MINISTRY OF ROADS AND HIGHWAYS (MRH)
GHANA HIGHWAY AUTHORITY (GHA)
REPUBLIC OF GHANA

REHABILITATION OF NATIONAL TRUNK ROAD NO. 8 (PHASE 2) IN THE REPUBLIC OF GHANA

OUTLINE DESIGN REPORT

JANUARY 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CENTRAL CONSULTANT INC.
EIGHT JAPAN ENGINEERING CONSULTANTS CO. LTD.

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on Rehabilitation of National Trunk Road No. 8 (Phase 2) and entrusted the survey to the consortium consist of Central Consultant Inc. and Eight Japan Engineering Consultants Co. Ltd.

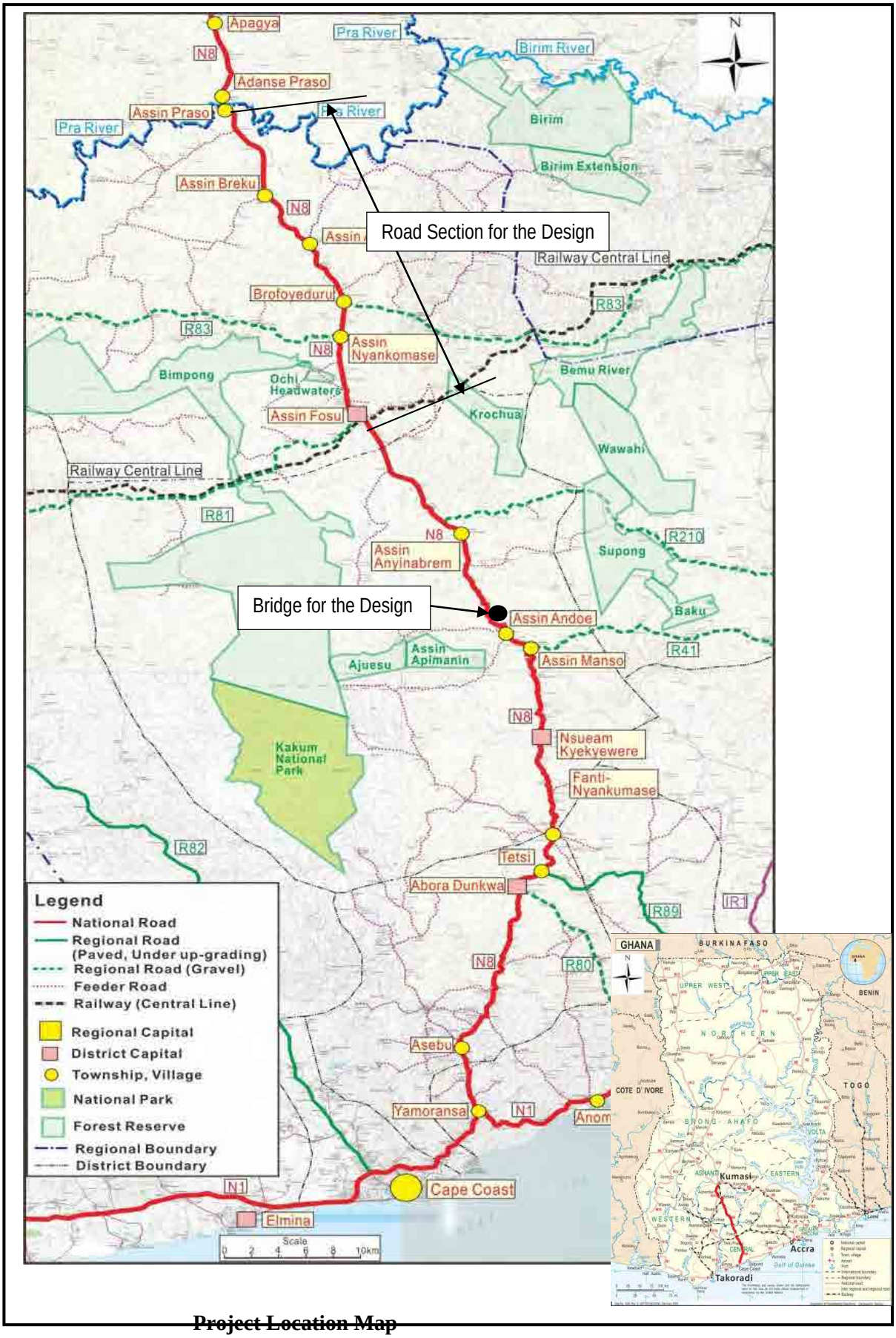
The survey team held a series of discussions with officials concerned of the Government of the Republic of Ghana, and conducted field investigations. As a result of further studies in Japan, the present report was finalised,

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

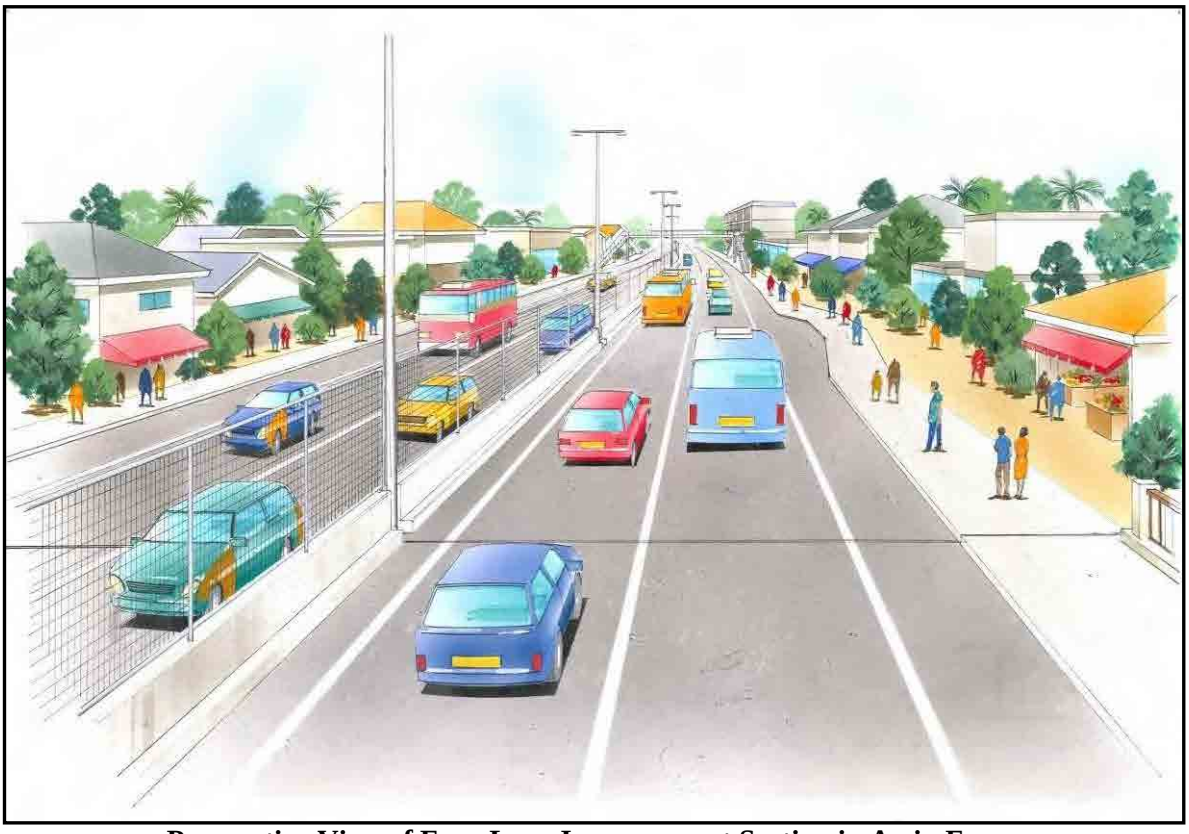
Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Ghana for their close cooperation extended to the survey team.

January 2015

Akira NAKAMURA
Director General
Infrastructure and Peacebuilding Department
Japan International Cooperation Agency



Project Location Map



Perspective View of Four Lane Improvement Section in Assin Fosu

Perspective View of Two Lane Rehabilitation Section

SUMMARY

SUMMARY

1. Outline of the Country

The Republic of Ghana (Ghana) lies in a tropical region in the western part of the African continent between 4º and 11º from the equator and its climate is classified as tropical savannah.

The total population of the nation is 25 million, and the total land area is 238,537 km^2. Ghana has reduced the poverty headcount ratio at USD 2.00 a day and USD 1.25 a day by about 26 points and 23 points, respectively, however, the poverty headcount ratio at USD 2.00 a day was still as high as 51.8% in 2006.

The per capita gross domestic product (GDP) in 2012 was USD 1,645 (World Bank), of which primary industry accounted for 23.0%, secondary industry for 28.6% and tertiary industry for 48.4%. Ghana's economy depends on primary products such as agricultural and mining products, and the three major export commodities are gold, cacao and timber. These products tend to be influenced by international market prices and the climate. However, the agriculture and mining sectors have received major foreign direct investment.

Agriculture is the most important economic sector: more than half of the population engages in agriculture, and agricultural products account for 27% of GDP and 34% of exports by value. The production volume of agricultural products in total excluding cocoyam has increased by 5.1% per annum and is currently 28 million tonnes. By product, annual production of rice accounts for 8.6% by volume, followed by maize and plantain. Cacao is a traditional export commodity of Ghana, with the world's sixth largest share at 5.4%, and accounting for 27% of total exports by value of Ghana in 2010. Furthermore, production of oil palm has increased thanks to large-scale plantations and individual farms, however, oil palm is mainly consumed within Ghana and neighbouring countries. Even though the export values of cash crops vary year by year, exports of bananas, vegetables and cashew nuts have continuously increased.

The total length of the trunk road network is 14,588 km, consists of 2,106 km of asphalt concrete paved roads (14.4%), 38 km of cement concrete paved roads (0.3%), 5,005 km of bitumen surface roads (34.3%), and the remaining roads are unpaved. Infrastructure development in Ghana, mainly road development, has focused on the so-called 'golden triangle' in the southern part of the country, connecting Accra, Tema Port and Kumashi Takoradi Port, which have large concentrations of population, mineral resources and agricultural production.

2. Background, Circumstances and Outline of the Grant Aid Project

The N8 was improved to an asphalt concrete road between 1990 and 1994 with financial assistance from Japan. However, the road surface has rapidly deteriorated mainly due to the much faster increase in traffic and deterioration with age than was expected at the design stage. As a result, it became impossible for the Ghana Highway Authority (GHA) to maintain the road by routine and periodic maintenance alone. The Government of Ghana (GoG) requested grant aid from the Government of

Japan (GoJ) in order to improve and rehabilitate 176 km of road sections, including the reconstruction of two bridges, in 2006. Within this requested road section, improvement works of the section between Assin Praso and Bekwai (about 60 km), where the road surface had deteriorated seriously, were commenced in 2009 under the grant aid programme of the GoJ under the Rehabilitation of National Trunk Road No. 8 (Phase 1 Project) and were completed in December 2013.

The contents of the request for this Project from the GoG were rehabilitation of the N8 between Assin Praso and Yamoransa (about 100 km), which was excluded in the Phase 1 Project, and two other sections. The Preparatory Survey Team (Study Team) surveyed the road surface damage, and examined past records of rehabilitation as well as the need for rehabilitating the road section as requested by the GoG. As a result, the Study Team selected the section between Assin Praso and Assin Fosu (31.2 km) for the outline design in consideration of severe damage to the road surface, insufficient traffic capacity which causes chronic traffic congestion in the centre of Assin Fosu township, and continuation from the Phase 1 Project, and the GHA agreed with this selection.

Also, the centre of Assin Fosu township suffers constant traffic congestion and is the worst bottleneck on the N8 mainly due to many minibuses and taxis waiting for passengers on the carriageway. Based on the further request of the GHA for dualisation of a part of the section in the centre of Assin Fosu township, the Study Team has decided to dualise 1.2 km of this section, based on traffic demand forecasts and the social benefits generated by dualisation. The Study Team also clarified the deterioration of the existing railway underpass bridge and its insufficient traffic capacity, and decided to reconstruct the railway underpass as a box culvert.

Furthermore, road closures occasionally occur north of Assin Andoe (about 20 km south of Assin Fosu) when the Okyi River overflows the four continuous box culverts installed at the N8, causing a bottle neck during the rainy season. The Study Team also selected these four-continuous box culverts for the outline design to be replaced by a bridge.

3. Outline of the Results of the Study and Summary of the Project

JICA dispatched the Study Team to Ghana between 5th October and 20th November, 2014 and 1st and 22nd December to carry out survey works in Ghana to prepare the rehabilitation plan for the above-mentioned road section. The Study Team had discussions with relevant agencies of the GoG, conducted site surveys, carried out engineering studies and examined the suitability of the Project for the Grant Aid Scheme. Then, the Study Team selected a section for the outline design, and confirmed the necessity and importance of road rehabilitation of the section selected for the outline design.

JICA also dispatched the Study Team to Ghana between 26th February and 25th March, 2014 for verification of the draft design drawings and the traffic safety audit by the GHA, as well as to help the GHA hold a public forum.

The Study Team then examined the justification for rehabilitating 31.2 km of the road section between Assin Fosu and Assin Praso (including dualisation in the centre of Assin Fosu township and reconstruction of the railway underpass bridge), and reconstruction of the Okyi River bridge, at the stage of works in Japan. Based on the results of the site investigations and analyses of natural

condition surveys, the Study Team studied the scale of road rehabilitation and reconstruction of the Okyi River bridge (including approach roads), prepared the outline design drawings, estimated construction works quantities, prepared the implementation programme, and estimated the preliminary project costs.

The Study Team compiled the results of the works in Ghana and in Japan as the Draft Outline Design (DOD) Report. Then, JICA dispatched a mission to explain the contents of the DOD Report to Ghana between 20th and 29th November, 2014, and obtained basic agreement from the relevant authorities in Ghana on the contents of the DOD Report.

The outline design based on the results of the Study is summarised in Table S-1.

Table S-1 Summary of the Outline Design

Item	Type/Specification
Rehabilitation of road between Assin Fosu and Assin Praso	
Section to be rehabilitated	Assin Fosu Police Barrier – Assin Praso community: 31.2 km 2-lane section: 30.0 km Dualised section: 1.2 km (centre of Assin Fosu township)
Cross sectional elements	2-lane section: Total road width 12.3 m Carriageway 3.65 m × 2, shoulder 2.50 m × 2 Dualised section: Total road width 22.5 m Carriageway 3.25 m × 4, shoulder 2.00 m × 2, sidewalk 2.00 m × 2, median 1.50 m
Pavement	Asphalt concrete pavement
Drainage facilities	Box culvert, RC pipes (cross drainage and vertical drainage at cross roads), U-shape ditch and side ditch
Railway underpass bridge	Reconstructed by a RC box culvert
Ancillary works	New Jersey type centre median (dualised section), bus stops, steps, street lightings, pedestrian overpass bridge, toll plaza, traffic safety devices, etc.
Reconstruction of four-continuous box culverts on the Okyi River by a bridge	
Location of bridge	Okyi River north of Assin Andoe community on the N8
Bridge length	25 m
Cross-sectional elements	Bridge section Carriageway 3.65 m × 2, shoulder 0.60 m × 2 Total 8.5 m (road section) Sidewalk 1.50 m × 2 Approach road section Carriageway 3.65 m × 2, shoulder 2.50 m × 2 Total 12.3 m
Superstructure type	2-span Continuous T-Girder Rigid-frame RC Slab Bridge
Substructure type	Reverse T-style abutments (two) Elliptical type pier (one) Direct foundation
Pavement on bridge surface	Asphalt concrete pavement
Ancillary works	Drainage facility, street lightings, steps, traffic safety facility

Source: Study Team

4. Implementation Programme and Preliminary Cost Estimation

The planned implementation period necessary for the Project is 9 months for the detailed design and 36 months for the construction works.

The project will be implemented in accordance with Japan’s Grant Aid scheme and the costs will be

determined before concluding the Exchange Note for the project.

5. Project Evaluation

(1) Quantitative Effects

Table S-2 shows the quantitative effects that are considered to be generated by implementation of the Project.

Table S-2 Quantitative Effects of the Project

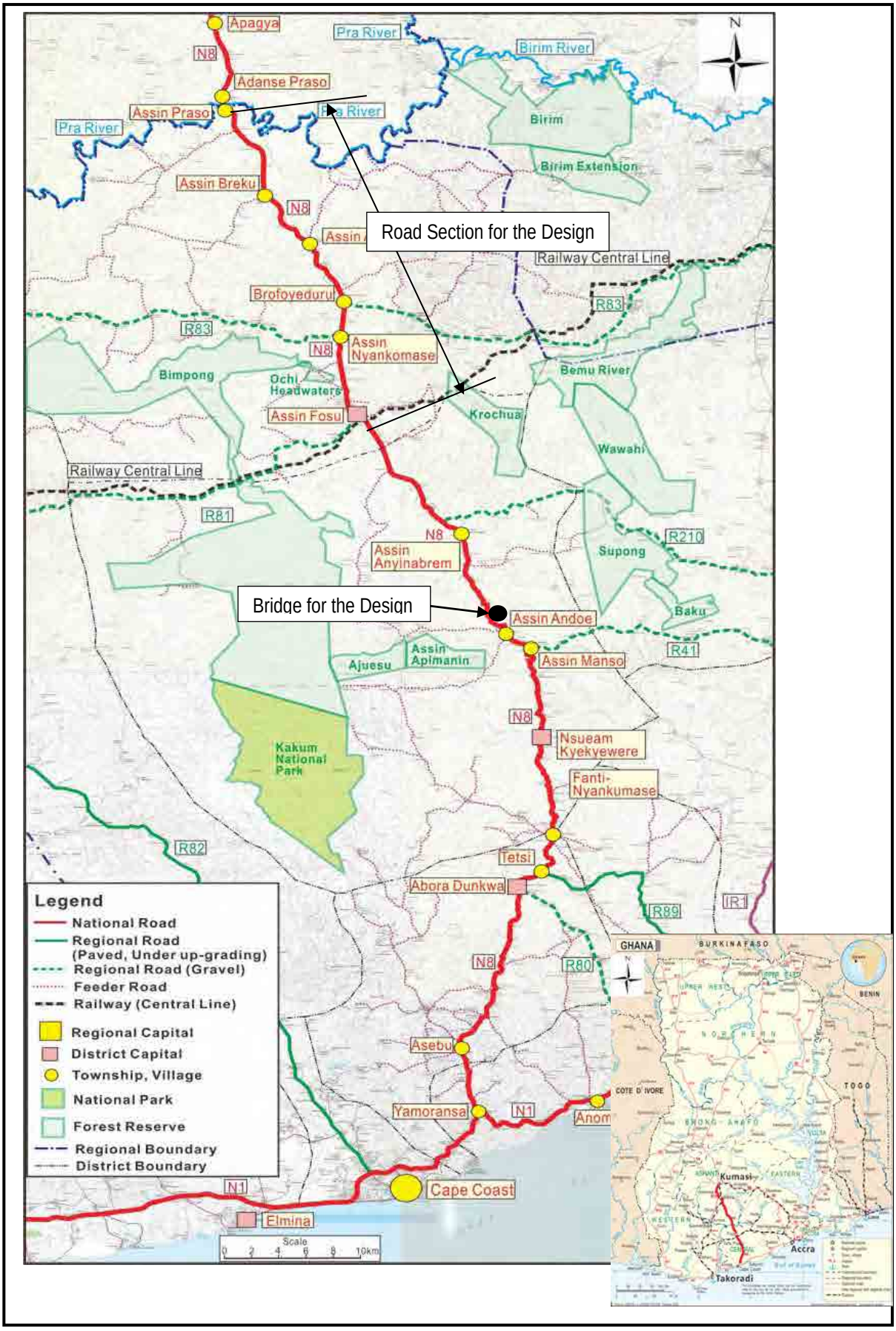
Index	Base Year (2013)	Target Value (2021) [3 years after completion of the Project]
1. Average daily traffic volume (veh./day)		
Assin Fosu	12,473	14,361
Assin Praso	2,749	4,546
2. Travel speed for the project section (between Assin Fosu and Assin Praso)	30’15”	22’30”

Source: Study Team

(2) Qualitative Effects

The qualitative effects that are considered to be generated by implementation of the Project are as follows:

1) Rehabilitation of the national trunk road will help strengthen and stabilise the transport capacity of logistics connecting the coastal area of Ghana, and central and northern areas as well as neighbouring landlocked countries.
2) Road closures due to inundation of the road during the rainy season will be eliminated, and access to markets and public services by residents of local communities will be secured.
3) Dualisation of the road and railway overpass bridge at the centre of Assin Fosu township will solve chronic traffic congestion and improve traffic safety by sidewalks and intersections.
4) Even though Ghana has reduced the poverty headcount ratio since 1991, the ratio based on USD 2.00/day was still as high as 51.8% in 2006. One of the qualitative effects of rehabilitating the N8 is expected to be alleviation of the poverty ratio, especially of local residents living along the N8.



