Republic of South Sudan
Ministry of Roads and Bridges

IMPLEMENTATION REVIEW STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF THE BRIDGES IN JUBA CITY IN THE REPUBLIC OF SOUTH SUDAN

December 2021

JAPAN INTERNATIONAL COOPERATION AGENCY

CTI ENGINEERING INTERNATIONAL CO., LTD.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the implementation review study on the project for the Construction of the bridges in Juba City in the Republic of South Sudan and entrust the survey to CTI Engineering International Co., LTD. (CTII).

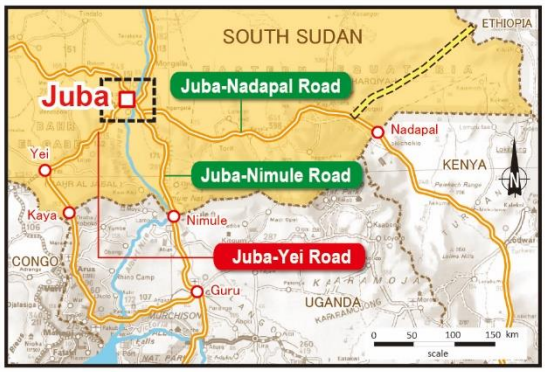
The survey team held a series of discussions with the officials concerned of the Government of the Republic of South Sudan, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

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

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

December, 2021

Akihito SANJO
Director General
Financial International Cooperation Agency
Japan International Cooperation Agency



Legend

: International Road
: Existing Road (un-paved)
: Existing Road (paved)
: Plan Road
C1～C3 : Circumferential Road
R1～R6 : Radial Road

Location Map

Perspective (Bridge No.1)

Perspective (Bridge No.4)

Perspective (Bridge No.7)

Perspective (Bridge No.10)

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Note) * The section which is referred to the Preparatory Survey Report on the Project for Construction of Bridges in Juba City in the Republic of South Sudan (2016)

[Appendices]

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Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Office
ABMC	Contractor's name
A/P	Authorization to Pay
AS	Asphalt Concrete
ASTM	American Society for Testing and Materials
BDM	Bridge Design Manual
CBR	California Bearing Ratio
CD	Capacity Development
CES	Central Equatoria State
CIDA	Canadian International Development Agency
CPI	Consumer Price Index
DDM	Drainage Design Manual
DEM	Digital Elevation Model
DfID	Department for International Development
DRB	Directorate of Roads and Bridges
DS	Design Standard
EIA	Environmental Impact Assessment
EIE	Environmental Impact Evaluation
EIR	Environmental Impact Review
EIS	Environmental Impact Statement
EU	European Union
ESIA	Environment and Social Impact Assessment
E/N	Exchange of Notes
ESAL	Equivalent Single Axle Load
EYAT	Contractor's name
G/A	Grant Agreement
GDP	Gross Domestic Product
GOSS	Government of South Sudan
IEE	Initial Environmental Examination
IMF	International Monetary Fund
JRA	Japan Road Association
JICA	Japan International Cooperation Agency
LRFD	Load and Resistance Factor Design
MD	Minutes of Discussion
MDTF	Multi-Donor Trust Fund

MFEP	Ministry of Finance and Economic Planning
MOE	Ministry of Environment
MOPI	Ministry of Physical Infrastructure
MTR	Ministry of Transport and Roads
MTRB	Ministry of Transport, Roads and Bridges
MRB	Ministry of Roads and Bridges
NMT	Non-Motorized Transport
PAP	Project Affected Persons
PCU	Passenger Car Unit
RAP	Resettlement Action Plan
RC	Reinforced Concrete
ROW	Right of Way
SSRA	South Sudan Road Authority
SSUWC	South Sudan Urban Water Corporation
TOR	Terms of Reference
TRRL	Transport and Road Research Laboratory
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations International Children's Emergency Fund
UNMAS	United Nations Mission Action Service
UNOPS	United Nations Office of Project Services
USAID	United States Agency for International Development
WB	World Bank
WFP	World Food Programme

Chapter 1 Background of the Project

1-1 Background and Outline of the Japan Grant Aid Project

The traffic volume in Juba city, a capital city of the Republic of South Sudan, has continued to rise according to the population inflow after the independence. Since the Republic of South Sudan (hereinafter referred to as South Sudan) is an inland country, they depend on imported goods which mainly come from neighboring countries. Cargos landed at Mombasa port in Kenya are transported to various parts of the country via Juba. That is because the city is the crossing point between international corridor and national major highway. Mitigation of traffic congestion in Juba plays an important role in facilitating intra-city traffic as well as in promoting distribution in wide area. However, slow construction of infrastructure due to two decades civil war is quite noticeable in Juba. In addition, most of the roads in the city are earth roads and gravel pavement. Therefore, it happens that some sections are impassible due to muddy soil and a lot of vehicles need to pass a bypass road. Moreover, road bumps are serious even in dry season and it is required to drive at low-speed.

Highways in Juba city have been gradually upgraded and maintained with a budget of the Ministry of Roads and Bridges (hereinafter referred to as MRB). As of 2015, the extension of pavement became approximately 60 kilometers long. Despite a specific local contractor is in charge of these construction works, they are unable to conduct the upgrade and replacement of bridges due to the lack of technical capabilities. As a result, the bridges and their approach roads remain narrow even in the case of major roads in the city. These bridges became not only the bottleneck of transportation but also the cause of traffic congestion in the entire city. In addition, most of the bridges were constructed in 1970s and do not have adequate durability against both the increase of traffic volume and traffic load. To make these bridges durable and to solve these bottlenecks are the urgent issues for the social and economic development of South Sudan.

In March 2013, Japan International Cooperation Agency (JICA) started “The Preparatory Survey on the Project for Construction of Lologo Bypass and Bridges in Juba”. Although the draft of the Preparatory Survey was already written, the survey itself was suspended temporarily due to worsening security situation by civil war. In 2015, “The Preparatory Survey on the Project for Construction Bridges in Juba” (hereinafter referred to as “the previous survey”) was started as a resurvey after the security situation was improved. In May 2016, “The Project for Construction of the Bridges in Juba City” was approved by the Cabinet as the Japanese Grant Aid for the reconstruction of four bridges in Juba. Nevertheless, the project has not started until the present because the military conflict occurred in July 2016.

It has been more than four years since the project was approved by the Cabinet. Thus, it is necessary for the survey to conduct cost estimation within the Cabinet decision amount based on the surrounding conditions of bridges and the latest construction cost, and to reexamine the construction plan corresponding to the current site situation.

1-2 Traffic Volume Survey

The traffic volume survey has been conducted at four bridges where the survey was conducted in 2013 to update the future traffic volume at 10 years after the completion of the project. In addition to four bridges, the survey at No.19 bridge has been also conducted since the upgrading of the paving of the roads in Juba city has been observed. The results of the traffic survey are shown in Table 1-2-1 and Table 1-2-2.

Table 1-2-1 Survey Results of Traffic Volume by Car Type

		1	2	3	4	5	6	7	8	9	10	11
Location	year	Pedestiran	Bicylcle	Motorcycle	Passenger Car	Mini Bus	Bus	Pickup	Light Truck	Medium Truck	Heavy Truck	Others
Br.1	2013	3,435	246	5,183	3,857	1,494	261	1,074	338	81	38	63
	2021	5,531	40	13,835	6,576	3,576	345	1,033	97	97	67	805
Br.4	2013	3,012	145	4,004	2,043	139	13	418	211	12	3	46
	2021	6,913	114	9,909	4,635	5,535	587	450	415	64	104	792
Br.7	2013	3,603	129	5,196	2,335	105	7	445	105	13	1	228
	2021	7,086	115	12,227	5,225	3,624	411	510	291	380	200	374
Br.10	2013	1,744	126	5,045	5,083	180	30	827	206	19	0	20
	2021	1,912	26	11,406	8,171	3,930	16	1,014	267	101	8	258
Br.19	2013	-	-	-	-	-	-	-	-	-	-	-
	2021	1,184	85	4,049	838	168	10	186	233	81	66	213

Source: JICA Survey Team

Table 1-2-2 Summary of Survey Results of Traffic Volume

		1,2	3	4,5,7,8,11	6,9,10	3～11	4～11	3～11
Location	year	NMT*	2W Vehicle	L & M Vehicle	Heavy Vehicle	Vehicle Total 1	Vehicle Total 2	PCU** Total
Br.1	2013	3,681	5,183	6,826	380	12,389	7,206	8,983
	2021	5,571	13,835	12,087	509	26,431	12,596	16,725
Br.4	2013	3,157	4,004	2,857	28	6,889	2,885	4,216
	2021	7,027	9,909	11,827	755	22,491	12,582	15,450
Br.7	2013	3,732	5,196	3,218	21	8,435	3,239	4,961
	2021	7,201	12,227	10,024	991	23,242	11,015	15,063
Br.10	2013	1,870	5,045	6,316	49	11,410	6,365	8,041
	2021	1,938	11,406	13,640	125	25,171	13,765	17,440
Br.19	2013	-	-	-	-	-	-	-
	2021	1,269	4,049	1,638	157	5,844	1,795	3,048

Source: JICA Survey Team

NMT*:Non-Motorized Transport
PCU**: Passenger Car Unit

PCU conversion rate

Type of Vehicle	ratio
Car	1
Motercycle	0.33
Bus	1.01
Truck	1.38

To compare the traffic volume in 2013 and in 2021, pedestrians and 3 wheels vehicle categorized in others are increased as well as bike, bus, and truck. At bridge No.1, shared buses and big vehicles are remarkably increased. It implies that the economic activities are increased in accordance with the increase of the population 293,000 in 2013 to 421,000 in 2021. The results of the future traffic volume predicted based on the present traffic volume is shown in Table 1-2-3.

Table 1-2-3 Future Traffic Volume

Bridge No	Survey		Open to the Public		After 10 years	
	2013	2021	2020	2025	2030	2035
No.1	11,677	21,742	24,225	27,970	38,946	38,512
No.4	5,481	20,085	9,096	25,839	14,623	35,578
No.7	6,449	19,582	13,296	25,192	21,376	34,687
No.10	10,454	22,672	16,400	29,167	26,366	40,160

Source: JICA Survey Team

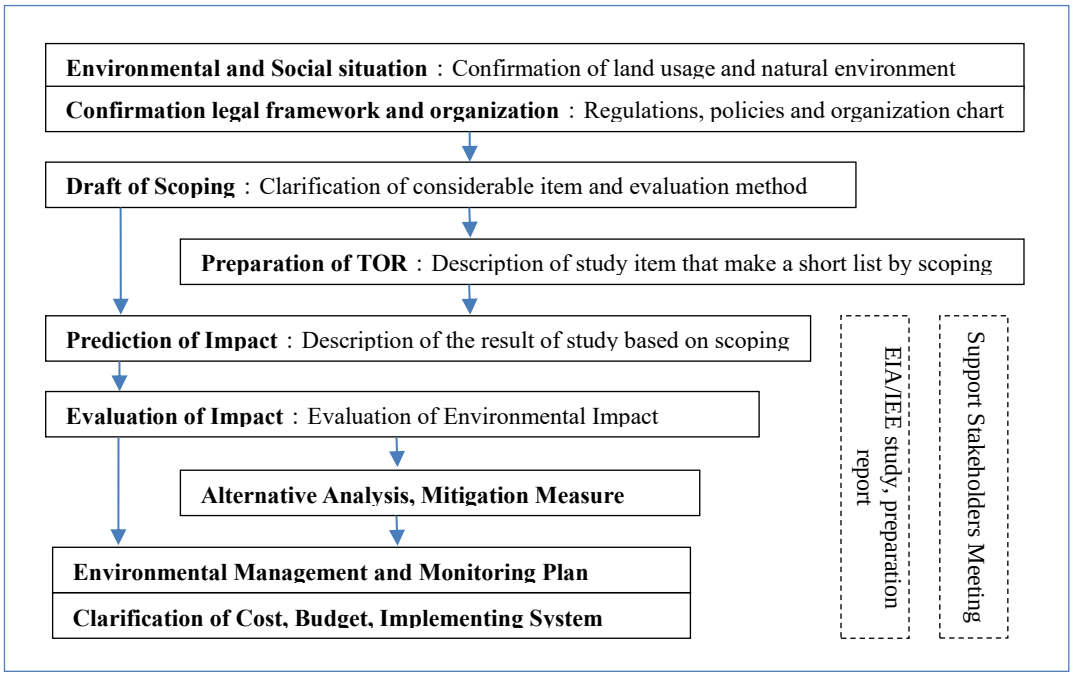
The future traffic volume in 2020 based on the survey in 2015 is coincident with the traffic volume surveyed in 2021 only at Bridge No.1. However, other results at No.4, No.7 and No.10 are increased by far 1.4 to 2.2 times as big as future traffic volume predicted based on the actual traffic volume in 2015.

1-3 Environmental and Social Considerations

It was confirmed that the expired EIA could be renewed. The situation at the site has not been changed since the previous survey, and there is no illegal occupation.

1-3-1 Environmental Impact Evaluation

This Survey was conducted according to the 'JICA Environmental and Social Consideration Guidelines (2010)'. The procedure of this study is shown in Figure 1-3-1.



Source: JICA Survey Team

Figure 1-3-1 Procedure of the Environmental and Social Considerations

The considerations of the Draft of Scoping and TOR, Prediction of Impact and Evaluation of Impact were surveyed and analyzed. Concerning the alternative analysis, the study team verified the relevance of environmental and social aspects including the comparison of Alternative Analysis (Including without project).

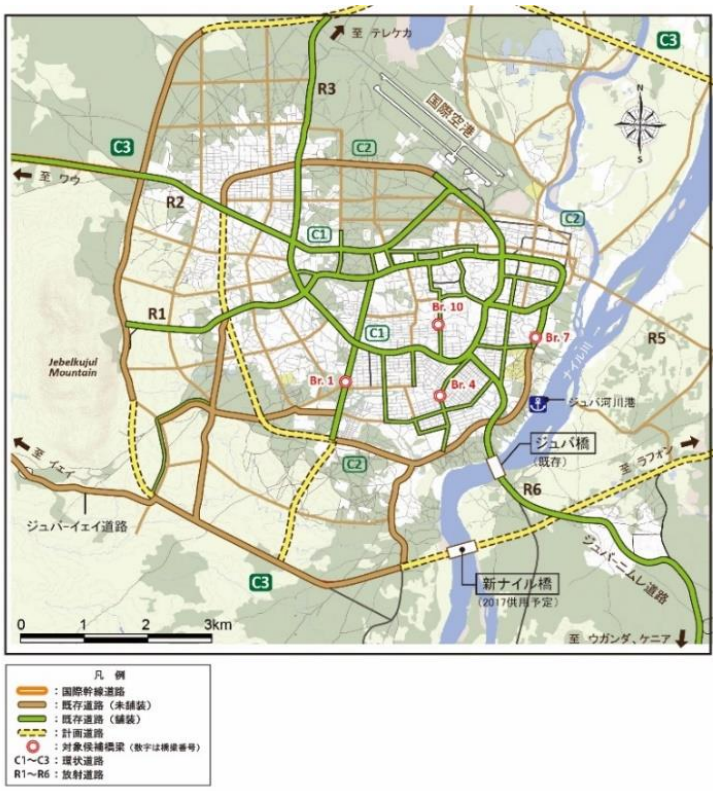
1-3-1-1 Outline of the Project*

The 13 bridges requested by the Government of South Sudan (hereinafter referred to as GOSS) and the selected 4 bridges (No.1, No.4, No.7, and No.10) in this project are shown in Table 1-3-1. And the selected bridges for the project are shown in Figure 1-3-2.

Table 1-3-1 Outline of the Project

	Bypass & Bridges	River	Payam	Priority	Outline
Br. 1	Shuhada	Lobuliet	Kator	○	Repaired temporarily.
Br. 3	Salam	Lobuliet	Kator	—	No pavement.
Br. 4	Albino	Lobuliet	Kator	○	Bottleneck (road is 2 lanes but bridge is 1 lane)
Br. 7	Salakana	Korbou	Juba	○	2 lanes road and paved.
Br. 10	Kokora	Korbou	Juba	○	Collector road. Bottleneck and Decrepit
Br. 11	Lukabadi	Korbou	Juba	—	Collector road. Bottleneck and Decrepit
Br. 17	Lodoro	Lodoro	Juba	—	A part of C2. Condition is good.
Br. 18	Korweliang 1	Korweliang	Rajaf	—	A part of C3. Impassable Road (without bridge)
Br. 19	Korweliang 2	Korweliang	Rajaf	—	Broken pipe. Soil erosion (when it is heavy rain)
Br. 20	Korweliang 3	Korweliang	Kator	—	Connecting C2 & C3. No pavement.
Br. 21	Korweliang 4	Korweliang	Kator	—	Existing Lologo road. Bottleneck and Decrepit
Br. 22	Saledo	Saledo	Juba	—	A part of C2. Impassable road (without bridge)
Br. 23	Kuwait	Saledo	Munuki	—	Broken the culvert. Expecting resettlement.

Remarks：
(1) Rehabilitation of Bridges（RC, length 10-15 m, 4 lanes）
(2)Project proponent：MRB (Ministry of Roads and Bridges, GOSS)
MRB-CES (Ministry of Roads and Bridges, Central Equatoria State)
(3) Final Bridges requested as Japanese Grant Aid Assistance is shown mark “○”.
Source: JICA Survey Team



Here is the bottleneck.
Approach Road: 4 lanes
Bridge: 1 lane

Bridge No.4

Figure 1-3-2 Location Map and Photo of the Project Site (Bridge No.4)

1-3-1-2 Baseline of the Environmental and Social Condition*

Outline of Environmental and Social Condition that was obtained from the results of other studies and related information is shown in Table 1-3-2.

Table 1-3-2 Baseline of the Environmental and Social Condition of the Project Sites[1]

	Outline of Project Site
Outline of District	Project site is located Juba city, Central Equatria State, South Sudan. There are 2 payams at project site named Juba, Kator. Outline of those 2 Payams are as follows; ✓ Juba Payam: consist center of old city area, Central Government, State Government, International Organization, Public Institution (Hospital, Schools etc.), Commercial area and Residential area. Population: 120,900 (2020) ✓ Kator Payam: there is the largest Catholic Church and big market named Konyokonyo. Residential area is extending around the Lologo community. Population 100,750,(2020)
Social Environment	Population of Juba City was 250,000 in 2005 census and has increased to an estimated 370,000 in 2011. Bari people originally live at residential area. Currently, there are over 10 ethnic groups in the area. 87% are Christian, 13% are Muslim, and remaining is animist. Main economic activity is small. Commercial, transportation and public service are the main activities. Also a number of people work at International organizations and NGOs. Residential and Commercial facilities are mixed in the city, and new residential area has spread to west and south direction of Juba City. Concerning the basic infrastructure development, main road and access road have been degraded by rain and road shoulders were eroded. Main power source is from generator and there is a shortage in the amount of supply. Water supply and sewerage system has not been developed yet. Concerning the social service, Juba Teaching Hospital is the biggest hospital and there are 2 public hospitals, 7 clinics and 36 health centers. There are Juba University, Teacher Training Institution, 13 of which are Junior high schools and 36 elementary schools as educational institution. Juba is endemic to tropical malaria and yellow fever. There are many patients of diarrhea and typhoid.
Natural Environment	Target area is located on the west side of Nile River shelving from west to east. West bank of river became floodplain and is flooded in rainy season. Character of Rock is classified as mainly metamorphic rock but is mixed. The average minimum temperature is 19.4-23.7C, the average maximum temperature is 31.5-37C, the average monthly precipitation 145-154mm in rainy season (May to October), 24.9-50.1mm in dry season (November to April). Main area of watershed is a small river such as Loblet and Koro Bou that flows to there. The small rivers are called Wadi that flow only in rainy season. Rain water doesn't penetrate to underground and become flash flood in rainy season. A large amount of mud and waste inflow to these rivers. Concerning vegetation and ecosystem, rich forest and small wildlife have existed before civil conflict. There are mango, papaya and neem which is a useful tree in many places in the city.
Pollution	Consistency of dust is high because the ring road surrounding Juba and collector road in the city is unpaved, and there are sand and dust when vehicle pass or wind blows. The open burning of plastic and garbage is carried out on a daily basis; the occurrence of smoke is also persistent. Concerning water contamination, there is no water retention function to the ground and drainage system is not developed, sewage is retained in low lands, which is the cause of water-borne diseases. Large quantities of waste are dumped and are left at various parts of the city. Handling situation is poor. There are many wastes dumped into the river. The large amount of waste flows to lowlands near the airport.

Source: JICA Survey Team

[1] Refer to the Report of 「Juba City Water Supply System Improvement Plan」 (April 2010)

	
Bridge No.1 Area	Bridge No.4 Area
	
Bridge No.7 Area	Bridge No.10 Area

Source: JICA Survey Team

Photo 1-3-1 Vecinity Photos of the Target Bridges

1-3-1-3 Environmental and Social Consideration Framework of South Sudan*

South Sudan National Environmental Policy' and 'Environmental Protection Bill' are the main policies concerning Environmental and Social Consideration in South Sudan. The former has been approved by Parliament in March 2012, but the latter yet to be approved. MRB sets 'Environmental Guidelines for directorate of Roads and Bridges' as environmental guidelines, but it has not been approved yet. The outline of these policies is as follows;

(1) South Sudan National Environmental Policy, 2012

This aims to properly protect and to sustainably use the natural environment and resources for present and future generations in South Sudan. The sectors of protection are: fisheries, forestry, wild life and tourism, agriculture, oil industry, trade, energy, mining, transport and road, housing, health, potable water, public hygiene etc. The common issues in these sectors, to be the subjects of policies are: natural hazard and desertification, dispute and environment, population growth and environment, gender and environment, wetland/river/lake. As an instrument to implement the above mentioned issues, 8 environmental policies are proposed to be established: environmental registration, economic incentive, EIA, to cope as an organization, environmental education, environmental standards, regional/international cooperation, public investment and monitoring or evaluation.

(2) Environmental Protection Bill (Draft), 2010

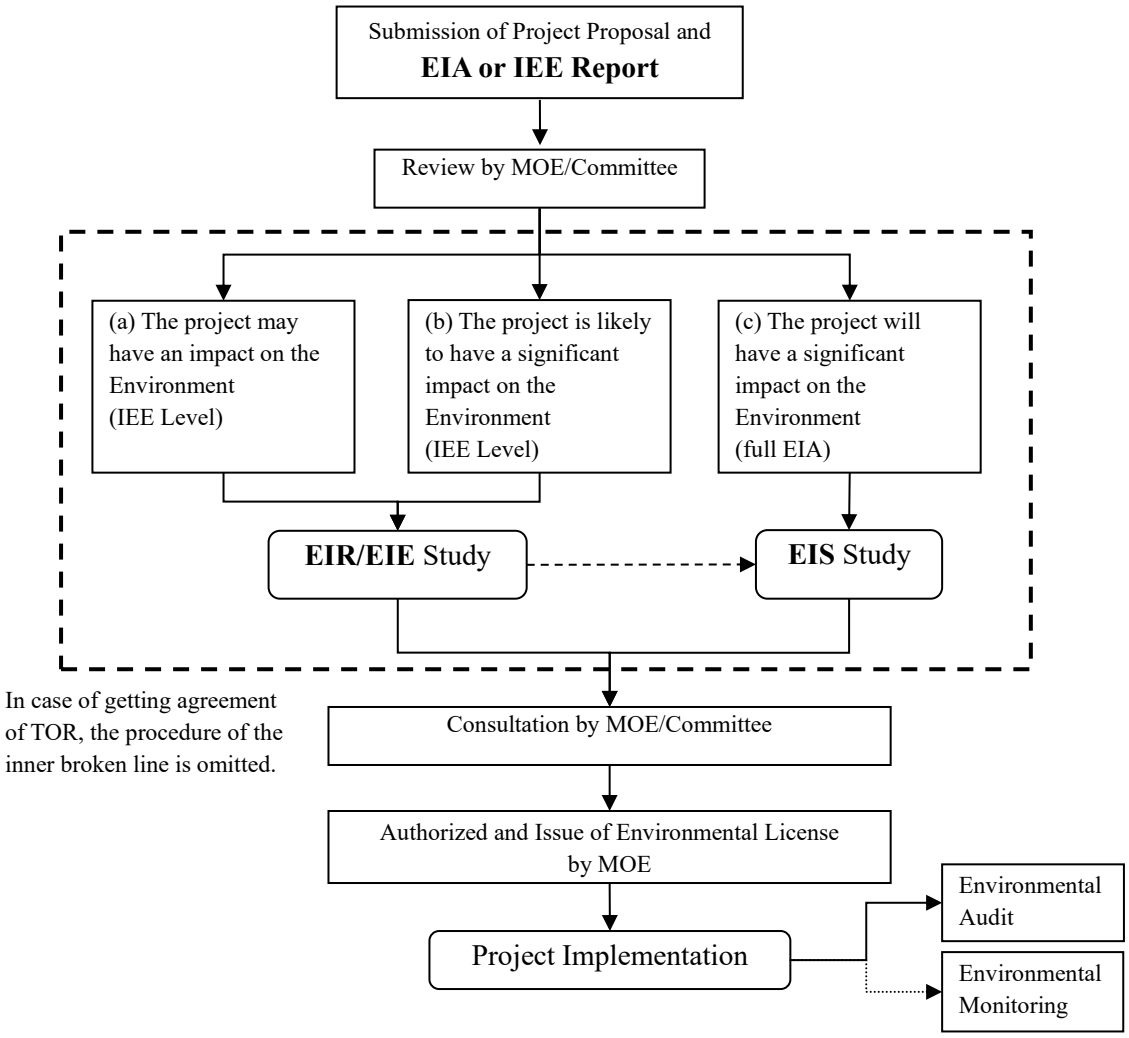
Specifies (a) the members of administrations in the levels of ROSS, states, county, Payam and Boma, (b) process of environmental impact assessment, (c) consideration of the statement, (d) obligation of the proponent, environmental audit, (e) establishment of environmental standards of air quality, water quality, discharge, odor, noise and vibration, soil quality etc., (f) management of environment for water courses, community, mountainous areas, waste management, control of pollution, environmental restoration order and so on. The problem is that this bill is not yet authorized. A present there is no legal procedure that is authorized for environmental activities. After the approval, based on this bill, the administrative committee shall be set up and environmental standards shall be proposed immediately.

(3) Environmental Guideline for directorate of Roads and Bridges, 2007

This is the environmental guidelines for roads and bridge construction by MRB and isn't approved yet. This Guidelines details the activities to be done for protection of the environment in the stages of tender, design, construction, operation and maintenance for construction of roads or bridges, sampling materials camp preparation, etc. Also proposes checklists for identifying environmental impacts. This is a convenient manual, easy to understand, and can be followed even if the person is not familiar with environmental policies.

(4) EIA/IEE Study Process

EIA/IEE Study Process is described in Environmental Protection Bill (Chapter 7, Section 29-33). Though this Bill is not yet approved by parliament as mentioned in the above section, the EIA/IEE Study already implemented and followed this process according to the MOE staff. The flow of the EIA/IEE study process is shown in the following figure. Concerning the Environmental study of this project, two (2) studies have been conducted; one is EIA study for Lologo Bypass construction including resettlement and the other one is IEE study for Bridge construction.



