of the Directorate of Roads and Bridges, MOPI .....	26-2
Table 26.1.2-2	Classified Male Staffs.....	26-2
Table 26.1.2-3	Budget Allocation for Roads and Bridges in 2008 and 2009 .....	26-2

Table 26.1.3-1	Training Need Areas for Current Position .....	26-3
Table 26.1.3-2	Training Need Areas for Career Development .....	26-4
Table 26.2-1	Classification of Participants .....	26-5
Table 26.2-2	Alternative Analysis .....	26-6
Table 26.2-3	PDM for 1st Pilot Project .....	26-8
Table 26.2-4	PDM for the 2nd Pilot Project .....	26-9
Table 26.2-5	Plan of Operation.....	26-12
Table 26.2-6	List of Workshops.....	26-12
Table 26.3.2-1	Critical Issues and Countermeasures for the MTR.....	26-15
Table 26.3.2-2	Critical Issues and Countermeasures for MOPI .....	26-15
Table 26.3.2-3	Critical Issues and Countermeasures for Munuki Payam.....	26-16
Table 26.3.2-4	Critical Issues and Countermeasures for Local Contractor .....	26-16
Table 26.3.2-5	Critical Issues and Countermeasures for Munuki Community.....	26-16
Table 26.3.2-6	Capacity Issues and Countermeasures Identified in the 2nd Pilot Project .....	26-17
Table 26.5.1-1	Subjects and Groups for Engineering Capacity Development .....	26-25
Table 26.5.1-2	Subjects and Groups for Construction Capacity Development .....	26-26
Table 26.5.3-1	Proposed Action Plan for Capacity Development for Road Maintenance.....	26-32
Table 27.1.2-1	Annual Budget Required for Maintenance in 2010 and 2016, the MOPI, CES .....	27-3

**PART I**

**GENERAL**

---

# CHAPTER 1

---

## INTRODUCTION

## **CHAPTER 1 INTRODUCTION**

### **1.1 BACKGROUND**

Urban infrastructure such as roads, water supply system, etc. in Southern Sudan, even in the capital Juba is not well provided due to civil wars lasting for more than 20 years. Under such situation, the Japan International Cooperation Agency (JICA) conducted the “Emergency Study on the Planning and Support for Basic Physical and Social Infrastructure in Juba Town and the Surrounding Areas” (the Emergency Study) which was completed on March 2007. The Emergency study included the formulation of an urban infrastructure development plan targeted on year 2015, the identification of urgently needed infrastructure projects and the implementation of three pilot projects, namely, improvement of Juba Port, provision of water supply facilities in Munuki, and establishment of vocational skills training facility.

In the Emergency Study, the progress of refugees and Internally Displaced Persons (IDPs) returning was monitored. However, the returning movement is expected to be accelerated as Juba recovers and its condition improves. At present, Juba has many negative factors for development and investment, such as obscure demarcation of the roles of the Government of the Southern Sudan (GOSS) and the State Government, undefined land tenure, etc. However, even with such negative factors, rehabilitation of the existing infrastructures is being undertaken initiated by GOSS while private investments started to pour in. It is expected that in the future, the population growth in Juba will be accelerated further and the urbanized area will be expanded.

Under such situation, serious urban problems are expected to arise - such as shortage in capacity of basic infrastructure like roads and water supply, disorderly land use due to development without guidance, spread of residential areas in poor environment conditions like slums, difficulty in providing job opportunities for people without experience to be engaged in urban industries including refugees and IDP returnees. These expected problems need preventive measures, one of which GOSS considered in urgent need is the improvement of the urban transport network, especially the improvement of the urban roads including secondary arterial roads with a total length of some 85km. A part of the road improvement being implemented is the on-going “Emergency Road Rehabilitation Project” which covers a total length of 63km and the proposed reconstruction of bridges and culverts as a separate project.

With such background, the GOSS requested a technical cooperation from the Government of Japan (GOJ) to conduct the “Juba Urban Transport Infrastructure and Capacity Development Study” (the Study) based on the findings of the Emergency Study. In response to the request, GOJ has decided to conduct the Study and JICA, the official agency responsible for the implementation of the technical cooperation program of GOJ, has organized and dispatched a Study Team for the Study to be conducted in accordance with the Scope of Work agreed between GOSS and JICA in February 2008.



## 1.2 OBJECTIVES OF THE STUDY

The objectives of the Study are as follows:

- (1) To formulate a transport network master plan for Juba Town and its surrounding areas with the target year until 2025, based on the review of the transport development plan in the Emergency Study,
- (2) To formulate a project for the reconstruction of bridges/culverts which is not included in the on-going “Emergency Road Rehabilitation Project”,
- (3) To conduct feasibility studies on high priority projects in the transport network master plan,
- (4) To prepare a capacity development plan for the engineers in-charge of the road improvement and maintenance in the Ministry of Transport and Roads (MTR) of GOSS, the Ministry of Physical Infrastructure (MOPI) of Central Equatoria State (CES) and other organizations related to the Study, and to support in the execution of the capacity development plan, and
- (5) To support in planning and implementation of pilot projects as an important part of the capacity development.

## 1.3 STUDY AREA

The Study shall cover Juba Town and the surrounding areas (Juba urban area).

## 1.4 SCOPE OF THE STUDY

In order to achieve the objectives mentioned above, the Study shall cover the following items:

**TASK 01** : Preparation of Inception Report

**TASK 02** : Presentation and Discussion of Inception Report

**TASK 03** : Review and Analysis of the Present Condition of the Study Area

**TASK 04** : Site Survey of the Study Area

**TASK 05** : Traffic Survey

**TASK 06** : Formulation of Transport Network Development Master Plan

- (1) Establishment of socio-economic framework
- (2) Traffic demand forecast
- (3) Establishment of transport network development strategies and policies
- (4) Establishment of design standards
- (5) Formulation of transport network development master plan

**TASK 07** : Formation of Bridges/Culvers Reconstruction Project

- (1) Selection of target bridges/culverts
- (2) Natural condition survey
- (3) Establishment of design policy
- (4) Preliminary plan and design
- (5) Construction plan
- (6) Project cost estimate
- (7) Project justification

- (8) Preparation of project report
- TASK 08:** Preparation of Capacity Development Plan for MTR and MOPI
  - (1) Review of road improvement/maintenance system of MTR and MOPI
  - (2) Identification of problems in MTR and MOPI's systems
  - (3) Preparation of capacity development plan
- TASK 09:** Preparation and Discussion of Progress Report
- TASK 10:** Support in Execution of Capacity Development Plan through Pilot Project (First Phase)
  - (1) Support in creation of working group for pilot project
  - (2) Support of working group in preparation of pilot project plan
  - (3) Procurement of computers, printers/copiers and application software for mapping necessary for road inventory survey, preparation of data base and formulation of maintenance plan
- TASK 11:** Feasibility Study of High Priority Projects (First Phase)
  - (1) Selection of projects for feasibility study
  - (2) Preparatory works
- TASK 12:** Preparation and Discussion of Interim Report
- TASK 13:** Amendment of master plan based on census results
- TASK 14:** Support in Execution of Capacity Development Plan through Pilot Project (Second Phase)
  - (1) Support in pilot project implementation
  - (2) Evaluation of pilot project implementation
- TASK 15:** Feasibility Study of High Priority Projects (Second Phase)
  - (1) Formulation of urban street maintenance system
  - (2) Urban street improvement in Central Commercial District (CCD)
  - (3) Route location study of major arterials
  - (4) Urban street network development in southern Juba
- TASK 16:** Conclusion of Study and Recommendations
- TASK 17:** Preparation and Discussion of Draft Final Report
- TASK 18:** Counterpart Training
- TASK 19:** Support in Execution of Capacity Development Plan through Pilot Project-2
  - (1) Support in creation of working group for pilot project-2
  - (2) Support of working group in preparation of plan of pilot project-2
  - (3) Establishment of implementation system
  - (4) Support in implementation of pilot project-2
  - (5) Evaluation of implementation of pilot project-2
- TASK 20:** Preparation and Discussion of Draft Supplemental Report
- TASK 21:** Preparation of Final Report

The study flow of the whole work is illustrated schematically in Figure 1.4-1.

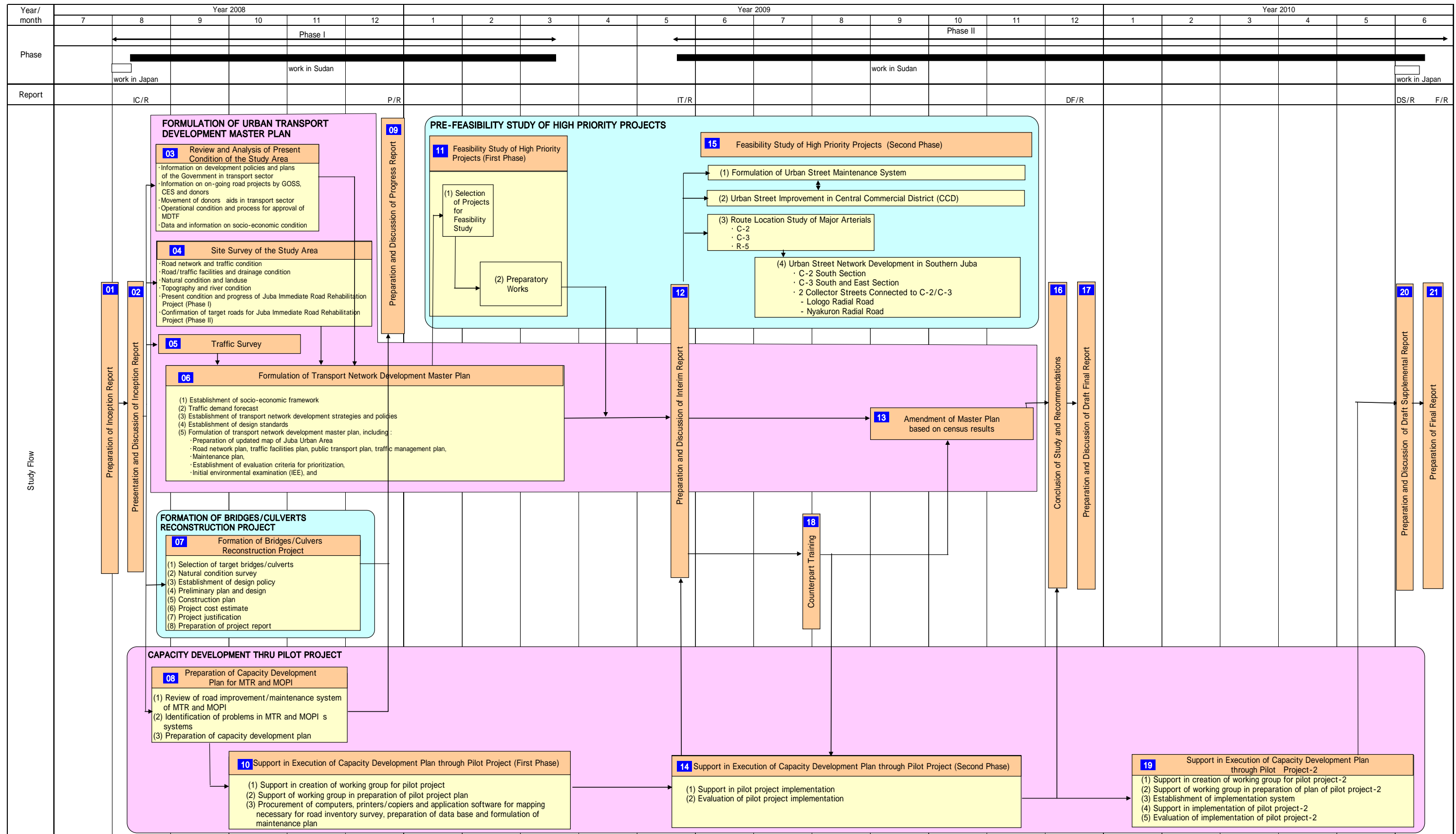
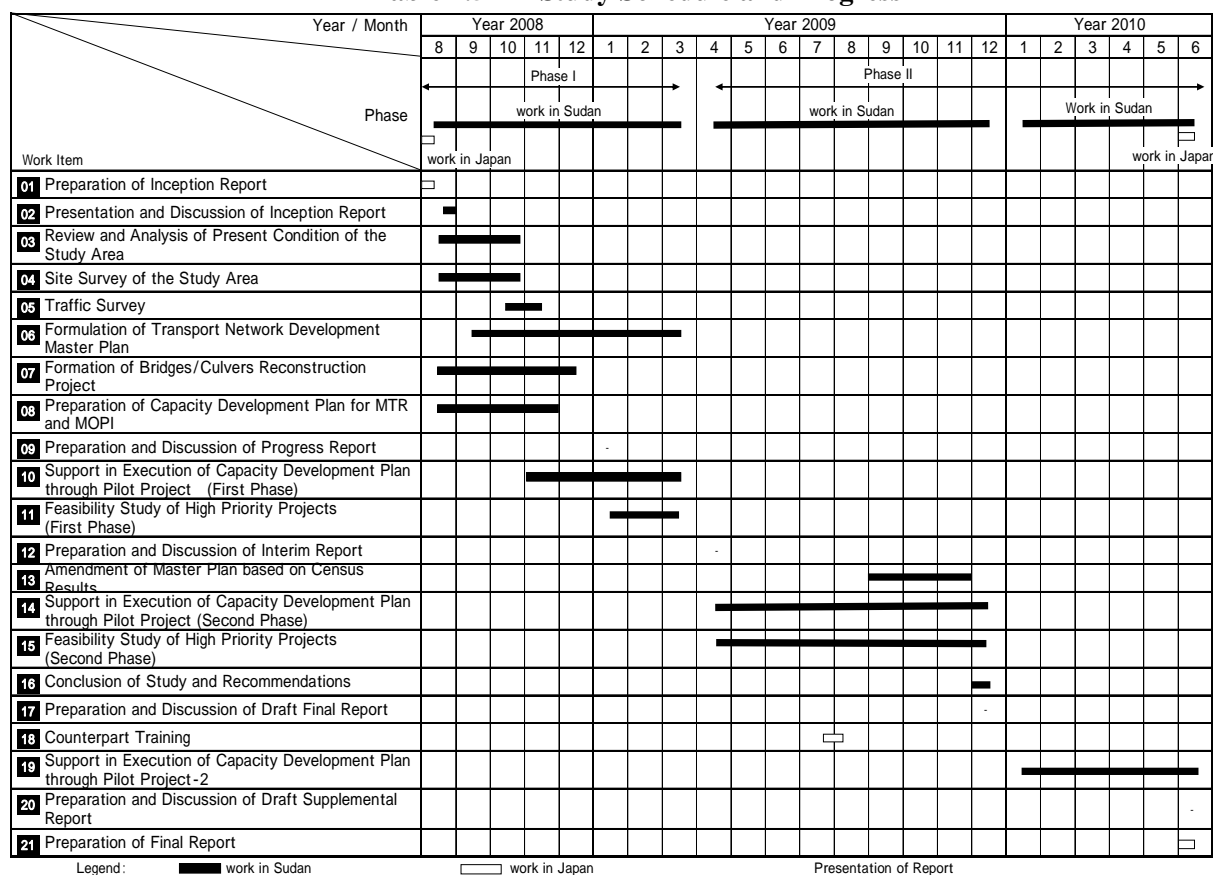


Figure 1.4-1 Study Flow Diagram

## 1.5 STUDY SCHEDULE AND PROGRESS

The Study commenced in August 2008 and completed in June 2010. Table 1.5-1 presents the study schedule.