Project Location Map

Perspective View of Four Lane Improvement Section in Assin Fosu

Perspective View of Two Lane Rehabilitation Section

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List of Abbreviations

Abbreviation	Full Name
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphalt concrete
ADT	Average Daily Traffic
ADF	African Development Fund
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ANMA	Assin North Municipal Assembly
A/P	Authorisation to Pay
ARAP	Abbreviated Resettlement Action Plan
BADEA	Arab Bank for Economic Development in Africa
B/A	Banking Arrangements
BS	British Standard
CBR	California Bearing Ratio
CO_2	Carbon dioxide
ECOWAS	Economic Community of West African States
EIA	Environmental Impact Assessment
EMU	Environmental Management Unit, GHA
E/N	Exchange Note
EPA	Environmental Protection Agency
ESAL	Equivalent Single Axle Load
EU	European Union
FWD	Falling Weight Defectometer
GHA	Ghana Highway Authority
GHACEM	Ghana Cement
GHS	Ghana Cedi
GoG	Government of Ghana
GRDA	Ghana Railway Development Authority
HIV	Human Immunodeficiency Virus
IRI	International Roughness Index
IDA	International Development Association
JICA	Japan International Cooperation Agency
LED	Light-emitting diodes
LI1652	Environmental Assessment Regulations LI1652, 1999
MCC	Millennium Challenge Corporation
MRH	Ministry of Roads and Highways
N8	National Road No. 8
NGO	Non-Governmental Organizations
NO_2	Nitrogen dioxide
O/D	Origin and Destination
OPEC	Organization of the Petroleum Exporting Countries
PAPs	Project Affected Persons
PC	Prestressed Concrete
PM_{10}	Particulates
P/Q	Prequalification
RAP	Resettlement Action Plan
RC	Reinforced Concrete
ROW	Right of Way
RPF	Resettlement Policy Framework
SF	Saudi Fund for Development
SO_2	Sulfur dioxide
TOR	Terms of Reference
USD	United States Dollar
WB	World Bank

CHAPTER 1

BACKGROUND OF THE PROJECT

Chapter 1 Background of the Project

1-1 Background, Circumstances and Outline of the Grant Aid Project

1-1-1 Background and Circumstances of the Grant Aid Project

Infrastructure development in Ghana, mainly road development, has focused on the so-called golden triangle in the southern part of the country, connecting the Accra economic region consisting of the capital Accra and Tema Port, the Kumashi economic region in the inland area, and the western economic region centred on Takoradi Port, where there are high concentrations of population, mineral resources and agricultural production. The target road of the Preparatory Survey on Rehabilitation of National Trunk Road No. 8 (Phase 2) (Study), National Road No. 8 (N8), is located in the centre of this golden triangle, and connects a part of these economic regions and functions as an important economic corridor for transporting major export commodities such as timber, cacao, gold, manganese and bauxite to Takoradi Port as well as transporting major import commodities to Kumashi from Tema Port. In addition, due to political instability in Cote d'Ivoire in 2002, much transit cargo related to landlocked countries such as Burkina Faso, Mali and Niger shifted from Abidjan Port to Takoradi and Tema Ports, and so the N8 became part of international transport routes and its role as an international logistics corridor has increased.

The N8 was improved to an asphalt concrete road between 1990 and 1994 with financial assistance from Japan. However, the road surface has rapidly deteriorated mainly due to the much faster increase in traffic and deterioration with age than was expected at the design stage. As a result, it became impossible for the Ghana Highway Authority (GHA) to maintain the road by routine and periodic maintenance alone.

Therefore, the Government of Ghana (GoG) requested grant aid from the Government of Japan (GoJ) in order to improve and rehabilitate 176 km of road sections, including the reconstruction of two bridges, in 2006. Within this requested road section, improvement works of the section between Assin Praso and Bekwai (about 60 km), where the road surface had deteriorated seriously, was commenced in 2009 under the grant aid programme of the GoJ and was completed in December 2013.

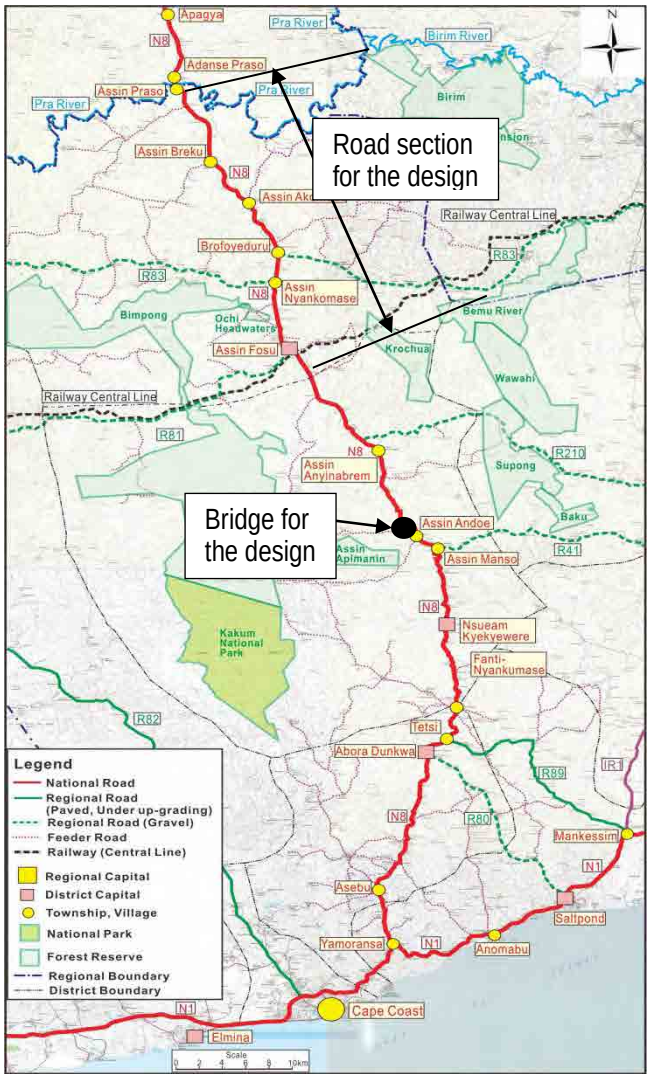
In the present Study, the Study Team of Japan International Cooperation Agency (JICA) investigated the condition of the remaining road sections, selected appropriate road section(s) for the project after identifying the priority, carried out an appropriate outline design for the grant aid scheme, prepared the project implementation plan, and estimated the preliminary costs.

1-1-2 Outline of the Project

(1) Rehabilitation of Road Section

The Study Team surveyed the road surface damage, and examined past records of rehabilitation as well as the necessity of rehabilitating the road section as requested by the GoG. As a result, the Study Team selected the section between Assin Proso and Assin Fosu (31.2 km) in consideration of severe damage to the road surface, insufficient traffic capacity which causes chronic traffic congestion in the centre of Assin Fosu township, and continuation from the previous Project of Rehabilitation of National Trunk Road No. 8 (Phase 1). The Study Team then proposed this selection to the GHA, and both parties agreed to proceed with the Study.

The centre of Assin Fosu township suffers constant traffic congestion, not only on market days (Tuesday and Friday) but also on other days, and is a bottleneck on the N8. Therefore, the Study Team has decided to dualise 1.2 km of the section in the centre of the township, after consultation with the GHA. Furthermore, the Study Team clarified the deterioration of the existing railway underpass bridge and its insufficient traffic capacity, and decided to reconstruct the railway underpass as a box culvert. Figure 1 shows the road section for the outline design, and the outline of the rehabilitation project is shown below.



Source: Study Team

Figure 1 Sections for the Outline Design

- Rehabilitation of 31.2 km of road section between Assin Fosu and Assin Praso by asphalt concrete (AC) pavement.
- Dualisation to a 4-lane carriageway of a 1.2 km section in the centre of Assin Fosu township
- Reconstruction of the railway underpass bridge by a reinforced concrete (RC) box culvert
- Construction of a pedestrian overpass bridge at adjacent to the new market in Assin Fosu
- Reconstruction and rehabilitation of drainage structures between Assin Fosu and Assin Praso
- Installation of a toll plaza for north-bound traffic at the south of Assin Praso township

(2) Reconstruction of Bridge

Road closures occasionally occur north of Assin Andoe (about 20 km south of Assin Fosu)

when the Okyi River overflows the four continuous box culverts installed on the N8, causing a bottle neck during the rainy season. The Study Team also selected these four continuous box culverts for the outline design to be replaced by a bridge. The bridge to be constructed is as follows:

- Position of bridge: At the same position as the existing box culverts
- Bridge length: 25 m
- Superstructure type: 2-span continuous T-girder rigid-frame RC slab bridge
- Substructure type: reverse T-style abutments and an elliptical type pier
- Foundation type: Direct foundation
- Length of approach roads: 494 m

1-2 Present Condition of the Project Sites and Surrounding Areas

1-2-1 Present Condition of Existing Facilities

The present condition of the N8, which is the target road of the Project is as described below.

(1) Section between Assin Praso and the North of Assin Fosu Township (27.0 km)

This road section, which is a continuation of the Phase 1 section from Assin Praso, was mostly constructed in a hilly terrain, the same as the section from Adanse Asokwa toward the south in the Phase 1 section, and there are many curved sections and sags (transition point from a downgrade to an upgrade of the road). There are several sections with damaged pavement, and many of these sections are sags where surface water cannot be drained.

The present average daily traffic (ADT) volume at Assin Praso in this section is 2,739 veh./day, and it is expected to increase to 6,785 veh./day in 2038, 20 years after completion of the Project.

According to the results of the axle road survey conducted in this section, many semi-trailers carrying cargoes with close to the allowable axle load, mainly carrying raw lumber, were observed, since commercial logging is active on both sides of this section.

(2) Section between Assin Fosu Old Township Area and Railway Underpass Bridge (3.1 km)

Assin Fosu township, which is the centre of Assin North Municipal, has rapidly expanded from the old township area towards the railway side, and the main market was constructed on the east side of the Assin Fosu railway station. As a result, the largest commercial area along the N8 was formed, as shown in Figure 2. The market has become too crowded and many vendors are doing business regularly along the N8, which cause traffic congestion in the centre of Assin Fosu township. In order to solve this problem, the Assin North Municipal Assembly has constructed a new market and a lorry park for minibuses and trucks to the north of the new market. However, traffic congestion in the centre of Assin Fosu remains, mainly due to many taxis waiting for passengers and minibuses entering/exiting the lorry terminal, thus obstructing the main traffic flow.

The present ADT at this section is 10,654 veh./day on the railway underpass bridge, and the future traffic volume is projected as 26,947 veh./day, exceeding the traffic capacity of the two-lane carriageway. In addition, even though the maximum speed limit in urbanised area and township area is set at 50 km/h, the actual average speed of vehicles in the centre of Assin Fosu township is much slower at 22 km/h, according to the result of a travel speed survey conducted by the Study Team. Thus, it was confirmed that the centre of Assin Fosu township is the worst bottleneck on the N8.

Source: Study Team

Figure 2 Present Situation of Assin Fosu Township

(3) Railway Underpass Bridge at Assin Fosu

The existing railway underpass bridge is 6.5 m wide and 14.2 m long, and it was not reconstructed during reconstruction of the N8 with a Japanese Yen Loan. Therefore, the bridge structure has deteriorated. At the time of the Study, the Central Line of Ghana Railway under the bridge had ceased operation as of 2009. The Ministry of Transport (MoT) and Ghana Railway Development Authority (GRDA) plan to reconstruct the Central Line using standard gauge (1,435 mm), and so it is necessary to satisfy the construction standard required by the GRDA when reconstructing this underpass bridge.

In addition to the traffic volume counting survey on this bridge, the Study Team also counted the number of pedestrians and bicycles crossing the bridge. The results showed that 11,624 persons/day and 721 bicycles/day cross this bridge, which has no sidewalk and hence a very high risk of traffic accidents.

(4) Section between Railway Underpass Bridge and Police Barrier (1.2 km)

At about 500 m south of the Assin Fosu railway underpass bridge, there is a section where pavement deterioration is the worst between Assin Praso and Yamoransa. This section is a sag from a downgrade of the vertical alignment both from the railway underpass bridge and the police barrier, and almost all AC structures have disappeared and the base course is exposed across the whole width of the carriageway, due to inundation during the rainy season.

(5) Four-continuous Box Culvert at Assin Andoe

The four-continuous box culvert located to the north of Assin Andoe community, about 20 km south of Assin Fosu township, was constructed at a new location across the Okyi River during reconstruction of the N8 with a Japanese Yen Loan. After the 2-span bridge on the old alignment was replaced by this four-lane box culvert, overflows at this box culvert sometimes occurred during the rainy season, causing road closure of the N8, even though the N8 is

expected to function as an all-weather road. The main cause of overflow is considered to be floating matter, such as branches, blocking the flow area of the box culvert.

1-2-2 Present Condition of Related Infrastructures

As this project involves rehabilitation of the existing road and bridges, there are many townships and communities located along the existing road. Therefore, the existing paved road can serve as a transport route for equipment and materials for the road rehabilitation works. Also, there are electricity cables, water supply pipes and optical fibre cables laid underground, as well as communication towers for cell phones installed at several locations. Furthermore, there are filling pumps at some locations, which will be required to refill to vehicles and construction equipment with petrol and diesel oil to be used for construction works.

Note that some of these electricity cables, water supply pipes and optical fibre cables should be relocated before commencing road rehabilitation works.

1-2-3 Natural Conditions

1-2-3-1 Natural Conditions

(1) Terrain Condition

The project site is located in a hilly area slightly inland from the coast line with an altitude of about 100–200 m above sea level. The retain is hilly with gentle gradients.

The main river in this area is the Pra River, which is located at the northern end of the project road section, while to the south is a catchment area of small and medium-scale rivers which flow into the Gulf of Guinea.

(2) Geological Condition

The base formation along the N8 consists of the Eburnean Plutonic Suite and Birimian Protoliths. The main formation of rocks consists of undifferentiated biotite granite between Assin Fosu and Assin Break, sericite schist and quartz-sericite schist containing garnet and staurolite. The surface layer consists of sandy conglomerate and clay conglomerate.

(3) Soil Condition

According to the soil classification by the Food and Agriculture Organization (FAO) of the United Nations, a ferric lixisos layer is widespread in the project area and this type of soil is suitable as a construction material. However, increasing weathering of a podsol layer tends to cause high acidity after eluviation of the base. In addition, the drainage capacity is limited in some areas with a concentration of clay layers in forest areas.

(4) Meteorological Condition

Ghana lies in a tropical area in the western part of the African continent between 4º and 11º from the equator and its climate is classified as tropical savannah according to the Köppen climate classification. However, there are rainy and dry seasons with relatively high precipitation in the south-western coastal area. Generally, the rainy season runs from March to October (major rainy season between May and June, and minor rainy season between September and October), while the dry season runs from November to February.

The Project area is located in an area with relatively heavy precipitation, which is a hilly area slightly away from the coast where the weather conditions are different from the arid region in the north and coastal area. The prevailing wind direction in this area is mainly from the coast to the inland with high humidity

1-2-3-2 Results of Natural Condition Surveys

In order to grasp the natural conditions along the project road, the Study Team conducted the following natural condition surveys.

(1) Meteorological Condition Survey

In order to grasp the meteorological condition in the project area, which is necessary for the planning, design, construction and maintenance of the project road and bridge, the Study Team gathered meteorological data in the project area. The Ghana Meteorological Agency (GMA) collects and analyses meteorological data from all over the country, and the Study Team collected and analysed data of the Assin Fosu and Twifo Praso meteorological observatories. The detailed results of the meteorological condition survey are attached in Appendix 7-1.

The monthly average temperature at the Assin Fosu meteorological observatory between 2003 and 2012 was lowest in January (21.9ºC) and the maximum temperature was highest in February (33.1ºC). As a whole, the differences in temperature between each month are limited and steady.

The average yearly precipitation at Assin Fosu varied between 1,446.7 mm in 2005 and 2,093.3 mm in 2007. The average yearly precipitation at Twifo Praso varied between 1,231.5 mm in 2007 and 1,774.4 mm in 2007. The rainy season in the project area starts in March and ends in July, and starts again in September and ends in November; rainfall is very limited in January, and no rainfall was recorded in some years..

Daily precipitation exceeded 80.0 mm on 12 days at Assin Fosu and 7 days at Twifo Praso in the last 10 years and the highest daily precipitation of 151.2 mm was recorded in June 2012 at Twifo Praso.

(2) Earthquake

Even though there is no frequent earthquake in Ghana, there are records of earthquake although most were small and medium in scale in the past. Stronger earthquakes were recorded in 1862, 1906 and 1939 in the coastal area of Accra. The epicentre of the earthquake on 22nd June, 1939 was estimated to be 0°13' west latitude and 5°18' north of the equator, with the magnitude of 6.5. Hence, it is necessary to consider seismic effects when designing structures in Ghana.

(3) Topographical Survey

The Study Team conducted topographical surveys to grasp the topography of areas along the project road necessary for preparing design and construction plans for the road and bridges. The contents of the topographical survey are as follows and the area of the topographical survey is shown in Appendix 7-2.

- Land survey for road: 32,000 m x 50 m=1,600,000 m^2
- Land survey for Assin Fosu railway underpass bridge: 100 m x 50 m=5,000 m^2
- Okyi River bridge: Land survey 1,000 m x 100 m=100,000m^2

  River profile survey: 1,000 m

(4) Geotechnical Investigations

The Study Team conducted geotechnical investigations to obtain geological data necessary for planning, designing and construction planning of structures for reconstruction of the Assin Fosu railway underpass bridge and Okyi River bridge. The geotechnical investigation consists of boring works (one borehole each for Assin Fosu railway bridge and Okyi River bridge), investigation of materials at borrow pits for embankment materials and at a possible quarry site for aggregate, the laboratory tests of collected samples. The locations of boring works and results of geotechnical investigations are attached in Appendix 7-3.

(5) Hydrological Survey

The Study Team conducted a site investigation to grasp the characteristics of the river channel and interviewed local residents about the highest level of water during floods near the location where the bridge across the Okyi River is planned to be reconstructed.

1-3 Environmental and Social Considerations

1-3-1 Results of Environmental and Social Consideration Survey

The Study Team conducted the environmental and social consideration survey of projects for the outline design. The results are summarised below.

1-3-1-1 Outline of Project Components which Affect the Environment and Social Conditions

The Project consists of two major components, road rehabilitation and reconstruction of a bridge, which will affect the environment and social conditions. The outline of the Project is summarised in Table 1.

1-3-1-2 Baseline Information of Natural and Social Environment

(1) Natural Environment

a) Meteorology

The Project Area is located in Assin North Municipal and in Assin South District. Both are in the Central Region of Ghana and meteorologically are categorised as tropical rainforest with annual rainfall of between 1,500 to 2,000 mm or more and a temperature of approximately 30°C throughout the year.

Average relative humidity is high, ranging from 80% to 90%. The Municipal receives relatively cool and moist South-West monsoon winds that blow from the Atlantic for most of the period between December and February. However, the dry Hamattan or North-East trade winds blow from the North, although these winds are greatly dissipated by the long passage over forest areas. The rainfall pattern is bimodal, with two peaks with an average monthly precipitation of 200–330 mm in June and October coinciding with the major farming season.

Table 1 Outline of the Project Related to Environmental and Social Conditions

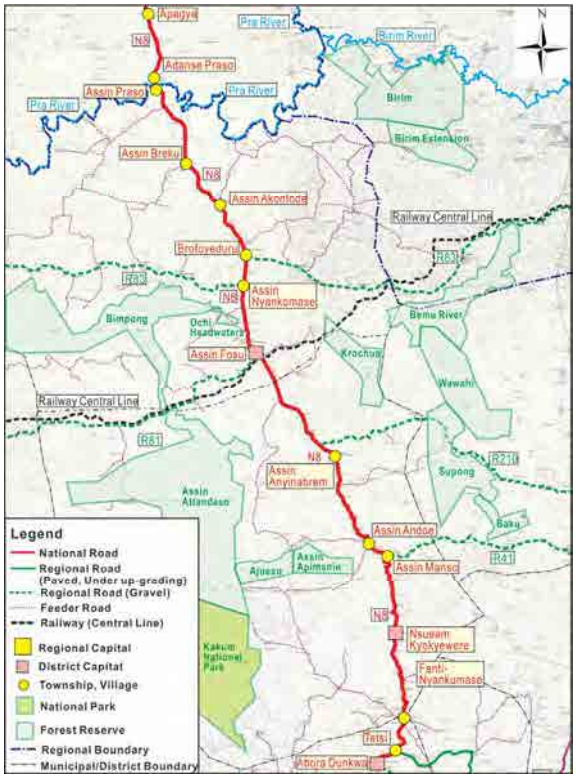
Contents	Road Rehabilitation		Bridge Reconstruction
Project component	Rehabilitation of existing road	Reconstruction of existing railway underpass bridge	Reconstruction of existing box culverts to a bridge
Location	N8 between Assin Fosu and Assin Praso (Assin North Municipal)	Railway underpass bridge at Assin Fosu township (Assin North Municipal)	Okyi River north of Assin Andoe village (Assin North District)
Length	Total length 31.2 km (including dualised four-lane section of about 1,200 m	10.00 m	25.00 m
Width	• Two-lanes section Carriageway width: W = 3.65 m x 2 = 7.30 m Shoulder width: W = 2.50 m x 2 = 5.00 m • Four-lanes section Carriageway width: W = 3.25 m x 4 = 13.00 m Shoulder width: W = 2.00 m x 2 = 4.00 m Sidewalk width: W = 2.00 m x 2 = 4.00 m	• Four-lanes section Carriageway width: W = 3.25 m x 4 = 13.00 m Shoulder width: W = 2.00 m x 2 = 4.00 m Sidewalk width: W = 2.00 m x 2 = 4.00 m	• Two-lanes section Carriageway width: W = 3.65 m x 2 = 7.30 m Shoulder width: W = 0.60 m x 2 = 1.20 m Sidewalk width: W = 1.50 m x 2 = 3.00 m
Structure type	• Earth work (cutting and embankment) • Pavement • Road drainage facilities (culverts and side ditches) • Road ancillary works	• Earth work (cutting and embankment) • Box culvert (railway underpass) • Road ancillary works	• 2-span continuous T-girder rigid-frame RC slab bridge • Direct foundation • Road ancillary works
Other matters	• Operation of construction vehicles during construction • Detour and traffic control during construction • Procurement of road construction materials	• Operation of construction vehicles during construction • Detour and traffic control during construction • Procurement of road construction materials	• Operation of construction vehicles during construction • Detour and traffic control during construction

Source: Study Team

b) Flora and Fauna

The site survey and reference collection did not identify a significant natural environment with valuable species of insects and wildlife along the project area of the N8; small settlements of people are scattered throughout the area.