Source：Environmental Protection Bill, 2010 and hearing based on the stuffs of Ministry of Environment

＊ MOE: Ministry of Environment

＊ EIR: Environmental Impact Review, EIE: Environmental Impact Evaluation, EIS: Environmental Impact Statement

＊ EIR/EIE

＊ EIA（Committee）

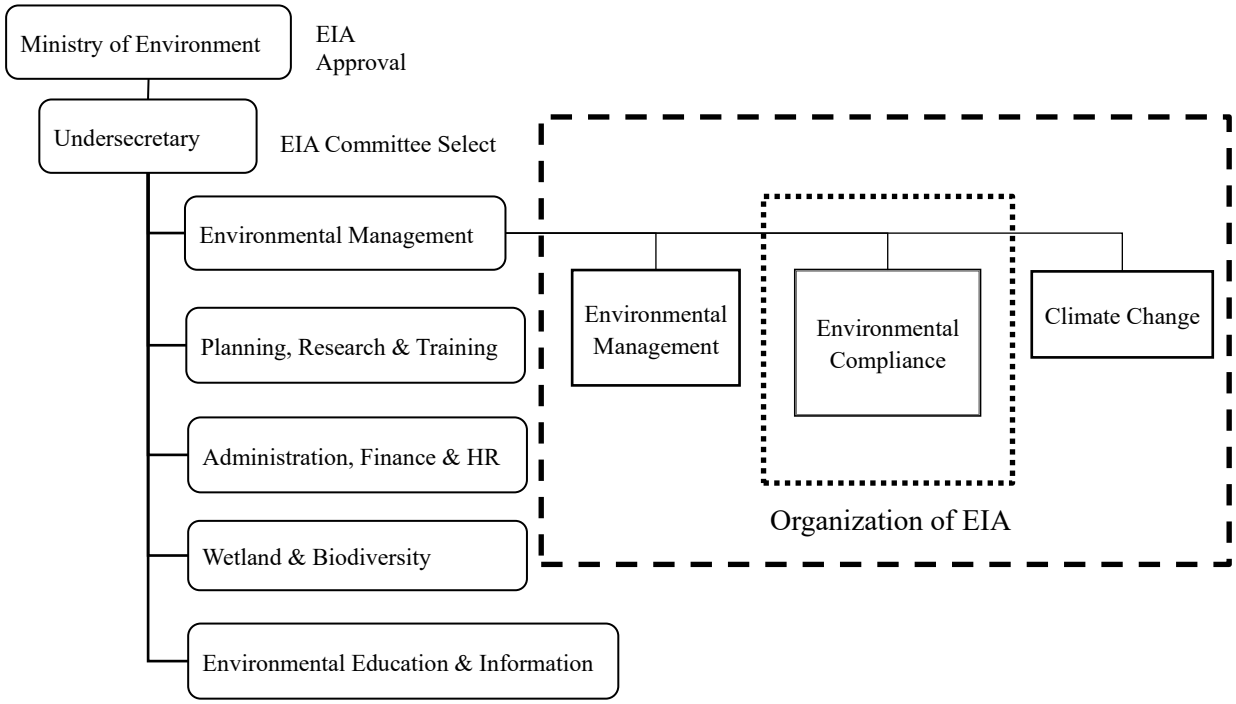
Source: JICA Survey Team

Figure 1-3-3 EIA/IEE Study Procedure

EIA and RAP study for Lologo Bypass construction and IEE study for Bridges construction were implemented as an outsourced activity of this project. The Study team has confirmed to MOE that IEE study was necessary for bridges construction because potential environment impact seems minimal. On the other hand, ESIA (Environmental and Social Impact Assessment) usually implemented at East Africa Region follows the same procedure same as the IEE, which includes environmental and social considerations. This is the reason behind the conduct of an ESIA study for the bridge construction project. The Study team explained to MOE about this background and process of ESIA. MOE has agreed with the TOR drafted for EIA, ESIA and RAP at the 2nd Stakeholders meeting and also through site survey.

(5) Organizational Structure of Ministry of Environment (MOE)

Organizational chart of MOE is shown in the following figure. As of the survey period, the post for Undersecretary is unoccupied. In addition, MOE has plans to hire more staff to comply with the allocation of their budget. But still many positions remain vacant.



Source: JICA Survey Team

Figure 1-3-4 Organization of MOE

1-3-1-4 Comparison of Alternative Analysis (including without project)*

Alternative analysis for the City Bridges Construction is described in this section.

1) Bridges Construction: Without Project

Without project, sufficient width of the bridge will not be obtained and the bridge will always be a bottleneck. Hence, heavy traffic jam is expected at each bridge. In addition, it is expected that there will be increase in traffic accidents/road crashes, and air pollution and serious soil erosion in rainy season.

2) Bridges Construction: Alternative analysis with Project

Environmental and Social Impact is minimal due to use of existing right of way.

Table 1-3-3 Comparison of Alternative

Bridge No	Impact	Evaluation
Br. 1	○	It is possible to construct the bridge and approach road for Bridges Construction within the existing right of way
Br. 4	○	It is possible to construct the bridge and approach road for Bridges Construction within the existing right of way.
Br. 7	○	It is possible to construct the bridge and approach road for Bridges Construction within the existing right of way.
Br. 10	○	It is possible to construct the bridge and approach road for Bridges Construction within the existing right of way.

○ : No impact is expected △ : Small negative impact is expected.

Source: JICA Survey Team

1-3-1-5 Scoping*

Table 1-3-4 Scoping for Bridges Construction

	Items		Evaluation		Description
			Planning & construction	Operation	
Social Environment	1	Land Acquisition Resettlement	B－	D	Land Acquisition will not be expected. Involuntary Resettlement will not be expected at all sites.
	2	Local Economies, such as employment, livelihood	C	D	(Construction) Job opportunities will be increased during construction works. The works will disturb business of shops and gas stand.
	3	Land use and utilization of local resources	D	D	No adverse impact is expected due to renovation of existing bridges.
	4	Social Institution such as local decision making institution	D	D	No adverse impact is expected.
	5	Existing social infrastructure and services	C	D	(Construction) Difficulties of access to school will be expected at Br.4 site.
	6	Poor, Indigenous or Ethnic people	D	D	No adverse impact is expected.
	7	Misdistribution of benefits and damages	D	D	No adverse impact is expected.
	8	Cultural Heritage	D	D	Cultural heritage does not exist.
	9	Local conflict of interest	D	D	No adverse impact is expected.
	10	Usage of water and water Right	D	D	No adverse impact is expected.
	11	Accident	B－	B－	(Construction) It is likely to observe the traffic congestion. (Operation) It is likely to increase traffic volume.
	12	Sanitation	B－	D	(Construction) Because of increasing workers, sanitary condition will be worse.
	13	Infection diseases, such as HIV/AIDS	D	D	No adverse impact is expected.
	14	Gender	D	D	No adverse impact is expected.
	15	Children’s Right	C	D	(Construction) It is likely that difficulty of access to school will be observed.
Natural Environment	16	Topography and Geology	D	D	Large scale of geological alteration will not be expected.
	17	Soil erosion	D	D	No adverse impact is expected due to renovate of existing bridges.
	18	Groundwater	D	D	No adverse impact is expected.
	19	Hydraulic Situation	D	D	No adverse impact is expected due to renovate of existing bridges.
	20	Coastal Zone	D	D	There is no coastal area.
	21	Fauna, Flora and Biodiversity	B－	B－	(Construction) Removing of livestock and cutting trees will be necessary.
	22	Meteorology	D	D	No adverse impact is expected.
	23	Landscape	D	D	No adverse impact is expected.
	24	Global Warming	B－	C/D	(Construction) It is likely to increase GHGs by using machineries. (Operation) It is likely to decrease GHGs because of running speed up. Extent of impact is unknown.

	Items		Evaluation		Description
			Planning & construction	Operation	
Pollution	25	Air Pollution	B－	C/D	(Construction) It is likely to increase gas emission and dust by using machineries. (Operation) It is likely to decrease gas emission because of running speed up.
	26	Water Contamination	D	D	No adverse impact is expected.
	27	Soil Pollution	B－	D	(Construction) Oil spillage from machineries or vehicles is likely to occur.
	28	Waste	B－	D	(Construction) It is likely to generate waste such as concrete, surplus soil and cutting trees.
	29	Noise and Vibration	B－	C/D	(Construction) It is likely to generate noise and vibration by using machineries. (Operation) Noise and vibration will be decreased because constructed pavement can keep the vehicles smooth driving on the road.
	30	Ground subsidence	D	D	No adverse impact is expected.
	31	Odor	B－	D	(Construction) It is likely to generate odor such as gas emission by using machineries.
	32	Bottom Sediment	D	D	No adverse impact is expected.

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

Source: JICA Survey Team

1-3-1-6 TOR for the Environmental and Social Survey*

Table 1-3-5 TOR for the Environmental and Social Survey

	Items		Site Survey Items	Method of Survey
Social Environment	1	Involuntary Resettlement Land Acquisition	♦ Confirmation of Land Acquisition • Eligibility, Valuation, Compensation for loss (Entitlement matrix) • Organization and responsibilities, Cost and Budget • Community Participation	♦ Collect and Analyze information ♦ Interview / hearing survey ♦ Site survey ♦ Meeting and Discussion with SHs, Payam leaders and target people Market price Survey
	2	Local Economies, such as employment, livelihood	♦ Confirmation of opinion and acknowledgement of shop owner	♦ Hearing (Target people)
	3	Land use and utilization of local resources	♦ Confirmation of Land use condition	♦ Hearing/Site survey (Confirmation of the location of houses and shop etc.)
	4	Social Institution such as local decision making institution	♦ Confirmation of existing local groups	♦ Hearing (village leader etc.)
	5	Existing social infrastructure and services	♦ Confirmation of social infrastructure (School, hospital, church etc.)	♦ Site survey / utilize satellite photo
	6	Poor, Indigenous or Ethnic people	♦ Confirmation of presence of refugees	♦ Hearing (village leaders)
	7	Misdistribution of benefits and damages	♦ No need for physical site survey	♦ No need to physical site survey
	8	Cultural Heritage	♦ No need for physical site survey	♦ No need to physical site survey
	9	Local conflict of interest	♦ No need for physical site survey	♦ No need to physical site survey

	Items		Site Survey Items	Method of Survey
	10	Usage of water and water Right	♦ No need for physical site survey	♦ No need to physical site survey
	11	Road crashes	♦ Confirmation of the number of traffic accident and reason. ♦ Refer to prediction of traffic volume	♦ Hearing (Police etc.) ♦ Collect and analyze information
	12	Sanitation	♦ Confirmation of location of enable latrine	♦ Site survey and hearing
	13	Infection diseases such as HIV/AIDS	♦ No need for physical site survey	♦ No need to physical site survey
	14	Gender	♦ No need for physical site survey	♦ No need to physical site survey
	15	Children's Right	♦ Confirmation of the location of school	♦ Site survey and hearing (teachers and family members)
Natural Environment	16	Topography and Geology	♦ Collection of Topography and Geology data	♦ Correct and analyze information
	17	Soil erosion	♦ Confirmation present condition affected by flood	♦ Site survey, check with eyes
	18	Groundwater	♦ No need for physical site survey	♦ No need to physical site survey
	19	Hydraulic Situation	♦ No need for physical site survey	♦ No need to physical site survey
	20	Coastal Zone	♦ No need for physical site survey	♦ No need to physical site survey
	21	Fauna, Flora and Biodiversity	♦ Confirmation of the amount of livestock (roughly) and grazing place. ♦ Confirmation of the amount of cutting trees, species and place. ♦ Refer to the result of RAP (Replacement cost Survey) ♦ Predicted condition (during operation)	♦ Site Survey and hearing (villagers) ♦ Refer to the result of RAP
	22	Meteorology	♦ No need for physical site survey	♦ No need to physical site survey
	23	Landscape	♦ No need for physical site survey	♦ No need to physical site survey
	24	Global Warming	♦ Prediction of the amount of GHGs (CO2: present and construction)	♦ Collect and analyze information and data
Pollution	25	Air Pollution	♦ Obtain related to the NO_2, SO_2, CO, SPM data as baseline ♦ Measurement, if necessary	♦ Collect and analyze data ♦ Measurement at site
	26	Water Contamination	♦ Measurement of pH, BOD, turbidity, if necessary	♦ Collect and analyze data ♦ Check with eyes
	27	Soil Pollution	♦ Confirmation of historical of land	♦ Hearing (Village leaders etc.)
	28	Waste	♦ Confirmation of Waste condition and Waste management system ♦ Confirmation of dumping site	♦ Correct and analyze information ♦ Hearing (village leaders etc.)、Site Survey
	29	Noise and Vibration	♦ Obtain related to the noise and vibration data as baseline ♦ Measurement, if necessary	♦ Correct and analyze data
	30	Ground subsidence	♦ No need to physical site survey	♦ No need to physical site survey
	31	Odor	♦ Confirmation of presence of source of odor	♦ Hearing and Site Survey
	32	Bottom Sediment	♦ No need for physical site survey	♦ No need to physical site survey

Source: JICA Survey Team

1-3-1-7 Prediction of Environmental Impact*

Table 1-3-6 Prediction of Environmental Impact for Bridges Construction

	Items		Prediction of Environmental Impact
Social Environment	1	Involuntary Resettlement Land Acquisition	1) In Br. 1, to remove bamboo fence and barbed wire in the part of the river channel, to remove the signboard in the road site. It is a Public Area, thus land acquisition and resettlement for the obstruction removal is not necessary. 2) In Br. 4, by prospecting results of the investigation of the rock, raising about 2 m the lower face of footing bring the good result that there is no effect of bridge foundation excavation to the restaurant, therefore, partial removal and restoration of the restaurant is not necessary. 3) In Br. 7, but to remove a part of the outer wall of the existing hotel on-site, there is no land acquisition and resettlement due to Right-of Way of the road. In addition, for the new hotel, as its construction to the outside of the Right of Way of the road has been agreed with the hotel owner and MRB & MRB-CES, there is no land acquisition and resettlement. 4) In Br. 10, to remove a part of the bamboo fence and the brick and masonry wall, because of the river channel (public land), there is no land acquisition and resettlement.
	2	Local Economies, such as employment, livelihood	There are some factories near Br. 1, hotel and livestock market near Br. 7 and commercial area near Br. 10. There is a possibility that some work activities in these establishments maybe affected during construction.
	3	Land use and utilization of local resources	Mainly residential and commercial areas occupies the construction site. No adverse impact is expected because length of bridge is short (10-15m).
	4	Social Institution such as local decision making institution	Bari group live originally in Juba. Dinka, Madi and other groups from surrounding areas came after. Relation between groups is well. No adverse impact is expected.
	5	Existing social infrastructure and services	The Kator Health Center and elementary school are near Br. 4, hospital is near Br. 10. Land acquisition for these infrastructures are not necessary at any site. It is expected that access to those facilities will be temporarily difficult during construction.
	6	Poor, Indigenous or Ethnic people	Surrounding areas for all construction sites has been demarcated and people have land certification. No adverse impact is expected to the poor, indigenous or ethnic people.
	7	Misdistribution of benefits and damages	It is expected that the gap widens between PAPs with the identification of affected asset or compensation. Adverse impact is reduced through setting the clear standard for eligibility and implemented market price study.
	8	Cultural Heritage	Cultural Heritage doesn't exist at project site.
	9	Local conflict of interest	Any conflicts between groups are not confirmed. No adverse impact is expected.
	10	Usage of water and water Right	There are wells everywhere in Juba. Mainly, water is distributed by tank car. Price is 2USD/200 ℓ. Some adverse impact is expected during construction.
	11	Accident	Accidents happened due to heavy traffic volume around Br. 1, 4,7,10. Especially the width of road at Br. 4 is narrow; children are high risked for accidents. It is expected that accident will increase during construction. On the other hand, it is considered that accident is controlled because the constructed wide roads.
	12	Sanitation	There are many pet bottles everywhere in Juba. Condition of waste treatment is bad. It is expected that environmental condition is getting worse by increasing workers during construction.
	13	Infection diseases such as HIV/AIDS	It is anticipated that risk of infection will increase. By conducting educational activities to workers, negative impact is reduced.
	14	Gender	It is expected that impact is mitigated through provisions of employment opportunity equally.
	15	Children's Right	It is expected that access to schools will be difficult during the construction.

	Items		Prediction of Environmental Impact
Natural Environment	16	Topography and Geology	Rock stratum at Juba consists of metamorphic rock mainly with mixed gneiss, granitic gneiss, and amphibolite. Large scale of geological change is not expected
	17	Soil erosion	Soil erosion can be found everywhere in Juba. It is expected that this situation will be improved by the construction of pavement, which is included in this plan.
	18	Groundwater	Um Rwaba is as a kind of aquifer according to the result of Nile Bridge study. The groundwater level is between 1.5-3.5m below the ground.
	19	Hydraulic Situation	2 rivers (Br. 1 & Br. 4 belong to Lobulet river and Br. 7 & Br. 10 to Kor-Bou river) are Wadi, which water flows only on rainy season. For dry season, water was not confined or very small amount in the rivers during the time of survey. Large scale of excavation is not planned and it is possible to prevent flood by bridge construction.
	20	Coastal Zone	Coastal Zone doesn't exist at project site.
	21	Fauna, Flora and Biodiversity	Some fruit and useful trees to be cut at Br. 7. There are few livestock at all site. It is expected that some adverse impact is expected during construction. (e.g. movement of livestock)
	22	Meteorology	The average minimum temperature is between 19.4-23.7C while average maximum temperature is 31.5-37.9C. Annual maximum temperature is as high as 38.4C on February while the annual minimum temperature is 27.5C on July (statistic data 1998-2004). The average monthly precipitation is between 145-154mm in rainy season, and 24.9-50.1mm in dry season. No adverse impact is expected.
	23	Landscape	Residential area, vacant lot and weed land are found as landscape at site. It is not planned to construct high/tall building. Negative impact is not expected.
	24	Global Warming	Emission of greenhouse gases will increase due to -increase traffic amount and deterioration of the road network. It is expected that amount of emission will increase because usage of construction machineries.
Pollution	25	Air Pollution	Generation of exhaust gas and dust by low speed driving will occur due to the bottle neck at the bridge. It is expected that amount of emission will be increased because of the machineries to be used during the construction phase. It is expected that emission of gas and dust will be reduced due to road pavement and speed up of drive.
	26	Water Contamination	Some adverse impact is expected in case from oil used in machineries leaked to the river
	27	Soil Pollution	There are no anthropogenic sources to contaminate the soil at the site up to now. Natural contaminations were not present at all. Negative impact is expected if oil from construction machineries leaks to land during the construction.
	28	Waste	General wastes such as pet bottles are strewn everywhere at project site. Condition of waste treatment is quite bad. In Juba City, garbage collection service was started using compaction car. Waste is a one of the main source of odor. Garbage was dumped at small rivers at site too. It is expected that construction waste (such as concrete, sand and trees) will be generated during construction.
	29	Noise and Vibration	Because cars are operating at low speed, environmental standards for both noise and vibration is cleared now. Due to the increasing construction machineries, it is necessary to check periodically. It is expected that noise and vibration will be reduced. Constructed pavement can keep the vehicles driving smoothly on the road.
	30	Ground subsidence	Large amount of groundwater usage is not found around site. Negative impact is not expected.
	31	Odor	Presence of garbage is visible at site. It is confirmed that bad odor extends any place in the area. It is expected that odor generate more from machineries during construction.
	32	Bottom Sediment	Large scale of excavation is not planned. Negative impact is not expected.

Source: JICA Survey Team

1-3-1-8 Evaluation of Environmental Impact*

Table 1-3-7 Evaluation of Environmental Impact for Bridge Construction

	Items		Evaluation (scoping)		Evaluation (results)		Reason of Evaluation
			Pl/Con	OP	Pl/Con	OP	
Social Environment	1	Involuntary Resettlement Land Acquisition	B-	D	D	D	The need to carry out the land acquisition is not expected.
	2	Local Economy	C	D	B-	B+	(C) Some adverse impact is expected. (O) Positive impact such as improvement of transportation is expected.
	3	Land use and local resources	D	D	D	D	No impact is expected.
	4	Social Institutions	D	D	D	D	No impact is expected.
	5	Existing social infrastructure	C	D	B-	D	(C) Access to public facilities is difficult. (O) Shortened the accessing time to facilities is expected.
	6	Poor or Ethnic people	D	D	D	D	No impact is expected.
	7	Misdistribution of benefits and damages	D	D	D	D	No impact is expected.
	8	Cultural Heritage	D	D	D	D	No impact is expected.
	9	Local conflict of interest	D	D	D	D	No impact is expected.
	10	Water usage and water right	D	D	D	D	No impact is expected.
	11	Accident	B-	B-	B-	B-/B+	(C) It is likely to increase accident. (O) It is expected that accident is decreased due to road improvement. But some impact is expected due to increased traffic amount.
	12	Sanitation	B-	D	B-	D	(C) General waste is increased by workers and construction waste is generated too. (O) It is necessary to establish some appropriate management to control waste.
	13	Infection diseases such as HIV/AIDS	D	D	B-	D	(C) Risk of infection diseases is higher due to the number of workers. (O) Positive impact is expected because it is expected that the road will shorten transport time to hospital.
	14	Gender	D	D	D	D	No impact is expected.
	15	Children's Right	C	D	B-	D	(C) Some adverse impact is expected due to school.
Natural Environment	16	Topography and Geology	D	D	D	D	No impact is expected.
	17	Soil erosion	D	D	D	D	No impact is expected.
	18	Groundwater	D	D	D	D	No impact is expected.
	19	Hydraulic Situation	D	D	D	D	No impact is expected.
	20	Coastal Zone	D	D	D	D	No impact is expected.
	21	Fauna, Flora and Biodiversity	B-	B-	D	D	No impact is expected.

	Items		Evaluation (scoping)		Evaluation (results)		Reason of Evaluation
			Pl/Con	OP	Pl/Con	OP	
	22	Meteorology	D	D	D	D	No impact is expected.
	23	Landscape	D	D	D	D	(C) Some adverse impact is expected due to use of construction machineries. (O) No impact is expected.
	24	Global Warming	B-	C/D	B-	B-/B+	(C) Emission of GHGs is increased due to use of construction cars and machineries. (O) Though it is expected that Emission of GHGs is reduced due to decreasing low speed, it may be increase due to increasing traffic amount.
Pollution	25	Air Pollution	B-	C/D	B-	B+	(C) Gas and dust are increased due to use of construction cars and machineries. (O) It is expected that gas and dust are reduced due to the concrete paved road and speeding up cars.
	26	Water Contamination	D	D	D	D	Some adverse impact is expected if oil leaks from machines.
	27	Soil Pollution	B-	D	B-	D	Some adverse impact is expected if oil leaks from machines.
	28	Waste	B-	D	B-	D	(C) It is possible that waste from construction is generated. (O) Appropriate control of waste is necessary.
	29	Noise and Vibration	B-	C/D	B-	/B+	(C) Generation of noise and vibration is expected due to the increase in the number of cars for construction. (O) Constructed pavement can keep the vehicles smooth driving on the road.
	30	Ground subsidence	D	D	D	D	No impact is expected.
	31	Odor	B-	D	B-	D	(C) Odor generated by gas and waste is expected at site. Appropriate management is necessary.
	32	Bottom Sediment	D	D	D	D	No impact is expected.

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

Source: JICA Survey Team

1-3-1-9 Mitigation Measure*

Mitigation Measure proposed in the EIA and ESIA are shown in Table 1-3-8.

Table 1-3-8 Mitigation Measures (Bridge Construction)

Environmental Issues	Anticipated impact	Management and Mitigation measure	Actors	Estimated Cost (SSP)
Vegetation loss due to clearance of site	Impact on ecology and vegetation	The extent of clearing within the project area should be clearly marked	Contractor	—
		The clearance of the site for construction purposes should be kept to a minimum		
		Instruct all construction workers to restrict clearing to the marked areas and not to work outside defined work areas.		

Environmental Issues	Anticipated impact	Management and Mitigation measure	Actors	Estimated Cost (SSP)
		Rehabilitate all disturbed areas by planting vegetation cover and reforestation		
Trench excavation	Disturbance, soil erosion and siltation in rivers	Earthworks should be carried out during the dry season to prevent the highly erosive soils from being washed away by rain.	Contractor	No additional cost from that of construction
		Control of earthworks so that land not required for construction works		
		Excavated materials should be kept / stockpiled at appropriate sites for possible reuse		
		Protect areas susceptible to erosion by installing necessary temporally and permanent drainage works. Also minimize the need for cut and fill		
	Open trenches hazardous to individuals	Backfilling trenches as soon as works are completed	Contractor	48 for warning signs
		Warning signs at both deep and shallow trenches		
		Provide protection rails when constructing sections of the bridge		
	Dumping of collapsed culverts and surplus excavated material	Dump at designated sites		
Construction activities	Soil, water and groundwater contamination	Construct oil- water interceptors to capture discharge of oils, fuels and other polluting liquids	Contractor	No additional cost
		Ensure proper handling of lubricants, fuels and solvents while maintaining the equipment		
		Surface runoff to be controlled by provision of detention works		
		A safety and emergency response plan to be developed for all operations with emphasis on the protection of the environment		
Contractor's campsite & Construction Site	Solid waste generation which pollutes the environment may cause water borne diseases	Bins should be strategically placed within the campsite and construction site. They should also be covered to prevent access by vermin and minimize odor. The bins at both the campsite and construction site should be emptied regularly to prevent overfilling Use of cleaner technologies / generation to minimize on generation of solid wastes	Contractor	50 waste bins 8 times / month for waste collection and disposal
		A waste management plan to be developed to handle temporary storage, transport and disposal of hazardous waste		
		Solid waste should be recycled, reused and utilized in an environmentally acceptable manner		
Pollution	Gaseous emissions which pollutes air causing respiratory problems (SO2, CO, NO)	Maintaining machines at manufacturers specifications	Contractor	Routine Construction Machine maintenance Routine Construction Machine maintenance
		Site roads should be dampened within reasonable time to prevent dust nuisance.		
		Cover or wet construction materials such as sand to prevent dust nuisance. Also minimize cleared areas to those that are needed for construction		

Environmental Issues	Anticipated impact	Management and Mitigation measure	Actors	Estimated Cost (SSP)
		Limit removal of vegetation and a rehabilitation program of the site and associated infrastructure following construction		
	Noise pollution and vibrations which are nuisance and may cause health complications	Use equipment that have low noise emissions as stated by the manufacturers		
		Use equipment that is properly fitted with noise reduction devices such as mufflers		
		Operate noise generating equipment during regular working hours so as to reduce the potential of producing noise during night hours		
		Heavy equipment should be transported early morning with proper pilotage		
		Construction workers operating equipment that generates noise greater than 80 dB should be equipped with noise protection devices		
		Access roads for haulage trucks used during road construction should not be located near schools, hospitals and residential areas.		
		Provide warning to shop owners and other commercial businesses close to the road at least two weeks before use of such equipment near their premises.		
Occupational health and safety	Impacts on health of workers	Training of all workers in Safety Health and Environment (SHE)	Contractor	12 per head per year for training
		Provision of adequate sanitary facilities e.g. washrooms and clean water		
	Health Control	Rehabilitate excavated sites as soon as construction is complete		The rest included in contractors fee
		Ensure workers health and safety through awareness campaign and provision of protective personal equipment (PPE)		
		Construction workers should be informed about diseases that are prevalent in the project area, and how they can minimize their transmissions.		
		The company should consider hiring a permanent nurse to attend to emergencies and to mount awareness campaigns amongst the workers.		
		The contractor should regularly consult those providing health services to determine any changes in disease patterns that may be associated with road construction.		
	Handling of combustible materials	Training the workers on the emergency Control and Deposit for combustible material and Installation of fire extinguishers		
	Sanitation	Supply drinkable water		
		Supply sanitary material		
		To be available to use first-aid kit		
	Safety Board	Safety Boards for workers and pedestrians should be installed to keep safety.		
	Safety Control	The safety person should be employed to		No

Environmental Issues	Anticipated impact	Management and Mitigation measure	Actors	Estimated Cost (SSP)
		supervise the safety control and safety guideline.		additional cost
Disincentive	Temporally relocation causing inconveniences	Need to develop traffic management plan to provide for safe and efficient movement of traffic during construction.	Contractor	Routine activities
		Providing alternative access to dwellings and roadside businesses and feeder roads.		
		Warn residents and businesses within trading centers of possible generation of dust beyond normal levels.		
	Land acquisition and resettlement	Landscaping to blend with existing environment	MRB	To be determined of necessary
		Adequately compensate the project affected persons		
Commercial activities	Changes in the local economy Unplanned settlements Employment opportunities	The contractor should wherever possible obtain various types of goods from the local area	Local Authority	No additional cost
		Local entrepreneurs should be given first priority when subcontracting road construction related activities e.g. provision of food and accommodation		
		Preference should be given to the locals when recruiting labor force so as to minimize development of unplanned settlements		

Source: JICA Survey Team

1-3-1-10 Environmental Monitoring Plan*

Environmental Monitoring Plan that proposed in EIA/ESIA is shown in Figure 1-3-5.