**Table 1.5-1 Study Schedule and Progress**



## 1.6 STAKEHOLDERS MEETING

During the Study, a series of the Stakeholders Meetings were held to discuss the issues and concerns of the stakeholders and to reflect the discussed matters in the Study. The date and agenda are as follows:

	<u>Date</u>	<u>Agenda</u>
· 1 <sup>st</sup> Meeting:	28 Aug. 2008	- Inception Report presentation
· 2 <sup>nd</sup> Meeting:	5 Nov. 2008	- Future land use - Road network plan - Bridge and culvert reconstruction plan
· 3 <sup>rd</sup> Meeting:	16 Feb. 2009	- Urban transport development policy and strategy - Road network development plan - Implementation plan - Pilot project plan - Proposed projects for feasibility study
· 4 <sup>th</sup> Meeting:	2 Jun. 2009	- Interim Report presentation

- 5<sup>th</sup> Meeting: 1 Jul. 2009 - Proposed road network for Juba and surrounding areas  
- Alternative routes for major arterials (C-2, C-3 and R-5)
- 6<sup>th</sup> Meeting: 18 Aug. 2009 - Environmental and social considerations
- 7<sup>th</sup> Meeting: 30 Oct. 2009 - Execution and evaluation of pilot project  
- Capacity development plan
- 8<sup>th</sup> Meeting: 15 Dec. 2009 - Draft Final Report presentation
- 9<sup>th</sup> Meeting: 3 Jun. 2010 - 2<sup>nd</sup> Pilot Project Presentation/Workshop  
- Evaluation of 2<sup>nd</sup> Pilot Project

The program, presentation materials, minutes of meeting and list of attendant of the Stakeholders Meetings are presented in Appendices 1 to 9.

## 1.7 ORGANIZATION OF THE STUDY

The Study is carried out by the Study Team organized and managed by JICA with the cooperation of GOSS and the Government of Central Equatoria State. The members involved in the Study are as follows:

### **JICA**

Mr. Yuichi Sugano	Director, Urban and Regional Development Division II, Urban and Regional Development Group, Economic Infrastructure Department, JICA
Mr. Naomichi Murooka *	Senior Program Officer, Urban and Regional Development Division II, Urban and Regional Development Group, Economic Infrastructure Department, JICA
Mr. Shigehiko Sugita **	Urban and Regional Development Division II, Urban and Regional Development Group, Economic Infrastructure Department, JICA
Mr. Kenichi Shishido	Resident Representative, JICA Sudan Office
Mr. Kensuke Oshima	Project Formulation Advisor, JICA Sudan Office
Mr. Kiyotaka Tamari	Project Formulation Advisor, JICA Sudan Office

### **Government of Southern Sudan**

H.E. David Deng Athorbei *	Minister, MTR
H.E. Anthony Lino Makana **	Minister, MTR
Dr. Daniel Wani *	Undersecretary, MTR
Eng. Raymond Pitia Morbe **	Undersecretary, MTR
Mr. Jacob Marial Maker	Director General, Roads & Bridges, MTR
Mr. Gabriel Makur Amour	Director, Roads & Bridges, MTR
Mr. Lado T. Tombe	Director, Road Transport & Safety, MTR
Mr. Otim Bong Mike	Deputy Director, Urban Roads, Roads & Bridges, MTR
Mr. Philip Waiwai	Deputy Director, Road Maintenance and Equipment, Roads & Bridges, MTR
Mr. James Alam	Project Manager, Interstate Roads, Roads & Bridges, MTR
Mr. Duku George Aggrey	Project Manager, Bridges, Roads & Bridges MTR

### **Government of Central Equatoria State**

H.E. Prof. Ladu Bureng	Minister, MOPI
Mr. Lewis Gore George Modi	1 <sup>st</sup> Director General, MOPI
Mr. Peter Laku Loro Ladu	Director General, Roads & Bridges, MOPI
Mr. Emmanuel Matayo Wani	Director General, Housing & Construction, MOPI
Mr. Bullen Pitya Abraham	Deputy Director, Roads & Bridges, MOPI
Mr. Charles Hakim Mila	Deputy Director for Planning

### **Study Team**

Mr. Tsuneo Bekki	Team Leader / Transport Planner
Mr. Kunihiro Sawano *	Deputy Team Leader / Highway Planner
Dr. Shingo Gose **	Deputy Team Leader / Highway Planner
Mr. Ryuichi Ueno	Highway Designer
Mr. Shrestha Robinson	Highway Designer
Mr. Mitsuo Kiuchi	Bridge Planner / Designer
Dr. Jovito C. Santos	Bridge Designer / Project Planner
Mr. Takeshi Yoshida	Capacity Development Specialist
Mr. Yasuhiro Yamauchi	Project Coordinator
Mr. Toyohiro Takagi	Project Coordinator
Mr. Ryuichi Yamasaki	Construction Planner / Cost Estimator
Mr. Yuzi Sorayama	Natural Condition Surveyor
Mr. Mamoru Shibata	Environmental and Social Considerations Specialist
Ms. Madoka Aizawa	Highway Location Planner
Mr. Yozo Mizota	Highway Maintenance Specialist

\* Predecessor

\*\* Successor

---

## **CHAPTER 2**

---

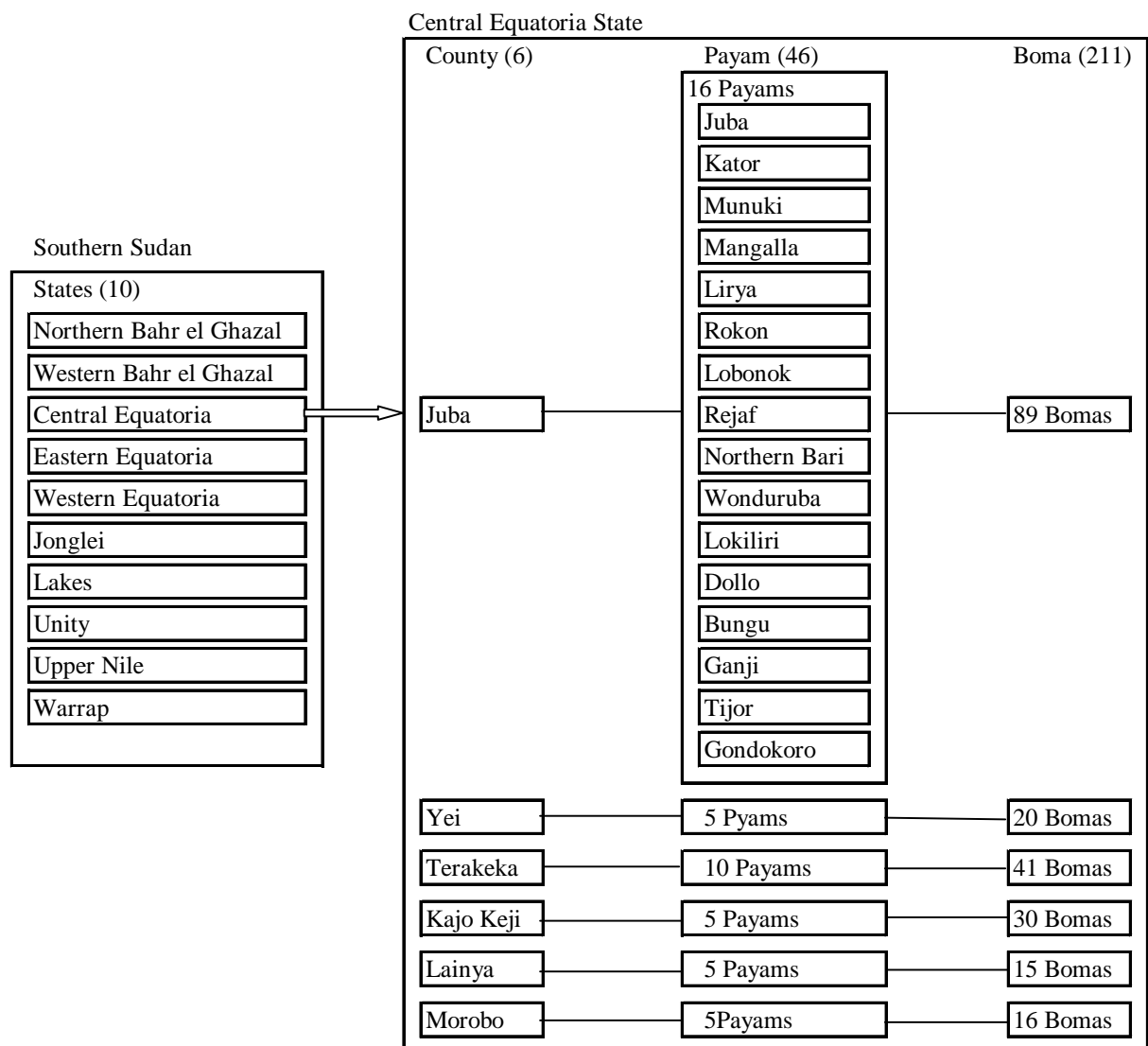
# **P**RESENT CONDITION OF THE STUDY AREA

## CHAPTER 2     PRESENT CONDITION OF THE STUDY AREA

### 2.1    ADMINISTRATIVE SYSTEM

#### 2.1.1    Administrative Division of Southern Sudan

The administrative divisions of Southern Sudan consist of the State – County – Payam – Boma structure as shown in Figure 2.1.1-1. Southern Sudan is divided into 10 states; Central Equatoria State is composed of 6 Counties; and Juba County is composed of 16 Payams and 89 Bomas. Figure 2.1.1-2 illustrates the boundaries of the administrative divisions of the States and the Payams of Juba County.