There are several forest reserves in the project area, as shown in Figure 3. Assin South District has Kakum National Park located 30 km south of Assin Fosu and 13 km west of Assin Manso. The park contains about 40 species of wild mammals such as wild elephants and monkeys, 300 species of birds and 400 species of butterflies. The forest areas including Kakum National Park are also home to endemic species of wet forest trees and riparian forest trees such as African teak (*Milica spp.*), Garea (*Guarea spp.*) and Sapele (*Entandrophragma spp.*). Access to the park is gained not from the N8 which runs along the east side of the park, but from the R32 regional road



Source: Prepared by the Study Team based on data from the Forestry Commission

Figure 3 Location of National Park and Forest Reserve

on the west side.

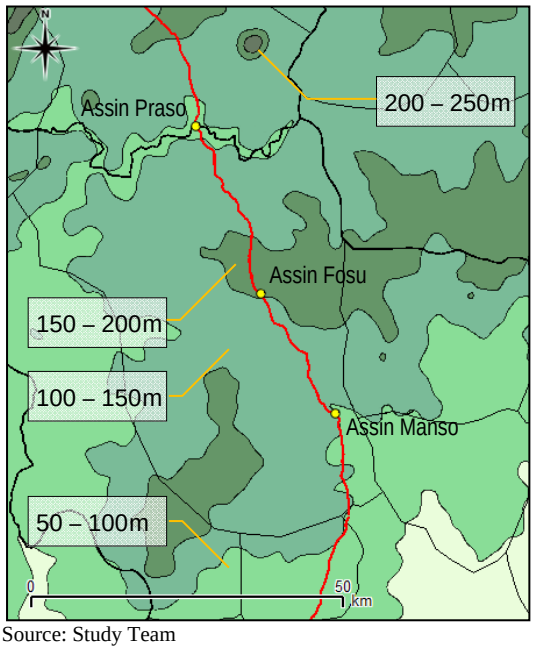
Regarding the flora in the project area, there are no protected areas such as national parks according to the environment survey, but there are eight forest reserves controlled by the Forestry Commission to encourage sustainable forestry with a balance between reforestation and deforestation along the road in the project area. The areas are not for protecting wildlife; instead, the Forestry Commission strictly manages the areas to control sustainable development of the forestry industry of Ghana. Moreover, most of the forest reserves are located about 3 to 8 km from the road.

c) Geography

The project area is characterised by undulating topography and has an average altitude of about 100–200 m above sea level. The terrain is hilly without great differences in height. A geographical overview is illustrated in Figure 4.

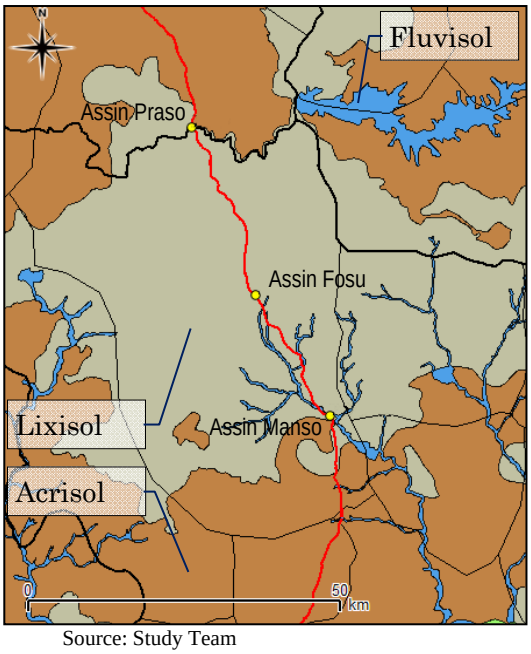
d) Geology and Soil

In terms of geology, the project area is classified as Cape Coast granite mixture composed of adamellite and granite belonging to the Pre Cambrian Platform. There are three major soil types in the project area: Acrisol, Lixisol and Fluvisol. Acrisol and Lixisol are mostly found in the tropical area especially in the Central Region and are suitable for agriculture since the soils contain many nutrients. Fluvisol is normally found along rivers, and is suitable for cultivating wet crops because the alluvial soil is often saturated and formed by deposition during flooding of rivers and irrigation. Figure 5 shows the geographical characteristics.



Source: Study Team

Figure 4 Geographical Characteristic



Source: Study Team

Figure 5 Geological Characteristic

e) Land Use

Most of the land along the project area of the N8 in rural areas is used for agriculture, where local farmers cultivate primarily palm, cacao and plantain. There are also commercial forests for timber scattered in the areas far from the road. Most of the felled trees are loaded onto heavy

trailers and transported to Kumasi for processing, and then the processed timbers are transported to Takoradi Port along the N8 again for export.

In the urban and settlement areas, commercial activities such as markets are run from shops in wooden huts, parasols and movable containers along the road. Especially in the centre of Assin Fosu, the capital city of Assin North Municipal, there is a large market with many shops along the road.

There is also a single-track railway running through the commercial area in the centre of Assin Fosu. Since the base of the railway track is located approximately 5.0 m below the existing road, a railway bridge spans the gap between the banks with a length of 5.0 m. However, the bridge is only 4.0 m wide, which is insufficient for the current traffic volume. Moreover, because the railway is not currently used, the railway track is covered with unmaintained grass and litter. The Photos-1 show typical land use in the project area.

	
Shops in AssinFosu (within ROW)	**Agricultural Farm (Citrus)**
	
Agricultural Farm (Cacao)	**Agricultural Farm (Oil Palm)**

Photos taken by the Study Team, November 2013

Photos 1 Land Use along the Road Section for the Outline Design

f) Hydrology

One of the major rivers near the project area is the Pra River, which forms the Northern border of the Central Region in Assin Praso. Between Assin Praso and Assin Fosu there are four smaller rivers which cross the N8 in concrete box culverts or colgate pipes. Additionally, near Assin Andoe, the larger Okyi River crosses the N8 in four continuous box culverts, but the

residents suffer chronic flooding after heavy rains. Table 2 shows an overview of the relevant rivers for the project. Although the rivers provide water for daily life including drinking and laundry for smaller communities near the rivers, the environmental survey found no significant water pollution. As a new bridge was constructed on the Pra River in the first phase of the project, no significant impact is expected since the river flows 300 m from the starting point of the project area.

Since the centre of Assin Fosu is located at the bottom of gentle hilly terrain and many of the drainage pipes are blocked by sand and mud and do not function well, floods often happen during heavy rain.

Table 2 Rivers in the Project Area

Name	Location（CSR:WGS84）		Remarks
	X	Y	
Pra	E 1.36827	N 5.93143	600 m north of Assin Praso town North boarder of Central Region
Tuatam	E 1.35726	N 5.90839	400 m south of Asempanaye
Dansame	E 1.34202	N 5.89454	480 m south of Dansame
Kyeremoa	E 1.33482	N 5.85741	720 m south of Assn Breku
Komkom	E 1.30622	N 5.81477	1.0 km south of Assin Akonfode
Subin	E 1.28928	N 5.78520	280 m south of Brofoyeduru
Bonto	E 1.29128	N 5.74897	380 m north of Assin Nyankomase
Okyi	E 1.18342	N 5.53435	470 m north of Assin Andoe

Source: Study Team

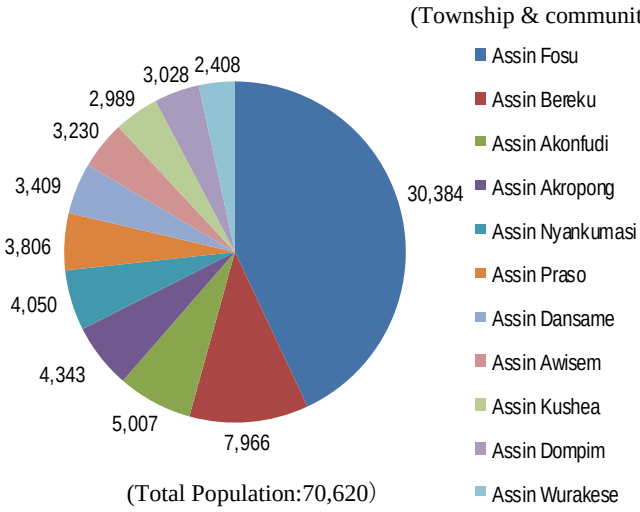
(2) Social Environment

a) Structure of the Community

The main component of the Project for rehabilitation of the N8 is located in the Assin North Municipal. The Municipal has a population of 160,000 and its centre, Assin Fosu township, has a population of 30,000, accounting for 40% of the total population in the Municipal. There are about 36,000 households in the Assin North Municipal and 23,000 households in the Assin South District, and the average number of family members is 4.3 and 4.4 in the Assin North Municipal and Assin South District, respectively, which are slightly higher than 4.0 in the Central Region.

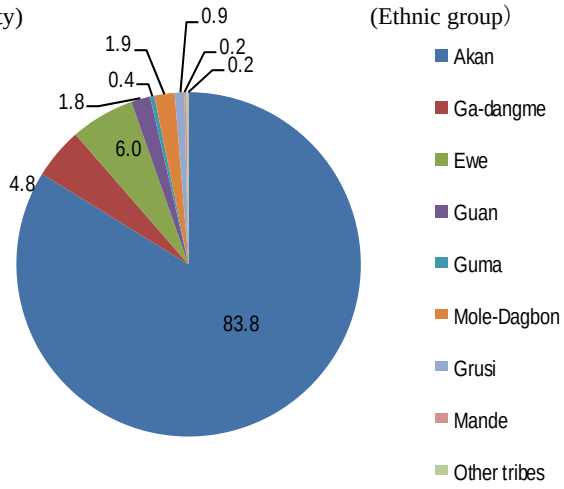
Regarding ethnicity in these two districts, 83.8% belong to the Akan tribe including the Ashante and Fante tribes according to the Population Census Report of 2010. Since the Assin North Municipal is located adjacent to the border of the Central Region, the ratio of the Ewe tribe is high in addition to the dominant tribe.

The Assin North Municipal Assembly is the administrative organisation which deploys direct services most closely related to the residents such as social infrastructure, public welfare, education and industry. When an administrative project or social activity project is conducted, the opinions and approval from relevant chiefs must be sought in accordance with the customs of the local chieftaincy system in the region.



Source: ANMA MTDP 2012

Figure 6 Population in Assin North Municipal



Source: ANMA MTDP 2012

Figure 7 Distribution Ratio of Ethnicity in Assin North Municipal

b) Economic Activity

63.2% of the people in the communities along the N8 in the Project section are engaged in agriculture, and palm oil fruits and cacao are the major products as cash crops. In addition, maize, plantain, cassava, cocoyam and rice are cultivated as food crops. Most of the agricultural products are consumed in the Central Region or nearby districts. Apart from these food and cash crops, there is a large-scale orange farm located 10 km north of Assin Fosu township which produces orange juice in a processing factory. A comparison of agricultural products by regional level is shown in Table 4.1.

Table 3 Agricultural Production Assin North Municipal

(Unit: Mt/ha)

Crop	Assin North Municipal	Central Region Level	National Level
Maize	11,601	176,222	1,215,502
Plantain	8,597	86,475	24,999,900
Cassava	109,907	18,671,160	10,225,752
Cocoyam	4,002	129,321	1,801,657
Rice	79	4,586	253,897

Source: ANMA MTDP 2012

Economic activities other than agriculture consist of 2.4% production business, 9.6% service industry and 24.8% other small-scale commerce. Forestry is another significant industry that supports Assin North Municipal, with many productive forest reserves near the Project road producing lumber trees such as odum, mahogany and wawa. Most of the cut trees are extracted from the forest and loaded onto heavy trailers to be carried by the N8 to other regions for processing and export. However, with the stagnation of forestry, there is concern about devastation of the forest environment due to the increase in unauthorised contractors illegally cutting the trees.

There are a total of five markets, both small and large, located in rural and urban

communities along the N8 and people sell food crops produced from farms along the N8 at the markets. In particular, many people do business in the market of Assin Fosu, the largest market in Assin North Municipal, selling not only agricultural crops but also daily goods. The bus and lorry station is located next adjacent to the market.

In terms of consumption tendency of residents, 55.7% of income comes from food. This shows that the residents tend not to spend money on items other than food compared with the national average of 35 to 40% for rural areas in Ghana. On the other hand, the average monthly income per capita of the Assin North Municipal is GHS 14.7. This shows that the living standard in the region is low compared to the national income per capita of GHS 44.0. The major reasons are considered to be insufficient infrastructure and lack of industry other than agriculture.

c) Social infrastructure

The electricity supply in the Assin North Municipal is inadequate, so about 50% of residents use wood or charcoal as an energy source. Conversely, the mobile phone network covers almost all townships and villages along the N8, as optical fibre cables have been installed along the N8 connecting to the antenna of each communication company.

In terms of water for daily living, 44.2% is taken from wells, 39.4% from boreholes and 16.4% from rivers. The site survey confirmed that no wells or boreholes will be affected by the rehabilitation of the N8.

There is one hospital, which is in Assin Fosu township, as well as three clinics and three Community based Health Planning and Service Compounds (CHPS) in the Assin North Municipal, as shown in Table 4. According to an interview survey of residents, more than 30% of residents struggle to receive medical treatment due to long distances to a medical facility.

Table 4 List of Medical Facilities in Assin North Municipal

Settlement	Type	Remark
Assin Fosu	Hospital	Along N8
Assin Praso	Health Centre	Along N8
Assin Akropong	CHPS	
Assin Akonfode	Clinic	Along N8
Assin Kushea	CHPS	
Assin Awisem	Clinic	
Assin Breku	CHPS	Along N8

Source: ANMA MTDP 2012

There are a number of education facilities both public and private, in the Assin North Municipal: 174 pre-schools, 161 primary schools, 108 junior high schools, and 4 senior high schools. Also, there is a teacher training college and a national vocational and technical institute, both in Assin Fosu. Of these education facilities: seven are located along the N8 in the Project Area: one primary school in each of Assin Fosu, Assin Brofoyeduru, Assin Dansama, and Assin Praso, one junior high school in Assin Fosu, one high school in Assin Akofonde, and one teacher training college in Assin Breku. The Project is expected to have some effects on pupils and students commuting to school.

The only method of refuse disposal in the Assin North Municipal is surface dumping. About 36% of residents use well-organised refuse disposal dumps, 51% use undeveloped refuse disposal dumps, 11% use open pits and only about 2% burn their refuse. Nearly three quarters of the residents have to walk between 10 m and 300 m to dispose of refuse, which causes indiscriminate dumping. Many refuse disposal dumps are not well organised and pollutant run-off from dump sites may cause water pollution and hence the risk of water related diseases such as bilharzia and cholera. Only 22% of the entire Municipal population have toilet facilities in their houses; the remaining 78% use public conveniences which are not properly maintained, causing people to resort to open defecation.

d) Health situation

Specific health statistics for the Assin North Municipal are not available, but are available for the Central Region. The statistics show the prevalence of HIV/AIDS for the region to be 1.9%, which is slightly above the national average of 1.3%. Immunisation is high with coverage of over 90% in the Central Region, which is higher than the national average. The 'under-five' mortality rate is 108 in the Central Region compared with a national average of 80, while the infant mortality rate is 73 against a national average of 50.

1-3-1-3 Policy, Legal and Institutional Framework for Environmental and Social Considerations

(1) Environmental Assessment Regulations and Procedures

Under the Environmental Assessment Regulations (EAR), LI1652, enacted in 1999, it is mandatory for agencies involved in road and bridge construction projects (including major road rehabilitation projects) to carry out an Environmental Impact Assessment (EIA) and submit the EIA report to the Environmental Protection Agency (EPA). The EPA then issues an Environmental Permit for a project that has been approved after investigation, and the project can then proceed.

In addition, if the project requires land acquisition and involuntary resettlement, based on the Resettlement Policy Framework (RPF) of the Ministry of Roads and Highways (MRH), which is one of the policy frameworks of the MRH for resettlement of residents, the agency in charge of the project will coordinate with the government agencies concerned such as the Land Commission, prepare a Resettlement Action Plan (RAP), and secure the necessary budget for compensation, payment, expropriation of land and structures, and monitoring.

(2) Institutional Framework

Institutional responsibilities in Ghana for environmental and social consideration issues, land acquisition and involuntary resettlement are fragmented among a number of agencies, ministries and organisations. The major institutions involved are shown in Table 5.

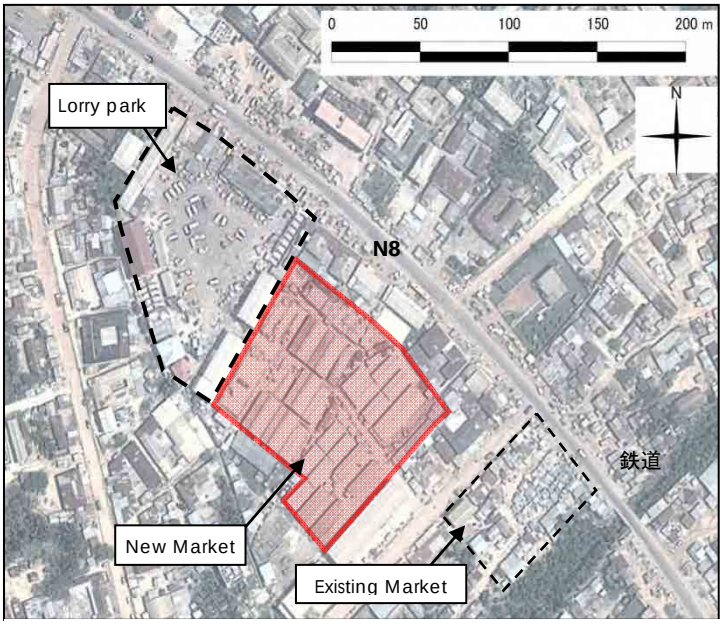
Table 5 Organisations related to Environmental and Social Considerations, Land Acquisition and Involuntary Resettlement

Name of Organisation	Responsibility
Environment Protection Agency (EPA)	The EPA is the agency with sole responsibility for environmental management in Ghana. The EPA will be responsible for supervision of Environmental Management Plan (EMP) implementation specified in the Environmental Impact Statement (EIS), and will conduct external monitoring as the regulatory agency during the construction phase.
Ministry of Road and Highway (MRH)	The MRH will be responsible for supervising the GHA's project implementation including environmental management throughout the project cycle, and for evaluating the project implementation. The evaluation of EMP shall be included in the completion audit.
Ghana Highway Authority (GHA)	The Environmental Management Unit (EMU) of the GHA will be the principal responsible agency of the implementation agency. The EMU will be responsible for the whole process of the EMP including legal environmental clearance, assurance of mitigation measures and monitoring. It will also be responsible for all monitoring activities throughout the project cycle including the operation phase and the completion audit.
Lands Commission (LC)	
Vested Lands Management Division (PVLMD)	The Public and Vested Lands Management Division (PVLMD) of the Lands Commission (LC), is responsible for guiding the subject area's development through policy framework development and stakeholder coordination. The PVLMD will be mainly involved in the preparation stage for matters concerning area development and allocation of land as a mitigation measure.
Land Valuation Division (LVD)	The Land Valuation Division (LVD) of the LC, formerly known as the Land Valuation Board, will be responsible for valuing project affected properties such as land, buildings, and economic activities for evaluating compensation. The compensation valuation list from the LVD will be forwarded to the acquiring agency for payment processing.
Assin North Municipal Assembly Assin South District Assembly	Assembly will be the principal representatives of the project affected persons (PAPs) as well as development of area under the jurisdiction. As representatives of the project affected communities, assembly members of district or commune level officials will be involved in the whole process of the projects throughout the project cycle.

Source: Study Team

(3) Relevant Development Project

There a large number of temporary shades and shops operating along the planned dualised four-lane road section in the centre of Assin Fosu township, and the Project may cause negative social impacts on these. On the other hand, the Assin North Municipal Assembly (ANMA) has launched a development project to construct a new market to replace the existing small market near the railway underpass bridge, and plans to relocate all temporary shades, shops, and kiosks that have obtained a temporary operation permit from the ANMA, into the new market, in order to ease the traffic congestion and confusion caused by these temporary structures.



Source: Study Team

Figure 8 Location of New Market Developed by ANMA

This project comprises the construction of a new market area next to the existing lorry park

and a resettlement programme to relocate all of the temporary structures to the new market. However, most of the people are still not willing to change their business environment even though the resettlement requirement has been approved by the relevant organisation of the commercial union in Assin Fosu through the stakeholder meeting organised by ANMA.

Details of the RAP related to the construction of a new market are described in a later stage of this report: Figure 8 shows the location of the new market and other circumstances.

1-3-1-5 Comparison of Alternatives Considered

The following alternatives were taken into consideration for the validity of the proposed rehabilitation component for the Project including the “zero option”.