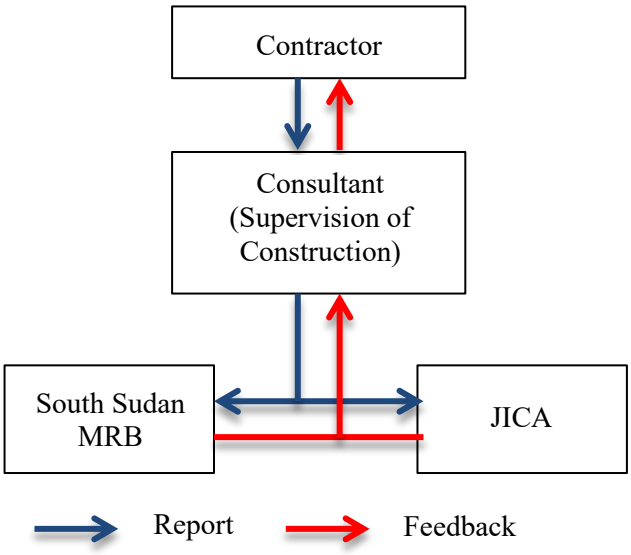


Figure 1-3-5 Environmental Control and Monitoring Implementation Organization

Table 1-3-9 Environmental and Monitoring Plan

Environmental Items		Impact	Measures	Implementing Body	Monitoring Contents and Frequency
1	Resettlement	Relocation Target：0 Households	－	MRB	－
2	Land Use and Planning and Construction	Use of Temporary Yard	Plan the Implemention method and Construction Superision to minimize the modification of the use of land	Consultant Contractor	Confirmation of the land use situation as a temporary construction yard / monthly
3	Existing Social Infrastructure and Service	Influence to the Existing Road	・Prior meeting with the police and person in charge ・Installation of speed limits, signs and protection facilities	Contractor	Confirmation of complaint / Acceptance of the complaint content due to traffic congestion in the detour, facilities, etc.
4	Cultural Heritage	－	Appropriate of removal, storage and re-installation planning and implementation	MRB	－
5	Accident	Accident during the construction	Safety equipment for high-place work, the development of emergency medicines, placement of traffic controllers, emergency measures, safety training, every morning meeting, the implementation of risk prediction activities ・By safety administrator of environmental health and safety recording and reporting	Contractor	・Check on the health and safety plan/monthly ・Accident reporting/each time of accident
6	Infectious disease, such as HIV/AID	HIV holder inflow to the construction camp	・Strict enforcement of drug use check of the situation of work ・By experts and police unprotected sexual activity prevention campaign	Contractor	Crackdown implementation status check and campaign implementation status check / monthly
7	Work Condition	Worker injuries and accidents	・Obligated use of work cloths and helmet ・Implementation of educational activities related to occupational health, accident ocurred at the time of emergency response ・Established the emergency response system at the time of accident occurence	Contractor	・Confirmation of the use of work cloths and helmet/monthly ・Implementation status check of enlightenment activities / monthly ・Accident reporting / each time of the accident
8	Gender	Wage discrimination between men and women	Regular monitoring of wage payment ledger of prime contractor, subcontractor	Consultant Contractor	Contractors wage payment ledger check / monthly

Environmental Items		Impact	Measures	Implementing Body	Monitoring Contents and Frequency
9	Biodiversity	―	―	―	―
10	Hydronic Situation	Change of water flow	Planning and appropriate implementation of drainage	Consultant Contractor	Confirmation of the water flow by visual inspection / daily
11	Air Pollution	Diffusion by construction machinery	・Thorough maintenance of construction machinery and suppression of unnecessary running. ・Watering an use of over sheets ・Air quality monitoring in quarter of the year each	Consultant Contractor	・Monitoring of air situation by visual / daily ・Watering at dust to the occurrence location/necessary depending on the situation. ・Air qualty monitoring(SO2,CO, SPM) (each bridge 1 point)/quater of the year each
12	Water	Water pollution according to the drainage	・Use of turbidity water treatment device ・Monthly water quality monitoring	Consultant Contractor	・Water quality monitoring (pH, SS, DO) (each bridge 1 point) / monthly
13	Soil Pollution	Leakage of light oil and gasoline from the construction machinery	Thorough daily check	Consultant Contractor	Monitoring of leakage situation / daily
14	Waste	Construction waste and workers' garbage	・Appropriate treatment of specified disposal sites ・Reuse of Planting	Contractor	Check of waste hauling record / daily
15	Noise and Vibration	The noise and vibration from the construction machinery	・Sound proof cover due to the noise and vibration ・Adoption of low noise equipment and low noise method	Consultant Contractor	Noise and vibration monitoring (equivalent noise level) (each bridge 1 point) / quarter of the year
16	Odor	Odor exhaust gas and waste	・Thorough implementation of construction machinery maintenance suppression of unnecessary running ・Proper treatment of life waste ・Monthly waste management monitoring	Contractor	Check of the waste enironmental management record / monthly

Source: JICA Survey Team

1-3-1-11 Stakeholders Meeting

At the end of the implementation Review Study, consultations were held with establishments that had major removal obstructions and a store whose livelihood impact was unclear among seven establishments in the vicinity of the construction area.

Table 1-3-10 Stakeholders Meeting Records

Phase of project	Date	Main Agenda
Inception	28th March, 2013	• Introduction of Project • Need for environmental and social consideration • Program environmental and social studies
	5th April, 2013	• TOR for the environmental social studies
Completion of study	27th June, 2013	• Result of environmental and social studies.
Implementation Review Study	15th February, 2022	• Explanation on the Impact on the livelihood and Compensation policy (Methodology) Convocation Method: Individual in-person meeting Language : English Interviewee : Bedwin Hotel, Pyramid Hotel, Shop owner at Br No.4

1-3-2 Land Acquisition and Resettlement

Due to the construction in the Right-of-Way, the Land Acquisition and Resettlement is not necessary. It is also confirmed that all obstructions will be removed, destroyed or relocated to another location by their respective owners. Compensation is not required under South Sudanese law since they do not affect the livelihood of the owners and they can be removed, destroyed or relocated at the will of the respective owners.

Table 1-3-11 Obstructions to be removed

Br No	No	Obstruction	Owner
No. 1	1	Removal of Barbed wire	Private Property
	2	Removal of scrap Cars	Private Property
	3	Relocation of Electric Poles	Private Company (JETCO)
	4	Removal of Billboard (1.3 m x 2.4 m)	Private Company
	5	Removal Barbed wire fence	Private Property
No. 4	1	Relocation of Electric Poles	Private Company (JETCO)
	2	Removal of Container	Private Property
No. 7	1	Removal of Stone Masonry Wall	Bedwin Hotel
	2	Removal of Iron fence	Bedwin Hotel
	3	Removal of sign Board 3 m x 2 m	Private Company
	4	Removal of cyclone wire fence	Private Property
	5	Removal of Garbage Room	Pyramid Hotel
	6	Removal of Parking area (5m x 100m)	Pyramid Hotel
	7	Relocation of Electric post and wire	Private Company (JETCO)
	8	Removal of Street Light	Bedwin Hotel
No. 10	1	Removal of brick and masonry wall	Freedom Hospital
	2	Removal of Concrete Box (1.9 m x 4.8)	Private Company

The results of the survey of the Impact on livelihood are shown in Table 1-3-12. If necessary, Value Assessment, Compensation and Resettlement Committee (VACRC) will be established to confirm the compensation policy. The details are shown in Table 1-3-11.

Table 1-3-12 Survey Results of the Impact on livelihood

Name of shop	Owner	Monthly Income	Affected monthly income	Compensation Policy
Bridge No.4 (Albino)				
Abdelgadir Eltay Mohamed (DN)	Abdelgadir Eltay Mohamed	SSP 180,000	SSP 90,000 (SSP 180,000×50%2)	27 month income 90,000×27=2,430,000
Bridge No.10 (Kokora)				
Freedom Hospital	Gabriel (Manager)	SSP 1,600,000	Non (Patients come as needed)	N/A
Anas Musa (DN)	Anas Musa	SSP 180,000	SSP 90,000 (SSP 180,000×50%)	27 month income 90,000×27=2,430,000
Bridge No.1 (Shuhada)				
Ungwech Ajongo Mawut (RT)	Ungwech Ajongo Mawut	None (Closed for long)	None	N/A
Bridge No.7 (Salakana)				
Bedouin Creek Hotel (Cafeteria)	Samuel Measho	SSP 900,000	N/A (Front entrance can be secured)	N/A
Meje Cafeteria	Ali Moses	SSP 1,000,000	SSP 300,000 (SSP 1,000,000×30%3)	27 month income 300,000×27=8,100,000
Pyramid Hotel	Imran Aslam (Manager)	N/A	N/A (Stable Regular Customer)	N/A

Note) DN: Daily Necessities, RT : Restaurant

1-3-3 Environmental Monitoring Form*

(1) Permit and Explanation

Monitoring Items	Actions to be taken
• ESIA and proposed monitoring plan need to be submitted: Approval from MOE • Monitoring shall be carried out according to approved plan	• Monitoring result: The result needs to be reported to MOE.

(2) Pollution Control

Air Quality

Items	Sampled Value (Average)	Sampled Value (Maximum)	Standard Value	Referred Standard	Sampling Point, Time, Method
Sulphur Dioxides: SO_2			20-125 (daily)	WHO WHO Japan	・ Nos. of Sampling:1 point per bridge ・ Sampling Items: SO_2, NO_2, CO, SPM, ・ Sampling Times: 2 times per year ・ Others: Traffic Volume, Metrological Data
Nitrogen dioxides: NO_2			40 (yearly)		
Carbon monoxide: CO			200 (8 hours)		
Ozone: O_3			-		
Suspended Particulate Matter: SPM			100 (daily) 200 (hourly)	Japan	
Dust			600	Japan	Physical Observation

[2] During construction, one side of the road will be closed.
[3] Since 30% of entrances and exits will be closed during construction

Water Quality

Items	Sampled Value (Average)	Sampled Value (Maximum)	Standard Value	Referred Standard	Sampling Point, Time, Method
pH			6.5-8.5	Japan	During & After Construction · Sampling Point:4 · Sampling Times:2 times per year · Sampling Items: PH, EC, SS,
Electric Conductivity: EC			< 2000mS/m	Environmental Protection Agency, USA	
Turbidity			<5 NTU	Japan	
Dissolved Oxygen: DO			>2	Japan	
Coliform				Not detected	
Oil			<0.50mg/L	Japan	
SS			50mg/m3	Japan	

Waste Material

Monitoring Items	Actions to be taken
• Physical observation of waste materials during the construction: Construction waste material, Deleterious material, Garbage • Physical observation of waste materials after the construction	• Monitoring of treatment of waste material and report: 1time per month.

Noise and Vibration

Items	Sampled Value (Average)	Sampled Value (Maximum)	Standard Value	Referred Standard	Monitoring Point, Time, Method
Noise			Day: 70dB Night:65 dB	Japan	· During and After Construction · Monitoring Points:2 · Monitoring Items: Noise and Vibration : 3times per monitoring day · Monitoring Times: 4 times per year
Vibration			Day: 70dB Night: 65dB	Japan	

(3) Natural Environment

Ecosystem

Monitoring Items	Monitoring Point, Time, Method
1) Hydrometeor • Physical observation to storm water during rain • Condition of storm water discharge	• Monitoring of discharge condition at drainage system: 1time per month

(4) Social Environment

Living and Livelihood

Monitoring Items	Monitoring Point, Time, Method
1) During Construction: Pollution status by Air quality, Noise, Waste material to residents 2) During Construction: Monitoring of Road Users and Residents	• During the construction: 1 time per month

Existing Social Infrastructure

Monitoring Items	Monitoring Point, Time, Method
1) During Construction: Pollution status by Air quality, Noise, Waste material to residents 2) During Construction: Monitoring of Road Users and Residents	• During the construction: 1 time per month

Road Safety

Monitoring Items	Monitoring Point, Time, Method
1) Grasping situation of intersection crossing by school children	• During the construction: 1 time per month

Working Environment

Monitoring Items	Monitoring Point, Time, Method
1) Grasping situation of EHS during the construction	• During the construction: 1 time per week

Traffic Accident

Monitoring Items	Monitoring Point, Time, Method
1) Grasping situation of traffic congestion during the construction 2) Grasping situation of traffic accident during the construction	• During the construction: 1 time per week

1-3-4 Environmental Check List*

Category	Environmental Item	Major Items to be checked	Yes: Y No: N	Confirmation of Environmental Consideration
1. Permit and Explanation	(1) EIA and Environmental Permit	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports have been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) N	(a) ESIA reports have been already prepared in official process. (b) ESIA reports was approved in October 2013 by authorities of the host country's government, MOE. (c) ESIA reports been unconditionally approved. (d) Nothing.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained	(a) Y (b) N	(a) Stake Holder Meetings were held on 28th March, 2013, 5th April, 2013 and 27th June, 2013. (b) The stakeholders have no comment on proceeding the project.

Category	Environmental Item	Major Items to be checked	Yes: Y No: N	Confirmation of Environmental Consideration
		from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?		
	(3) Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) One alternative plan without the project was examined. Without the project, sufficient width of the bridge will not be obtained and the bridge will always be a bottleneck. Hence, heavy traffic jam is expected at each bridge. In addition, it is expected that there will be increase in traffic accidents/road crashes, and air pollution and serious soil erosion in rainy season.
2. Pollution Control	(1)Air Quality	(a) Is there observation that air pollution emitted from traveling vehicles affects ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken? (b) Will project make air quality worsen in case the existing air quality exceeds the air quality standard? Are any mitigating measures taken?	(a) Y (b) N	(a) The urban network will be improved and traffic congestion will be relieved with less emission. (b) Current air quality which is the monitoring data at Juba downtown near Juba port is less than the reference values in Japanese air quality standards.
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater? (c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a)Y (b) N (c) Y	(a) River banks near the bridges are to be protected from erosion. (b)There is no well near the project area. (c) Liquid waste from workers, camp is dumped at the official dumping site.

Category	Environmental Item	Major Items to be checked	Yes: Y No: N	Confirmation of Environmental Consideration
	(3) Waste	(a) Are wastes generated from the project facilities, such as parking areas/service areas, properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Solid waste generated from the workers camp is properly dumped at the official dumping site
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) Y	(a) It could become greater than standard during construction in the area facing the road. Monitoring will be implemented and noise prevention sheet is installed if necessary.
3. Natural Environment	(1)Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) Nature of project site is city area
	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?	(a) N	(a) Nature of project site is city area. Ecosystem is far from this area.
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) N	(a) The project does not requires land modification due to reconstruction of bridges and roads.
4. Social Environment	(1)Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement?	(a) N	(a) No involuntary resettlement is expected
	(2) Living and livelihood	(a) Where roads are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts?	(a) N (b) Y (c) Y (d) Y (e) N (f) N	(a) Contents of the project is the bridge reconstruction and improvement of existing roads of both sides of bridge will be given within existing ROW which does not make significant environment change. (b) Special consideration and arrangement such as diversion is required for the pedestrian during the project as the number of pedestrian is large. (c) Provision of safety measures and prevention campaigns are planned. (d) In order to mitigate the

Category	Environmental Item	Major Items to be checked	Yes: Y No: N	Confirmation of Environmental Consideration
		(b) Is there any possibility that the project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)? (e) Is there any possibility that roads will impede the movement of inhabitants? (f) Is there any possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?		traffic congestion, simultaneous construction of four bridges is planned to be avoided. (e) Due to the widening the road to 4 lanes and installation of sidewalks the movement of inhabitants will be more free. (f) There will be hardly radio interference during the project due to small size of bridge construction area which will be very limited and momentary.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archaeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) No cultural heritage exists within the project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) There will be negative impact on landscape which will however be limited and momentary during the project.
	(5) Ethnic Minorities and Indigenous People	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples?	(a) N	(a) There are no ethnic minorities and indigenous peoples within the project site.
5. Working Environment	(6) Working Environment	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the	(a) Y (b) Y (c) Y (d) Y	(a) Compliance with the law is first prioritized policy in Environmental Monitoring Plan. (b) Health and safety for employees and residents are planned properly and secured. Safety Board for workers and pedestrians should be installed to keep

Category	Environmental Item	Major Items to be checked	Yes: Y No: N	Confirmation of Environmental Consideration
		project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?		safety. Provision of adequate sanitary facilities e.g. washroom and clean water should be installed (c) Safety education, including how to use safety accessories and how to behave in emergency case, are to be implemented.. (d) The safety control person should employed to supervise the safety control and safety guideline.
6. Others	(1) Impacts during construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) N (c) N	The following appropriate countermeasures are expected to reduce impacts during construction: - Air pollution: to apply sprinkle water for dust prevention. - Water pollution: to treat a turbid water. - Waste: to dispose construction wastes at the specified disposal site. - Noise: to prevent noise using sound-proof construction equipment. Monthly meeting will be held to monitor the complaints about construction. Based on the meeting, mitigation measures are taken when necessary. (a) Impact to ecosystem is negligible due to the bridge reconstruction and reconstruction of approach roads. (b) Impact can be considered to be mitigated and public meeting is continued.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework	(a) Y (b) Y (c) N (d) Y	(a) The contractor implements monitoring under the supervision of the proponent. (b) Scheduled before, during and after construction for air pollution, noise and vibration, water pollution and social conditions of affected people as indicated in the Environmental Monitoring Plan.

Category	Environmental Item	Major Items to be checked	Yes: Y No: N	Confirmation of Environmental Consideration
		(organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?		(c) Only one specialist is available but without any equipment. However proponent is going to request enough budget to fulfil the requirement of JICA Environmental and Social Considerations Guidelines as much as possible. (d) The contractor shall report the results of monitoring to Ministry of Environment and the Ministry will manage them. Every month the monitoring report is submitted to JICA.

Source: JICA Survey Team

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project*

2-1-1 Concept of the Project

The former project requested as Japanese Grant Aid Assistance is composed of two components, 1) Construction of Lologo Bypass and 2) Bridge construction in the capital city of Juba in South Sudan. Lologo Bypass is adjacent to the Nile River Bridge as shown in Figure 2-1-1. And some bridges inside the city are located on the main road. Development of road network by the Project would contribute to the alleviation of traffic congestion in the city and the promotion of internal and international logistics.

This survey aims to implement the construction of four bridges in Juba City to mitigate the traffic congestion as the first step in the project concept.

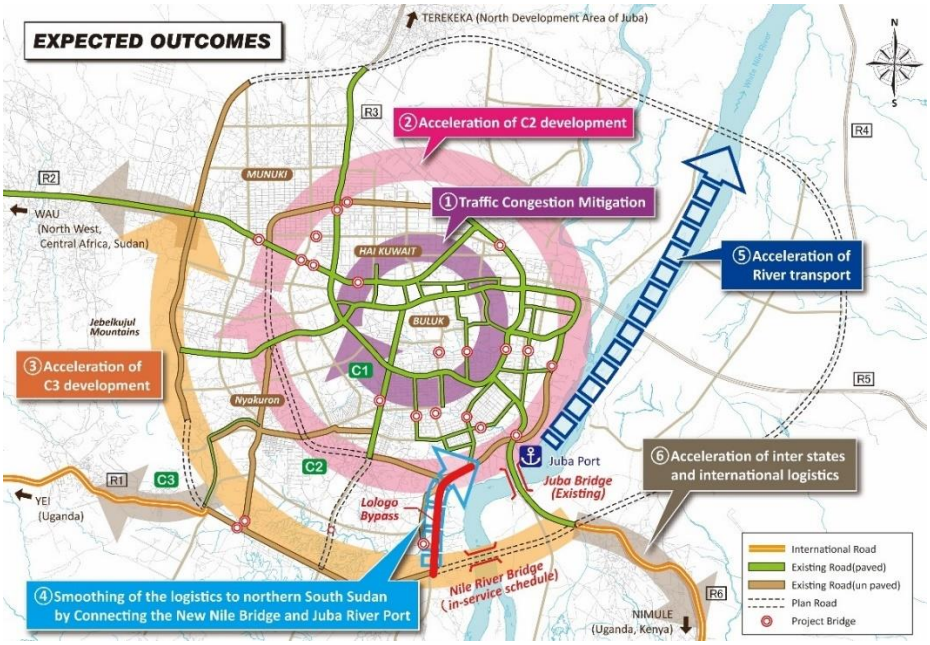


Figure 2-1-1 Effect of the Project

Table 2-1-1 Outline of the Requested Project (2013)

Lologo Bypass
1. This Project is a road construction project that connects the Nile River Bridge to the Juba river port. 2. Lologo bypass road is the shortest way road that connects in the center of Juba City to Nile River Bridge although it would cause traffic from Nimule road after opening Nile River Bridge flows into C3 ring road through Nile River Bridge. 3. Lologo bypass road functions as the link of C2 and C3, until road construction of east part of C3 is completed. 4. Lologo bypass becomes part of C2 ring road that connects between Nile River Bridge and Juba river port, and contributes promotion of logistics to north part of South Sudan.

Bridges in Juba city
1. 13 Bridges that have been requested for construction are located in major river crossing points in the city, where bridge maintenance level is low.

2-1-2 Impact of the Bridge Construction Project

2-1-2-1 Traffic Problem of Juba City

The number of vehicle registration in Juba city is rapidly growing at an increasing rate of 50% per year with an increase in the population. Likewise, the construction and improvement of major roads in the city is progressing accordingly at a rapid pace. In 2008, the length of paved road was only 11 km; in 2012, it was increased to 53 km. Total length of main roads (circumferential road, radial road and collector road) in the city is about 126 km long in 2021, 50% of which have been paved. On the other hand, the priority of road maintenance has been placed to the roads inside of the inner ring road "C1" where many public offices and markets are located, and radial road accessing from the suburbs. Road maintenance of ring road C2 and C3 remains in low priority. As of March 2016, paved rate was 91% of radial roads and 36% of ring roads, due to this situation, the traffic is concentrated in the city center, and traffic congestion occurs at all times in the morning and evening. In addition, traffic congestion has remained a problem due to bottlenecks in the existing old and has not worked as a substitute for a road network.

In addition, the construction of Nile River Bridge has commenced under Japan's grant aid, and ring road C3 will be a strategic logistic route after the completion. It is essential to enhance connection of the ring road and the bridge between logistic bases (ex. the river port) of the city.

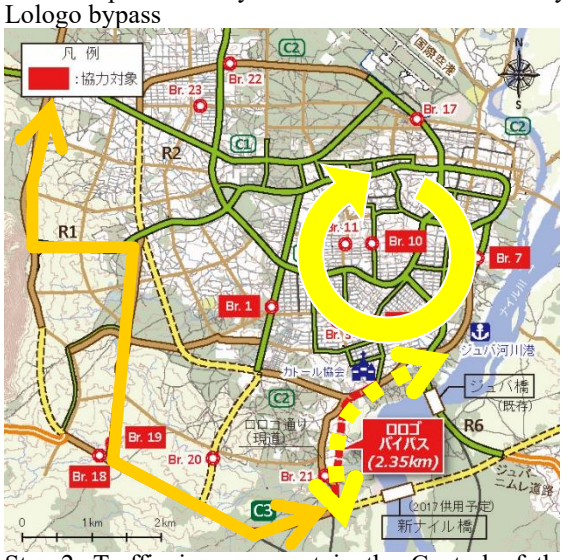
This project thus would mitigate the effects of the above mentioned problem.

1) Improvement of existing bottleneck bridge. This will smoothen the flow of the city traffic.

2) Development of Lologo bypass connecting Nimule road and Juba city center, and would form a ring road through an existing road. It would ensure bypass of the city traffic and logistic access.

3) Construction of bridges along the ring road C3 would promote the ring road C3 as an international logistic road. It is possible to plan further stabilization of logistics and dispersion of city traffic (Bridge No.18, 19). (Figure 2-1-2)

Step-1: Formation of Ring Road and connection to the river port and city central and Nimule road by Lologo bypass



Step-2: Traffic improvement in the Central of the City by development of the bridges in the City

Step-3: Development of international logistics road by erection of bridges located on Ring Road C3

Figure 2-1-2 Step of the Project Effect

In the request of the GOSS, the improvement of the existing bottleneck bridge of the city traffic is recommended.

2-1-2-2 Outline of the Project to be Studied

The outline of the project is summarized in Table 2-1-2.

Table 2-1-2 Outline of the Project (Bridges in the City)

Item	Bridges in the City	Relevance
Project Scope	4 bridges in the 10 bridge requested for construction	Selected as the bridges that should be prioritized based on construction period, condition of damage, the bottleneck of traffic, water passing ability, etc.
Scale	4 bridges and each approach road	Approach road should include in the scope because of the inadequacy to construct bridges only, because the road construction at both sides of the bridge have completed or been planned.
Contents	Road width 2.5-3.0m, 4 lanes, Sidewalk each side Bridge length: L = 10.0 m-15.0 m Approach road length: L = 88.0 m-198.5m	Consistent with the plan of existing developed section. It should be consistent with the existing plan for the road because bridge is part of the road.
Specifications	Road Pavement Concrete bridge Concrete bridge railing type Foundation type: Spread foundation or pile	Consideration of the design for continuity with the road pavement, and the maintenance requirements. Consideration of the economic and easy maintenance. Select the appropriate foundation type from the geological survey results.

The original request proposed 10 bridges, but the number of bridges reached 13 for the final survey.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

Basic policy related to the design is indicated below.

2-2-1-1 Request from Recipient Country*

Requested Date for the Japan's Grant Aid: March 2011

Requested Contents: Construction of thirteen (13) bridges in the City

2-2-1-2 Scope of the Project*

The grant aid request related to this Project was submitted by the government of South Sudan in 2011. The government of Japan has decided to implement the Feasibility Study.

The Study has been implemented with the following contents:

- Detailed study for the necessity and validity of the requested project
- Organization of the target section and the target bridge to be carried out as a grant aid
- Study for approach road, bridge type and road width

- Confirmation of environmental impact and natural conditions
- Design Outline
- Preparation the project planning
- Estimation of the project cost

As a result of the discussions with the South Sudan side, the scope of grant aid is confirmed as follows:

Four (4) bridges in the City (including approach road)

2-2-1-3 Policy on Natural Condition*

To reflect the natural conditions properly in the design is very important for the safety and proper scale of the structures. Basic policy of the Study is shown as follows:

- For decision of bridge length, the runoff in accordance with the standards of South Sudan is calculated from the available rainfall data, and it is reflected in the design.
- Existing ground is the determinant of the pavement structure and bridge foundation type. At least one boring survey at the abutment location should be conducted, and the result has to be reflected in the design.
- For the section considered as soft soil, a trial digging should be applied to confirm the soil condition. Application of point test like boring survey can only clarify just limited information about the ground water level and soil condition.
- For topography, a topographical survey in the scope area is conducted, and the result must be reflected in the design and execution plan.