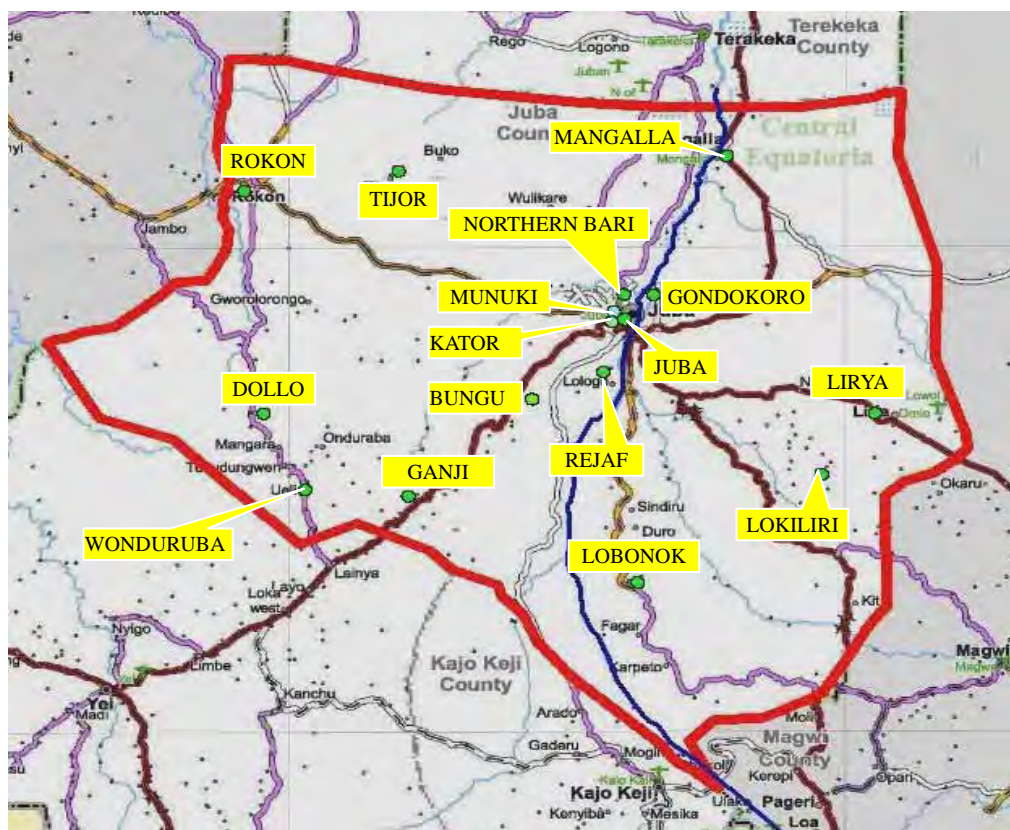


**Figure 2.1.1-1    Administrative Structure of Southern Sudan**





States in Southern Sudan



Payams in Juba County

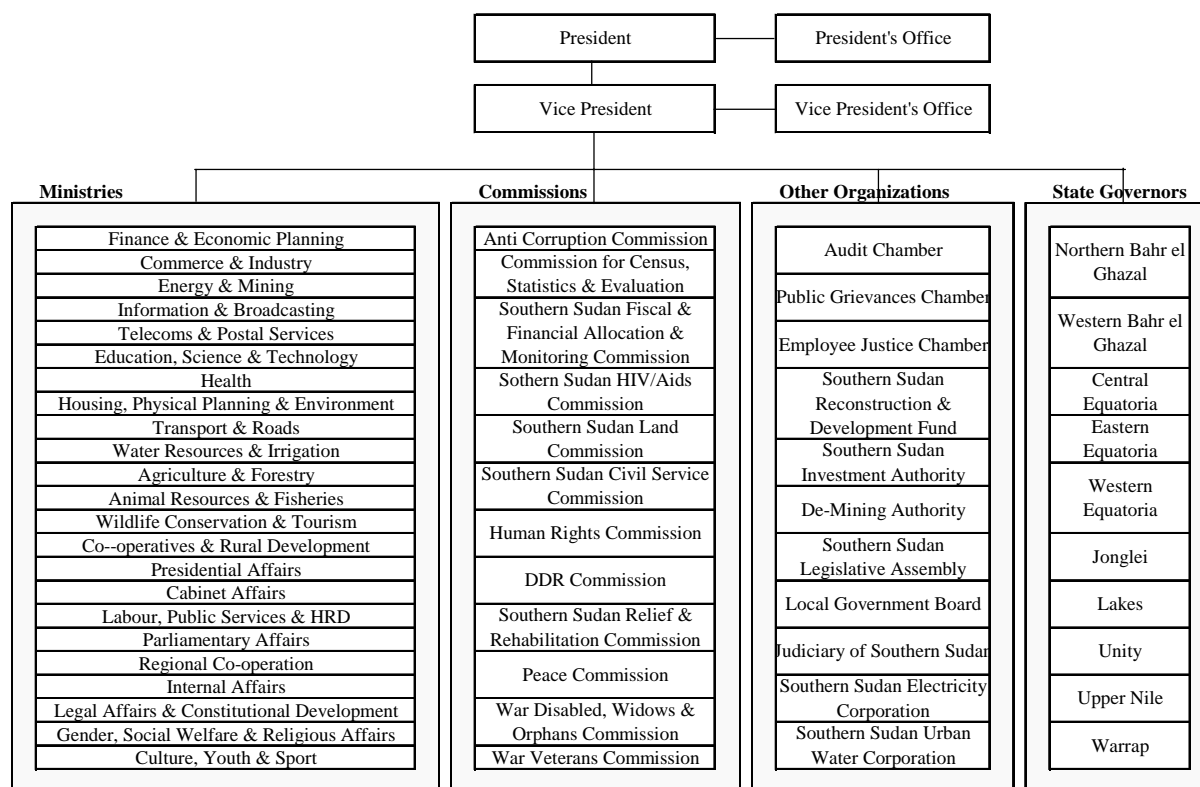
**Figure 2.1.1-2 Administrative Divisions**

The present Juba Urban area is composed of 3 Payams of Juba, Kator and Munuki, and its surrounding areas include Payams of Northern Bari and Rejaf.

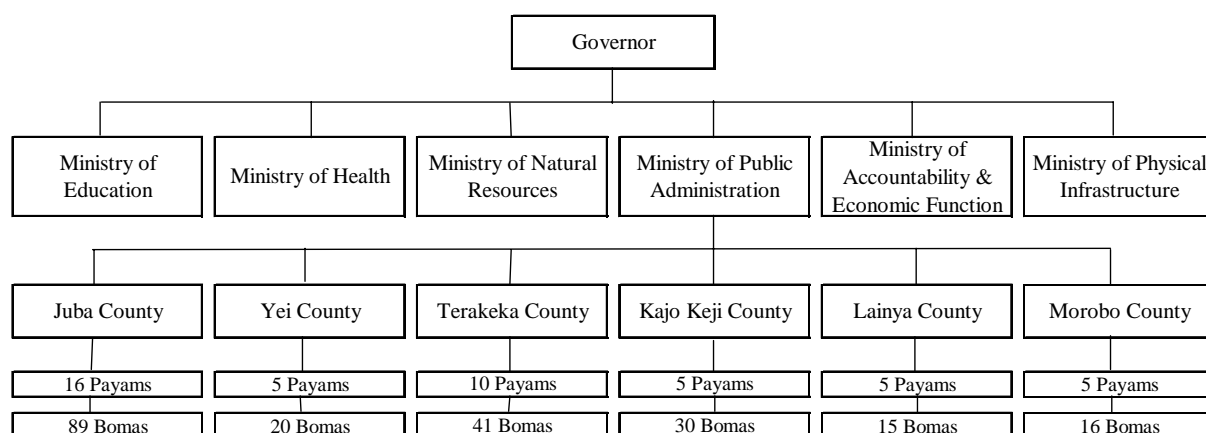
## 2.1.2 Organization of GOSS and CES

The Government of the Southern Sudan (GOSS) is administered by 23 Ministries under the President and Vice President. Independent from the Ministries, there are established 12 Commissions, 3 Chambers, a Fund, 2 Authorities, an Assembly, a Board, a Judiciary and 2 Corporations. The organization of GOSS is shown in Figure 2.1.2-1.

The Government of Central Equatoria State is headed by the Governor and administered by 6 Ministries, as shown in Figure 2.1.2-2.



**Figure 2.1.2-1 Organization of the Government of the Southern Sudan**



**Figure 2.1.2-2 Organization of Central Equatoria State**

## 2.2 NATURAL CONDITION

### 2.2.1 Location

Juba Town is located at 4°52' north of the equator and 31°36' east of eastern longitude, at an altitude of 460m above sea level.

### 2.2.2 Climate

In general, the temperature is high throughout the year with distinct characteristics of the dry and rainy seasons.

The monthly average minimum temperatures based on the 1998 to 2004 statistics (excluding 2001) fall in the range of 19.4° and 23.7° whereas the monthly average maximum temperatures for the same period were between 31.5° and 37.9°. The lowest monthly average minimum temperature was mostly recorded in December, while the highest average maximum temperature predominantly occurred either in January or February.

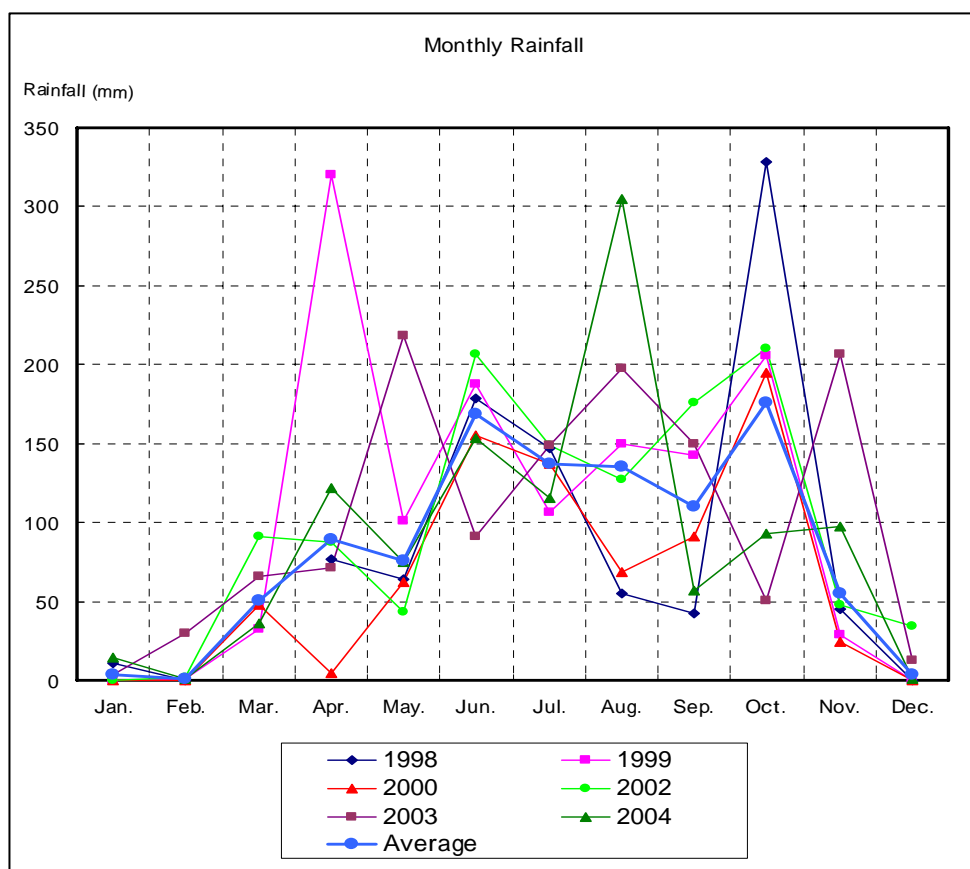
The rainy season usually starts in May and lasts to October. The average annual precipitation level is around 1,000mm. However, occasionally, precipitation levels of more than 1,200mm may be recorded. Most rainfall during the year concentrates in the rainy season, with almost no rainfall observed in the dry season (Table 2.2.2-1 and Figure 2.2.2-1)

The prevailing winds are always from the south. Nevertheless, in January and February winds mostly prevail from the north-north-west direction.

**Table 2.2.2-1 Monthly Rainfall in JUBA**

Month	1998	1999	2000	2002	2003	2004	Average
Jan.	10.4	0	0	0	4	14.3	3.6
Feb.	0	0.5	0	1.5	30	1.2	0.8
Mar.		32.2	48	91.5	66.1	36.5	50.2
Apr.	76.6	320.3	4.8	87.6	71	122.2	89.4
May.	64.1	100.7	62.5	43.2	218	74.8	75.5
Jun.	178.3	188	154.9	206.7	91.2	153.5	168.7
Jul.	146.8	106.8	136.9	148.6	148.9	115.1	136.9
Aug.	55.4	149.3	68.5	127.5	197.4	305.2	135.7
Sep.	42.7	142.4	90.9	175.6	149.6	56.5	109.9
Oct.	328.2	205.3	194.4	209.9	50.1	92.8	175.6
Nov.	45.4	29.2	24.3	48	206.9	97.3	55
Dec.	0	0	0	34.2	12.2	0.5	3.2

Note: Average = average of 4 years excluding minimum and maximum value.



**Figure 2.2.2-1 Monthly Rainfall in JUBA**

### 2.2.3 Topography

Juba Town and the surrounding area are located in the large Bahr al Jebel alluvial plain which inclines from south-southwest to north-northeast direction in general.

The White Nile River, with an average width between 250m to 600m width, delineates the town boundary in the east.

A gentle slope generally characterizes the area, where outcrops of hard and firm crystalline rocks are found. Among these outcrops of rocks, the most outstanding one is Jebel Krok, with an altitude of 744m above Mean Sea Level (MSL), 3km width and 1km length, located to the west of Juba Town and forming the natural boundary of the Juba Town area.

In the rainy season, the flooding water affects an area covering almost 50% of the alluvial plain prompting the emergence of the temporal and seasonal rivers flowing into the White Nile River.

### 2.2.4 Seismic Intensity

The record of the seismograph around Juba is shown following Table 2.2.4-1, the oldest record is 1982 years and the largest scale occurred in May 20, 1990.

Number of recorded seismic activity is few. If the earthquake on May 24, 1990 with magnitude of M=7.1 occurring four days after the large-scale earthquake is an aftershock, the number of large scale earthquake is very few.

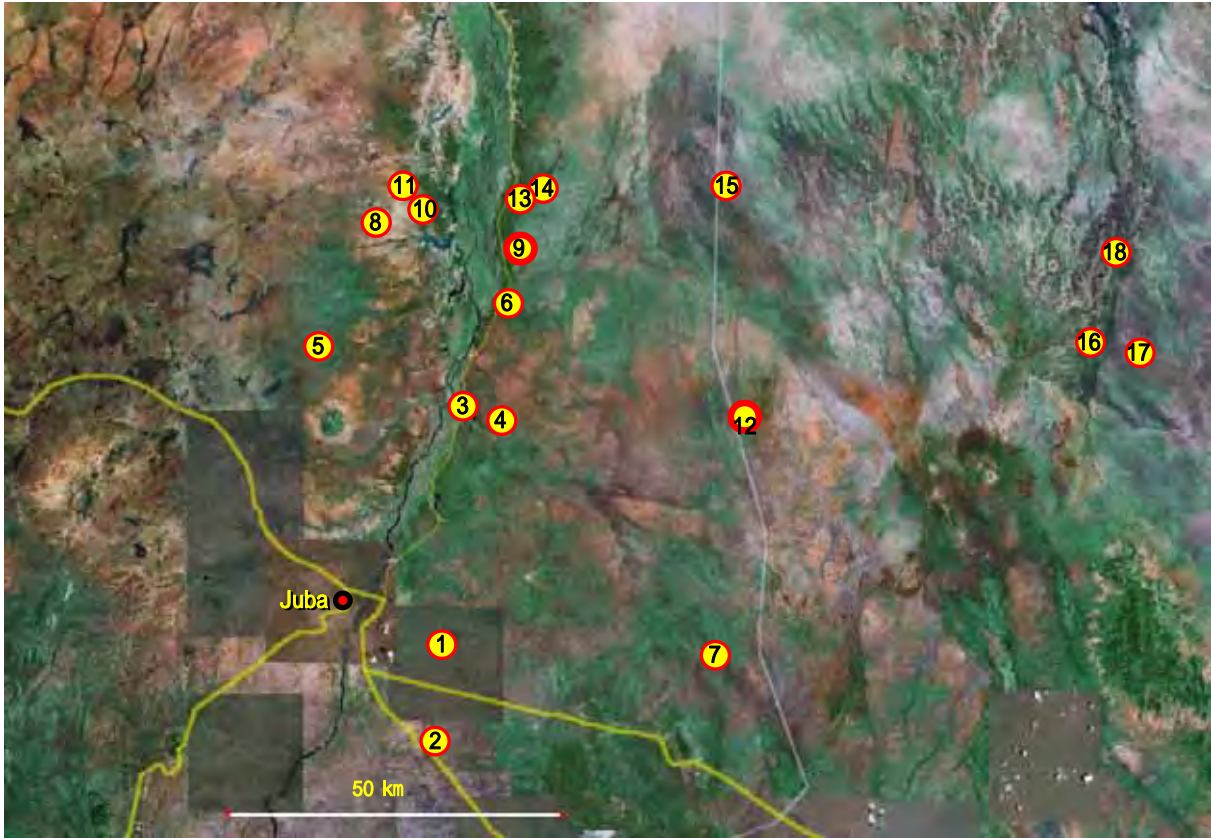
**Table 2.2.4-1 Seismic Intensity List**