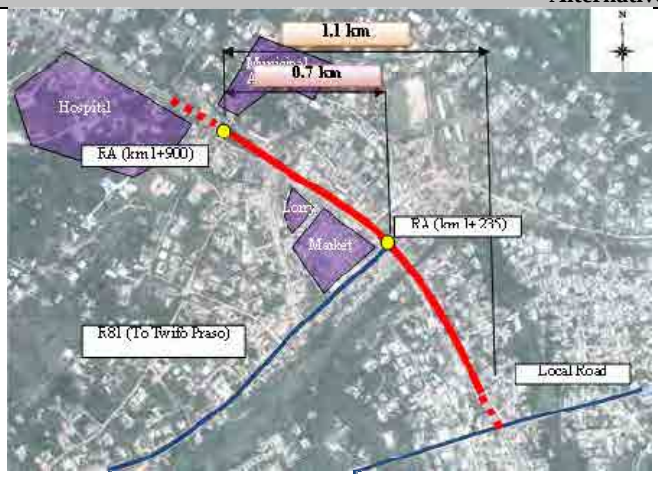
(1) Zero Option

The zero option means to maintain the status quo, which would be no rehabilitation of the road and no reconstruction of the railway underpass bridge at Assin Fosu. The existing deteriorated road from Assin Fosu to Assin Praso would be maintained without major rehabilitation work. This would result in congestion of vehicular traffic and possible accidents, especially during the rainy season, with no improvement of poor air quality caused by traffic congestion, especially in the centre of Assin Fosu township.

Regarding the existing four-continuous box culverts at Assin Andoe, no action for these would lead to the threat of chronic flooding, which would affect not only the residents in the region, but also logistics companies that use the N8 for transportation. For these reasons, The zero option would have a significant negative impact on the social environment and a lesser negative impact on the natural environment.

(2) Consideration of Alternatives

Under the design policy for the outline design, the horizontal alignment of the existing N8 is basically followed, except the planned dualised four-lane section in the centre of Assin Fosu township. Hence, the discussion focuses on this dualised four-lane section between two roundabouts, for which there are two alternatives to be considered as shown in Figure 9. As a result of comparing these two alternatives in terms of reducing traffic congestion, risk of traffic accidents, and negative social impact on business in the centre of the township, Alternative 1 is selected and approved by the GHA.

Alternative 1	
	Description / Evaluation • The length of the four-lane section is about 1.2 km from the intersection near the hospital and Assin North Municipal Assembly to the intersection connecting with a community road in the south. • Roundabouts are planned to be installed at both ends of the dualised four-lane section. • One house and 13 commercial buildings need to be resettled. • One electrical transformer located near the south end of the section needs to be relocated. Result: Highly desirable
Alternative 2	
	Description / Evaluation • The length of the four-lane section is about 1.1 km from the intersection near the hospital and Assin North Municipal Assembly to the point north of intersection of Alternative 1. • Roundabouts are planned to be installed at the intersection near the hospital and the one connecting to a regional road adjacent to the existing old market. • The distance between the two roundabouts is about 0.7 km, which might cause traffic congestion. • One house and 10 commercial buildings need to be resettled. • The south roundabout might become another bottleneck due to concentration of commercial activities around it. Result: Fair

Source: Study Team

Figure 9 Comparison of Alternatives for Dualised four-lane Section in the Centre of Assin Fosu Township

1-3-1-6 Scoping of the Project Impacts

According to the "JICA Guidelines for Environmental and Social Considerations, 2010" (hereinafter referred to as "JICA Environmental Guideline") and the policy for preparation of EIAs in Ghana, project impacts were selected and scoped, as shown in Table 6. The scoping of impacts was carried out based on a screening format provided by the GHA.

Table 6 Results of Scoping of Environment Items

Category	Items		Evaluation		Reasons
			P, C	O	
Pollution	1	Air pollution	B-	C-/B+	C: Exhaust emissions from construction equipment are expected. O: Dust will be reduced, but air pollution will be increased by traffic increase.
	2	Water pollution	B-	B-	C: Water pollution caused by construction equipment is expected. O: Road dust could affect the quality of nearby water.
	3	Soil pollution	B-	D	C: Leaking oil from construction equipment is expected to cause soil pollution. O: No substance which could cause serious soil pollution is identified.
	4	Waste disposal	B-	D	C: Leftover soil for filling and debris from existing structures could cause a negative impact from waste disposal. O: No material having a serious negative impact is expected.
	5	Noise and vibration	B-	D	C: Noise of construction equipment could cause a negative impact. O: No negative factor is identified for noise and vibration nuisance.
	6	Ground subsidence	D	D	No factor associated with negative impact is identified.
	7	Odour	D	D	No factor of odour associated with a negative impact is identified.
	8	Bottom sediment	D	D	No factor associated with a negative impact is identified.
Natural Environment	1	Protected area	D	D	No protected area such as a forest reserve or park is identified.
	2	Ecosystem	D	D	No valuable ecosystem is found.
	3	Hydrology	D	D	No significant hydrological feature around the Project site is identified.
	4	Geography and geology	D	D	No significant feature around the Project site is identified.
Social Environment	1	Involuntary resettlement	B-	D	C: Small-scale involuntary resettlement at the dualised four-lane section is expected.
	2	Local economy, such as employment, livelihood, etc.	D	B+	P: No significant impact on the local economy is expected. O: The forestry industry is expected to be boosted.
	3	Land use and utilisation of local resources	D	D	No significant impact on local resources is expected since the Project involves rehabilitation of the existing road.
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	No significant factor involved with local institutions is expected since the Project involves rehabilitation of the existing road.
	5	Existing social infrastructure and services	B-	C-	C: Traffic congestion could impair access to social services. O: Traffic increase in Assin Fosu township could cause problems with accessibility.
	6	Cultural heritage	D	D	No significant cultural heritage is found around the Project site.
	7	Landscape	D	D	No significant landscape feature is found around the Project site.
	8	Indigenous or ethnic people	D	D	No indigenous and ethnic people are found around the Project site.
	9	Misdistribution of benefits and damages	D	D	No implied factor for misdistribution of benefits is expected due to the rehabilitation project.
	10	Working conditions	C-	D	C: Appropriate working conditions for construction workers must be considered.
	11	Water usage	D	D	No significant impact on wells or rivers is expected during the construction and operational phases.
	12	Poverty group	C-	B+	P: It is possible to have poverty group along the Project section. O: Improved access to social services and markets is expected due to smooth traffic environment after the Project.
	13	Sanitary condition	D	D	No factor is identified associated with declining sanitary condition of settlements around the Project site.
	14	Gender	D	D	No significant factor caused by the rehabilitation project is expected.
	15	Children's rights	D	D	No significant factor caused by the rehabilitation project is expected.
	16	Infectious diseases such as HIV/AIDS	B-	D	C: The influx of construction workers may spread infectious diseases.
Other	1	Accidents	B-	B-	C: Traffic control during construction must be considered. O: Traffic accidents may increase after the rehabilitation due to the traffic increase.
	2	Global warming	D	D	No global warming factor is identified.

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

Source: Study Team

1-3-1-7 TOR of EIA Study

The Terms of Reference (TOR) for the environmental and social considerations survey associated with the scoping of the environmental impact are summarised in Table 7.

Table 7 TOR of Environmental and Social Considerations Survey

Item	Survey Item	Methodology of Survey
Air pollution	1. Environmental regulations of Ghana 2. Air pollution study 3. Future traffic projection 4. Locational survey of residence, school and medical facilities around the Project site 5. Impact during construction	1. Existing reference study 2. Existing reference study 3. Expectations based on future traffic demand forecast 4. On-site study, questionnaire 5. Details of construction works
Water pollution	1. River water quality 2. Current usage of river water	1. Existing reference study 2. On-site study, questionnaire
Soil pollution	1. Protection from oil leak during construction	1. Details of construction works
Waste disposal	1. Current systems of waste disposal	1. Details of construction works
Noise and vibration	1. Environmental regulations of Ghana 2. Distance from construction site to residences, schools and hospitals 3. Impact during construction	1. Existing reference study 2. On-site study, questionnaire 3. Details of construction works
Land acquisition and involuntary resettlement	1. Scope of land acquisition and involuntary resettlement 2. ARAP	1. On-site and aerial photo study 2. Existing reference study and questionnaire survey of relevant organisations 2. Similar project as a reference 2. Finalisation of preliminary ARAP with discussion with GHA
Local economy, such as employment, livelihood, etc.	1. Socio-economic activity of the residents of related settlements	1. Existing reference study and questionnaire
Existing social infrastructure and services	1. Locational survey of residence, school and medical facilities around the Project site	1. On-site study, existing reference study and questionnaire
Working condition	1. Mitigation measures for labour safety	1. Finding similar references
Poverty group	1. Poverty group around the Project site 2. Impact on poverty group	1. On-site study, questionnaire 2. Expectations based on future traffic demand forecast
Infectious diseases such as HIV/AIDS	1. Prevalence of HIV/AID in the district 2. Relevant organisations	1. Existing reference study and questionnaire survey of relevant organisations 2. Questionnaire survey of relevant organisations
Accidents	1. Level of increase in traffic accidents in operational phase	1. Expectations based on future traffic demand forecast

Source: Study Team

1-3-1-8 Results of Environmental and Social Impact Analysis

Based on the results of scoping described above, the environmental and social impact analysis of the Project is summarised in Table 8.

1-3-1-9 Environmental Impact Assessment

Based on the environmental and social impact analysis described above, environmental impact assessments of each component of the projects are summarised in Tables 9 and 10.

Table 8 Results of Environmental and Social Impact Analysis

Category	Item	Evaluation Results
Pollution	Air pollution	Currently, conspicuous exhaust emissions and dust from vehicular traffic especially in Assin Fosu township have been witnessed due to the chronic traffic congestion, although the traffic is controlled under the speed limit of 80 km/h in rural areas and 50 km/h in built-up areas. Under the current conditions, there will be temporary air pollution caused by traffic exhaust and dust in built-up areas where the population and buildings are concentrated. After the construction, although the impact of air pollution from the increase in traffic is expected to increase in the built-up and rural areas, mitigation of current air pollution caused by traffic exhaust and dust is also expected, since the traffic flow will be smoother after rehabilitation of the N8. For the construction works, plants for construction materials will need to be built, including a concrete and asphalt plant. The locations of the plants must be considered carefully in view of the air pollution they will generate.
	Water pollution	There are four small rivers in the Project area which the N8 crosses. Since construction equipment during the construction will not significantly pollute the water of these rivers, the negative impact on the water environment along the Project road is very limited. Regarding drainage in Assin Fosu township, drainage water is polluted due to eutrophication caused by urbanisation and loss of drainage capacity due to clogging of sediment. Replacing the drainage facilities during road construction is expected to improve the water quality by suppressing sand sedimentation in the drainage system. At the temporary construction yard, an appropriate management system for maintenance and system for deciding to establish facilities will be required, since the construction plant and workers' toilets could cause water pollution.
	Soil pollution	Although there are palm oil trees and cacao farms adjacent to the N8 in rural areas, the possibility of soil pollution by machinery oil is extremely limited since the construction scale and equipment are small. At the temporary construction yard, there is a serious concern of soil pollution such as by diesel oil from the asphalt plant and construction equipment in the parking lot, which may require treatment depending on the status.
	Waste disposal	When applying the pavement recycling method using existing pavement material for recycling the sub-base for part of the Project road, the amount of waste to be disposed of produced during the construction can be greatly reduced compared to the ordinary pavement reconstruction method. It is also necessary to choose an appropriate location for waste disposal of demolished asphalt pavement and existing concrete structures to prevent negative impacts on the environment.
	Noise and vibration	There is a concern about the negative impact of noise and vibration along the N8 in the Project area, including during the construction stage, since there are 11 townships and villages with residential houses. The stabiliser, which will be used for pavement recycling for the Project, could cause nuisance noise and vibration for residential districts. However, since one construction section will be less than 1.5 km long and the period of reconstruction work will take one week at most, the negative impact of noise and vibration will be limited and mitigation measures will be taken. The location of the temporary construction yard, which will produce the negative impacts of noise and vibration on the surrounding area from operating plant and generators, must be carefully considered.
Natural Environment	Hydrology	There are four small rivers crossing by the N8 in the Project area. Three existing box culverts are planned to be replaced and the other will be reconstructed by a bridge. The hydrological impact on the environment is very limited, since the design concept for the facilities will use their existing function and will not involve significant renovation.
Social Environment	Involuntary resettlement	In terms of houses and buildings to be resettled by the Project, there are three residential house, one religious facility and 13 businesses in the dualised four-lane section at the centre of Assin Fosu township. In addition, 427 simple temporary shops along the road in the centre of the township have been identified. However, these temporary shops will be resettled for the new market construction project conducted by Assin North District Municipal and all resettlements will be completed by the middle of October 2014. Other than those temporary shops in Assin Fosu, 40 temporary shops along the Project road need to be relocated.
	Local economy, such as employment, livelihood, etc.	Agriculture is a primary socio-economic activity of the residents near to the Project site. The amount of agricultural crops tends to be small due to the scale of each agricultural activity and most of the crops are distributed to neighbouring towns for their main revenue. After completion of the Project, many economic activities in the Assin North Municipal are expected to be activated due to the increase in logistics opportunities for trading agricultural crops. Furthermore, expansion of logistics will stimulate the service industry as well as agricultural industry.
	Existing social infrastructure and services	At present, the N8 at the centre of Assin Fosu township is used as a school route by primary and junior high schools pupils in the township. These pupils must go to school amid heavy traffic with the risk of accidents due to inappropriate safety devices such as lack of sidewalks, pedestrian crossing, etc. The provision of sidewalks and pedestrian crossings, and the installation of pavement markings and traffic signs under the Project will make the school route safer. On the other hand, access to the entrance of the hospital in Assin Fosu, the only hospital in Assin North Municipal, will be restricted, even though the flow of through traffic will be improved.
	Working conditions	The rights of labour unions in Ghana tend to be appropriately ensured throughout the nation. During the N8 Rehabilitation Project (Phase 1), which is a similar type of project, transportation to the working site, establishment of lodging and the legal minimum wage were appropriately ensured. The same level of working conditions is expected to be ensured for workers in the present Project. However, improvement of working conditions depending on the season and local customs must still be considered.
	Water usage	More than 80% of drinking water for the residents in the Assin North Municipal along the N8 relies on wells and boreholes, and river water is used mainly for living only. Regarding water usage along the Project road, there is no well for drinking water. Therefore, the negative impact of water usage by the Project in the Assin North Municipal is very limited. Regarding the management of water intake for irrigation from rivers near the construction site, mitigation measures to prevent dust being scattered from the construction site are required.
	Poverty group	No community mired in poverty or socially vulnerable groups have been found in the Project area.
	Infectious diseases such as HIV/AIDS	In the Central Region, the prevalence of AIDS is 4.7%, the highest in the nation according to the survey data for 2011 of the AIDS Commission. It is important to consider the rise in the prevalence of infectious diseases such as HIV/AIDS caused by the influx of construction workers related to the Project.
Other	Accidents	According to statistical data, more than 40% of fatal accidents in the nation involve pedestrians (National Road Safety Commission). Although the main cause of accidents is speeding by vehicles, lack of safety devices is another significant reason. For the Project, since single-lane traffic control will be planned during the construction period, proper traffic control management will be necessary at the start and end sections of the construction site. During operation, road safety in the centre of Assin Fosu township is expected to be improved by various road safety devices such as sidewalks, construction of a pedestrian overpass bridge and installation of guard fences on the median divider, installation of a pedestrian crossing on humps, traffic signs, etc., even though the traffic volume will increase in the future.

Source: Study Team

Table 9 Environmental Impact Assessment (Road Rehabilitation: 31.2 km)

Category		Environment Item	Scoping Evaluation		Impact Assessment		Reasons for Evaluation
			P, C	O	P, C	O	
Pollution	1	Air pollution	B-	C-/B+	B-	C-/B+	C: Dust and exhaust emissions from construction equipment is expected to cause air pollution in rural areas. O: Dust raising is expected to decrease in rural areas, whereas exhaust emissions are expected to increase in built-up areas due to traffic.
	2	Water pollution	B-	B-	C-	C-/B+	C: Possibility of water pollution is limited due to the few rivers crossing the Project road. O: Water pollution caused by dust from the road is limited due to rehabilitation of the road surface.
	3	Soil pollution	B-	D	B-	D	C: Chemical substances from temporary construction plants could affect the soil quality around the site.
	4	Waste disposal	B-	D	B-	D	C: The waste disposal of debris and leftover construction materials must be carefully managed.
	5	Noise and vibration	B-	D	C-	C+	C: Negative impacts are limited due to the few residential areas along the Project road. O: Nuisance noise and vibration are expected after the rehabilitation.
	6	Ground subsidence	D	D	D	D	-
	7	Odour	D	D	D	D	-
	8	Bottom sediment	D	D	D	D	-
Natural Environment	1	Protected area	D	D	D	D	-
	2	Ecosystem	D	D	D	D	-
	3	Hydrology	C-	D	C-	D	C: Construction work at the small rivers could have a negative, but very limited, impact on the hydrological environment.
	4	Geography and geology	D	D	D	D	-
Social Environment	1	Involuntary resettlement	B-	D	B-	D	C: Fewer than 20 buildings require resettlement. Some of the agricultural fields along the Project road will be affected by the construction work.
	2	Local economy, such as employment, livelihood, etc.	D	B+	D	B+	O: Expansion of business activities as well as trading of agricultural crops is expected, especially in the centre of Assin Fosu township.
	3	Land use and utilisation of local resources	D	D	B-	D	C: Roadside trees affected by the construction work along the Project road are a significant resource of the Municipal. Establishment of a borrow pit for construction materials will change the existing land use.
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	D	-
	5	Existing social infrastructure and services	B-	C-	C-	C-	C: Limited access to social services due to traffic congestion caused by single-lane traffic control is expected during construction. O: Limited access to social infrastructure and services caused by traffic congestion is expected in the centre of Assin Fosu township.
	6	Cultural heritage	D	D	D	D	-
	7	Landscape	D	D	D	D	-
	8	Indigenous or ethnic people	D	D	D	D	-
	9	Misdistribution of benefits and damages	D	D	D	D	-
	10	Working conditions	C-	D	C-	D	C: The working environment for construction workers must be considered.
	11	Water usage	D	D	C-	D	C: The intake of water for construction must be managed.
	12	Poverty group	C-	B+	D	D	No poverty group is identified along the Project road.
	13	Sanitary condition	D	D	D	D	-
	14	Gender	D	D	D	D	-
	15	Children's rights	D	D	D	D	-
	16	Infectious diseases such as HIV/AIDS	B-	D	B-	D	C: The spread of infectious diseases caused by the influx of construction workers must be controlled.
Other	1	Accidents	B-	B-	B-	B+	C: Traffic accidents are expected to increase due to single lane control during construction. O: Road safety in Assin Fosu township is expected to improve with the installation of traffic safety devices in the Project.
	2	Global warming	D	D	D	D	-

Notes: P: Planning stage, C: Construction stage, O: Operation stage, Z: Zero option
A+/-: Significant positive/negative impact is expected. B+/-: Some positive/negative impact is expected.
C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact could be clarified as the study progresses.), D: No impact is expected.

Source: Study Team

Table 10 Environmental Impact Assessment (Reconstruction of Okyi River Bridge)

Category		Environment Item	Scoping Evaluation		Impact Assessment		Reasons for Evaluation
			P, C	O	P, C	O	
Pollution	1	Air pollution	B-	C-/B+	C -	D	Possible negative impacts are negligible because of the small scale of the construction site.
	2	Water pollution	B-	B-	B-	D	C: Pollution of river water by spilled oil from construction machinery is a concern. O: No factors leading to water pollution are expected.
	3	Soil pollution	B-	D	C-	D	C: Leakage of oil from construction equipment is expected, but is very limited.
	4	Waste disposal	B-	D	B-	D	C: Management of debris from existing concrete structures is critical.
	5	Noise and vibration	B-	D	B-	C+	C: Noise and vibration could negatively affect adjacent residences. O: Rehabilitation of the road is expected to reduce noise and vibration.
	6	Ground subsidence	D	D	D	D	-
	7	Odour	D	D	D	D	-
	8	Bottom sediment	D	D	D	D	-
Natural Environment	1	Protected area	D	D	D	D	-
	2	Ecosystem	D	D	D	D	No significant ecosystem is found due to housing settled area
	3	Hydrology	C-	D	C-	D	C: Impact on the river channel route is a concern during the construction work.
	4	Geography and geology	D	D	D	D	-
Social Environment	1	Involuntary resettlement	B-	D	D	D	No involuntary resettlement is found for this construction work.
	2	Local economy, such as employment, livelihood, etc.	D	B+	D	B+	O: Expansion of business as well as trading of agricultural crops is expected, especially in the centre of Assin Andoe and Assin Manso.
	3	Land use and utilisation of local resources	D	D	D	D	-
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	D	D	-
	5	Existing social infrastructure and services	B-	C-	C-	B+	C: Limited access to social services due to traffic congestion caused by single lane traffic control during construction is expected. O: No significant negative impact is expected.
	6	Cultural heritage	D	D	D	D	-
	7	Landscape	D	D	D	D	-
	8	Indigenous or ethnic people	D	D	D	D	-
	9	Misdistribution of benefits and damages	D	D	D	D	-
	10	Working conditions	C-	D	C-	D	C: The working environment for construction workers must be considered.
	11	Water usage	D	D	C-	D	C: The intake of water for construction must be managed.
	12	Poverty group	C-	B+	D	D	No poverty group is identified around the construction site.
	13	Sanitary condition	D	D	D	D	-
	14	Gender	D	D	D	D	-
	15	Children's rights	D	D	D	D	-
	16	Infectious diseases such as HIV/AIDS	B-	D	C-	D	C: The spread of infectious diseases caused by the influx of construction workers must be controlled.
Other	1	Accidents	B-	B-	B-	B+	C: Traffic accidents are expected to increase due to single lane control during construction. O: Traffic accidents in Assin Andoe village are expected to be reduced with the installation of traffic safety devices in the Project.
	2	Global warming	D	D	D	D	-

Notes: P: Planning stage, C: Construction stage, O: Operation stage, Z: Zero option

A+/-: Significant positive/negative impact is expected. B+/-: Some positive/negative impact is expected.