2-2-1-4 Policy on Environmental and Social Considerations*

The basic policy is to minimize impacts to housing considering that the roads and houses are located in the area that are already developed and established.

The new investigation for the Environmental and Social Consideration was not conducted, because the previous investigation is available.

The procedures relating to environmental and social considerations should follow the JICA guidelines and comply with the "Environmental Protection Bill (draft), 2011" which defined the procedures in environmental and social considerations in South Sudan. It was already confirmed in consultation with MRB and MOE the preparation of ESIA (Environmental and Social Impact Assessment) for bridges in the Juba City even where resettlement will not occur.

2-2-1-5 Policy on Compliance with Design Standard*

MRB has formulated the manual for road structure design, drainage design, bridge design, road pavement design and site inspection in 2006 with the technical cooperation of USAID. Road design of the Project should follow the manual, and refer to the specification of AASHTO or Japan Road Association. The design criteria used in the Project is shown as follows:

- Geometric Design Manual, MRB, 2006
- Bridge Design Manual, MRB, 2006
- Drainage Design Manual, MRB, 2006
- AASHTO Policy on Geometric Design Highway and Streets, 2006
- AASHTO LRFD Bridge Design Specifications, 2007
- AASHTO for Concrete Pavement, 1993

- Road Design Ordinances, 2004
- Specification for Highway Bridges, Japan Road Association, 2002
- Specifications for River Facilities, Japan River Association, 1998
- AASHTO Standard Specifications for Highway Bridges, 2002

2-2-1-6 Policy on the Use of Local Supplier*

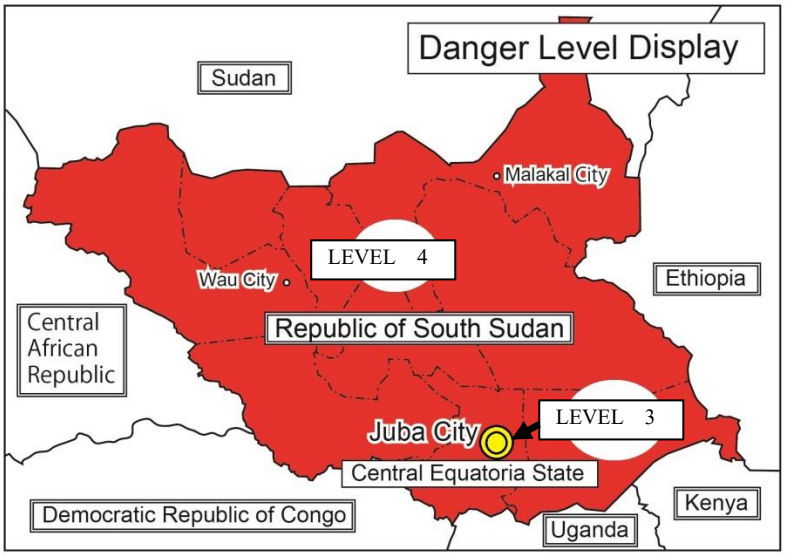
Crushed stone (aggregate) and embankment material as construction materials are available in the Juba City of South Sudan, however, the main materials for construction such as cement, rebars and major construction machines cannot satisfy both the quantity and the quality for the project. Thus, it is the basic policy that these items should be arranged from the third countries or Japan. And, it is more valid to organize the skilled workers from the third countries.

2-2-1-7 Policy on the Operation and Maintenance Capacity of the Implementing Agency*

Maintenance management of the facilities after completion of the Project would be controlled by MRB and MRB-CES who are the implementing agency of the Project. Technical assistance project for road maintenance "The Project for Capacity Development on Sustainable Road Maintenance and Management in Juba, South Sudan" was implemented for MRB and MRB-CES. Therefore, routine road maintenance and small repair can be conducted locally. However, since road maintenance budget is fluctuating due to unstable financial condition, the adoption of the design with easy maintenance is preferable.

2-2-1-8 Policy on Security

After confirming the latest security situation at the site, physical protection of the site, surveillance and security, transportation system of project-related personnel, communication equipment, and other items considered necessary will be organized with reference to JICA's safety measures guidance (April 2019). In addition, after confirming the prevalence of the new coronavirus in the area, countermeasures against infectious diseases during the construction stage will be considered. Based on these studies on safety measures and infectious disease countermeasures, the contents of safety measures during the construction stage and their costs will be reflected as necessary.



Source: HP of Ministry of Foreign Affairs, Japan

Figure 2-2-1 South Sudan Safety Information

2-2-2 Basic Plan (Construction Plan/Equipment Plan)*

2-2-2-1 Overall Plan

The Summary of the Project is shown in Table 2-2-1.

Table 2-2-1 Summary of the Project (Bridges in the City)

Bridge No.	Category	Item	Content	Length
1	Bridge	RC bridge, Concrete pavement, Pile foundation	Bridge width: 16.9 m	15.0 m
	Approach road	4-lane, Concrete pavement, Sidewalk on both sides	Lane width: 3.0 m Sidewalk width: 1.7 m	88.0 m
			Total	103.0 m
4	Bridge	RC bridge, Concrete pavement, Spread foundation	Bridge width: 17.3 m	11.5 m
	Approach road	4-lane, Concrete pavement, Sidewalk on both sides	Lane width: 3.0 m Sidewalk width: 1.9 m	198.5 m
			Total	210.0 m
7	Bridge	RC bridge, Concrete pavement, Pile foundation	Bridge width: 17.3 m	10.0 m
	Approach road	4- lane, Concrete pavement, Sidewalk on both sides	Lane width: 3.0 m Sidewalk width: 1.9 m	173.0 m
			Total	183.0 m
10	Bridge	RC bridge, Concrete pavement, Spread foundation	Bridge width: 14.8 m	13.0 m
	Approach road	4-lane, Concrete pavement, Sidewalk on both sides	Lane width: 3.0 m/2.5 m Sidewalk width: 1.5 m	122.0 m
			Total	135.0 m
			Total Bridge Length	49.5 m
			Total Approach Road Length	581.5 m
			Total Length	631.0 m

Source: JICA Survey Team

2-2-2-2 Confirmation of the Surveyed Bridges and the Selection of the Reconstruction Bridges

(1) Confirmation of the Surveyed Bridges for Reconstruction

The thirteen (13) target bridges requested by the GOSS are shown in Table 2-2-3. The result of the investigation is shown in Figure 2-2-2.

(2) Overall Condition of the Selected Bridges for Reconstruction

The overall condition of the selected bridges is shown in Table 2-2-2.

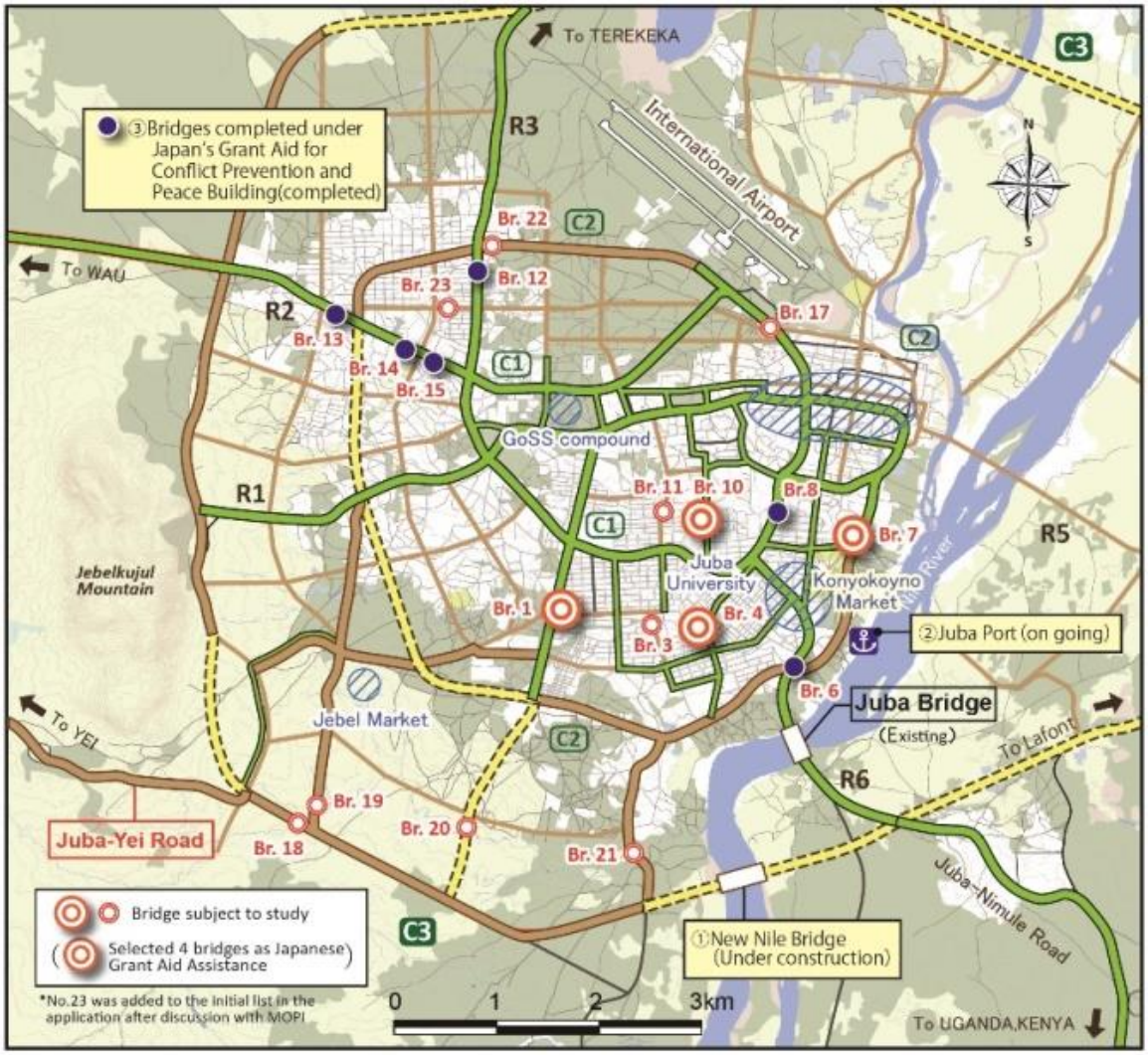


Figure 2-2-2 Result of Selection of the Surveyed Bridge

Table 2-2-2 List of Selected Bridges

Bridge No.	Name	Road Category	Location	Existing Structure		Construction Year	Width (m)		Present Problem
				Form	Length (m)		Access Road	Bridge	
Br.1	Shuhada	Main Access	Central Part	Bridge (2span)	2@6.0	Construction: 1991 Repair:2011	12.5 (AS)	9.15 (AS)	Both approach roads of the bridge are paved four lanes, and the bridge is two lanes and becomes the bottleneck of the traffic flow.
Br.4	Albino	Main Access	Central Part	Bridge (1span)	5.3	Construction: 1969	12.7 (AS)	5.0	Both approach roads of the bridge are paved four lanes, and the bridge is two lanes and becomes the bottleneck of the traffic flow.
Br.7	Salakana	Main Access	Central Part	Bridge (1span)	8.1	Construction: 1992	12.2 (AS)	7.9	Both approach roads of the bridge are paved four lanes, and the bridge is two lanes and becomes the bottleneck of the traffic flow. Ordinary vehicles and large automobile traffic is complicated, and safety is a problem.
Br.10	Kokora	Main Access	Central Part	Box Culvert	9.0	Construction: 1983	11.2 (AS)	8.55	Both approach roads of the bridge are paved four lanes, and the bridge is two lanes and becomes the bottleneck of the traffic flow. An accident that a car fell to the river occurred.

Source: JICA Survey Team

(3) The Selection of The Surveyed Bridges

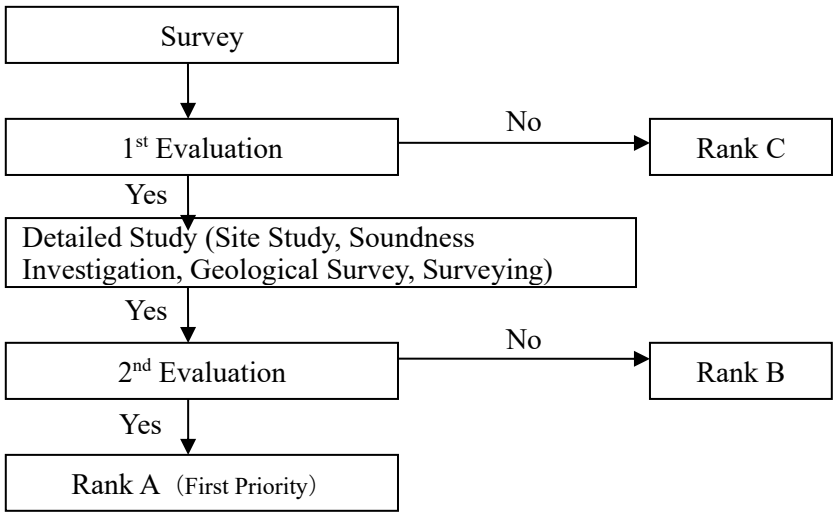
The target bridge was selected following the procedure shown in Figure 2-2-3 and is divided into three types as below.

A) Urgency is high, and the bridge which is suitable for Grant Aid Project.
B) The bridges with high priority of reconstruction. But the maintenance of the surrounding infrastructures such as approach roads and drainage is necessary in advance.
C) The bridges which are not necessary to reconstruct under the present condition.

The target bridge has been confirmed as first priority A. The selection result of the target bridges is shown in Table 2-2-3. The evaluation result is shown in Figure 2-2-3.

The following are the results of the selection:

A) 4 bridges (Candidates for Grant Aid)
B) 4 bridges
C) 5 bridges



Source: JICA Survey Team

Figure 2-2-3 Selection Procedure of the Target Bridge

Table 2-2-3 Result of Selection of the Surveyed Bridges

Bridge No.	Estimation	Detailed Study 2nd Study
Br.1	A	○
Br.3	C	—
Br.4	A	○
Br.7	A	○
Br.10	A	○
Br.11	C	—
Br.17	C	—
Br.18	B	—
Br.19	B	—
Br.20	C	—
Br.21	B	—
Br.22	N/A	—
Br.23	B	—

Table 2-2-4 Present Conditions and Main Problem of the Selected Bridges and Result of Evaluation (2nd Study)

Bridge No. and Photo	The Present Conditions of the Bridge and Main Problem	Evaluation	Reason
Br.1 Shuhada  	**Construction year: 1991** **Maintenance and repair year: 2011 (by the local contractor)** ・The bridge is the Main Access to the south from Mullah Kia of Kator district. ・In the road around the bridge, the pavement of 4 lanes has been completed. ・The depression of slab has been repaired by the Government of South Sudan in 2011. However, structural problems such as exposed bar of slab concrete still remains. ・It is the Main Access which connects central Juba City to the north and south. ・Traffic volume is large with the present Daily traffic volume of 9,368 vehicles/day ・Predicted traffic volume in year 2030 will be about 38,900 PCU/day.	A	・Due to the insufficient repairs in 2011, the reinforcing bar of the lower slab is exposed, and the damage progresses. ・Because the width of the bridge is narrow (2 lanes), there is bottleneck in the morning and evening. ・For the future traffic volume, there is shortage in the number of traffic lanes.
Br.4 Albino  	**Construction year: 1969** **No archival record of repair.** ・The bridge is located in the commercial area of Kator district Mullah Kia. ・The pavement of 4 lanes road before and after the bridge has been completed by the government. ・The unpaved road before and after the bridge has become a bottleneck of traffic due to one lane bridge. ・46 years has passed after construction and gets closer to the 50-year lifespan of the general concrete structure. ・Maintenance is barely accomplished until now, the deterioration of the bridge advances, and the slab has degraded. ・Predicted traffic volume in year 2030 will be about 14,600 PCU/day.	A	The present traffic condition is lack of sufficient traveling performance and carriage width which causes bottlenecks. ・The damage of the slab concrete deterioration and section defects of the steel beam progresses the bridge deterioration.
Br.7 Salakana  	**Construction year: 1992** **No archival record of repair.** ・The bridge is located on the planned route of Ring Road C2. ・The pavement of 4 lanes road before and after the bridge was completed by the government. ・The unpaved road just before and after the bridge and the bridge causes traffic bottlenecks. ・It is a part of the ring road but, due to the bad traffic flow, the traffic flow detours into the city. ・A cemetery and a hotel are located in the neighborhood. There is no influence on the cemetery. ・It is necessary to demolish a part of the wall of the hotel at the time of construction. ・9,368 vehicles/day of present situation as daily traffic volume. ・Predicted traffic volume in year 2030 will be about 21,300 PCU/day.	A	・The present traffic condition is lack of sufficient traveling performance and carriage width which causes bottlenecks. ・The damage of the slab concrete deterioration and section defects of the steel beam progresses. ・The width of road is insufficient for the future traffic volume.

Bridge No. and Photo	The Present Conditions of the Bridge and Main Problem	Evaluation	Reason
Br.10 Kokora  	**Construction year: 1983** **No archival record of repair.** ・The bridge is located in upstream of the No.9 Bridge which was constructed by Grant Aid for conflict prevention and peace building. ・It is located in the Main Access of the commercial area of the inner-city. The pavement of 4 lanes road before and after the bridge was completed by the government. However, bottleneck happens at the 2 lanes bridge. ・The slab concrete deteriorates, and a reinforcing bar is exposed. ・The present daily traffic volume is 8,275 vehicles/day ・Predicted traffic volume in year 2030 will be about 26,300 PCU/day.	A	・For present traffic condition is lack of sufficient traveling performance and carriage width which causes bottlenecks. ・The necessary thickness of the section is not secured due to the damage of the slab concrete.

Source: JICA Survey Team

2-2-2-3 Implementation Options for the Grant Aid Project

Based on the results of the aforementioned survey and site condition survey, four bridges in the city were selected as the target bridges for this project. The priorities of the four bridges were discussed with MRB, and the following Table 2-2-5 was presented by MRB and agreed upon in the Technical Note.

Table 2-2-5 Implementation Priority

Priority	Bridge No.
1	No.1
2	No.4
3	No.10
4	No.7

Table 2-2-6 Current Condition of the Priority Bridges

Picture		
Description	**Br. 1** W=9.15 m（2 lanes） Both sides were rehabilitated by 4 lanes paved road	**Br. 4** W=5.0 m（1 lane） Both sides were rehabilitated by 4 lanes paved road
Picture		
Description	**Br. 7** W= 8.45 m（2 lanes） Both sides were rehabilitated by 4 lanes paved road	**Br. 10** W= 8.5 m（2 lanes） Both sides were rehabilitated by 4 lanes paved road

Source: JICA Survey Team

2-2-2-4 Bridge Plan (Bridges in the City)

(1) Design Criteria for Bridge

Design criteria for bridge are indicated in Table 2-2-7.

(2) Geometry Conditions for Road Design

Geometry conditions for road design to be applied in approach road are indicated in Table 2-2-8.

Table 2-2-7 Bridge Design Criteria

<table>
<tr><th colspan="3">Design Item</th><th>Criteria / Value</th></tr>
<tr><td rowspan="4">General</td><td colspan="2">Design Reference</td><td>• Bridge Design Manual, Ministry of Transport and Roads, GOSS, 2006
• Geometric Design Manual, Ministry of Transport and Roads, GOSS, 2006
• Drainage Design Manual, Ministry of Transport and Roads, GOSS, 2006
• AASHTO LRFD Bridge Design Specifications, 5th Edition, 2012
• Specifications for Highway Bridges, Part I-V, Japan Road Association, 2012</td></tr>
<tr><td colspan="2">Road/Bridge Class</td><td>• Interstate Trunk Road (DS1)/Primary Arterial</td></tr>
<tr><td colspan="2">Bridge Section Length (m)</td><td rowspan="2">List of Bridge Length and Span Length<table><tr><th>Bridge No.</th><th>Bridge Length (m)</th><th>Span Length(m)</th></tr><tr><td>1</td><td>15.0</td><td>14.0</td></tr><tr><td>4</td><td>11.5</td><td>10.5</td></tr><tr><td>7</td><td>10.0</td><td>9.0</td></tr><tr><td>10</td><td>13.0</td><td>12.0</td></tr></table></td></tr>
<tr><td colspan="2">Span Configuration (m)</td></tr>
<tr><td colspan="2">Design Speed (km/hr)</td><td>50</td></tr>
<tr><td rowspan="6">Geometry</td><td colspan="2">Min. Horizontal Curve Radius (m)</td><td>150 (2.5%)</td></tr>
<tr><td colspan="2">Max. Gradient (%)</td><td>6</td></tr>
<tr><td colspan="2">Travel Lane Width (m)</td><td>2.5 – 3.0</td></tr>
<tr><td colspan="2">Sidewalk (m)</td><td>1.5 – 1.9</td></tr>
<tr><td colspan="2">Pavement Crossfall (%)</td><td>2.5</td></tr>
<tr><td colspan="2">Vertical Clearance on Roadway (m)</td><td>5.3 (GOSS BDM 2.4.5 for light structures)</td></tr>
<tr><td colspan="2">Vertical Clearance on Design Flood Level (m)</td><td>0.9 (GOSS BDM, DDM)</td></tr>
<tr><td colspan="2">Elevation of Design Flood Level (m)</td><td>Riverbed Level + 2.0m</td></tr>
<tr><td rowspan="6">Design Load</td><td colspan="2">Live Load</td><td>HS-25 (AASHTO)</td></tr>
<tr><td colspan="2">Pedestrian Load (kPa)</td><td>4.0 (GOSS BDM 3.12)</td></tr>
<tr><td colspan="2">Flood Velocity (m/s)</td><td>1.8</td></tr>
<tr><td colspan="2">Base Wind Velocity, V_B (m/s)</td><td>45 (Open Country)</td></tr>
<tr><td colspan="2">Peak Ground Acceleration Coefficient</td><td>0.2</td></tr>
<tr><td rowspan="2">Temperature</td><td>T_{max} (°C)</td><td>50</td></tr>
<tr><td>T_{min} (°C)</td><td>15</td></tr>
<tr><td rowspan="8">Materials</td><td rowspan="7">Concrete Strength</td><td>Footing/Pile Cap (MPa)</td><td>24</td></tr>
<tr><td>Bored Piles (MPa)</td><td>30</td></tr>
<tr><td>Pier/Abutment/Retaining Wall (MPa)</td><td>24</td></tr>
<tr><td>Concrete Pavement (MPa)</td><td>24</td></tr>
<tr><td>Slab/Railing (MPa)</td><td>24</td></tr>
<tr><td>Retaining Wall/
U-shape, Box Culvert (MPa)</td><td>21</td></tr>
<tr><td>Lean Concrete (MPa)</td><td>18</td></tr>
<tr><td>Reinforcing Bars</td><td>Yield Strength, f_y (MPa)</td><td>345</td></tr>
<tr><td colspan="3">Others</td><td>BDM, AASHTO, JARA</td></tr>
</table>

Source: JICA Survey Team

Table 2-2-8 Geometry Conditions of Approach Road Design

Geometric Design Standards

Project: Bridges in Juba City

	Item	Unit	MRB DSM	AASHTO	Japan	Applied (Br.1)	Applied (Br.4)	Applied (Br.7)	Applied (Br.10)	Remark
1.General	Road Classification					Collector	Collector	Collector	Collector	
	Road Functional Classifiction					DS-4	DS-4	DS-4	DS-4	
	Bridge Section Length	m								
	Span Configuration	m								
	Design Speed	kmh	50			50	50	50	50	
	Stopping Sight Distance	m	55			55	55	55	55	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Passing Sight Distance	〃	175			175	175	175	175	Page 2-6, Table 2-6 Geometric Design Manual-2006
	R.O.W	m	50			20	20	20	20	25m+25m
	Terrain Condition		Urban			Urban	Urban	Urban	Urban	
	Number of Carriage Way Lanes	nos	2			2	2	2	2	Page 2-4, Table 2-2, Geometric Design Manual-2006
	Number of Mixture Traffic Lane	nos	2			2	2	2	2	Depending on the development of the town, Page 2-4, Table 2-2, Geometric Design Manual-2006
2. Geometory	**1. Cross Section Elements**									
	Carriage Lane Width	m	6.7	6.6	6.5	6.0	6.0	6.0	6.0	for 2 lanes, Abuslute is referring to Road Structure Ordinance, Japan
	Mixture Traffic Lane Width	m	3.5	-	-	3.0	3.0	3.0	2.5	Page 2-4, Table 2-2, Geometric Design Manual-2006 including shoulder
	Walk Way Width	m	2.5	1.0	1.5	1.7	1.9	1.9	1.5	Page 2-4, Table 2-2, Geometric Design Manual-2006, Absolute value is referring to the Road Structure Ordinance,
	Outer Shoulder width	〃	N/A	0.5	0.5	N/A	N/A	N/A	N/A	Page 2-3, Table 2-1, Geometric Design Manual-2006
	Normal Crossfall	%	2.5	2.5	2.0	2.5	2.5	2.5	2.5	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Maximum Super elevation	%	4.0	4.0	6.0	4.0	4.0	4.0	4.0	Page 2-6, Table 2-6 Geometric Design Manual-2006
	2.Horizontal Alignment									
	Minimum Radius	m	85	86	85	∞	75	145	∞	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Minimum Transition Curve Lentgh	〃	NO	28	40	-	-	-	-	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Superelevation run off	%	0.50	0.43	0.87	-	-	-	-	Page 8-15, Table 8-5, Geometric Design Manual 2006
	3. Vertical Alignment									
	Max Vertical Gradient	%	7	8	8	0.3	5.6	2.5	3.61	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Min.K value Crest	〃	10	10	10	-	-	18	-	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Min.K value Sag	〃	12	12	12	-	13.2	8.9	10.2	Page 2-6, Table 2-6 Geometric Design Manual-2006
	Min. Vertical Curve Length	〃	30	40	40	-	100	40	40	Page 9-6, Figure 9-4 Geometric Design Manual-2006
	4.Vertical Clearance									
	Object	Vertical Clearance (m)			Remark					

Source: JICA Survey Team

(3) Approach Road Plan of the Bridges

The roads at both sides of the bridges that will be reconstructed in the Project (later called as “approach road”) had been improved by the "Rehabilitation of Urban Roads in Juba" formulated by the Government of South Sudan. The JICA Study Team has collected the related documents and studied the design conditions of the bridges and their approach roads.

Related plan, development status of approach roads of each bridge and typical cross sections which have been revealed by the project study are summarized in Table 2-2-9.