No.	Magnitude	Date	Original Time	Depth of Hypocenter (km)	Distance from JUBA (km)
1	5.0	27-May-1990	7:29:00 AM	10.0	16
2	5.1	15-Oct-1982	8:37:00 AM	10.0	25
3	5.0	26-May-1990	2:22:00 PM	10.0	37
4	5.2	10-Jan-1991	7:06:00 AM	11.4	38
5	5.0	02-Mar-1992	8:30:00 PM	10.0	41
6	6.5	24-May-1990	7:34:00 PM	16.5	54
7	5.0	03-Oct-1992	4:22:00 PM	33.0	57
8	6.6	09-Jul-1990	3:11:00 PM	12.6	61
9	7.1	24-May-1990	8:00:00 PM	16.0	63
10	5.2	20-Jun-1990	6:47:00 PM	15.6	64
11	5.2	07-Sep-1990	12:12:00 AM	10.0	66
12	7.2	20-May-1990	2:22:00 AM	14.9	67
13	5.3	25-May-1990	12:42:00 AM	10.0	69
14	5.5	24-May-1990	10:16:00 PM	10.0	71
15	5.1	03-Jun-1990	4:23:00 PM	10.0	87
16	5.3	28-Jul-1990	4:46:00 PM	10.0	118
17	5.4	29-Mar-1991	9:06:00 AM	10.0	125
18	5.0	11-Dec-1990	5:09:00 AM	10.0	127

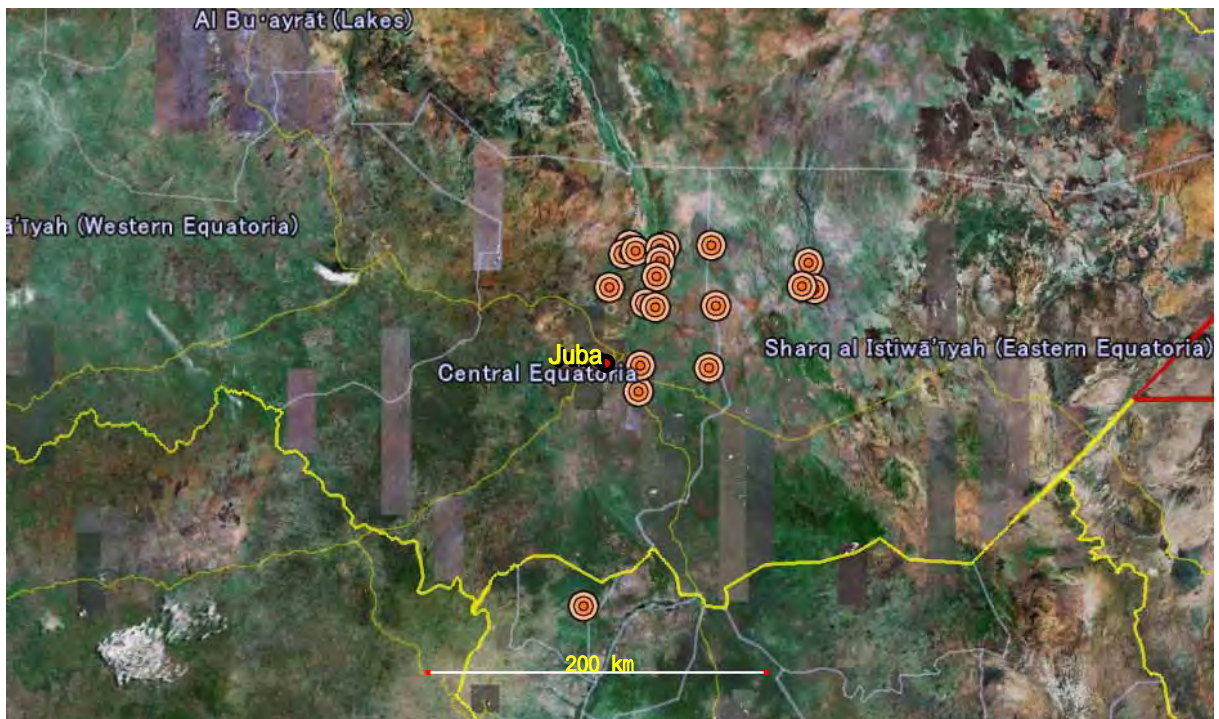
Seismic data are based on United States Geological Survey (United States Geological Survey USGS)

The earthquake occurrence position in Juba and the surrounding areas and the earthquake occurrence position in a wide area is shown in Figure 2.2.4-1 and Figure 2.2.4-2.





**Figure 2.2.4-1 Earthquake Occurrence Position in Juba and Environs**



**Figure 2.2.4-2 Earthquake Occurrence Position in Juba Wide Area**

### **2.2.5 Land Type**

Most of the land around Juba is covered with the bush. The river is of gentle slope with approximately 120km in length and flows to the east from the west at the north 10km of Juba and it is surrounded with the ponds around Juba.

There are many trees in both banks of the white Nile River and its tributaries. Woods and cultivated field also abound in the area.

A large pond and an open ground are on the north side of the airport, and grasslands and cultivated fields spread out in the northeastern direction.

Figure 2.2.5-1 illustrates the basic land types in Juba.



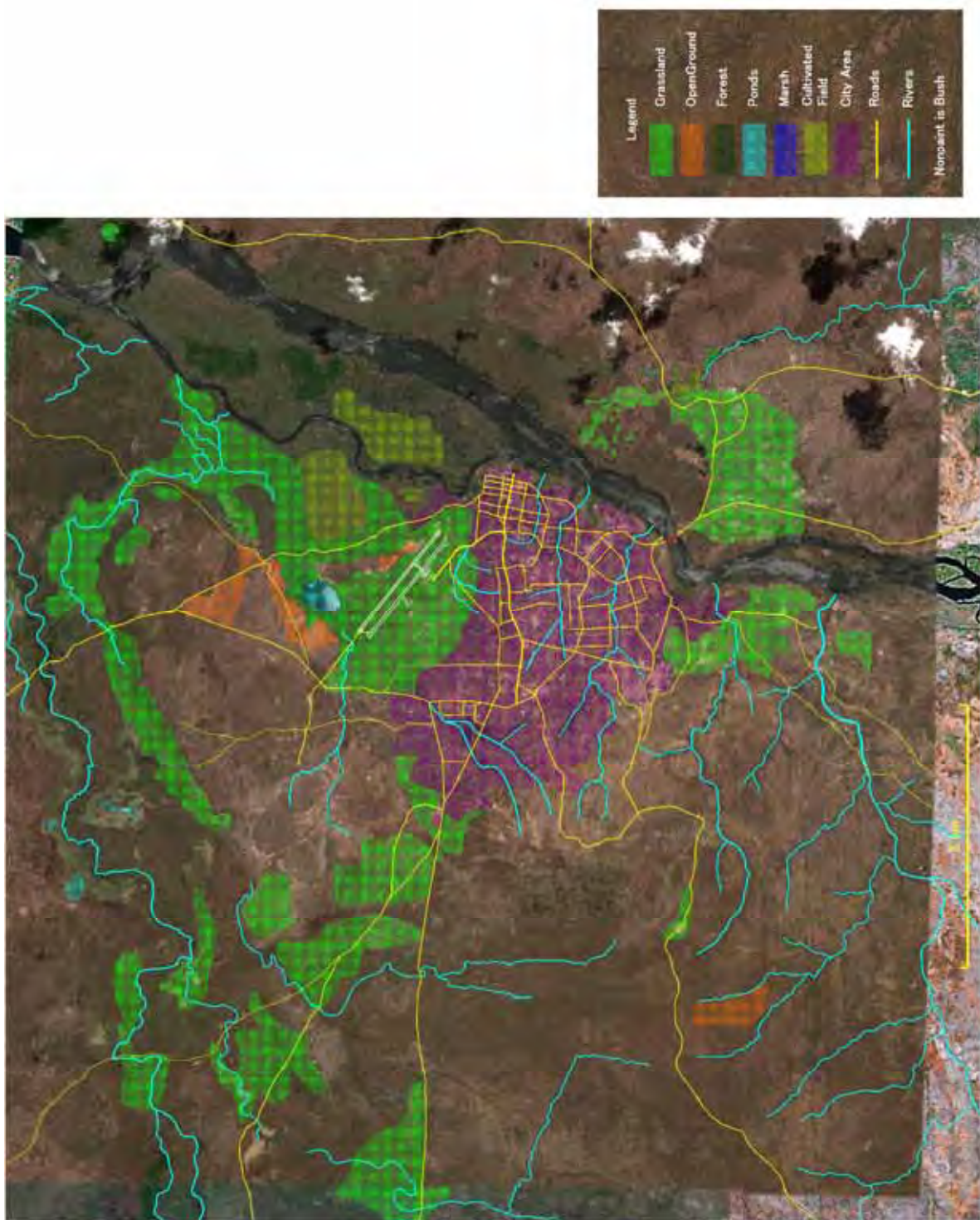


Figure 2.2.5-1 Land Type in Juba



## 2.3 SOCIO-ECONOMIC CONDITION

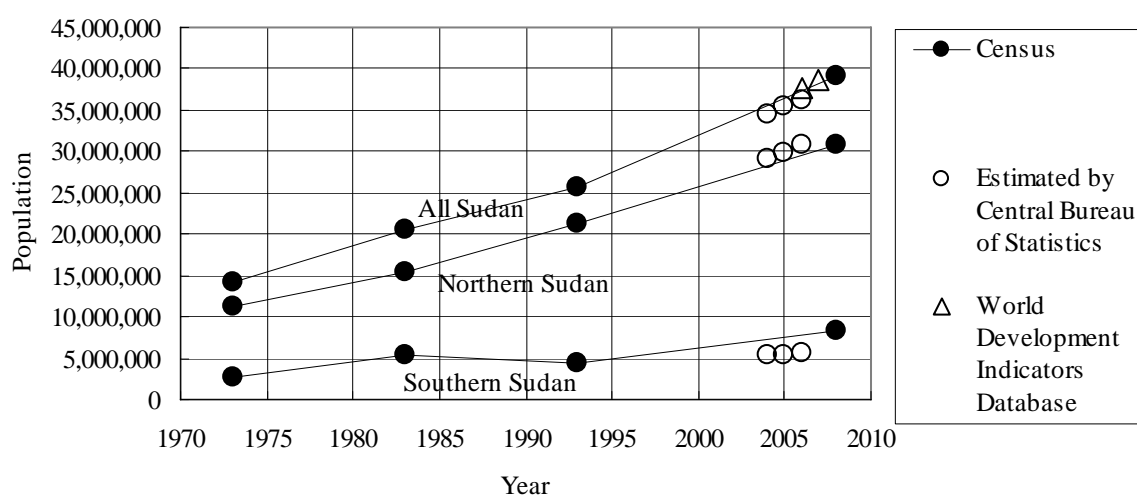
### 2.3.1 Population

#### (1) Population of Sudan

The population censuses were carried out in 1973, 1983, 1993 and 2008. The 1993 census covered all northern states but the southern states could not be entirely covered due to security considerations. Based on 1993 population for the northern states and 1983 population in the southern states, the populations by the year 2006 were estimated by Central Bureau of Statistics. 1973-2008 population of Sudan is summarized in Table 2.3.1-1 and graphically shown in Figure 2.3.1-1.

**Table 2.3.1-1 Population of Sudan for the Years 1973 - 2008**

Year	All Sudan	Northern Sudan	Southern Sudan	Source
1973	14,114,000	11,309,000	2,805,000	Census
1983	20,598,000	15,324,000	5,274,000	
1993	25,588,000	21,267,000	4,321,000	
2004	34,512,000	29,146,000	5,366,000	Statistical Year Book for the Year 2006 (Estimated by Central Bureau of Statistics)
2005	35,397,000	29,949,000	5,448,000	
2006	36,297,000	30,767,000	5,530,000	
	37,710,000	n.a.	n.a.	World Bank : World Development Indicators Database, September 2008
2007	38,560,000	n.a.	n.a.	
2008	39,154,490	30,894,000	8,260,490	Census



**Figure 2.3.1-1 Population of Sudan for the Years 1973 – 2008**

Table 2.3.1-2 shows the average annual population growth rate.

**Table 2.3.1-2 Average Annual Population Growth Rate**

(% p.a.)

Year	All Sudan	Northern Sudan	Southern Sudan
1973 to 1983	3.85	3.08	6.52
1983 to 1993	2.19	3.33	-1.97
1993 to 2008	2.88	2.52	4.41

Influenced by the civil war, the population growth of Southern Sudan changed as follows :

1973 to 1983 : High growth (6.5%)

1983 to 1993 : Negative growth (-2.0%) due to IDPs

1993 to 2008 : High growth (4.4%) due to returnees

Population growth of Southern Sudan from 1983 to 2008 is 1.8% in average, still small comparing with all Sudan, indicating that return of IDPs is not finished yet.

## **(2) Population of Juba Urban Area**

2008 census results are shown in Table 2.3.1-3.