C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact could be clarified as the study progresses.), D: No impact is expected.

Source: Study Team

1-3-1-10 Mitigation Measures and Their Costs

Proposed mitigation measures for the significant negative impacts of the project evaluated in the previous section and brief estimated costs for the measures are summarised in Tables 11 and 12, respectively.

Table 11 Proposed Mitigation Measures for the Project

Category	Environment Item	Mitigation Measures
Pollution	Air pollution	• Regular watering of exposed surfaces to prevent dust dispersion during the construction work is required. • Comprehensive management of equipment maintenance is required to prevent undesirable gas emissions from poorly maintained equipment. • Well managed construction supervision is critical to prevent dust dispersion during the construction work.
	Water pollution and soil pollution	• A control and management policy for the storage of construction materials, fuel, sewage and other chemical substances is required to prevent unexpected leakage. • Appropriate disposal and discharge points for disposing of waste and drainage from the area related to the construction work should be established. • Proper sanitary facilities and an appropriate sanitary management system for construction workers must be established.
	Waste disposal	• Providing disposal areas for protecting the natural and social environment in the relevant regions is the key to reducing the problems of waste disposal.
	Noise and vibration	• An appropriate construction schedule is required to avoid the nuisance of noise and vibration, particularly at night. • Maintenance management of construction equipment is required.
Natural Environment	Hydrology	• A well-organised construction scheme related to rivers must be considered before carrying out the construction.
Social Environment	Involuntary resettlement	• A system for monitoring RAP is required to ensure appropriate resettlement. • A grievance programme should be applied for the management of the RAP.
	Land use and utilisation of local resources	• Affected roadside trees must be properly replanted to restore regional resources. • The location and areal plan for borrow pits and quarry sites must be approved by the GHA as well as the excavation and restoration plan.
	Existing social infrastructure and services	• The management plan for single lane traffic control must be approved by the GHA and local police to avoid traffic confusion. • The accessibility of existing paths between roads and houses should be ensured by providing temporary access routes at affected points. • Utility lines such as electric cables, optical fibre cables, and water pipes should be relocated by the organisations concerned prior to commencement of the construction work.
	Working conditions	• The proper establishment of a work camp should be supervised. • Programmes for monitoring the working conditions should be applied to ensure appropriate working conditions. • Safety management for construction workers is essential to prevent unexpected fatal accidents during the construction.
	Water usage	• The management plan for water intake for the construction work should be authorised by relevant organisations including the Municipal Assembly.
	Infectious diseases such as HIV/AIDS	• An HIV/AIDS awareness campaign for construction workers should be established.
Other	Accidents	• The management plan for single lane traffic control must be approved by the GHA and local police to avoid causing more traffic accidents.

Source: Study Team

1-3-1-11 Environmental Management Plan and Monitoring Programme

An EMP for the Project is prepared in accordance with the EAR, LI165. This plan comprises the various measures that will be implemented to mitigate the environmental and social impacts rated as ‘medium’ and ‘high’ from the construction and operational phases of the project in order to reduce the potential impacts to reasonably practical levels.

Table 12 Estimated Costs for the Measures

Phase	Item	Amount (USD)	Remark
Planning Phase	Coordination with stakeholder	15,000	•Assembly men and chiefs for overall project •GCE, telecommunication companies and CWSA for relocation of utility lines and water supply pipes • Relevant commissions for relevant issues
	Compensation for involuntary resettlement	See following section	•Referring to ARAP
Construction Phase	Monitoring supervision	30,000	• Every month
	Training of contractor's staff	10,000	
	Training of GHA officers	70,000	
	HIV/AIDS awareness campaign	20,000	
	Provision of sanitary facilities	20,000	
	Replanting of trees	-	• Estimated as compensation in the ARAP
Operational Phase	Monitoring	20,000	• Annual base

Source: Study Team

Table 13 shows the main objectives of the EMP, policy for the management items, including the monitoring programme, and the contents, and Table 14 shows the concrete contents.

Table 13 Objectives and Contents of Environmental Management Plan (1)

Objectives	
・Appropriate implementation of mitigation measures and monitoring in EIA report ・Clarifying the basic policy of management contents in the environmental management plan as well as complying environmental guidelines in the operational and construction phase ・Clarifying the organization responsible for conducting the environmental management ・Specifying mitigation measures for the negative impacts on the natural and social environment ・Compiling the report including the monitoring plan and environmental management ・Ensuring the implementation of environmental management activities ・Ensuring a sound construction environment that the and needs of stakeholders including regional residents are satisfied	
Management Contents	**Basic Policy**
1. Potential sources of Occupational Health Hazards	
・Fire and drowning hazards	Collection of adequate information about organisation and equipment for avoiding fire and drowning accidents
・Materials handling, usage and storage	Establishment of guideline for handling construction materials and facilities expected to involve work hazard
・Waste and Sanitation at Temporary Construction Yard	Sharing information of methods of disposing of waste that could cause environmental pollution, to ensure a clean work environment and select construction materials that avoid environmental pollution
・Operation of construction equipment	Sharing knowledge on the appropriate operation of construction equipment to avoid noise nuisance
・Traffic and Public Safety	Development of traffic safety plan that prioritises regional safety
・Personal Protective Gear	Provision of protective safety gear to avoid injury accidents during construction work
・Incidence of Diseases	Creating a system to gather and share information on avoiding infectious diseases such as HIV/AIDS which are expected to spread due to the influx of construction workers
2. Environmental Action Plan	
・Waste management	Mandatory use of protective gears for workers, implementation of appropriate waste disposal
・Noise nuisance	Measurement of noise level, devices for reducing noise, appropriate measures for mitigating noise nuisance
・Water quality	Prevention of dispersion of water-polluting substances such as oil, fuel, and other solid waste
3. Work environment Action Plan for health and safety	
・Fire and drowning hazards	Mandatory training on the use of fire extinguisher, creation of operation manual for generators, designation of off-limit areas at river construction site
・Materials handling, usage and storage	Thorough guidelines on the handling of construction materials
・Waste and sanitation at temporary construction yard	Provision of appropriate waste disposal sites and waste bins, implementation of appropriate waste disposal, providing toilet
・Operation of construction equipment	Encouraging the use of guidelines on the operation of various plant and construction equipment

Table 13 Objectives and Contents of Environmental Management Plan (2)

Management Contents	Basic Policy
・Traffic and public safety	Provision of information on traffic controls to relevant organisations or persons such as assembly men and chiefs, installation of traffic control signboards, sharing and communicating information on control methods and training to persons in charge
・Personal protective gear	Compliance with occupational safety and health standards, encouraging risk awareness thoroughness of safety equipment guidelines
・Incidence of diseases	Implementation of training programme related to infectious diseases
4. Emergency Preparedness and Response/ Contingency Plan	
・Emergency response coordinator	Appointment of a person responsible for emergency incidents, creating an emergency incident manual
・Communication	Obligation to carry wireless communication devices such as cellular phones by responsible persons
・Emergency contact information	Prior coordination with relevant agencies and preparation of an emergency contact network including the fire department, police and medical facilities.
・Internal/external emergency reporting	Cooperation with the corresponding officer of the GHA responsible for emergency incidents
5. Emergency Response Procedures	
・Personnel Injury	Training for security awareness, provision of first aid in case of injury, contact details in case of emergency
・Fire	Designation of off-limit areas, request for assistance from medical, police and fire departments, firefighting training for accident prevention
・Chemical Spillage	Sharing information about methods of handling dangerous chemical substances with the police and fire departments, thoroughness of spillage prevention manual, transfer of authority to corresponding responsible persons for emergency incidents when leakage occurs
・Evacuation	Designation of evacuation area, guidance by responsible persons for emergency incidents, contact with the GHA and local administrative officer in case of serious situation
・Internal/external emergency reporting	Improvement programme for organisation, equipment, education and training, alarms, if the response was insufficient, validation of security systems, creation of accident investigation report
・Safety Training	Clarification of organisation, sharing information on Environmental Management Plan, development of monitoring result report, recognition of regulations and relevant laws of Ghana, conducting disaster prevention training
6. Administration, Monitoring and Implementation of Health, Safety and Environment Action Plan	
・EMP Administration	Organisation of environmental management committee responsible for supervising environmental management progress, responding to emergency incidents by the GHA, appointment of project manager for actions on Environmental Management Plan, periodical study and check-up of environment report on a weekly basis by health and safety environment officers
7. Employee Training	
・Training	Setting safety goals, clarifying the roles of responsible organisations, clarifying the authority of supervision, awareness of sanitary environment, handling of construction equipment and personal protective gear, sharing information on first-aid equipment, installation of safety boards and safety fences, prevention of dust dispersal, traffic safety, knowledge of HIV/AIDS
・Safety Booklet	Creation of environment manual for construction workers describing problems related to the environment, safety and health of the work environment
8. Monitoring Programme	Implementation of review with stakeholders and checking of current conditions of air, noise and water quality, checking of personal protective gear, sanitary conditions of the working environment, checking of implementation of safety measures such as installation of safety fences, review of the environment report on a weekly or monthly basis, study of accident prevention measures, checking of working system and number of workers, checking of maintenance condition of automobiles, construction equipment and other relevant facilities

Source: Study Team

1-3-1-12 Stakeholder Meeting

The Study Team assisted the GHA to hold the stakeholder meeting (public forum) based on the components of the proposed project. At the meeting, stakeholders gave many opinions and proposals, including appreciation for the Project, and the GHA and the Study Team answered questions. In addition, the Study Team explained that the opinions and proposals expressed at the meeting would be referred to the design of the Project. The contents of the meeting and summary of opinions are summarised in Table 15.

Table 14 Environmental Monitoring Items

Environment Item	Monitoring item	Location	Frequency	Implementing Institution
Planning Phase				
Resettlement	Progress of RAP	Area of RAP	Monthly	GHA
Construction Phase				
Air quality	SO_2, NO_2, PM_{10}	Construction site	Biannual	Contractor
Water quality	pH, SS, coliform bacteria, oil	Construction site (Okyi River)	Biannual	Contractor
Noise	Noise level	Settlements where impact is expected	Biannual	Contractor
	Report of using noise reduction devices	Construction site	Monthly	Contractor
Waste	Waste disposal record	Construction site	Monthly	Contractor
HIV/AIDS	Infected numbers	Construction site	Biannual	Contractor
Accident	Accident record	Construction site	Monthly	Contractor
Operation Phase				
Air quality	SO_2, NO_2, PM_{10}	Construction site	Annual	GHA
Noise	Noise level	Settlements where impact ise expected	Biannual	GHA
Accident	Accident record	Construction site	Monthly	GHA

Source: Study Team

Table 15 Outline of Stakeholder Meeting

Title of Meeting	Stakeholder meeting for the Rehabilitation of N8 Project
Sponsor, etc.	Sponsor: GHA, Co-sponsor: ANMA, Assistant: JICA Study Team
Date and time	20th March, 2014 (Thursday), 10:00 – 12:00
Venue	Assembly Hall, Assin North Municipal
Participants	• Sponsor side: GHA officials, Representative of ANMA, JICA Study Team • Participants: Representatives from related communities (chiefs, etc.), representative of Central Region Government, representative of electric company, representatives of communication companies, representative of police, residents of related communities (voluntary) • Total number of participants: about 300
Contents of discussions	• Explanation of outline of the rehabilitation project • Explanation of outline of the environmental and social impacts • Discussion on the contents of the rehabilitation project
Summary of Opinions	
• Extension of the section of the road to be dualised to four lanes from the northern entry (St. Andrews) into the town to the police barrier near the Assin Fosu College of Education • Provision of appropriate pedestrian bridges in town • Provision of traffic signals in front of Assin Fosu District Hospital • Provision of concrete barriers over the length of the proposed dual carriageway • Provision of bus bays in the towns along the proposed Project Road • Moving the proposed roundabout at Dompem junction in Assin Fosu to the Masarachi area • Ensuring that the relocation of utilities in the towns, especially Assin Fosu township, does not cause undue inconvenience to the population • Inclusion of the development of the old market in Assin Fosu township as a taxi rank to reduce traffic congestion in the town • Ensuring that flooding in the Besease area in Assin Fosu township is resolved • Further congestion is expected near the railway underpass in Assin Fosu township	

Source: Study Team

1-3-2 Land Acquisition and Involuntary Resettlement

1-3-2-1 Necessity of Land Acquisition and Involuntary Resettlement

The main component of the Project is rehabilitation of the target section of N8 (Assin Fosu – Assin Praso: 31.2 km) without major modification of horizontal/vertical assignment and road

width. Since very limited number of houses are located adjacent to the existing Right-of-Way (ROW), no major resettlement of local residents is expected. Even though, 1.2 km of section (including weaving sections) is planned to be dualised as four lane road in the centre of urbanised area of Assin Fosu township, limited number of local residents and commercial buildings should be relocated. Since this planned section is located in the commercial land use area, permanent and temporary commercial facilities are expected to be relocated. However, the ANMA has a plan to relocate all temporary operating vendors to the newly constructed market under their own project, and all temporary operating vendors will be relocated according to the RAP prepared by the ANMA.

Regarding to land acquisition, existing roads usually have an established ROW of 90 m (45 m from centreline of the road). Since no change of horizontal alignment of road is planned, except at planned dualised section in Assin Fosu, no land acquisition is required on the Project road section,. In addition, since all dualised section in Assin Fosu is planned within the existing ROW, no land acquisition is required.

As many agricultural lands are located along the Project roads, particularly in rural areas, there are several agricultural products, such as palm oil trees and cacao trees, as well as road side trees, which are either personal or local properties. In order to carry out smooth implementation of construction works, those trees should be copped and compensation for these properties, even within the ROW, will be necessary.

Furthermore, it will be necessary to rent sufficient land for the temporary construction yard for a certain period of time, and compensation will be necessary for renting this kind of land.

1-3-2-2 Legal Framework

Since the Project requires land acquisition and resettlement, the GHA will prepare the RAP, based on the RPF which was enacted by the Ministry of Transport (MoT) under the Transport Sector Development Programme in 2006 with the financial assistance of the World Bank (WB), and has been applied to projects by other government agencies, including the MRH, in accordance with the following legal framework. Table 16 shows the legal framework for land acquisition and involuntary resettlement in Ghana.

Table 17 compares the laws and regulations in Ghana and JICA environment and social consideration guidelines concerning the resettlement policy.

Table 16 Legal Framework for Land Acquisition and Involuntary Resettlement

Name	Description	Remarks
Constitution of the Republic of Ghana, 1992	Fundamental human rights and freedoms Act for protection from compulsory acquisition	Act 20
Administration of Lands Act, 1962	Management and administration of stool lands for the rights of ownership	Act 123
The State Lands Act, 1962	Mandatory requirement of acquiring land for development of public infrastructure	Act 125
The State Lands Regulation, 1962	Procedure of land acquisition	
Lands (Statutory Way-Leaves) Act, 1963	Execution of compulsory acquisition of land by the President	
Office of the Administration of Stool Lands Act, 1994	Ensuring establishment of administrative office to be managed for stool land	
Environmental Assessment Regulations	Defining regulations relevant to environmental matters	LI1652
The 2006 Resettlement Policy Framework (RPF)	Stating basic policy about land acquisition and involuntary resettlement	MoT

Source: Study Team

Table 17 Comparison of between Laws and Regulations in Ghana and JICA Environmental and Social Consideration Guidelines concerning Resettlement Policy (1)

No.	JICA Environmental and Social Considerations Guidelines	Resettlement policy of Ghana	Differences	Implementation policy for the project
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Land acquisition, involuntary resettlement and resettlement assistance are defined in the 2006 Resettlement Policy Framework (RPF).	The resettlement policy of the JICA guideline is adopted in the RPF.	Policies for land acquisition, involuntary resettlement and other resettlement assistance are adopted in the RPF in accordance with the JICA guide line.
2	When population displacement is unavoidable, effective measures to minimise impact and to compensate for losses should be taken. (JICA GL)			
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)			
4	Compensation must be based on the full replacement cost wherever possible. (JICA GL)	Evaluation of the loss is carried out by the Land Valuation Board and compensation shall consider economic well-being, as well as social and cultural value.	Compensation is not defined clearly as market value or replacement value in the RPF.	Compensation will be paid for the replacement value in accordance with the JICA guideline.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Prompt payment is defined in the RPF.	Payment of “Prior to displacement” is not clearly defined.	Payment of compensation will be completed prior to displacement in accordance with the JICA guideline.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	Public consultation is required to be held to carry out the RAP developed by the relevant authority.	Notification and explanation of resettlement is adopted in the RAP in accordance with the JICA guideline.	An abbreviated resettlement action plan is required to be developed in accordance with the JICA guideline.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)			
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)			
9	Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans. (JICA GL)			

Table 17 Comparison of between Laws and Regulations in Ghana and JICA Environmental and Social Consideration Guidelines concerning Resettlement Policy (2)

No.	JICA Environmental and Social Considerations Guidelines	Resettlement policy of Ghana	Differences	Implementation policy for the project
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Although a grievance mechanism is followed by the grievance redress committee in the GHA, there is no formal document to be defined.	A grievance mechanism is established in accordance with the JICA guideline in the customary way.	A grievance mechanism will be provided in accordance with the JICA guideline. To ensure that grievance redress is properly implemented, the activity will be comprehensively monitored.
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advantage of such benefits. (WB OP4.12 Para.6)	According to the RFP social survey is required for the RAP, and cut-off date is set at the end of the study.	The RAP is developed based on a social survey in accordance with the JICA guideline and it defines the cut-off date as the start date of the social survey	A social survey will be developed to provide base information for the RAP and the cut-off date will be defined as the end of the survey.
12	Eligibility for benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognised under law), the PAPs who do not have formal legal rights to land at the time of the census but who have a claim to such land or assets and the PAPs who have no recognisable legal right to the land they are occupying. (WB OP4.12 Para.15)	No compensation for squatters is defined.	Since the JICA guideline defines that the PAPs are eligible to receive compensation regardless of having formal or non-formal legal right to land, there is a difference between the two policies.	Squatters are eligible to receive supplementary assistance, but not compensation for land.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	Land based resettlement is not defined in the relevant policy	Apart from monetary base compensation, the PAPs can choose the alternatives of land-based resettlement.	The type of compensation will follow the PAPs request through public consultation.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)			
15	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	There is no formal definition of support for vulnerable groups.	There is a difference in support for vulnerable groups between the two policies.	Assistance including soft and hard programmes for vulnerable groups will be provided in accordance with the JICA guideline.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	An abbreviated resettlement action plan is required in the customary way in accordance with WB policy.	No difference is found between the two policies.	An abbreviated resettlement action plan will be developed since the project has fewer than 200 PAPs in accordance with the JICA guideline.

Source: Study Team

1-3-2-3 Scale and Area for Land Acquisition and Involuntary Resettlements

Based on the site observation and interviews carried out by the Study Team, number of permanent structures necessary to be relocated were identified in the centre of Assin Fosu township and Assin Praso. Number of those permanent structures to be relocated, with dualisation a part of the Project road in the centre of Assin Fosu town ship, are one residential house and 13 commercial buildings in Assin Fosu and one commercial building in Assin Praso, 15 in total. For identifying necessity of resettlement, 18.0 m (9.0 m each from the centre line) for two-lane road section, and 28.0 m (14.0 m each from the centre line) fir dualised section, are considered as influenced areas. Then, sections with slopes and drainage facilities are confirmed from the design drawings, and affected buildings were identified.

Since all construction/rehabilitation works can be performed within the existing ROW, any land acquisition will not be required. Even though the widening of the ROW will be required at

the planned widening section in Assin Fosu due to shifting the centre line of the road, this widening of ROW can be performed by only changing the land use, and actual land acquisition is not necessary.

It will be necessary to compensate for relocation of stalls using temporary structures/shades within the ROW. As every stall operate business in Assin Fosu will be relocated by the RAP of the ANMA (this RAP is attached in Annex 3) by another project, 40 cases of stalls operated by temporary structures, other than in the Assin Fosu township, are identified as necessary to be relocated.

A temporary construction yard of about 50,000 m^2 of area, will be necessary to be rented for the construction works, estimated in reference to the similar project, the Project for the Rehabilitation of N8, Phase 1. In addition, compensation for chopping agricultural products and roadside trees are also estimated. Table 18 shows the outline of resettlement of structures, other compensations, etc.