Table 2-2-9 Development Status and Plan for the Roads on Candidate Bridge in the Project

Bridge No.	Status of approach road	Contractor	Status of improvement plan
No.1	Completed: Pavement of carriageway To be completed: Drainage, sidewalk, and the road associated facilities	In 2010 by ABMC	Road C2 Rehabilitation of Urban Roads in Juba
No.4	Completed: Pavement of carriageway To be completed: Drainage and sidewalk	In 2010 by ABMC	Road Q
No.7	Completed: Pavement of carriageway To be completed: Drainage, sidewalk, and the road associated facilities	In 2010 by ABMC	Road F1b/1c
No.10	Completed: Pavement of carriageway To be completed: Drainage, sidewalk, and the road associated facilities	In 2012 by EYAT	Road J3

Source: JICA Survey Team

As per the above Table 2-2-9, the pavement of the existing road at both sides of the four bridges have been completed without the bridges associated facilities. Although the damages can be seen on the pavement in the vicinity of the existing bridge, the roadway width has satisfied the required standard cross-sectional. (Refer to Table 2-2-2: : W = 11.2 m-12.7 m). In contrast, the existing bridge width (Refer to Table 2-2-2: W = 5.0 m-9.15 m) are constricted, it has become a bottleneck that causes traffic congestion in urban area. There is an urgent need to solve its problem. 4 bridges (No.1, No.4, No.7, No.10) are shown in Figure 2-2-4 “Development Routes of Roads in Juba City”. The typical cross-sections (planned) road at four bridges are shown in Figure 2-2-5 to Figure 2-2-7 and the current states of the approach roads are shown in the photos.

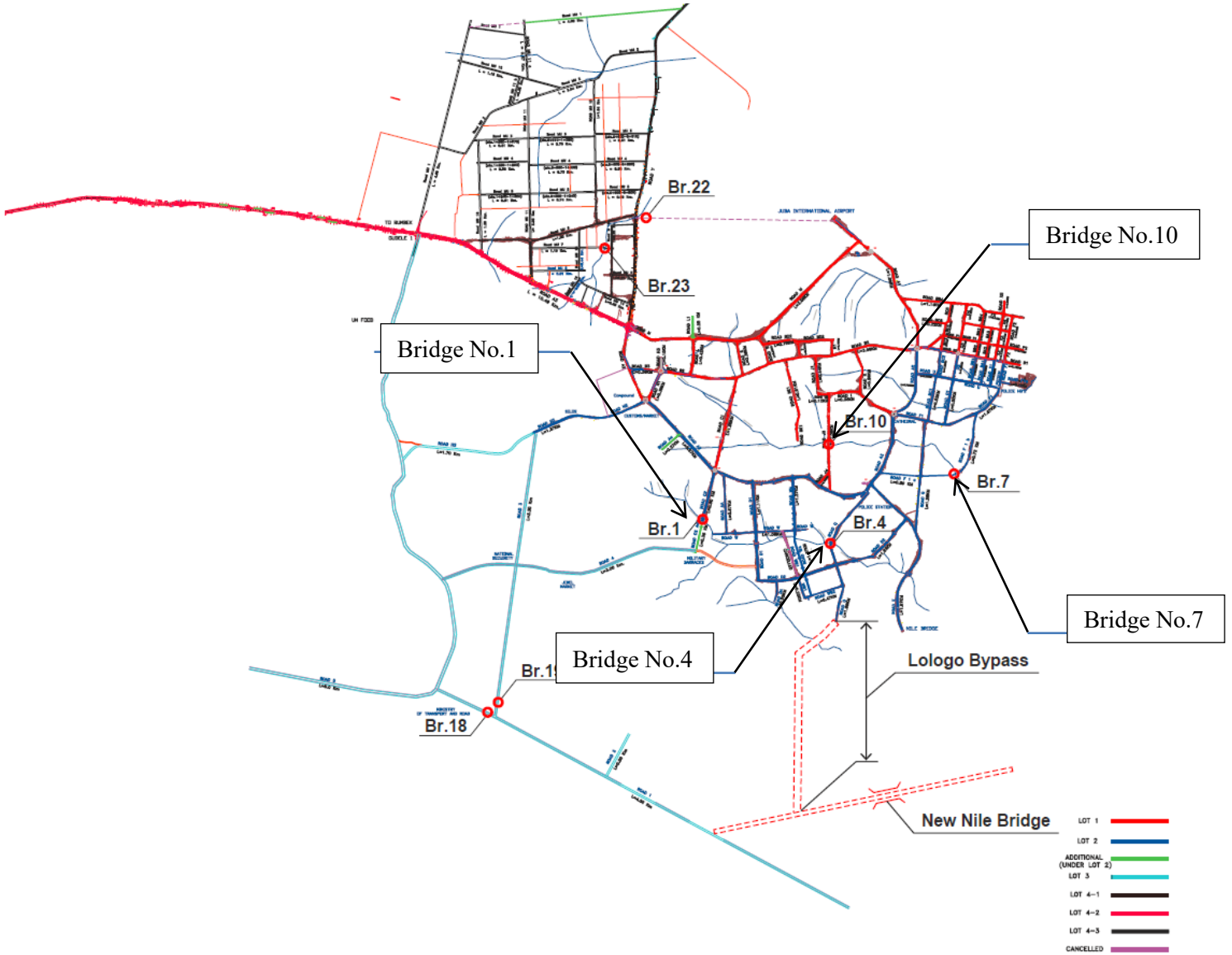


Figure 2-2-4 Development Routes of Roads in Juba City

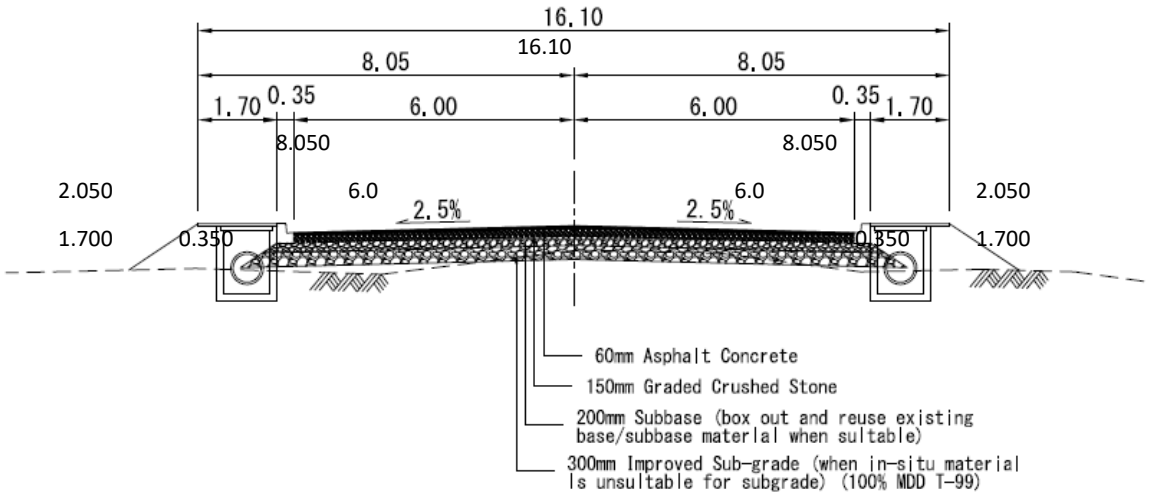
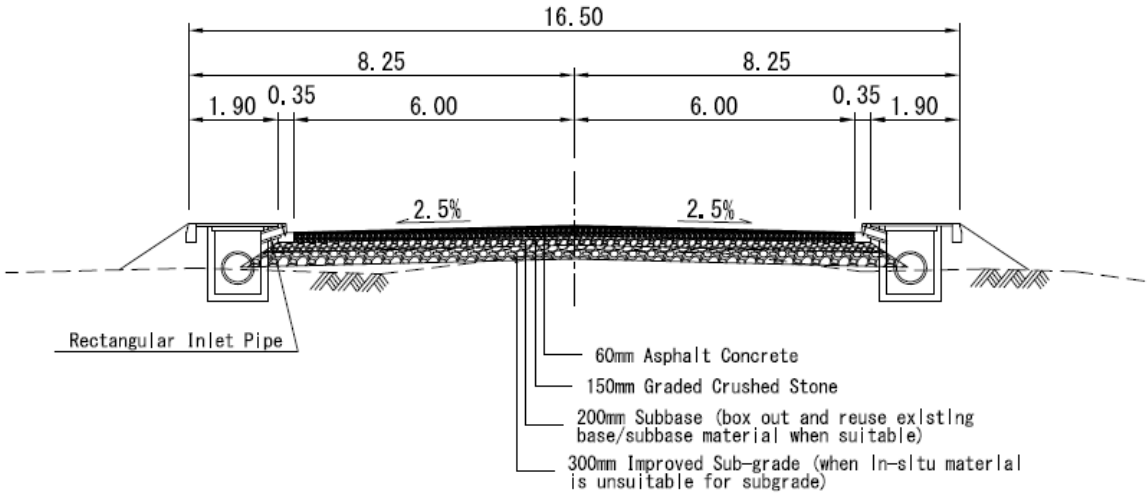


Figure 2-2-5 Typical Cross Section (Planned) Road C2 (Bridge No.1)

Photo 2-2-1 Current Situation of the Approach Road of Bridge No.1 (Completed until pavement)

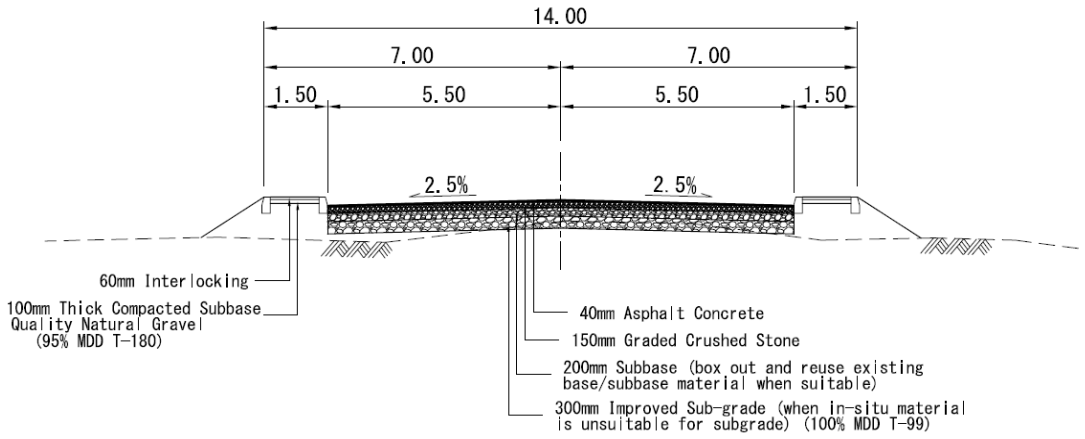


Source: JICA Survey Team

Figure 2-2-6 Typical Cross Section (Planned) Road F-1b/1c, Road Q (Bridge No.4 and No.7)

Photo 2-2-2
Current Situation of the Approach Road of Bridge No.4 (Completed until pavement)

Photo 2-2-3
Current Situation of the Approach Road of Bridge No.7 (Completed until pavement)



Source: JICA Survey Team

Figure 2-2-7 Typical Cross Section (Planned) Road J3 (Bridge No.10)

Photo 2-2-4 Current Situation of the Approach Road of Bridge No.10 (Completed until pavement)

(4) Design Traffic Volume

The design traffic volume is set for the predicted traffic after 10 years in service. The predicted traffic volume at each bridge is indicated in Table 2-2-10. However, the result should be for reference only because the subject bridge is located in the city center and there is a possibility that it will be changed depending on the value by the impact from the road network development and the urban development in the future.

Table 2-2-10 Actual Traffic Volume and Predicted Traffic Volume of Each Bridge

Bridge Number		Actual Traffic Volume (pcu/day)*	Predicted Traffic Volume (pcu/day)**	Predicted Traffic Volume (pcu/day)***
		Current Situation	Start of Service	10 years after start of service
		Year 2021	Year 2025	Year 2035
Condition	New Nile Bredge	Under Construction	In Service	In Service
	Bridges	No Operation	Br. No.1、No.2、No.4、No.10 Construction	In Service
Method of Prediction		-	JICA Strada 3-1_2015	
No.1		21,742	27,970	38,512
No.4		20,085	25,839	35,578
No.7		19,582	25,192	34,687
No.10		22,672	29,167	40,160

* Actual Traffic Volume counted on August 2021

** Predicted Traffic Volume calculated by JICA Strada

*** Predicted Traffic Volume calculated 6.5% as increasing ratio from year 2025 and 3.25% from year 2035

Source: JICA Survey Team

(5) Road Classification

Road classification of MRB has been set by road function and design traffic volume and listed in Table 2-2-11. Road classification of each bridge in the Project has been defined as shown in Table 2-2-12. Considerations in the setting of the road classification are below.

- The Bridges (No.1, No.4, No.7, and No.10) located in central of the city are appropriate to be set as the "Main Access" (just as DS4).

Table 2-2-11 Road Specification of South Sudan

Road Functional Classification	Design Standard	Design Traffic Flow (AADT)*	Surface Type	Width (m)		Design Speed (km/hr)				Urban/Peri-Urban
				Carriageway	Shoulder	Flat	Rolling	Mountainous	Escarpment	
INTER-STATE	DS1	10000–**15000	Paved	***Dual 2 x 7.3	See T.2-2	120	100	85	70	50
STATE	DS2	5000–10000	Paved	7.3	See T.2-2	120	100	85	70	50
MAIN ACCESS	DS3	1000–5000	Paved	7.0	See T.2-2	100	85	70	60	50
	DS4	200–1000	Paved	6.7	See T.2-2	85	70	60	50	50
COLECTORS	DS5	100– 200	Unpaved	7.0	See T.2 -2	70	60	50	40	50
	DS6	50–100	Unpaved	6.0	See T.2-2	60	50	40	30	50
	DS7	30–75	Unpaved	4.0	See T.2-2	60	50	40	30	50
FEEDER	DS8	25–50	Unpaved	4.0	See T.2-2	60	50	40	30	50
	DS9	0–25	Unpaved	4.0	See T.2-2	60	40	30	20	40
	DS10	0–15	Unpaved	3.3	See T.2-2	60	40	30	20	40

* The design two-way traffic flow is recommended to be more than one Design Standard Step in excess or the first year AADT (excluding DS1)

** For traffic volume more than 15,000 a different design approach should be followed

*** The width of each lane is 3.65m

**** Source: Geometric Design Manual, MRB, 2006

Source: JICA Survey Team

Table 2-2-12 Road Specification of Each Bridge

Bridge No.	Road Category	Road Classification	Bridge Location	Reason
No.1	Main Access	DS4	Central	Paved collector road. Specification as Main Access (Pavement).
No.4	Main Access	DS4	Central	Ditto
No.7	Main Access	DS4	Central	Ditto
No.10	Main Access	DS4	Central	Ditto

Source: JICA Survey Team

(6) Design Speed

Design speed shall be 50 km/h by adopting the "Urban/Peri-Urban" in the specification of MRB because the roads of the Project are located in urban area of Juba city.

(7) Typical Road Cross Section

Typical road cross section has been designed to be consistent with the existing plan of road improvement where the subject bridges are located. The standard cross sections are shown in Figure 2-2-8 and Figure 2-2-9.

1) Number of Lane

It shall be matched with the existing plan of road improvement.

2) Width of Carriageway

It shall be matched with the existing plan of road improvement, and is shown below.

- Bridge No.1, No.4, and No.7

Road lane width of the above bridges shall be designed as 3.0 m wide because the approach roads that are being developed were based on the design shown above. (Although development is suspended at present, it is assumed to resume when financial condition will improve.)

- Bridge No.10

This bridge was built by EYAT. It has a 5.5 m carriageway width (total width 11 m). It is considered a 3.0 m road lane and 2.5 m mixed lane (shoulder).

3) Sidewalk

Sidewalk of the roads and bridges shall be set up on both sides of the road because the roads and bridges of the Project are located on main road and assumed to be utilized by many people. The width of sidewalk shall be matched with the existing plan.

4) Shoulder

- Bridge No.1, No.4, No.7, and No.10

The pavement at both sides of the bridges have completed, and it is assumed that sidewalks shall be installed in the future with 0.35m clearance from carriage way. In this project also, the 0.35m shoulder between the carriage way and sidewalk shall be secured.

5) Median Strip

No median

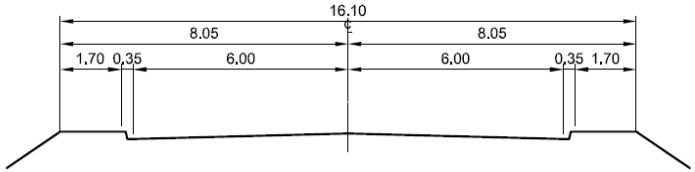
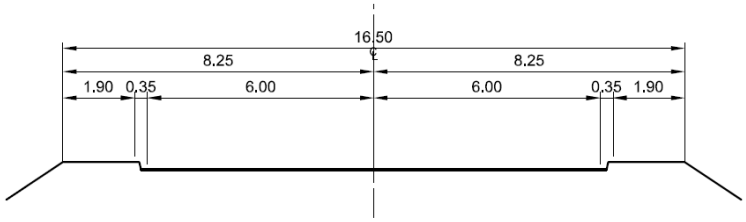
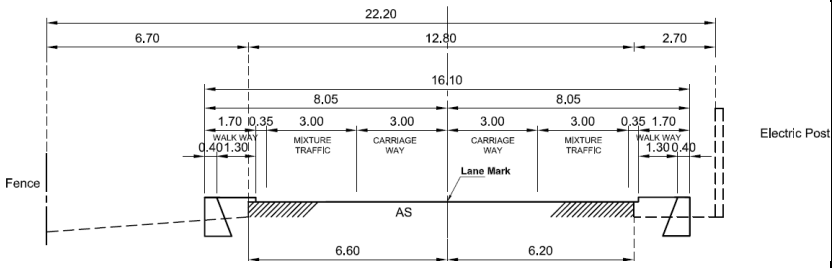
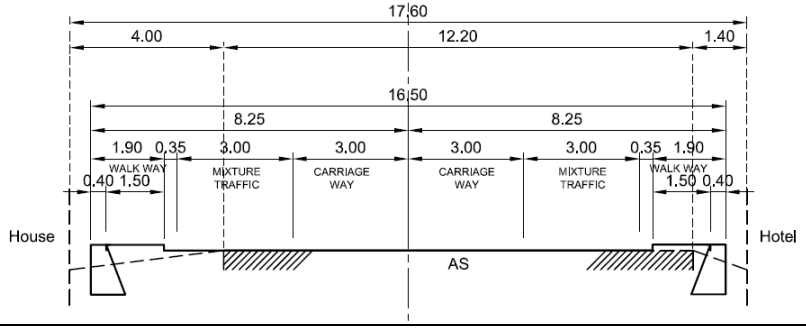
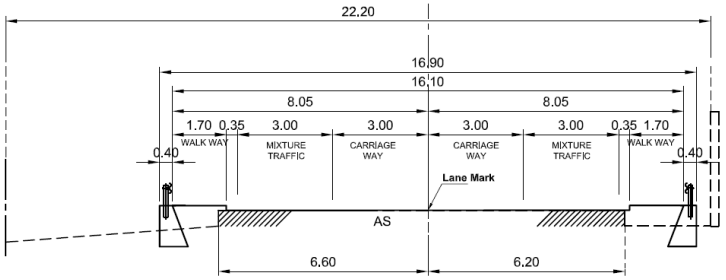
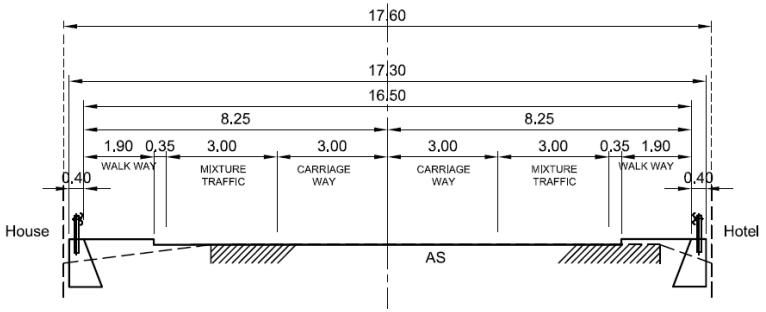
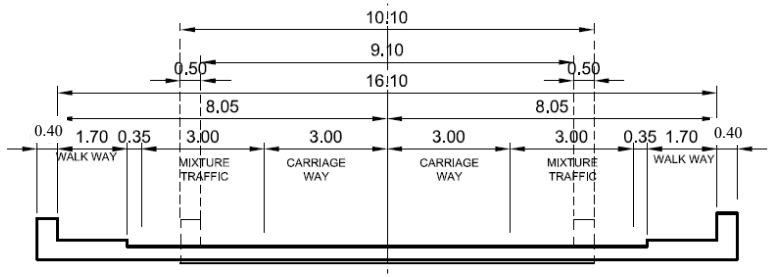
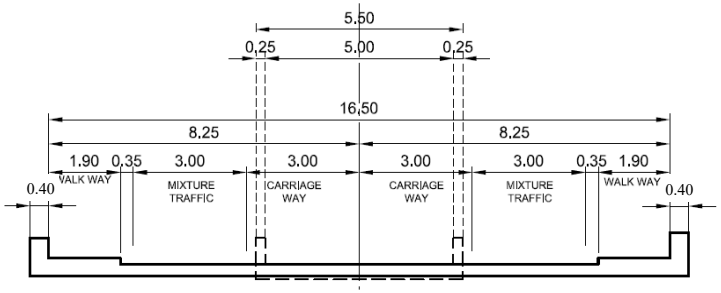
Bridge	Bridge No.1 (Road C1)	Bridge No.4 (Road Q)
Initial design		
For Road Difference in height is less than 2m		
For Road Difference in height is more than 2m		
For Bridge		

Figure 2-2-8 Typical Cross Section of Each Bridge (1/2)

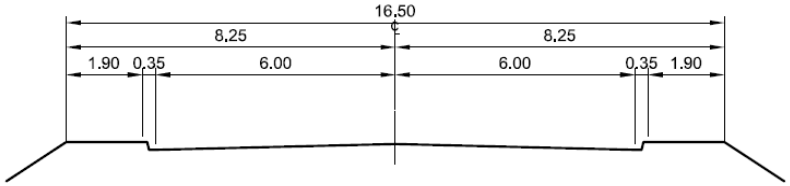
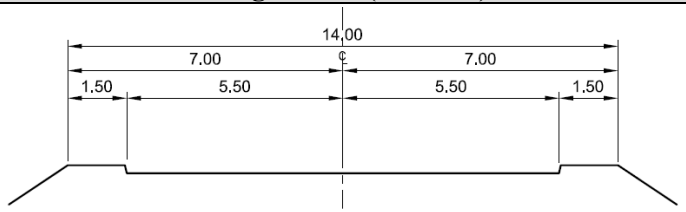
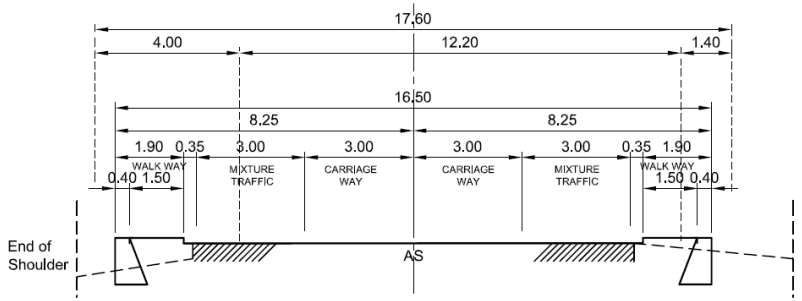
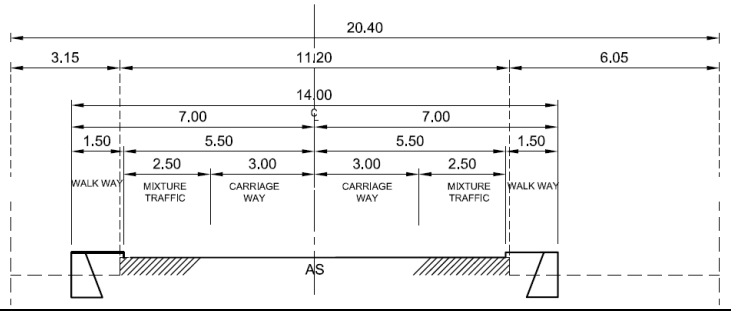
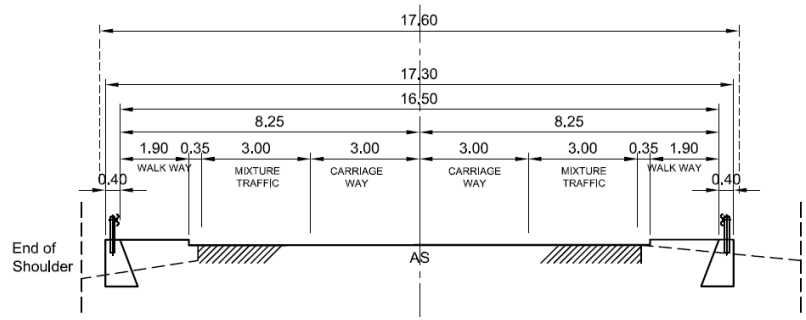
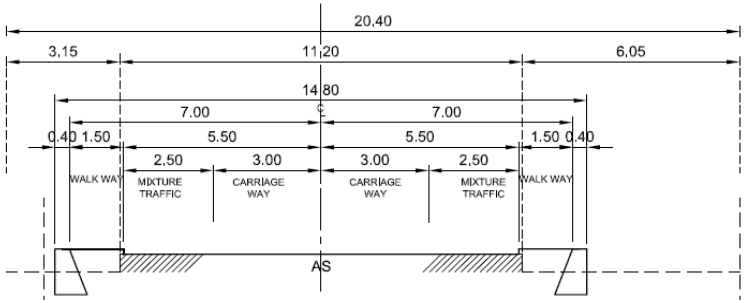
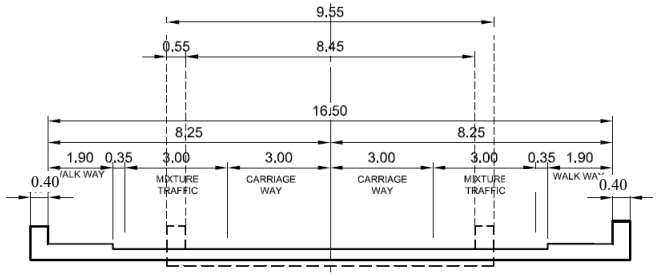
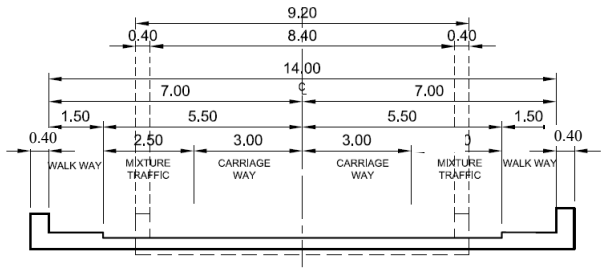
Bridge	Bridge No.7 (Road F1b)	Bridge No.10 (Road J3)
Initial design		
For Road Difference in height is less than 2m		
For Road Difference in height is more than 2m		
For Bridge		

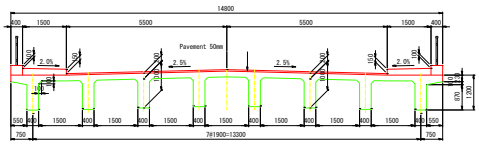
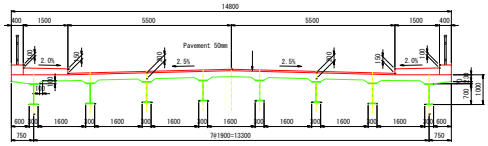
Figure 2-2-9 Typical Cross Section of Each Bridge (2/2)

(8) Selection of Bridge Type

1) Study of Superstructure

There are two types of superstructure proposal in the project. One is the RC girder and other is a steel girder based on the condition of the length of all bridges which are less than 16 m. Result of the study shows that RC girder type is more appropriate, as the JICA Study Team recommended. Likewise, the recipient government has requested for RC girder type. Comparison of superstructure alternatives is shown in Table 2-2-13.