**Table 2.3.1-3 2008 Population**

Area	Total	Male	Female
<b>All Sudan</b>	<b>39,154,490</b>	<b>20,073,977</b>	<b>19,080,513</b>
<b>Northern Sudan</b>	<b>30,894,000</b>	<b>15,786,677</b>	<b>15,107,323</b>
<b>Southern Sudan</b>	<b>8,260,490</b>	<b>4,287,300</b>	<b>3,973,190</b>
<b>Northern Bahr el Ghazal State</b>	<b>720,898</b>	<b>348,290</b>	<b>372,608</b>
<b>Western Bahr el Ghazal State</b>	<b>333,431</b>	<b>176,895</b>	<b>156,536</b>
<b>Central Equatoria State</b>	<b>1,103,592</b>	<b>581,544</b>	<b>522,048</b>
<b>Juba County</b>	<b>372,413</b>	<b>205,674</b>	<b>166,739</b>
Bungu Payam	2,737	1,429	1,308
Dolo Payam	14,132	7,530	6,602
Ganji Payam	2,689	1,358	1,331
Gondokoro Payam	6,522	3,211	3,311
Juba Payam	82,346	48,854	33,492
Kator Payam	64,130	35,012	29,118
Lirya Payam	5,949	3,008	2,941
Lokiliri Payam	8,215	4,274	3,941
Lobonok Payam	8,980	4,536	4,444
Mangala Payam	11,016	6,036	4,980
Munuki Payam	83,719	45,743	37,976
Northern Bari Payam	39,810	23,088	16,722
Rejaf Payam	15,604	8,274	7,330
Rokon Payam	5,684	2,906	2,778
Tijor Payam	8,132	4,116	4,016
Wonduruba Payam	12,748	6,299	6,449
<b>Yei County</b>	<b>201,443</b>	<b>105,165</b>	<b>96,278</b>
<b>Terakeka County</b>	<b>140,396</b>	<b>71,984</b>	<b>68,412</b>
<b>Kajo Keji County</b>	<b>196,422</b>	<b>98,321</b>	<b>98,101</b>
<b>Lainya County</b>	<b>89,315</b>	<b>47,424</b>	<b>41,891</b>
<b>Morobo County</b>	<b>103,603</b>	<b>52,976</b>	<b>50,627</b>
<b>Eastern Equatoria State</b>	<b>906,126</b>	<b>465,365</b>	<b>440,761</b>
<b>Western Equatoria State</b>	<b>619,029</b>	<b>318,469</b>	<b>300,560</b>
<b>Jonglei State</b>	<b>1,358,602</b>	<b>734,327</b>	<b>624,275</b>
<b>Lakes State</b>	<b>695,730</b>	<b>365,999</b>	<b>329,731</b>
<b>Unity State</b>	<b>585,801</b>	<b>300,247</b>	<b>285,554</b>
<b>Upper Nile State</b>	<b>964,353</b>	<b>525,430</b>	<b>438,923</b>
<b>Warrap State</b>	<b>972,928</b>	<b>470,734</b>	<b>502,194</b>

Source : 2008 Census

Juba urban area includes Juba Payam, Kator Payam, Munuki Payam, Rejaf Payam and a part of Northern Bari Payam. The total population of Juba urban area in 2008 is estimated as shown in Table 2.3.1-4.

Thus, the population of Juba urban area is about 260,000 in 2008, composed of 56% male and 44% female.

**Table 2.3.1-4 2008 Population of Juba Urban Area**

Area	Total	Male	Female
Juba Payam	82,346	48,854	33,492
Kator Payam	64,130	35,012	29,118
Munuki Payam	83,719	45,743	37,976
Rejaf Payam	15,604	8,274	7,330
Northern Bari Payam (assuming 1/3)	13,270	7,696	5,574
Total	259,069 (about 260,000)	145,579 (56%)	113,490 (44%)

**(3) Return of IDPs and Refugees**

The March 2005 report of the Sudan Joint Assessment Mission (JAM) estimated that approximately 4 million people were displaced from (or within) Southern Sudan by the 20 years of fighting between the northern and southern regions of Sudan. Following the signing of the Comprehensive Peace Agreement (CPA) in January 2005, IOM calculates that both the North-South and the South-South return movements up to June 2008 stand at almost 1.8 million.

IOM, in the “IOM Tracking of Spontaneous Returns Project”, has been conducting the tracking of a large number of the returnees within a huge geographic area. By extrapolation of the tracking data, the total number of returns that have occurred to South Sudan and Southern Kordofan is estimated. The tracking activities in Sudan are divided into two types : ”En-route Tracking” and “Area of Return Tracking”. En-route Tracking is the recording of returnee movements by collecting data at main transport routes, transit hubs, key geographic entry points etc., while Area of Return Tracking is the gathering of data on returnee movements by physically visiting villages in the area of return to collect data. The total number of returnees is estimated from the following equation:

$$RE = (x \cdot 100) / y$$

Where,  $RE$  : the estimated number of returnees  
 $x$  : total number of returnees tracked  
 $y$  : percentage of villages coverage out of the total village.

The numbers of tracked returnees and estimated total returnees are summarized in Table 2.3.1-5. The total number of returnees to South Sudan and Southern Kordofan is estimated at 1.77 million, out of which the returnees to Central Equatoria State (CES) account for about 10%, amounting to 178,050. The returnees to Juba urban area are not known, but En-route Tracking data shows that the total number of tracked returnees to Juba urban area is 12,413\* accounting for 90 % of the total tracked returnees to CES (13,786). Assuming that 90 % of the total returnees to CES are those to Juba urban area, the number of the total returnees to Juba urban area is about 160,000 (=178,050 x 90%).

\* 10,185(Juba) + 813(Kator) + 1,415(Munuki) + 90(Rejaf) = 12,413

**Table 2.3.1-5 Cumulative Number of Returnees up to June 2008**

Final Destination			Tracked Returnees		Projected Number of Returnees up to June 2008, based on Area of Return Tracking Data
State	County	Payam	Area of Return Tracking Data (Feb.2007 - June 2008)	En-route Tracking Data (Nov.2005 - June 2008)	
Central Equatoria	Juba	Juba		10,185	
		Kator		813	
		Munuki		1,415	
		Bungu		8	
		Dolo		8	
		Liria		8	
		Lobonok	1,483	32	
		Mangalla		16	
		Molbor		2	
		Rejaf		90	
		Rokon		22	
		Wonduruba	229	17	
		Total	1,712	12,616	
	Yei River	Lasu	453	46	
		Mugwo	489	1	
		Otogo	861	480	
		Tore	345	11	
		Yei Town	1,222	227	
		Lainya		113	
		Morobo		54	
		Total	3,370	932	
	Terakeka	Terakeka		94	
		Tali		11	
		Tombe		5	
		Total		110	
	Kajo Keji	Kangapo I	211	19	
		Kangapo II	234	18	
		Lire	406	81	
		Livolo	304		
		Ngepo	12	6	
		Total	1,167	124	
	Lainya	Kenya	3,799		
		Kopera	3,177	2	
		Lainya	715		
		Mukaya	1,175	2	
		Wuji	2690		
		Total	11,556	4	
	Total		17,805	13,786	178,050
Northern Bahr el Ghazal	Total		140,617	43,171	401,763
Western Bahr el Ghazal	Total		34,267	1,099	62,304
Eastern Equatoria	Total		20,824	2,039	53,395
Western Equatoria	Total		14,919	1,495	124,325
Jonglei	Total		5,460	6,474	182,000
Lakes	Total		74,952	6,073	91,405
Unity	Total		26,024	8,837	113,148
Upper Nile	Total		11,488	33,219	143,600
Warab	Total		18,890	22,161	125,933
Southern Kordofan	Total		298,098	68,314	298,098
Total of Southern Sudan and Southern Kordofan State			663,344	206,668	1,774,021

Source : IOM Tracking of Spontaneous Returns Project, Total Returns to South Sudan, Post CPA to June 2008

The population of Juba urban area is estimated to change as follows:

- Until 2005, the population decreased to about 100,000 due to displacement.
- Up to 2008, about 160,000 IDPs returned or migrated to Juba. As a result, the 2008 population reached about 260,000.
- The return movement may still continue after 2008.

### 2.3.2 Economy

Table 2.3.2-1 shows the gross domestic product (GDP) by sector for the years 2004 – 2006 shown in the Statistical Yearbook.

The GDP growth rate is high, showing 7.4 %, 8.7 % and 9.4 % in 2004, 2005 and 2006 respectively. The GDP per capita grows also at high rates of 4.7 %, 6.0 % and 6.7% in 2004, 2005 and 2006 respectively.

The composition of GDP is as follows:

- Agricultural sector accounts for 34.0 %, 32.6 % and 31.1 % in 2004, 2005 and 2006 respectively, approximately one third, and tends slightly downward.
- Mining/Industrial sector (Petroleum ~ Building & Construction in Table 2.3.2-1) accounts for 21.4 %, 23.1 % and 25.0 % in 2004, 2005 and 2006 respectively, approximately one fourth, and tends upward due to significant increase of petroleum and considerable increase of building and construction.
- Service sector (Commerce, Restaurant & Hotels and below in Table 2.3.2-1) accounts for 44.6 %, 44.3 % and 43.9 % in 2004, 2005 and 2006 respectively, showing a constant share.

**Table 2.3.2-1 Gross Domestic Product at Current Market Prices**

Kind of Economic Activity	2004			2005			2006		
	GDP (million SD)	Percentage	Growth Rate* (%)	GDP (million SD)	Percentage	Growth Rate* (%)	GDP (million SD)	Percentage	Growth Rate* (%)
Agriculture, Livestock, Forestry & Fishing	2,336,944.7	34.0	-2.0	2,632,428.0	32.6	2.8	2,965,272.1	31.1	3.5
Petroleum	476,074.0	6.9	17.1	672,002.2	8.3	9.5	948,564.7	10.0	37.9
Mining and Quarrying	12,009.0	0.2	-17.0	15,184.2	0.2	15.0	19,198.8	0.2	16.0
Manufacturing and Handicrafts	639,250.0	9.3	6.0	754,621.7	9.3	9.5	890,815.8	9.3	8.5
Electricity & Water	82,894.5	1.2	67.4	97,225.4	1.2	20.0	114,033.7	1.2	8.9
Building & Construction	261,453.0	3.8	15.2	328,639.3	4.1	12.0	413,090.7	4.3	12.9
Commerce, Restaurant & Hotels	1,077,313.8	15.7	2.8	1,266,468.6	15.7	4.5	1,488,835.2	15.6	5.6
Transport & Communication	841,053.7	12.2	9.0	977,321.2	12.1	8.5	1,135,666.8	11.9	8.6
Finance, Insurance, Real-estate & Business Services	529,999.5	7.7	4.2	617,287.8	7.6	8.5	718,951.9	7.5	8.9
Community, Social & Personal Services	91,669.2	1.3	6.4	103,480.8	1.3	5.0	116,814.4	1.2	5.5
Nominal Finance Institutions	-53,921.1	-0.8	3.5	-59,714.6	-0.7	3.3	-66,130.6	-0.7	3.5
Government Services	384,556.0	5.6	23.3	453,910.7	5.6	20.0	535,773.6	5.6	11.8
Producers of Private Non-profit Services to Households	70,786.2	1.0	5.4	80,128.3	1.0	5.0	90,703.3	1.0	5.3
Import Duties	118,800.0	1.7	39.6	137,338.8	1.7	2.0	158,770.7	1.7	2.5
Total	6,868,882.5	100.0	7.4	8,076,322.4	100.0	8.7	9,530,361.1	100.0	9.4
GDP per capita (SD)	199,028.8		4.7	228,164.0		6.0	262,566.1		6.7

\* Growth Rate of GDP at Constant Market Prices Base

Source : Statistical Yearbook for the Year 2006, Central Bureau of Statistics

Table 2.3.2-2 shows the major economic indicators in the “World Development Indicators Database” prepared by the World Bank. This table also shows a high GDP growth rate in recent years, approximately 10 % p.a.

**Table 2.3.2-2 Economic Indicators**

	2000	2005	2006	2007
GNI (billion US\$)	10.27	22.94	29.25	37.03
GNI per capita (US\$)	310	620	780	960
GDP (billion US\$)	12.37	27.39	36.40	47.63
GDP Growth Rate (annual %)	8.4	6.3	11.3	10.2
Inflation, GDP deflator (annual %)	8.7	12.2	6.5	7.0
GDP per capita (US\$)	371	742	965	1,235

Source : World Development Indicators Database, September 2008, World Bank

There is no official information/data on the GDP of the Southern Sudan nor the GRDP in the study area (Juba urban area). The report, “Towards a Baseline : Best Estimates of Social Indicators for Southern Sudan” prepared by NSCSE (New Sudan Centre for Statistics and Evaluation) in association with UNICEF, May 2004 says that :

- The Gross National Income (GNI) per capita in SOSUS (Southern Sudan SPLM areas) is estimated to be less than US\$90 per year (in 2001) and makes SOSUS alongside the poorest countries in the world. SOSUS income is about four times lower than the level of the rest of Sudan. (GNI per capita of Sudan in 2001 is US\$350.)
- The proportion of the population earning less than one dollar a day in SOSUS is around 90 %, putting SOSUS among the poorest regions in the world.

The above estimate is for the year 2001, before the signing the Comprehensive Peace Agreement (CPA), and the situation has improved now. However, the recovery movements are still in the initial stage and the income per capita at present must be still far behind the Sudan average.

Assuming that GRDP per capita in the study area is one third of that in the whole Sudan, the GRDP of the study area in 2008 is roughly estimated as follows :

- GDP of Sudan at current price in 2008 : US\$47.63 billion in 2007 x 1.3 = US\$61.9 billion (assuming 30 % of economic growth and inflation combined),
- GDP per capita of Sudan : US\$61.9 billion / 39,154,490 (2008 population, see Table 2.3.1-1) = US\$1,580,
- GRDP per capita of the study area : approximately US\$530 (1/3 of US\$1,580),
- GRDP of the study area : US\$530 x 260,000 = US\$138 million, approximately US\$140 million

### 2.3.3 Livelihood

The Southern Sudan Centre for Census, Statistics and Evaluation (SSCCSE) prepared the report entitled “Southern Sudan Livelihood Profiles (2<sup>nd</sup> Edition May 2007)”, compiling existing livelihood baseline information. The report divides Southern Sudan into relatively homogeneous zones, defined according to a livelihoods framework. The following are the 7 livelihood zones (refer to Figure 2.3.3-1):

- Zone 1 : Western Flood Plains Zone
- Zone 2 : Eastern Flood Plains Zone
- Zone 3 : Nile and Sobat Rivers Zone
- Zone 4 : Ironstone Plateau Zone
- Zone 5 : Greenbelt Zone
- Zone 6 : Hills and Mountains Zone
- Zone 7 : Arid / Pastoral Zone



**Figure 2.3.3-1 Livelihood Zones of Southern Sudan**

Central Equatoria State stretches over three zones : Ironstone Plateau in the north and northwest, Greenbelt in the south, and Hills and Mountains in the central and east. Juba and its surrounding areas belong to Hills and Mountains Zone.