Table 18 Scale of Involuntary Resettlement and Other Compensations

Type	Item	Details	Quantity	Location	Note
Involuntary resettlement	Relocation of non-temporary structure	• Residential house: • Commercial building and religious facility: • Commercial building:	3 14 1	Assin Fosu - ditto - Assin Praso	Non-temporary structure 14 owners
	Relocation of temporary structure	Kiosk, shade, container shop	40	Whole section	Wooden and container shops
Compensation for vegetation and crops	Roadside trees		666	Whole section	
	Oil palm trees		74		
	Plantain		64		
	Cacao		41		
	Cassava		10		
Renting land	Temporary construction yard		50,000 m^2		

Source: Study Team

1-3-2-4 Concrete Measures for Compensation and Assistance

Land-taking typically entails compensation for land, houses, businesses and other structures on that land, as well as other assistance in order to mitigate the adverse consequences that affect people and communities when they give up property for the public good. Also, production of agricultural land within the ROW is considered as renouncing the right of properties during a certain period, and assistance to mitigate the negative impact is provided. The form of resettlement agreeable to the PAPs for both the permanent properties and temporary structures affected by the Project Road is restoration with monetary compensation, and no assistance for relocation is considered. In areas where utility lines such as water supply pipes, underground electricity lines and optical-fibre cables will be affected by the construction, the GHA will liaise with the utility companies for the relocation of service lines and the restoration of services.

The provisional cut-off date for being eligible for compensation and/or resettlement assistance was 13th March 2014, which is the last day during which the socio-economic survey was completed. The provisional cut-off date was explained and agreed with the Assin North

Municipal Assemblies as well as community and opinion leaders.

Project-affected persons also include:

- Those who have formal legal rights to land (including customary and traditional rights recognised under the laws of the country)
- Those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets and become recognised during the survey
- Those who have no recognisable legal rights or claim to the land they are occupying

Table 19 Entitlement Matrix

Type of Loss	Eligibility Criteria	Compensation	Responsible Organization
1. Loss of structure			
Temporary business structures (wooden kiosk, containers)*	Various interest and rights – freeholder, leaseholder	Payment based on capital market value of asset	ANMA
Permanent structures (residential house and shops)	Landlord/leaser	Payment based on capital market value of asset	GHA
2. Loss of income			
Loss of business income	Business owner/operator	Payment as supplementary assistance based	GHA
Loss of business rent	House owner/tenants	Average net monthly profit	GHA
Loss of residential rent	Landlord/leaser	Monthly rent passing	GHA
Loss of advance rent for tenants	Business employees/attendants Owner of building during the reinstatement period	Equivalent of rent advance to be refunded Monthly wages earned	GHA
Loss of agricultural crops	Landlord/leaser	Payment based on capital market value of asset	GHA

Source: Study Team

*All of the temporary structures are to be replaced before the construction regarding to the reconstruction project of Assin Fosu Market conducted ANMA

1-3-2-5 Grievance Mechanism

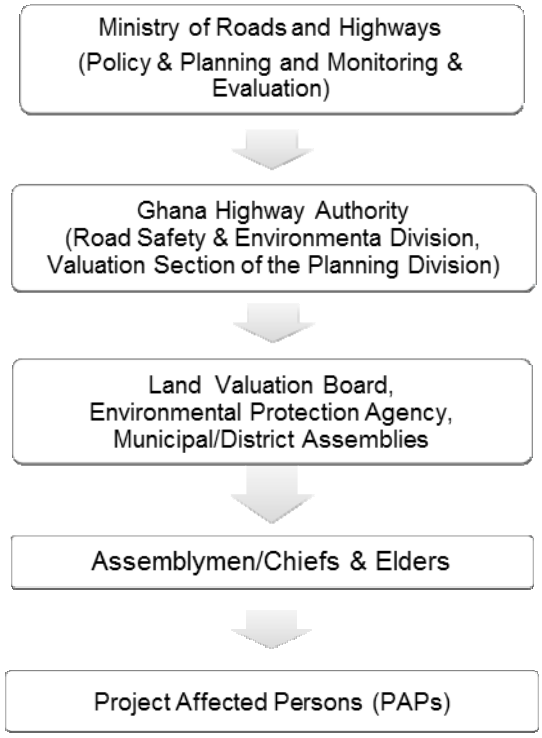
All PAPs will be offered the compensation approved by the Land Valuation Board (LVB). If the property owner or PAP is not satisfied with the offer, he/she has the option of petitioning the Grievances and Redress Committee set up by the GHA or employing a private valuer of his/her choice to reassess the property and submit same to the LVB for consideration and final determination of the value of the property. The figure of PAPs re-determined by the LVB is then communicated to the GHA for payment to the beneficiaries. The Committee is composed of the Director of Survey and Design, the Principal Valuer, the Manager of Environmental Management Unit and the Principal Legal Officer of the GHA, and an EPA officer as well as a representative from the relevant Municipal/District Assembly. In situations where the beneficiary is still not satisfied with the amount of compensation payable to him/her, the PAP can seek redress from the Magistrate Court at the Municipal/District Assembly to the High Court as is common practice in Ghana. The litigation commences from the Magistrate Courts, and if the applicant is still not satisfied with the decision, he/she can appeal to the highest court, which is the Supreme Court.

However, it is preferred that grievances first be settled amicably whenever possible. That is, the PAP is allowed to engage his own valuer at the cost of the project to determine the

compensation due. The valuer and the LVB will then together to negotiate a settlement.

1-3-2-6 Institutional Responsibility

The MRH is ultimately responsible for ensuring the smooth implementation of the road project. The GHA as the implementing agency has the ultimate responsibility for implementing this ARAP. The GHA, through its Road Safety and Environment Division and the Valuation Section under the Planning Division, will be directly responsible for ensuring that every PAP entitled to supplemental assistance and/or compensation is adequately paid and on time. The various governmental agencies also have roles to play in ensuring the effective implementation of the programme. At the same time, the GHA will work in collaboration with local officials to implement the clearance programme. The GHA will inform the Municipal Assembly of the date to begin clearance of the construction corridor. A public forum will be convened to further explain the programme to the affected people. The district assemblies will also assist in identification of the rightful owners of properties and farms and in paying the PAPs. The organisational structure for ensuring fair and timely compensation to PAPs is shown in Figure 10.



Source: Study Team

Figure 10 Organisational Structure

1-3-2-7 Implementation Schedule

Table 20 indicates the proposed implementation schedule of the resettlement and land acquisition related to the rehabilitation of the N8.

Table 20 Implementation Schedule

Major Activities	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Disclosure of ARAP and re-disclosure of RPF	→											
Effectiveness of Credit		→	→	→								
Formation Project Implementation Committee			→	→								
Education and awareness creation about ARAP procedures and compensation payment				→	→	→						
Payment of compensation for both permanent & temporary properties as well as tenants							→	→	→			
Complaint redress measures											→	→
Monitoring and Evaluation					→	→	→	→	→	→	→	→
Completion Report Writing												→

Source: Study Team

1-3-2-8 Estimated Cost and Finance

Table 21 shows the estimated resettlement and other compensation budget. The GHA, as the agency in the GoG, is mainly responsible for coordinating the securing of budget for compensation for resettlement by the Project.

1-3-2-9 Monitoring Programme

The implementation of the ARAP, prepared by the GHA, activities shall be monitored regularly to ensure that the activities have proceeded in accordance with the provisions of the ARAP. The GHA has established two monitoring mechanisms in the implementation of this ARAP: internal monitoring and external (independent) monitoring.

Internal monitoring will be carried out by the MRH, LVB, EPA and the Municipal/District Assemblies to ensure that the GHA's Project Management Unit follows the schedule and abides by the principles of this ARAP. The purpose of this internal monitoring is to maintain the responsibilities of the resettlement implementation institution, i.e. the GHA. The services of an external (independent) monitoring organisation will be procured to regularly conduct independent monitoring and evaluation of the activities of this ARAP. The purpose of independent monitoring is to provide an evaluation and to review the overall implementation from a broader, long-term point of view. A draft monitoring form is attached in Appendix 3.

Table 21 Estimated Resettlement and Other Compensation Budget

(Unit: GHS)

Item	Quantity	Unit Price	Price	Remarks
Non-Temporary Structure				
Residential House	1	62,000	62,000	Fence wall / compound
Commercial building	13	25,000	325,000	Concrete building
Commercial building	1	15,000	15,000	Wooden structure
Mosque	1	40,000	40,000	
Sub total			566,000	
Temporary Structure				
Kiosk	28	1,356	37,968	
Shade	7	696	4,872	
Container	5	2,568	12,840	Shop
Sub total			55,680	
Vegetation and Crops				
Roadside Trees	666	5.00	3,330	
Palm Trees	74	8.00	592	
Plantain	64	0.50	32	
Cocoa	41	1.60	66	
Cassava	10	0.51	5	
Sub total			4,025	
Other Expense				
Consultation with PAPs	6	1,000.00	6,000	
Monitoring	6	3,000.00	18,000	
Completion Report	1	4,000.00	4,000	
Contingency	1	60,000.00	60,000	
Subtotal			88,000	
Total			**713,705**	

Source: Study Team with unit price from Land Valuation Board

Table 22 Monitoring Responsibilities

Organisation	Roles
GHA (Environmental Management Unit)	Lead the internal monitoring on a daily and periodic basis.
Policy Planning and M & E Directorates of MRH	Lead agency and coordinating institution for both internal and external monitoring of the implementation of this ARAP. Periodic monitoring of implementation of the Plan and its impact.
LVB	Regular monitoring to ensure that the approved assessed compensation is paid
EPA	Periodic monitoring of the implementation of the Plan and its impact
Assin North Municipal Assembly Assin South District	Periodic monitoring on the impacts of implementing the Plan
External Consultant(s) or NGOs	Periodic monitoring, evaluation and auditing of implementation of ARAP

Source: Study Team

1-3-2-10 Public Consultation

Prior to the stakeholder meeting, the Study Team held public consultations with individual PAPs and opinion leaders in the communities. During these consultations, the impacts of the project and proposed mitigation measures were explained to them and they individually gave their assurance that they would cooperate to ensure smooth implementation of the project.

A summary of the consultations and the concerns raised by the opinion leaders in the project zone of influence is given in Table 23.

Table 23 Consultation with Chiefs and Assemblymen along the Project Road

Location	Contact Person	Role	Concerns Raised / Information Received
Fosu	Nana Krontihene	Traditional Ruler	• The Betinsin river was dredged recently due to flooding during the rainy season. The upstream flow is used as drinking water but the downstream has become polluted with rubbish and garbage. • Smaller vehicles cannot ply the road due to floods during the rainy season. • The drains near the river are blocked with sand and wooden structures have been built on them, making desilting impossible. Drains should be constructed in such a way that people cannot build wooden structures on them. • The major drainage system is blocked. It should therefore be tackled first so that the hawkers and vendors by the road can relocate to allow the project to proceed unhindered. • If, as a result of relocation of the market, any compensation or money is to be paid, it should not be paid to individuals but to the Municipal Assembly.
Brofoyedru	Nana Agyapong II	Traditional Ruler	• Rehabilitation of the road will be good because several accidents occur on it. Libation must be poured before construction starts.
Endwa	Nana Konagye Ampaw II	Traditional Ruler	• There are too many accidents on this stretch of the road and so we hope that speed ramps will be constructed around here. We also need a bus stop.
Akonfudi	Hon. Alex Ayma	Assembly man	• We are happy about the project and hope it begins soon as the Nketego river crosses the road in this town.
Breku	Hon. F. K. Asare Bediako	Assembly man	• We are also glad about the project. There are two rivers passing through this town, the Brupan and the Kutupan.

Source: Study Team

1-3-2-11 Environmental Checklist

Table 24 summarises the environmental checklist covering the items necessary for the environmental and social conditions survey based on the request letter from the GoG and details examined in the later stage.

Table 24 Environmental Checklist (1)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports already been prepared in the official process? (b) Have EIA reports been approved by the 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) N (b) N (c) N (d) N	(a) The EIA report is under preparation. The Study Team submitted the draft EIA report to GHA (November 2014). (b) The GHA will submit the EIA report to the EPA after completion of the report. (c) No particular condition will be required for approval of the EIA. (d) No other authority will be involved in the approval of the EIA.
	(2) Explanation to the Local Stakeholders	(a) Have the contents of the project and the potential impacts been adequately explained to the local stakeholders based on appropriate procedures, including information disclosure? Has the understanding of local stakeholders been obtained? (b) Have the comment from stakeholders (such as local residents) been reflected in the project design?	(a) Y (b) Y	(a) Stakeholder meeting was held during the EIA study (20th March, 2014). (b) The EIA study was completed and the opinions of stakeholders in the stakeholder meeting were reflected in the report.
	(3) Examination of Alternatives	(a) Have alternative plans for the project been examined with social and environmental considerations?	(a) Y	(a) Three alternative analyses including the zero option from technical, economic and environmental and social considerations have been conducted in the EIA study.

Table 24 Environmental Checklist (2)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from project-related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Will any mitigating measures be taken? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) N (b) N	(a) Although dust dispersal from construction equipment during construction activities is expected, it will be mitigated through appropriate mitigation measures. (b) No significant air pollution is expected during the operational phase.
	(2) Water Quality	(a) Is there a possibility that soil runoff from bare land 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) N (b) N	(a) There is no large volume of cut-and-fill in the construction activities. Although there will be some partial and small volume of cut-and-fill, no significant impact on the current land form resulting in outflow of soil is expected. No outflow of soil is expected during the operational phase. (b) Since the designed alignment basically follows the existing one, no negative impact on water resources such as wells is expected.
	(3) Wastes	(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) An appropriate waste disposal system will be implemented using the same waste disposal site as the previous relevant road rehabilitation project.
	(4) Noise and Vibration	(a) Do noise and vibrations from vehicles and train traffic comply with the country's standards?	(a) Y	(a)Mitigation measures will be implemented in line with the environmental regulation of Ghana for noise and vibration.
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) No negative impact on protected areas is expected since there is no protected area adjacent to the project site designated by the GoG.
	(2) Ecosystem	(a) Does the project site encompass primaeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accidents of wildlife and livestock? (e) Is there a possibility that installation of roads will cause impacts, such as destruction of forests, poaching, desertification, reduction of wetland areas, and disturbance of ecosystems due to the introduction of exotic (nonnative invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In case the project site is located in an undeveloped area, is there a possibility that the new development will result in extensive loss of natural environments?	(a) N (b) N (c) – (d) – (e) N (f) N	(a) No primaeval forests, tropical rain forests, or ecological valuable habitats exist around the project site as the designed road follows the existing road alignment. (b) No protected habitats of endangered species have been confirmed. (c) No significant negative impact on the ecosystem is expected. (d) No significant negative impact on habitat fragmentation and migrating wild life or livestock is expected since the project involves rehabilitation of the existing road. (e) There will be no destruction of forests, poaching, desertification, or reduction of wetland areas since no such relevant elements subject to negative impact were confirmed. (f) The project will not be implemented in an undeveloped 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) Although construction of a bridge pier in the river will affect river water flow, significant negative impact on the existing water flow as well as high water line is not expected since the project includes widening the river section at the point where the road crosses. Additionally no negative impact on ground water at the site is expected since the construction activities will not include pumping up of ground water.

Table 24 Environmental Checklist (3)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut-and-fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a) Since the designed alignment follows the existing road, no slope failures and landslides are expected. (b) No large volume of cut-and-fill is planned for the construction activities. (c) No significant modification of land form by construction activities is expected. Installation of road side drainage is designed to avoid soil outflow related to the rehabilitated road.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimise the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in a document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organisational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i) Y (j) Y	(a) – (j) Although involuntary resettlement is expected, the draft ARAP was prepared and submitted to the GHA (November 2014) in accordance with the JICA's environment and social consideration guideline.
	(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? (b) Is there a 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 a possibility that diseases, including infectious diseases, such as HIV will be brought due to the influx of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there a 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 a possibility that roads will impede the movement of inhabitants? (f) Is there a possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	(a) Y (b) Y (c) N (d) N (e) Y (f) N	(a) Since there is a possibility of traffic congestion during construction of the temporary bridge and single-lane road, traffic control signboards will be used to avoid traffic congestion during the construction activities. (b) No significant negative impact on the regional residents after the rehabilitation of the road is expected. (c) Mitigation measures in the form of training will be implemented to prevent the expected spread of infectious disease due to the influx of construction workers. (d) Although traffic congestion is expected at the diversion point, the counter measures described in "(a)" will be implemented and the volume of traffic accidents is expected to decrease after the project due to smooth traffic flow. (e) Since the project involves rehabilitation of the existing road, no impediment to residents movement is expected. (f) No sun shading or radio interference is expected since the project will not include the construction of any high object such as bridges associated with these impacts.
	(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 local archaeological, historical, cultural or religious heritage affected by the project has been confirmed through the EIA study.

Table 24 Environmental Checklist (4)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) Y	(a) Replantation of street trees to restore the road landscape is planned when these trees need to be cut.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) – (b) -	(a) and (b) No ethnic minorities and indigenous people have been found through the EIA study.
	(6) Working Conditions	(a) Is the project proponent 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 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 programme, 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 do not threaten the safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Supervision of construction contractors concerning labour laws will be implemented. (b) Supervision of construction contractors concerning appropriate safety measures will be implemented. (c) A safety management plan will be developed with supervision of construction contractors. (d) Safety measure for regional residents and project officers as well as the natural environment will be implemented with supervision of construction contractors.
5 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	(a) Supervision of construction contractors regarding all kinds of pollution will be implemented. (b) No adverse impacts on the natural environment are expected. (c) No significant negative impact on the social environment during the construction activities is expected.
	(2) Monitoring	(a) Will the proponent develop and implement a monitoring programme for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring programme? (c) Will the proponent establish an adequate monitoring framework (organisation, 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?	(a) Y (b) Y (c) Y (d) Y	(a) Monitoring of the conditions of air, water, noise, vibration, waste disposal and accidents will be conducted based on the ARAP. (b) The monitoring programme will be carried out based on the EMP. (c) Monitoring will be conducted based on EIA and ARAP covering the monitoring framework. (d) A monitoring report will be compiled regarding the EMP in the EIA report.

Table 24 Environmental Checklist (5)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). (b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) – (b) -	(a) – (b) No items related to forestry project were found through the EIA study.
	Notes on Using Environmental Checklist	(a) If necessary, the impacts on transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) -	(a) No significant negative impact on transboundary or global issues is expected.

Note: 1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) The environmental checklist provides general environmental items to be checked. It may be necessary to add or delete items taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Source: Study Team

1-4 Results of Future Traffic Projection

The details of future traffic projections are attached in Appendix 10.

1-4-1 Future Traffic Volume Projection

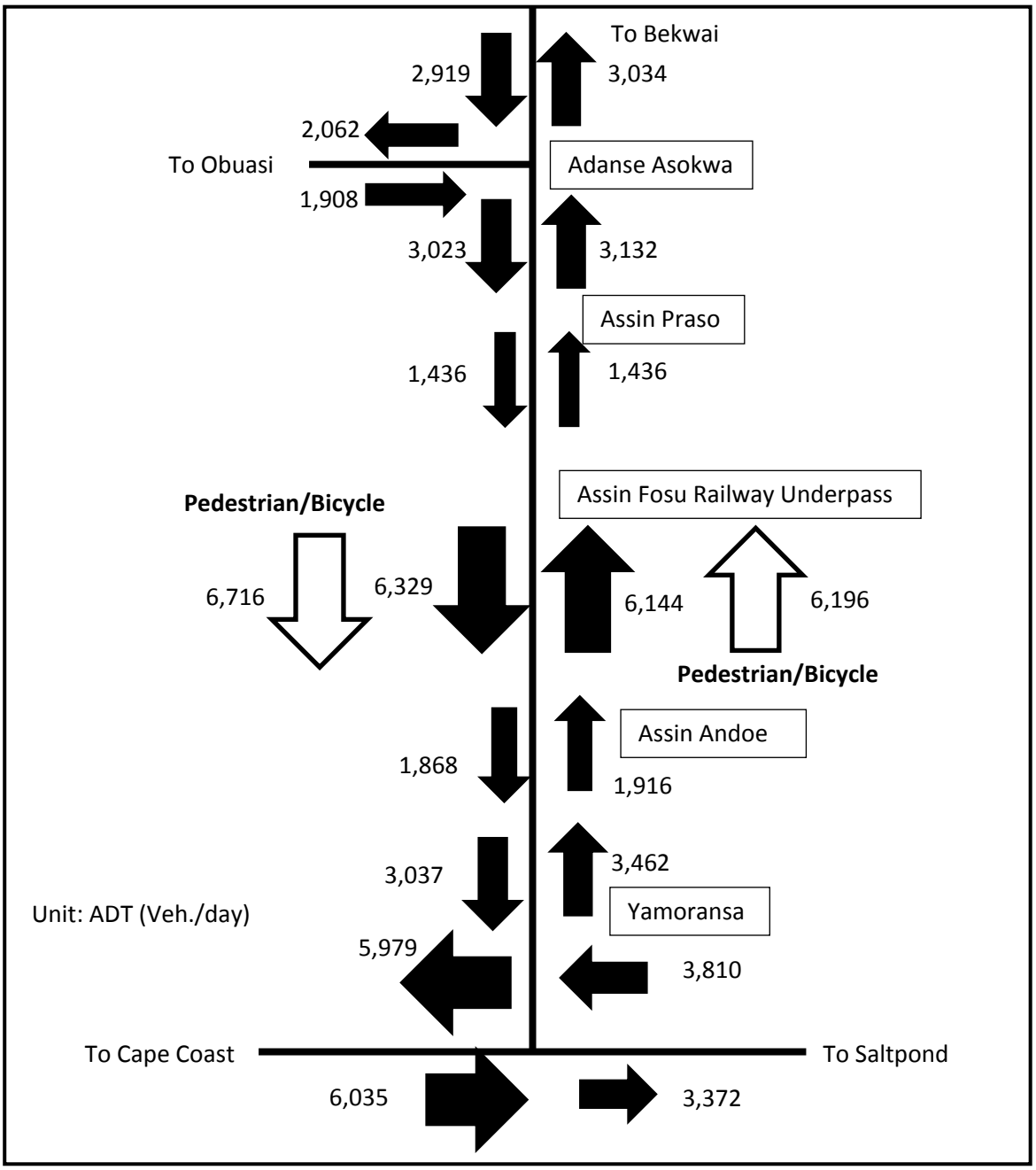
The Study Team carried out directional traffic volume counting at two intersections, cross-sectional traffic volume counting at seven locations, and roadside origin-destination (O/D) interview surveys at two locations, and then estimated future traffic demand for 2021 and 2038, 3 years and 20 years after completion of the Project. Figure 11 shows the present daily traffic volume on the N8 (including pedestrian/bicycle traffic on the Assin Fosu railway underpass bridge), and Table 25 shows the projected traffic on the N8 in 2021 and 2038.