Table 2-2-13 Comparison of Superstructure Alternatives

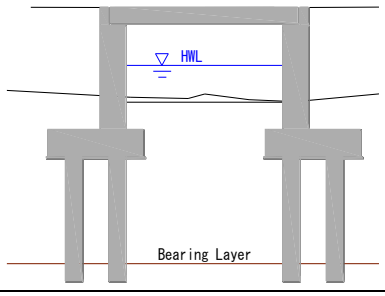
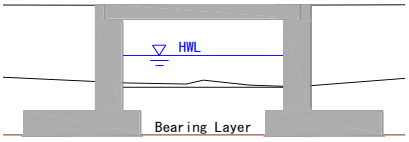
	Option-1 RC girder	Option-2 Steel girder (H beam)
Cross Section		
Feature	Heavier than steel girder. (△) Easy maintenance. (◎)	Lighter than RC girder. (○) Necessary to paint periodically. (△)
Workability	Possible to get the almost all materials for construction in Juba. (○) Necessary to study the construction methodology during rainy season to establish supporting needs. (△)	Necessary to get the major material from 3rd country. (△) Possible to erect a steel girder by crane even during rainy season. (○)
Cost	1.00 (◎)	1.20 (△)
Period	Necessary to avoid the construction work during rainy season. (△) Whole construction period is almost same as steel girder. (○)	Erection of the superstructure is faster than RC Bridge. (○) Whole construction period is almost same as RC girder. (○)
Environmental impact and landscape	Road surface become higher by due to girder height. (△)	Impression innovative by low girder height. (○)
Evaluation	○	△
	The recipient government has requested concrete bridge, and also it is better economically.	

Source: JICA Survey Team

2) Substructure and Foundation Design

Applicability of foundation type is shown in Table 2-2-14.

Table 2-2-14 Applicability of Foundation Type

	Cast-in-Place Pile	Spread Foundation
Side view		
Summary	Casing pipe is driven into the ground, and the soil in the pipe is dug out. Then rebar cage is installed into the pipe. Concrete is poured while pulling out the casing, and concrete pile is constructed.	Concrete foundation is constructed after excavation until bearing layer. If the bearing layer is shallow, it is possible to construct by open excavation without temporary structure.
Applicability	It is applied when the bearing layer is deep.	It is applied when the bearing layer is shallow.

3) Bearing Layer

Bearing layer is decided based on the result of the geological survey that were conducted at the locations of each bridge. The bearing layer and foundation type of each bridge is shown in Table 2-2-15.

Table 2-2-15 Bearing Layer and Foundation Type of Each Bridge

Bridge No.	Bearing Layer		Foundation Type	Average Pile Length (m)
No.1	GNEISS Layer	GL-10.0 m	Cast-in-Place Pile	6.5
No.4	GNEISS Layer	GL-1.3 m	Spread foundation	-
No.7	GNEISS Layer	GL-17.5 m	Cast-in-Place Pile	14.0
No.10	GNEISS Layer	GL-3.5 m	Spread foundation	-

Spread foundation shall be applied in Bridge No.4 and No.10 because the bearing layer is shallow. Other bridges adopt Cast-in-Place pile, and the bottom of pile shall be penetrated by more than one (1) diameter into GNEISS layer as bearing layer and must be fixed firmly.

(9) Bridge Facilities Plan

1) Bridge Pavement

Pavement thickness on the bridge is determined to be 5 cm. Based on the difficulty of the asphalt pavement, the desk slab pavement to be applied will be concrete.

2) Bridge Railing

Comparison of bridge railing is shown in Table 2-2-16.

Table 2-2-16 Comparison of Bridge Railing

Type	(1) Concrete	(2) Metal
Image		
Feature	・ Concrete structure ・ Heavy weight than steel railing ・ Closed-type ・ Materials for construction are locally available	・ Steel structure ・ Light weight than concrete railing ・ Open-type ・ Difficult to get materials for construction at local market
Cost	230 USD/m (23,000 JPY/m)	370 USD/m (37,000 JPY/m)
Evaluation	○	△
	In the case of steel railing, repair is difficult because of financial condition; local procurement of materials is difficult, if vehicle clashed and the railing damaged. Therefore, concrete railing is recommended for better cost-effectiveness.	

Source: JICA Survey Team

3) Expansion Joint

Joint device shall be adopted based on its excellent durability, cost-effectiveness, and maintainability.

4) Approach Slab

Approach slab shall be installed to prevent uneven settlement behind abutments.

5) Support Bearing

It is recommended to be supported with pad-type rubber bearing due to its simple structure, inexpensive, and excellent durability.

6) Structure Fall-Down Prevention Device

All the bridges in this Project are single short spans and supported by abutments. In bridges like these, it is less likely to occur in large relative displacement in longitudinal direction between superstructure and substructure that leads to the collapse of a bridge. Therefore, installing unseating prevention device is not necessary. However, structure limiting excessive displacement in transverse direction shall be installed.

(10) Considerations and Basic Plan of Each Bridge

Considerations in the planning of each bridge are indicated below.

1) Bridge No.1

Area of work: Construction area covers the bridge construction and the approach road that can reach both sides of the existing pavement road

i) Execution of bed protection work under the bridge to prevent riverbed scouring

ii) Execution of revetment (gabion) works to prevent the influence of the house located near the bridge by bank erosion of the downstream

iii) Improvement of road drainage facilities within the scope of work

iv) Installation of sidewalk with stairs to ensure access of pedestrians

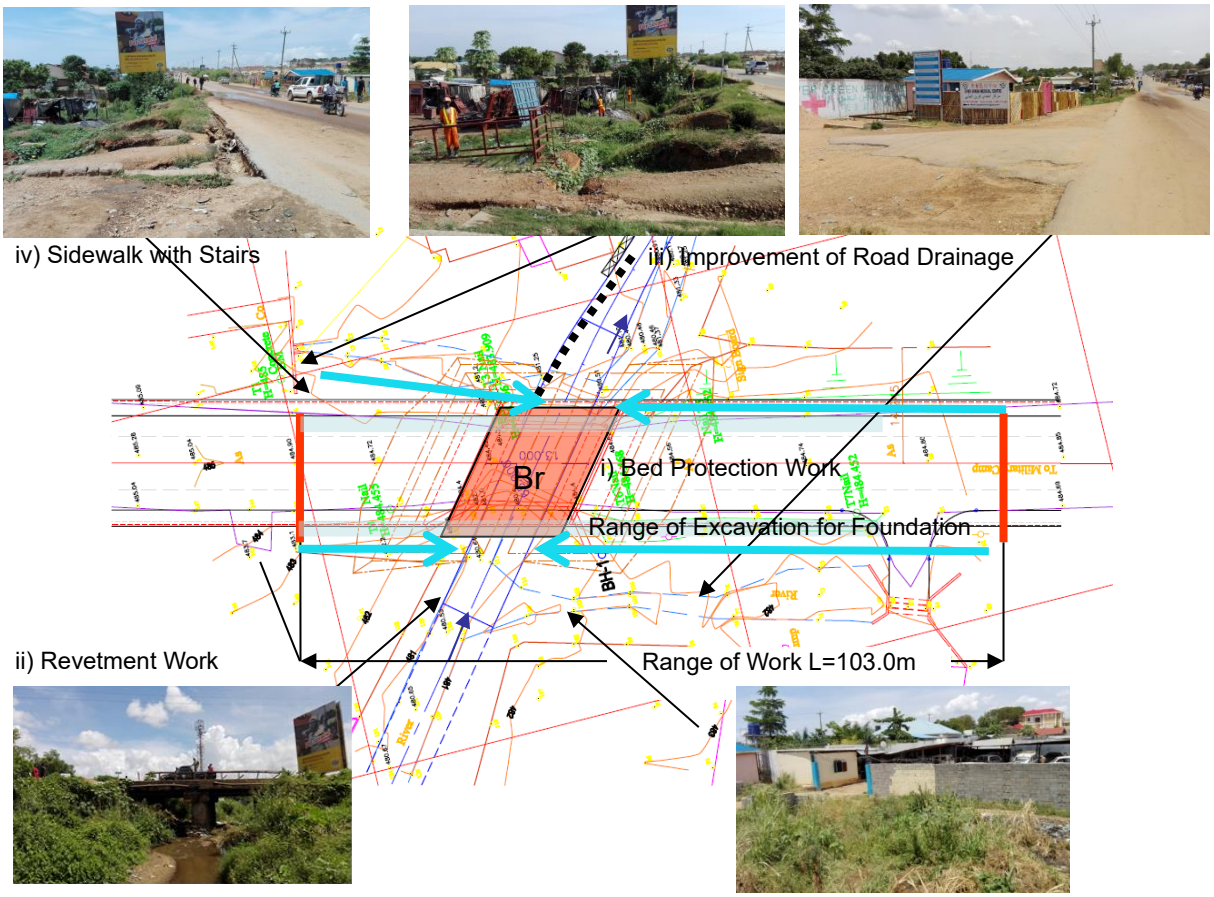


Figure 2-2-10 Plan around Bridge No.1

2) Bridge No.4

Area of work: Between ends of existing asphalt pavement

i) Execution of the bed protection work under the bridge to prevent riverbed scouring

ii) Execution of the revetment (gabion) work to prevent the influence of the house located near the bridge by bank erosion of the downstream portion

iii) Renovation of the existing box culvert

iv) Adjustment of connection to the existing intersection

v) Improvement of the drainage for the road in the project

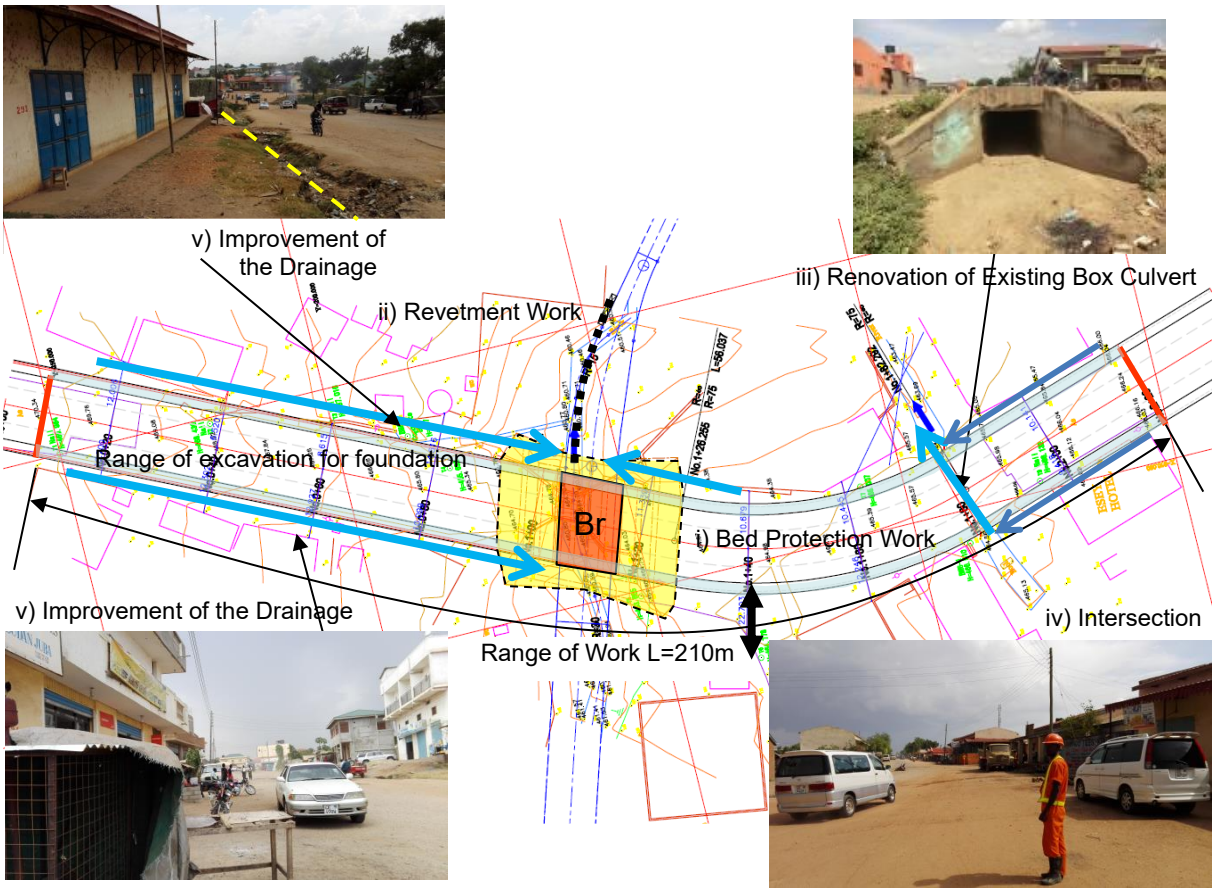


Figure 2-2-11 Plan around Bridge No.4

3) Bridge No.7

Area of work: Between ends of existing asphalt pavement

i) Execution of the bed protection work under the bridge to prevent riverbed scouring

ii) Adjustment of connection to the existing intersection

iii) Execution of revetment (gabion) work for river erosion

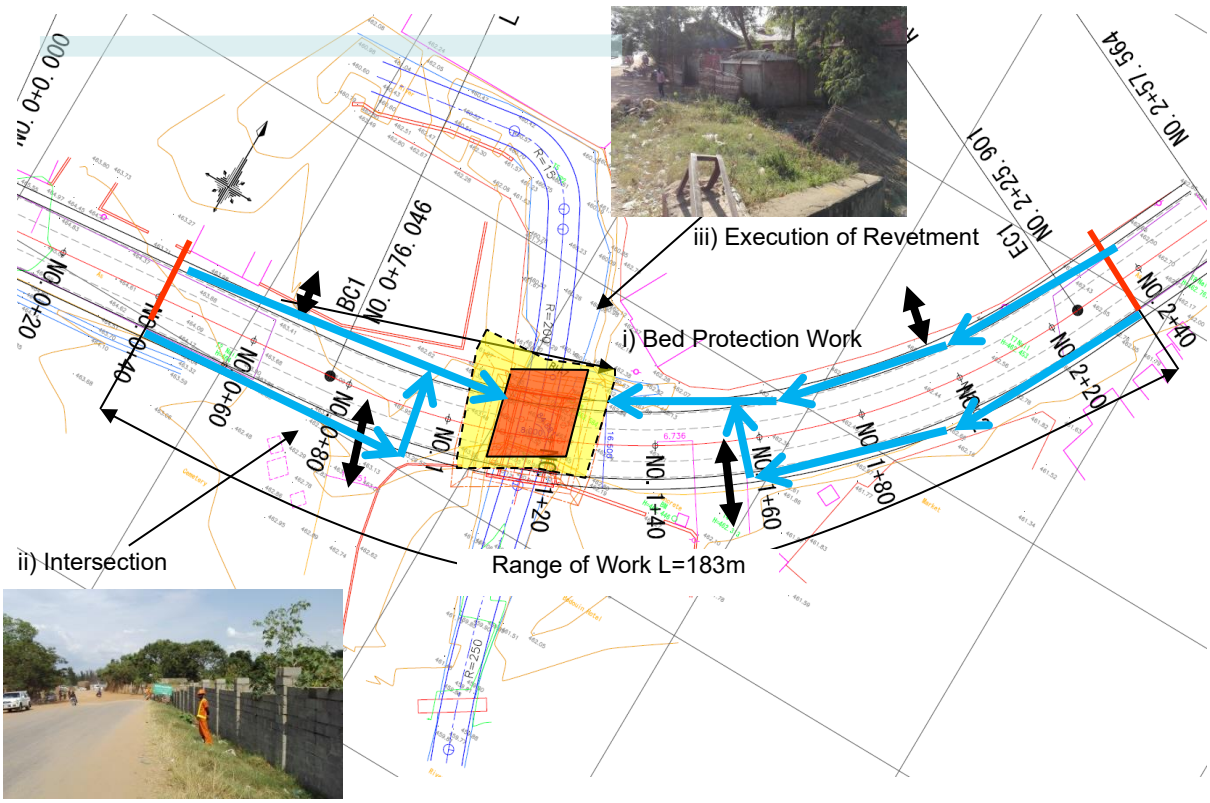


Figure 2-2-12 Plan around Bridge No.7

4) Bridge No.10

Area of work: Between ends of existing asphalt pavement

iv) Execution of the bed protection work under the bridge to prevent riverbed scouring

v) Renovation of the existing drainage to prevent erosion of the road

vi) Installation of stairs for the Restaurant

vii) Installation of sidewalks with stairs to secure access for neighbors

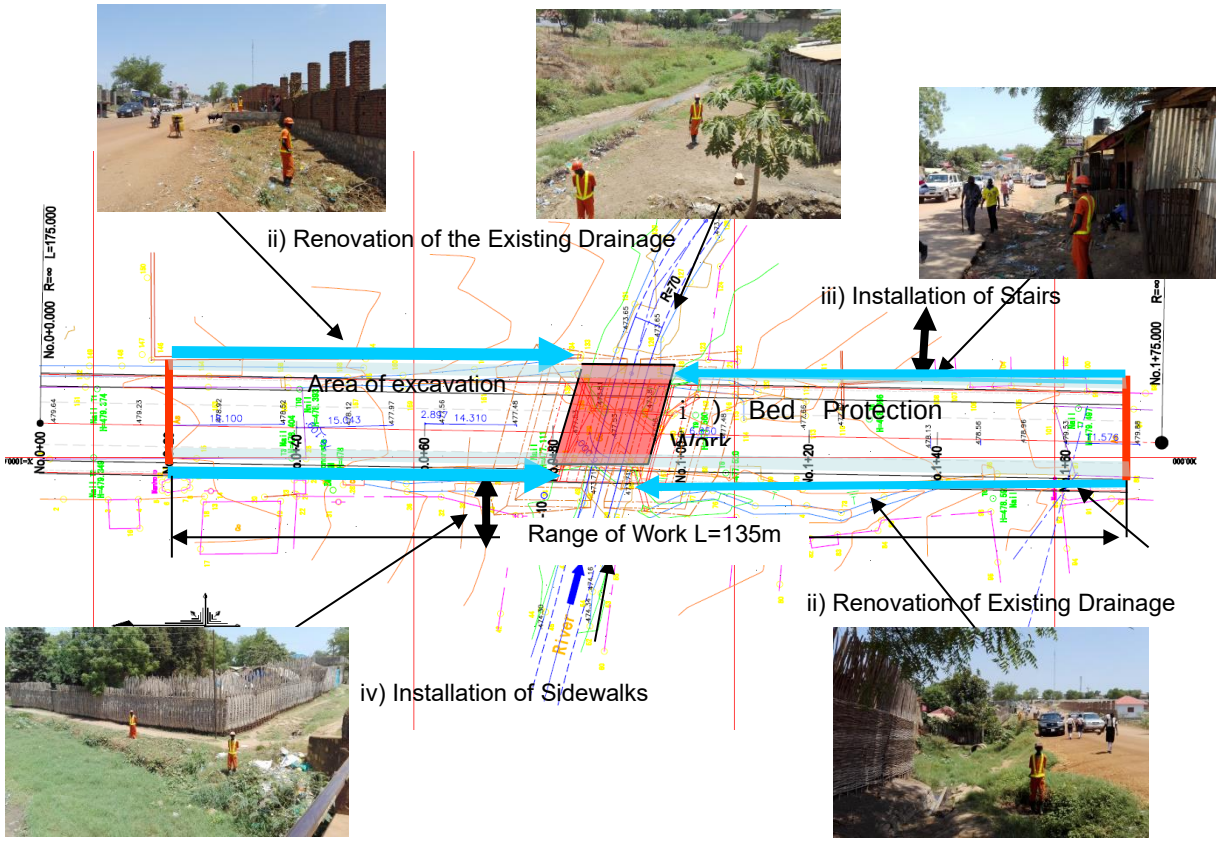


Figure 2-2-13 Plan around Bridge No.10

2-2-2-5 Planning for High Water Level and Minimum Span Length Design

(1) Design Discharge

Development level of subject facilities shall be determined in consideration of experiences in Japan and planning of the past based on the concept described below.

Rainfall intensity in bridge planning adopted 50 years probability in accordance with the standard of South Sudan.

Table 2-2-17 Probability Rainfall Intensity in Bridge Plan

Table 2-1 Design Storm Frequency (Yrs) by Geometric Design Criteria

Structure Type	Geometric Design Standard			
	DS1/DS2	DS3/DS4	DS5/6/7	DS8/9/10
Gutters and Inlets*	10/5	2	2	-
Side Ditches	10	10	5	5
Ford/Low-Water Bridge	-	-	-	5
Culvert, pipe (see Note) Span<2m	25	10	5	5
Culvert, 2m<span <6m	50	25	10	10
Short Span Bridges 6m<span<15m	50	50	25	25
Medium Span Bridges 15m<span<50m	100	50	50	50
Long Span Bridges spans>50m	100	100	100	100
Check/Review Flood	200	200	100	100

* See *Chapter 10 – Storm Drainage Facilities* for further details

Note: Span in the above table is the total clear-opening length of a structure. For example, the span for a double 1.2-meter diameter pipe is 2.4 meters, and the design storm frequency is therefore "culvert, 2m<span<6m." Similarly a double box culvert having two 4.5-meter barrels should use the applicable design storm frequency for a short span bridge and a bridge having two 10-meter spans is a medium span bridge.

Source: [Drainage Design Manual, MRB, 2006]

(2) Basin Divide

The contour map, the CAD drawing and the satellite photo utilizing the public satellite data of NASA were incorporated, and used to calculate the volume of flow conducted on a basin divide in the subject area of Juba city. Figure of basin is shown in Figure 2-2-14.

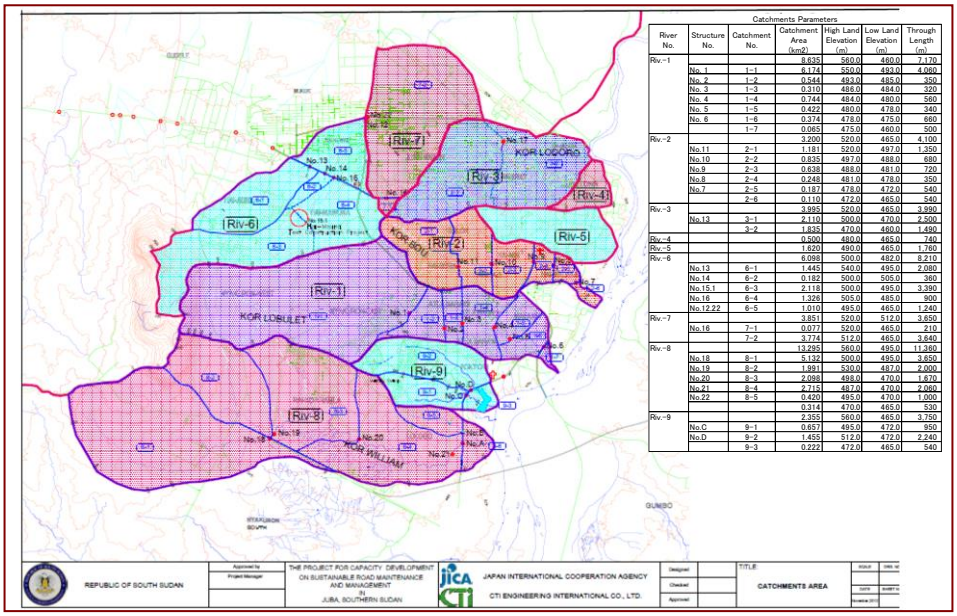


Figure 2-2-14 Figure of Basin in Juba City

(3) Rainfall Intensity

Rainfall data was collected for the computation of rainfall intensity. The available rainfall data was four (4) years from 2006 to 2009 in Juba International Airport only.

The data was analyzed by Gumbel method (extreme value probability method), the rainfall intensity by return period was calculated as in Table 2-2-18 was calculated.

Table 2-2-18 Probability Rainfall Intensity (JUBA Airport)

Return Period (year)	1.1	2	5	10	30	50
Rainfall (mm/day)	56.0	72.0	87.0	96.0	111.0	118.0
r0 (mm)	2.3	3.0	3.6	4.0	4.6	4.9

r0: daily rainfall/24h

The hourly rainfall intensity was calculated by the Mononobe method and results are shown in Table 2-2-19.

Table 2-2-19 Hourly Rainfall Intensity

Tc (hr)	Return Period (year)					
	1.1	2	5	10	30	50
0.25	48.9	62.9	76.0	83.9	97.0	103.1
0.5	30.8	39.6	47.9	52.8	61.1	64.9
1	19.4	25.0	30.2	33.3	38.5	40.9
3	9.3	12.0	14.5	16.0	18.5	19.7
6	5.9	7.6	9.1	10.1	11.7	12.4
9	4.5	5.8	7.0	7.7	8.9	9.5
12	3.7	4.8	5.8	6.3	7.3	7.8
18	2.8	3.6	4.4	4.8	5.6	6.0
24	2.3	3.0	3.6	4.0	4.6	4.9

(4) Calculation Results of the Bridge Length

The bridge length is planned according to the technical approach shown below. To ensure the flow capacity for the discharge of 50 years return period

i) The design water depth at the design discharge is 2.0 m.
ii) The current bridge length will be maintained in case the calculated result is smaller than the current one. This is because 1) the urban development has progressed on the basis of the current rivers shape and alignment, and 2) the flow is likely to change because the river is a natural river. Such changes of flow direction and rise of upstream water level may have an impact on the surrounding environment unexpectedly by changing the bridge length.
iii) Existing Bridge No.1 is skew bridge of 60 degree or less, and there is a possibility to occur negative reaction force. It is structurally not desirable situation. Therefore, skew angle of Bridge No.1 is fixed to be 65 degree, and bridge length has been decided in consideration with river situation around bridge.

The calculation results are shown in Table 2-2-20 and Table 2-2-21.

Table 2-2-20 Bridge Length of Each Bridge and Determinant

Bridge No.	Current cross-sectional area of flow	Bridge length that is required from the flow calculation	Bridge length of design	Determinant of bridge length
No.1	9.80	9.0	15.0	For oblique angle of the current bridge is small, the skew angle was 65 degrees from a structural standpoint.
No.4	4.85	11.5	11.5	Determined from the flow rate calculation results.
No.7	8.10	8.0	10.0	Ensure the water flow width of the current bridge.
No.10	8.80	7.0	13.0	Determined from the center of flow, rivers situation (flood floor, etc.) and the length of bridge.