The Hills and Mountains Zone lies in the central to eastern side of Central Equatoria State and western side of Eastern Equatoria State and separately includes the eastern tip of Jonglei State. Two distinct rainy seasons and the relationships between highland and lowland systems give this zone some unique characteristics that have helped to sustain its food security through times of conflict. Agro-pastoralists normally use livestock as their safety net in difficult years as they can trade them for grain. More agriculturally based systems tend to depend on the reserves found in their root crops. This zone has the benefit of both options in addition to important trade and exchange options inherent in highland and lowland economies, and the seasonal and spatial variations that stimulate trade. Unfortunately, most of these options have been frequently disrupted by conflict, but given a sustained peace following the signing of the CPA in early 2005, this zone should experience a re-strengthening of the traditional resilience of its agro-pastoral livelihoods.

Crops, livestock and grain from trade form the main sources of food for the residents of this zone. Main sources of income in this zone are trade in livestock (45% of better-off households), followed by crops, petty trade and milk sales (32%, 9% and 9% respectively of better-off households). Labor is an important income source for the poor (about 40 %), who typically work on the farms of their middle and better-off neighbors.

The above-mentioned is the general profile of the zone, mainly for rural areas. On the other hand, the livelihood profile in the urbanized area is far different. In Juba Town, approximately 45 % of the working population is engaged in public sector, whereas those in agricultural sector accounted for 15 %, commercial 9%, transport 8 %, construction 7% and manufacturing 6% in 1973, according to the 1973 Census.



---

## **CHAPTER 3**

---

# **P**RESENT CONDITION OF URBAN TRANSPORT INFRASTRUCTURES

## **CHAPTER 3     PRESENT CONDITION OF URBAN TRANSPORT INFRASTRUCTURES**

### **3.1    TRANSPORT SYSTEM**

The transport sector in Southern Sudan is basically composed of four major modes, namely: roads, railways, inland water and air transport.

#### **(1) Roads**

It is estimated that Southern Sudan has a road network of about 12,642 km consisting of 7,369 km of interstate roads, 1,451 km of state primary roads and 3,822 km state secondary roads. Most of these roads are in bad condition as they have not been maintained during the long civil war. A few roads of the interstate and primary road have been improved to gravel roads. The road networks of Southern Sudan and Juba are described in Section 3.2.

#### **(2) Railways**

Southern Sudan is connected only to the Bananusa-Aweil-Wau railway line. However this railway has not been operational since 1991. Although rehabilitation and extension of the railway line will require a feasibility study to determine the potential for the railway service as an alternative transport mode, there is no detailed plan yet to connect Juba with the railway network.

#### **(3) Inland water transport**

The Nile River, traversing Sudan from South to North, provides an important inland transport route.

At present only two sections of the Nile have commercial transport services. The major important route is the 500km stretch of the White Nile from Kosty to Malakal, which is served regularly. Occasional services are also being provided between Malakal and Juba by the River Transport Corporation (RTC), a distance of 936 km.

In Juba, there are several existing ports - an old port, a new port and a small wharf for small private boats. The old port has not been used due to the heavy sedimentation that has made river navigation impossible. The small wharf is located 200m downstream of the old port on the tributary of the Nile River.

The new river port is located 2km upstream of the old port on the river bank of the main stream of the Nile River. In 2007, this new port improvement project was conducted by JICA as a pilot project.



New river port



New port improvement project by JICA

#### **(4) Air Transport**

Air transport in Southern Sudan is inadequate with Juba airport as the only airport that receives limited international flights.

The existing Juba International Airport is located at 2km north of the Juba Old Town. The airport is administrated by South Sudan Airport Authority under the Ministry of Transport and Road, GOSS since 2006. Two 2,500m runways of concrete pavement are running in parallel in northwest – southeast direction.

Since present location of Juba International Airport is very close to the old built-up area, it causes problems of noise and urban development. A New Juba International Airport Construction Project is proposed at eastern bank of the Nile River.

## 3.2 ROAD NETWORK AND CONDITION

### 3.2.1 Road Network

#### (1) Administrative Road Classification

A functional road classification is not yet established in Sudan; hence the various road agencies do not know their delegated responsibilities for the road network. However the MTR will carry out the classification of all roads in Southern Sudan in liaison with the Southern Sudan Road Agency.

The road network in Southern Sudan is classified in order of importance as follows.

**Table 3.2.1-1 Road Type and Responsible Organization**

Road Type	Responsible Organization
International/Interstate Road	GOSS, Ministry of Transport and Roads (MTR)
State Road	State, Ministry of Physical Infrastructure (MOPI)
County Road	County

Presently all roads including interstate/international roads, distributor roads and feeder roads in Juba are planned and constructed through funding of GOSS (MTR), since Juba has important roles as the capital city in Southern Sudan and settlement of IDP.

The GOSS is in the process of establishing the following institutions to fund and manage the road network in Southern Sudan.

**Table 3.2.1-2 Proposed Institution and Function**

Institution	Function
SSRB: Southern Sudan Road Board	Responsible for fund management for development and maintenance of the entire Southern Sudan road network
SSRA: Southern Sudan Road Agency	Responsible for the administration, control, development, and maintenance of Interstate and International roads and related structures
SRA: State Road Agency	Responsible for the administration, control, development, and maintenance of Primary and Secondary State roads and related structures
SSURA: Southern Sudan Urban Road Agency	Responsible for the administration, control, development, and maintenance of all roads and related complementary infrastructure within the areas of agency of city in Southern Sudan
SSCRA: Southern Sudan County Road Agency	Responsible for the administration, control, development, and maintenance of secondary roads and below and small town roads.

Source: STRATEGIC PLAN FOR ROAD SECTOR, MINISTRY OF TRANSPORT AND ROADS, July 2006

## (2) International / Interstate Road Network

Figure 3.2.1-1 shows the arterial roads to connect Juba with the neighboring regions and countries. Although the Southern Sudan is bordered by several countries including Ethiopia, Kenya, Uganda, Congo and Central Africa, the main roads in Southern Sudan are internationally linked with Uganda and Kenya. There are two main routes that connects Southern Sudan with Uganda: the Juba-Yei - Kaya and the Juba - Nimule Roads. Yei - Kaya link has become the main corridor on the west bank of the White Nile connecting westwards to Maridi - Yambio - Tambura and northward to Mundri - Rumbek - Tonj - Wau - Aweil. Juba-Nimule Road is being rehabilitated with DBST(double bituminous surface treatment) pavement. The other international road link is Juba-Kapoeta connected to Likichogio in Kenya.

The conditions of other arterial roads have deteriorated due to long time negligence and apparently no maintenance during civil war.



Figure 3.2.1-1 International Road Network

Figure 3.2.1-2 and Table 3.2.1-3 shows the arterial roads in Central Equatoria State (CES), showing Juba being at the center of CES. Six primary roads form the radial road network from Juba to other towns, namely, Bor, Torit, Nimule, Kajo keji, Yei and Mundri. As seen in Figure 3.2.1-2, Juba has an important role as a transport hub to carry the passenger and freight traffic in Southern Sudan.



**Figure 3.2.1-2 Interstate Road Network**

**Table 3.2.1-3 Road List in Central Equatoria**

Road Class		Name of the Road	Length(km)
Interstate	P1	Juba-Mundri-Yambio-Tambura-Wau	586
Interstate	P2	Juba-Yei	160
Interstate	P3	Juba-Bor	174
Interstate	P4	Juba-Torit -Kapoeta - (Nadpul) Narus	407
Interstate	P5	Juba-Moli-Nimule	171
State	P6	Juba-Kajo keji	145
State	S1	Terekeka-Tindalo	207
State	S2	Terekeka-Juba Junction	68
State	S3	Lainya-Rokon	92
State	S4	Kajo keji-Shukoli	13
State	S5	Galumbo-Kanchu	46
State	S6	Akeu-Tali-Border	61
P1, P2, P3, P4, P5, P6: Primary Road			
S1, S2, S3, S4, S5, S6: Secondary Road			

Source: Strategic Plan for Road Sector, Ministry of Transport and Roads, July 2006



### (3) Juba Urban Road Network

As shown in Figure 3.2.1-3 and 3.2.1-4, the road network in Juba urban area consists of radial roads and circumferential roads.

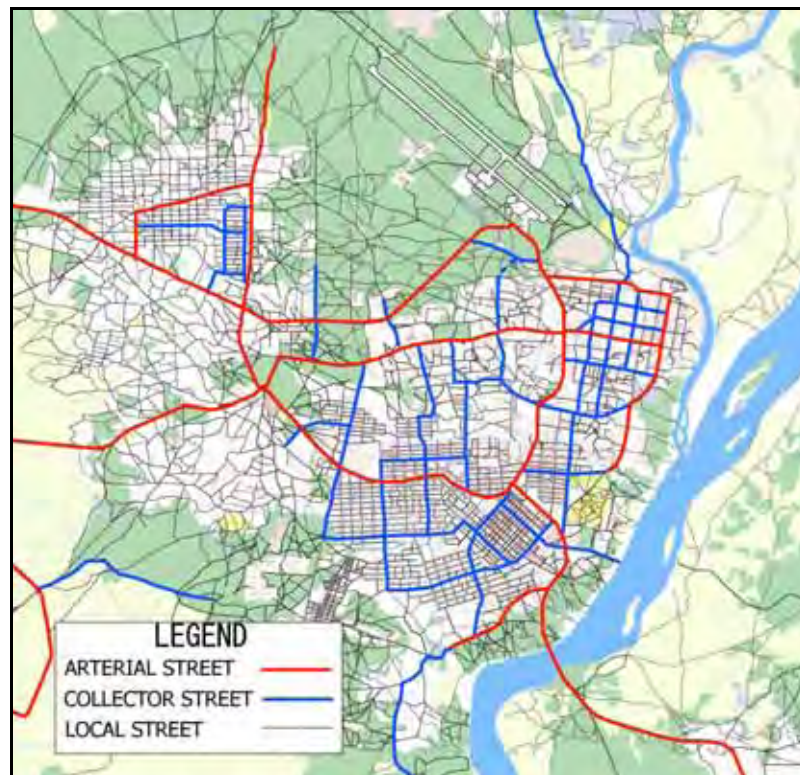


Figure 3.2.1-3 Present Road Network in Juba



Figure 3.2.1-4 Present Road Network in Juba and Surrounding Area

### **Radial Road**

The road network in Juba urban area consists of six arterial roads that handle mainly international, interstate and inter-city traffic.

All radial roads start from Juba to the suburbs and surrounding cities. Table 3.2.1-4 presents the destinations at the arterial roads which are also shown in Figure 3.2.1-4.

**Table 3.2.1-4 Summary of Arterial Radial Roads**

No	Road Name	Direction from Juba	Connection
R-1	Juba-Yei	To south-west	Juba to Yei /UGANDA
R-2	Juba-Mundri	To west	Juba to Mundri / Yambio/ Tambura /Rumbek/Wau
R-3	Juba-Terekeka	To north	Jutba to Terekeka
R-4	Juba-Bor	To north-east	Juba to Bor / Pochalla / ETHIOPIA
R-5	Juba-Lafon	To east	Juba to Lafon
R-6	Juba-Nimule	To south-east	Juba to Nimule / UGANDA, Kapoeta /KENYA

### **Circumferential Road**

Presently, there is only one completed circumferential road (C-1) in Juba urban area. A 3-km section of C-3 road originating from Juba-Yei road was constructed at the southern area of Juba. Table 3.2.1-5 presents information of the circumferential roads.

**Table 3.2.1-5 Summary of Arterial Circumferential Roads**

No	Road Name	Radius	Connection
C-1	Unity Ave. and Old Airport road	R=1~2 km (Total Length = 9.5km)	R-1(Juba-Yei) ,R2(Juba-Mundri) R-3(Juba-Terekeka) ,R6(Juba-Nimule)
C-2	N/A	-	-
C-3	South section (Yei road to Kator)	R=5km in the south side (Total Length = 3km)	R-1(Juba-Yei)
C-4	N/A		

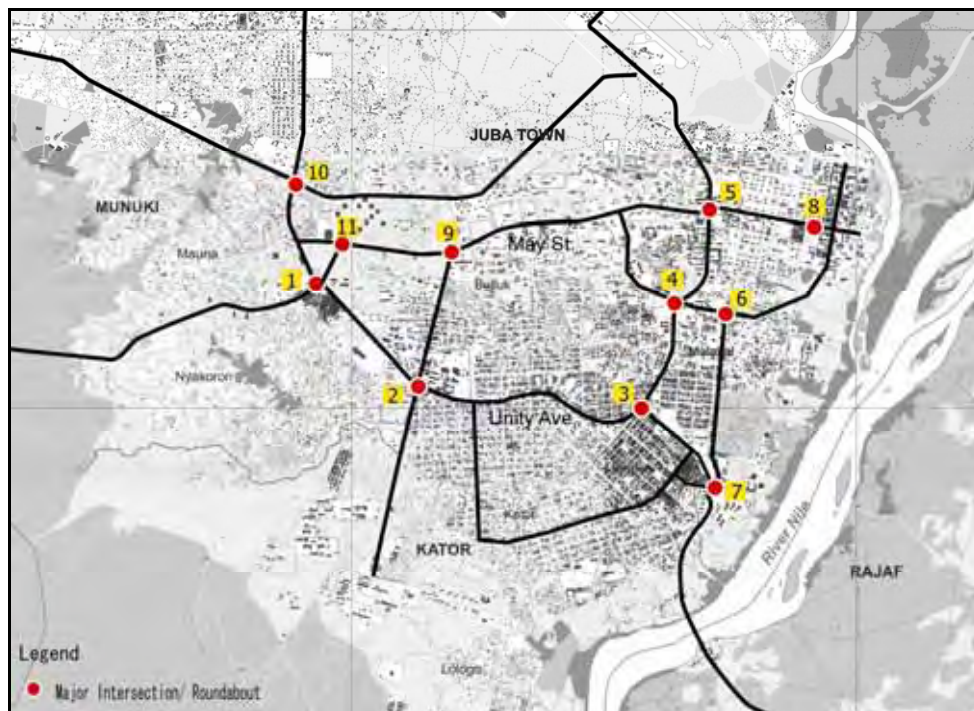
## **3.2.2 Intersection**

The major intersections are shown in Figure 3.2.2-1 and their present conditions are shown in Table 3.2.2-1. These intersections are identified as future bottlenecks that need improvement. Presently the roundabout with Unity Avenue and May Street (No.5) has a long queue of traffic. Although other junctions have not yet indicated traffic congestion, it is expected to become a bottleneck as the traffic increases in the future.