The present traffic volume counting survey revealed that vehicular traffic in both directions on the Assin Fosu railway underpass is particularly high at 12,473 veh./day, while the number of pedestrians and bicycles is also high at 12,912 people. This volume of traffic, together with many taxis waiting for passengers on the carriageway and many pedestrians, is one of the major causes of traffic congestion in the centre of Assin Fosu township almost every day even at present.

Furthermore, it is estimated that the traffic volume on the Assin Fosu railway bridge will reach 22,001 veh./day in 2038, exceeding the capacity of the two-lane road.

1-4-2 Travel Speed and Travel Time on the N8

According to the result of the travel speed survey conducted by the Study Team, the average travel speed between the north of Assin Fosu township and Assin Praso was about 77.1 km/h, 15 km/h slower than the travel speed between Assin Praso and Bekwai, where the N8 was rehabilitated under the Phase I Project.



Source: Study Team

Figure 11 Present Daily Traffic Volume on N8

In addition, the average travel speed in the centre of Assin Fosu township was as slow as 22 km/h, due to traffic congestion in every day.

After completion of the Project, the travel speed between the north of Assin Fosu township and Assin Praso is expected to be about 90 km/h, the same level as the Phase I Project section, ande about 40 km/h (10 km/h less than the maximum speed limit in a township) in the centre of Assin Fosu township, due to the effects of roundabouts and crossing pedestrians. Based on these assumed travel speeds for each section of the Project road, the average travel time between Assin Praso and the Assin Fosu police barrier is expected to be shortened from 30'15" at present to 22'30" after completion of the rehabilitation of the N8 under the Project.

Table 25 Results of Future Traffic Volume Projection at each Traffic Survey Point

1) Results of Future Traffic Projection at Yamoransa Intersection

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	1,990	1,687	3,148	2,618	4,250	3,533
Minibus	1,049	975	1,420	1,319	1,918	1,786
Bus	34	29	62	95	84	127
Truck	163	186	338	318	439	426
Semi-trailer	156	95	361	359	361	359
Sub-total	3,392	2,972	5,329	4,709	7,052	6,231
Total of both directions		6,364		10,038		13,283

2) Results of Future Traffic Projection at Assin Andoe Community

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	1,308	1,230	2,231	1,833	3,009	2,475
Minibus	244	296	298	415	406	564
Bus	43	48	61	91	88	121
Truck	135	129	224	169	285	231
Semi-trailer	139	123	273	249	357	329
Sub-total	1,869	1,826	3,087	2,757	4,145	3,720
Total of both directions		3,695		5,844		7,865

3) Results of Future Traffic Projection on Assin Fosu Railway Underpass

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	5,368	5,286	7,268	7,155	9,447	9,141
Minibus	351	581	422	697	642	1,065
Bus	44	43	48	75	79	112
Truck	244	252	287	302	414	436
Semi-trailer	137	167	243	215	353	312
Sub-total	6,144	6,329	8,268	8,444	10,935	11,066
Total of both directions		12,473		16,712		22,001

4) Results of Future Traffic Projection at Assin Praso Township

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	893	888	1,077	1,308	1,453	1,766
Minibus	193	170	260	255	353	311
Bus	44	54	56	134	69	108
Truck	128	124	186	176	238	178
Semi-trailer	116	139	224	237	312	313
Sub-total	1,374	1,375	1,803	2,110	2,425	2,676
Total of both directions		2,749		3,913		5,101

5) Results of Future Traffic Projection at Asanse Asokwa Intersection

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	1,545	1,532	1,865	2,258	2,514	3,047
Minibus	912	955	1,232	1,438	1,670	1,749
Bus	58	29	74	72	92	118
Truck	231	207	337	295	431	298
Semi-trailer	161	126	312	215	434	284
Sub-total	2,907	2,849	3,820	4,278	5,141	5,496
Total of both directions		5,756		8,098		10,637

Source: Study Team

CHAPTER 2

CONTENTS OF THE PROJECT

Chapter 2 Contents of the Project

2-1 Basic Concept of the Project

The components of the Project are rehabilitation of the road section of the N8 between Assin Fosu and Assin Praso, and reconstruction of the four-continuous box culverts installed at the Okyi River north of Assin Andoe community to a bridge.

The rehabilitation of the road section between Assin Fosu and Assin Praso consists of the following:

1) Rehabilitation of 31.2 km of the road section between Assin Fosu and Assin Praso with AC pavement
2) Dualisation of 1.2 km of the section in the centre of Assin Fosu township
3) Reconstruction of the existing railway underpass bridge
4) Reconstruction and rehabilitation of the drainage facilities between Assin Fosu and Assin Praso
5) Installation of a toll plaza for north-bound traffic to the south of Assin Praso community

Also, the four-continuous box culverts installed at the Okyi River are planned to be reconstructed by a RC bridge with the length of 25 m; rehabilitation of the approach roads to the existing alignment is also included in the Project.

The Project will restore the function of the N8 as a trunk national highway, by rehabilitating road sections where the pavement has been seriously damaged and hinders driving of vehicles, and will ease the traffic congestion in the centre of Assin Fosu township by dualisation.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The N8, which is the road for the Study, not only contributes to economic development in Ghana, but also functions as an important logistics route for transporting goods to nearby landlocked countries. The N8 was improved as an asphalt concrete (AC) road in 1993 with a Yen Loan from Japan. However, the pavement of the N8 has deteriorated and is damaged, and can no longer function as a national trunk road with merely routine maintenance. In addition, several sections are often submerged after heavy rainfall in the rainy season, while some sections do not have sufficient carriageway width. Furthermore, there is chronic traffic congestion at the centre of Assin Fosu township, due to the concentration of both internal traffic and through traffic as a result of increasing traffic demand in recent years. These situations adversely affect not only the socio-economic conditions in the region, but also the road safety and smooth traffic flow on the national trunk road.

In view of these situations, the Study Team set up the basic policy for the outline design as follows:

- To prepare a plan to restore the original function of the existing road in compliance with the design standard of Ghana as far as possible.
- To prepare a plan within the existing right-of-way (ROW).
- To prepare a plan to minimise social effects, such as resettlement of residences and land acquisition.
- To prepare a plan to use the existing pavement and structure as far as possible to improve the function of the road, while aiming to reduce the cost and impacts on the environment and lives of those living along the road.
- To prepare a plan for the road structure and traffic safety devices, which will contribute to smooth traffic flow and road safety.
- To prepare a plan that considers the traffic characteristics of public transportation (bus and taxi) and pedestrians.
- To prepare a plan to secure the long-term durability of the road.
- To prepare a plan for the roadway to minimise the influence on through traffic caused by other traffic (right- and left-turning vehicles, parking and stopping commercial and passenger vehicles, broken-down vehicles) in the centre of Assin Fosu township.

2-2-1-2 Policy for the Natural Conditions

(1) Topographical Conditions

The average altitude of Assin Fosu township is about 140 m, and the altitude about 5 km north of the township, the highest point within the road section for the Project, is 180 m. The terrain then descends to Assin Praso township, where the altitude is about 95 m. The N8 in the Study Area passes through mainly rolling terrain with ups and downs of 10 to 20 m for the whole section. Therefore, the Study Team has considered these terrain conditions when preparing the rehabilitation plan.

(2) Geological Conditions

The bedrock along the N8 is granitite and schist, while the surface soil is mainly sandy gravel and clay with gravel. According to the Soil Classification developed by the United Nations (UN) Food and Agriculture Organization (FAO), Ferric Lixisos is widespread in the Study Area and this type of soil is suitable for road construction. Also, areas with many clay layers suffer insufficient drainage, such as in forest areas. In addition, a rock layer was confirmed at 14.2 m below ground level close to the railway underpass in Assin Fosu township. Therefore, the Study Team has thoroughly considered these geological conditions when preparing the rehabilitation plan.

(3) Meteorological Conditions

The monthly average temperature at the Assin Fosu meteorological observatory for the last 10 years is lowest in January (21.9ºC) and the maximum temperature is highest in February (33.1ºC). In general, the temperature is stable without significant variations. The average yearly

precipitation at Assin Fosu meteorological observatory for the last 10 years is 1,610.4 mm. The rainy season starts in March and ends in August, and starts again in September and ends in November. Even though Ghana is not considered to be located in a region with frequent earthquakes, there are some effects of large-scale earthquakes (about magnitude 6.5) near the coastal Accra Region. Therefore, it is necessary to consider the effects of earthquake when designing structures in Ghana.

(4) Hydrological Conditions

Some medium- and small-scale rivers cross the N8, including the Okyi River north of Assin Andoe township, and the road is often submerged when these rivers flood during the rainy season. The Study Team has conducted hydrological and hydraulic analyses of the rivers to determine the vertical alignment and the length of the bridge across the Okyi River at Assin Andoe to replace the existing four continuous box culverts, and sizes of box culverts for other rivers.

2-2-1-3 Policy for the Socio-Economic Conditions

(1) Economic Activities in Ghana and Neighbouring Landlocked Countries

The traffic volume on the N8 has been increasing year by year resulting from the economic growth in Ghana and nearby landlocked countries, and the traffic demand is also expected to increase in future. Particularly, it is necessary to pay attention to heavy commercial vehicles, such as trucks and semi-trailers, which may cause damage to the pavement. Ghana ratified the "Decision C/DEC.7/91 Relating to the Road Traffic Regulations based on the 11.5 tons Axle Load to Protect Road Infrastructure and Road Transportation Vehicles" of the Economic Community of West African States (ECOWAS), and the maximum permissible axle load is set at 13.5 tonnes per axle. Even though the GHA has been implementing strict axle load control by installing weigh bridges at major national roads, there are still many overloaded vehicles. Also, there are many parking/waiting taxis and passenger cars on the shoulder at the centre of Assin Fosu township and some broken-down heavy commercial vehicles on the carriageway. The Study Team has thoroughly considered this traffic environment and prepared plans to secure smooth traffic flow and road safety.

(2) Socio-economic Activities of Communities along the N8

There are 13 communities along the N8 in the Study Area. In addition, there are some communities located some distance from the existing N8, where the alignment of the N8 was changed to bypass these communities during the improvement of the N8 in 1993. In order to improve convenience and stimulate the socio-economic activities of these communities, the Study Team has prepared plans to construct bus-bays at or near these communities to enable them to use buses and minibuses as a mode of transport.

(3) Minimising Negative Social Impacts along the N8

The Study Team has prepared a plan to minimise the involuntary resettlement of residences

and land acquisition. It should be noted that the ANMA already has the RAP to relocate all vendors doing business in temporary stalls to the newly constructed market along the N8 in the centre of Assin Fosu township under another project. Also, the GoG has agreed to relocate permanent structures and residences, other than temporary stalls, affected by the road rehabilitation works prior to the commencement of the Project.

2-2-1-4 Policy for the Construction and Procurement Conditions

Many foreign contractors have been working on road construction works financed by various development partners in Ghana. General-purpose construction equipment and construction materials are available in Ghana, but other types of equipment and materials should be procured by each project.

Construction of the Project will be executed by a Japanese contractor under the Grant Aid Scheme of Japan. In this case, it is better to effectively use local resources (labour, material and construction equipment) as far as possible, and to procure unavailable equipment and materials from either Japan or a third country.

2-2-1-5 Policy for the Local Contractor

For sub-contracting a local contractor, its experience of construction works and resources (staff and labour, and construction equipment) must be considered. In order to complete the Project successfully, it is necessary to train and transfer technologies to the sub-contractor during construction works. However, for those works items that are critical for the work schedule and quality of works, the contractor should carefully decide whether to sub-contract with a local contractor, or with a contractor from Japan or a third country.

2-2-1-6 Policy for the Operation and Maintenance

The Central Region Highway Directory of the GHA is in charge of the operation and maintenance (O&M) of the section of the N8 in the Study. Periodical maintenance, including heavy maintenance of pavement such as reconstruction and sealing at certain sections (contract with private company), routine maintenance, including light maintenance of pavement such as patching of potholes (contract with private company) and ROW cleaning such as cutting grass and cleaning side ditches (contract with workers), have been carried out. There is no major problem for the system of O&M of the road so far. On the other hand, it is necessary to secure sufficient budget for the O&M of the road network in the Central Region in the future, to cope with the increasing traffic demand and heavy commercial vehicles. Therefore, the Study Team has prepared rehabilitation plans to reduce the long-term O&M cost of the Project road section, in order to secure and allocate adequate budget for the road network under the jurisdiction of the Central Region Highway Directory.

2-2-1-7 Policy for Determining the Scale and Contents of the Facility for the Assistance

2-2-1-7-1 Scale and Contents of the Facility

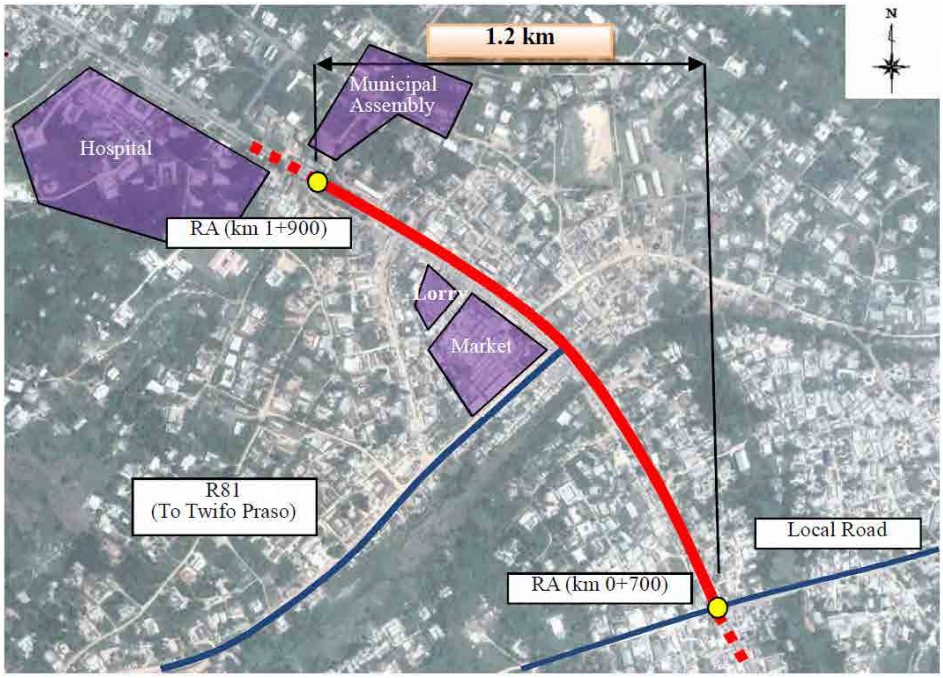
Based on the request from the GoG for the technical contents of the Project, the Study Team has studied the scale and contents of the road rehabilitation works in terms of applicability of the Japanese Grant Aid scheme, and carried out the outline design within the scope that is judged as appropriate.

2-2-1-7-2 Road and Ancillary Works

(1) Dualisation to Four-lanes at the Centre of Assin Fosu Township

a) Selection of a section to be dualised to four-lanes

The present vehicular traffic volume at the centre of Assin Fosu township is about 12,500 veh./day, which is a very high volume on the N8. A particular characteristic is a very high volume of taxis, mainly moving within the township. Also, there are many obstacles for traffic passing through the centre of the township, including mini-buses entering and exiting from the lorry terminal, many parking/stopping vehicles (mainly taxis) waiting for passengers adjacent to the newly constructed market, and many vehicles making right-turns, left-turns, and U-turns. Furthermore, the pedestrian volume at the railway underpass is also high at about 12,000 persons/day due to the lorry terminal and big market in the centre of the township. According to traffic projections, the traffic volume at the centre of the township will increase to about 22,000 veh./day.



Source: Study Team

Figure 12 Dualised Section at the Centre of Assin Fosu Township

Accordingly, the Study Team has drawn up plans to dualise a part of the N8 to four-lanes at the centre of Assin Fosu township. After consultation with the GHA, it was decided to dualise a

1.2-km section between KM0+700 and KM1:900 as shown in Figure 12, with roundabouts to be constructed at both ends of dualised four-lane section to consider for accommodating U-turn traffic.

b) Cross-sectional element of the four-lanes section

For the proposed four-lane section in the centre of the township, the road formulation and cross-sectional element were compared, considering the roadside condition and traffic volume projections, as shown in Table 26 and Figure 13.

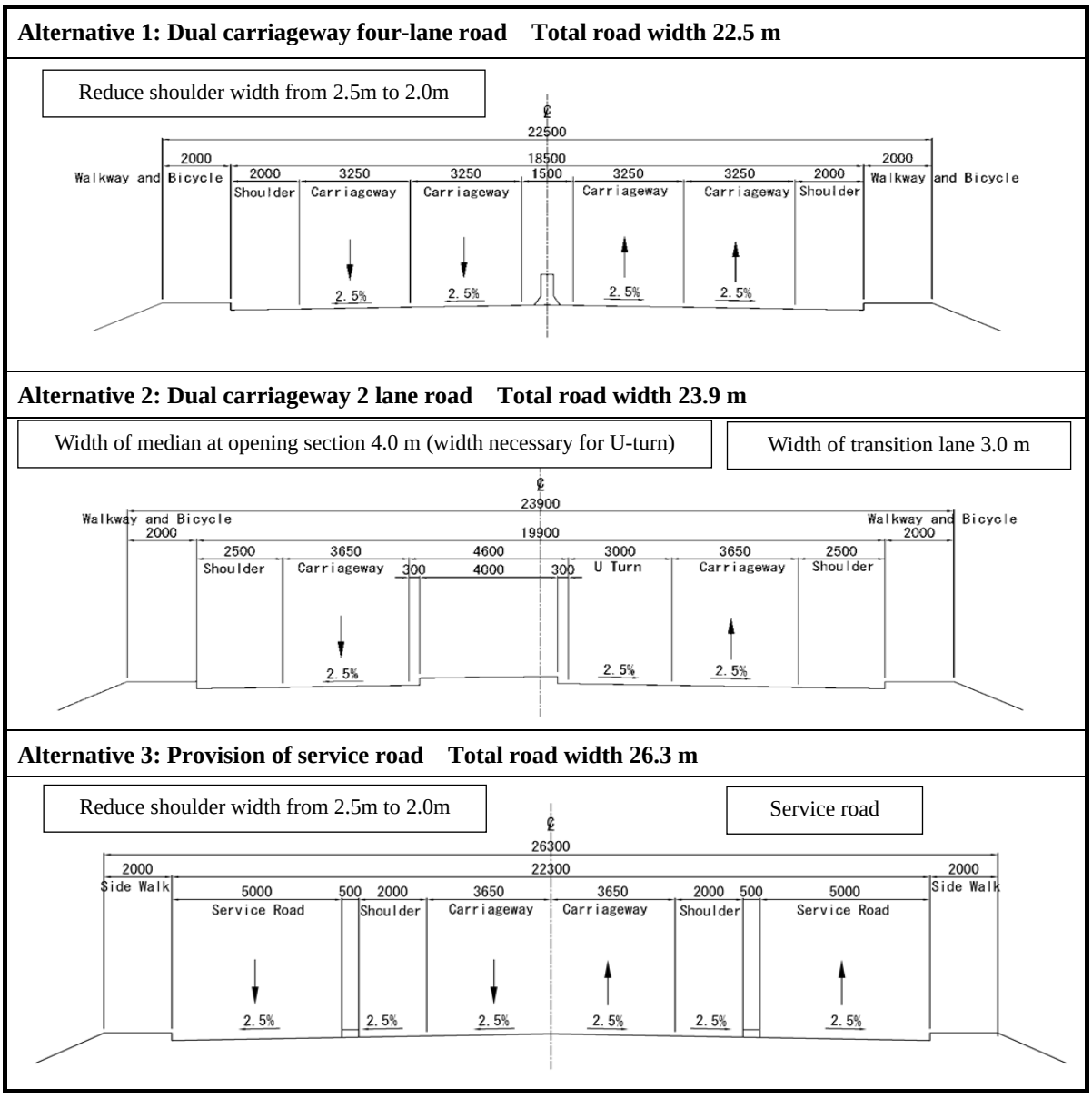
Table 26 Comparison of Road Formulation and Cross-sectional Element at the Centre of Assin Fosu Township

Items Studied	Alternative 1	Alternative 2	Alternative 3
Outline	• To widen the existing road to a four-lane dual carriageway	• To widen the existing road by providing a transition lane	• To widen the existing road by providing a service road
	• To provide a median to restrict turning left and secure smoother traffic flow	• To provide a median to restrict turning left and secure smoother traffic flow	• To provide a service road to separate the main traffic flow from the traffic for roadside service
	• To provide roundabouts to allow U-turns and to secure access to roadside facilities	• To provide an exclusive U-turn lane and to secure access to roadside facilities	• To provide roundabouts to allow U-turns and to secure access to roadside facilities
No. of lanes	Four-lanes	Partial four-lanes (Two-lanes + transition lane)	Four-lanes (Two-lanes + service road)
Total road width	22.5 m	23.9 m	26.3 m
Increase of width (Effects for roadside)	• Smallest of the 3 alternatives A	• 1.4 m wider than Alt. 1 B	• 3.8 m wider than Alt. 1 C
Smooth traffic flow on N8 and separation of through traffic from traffic for roadside facilities	• Carriageway width necessary for through traffic and access traffic to roadside facilities are secured A	• Queuing traffic on a transition lane may affect the through traffic flow B	• Through traffic and traffic access to roadside facilities (service road) are physically separated A
Emergency case (broken-down heavy vehicles occupying carriageway, etc.)	There will be no major problem to use one side of the carriageway for traffic of both directions in case of emergency, as the road width on one side is 8.5 m A	It will be possible to use one side of the carriageway for traffic of both directions in case of emergency, as there is a section with a road width of 6.15 m C	There will be no major problem to use one side of the carriageway for traffic of both directions in case of emergency, as the road width on one side is 11.3 m A
Overall evaluation	After comparing alternative plans and consultation with the GHA, Alternative 1 was selected as the desirable road formulation and cross-sectional element		

Source: Study Team

(2) Horizontal Alignment of the Road

As mentioned in the basic policy for the design, the Study Team mainly follows the existing horizontal alignment of the N8: 1) to ensure the rehabilitation plan is within the existing ROW, 2) to minimise negative social impacts such as resettlement of residents along the N8 and land acquisition, and 3) to maximize utilisation of the existing pavement and road structures.