Table 2-2-21 Bridge Length and Runoff Volume Calculation Result

No.	Cooperation target	Water catchment area	Bridge length that is required from the flow calculation		calculation of cross sectional runoff volume						hill	Water flow cross-sectional area	wetted perimeter	Average water depth	coefficient of roughness	flow rate	flow volume	Q＞Q50 Check	Parameter		Bridge plan		River No.
			Span	Length	Cross section		allowance height	Water flow cross section											Runoff volume	specific discharge	Span length	Bridge length	
		A	B	BL	B	H	-	h	B1	B2	I	A	S	R	n	V	Q		Q_{50}	$Q_{50/A}$	B	BL	
		(km^2)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(%)	(m^2)	(m)	(m)	-	(m/sec)	(m^3/sec)		(m^3/sec)	(m^3/s/km^2)	(m)	(m)	
No.1	○	6.174	8.0	9.0	7.0	2.9	0.9	2.0	-	-	0.90	14.00	11.00	1.273	0.035	3.184	44.6	OK	44.5	7.2	14.0	15.0	River-1
No.4	○	7.772	10.5	11.5	9.5	2.9	0.9	2.0	-	-	0.60	19.00	13.50	1.407	0.035	2.779	52.8	OK	50.5	6.5	10.5	11.5	River-1
No.7	○	3.090	7.0	8.0	6.0	2.9	0.9	2.0	-	-	0.60	12.00	10.00	1.200	0.035	2.499	30.0	OK	30.0	9.7	9.0	10.0	River-2
No.10	○	2.016	6.0	7.0	5.0	2.9	0.9	2.0	-	-	0.70	10.00	9.00	1.111	0.035	2.564	25.6	OK	23.4	11.6	12.0	13.0	

Source: JICA Survey Team

2-2-2-6 Pavement Design

(1) Applied Design Criteria

Since the design criteria of South Sudan are not shown for the concrete pavement design, pursuant to AASHTO 1993. In addition, joint split and joint structure shall confirm to the pavement design and construction guidelines (Japan Road Association, Feb, 2006).

(2) Analysis Period

It was 20 years according to AASHTO.

(3) Design Procedure

It was designed in accordance with Figure 2-2-15.

(4) Design CBR

Since Approach Roads are in place until the subgrade, the condition was designed to be CBR 20.

(5) Selection of the Pavement Structure

Study of pavement thickness results are shown in Table 2-2-22.

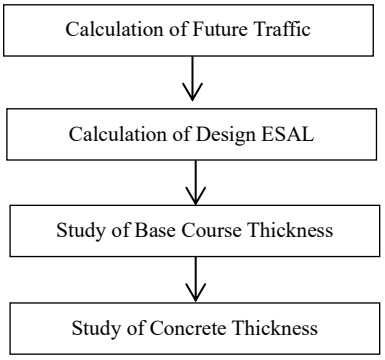
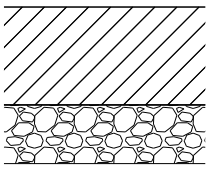


Figure 2-2-15
Procedure of Pavement Design

Table 2-2-22 Selection of Pavement Structure

Bridge No.	Pavement Structure	Design ESAL	Design CBR	Check by AASHTO Thickness of Concrete Pavement (Inch)
Br.1	**Pavement Depth (t=40cm)**  Concrete Pavement (t=25cm) Base Course (Treated Crushed Stone) (t=15cm)	11.37 x10^6	CBR=20	More than 8.71
Br.4		7.14 x10^6	CBR=20	More than 7.94
Br.7		12.87 x10^6	CBR=20	More than 8.92
Br.10		11.86 x10^6	CBR=20	More than 8.78

Source: JICA Survey Team

2-2-3 Outline Design Drawing*

The preparatory design drawing is attached in Appendix 6.

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Procurement of Materials and Equipment*

The buildings with few floors are constructed in several local places, but general civil engineering construction has mostly not been carried out. Among the construction materials, fill and crushed stone

materials can be locally procured. However, the type, quantity and quality of primary materials such as rebar and cement cannot be supplied locally in this project. In addition, the contractor which own general construction machines are available, however, the quantity of machinery, model year, lease, operational status and construction materials are not the kind that can be supplied to this project. Most of the local skilled workers are migrant workers from neighboring countries. Therefore, it was determined that importation of major construction machinery and primary materials such as the asphalt materials, cement and rebar from Japan and third countries is reasonable. Likewise, it is determined to be reasonable that the skilled workers are also recruited from the third countries.

1) Labor Procurement

a. Local construction companies have track record of implementing small road construction projects. However, their awareness of safety, process and quality is minimal, and thought that there is a problem in management. It is then considered that labor provision is main reasonable solution.

b. Procurement in the field of civil general foreman, bridges foreman, bridge labor, rebar fixer, timberman, special driver is difficult. Therefore, a need to procure from neighboring third countries is prevalent.

2) Material Procurement

a. Ready-Mixed Concrete

Three contractor companies which have a ready-mixed concrete plant were confirmed. However, the two has no external sales, and the only company which can supply is Tone South Sudan (Japanese company). However, there are greater risks with the plan batcher plant of this company due to small and old equipment, the breakdown of the machines, and the company's withdrawal from South Sudan. Therefore, it is reasonable that the concrete will be directly supplied from the plant.

b. Aggregate for Ready-Mixed Concrete and Pavement

The aggregate for Ready-Mixed Concrete and Pavement are possible to be procured from a private quarry. The available supply volume are as follows:

i) EYAT ROADS AND BRIDGES

The company is located in Jebel Kujur which is about 13km from Juba center. Production volume is 50m^3/h, and can be delivered using the dump trucks of the company. And all the particle sizes which is needed in this project is being produced. The particle size is relatively good, however, the lithic is not good compared to the other two possible suppliers.

ii) Tone South Sudan

The company is located on the side of Jebel Kujur which is about 8km from Juba center. Production volume is 50m^3/h, and it can be delivered using the dump trucks of the company. The production volume is less, but it is possible that production of 80 ~ 100m^3/day can be met if the production activity is carried out at daytime and nighttime. At present, the company is producing the aggregates for concrete (9 ~ 20mm) only, but it is possible that all particle sizes needed in this project can be produced. The flat shape is many.

iii) Fattouch Industrial Holding, LTD.

The company is located in Jubel Knfi which is about 17km from Juba center. Production volume is 5,000m^3/h, and all particle sizes needed in this project is produced. The particle size is good and the stock volume is enough.

YET ROADS AND BRIDGES

TONE SOUTH SUDAN

Photo 2-2-5 Concrete Aggregate Plant

3) Embankment/Backfill Material and Sub-base Material

a. Embankment/Backfill and Sub-base

Currently, the borrow pit is located 20 km north from the center of Juba City, and are mined in several places. The materials from this place are sampled and tested. If the specified value as the lower sub-base material (CBR value of 30 or more) is not met, an additional procedure such as mixing with other aggregate is needed.

b. Base Course Material

Upper sub-base material is planned to be mechanically stabilized crushed stone.

Currently, the aggregates from the three places has been tested, and the suppliers were evaluated based on the overall quality and price.

Borrow Pit at the North Area

Photo 2-2-6 Material for Embankment and Subbase

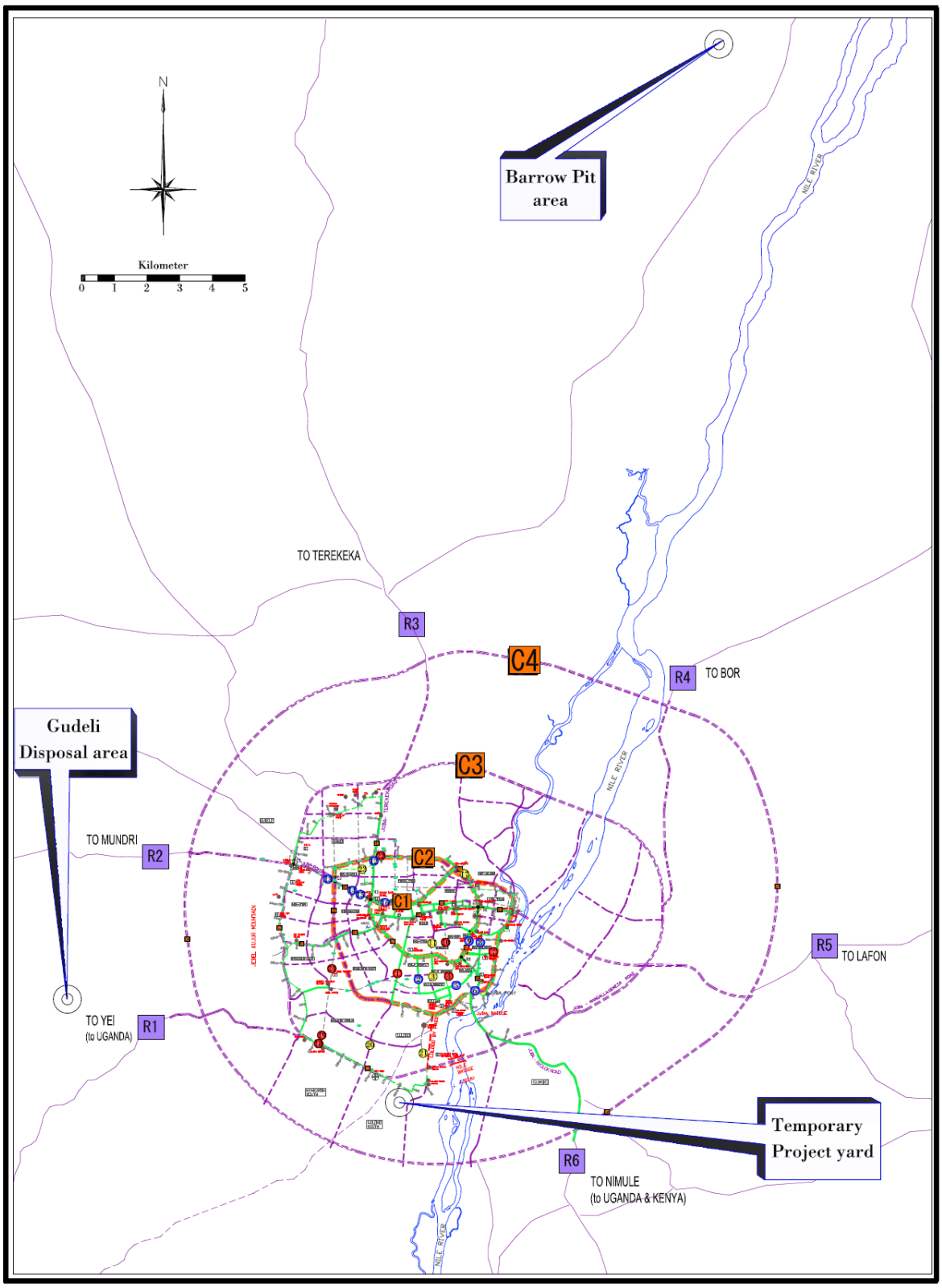


Figure 2-2-16 The Locations of Waste Disposal Site and the Borrow Pit

4) Reinforcing Bar

The reinforcing bar of small diameter round and the plain bar are mainly available in the market, however, it is very difficult to procure the type and size of rebar needed in this project in Juba City. It is determined that the procurement from Japan is reasonable for a stable supply and high quality of reinforcing bars.

In Juba City, cement is imported from Egypt, Pakistan and Kenya. However, there were cases when predetermined intensity cannot be obtained due to quality problem. Typically, contractors procure from Kenya and Rwanda. For this project, the concrete plant will be erected by their own, and it is determined to be more reasonable to import from third countries.

5) Timber

Local procurement of formwork wood is possible. However, the formwork plywood cannot be procured, thus, importation from third countries is required.

6) Special Material

Procurement of falsework and steel materials needed in this project is difficult in South Sudan. Therefore, it is determined that procurement from third countries and Japan is reasonable.

7) Construction Equipment

The construction machines are owned by local contractors, however, decrepit machines repaired by own company are being used. There are also machines which are not decrepit in the transport machinery and drilling machinery, however, the number is extremely small and the risk that utilization of these machines in this project is large. The contractors owning a crane is very few, and the cranes for lease is also very few. Therefore, to procure the construction machines from third countries or Japan is determined to be reasonable. Trailer or self-propelled equipment is used for its transport. In addition, the asphalt plant is very difficult to procure from the third countries. Therefore, the asphalt with concrete plant will be procured from Japan is determined to be reasonable.

(2) Transportation Route*

The sea transport from Japan and third countries is discharged in Mombasa port, about 500 km to southeast from Nairobi due to closure of Sudan border. The shortest and reasonable route (about 1,680 km) is Nimule in Southern Sudan via Nairobi and Uganda. The transit distance between Nairobi and Uganda is about 1,180 km.

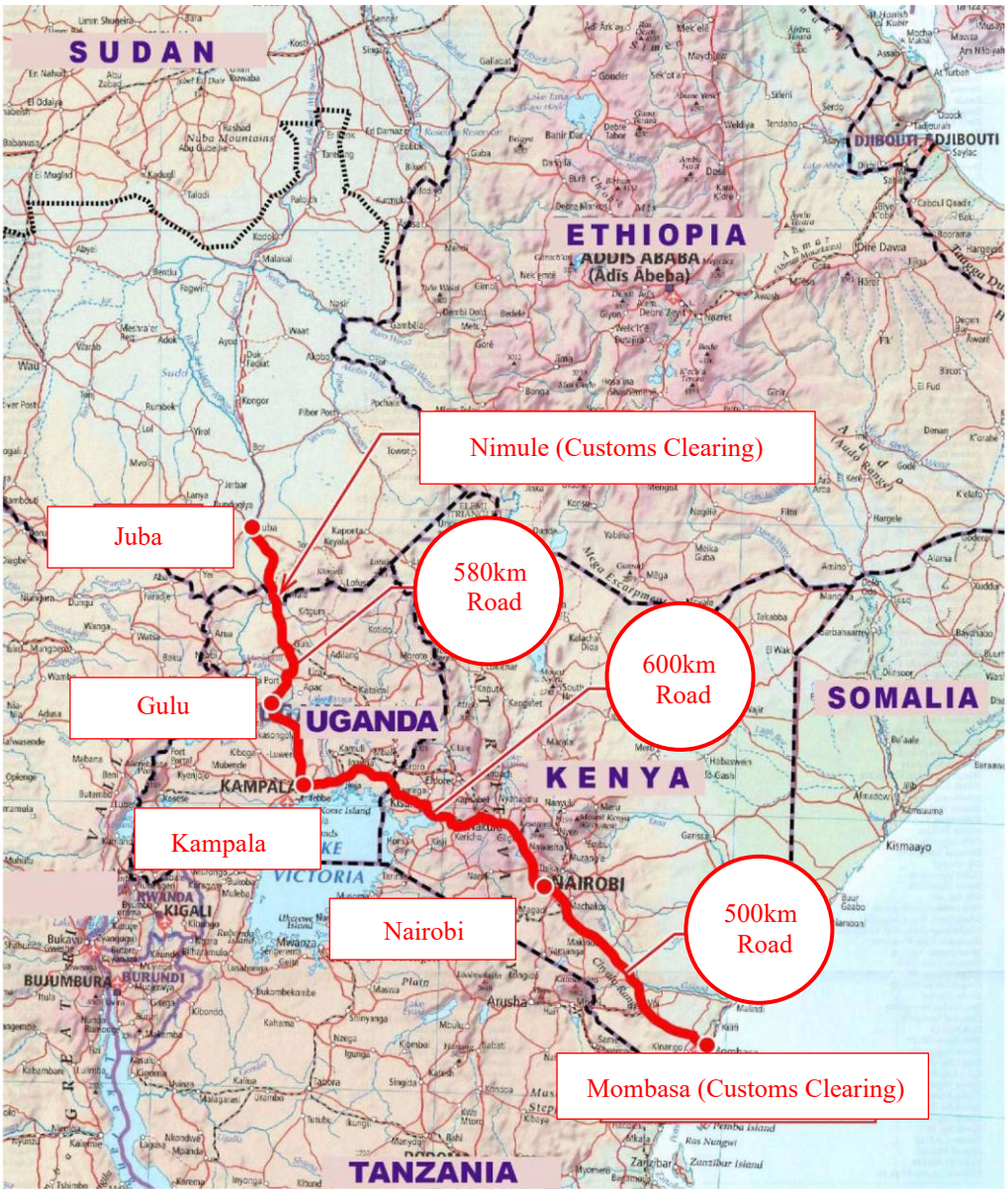


Figure 2-2-17 Transportation Route

(3) Price Escalation

The price escalation rate adopted in the previous preparatory survey in 2016 and adopted in the implementation review study are shown below. This implementation review study adopts 1.0 since the detailed design is scheduled soon.

Table 2-2-23 Price Increase Rate

Year	Nov. 2015	August 2021 (This Study)
Price Increase Rate (%)	1.281	1.0

(4) Survey of Implementation Plan

1) Temporary Yard

The size of the temporary yard needed to accommodate temporary office, accommodation, material yard, concrete plant, and the stock yard for soil material for this project is 12.000 m^2 (80 m*150 m). In this study, a candidate temporary yard in front of the MRB-CES office was agreed with MRB

on the Technical Note in August 2021. However, due to the conflict with the occupiers, MRB informed that the site could not be availed this project during the discussion in November in 2021. It is discussed and agreed that the alternative location should be determined by February in 2022 before commencement of the Detailed Design.

Table 2-2-24 Evaluation Result of the Prospected Site for Temporary Construction Yard

No.	Name	Condition of site	Possible Area	Overall Condition	Opinion
1	Front of MRB-CES Office	Good	80 x 150	▪ The area is enough.	○

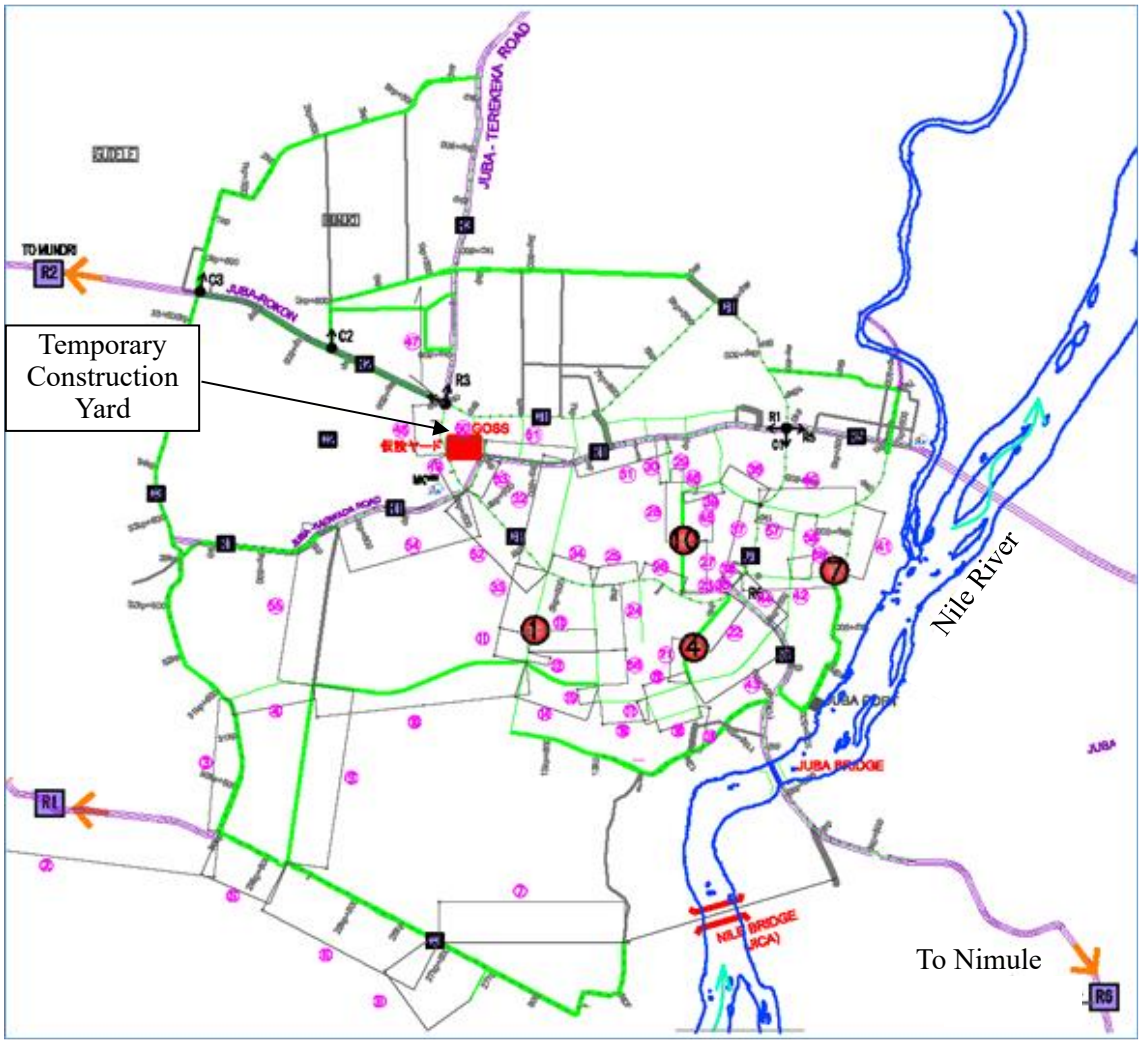


Figure 2-2-18 Prospected Site of Temporary Construction Yard

2) Detour

The existing roads around the construction site are basically used as detour, and new detour is not constructed. However, the road planned as detour of Bridge No.1 currently crosses the waterway, therefore, temporary waterway facility will be constructed. Also, the temporal steal pedestrian bridge will be provided for motorcycles and bicycles, however, cattle and pedestrians need to cross the construction area.

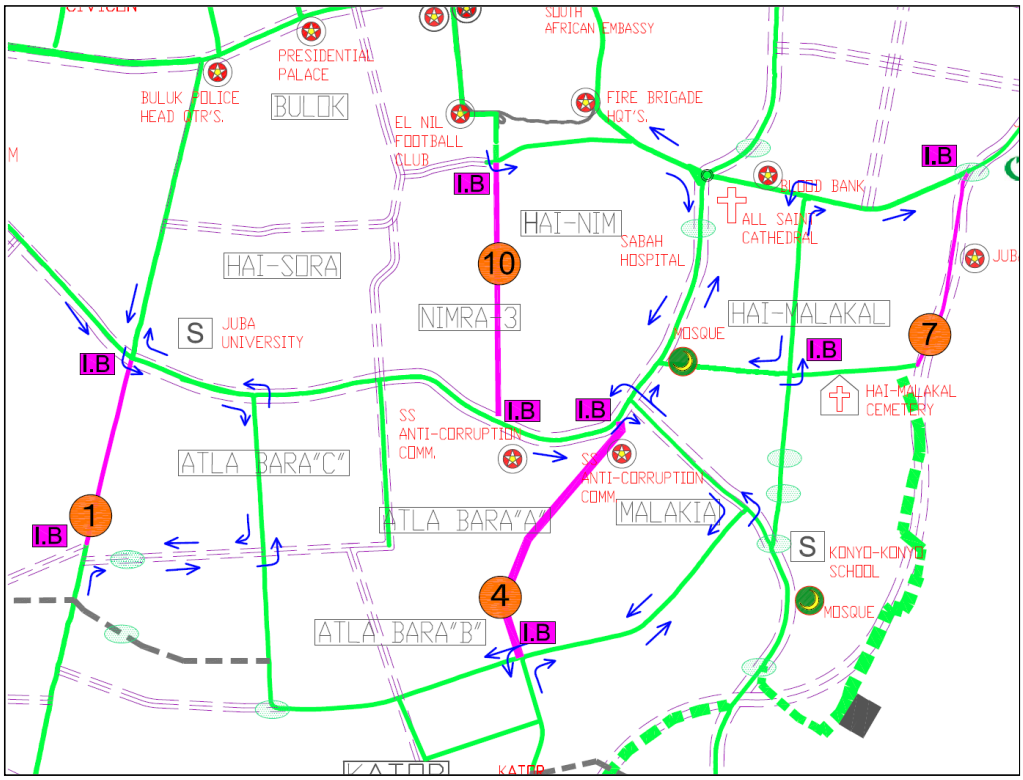


Figure 2-2-19 Detour Plan

3) Removal of Obstructions

Table 2-2-25 List of Obstructions

Br. No	Item	Name of Obstructions	Quantity
No.1	①	Removal of Barbed Fence	16 m
	②	Removal of Cars	6 cars
	③	Relocation of Electric Poles	110 m
	④	Removal of Bill Board（1.3 m × 2.4 m）	1 unit
	⑤	Removal of Barbed Fence	15 m
No.4	①	Relocation of Electric Poles	40 m (3 poles)
	③	※Removal of Container	1 unit
No.7	①	Removal of Stone Masonry Wall (Bedwin Hotel)	16 m
	②	※Removal Iron Sheet (Bedwin Hotel)	20 m
	③	Removal of Bill Board（3.0 m × 2.0 m）	1 unit
	④	※Removal of Barbed Wire	10 m
	⑤	※Removal of Garbage Room（Pyramid Hotel）	10 m^2
	⑥	※Removal of Parking Area（5 m × 100 m）	500 m^2
	⑦	※Relocation of Electric Poles	4 Poles
	⑧	※Removal of Street Light	3 Poles
No.10	①	Removal Riprap Wall	8 m
	②	Removal of Concrete Box (1.9 m × 4.8 m)	9.2 m^2

※Newly found

Source: JICA Survey Team

	
No.4 Container	No.7 Iron Fence
	
No.7 Barbed Wire Fence	No.7 Garbage Room
	
No.7 Parking Area-1	No.7 Parking Area-2
	
No.7 Electric Poles	No.7 Street Light

Photo 2-2-7 Removal of Obstructions

Waste Disposal Site

There is a waste disposal site controlled by the state government, located in the southwestern part 14 km from Juba City. Construction waste material, such as demolished concrete, excavated rock and excavated soil will be discarded here to be the waste disposal site, as confirmed by a Technical Note. (Refer to Figure 2-2-16)

Photo 2-2-8 Waste Disposal Site

2-2-4-2 Implementation Condition

(1) Considerations on the Natural Conditions

The river water volume during dry season at construction location is relatively small. However, during the rainy season, there is always flowing water, and the flow volume is rapidly increased by sudden rain. According to the rainfall data, dry season is 6 months from November to April. The rainy season (June small rainy season) is 6 months from May to October. Because the construction of all the bridges at the same time will cause a great deal of traffic congestion in Juba city, the year round construction shall be adopted in terms of the economy and construction period. Further, in order to minimize the impact of simultaneous construction on traffic congestion, No. 1 and No. 10 bridges will be started first and, followed by No. 4 and No. 7.

(2) Social and Environmental Considerations

It is necessary to consider the traffic of residents and existing dwelling houses because the bridges are located in the inner city. The construction is carried out at site secured by the South Sudan Government.

Since Bridges of No.1, No.4, No.7, and No.10 are located at the city center, it is necessary that the traffic of pedestrian, bicycle, motorcycle, and livestock are secured for their transit. Therefore, installation of a temporary bridge during construction was planned.

(3) Transportation Plan

The major items to be transported to the designated area of the construction site include aggregate for concrete, road base and sub-base materials and embankment materials. These will be transported near the bridge construction.

2-2-4-3 Scope of Works*

The responsibilities to be borne by Japan and South Sudan are summarized in Table 2-2-26.

Table 2-2-26 Responsibility of Each Government

Item	Content	Responsible		Remarks
		Japan	South Sudan	
Land acquisition (ROW) and house relocation	Land acquisition and house relocation		○	
Procurement	Procurement of materials and equipment	○		
	Custom clearance of materials and equipment		○	
Construction Preparation	Land acquisition necessary for construction		○	Project office, accommodation, equipment storage yard, work shop, etc.
	Preparation other than above	○		
Removal/relocation of obstruction to construction	Relocation of obstruction		○	Trees and clearance of ROW
Permission to use river water	Request for exemption/permission from WWRMI		○	
Main Construction	Bridge construction and approach road construction	○		Bridge, approach road, and revetment work

Source: JICA Survey Team

2-2-4-4 Consultant Supervision*

Basically, the Japanese Consultant will enter into an agreement with the GOSS to undertake the detailed design and construction supervision of the Project.