**Table 3.2.2-1 Major Intersection Conditions**

No.	Name	No. of legs	Conditions
1	Old Custom Market	4	Roundabout
2	Junction with May St. -Juba uni. Road	4	Roundabout with broken Signal
3	Junction with Unity Ave.-Torit Rd.	3	T-intersection
4	Junction with Unity Ave.-Addis Ababa St.	4	Roundabout
5	Junction with Unity Ave.-May St..	4	Roundabout
6	Junction with Addis Ababa St.-	3	T-intersection
7	Konyo Konyo Market	4	Roundabout
8	Juba Market Roundabout	4	Roundabout, one-way
9	Junction with May St.- Juba Uni. Rd.	3	T-intersection
10	Junction with Unity Ave.- Old Airport St.	4	Roundabout
11	Legislative Assembly Roundabout	4	Roundabout





**Figure 3.2.2-1 Location of Major Intersections in Juba**



No.1 Custom Market Roundabout



No.2 Unity Ave.-Juba Uni. Roundabout



No.5 May St.- Unity Ave. Roundabout



No.11 Legislative Assembly Roundabout

### 3.2.3 Road Condition

To identify the present road network condition, road inventory survey was conducted by JICA Study Team in October 2008. The present road condition is shown in Figure 3.2.3-1. The routes of the inventory survey are shown in Figure 3.2.3-2 and the survey data are shown in Table 3.2.3-1.

May Street, Airport Road and a part of Unity Avenue is partially completed with pavement construction. The total length of these roads is about 6 km with good condition. In the Juba Central Commercial District, there are some old asphalt paved roads which have deteriorated due to long time negligence and lack of maintenance. Other roads are unpaved road and vehicles are forced to travel at a speed of under 30 km/h due to such bad surface condition. In the rainy season, some road sections crossing the rivers without bridge/culvert structures become impassible during and after rains. No attention is given to pedestrian and Non-Motorized Transport (NMT).

Due to the above road conditions and insufficient road network, the traffic tends to concentrate on the specific sections in good condition such as May Road, Airport Road and Unity Avenue. As a result, traffic congestion occurs presently at the intersection of May Street and Unity Avenue and this congestion will become more serious in the near future.

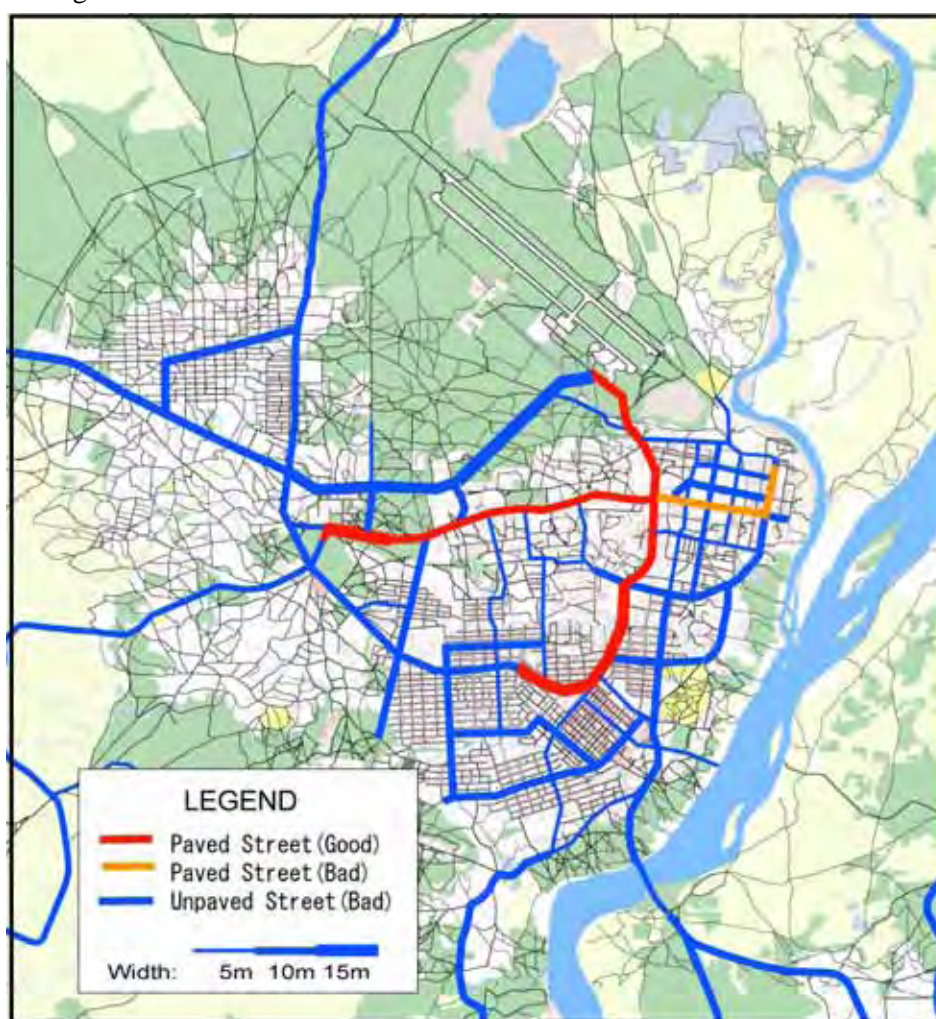
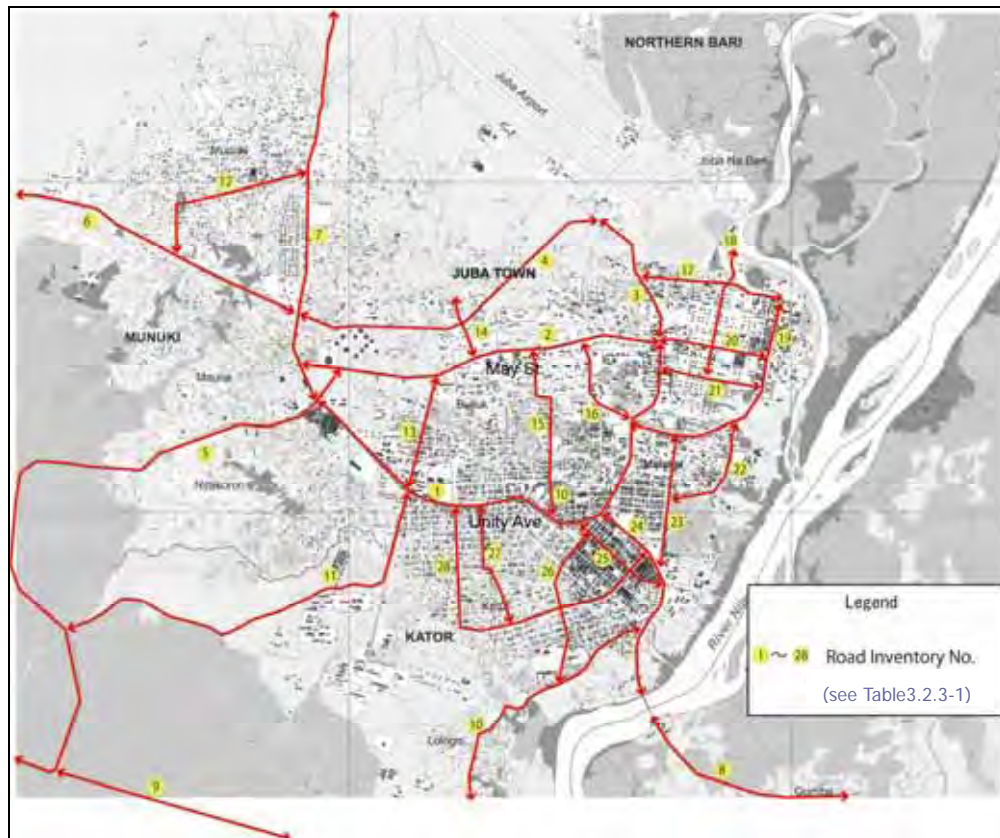


Figure 3.2.3-1 Road Condition (as of October 2008)





**Figure 3.2.3-2 Route of Road Inventory Survey**



May Street (newly paved with sidewalk)



Airport Road (newly paved with sidewalk)



Unity Avenue (Under construction)



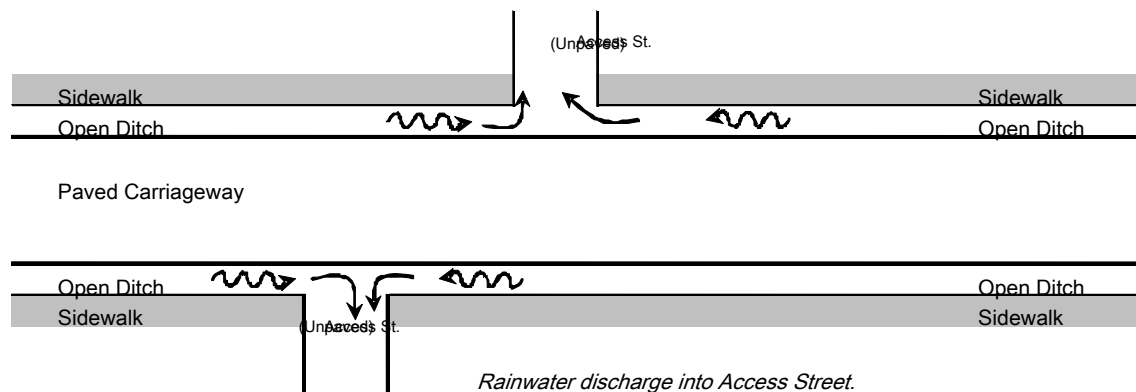
C3 Road (Gravel, W=20m)

**Table 3.2.3-1 Road Inventory Data in Juba**

No.	Road	Length (km)	Carriageway Width(m)	Remarks
1	Unity Ave.	4.6	11.0-14.0	Paved and under construction(old custom market – Juba university)
2	May St.	3.3	10.9-14.0	Paved with both sidewalk(1.8m)
3	Airport Road	1.2	11.1	Paved
4	Old Airport Road	3.0	14-16.6	Unpaved
5	Yei Road	5.0	9.0	Unpaved
6	Junction of Seventh days Adventist - Gudele	2.9	11.0-13.0	Unpaved
7	Custom market- Terekera	5.4	10	Unpaved
8	Nile Bridge – Radio Gumba	3.0	15.1-18.0	Unpaved
9	C3	4.0	20.0	Unpaved
10	Lologo-Nile Bridge	3.8	10	Unpaved
11	Junction of Yei road – Juba Uni.	4.0	6.0-15.0	Unpaved
12	Munuki Area	1.8	8.0-10.0	Unpaved
13	Juba University Road	1.1	11.1	Unpaved
14	Road connecting UNDP – Tomping	0.4	11-15	Unpaved
15	Kokora St.	1.7	10	Unpaved
16	Mobile –May St.(via Totochan)	1.0	7-13	Unpaved
17	Gabad Jct. from Airport Road- Custom office	1.2	4.5-6.0	Unpaved
18	Youth Sport Office-WFP	1.9	10.5	Unpaved
19	Addis Ababa Road	2.1	9.9	Unpaved & Old Paved
20	Jct. Unity,May – MOPI	1.0	8-11	Old Paved
21	Juba Hospital – Prison	1.0	8-20	Unpaved
22	Football Stadium	1.2	9.2-16.0	Unpaved
23	Freedom Sq.-Cinema	1.4	9.2-21.9	Unpaved
24	Nyigilo St.	2.0	15-18	Unpaved
25	Kwait St.	1.0	22-35	Unpaved
26	Albino St.	1.6	10-18	Unpaved
27	Lazaro St. – Tombua St.	1.2	16-17.2	Unpaved
28	Tombura St.	3.1	16	Unpaved

### 3.2.4 Drainage Condition

There are no drainage systems in Juba urban area. Though May Street is a newly paved road and has open drain, there is no connection to the main channel /river to discharge rainwater. After heavy rainfall, rainwater flows on the drain and then discharges to the intersecting access roads. A schematic illustration of rainwater flow is shown in Figure 3.2.4-1.



**Figure 3.2.4-1 Image of Rainwater Flow on May Street**

Regarding unpaved road in Juba urban area, its condition deteriorates seriously after heavy rain. Surface of unpaved street becomes bumpy and some sections retain a pool of rainwater in the road making it difficult for passing vehicles to traverse the road.



Unpaved Street (Bumpy Surface)



Puddle on the road

### 3.2.5 Bridge and Culvert Condition

As mentioned in the earlier sections, the road network in Juba urban area consists basically of international/interstate, state and county roads. Several streams and rivers cut through these roads with Lobulet and Korobo rivers flowing from west to east and discharging to the White Nile River. About 12 reinforced concrete bridges and culverts cross over these rivers and streams (Figure 3.2.5-1) and concrete and corrugated steel pipe culverts cross small streams. At present, there is only one bridge crossing over the Nile River to link Juba with the eastern side of the White Nile River.