(1) Major Works to be Undertaken

The major works to be carried out during the detailed design consultant are as follows:

- Undertake consultations with concerned authorities of South Sudan; field surveys,
- Detailed design and drawings preparation
- Project Cost estimate

The duration to carry out the detailed design work is about 5.5 months.

(2) Bidding Activities

The major tasks to be undertaken from bid announcement to construction agreement include:

- Preparation of bid documents (in parallel with detailed design).
- Bid announcement
- Pre-qualification of bidders
- Bidding
- Evaluation of bid documents
- Preparation of Contract Agreement

The duration of the bid-related activities is about 5.5 months.

(3) Construction Supervision

The Consultant will supervise the Contractor's planning and implementation of the construction contract. The major tasks under this stage include:

- Verification/Approval of related surveys and quantities
- Review/Approval construction plans
- Quality Control
- Process Control
- Work Output Control
- Safety Management
- Turnover Inspection and Acceptance

The duration of construction supervision is approximately 36.0 months.

The construction supervision team shall consists of: 1-Resident/Chief Engineer (Japanese), 1-Pavement Engineer (Japanese), 1-Safety Engineer (Local), 1-Site Engineer (Kenya or Eritria), 1-Clerk (Local) and 1-Office Boy (Local). Moreover, the Chief Engineer may dispatch Inspector/s for turnover inspection during completion.

2-2-4-5 Quality Control Plan*

The tasks to be carried out for the quality control during the construction period are as follows:

- Concrete Work
- Reinforcing Bars and Formworks
- Earth Work
- Pavement Work
- Structure shape and Dimension

Based on the above, the quality control items for Concrete works are presented in Table 2-2-27 while the quality control items.

Table 2-2-27 Concrete Quality Control Plan

Item	Test Items	Method (Specification)	Frequency of Test
Cement	Physical test of cement	AASHTO M85	Once before trial mixing, and every once every 500m^3 batch of concrete; or change in source/quarry location (Mill sheet)
Aggregate	Physical test of fine aggregate	AASHTO M6	Once before trial mixing, and every once every 500m^3 batch of concrete; or change in source/quarry location (check supplier data)
	Physical test of coarse aggregate	AASHTO M80	Once before trial mixing, and every once every 500m^3 batch of concrete; or change in source/quarry location (check supplier data)
	Sieve analysis	AASHTO T27	Once a month
	Potential alkali reactivity of aggregates (Mortar-Bar Method)	ASTM C1260	Once before trial mixing, and change in source/quarry location
	Petrographic Examination of Aggregates for Concrete	ASTM C295	Once before trial mixing, and change in source/quarry location
Water	Water examination	AASHTO T26	Once before trial mixing, and when necessary

Item	Test Items	Method (Specification)	Frequency of Test
Admixture	Quality test	ASTM C494	Once before trial mixing, and when necessary (Mill sheet)
Concrete	Slump	AASHTO T119	Every 75 m^3 or a batch
	Air Content	AASHTO T121	Every 75 m^3 or a batch
	Test for compressive strength	AASHTO T22	6 samples per batch or 6 samples for every 75 m^3 of concrete (3 samples each for 7-day strength and 28-day strength
	Temperature	ASTM C1064	Every 75 m^3 or a batch

Source: JICA Survey Team

Table 2-2-28 Quality Management Plan for Earthwork and Pavement Work

Item	Test Items	Test Method (Specification)	Test Frequency
Embankment	Density test (Compaction)	AASHTO T191	Every 500 m^3
Base Course /Sub-Base	Sieve analysis	AASHTO T27	Once before placing, and once every 1,500 m^3 or change in source/quarry location
	CBR test	AASHTO T193	Once before placing, and once every 1,500 m^3 or change in source/quarry location
	Moisture - Density Relations of Soils (Compaction)	AASHTO T180	Once before placing, and once every 1,500 m^3 or change in source/quarry location
	Density test (Compaction)	AASHTO T191	Every 500 m^2

2-2-4-6 Procurement Plan*

Assumed procurement of Labor Force, Construction Equipment and Construction Materials are shown in Table 2-2-29 and Table 2-2-30.

Table 2-2-29 Procurement of Labor Force

Item		Procurement Sources			Procurement Sources, Condition
Job Classification	Spec.	Local	Japan	3rd Country	
Foreman				○	3rd Country
Bridge Foreman				○	3rd Country
Bridge Skilled Labor				○	3rd Country
Skilled Labor				○	3rd Country
Unskilled Labor		○			South Sudan
Common Labor		○			South Sudan
Rigger				○	3rd Country
Rebar Worker				○	3rd Country
Operator	For Heavy Machines			○	3rd Country
Driver	General			○	3rd Country
Carpenter				○	3rd Country
Mason				○	3rd Country
Welder				○	3rd Country
Traffic Controller		○			South Sudan
Security Guard		○			South Sudan

Source: JICA Survey Team

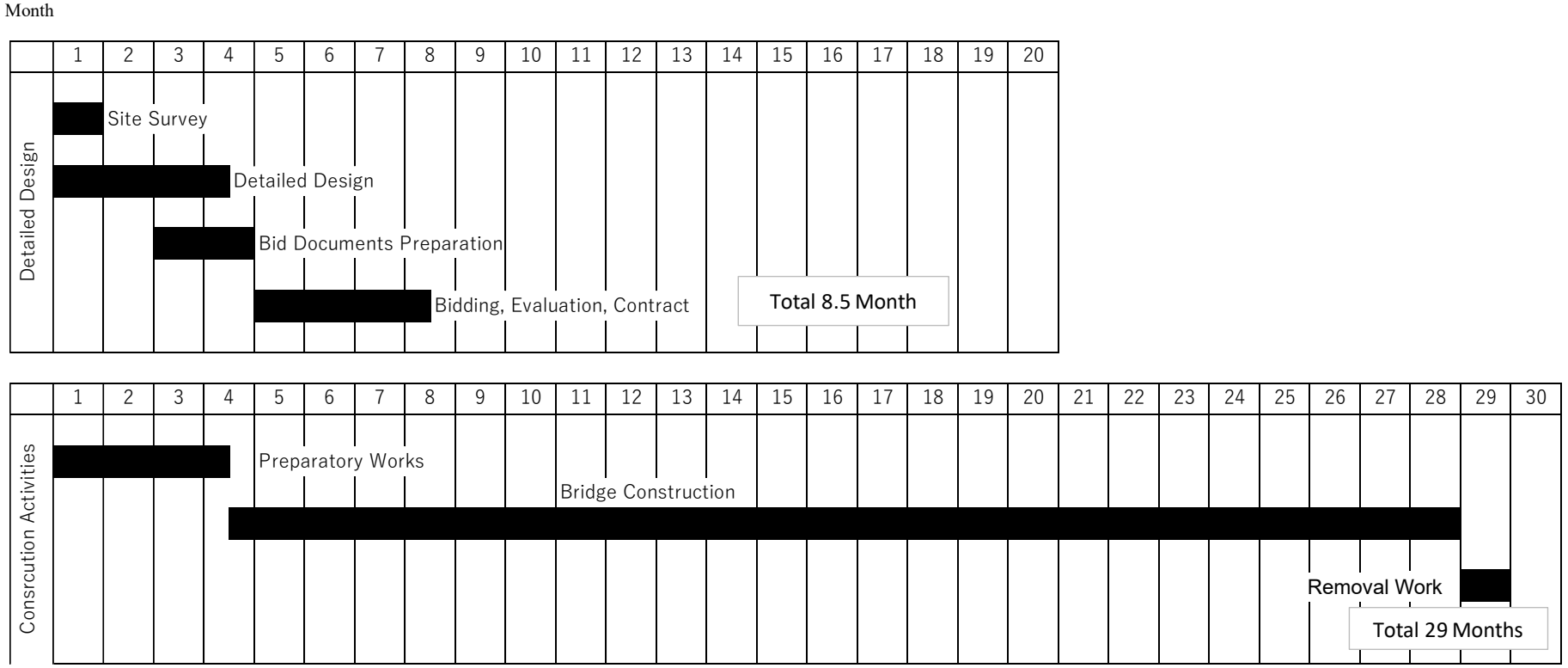
Table 2-2-30 Procurement of Major Construction Materials and Equipment to be Procured

Item	Procurement sources			Remarks
	Local	Japan	3rd	
Material for Structures				
Cement			○	Assumed From Kenya
Rebar		○		
Aggregate for Concrete	○			
Admixture		○		
Rocks	○			
Rubber bearings and Expansion Joint		○		
Anchor		○		
Sub-base Course	○			
Base Course	○			
Embankment Material	○			
Guard Rail and Fence		○		
Gabion		○		
Temporary Materials				
Fuels, oils and lubricants	○			
Timber Formwork	○			
Temporary Steel and Steel Falsework		○		
Construction Equipment				
Backhoe	○			
Dump Truck and Bulldozer			○	Assumed From Kenya
Motor Grader and Road			○	Ditto
Wheel loader and Tire Roller			○	Ditto
Truck Crane			○	Ditto
Crawler Crane (60t)		○		
Trailer			○	Assume From Kenya
Rotary Drill (All casing)		○		
Hammer Grab		○		
Truck with Crane and Small Vibrator Roller		○		
Concrete Pump Car with Boom		○		
Generator 125/150KVA		○		
Small Backhoe and Submersible Pump		○		
Line Marker		○		
Heavy Weight Breaker			○	Assumed From Kenya
Truck mixer			○	Ditto
Concrete Plant		○		

2-2-4-7 Implementation Schedule

The Implementation Schedule is shown in Table 2-2-31.

Table 2-2-31 Implementation Schedule of the Bridge Construction in Juba City



Source: JICA Survey Team

2-3 Security Plan

2-3-1 Safety Plan for Security

After independence in 2011, South Sudan's security deteriorated due to armed conflicts that occurred in 2013 and 2016 but is now improving. In addition, although there is a possibility of unexpected violent clashes based on political backgrounds and the resulting rapid deterioration of security and expansion of social disorder, the risk of indiscriminate terrorism/suicide bombings by car, etc. is low. Under such circumstances, the Nile River Bridge Construction Project is underway in South Sudan, and based on the safety measures taken in the Nile River Bridge Construction Project, the safety measures plan for this project was reviewed. The main points of the safety measures plan are as follows.

- Strengthening of 24-hour security in the construction area
- Installation of an emergency team facility in the contractor's quarters
- Transportation by bulletproof vehicles
- Assignment of security advisors
- Preparation of safety manual and evacuation manual by contractors
- Hold weekly meetings on safety measures around the project site, office, and quarters

2-3-2 Safety Plan against Covid-19

The number of people infected with the new coronavirus announced in South Sudan peaked in February 2021 and has remained at a low level. In Juba city, awareness of countermeasures against the new coronavirus infection is low, and few people wear masks. It is difficult to accurately grasp the status of infection in the city, and measures to prevent infection are necessary. Therefore, contractors/consultants and other related personnel should take thorough measures to prevent infection by wearing masks when going out or meeting with people, washing their hands and disinfecting with alcohol when returning indoors, and avoiding large gatherings and dinners to reduce the risk of infection.

2-4 Obligations of Recipient Country

The Obligation of the Government of South Sudan for the implementation of this project are as follows.

- Securing of land for construction yards, material storage areas, site offices, construction roads, detours, etc., necessary for the construction work, and burden of land lease fees
- Securing of the quarry sites, earth dumping sites, and waste disposal sites necessary for construction
- Relocation of utility facilities such as utility poles, power lines, communication facilities, water supply, etc. that may interfere with the construction work, and attachment of such facilities to new bridges as necessary
- Covering the fees and payment charges of banks that open accounts in Japan for this project (advising commission and payment commission)
- Tax exemptions for the importation of materials and equipment for the Project, customs clearance, and expedited domestic transportation
- Exemption from VAT, corporate income tax of Japanese vendors and personal income tax of employed staff for equipment and materials purchased under the Project
- Legal measures necessary for Japanese nationals engaged in this project to enter and stay in South Sudan
- Issuance of permits and approvals necessary for the implementation of the Project, environmental approvals, bridge construction permits, river construction permits, earthwork permits, traffic control permits during construction, etc.
- Appropriate use and maintenance of bridges and attachment roads after construction

- Cooperation in resolving any problems that may arise with residents or third parties in the implementation of this project
- Bearing of expenses required for the implementation of the Project, other than those covered by Japanese grant aid
- Systematic observation, measurement, analysis, and monitoring of the natural and social environment, including air and water quality, during construction and operation of the project. In addition, to respond to problems and take measures to deal with the measurement results

2-5 Project Operation Plan*

2-5-1 Organizations for Operation and Maintenance

The different organizations for road maintenance is shown in Table 2-5-1. MRB is responsible for the major maintenance, MRB-CES is responsible for periodic maintenance and daily management and Juba City is responsible for the minor works.

Table 2-5-1 Organizations of Road Maintenance (Present)

Organization	Role	Role of Juba City
MRB	Construction and maintenance of interstate roads and international roads	Construction and repair of paved roads
MRB-CES (Central Equatoria State)	Construction and maintenance of feeder roads.	Minor repair and maintenance of paved roads
Juba City Council	Construction and maintenance of community roads.	Road cleaning, etc.

2-5-2 Maintenance Equipment

MRB-CES owns equipment for road maintenance procured by the government of South Sudan in 2007 and 2010 and by the technical cooperation project of Japan. The equipment maintenance capacity of MRB-CES has been enhanced through the technical cooperation project. The daily maintenance of equipment can be directly managed.

Table 2-5-2 Equipment for Road Maintenance of MRB-CES

Type	No	Equipment	Amount	Notes
Existing	1	Bulldozer	1	
	2	Grader	1	
	3	Backhoe with Shovel	1	
	4	Backhoe	1	
	5	Vibration Roller	1	
	6	Dump Truck	3	One is available.
Grant	1	Light Truck	2	For small equipment and workers transfer
	2	Spreader	1	For asphalt repair
	3	Concrete Cutter	1	For asphalt repair
	4	Air Compressor	1	For asphalt repair
	5	Hand Breaker	2	For asphalt repair
	6	Movable Vibrating Plate	2	For asphalt and gravel road repair
	7	Rammer	2	For asphalt and gravel road repair
	8	Hand Cutter (Engine Type)	1	For asphalt and gravel road repair
	9	Distributor（Engine Type)	2	For gravel road repair
	10	Skip (60)、Pick (40)	1 set	For asphalt and gravel road repair
	11	Concrete Mixer	2	For gutter repair
	12	Water Pump	1	For asphalt and gravel road repair
	13	Wheel Barrow	20	For asphalt and gravel road repair
	14	Maintenance Equipment for Training	1 set	For training
	15	Maintenance Equipment	1 set	For equipment maintenance
	16	Track Crane (6t)	1	For small equipment and machine transfer
	17	Dump Track (4t)	1	For road repair
	18	Diesel Welding Machine	1	For cutting damaged part of concrete
	19	Belt Conveyer	4	For excavated soil transport
	20	Maintenance and Repair Equipment	1 set	Repair tool for road equipment
	21	High Water Pressure Machine for Car Washing	1 set	For carwash
	22	Pump for well and Piping Material	1 set	For waterworks in the maintenance station
	23	Diesel Generator	2 set	For power supply in the maintenance station
	24	Distribution Board	3 set	For power supply in the maintenance station
	25	Container Workshop	4 set	Machine maintenance
	26	Formwork for Concrete Pipe (φ600mm)	2 set	For drainage maintenance
	27	Formwork for Concrete Pipe (φ600mm)	2 set	For drainage maintenance
	28	Concrete Barricade	2 set	For road division maintenance
	29	Concrete Vibrator with High Frequency	4 set	For improvement of placement
	30	Gantry Crane	1 set	For concrete pipe manufacture
	31	Water Tank, Piping Material	2 set	For concrete pipe manufacture
	32	Road Line Marker and Remover	1 set	For road white line repair
	33	Hand Vibrating Roller	1 set	For compaction repair of soft ground

2-5-3 Contents of the Maintenance Work

The required maintenance works for the Project are the following;

Periodic Inspection:	Periodic inspection of Bridges and Approach Roads
Routine Maintenance:	Cleaning of drainage facilities, Road Pavement, Expansion devices, Shoulder and Bridges
Repair:	Repair of Road Pavement, Drainage facilities, Structures, Bridges, Shoulder, Slopes, Prevention block, etc.

2-5-4 Consideration in Maintenance Work

Maintenance of the roads and bridges to keep in a good condition is the responsibility of the GOSS. To keep a smooth flow of traffic and to maintain the life of facilities, the following should be taken into consideration.

- Implement regular maintenance and always understand the situation of the facilities.
- Cleaning especially Drainage facilities, Bearing, Expansion devices and the area around them
- Secure the required budget for maintenance

There will be no big repairs and technical difficulties for the daily maintenance due to the high quality of durability and on the influence of the climate. If the above-mentioned maintenance is noted, upkeep of the good condition of the bridges with the current and organization will be easy.

2-6 Project Cost Estimation

2-6-1 Initial Cost Estimation

2-6-1-1 South Sudan's Contribution

Table 2-6-1 Approximate Project Cost Contribution of South Sudan

Item		Amount (US$)
i)	IEE, EIA	1,000
ii)	Bank Charge	24,600
iii)	Removal of Obstructions	5,000
iv)	PMP, EMP, EMoP	5,000
v)	Power Supply	40,000
vi)	Safety Measures	50,000
vii)	Compensation Cost	1,000
Total		126,600

2-6-1-2 Cost Estimation Condition

Cost Estimation Date: August 2021
Foreign Exchange Rate: US$ 1.00 = 110.90 JPY

2-6-2 Operation and Maintenance Cost*

The Ministry of Roads and Bridges (MRB) has an annual budget of US$ 262 million in 2020/21. The annual maintenance cost of the four (4) bridges is about US$ 6,460 per year, as shown in Table 2-6-2 which represents 0.0025% of the total budget. Likewise, the annual maintenance cost of the approach road is about US$ 10,680 which represents 0.004% of the budget. Therefore, it is possible to carry out the operation and maintenance of the facility within the budget amount.

Table 2-6-2 Bridge Maintenance Cost

Item	Frequency	Amount (US$)
Periodic Inspection	12 times/year (1 day/ea)	2,192.40
Routine Maintenance	4 times/year (2 day/ea)	2,217.60
Repair	1 times/year (4 day/ea)	2,049.54
	Total	6,459.54

* Details are shown in Table 2-6-4.

Table 2-6-3 Road Maintenance Cost

Item	Frequency	Amount (US$)
Periodic Inspection	12 times/year (1 day/ea)	2,192.40
Routine Maintenance	4 times/year (2 day/ea)	2,217.60
Repair	1 times/year (4 day/ea)	6,272.10
	Total	10,682.10

* Details are shown in Table 2-6-5.

Table 2-6-4 Major Maintenance Items and Annual Expenses for Bridges

	Facility Name	Items to be Checked	Frequency	Number of Staff	Equipment to be Used	Required Quantity	Amount (US$)
Periodic Inspection	Pavements Drainage Main Body Revetment Bridge Facility	Crack, undulations, defects Siltation, obstacles, Damage, deformation, stains, abrasion, etc. Failure Cracks, defects, detachment, Handrails damage	12 times/year (1 day per inspection)	2	Shovel, hammer, sickle, barricades, Pickup truck	24 man-days/year 12veh-days/ year	756.00 1,436.40
						Sub-total	2,192.40
Routine Maintenance	Pavement Drainage Expansion Joint Bridge	Cleaning Sediment and obstacle removal, cleaning Sediment and obstacle removal, cleaning Cleaning	4 times/year (2 days per maintenance)	5	Shovels, barricades, mower, brooms, tools, Pickup truck	40 man-days/year 8 veh-days/ year	1260.00 957.60
						Sub-total	2,217.60
Repair	Pavements Drainage Main Body Bridge Facility Pavement Marking	Crack sealing, damage repair Repair of damages Repair of damages Repair of handrail damages, etc. Maintenance of road pavement marking	1 time/year (4 days per repair)	6	Plate compactors, Pickup truck Concrete Lane Paint	24 man-days/year 4veh-days/ year 4veh-days/ year 1.0m^3/year 15m/year	756.00 140.40 624.40 524.99 3.75
						Sub-total	2,049.54
						Total	**6,459.54**

Table 2-6-5 Major Maintenance Items and Annual Expenses for Approach Roads

	Facility Name	Items to be Checked	Frequency	Number of Staff	Equipment to be Used	Required Quantity	Amount (US$)
Periodic Inspection	Pavements Shoulder Slope Drainage	Cracks, undulations, defects, etc. Deformation, erosion, settlement, etc. Sediment, presence of obstacles	12 times/year (1 day per inspection)	2	Shovel, hammer, sickle, barricades, Pickup truck	24 man-days/year 12veh-days/ year	756.00 1,436.40
						Sub-total	2,192.40
Routine Maintenance	Shoulder Slope	Grass cutting, cleaning	4 times/year (2 days per maintenance)	5	Shovels, barricades, mower, brooms, tools, Pickup truck	40 man-days/year 8 veh-days/year	1,260.00 957.60
						Sub-total	2,217.60
Repair	Pavement Shoulder Slope Road Ancillary	Crack sealing, defect repair, Repair of the damaged area Repair of the damaged area	1 time/year (4 days per repair)	6	 Plate compactors, Pickup truck, Asphalt Roadbed material Lane Paint	24 man-days/year 4veh-days/ year 4veh-days/ year $4m^3$/year $35m^3$/year 15m/year	756.00 140.40 624.40 537.00 2,234.00 2,217.30 300.00
						Sub-total	6,272.10
						Total	**10,682.10**

Chapter 3 Project Evaluation

3-1 Preconditions*

The preconditions for project implementation are as follows;

(1) Conditions Related to Environment

- The land acquisition and resettlement are not expected for the bridge construction.

(2) Conditions Related to Construction

- MRB completes the removal of the obstructions before the bidding.
- MRB obtains the permission relating to the use of borrow pit and construction yard before the bidding.
- If the water of the Nile River is needed for the project, MRB gets the permission of its use.

3-2 Necessary Inputs by Recipient Country*

After project completion, road maintenance is necessary to prolong the life of the structure and the road. Maintenance work that includes daily or routine maintenance, removal of obstacles, cleaning, etc. Periodic inspection shall be carried out and essential repairs will be undertaken appropriately if damage is observed to structures and pavements.

It is, therefore, necessary to secure an annual maintenance budget to maintain and repair the facilities (Bridges and Approach Roads; U.S.$ 17,142/year). As noted in the earlier section, the allocation of operation and maintenance budget in South Sudan is considered possible.

3-3 Important Assumption*

In order to express and prolong the effect of the project, the budget should be ensured the maintenance costs of the bridge and the approach road. It becomes the important assumption.

3-4 Project Evaluation

Based on the overall picture of the project, the Relevance and the Effectiveness of the project (quantitative effect and qualitative effect) are shown as follows;

3-4-1 Relevance*

Relevance of the Project is shown in Table 3-4-1.

Table 3-4-1 Relevance of the Project (Small Scale Bridges)

View Point	Relevance
Consistent with the development plan	・The national plan of post-independence " South Sudan Development Plan 2011-2013 " is extended to 2016 and it is the pillar of the development. The plan focuses on " Governance " , " Economic development " , " Social and human development ", and " Conflict prevention and security " as the four pillars of development. It is possible to develop the safe, efficient and sustainable road network of Juba city by this project. Thereby supporting the development of South Sudan, the economic growth in the region of Juba city, domestic and international logistics, investment promotion , consolidation

View Point	Relevance
	of peace and even contribution to poverty reduction . The aforementioned corresponds to "Economic development" and "Social and human development" and "Conflict prevention and security" and therefore the project is consistent with the development plan.
Consistency of aid policy and policies	・ The basic policy of Japan's ODA to the South Sudan is shown as follows. These points follow the history of South Sudan gaining independence in July 2011 after experiencing 2 civil wars since 1955 and JICA supports nation building based on the South Sudan Development Plan. 1) Basic economic and social infrastructure upgrading, 2) Alternative industrial development , 3) Basic life and livelihood improvement , 4) Support in accordance with the governance and security capacity building, 5) Continued humanitarian assistance to internally displaced persons All 5 points are to provide assistance to support the consolidation of peace in the country. ・ Therefore, this project is line with the policy of " Basic economic and social infrastructure upgrading. And there is a necessity and advantages of using Japanese bridge construction technologies. In addition, it is possible to implement the project under the system of Japan's Grant Aid.
Construction Techniques	・ The construction of the bridge with required quality is difficult for the local contractors in South Sudan due to lack of experience.

3-4-2 Effectiveness

3-4-2-1 Quantitative Effects

The design traffic volume is set for the predicted traffic after 10 years in service. The predicted traffic volume at each bridge is indicated in the Table 3-4-2.

The service starts at the time of the completion of the project (2025 year), The service of the 3 years later (2028 year) enables bridges to correspond to the increase of the predicted traffic.

In addition, the running speed improvement and the increase of passable vehicle weights contribute to the mitigation of the traffic congestion in Juba city.

Table 3-4-2 Effectiveness/Quantitative Effects

Bridge Number.	Actual Traffic Volume(pcu/day)*	Predicted Traffic Volume (pcu/day)**	Predicted Traffic Volume (pcu/day)***
	Current Situation	Start of Service	3 years after start of service
	2021	2025	2028
No.1	21,742	27,970	30,787
No.4	20,085	25,839	28,441
No.7	19,582	25,192	27,729
No.10	22,672	29,167	32,104
Average Speed(km/h)	10	50	50
Passable Vehicle Weight	10 ton (one bridge 20 ton)	25 ton	25 ton

* Actual Traffic Volume Counted on August 2021
** Predicted Traffic Volume calculated by JICA Strada
*** Predicted Traffic Volume calculated 6.5% as increasing ratio from 2025 and 3.25% from 2031

3-4-2-2 Qualitative Effects

Table 3-4-3 Effectiveness/Qualitative Effects

View Point	Effectiveness/Qualitative Effect
Urgency	・The slab floor of the bridge No.1 partly collapsed under the existing traffic load and it was repaired in 2011 by the GOSS. However, since the quality of the construction was poor, deterioration of concrete or the exposure of rebars were already found and there is a possibility to recurrent collapse very soon. Reconstruction of the bridges is able to avoid this risk at an earlier stage. ・The structural strengths of other bridges have been greatly reduced due to aging. All requested bridges become traffic bottlenecks due to narrower widths to approach roads. In addition, accidents such as vehicles falling off a bridge have occurred at the bottlenecked location. Reconstruction of the bridges is able to avoid this risk at an earlier stage.
Benefit	・Bridges No.1, 4, 7 and 10 are located on the main roads of Juba city, has become a bottleneck of the traffic flow in the city center. Since the road of Juba city has been developed prior to the radiation road and the city center place, the city traffic suffers the congestion without dispersion of traffic flow. By widening the bridge width from a two-lane or single lane to a four-lane, improvement of traffic flow is anticipated contributing to mitigation of traffic congestion in Juba city. ・Bridges promote the ring road network development and also contribute to reduce the exhaust gas and noise and to improve the environment. ・In the 2020, the population of Juba city was 400 thousand people according to World Bank. The population growth expected by the World Population Prospects assumes that it may be about 567 thousand in 2028. The entire population is able to be benefited. ・The cargo is transported to various places through the Juba city where is located in the node of the international corridor and the major domestic trunk lines. The mitigation of the congestion in Juba city will serve benefits not only to Juba city traffic flow but also for facilitation of international and domestic logistics. ・The traffic to Juba city from neighboring community residents is promoted after the bridge reconstruction. ・This project is intended to continue to the city development following the development of 6 bridges under the peace-building program and the Nile bridges construction under the Japan's Grant Aid. Implementation of this project will contribute to the trust-building between the two countries.