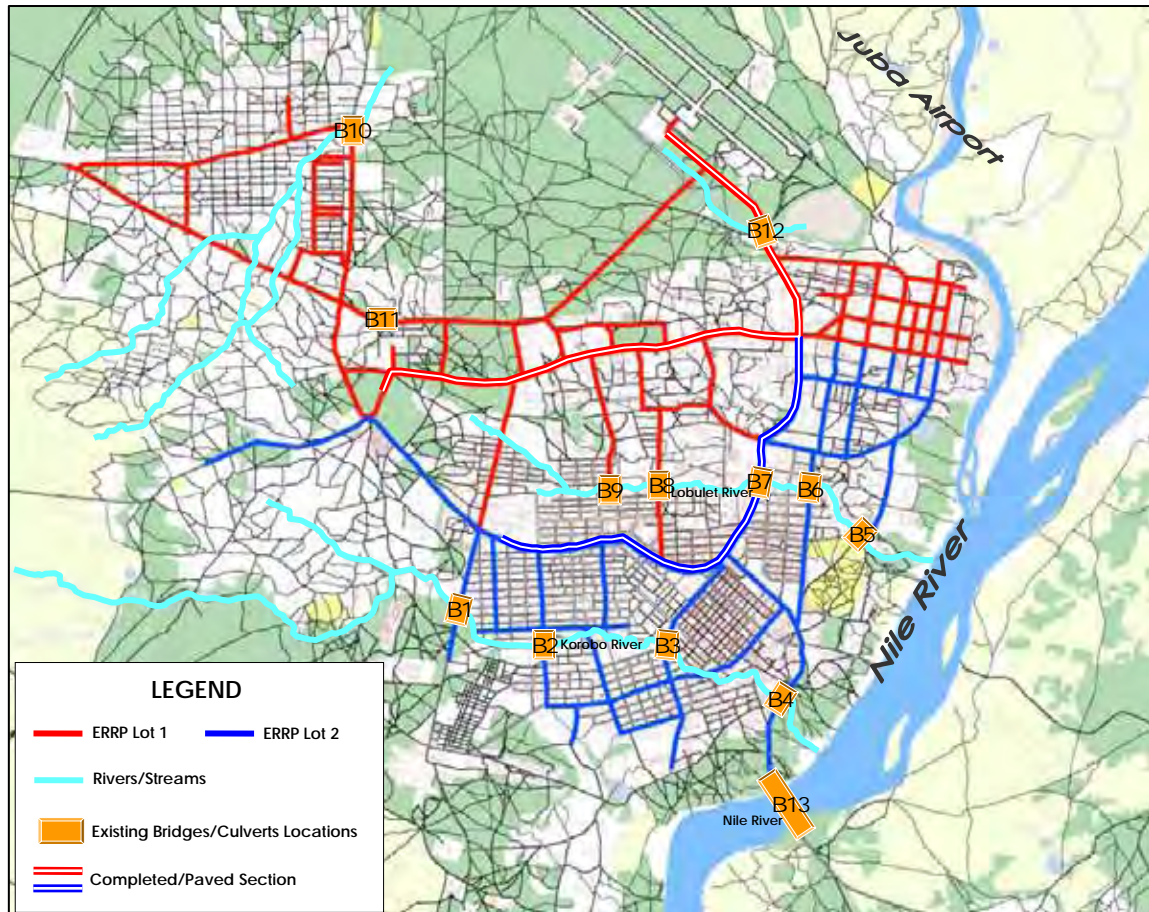


Figure 3.2.5-1 Existing Bridges/Culverts in Juba

#### (1) Existing Bridges and Culverts in Juba

Existing bridges in Juba are mostly one- or two-span reinforced concrete slab on steel H-beam with length ranging from 5.0m to 16.0m. These bridges are supported on masonry abutments with masonry wing walls. The existing conditions of these bridges are summarized as follows:

- Bridges were built in similar time period with similar structural configurations – as such, these bridges have similar load-carrying capacity.
- The superstructure shows signs of wearing and distress with some concrete cracks and damages on the deck slab.



- All bridges are found to be narrower than the existing roads, providing only one-lane or narrow two-lane traffic.
- The bridge centerline is basically offset from the approach road centerline providing risks to traffic accidents.
- Some bridges have freeboards less than 0.5m during flood.
- Scouring of banks and road embankments are observed in the upstream side of some bridges.

Existing culverts are basically one-cell and two-cell reinforced concrete slab on masonry abutment. The conditions of the culverts are similar to those of the bridges. The culvert along Terekeka Road (R-3 Road) is overtopped during flood. Table 3.2.5-1 presents a summary of the existing bridges and culverts in Juba. The details of the conditions of these bridges and culverts are discussed further in Part IV “Bridges and Culverts Reconstruction Project”. Some typical short bridges and culverts are shown in the photos below.

**Table 3.2.5-1 Summary of Existing Bridges and Culverts Conditions**

No. (see Fig. 3.2.5 -1)	Bridge/ Culvert Name	Road Name	River	Bridge/Culvert Superstructure & Substructure Type	Bridge/ Culvert Length (m)	Year Built
B1	Shuhada	Mayo	Korobo	2-Span RCDHB on Masonry Abutment	13.0	1991
B2	Tombror	Tombror	Korobo	1-Span RCDHB on Masonry Abutment	5.9	1974
B3	Albino	Albino	Korobo	1-Span RCDHB on Masonry Abutment	5.95	1974
B4	Madra	Nglilo	Korobo	2-Span RCDHB on Masonry Abutment	15.7	1972
B5	Salakana	Salakana	Lobulet	1-Span RCDHB on Masonry Abutment	9.65	1995
B6	Hai Malakar	Cinema	Lobulet	1-Span RCDHB on Masonry Abutment	5.4	
B7	Korobo	Unity	Lobulet	1-Span RCDHB on Masonry Abutment	5.5	1960
B8	Kokora	Kokora	Lobulet	1-Span RCDHB on Masonry Abutment	10.5	1983
B9	Lukabadi	Lukabadi	Lobulet	2-Span RCDHB on Masonry Abutment	12.1	1999
B10	Terekeka	Terekeka	-	2-Cell RC Slab on Masonry Abutment	3.3	1950
B11	Gonya	Salvation	-	1-Cell RC Slab on Masonry Abutment	4.5	
B12	Lodoro	Lay	-	1-Cell RC Slab on Masonry Abutment	6.1	1986
B13	Juba	R6	Nile	6-Span Continuous Steel Truss	240	2008*

RC – Reinforced Concrete

RCDHB – Reinforced Concrete Deck on Steel H-Beam

\* Replacement of Superstructure for Juba Bridge was completed in 2008. Original substructure is retained.



Typical 1-Span RC Deck on Steel H-Beam with  
Masonry Abutments



Typical 2-Span RC Deck on Steel H-Beam with  
Masonry Abutments and Pier



Typical 1-Cell RC Slab with Masonry Abutments



Typical 2-Cell RC Slab with Masonry Abutments



Typical Corrugated Steel Pipe Culvert



Typical RC Pipe Culvert

## **(2) Existing Juba Bridge Crossing White Nile River**

At present, only one bridge, Juba Bridge connects Juba with the eastern side of the White Nile River. This is an important bridge providing direct connection to the eastern states via the Juba-Bor, Juba-Lafon and Juba-Nimule roads towards Uganda. All movements of people and goods from the eastern side to Juba pass over this bridge.

The existing Juba Bridge, crossing over the White Nile River, is a twin-deck 6-span continuous steel truss bridge (Mabey and Johnson type) with double panels. Pedestrian walkways are provided on both sides of the bridge. The bridge is supported on five steel pile bent piers.

The original bridge was built in 1974 but collapsed in 2006 due to the constant passage of heavy trucks and lack of control of overloading. Following the bridge failure, a structural assessment was carried out by Mabey and Johnson in 2006. It was evaluated that the substructures (piers and foundations which are in very firm rock layer) were in good condition and that the need is only to replace the superstructure (steel truss and deck). Sudken International, a locally registered South Sudan company, was awarded the US\$5.8 million contract for the superstructure replacement in August 2006. Delays in the release of funds from the Ministry of Finance caused the delay in the procurement of the structural



members. The bridge was finally completed and inaugurated in October 6, 2008. After completion of the superstructure replacement, the bridge load limit is posted at 45 tons and the maximum speed is limited to 20km/hr.



Juba Bridge over the White Nile River



Load Limit Posted at 45 Tons (20 km/hr) During  
Juba Bridge Inauguration (Oct. 6, 2008)



Steel Deck and Truss Panels



Double Truss Panel and Pedestrian Walkway at  
bridge side



Steel Pile Bent Piers

### 3.3 VEHICLE REGISTRATION

Vehicle registrations are controlled by the different authorities in GOSS and the State Traffic Police. As shown in Table 3.3-1, the GOSS vehicles and NGOs, aid agencies and diplomatic vehicles are controlled by MTR, GOSS. State government vehicles, private vehicles, motor cycles and commercial vehicles are controlled by the State Traffic police. Traffic police grasped only the number of vehicles given as plate number “CE\*\*\*\*\*”. Since many vehicles registered by GONU are seen in Juba, the number of registered vehicles do not match as actual numbers in Juba. A vehicle registration system that will be controlled by one organization in Southern Sudan should be established.

**Table3.3-1 Vehicle Registration System and Number of Registered Vehicles**

Category		Agency to register	Number of registered vehicles	Remarks
GOSS vehicles		MTR, GOSS	1,600	
NGOs, aid agencies and diplomatic missions vehicles		MTR, GOSS	210	Except those registered in Khartoum
State Government vehicles		Central Equatoria State, Traffic Police	100	
Private Vehicles		Central Equatoria State Traffic Police	1,724	Plate Number “CE-*****” only.
Commercial Vehicles		Central Equatoria State Traffic Police	513	Bus, Truck
Motor-cycles	State Government	Central Equatoria State Traffic Police	65	
	Private	Central Equatoria State Traffic Police	935	

Source: Department of Transport and Safety, MTR and Traffic Police

### 3.4 TRAFFIC MANAGEMENT

No traffic signal is installed in Juba. Presently, some roundabouts/ junctions are manually controlled by traffic police during peak hour.



During daytime, long queue occurs at Roundabout with May St. and Unity Ave.



Traffic in Juba is being controlled by the traffic police.

An one-way system is introduced into 3 short sections in Juba to maximize the limited road space illustrated in Figure 3.4-1.



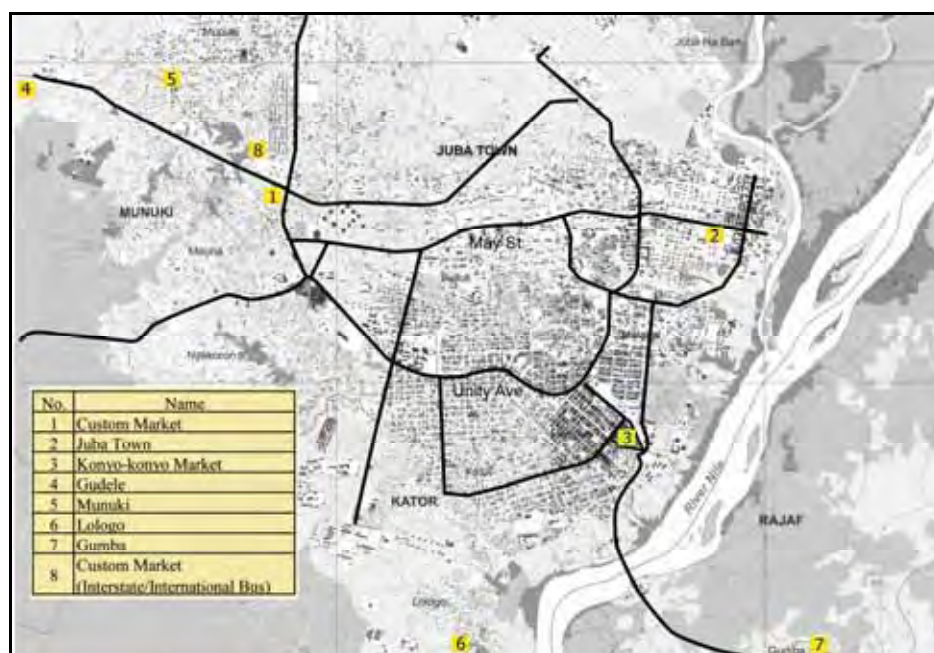
**Figure 3.4-1 Existing Traffic Management in Juba**

### **3.5 PUBLIC TRANSPORT**

#### **(1) Bus**

The bus terminals are located beside market places, such as Juba, Custom, Konyo-konyo, Muniki, Gudele, Gumba as shown in Figure 3.5-1. The public transport services between the bus terminals and other places are provided by minivans. Most of minivans are operated by individuals, and not by company. In order to operate minivans as public transport, the registration to traffic police is required.

The number of registered minivans is 513 vehicles. Since this figure includes trucks as commercial vehicles, it is difficult to grasp the actual number of minivans operating in Juba.



**Figure 3.5-1 Location of Bus Terminal**





No.1 Bus Terminal in Custom Market



No.3 Bus Terminal in Konyo Konyo Market



No2. Bus Terminal in Juba



No.8 International/Interstate Bus Company  
(near Custom Market)

Interstate/International bus is administrated by the Department of Road Transport and Safety, MTR. Most of these buses start from/to the terminal beside Custom Market and the Interstate/International bus are operated by the following bus companies.

**Table 3.5-1 Interstate/International Bus Operation from/to Juba**

	Bus Company Name	Route	Number of Bus	Seat Capacity	Fare(one-way) SDG
1	1.MUNDRI EXPRESS	Juba- Mundri - Yei	1	60	60
2	NATONDIT	Juba - Nimule - Kampala	2	60	70
3	GATEWAY	Juba - Nimule - Kampala	1	60	70
4	GRACE	Juba - Nimule - Kampala	1	60	70
5	VICTORIA NILE SAFARI	Juba - Nimule - Kampala	1	60	70
6	GATANI STAR	Juba - Nimule - Kampala	1	60	60
7	BLUE NILE COMPANY	Juba - Nimule - Kampala	6	60	120
8	NIMULE EXPRESS	Juba-Nimule	1	24	50
9	NILE COACH COMPANY	Juba - Yei - Kampala	2	60	100
		Juba - Aulu	2	60	50
10	YEI EXPRESS	Juba-Yei	1	60	50
11	Mini Bus Company	Juba - Yei	7	24	35

Source: Bus company interview survey by JICA Study Team



Minivans (Seat Capacity 14)



International Bus(Seat Capacity 60)

## **(2) Taxi**

Another public transport available in Juba is the taxi. The taxi type is divided into sedan type and bike type. The bike taxis called *boda-boda* is more popular and many bike taxis wait for passenger at the main bus terminals as para-transit mode. There is no registration system and responsible organization which controls and operates the taxi service.



Bike Taxi (*boda-boda*) in Custom Market

## **(3) License System**

The law/regulation on licensing of buses and taxis is not established yet. Buses and taxis are presently operated arbitrarily.