Source: Study Team

Figure 13 Comparison of Cross-sectional Element at the Centre of Assin Fosu Township

If the road is widened to four-lanes from the centre of the existing road in the case of the proposed dualised four-lane section in the centre of Assin Fosu township, it will be necessary to demolish many permanent structures, such as several shops in front of the new market, and several shops and houses near the railway underpass bridge market, which are the main base of commercial activities. Also, it is necessary to consider the construction method and process of reconstructing the railway underpass bridge. In order to minimise resettlement of shops and houses, and consider the reconstruction method of the railway underpass bridge, the Study Team has planned to shift the centre line of the dualised section to eastern side with the maximum shifting range of about 5.4 m.

(3) Vertical Alignment of the Road

a) Raising the level of the road to reduce the influence of water

According to the results of a road damage survey, pavement damage was found at many

sections at sags of the vertical alignment. The main causes are considered to be insufficient capacity to drain water, which infiltrates from the road surface into the pavement, or inadequate drainage facilities, etc. In addition, it is also considered that once the pavement is damaged (mainly alligator cracks), water infiltrates through those cracks and further damages the pavement, especially at sag sections where drainage water concentrates. Especially, the most serious pavement damage is found at the sag section near the starting point of the project road in Assin Fosu where the asphalt concrete wearing course has already disappeared. Other than sag sections, there are some sections where the pavement is seriously damaged by water due to the local topography.

Therefore, the Study Team plans to raise the level of the road surface from the existing level in order to reduce deterioration of pavement at: 1) sag sections of the vertical alignment where pavement damage is serious, and 2) sections other than sag sections where pavement damage is serious.

As the height to which the level of the road surface must be raised depends on the surrounding topography and vertical alignment of the road before and after a sag section, the Study Team considered raising the level by 60 cm to 100 cm. Also, the design speed of 100 km/h is applied at the planned sag sections for improvement of the vertical alignment in order to secure driving comfort and safety. Table 27 shows the sections for raising the road level and their length.

Table 27 Road Sections for Raising Road Level (Purpose to reduce influences of water)

Location of Section (KM)	Length of Section (m)
0+180 – 0+240	220
1+890 – 2+850	960
6+050 – 6+750	700
9+400 – 9+700	300
10+950 – 11+300	350
13+800 – 14+900	1,100
23+800 – 23+600	300
27+450 – 27+850	400
28+600 – 29+100	500

Source: Study Team

b) Changing the level of the approach sections of crest with a present vertical alignment design speed of 60 km/h

According to the results of the topographical survey of the road section for the Project, the Study Team found some sections with a slightly steep gradient where the vertical alignment was equivalent to the design speed of 60 km/h, and not conforming the standard vertical alignment design speed of 80 km/h. At these sections equivalent to 60 km/h, the risk of traffic accidents is higher due to insufficient vertical sight distance, based on the observed actual traffic conditions and running speed of vehicles. Therefore, the Study Team plans to improve the vertical alignment of those sections to conform to the design speed of 80 km/h, in order to secure the

safety of running vehicles.

The Study Team identified 12 crest sections and 2 sag sections, other than those sections where the road level should be raised to minimise the effects of water, where the vertical curvature radius and length do not conform with the design standard of 80 km/h. Table 28 summarises the sections where the road level of approach sections needs to be raised at crest sections, and road level of sag sections.

Table 28 Sections Necessary to Change Road Level to Improve the Vertical Sight Distance

KM	Formation	Vertical Curve Radius (m)	Vertical Curve Length (m)	Improvement
1+700	Crest	2,800	200	Raise the road level of approach sections
3+870	Sag	1,500	70	Raise the road level
5+200	Crest	2,800	230	Raise the road level of approach sections
12+700	Crest	2,800	200	- ditto -
13+400	Crest	1,400	140	- ditto -
18+150	Crest	2,500	190	- ditto -
18+600	Crest	1,800	150	- ditto -
19+700	Crest	2,100	180	- ditto -
21+000	Crest	2,300	230	- ditto -
22+850	Crest	2,900	190	- ditto -
25+800	Sag	1,700	190	Raise the road level
26+200	Crest	1,500	150	Raise the road level of approach sections
26+950	Crest	2,300	170	- ditto -
29+550	Crest	2,300	190	- ditto -

Note: Standard values for the design speed of 80 km/h:

1. Crest section: Minimum vertical curvature radius R=3,000 m, Minimum vertical curvature length L=70 m
2. Sag section: Minimum vertical curvature radius R=2,000 m, Minimum vertical curvature length L=70 m

Source: Study Team

(4) Construction Method to Rehabilitate Pavement

a) Necessity of improving the pavement structure

In compliance with the visual inspection method to check road surface damage adopted by the GHA, the Study Team conducted a visual inspection of the pavement for the whole section of the road for the outline design and evaluated the road surface condition (The result of the visual inspection is attached in Appendix 11). As a result, damages were confirmed to be scattered and severe for the whole section. On the other hand, as shown in Table 29, the present pavement structure coefficient is calculated as 1.99, which is 2.07 less than the value of 4.06 required to accommodate the future traffic volume.

This result indicates that preliminary or emergency measures (e.g. thin overlay) to restore smoothness and skid resistance capability for the wearing course are insufficient. Therefore, it is necessary to strengthen the bearing capacity of the pavement and improve smooth driving, by applying structural measures to protect the pavement from repeated loading by future traffic volume.

Table 29 Existing Pavement Structure Index Value and Value Required in the Future

Item	Pavement Structure coefficient
(1) Present pavement structure index	1.99
(2) Pavement structure index required for future traffic volume	4.06
(2) - (1) Shortfall	2.07

Notes: 1. This analysis was conducted for a section near Assin Fosu.
2. Calculation method: According to AASHTO and Pavement Design Manual of Ghana.
3. Elasticity coefficient of pavement and sub-grade are based on the results of FWD investigation.
4. Pavement thickness is based on the observation of test pits.
5. Strength of existing wearing course for the overlay method was calculated by considering the remaining lifespan of the wearing course.

Source: Study Team

As shown in Table 30, three structural measures to rehabilitate the pavement in the section for the Study are considered: 1) Overlay method, 2) Pavement recycling method on road, and 3) Pavement reconstruction method.

Table 30 Pavement Rehabilitation Methods for Structural Measures

Pavement Rehabilitation Method	Outline of Method
Overlay method	After repairing damages on the existing wearing course, newly lay asphalt mix on the existing wearing course.
Pavement recycling method	After crushing the existing asphalt surface layer, mix and stir it with the existing base course material and additives such as cement or bitumen, construct the recycled base course, then newly lay AC mixture on the recycled base course.
Pavement reconstruction method (reconstruction of parts of pavement)	After demolishing and removing the existing asphalt surface layer, construct an additional base course, and newly lay AC mixture on the base course.

Source: Study Team

b) Comparison of Pavement Rehabilitation Methods (Selection of Basic Rehabilitation Method)

The Study Team compared the above three pavement rehabilitation methods in terms of cost performance, workability, traffic control during construction, environment, impacts on roadside residents, demolition damages on wearing course, and applicability for sections where the road level must be raised. Table 31 shows the results of the comparison.

As a result of the comparison, the “Pavement recycling method”, which is more favourable than the other methods, is selected as the basic pavement rehabilitation method for the section of the Project. In addition, the “Pavement reconstruction method”, which can adjust the height of raising the road level by adding embankment and base course materials, is also selected for the section where the road level must be raised.

(5) Intersections

Intersections with other cross roads are basically planned to be at-grade intersections. However, for the intersections at both ends of the dualised four-lane section at the centre of Assin Fosu township, roundabouts are planned in consideration of the many U-turning taxis and mini-buses according to the results of a site survey and traffic volume counting survey, as well as in view of the power supply with frequent blackouts.

Table 31 Comparison of Pavement Rehabilitation Methods

Item	Overlay Method	Pavement Recycling Method	Pavement Reconstruction Method
Cost performance	• The AC layer tends to be thickest (e.g. 17 cm near Assin Fosu) • This method has cost advantage compared with the pavement reconstruction method C	• It requires cost of recycling base course, however, the AC layer becomes thin (e.g. 13 cm near Assin Fosu) • This method has cost advantage compared with pavement reconstruction method A	• It requires demolishing existing AC layer and base course, and construct new base course • Thickness of AC layer is between two methods (e.g. 15 cm near Assin Fosu) B
Workability	• The condition and extent of damages differ by location, so maintenance works for the existing pavement will be complicated C	• Curing time for the cement mixture to construct the recycling sub-base is necessary (about one week), which can be reduced by adding bitumen B	• After demolishing and removing the existing AC layer, an additional base course must be constructed to secure the required strength of pavement C
Traffic control during construction	• One-side traffic control is necessary B	• One-side traffic control is necessary B	• One-side traffic control is necessary B
Environment	• It is not necessary to dispose of a part of the existing AC mixture B	• It is not necessary to dispose of the existing AC mixture A	• It is necessary to dispose and transport all existing AC mixture (generating CO_2) C
Elimination of damages of AC layer	• Impossible to eliminate causes of pavement damages B	• Possible to eliminate causes of pavement damages A	• Possible to eliminate causes of pavement damages A
Applicability for a section where road level must be raised	• Not applicable C	• Applicable only up-to a certain level of raising height by adding materials for base course B	• Applicable because it is possible to easily adjust the raising height by embankment material and base course materials A
Technology transfer	• This method is widely used in Ghana B	• There is no experience of recycling base course method on AC paved road in Ghana, and expectation is high for introducing new technology A	• This method is widely used in Ghana B
Overall evaluation	• The “Pavement recycling method” is selected as the basic pavement rehabilitation method, since it has more advantages compared with the other methods. • The “Pavement reconstruction method” is selected as the basic pavement rehabilitation method only for the section where the road level must be raised, since it is easy to adjust the height raised by embankment material and base course materials.		

Note: A: Favourable, B: Medium, C: Unfavourable
Source: Study Team

(6) Median Divider

The Study Team plans to install a concrete barrier as a median divider for the whole dualised four-lane section in order to ensure orderly traffic flow by physically preventing left-turn and U-turn manoeuvres by vehicles in the section. Also, guard fences are planned to be installed on top of the concrete barrier to prevent traffic accidents caused by random crossing by pedestrians.

(7) Toll-plaza

In order to collect tolls for the Pra Bridge newly constructed by the Phase 1 Project, instead of collecting tolls by a toll collector on the road, even after completion of the new bridge, the Study Team plans to install a toll-plaza at the south of Assin Praso township. However, after discussion with the GHA, this toll-plaza facility will only collect tolls from north-bound traffic. The pavement of the toll-plaza is planned to be inter-block pavement, which is widely used for other toll-plazas in Ghana and which can be maintained by the GHA (GHA Standard).

(8) Bust Stop

The Study Team plans to install at least one bus stop in each township along the section for the Project. Bus bays with cement concrete (CC) pavement for each direction are planned to be installed at each bus stop.

(9) Street Lighting

For rehabilitation of the section for the Project, it is necessary to demolish the existing street lights installed in Assin Fosu township. Instead, the Study Team plans to install new street lights along 3.8 km of section in the township..

(10) Guardrail

The Study Team plans to install guardrails on the top of the side slope of the embankment with a height of at least 3 m, and to install guardrails at sections where necessary for safety.

(11) Overhead Information Sign Board with Gate Type Support

The Study Team plans to install overhead type guidance signs near the railway underpass bridge at Assin Fosu and a toll plaza at Assin Praso. These signs will indicate that the road section is rehabilitated with Grant Aid of Japan.

2-2-1-7-3 Drainage Structures

(1) Box Culverts for Drainage

Box culverts are installed at locations where small rivers and streams cross the road sections for the Project. There is no major deterioration or damage to these box culverts. The Study Team calculated the maximum discharge volume of each river and stream, measured the inner size of the culverts to calculate the flow capacities, then compared the water discharge volume and flow capacity of each culvert. As a result, the culverts which have enough capacity to discharge the maximum volume will be reused in the Project, while the culverts with insufficient capacity will be replaced with ones having sufficient flow capacity.

(2) Pipes for Drainage

Since existing corrugated pipes have seriously deteriorated and are damaged, all of them will be replaced. Concrete pipe culverts are planned to be used in order to prevent deterioration and damage. All existing pipe culverts with a diameter of 600 mm will be replaced by pipe culverts with a diameter of 900 mm for ease of maintenance (cleaning).

(3) Side Ditches

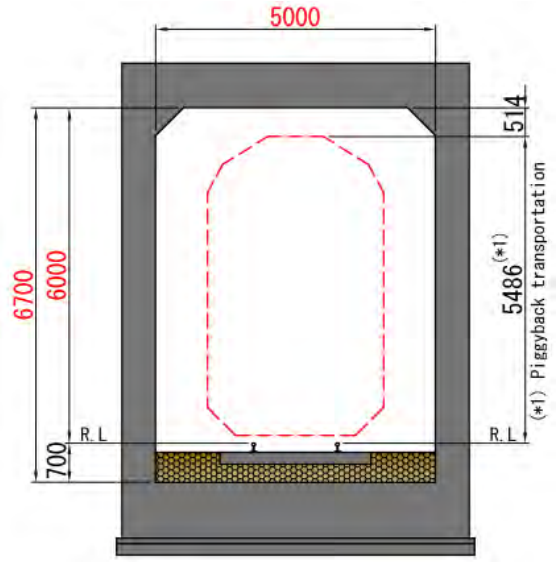
At present, side ditches with concrete lining (about width 120 cm, height 50 cm, cross section for water flow A = 0.43 m^2) are installed at road sections in every township. Since this type of side ditch is the open type with a wide width, residents in townships must place wooden or concrete plates to enable them to cross these side ditches, which is inconvenient them. The GHA requested that concrete side ditches capable of being covered should be installed in the rehabilitation project. Therefore, the Study Team plans to install concrete side ditches (cross section for water flow of about A = 0.50 m^2) with concrete covers at every township along the section for the Project.

2-2-1-7-4 Bridges

(1) Reconstruction of Railway Underpass Bridge

Bridge at Assin Fosu

According to the Ghana Railway Development Authority (GRDA), the central line of Ghana Railway is planned to be rehabilitated by a single track, but double track space is required for the underpass. The Study Team and the GHA agreed with the GRDA to reconstruct the underpass bridge by using a box culvert structure, which will be relatively easy to expand in future. Also, based on discussions with the GRDA about the construction gauge of the railway line, the Study Team has planned a box culvert with a hollow section (height from the surface of a rail to the ceiling is 6.0 m and width of the inner section is 5.0 m) to secure the construction gauge requirement by the GRDA, as shown in Figure 14.



Source: Study Team

Figure 14 Dimensions of Hollow Section of the Box Culvert for Railway Underpass

(2) Reconstruction of Okyi River Bridge at Assin Andoe

Four continuous box culverts are installed at the location where the Okyi River crosses the N8 to the north of Assin Andoe community, and river water sometimes overflows onto the road surface during the rainy season according to interviews with local residents. The causes of this overflow are considered to be complex, such as increasing volume of rainfall in recent years, stacking obstacles on culverts such as branches flowing from upstream, blocking of the river flow, and bending of the river channel downstream.

Furthermore, even though these continuous culverts were constructed according to the design standard in the early 1990s, the discharge cross section is insufficient under the existing design

standard (15-year return period of frequency of occurrence). Hence, the insufficient discharge capacity of these continuous culverts is one of the causes of overflow on the road surface (the present allowable discharge volume of 80% of water depth is calculated as 283.38 m^3/s, which is insufficient for the flood discharge volume of 290.10 m^3/s calculated for a 15-year return period).

In view of the above situation, rehabilitation of these four continuous box culverts is judged as necessary, and reconstruction by a bridge is planned in order to improve the discharge capacity at the point where it crosses the river to eliminate the effects of flowing obstacles such as branches.

2-2-1-8 Policy for the Construction Method and Implementation Programme

(1) Construction Method

As the N8 is the trunk national highway, it is necessary to carry out the road rehabilitation works while allowing traffic to move during construction. Since it is very difficult to provide a detour for the whole section of the Project because of land use along the road, the Study Team plans to control only one lane for the construction works and to allow traffic to use the other lane. However, for those locations where existing box culverts or pipes for drainage are planned to be replaced or newly constructed, the Study Team is considering providing detours for the passage of traffic in both directions in order to allow effective construction works.

For reconstruction of the railway underpass bridge at Assin Fosu, it is planned to demolish the existing 2-lane bridge and construct a four-lane-width box culvert. The Study Team has designed the construction plan so as not to stop the traffic during the construction period. For reconstruction of this bridge, it is difficult to rent land for a temporary construction yard along the road, however, it is possible to use a part of the existing ROW as a temporary construction yard, since this section will be widened to four-lanes.

Reconstruction of four continuous box culverts to a bridge at Assin Andoe (Okyi River Bridge) is planned at the same position as the existing box culverts, considering the existing horizontal alignment of road, topography of surrounding area and land use along the N8, and it is planned to provide a detour just beside the existing box culverts so as not to stop the traffic during the construction period.

(2) Implementation Programme

There are two rainy seasons: the main rainy season between May and June, and the minor rainy season between September and October, however, rain is also expected before and after these rainy seasons. Therefore, it is necessary to prepare the implementation programme not only considering the construction schedule concentrated in the dry season, but also to consider an efficient work schedule during the rainy seasons.

Furthermore, resettlement of permanent structures, land acquisition and relocation of utilities (electricity lines, water supply pipes, optical fibre cable, etc.) should be carried out by the GoG

before execution of the construction works commences. Hence, the Study Team has prepared the implementation programme in consideration of the necessary duration of these arrangements by the GoG.

2-2-2 Basic Plan

2-2-2-1 Outline of the Plan

(1) Summary of Basic Design Specifications

Table 32 summarises the basic design specifications determined based on discussions with the GHA. The areas to be covered by the outline design are the rehabilitation of the N8 between Assin Fosu and Assin Praso (L=31.2 km) and reconstruction of four continuous box culverts to a bridge (within the total length of road rehabilitation L = 515 m, the length to reconstruct a bridge is L = 25.0 m) across the Okyi River on the N8 in Assin Andoe, located about 20 km south of Assin Fosu.

(2) Design Standard

The following design guidelines and specification are used for the design of road and pavement. In addition, the standards and guidelines of Japan and of the American Association of State Highway and Transportation Officials (AASHTO) are also referred to where necessary.

- Ghana Road Design Guide, 2009
- Ghana Pavement Design Manual, 1998
- Ghana Overlay Design Method – Design, 1998
- Standard Details, Road Signs and Markings for Urban and Trunk Roads, Ghana,1991
- Maximum Rainfall Intensity – Duration Frequencies in Ghana, 1974
- Standard Specification for Road and Bridges, Ghana 2007

On the other hand, the Study Team compared the bending moments by live load HB of BS5400 and live load B of the Specification of Highway Bridges (SHB) in Japan (Japan Road Association) for each span from 20 m to 100 m, and confirmed that the bending moments by live load B of the SHB mostly exceed that of BS5400. In addition, reconstruction of bridges in the Project will be executed under the Grant Aid Scheme of Japan. Considering these facts, the Study Team consulted with the GHA, and the GHA agreed to adopt the SHB as a design standard for reconstruction of the railway underpass bridge at Assin Fosu and the bridge across the Okyi River at Assin Andoe.

Table 32 Summary of Basic Design Specifications

Item		Concepts	Note
Geometric Design Standard of Road	Design Speed	100 km/h (80 km/h) • In order to rehabilitate the project road to an appropriate level by Japanese Grant Aid, the design speed of 100 km/h is applied at sections where a change of horizontal or vertical alignment is required (e.g. dualised section and sections where it is necessary to raise the road level at sag). • The design speed of 80 km/h is applied at sections with restrictions, such as in township areas and rolling terrain.	The existing road was constructed with the design speed of 80 km/h (partially 60 km/h). The vertical alignment of sections with the design speed of 60 km/h are planned to be improved to comply with the design speed of at least 80 km/h, based on the discussion with the GHA.
	Horizontal Alignment	The existing horizontal alignment will be followed in principle. • The horizontal alignment of the dualised four-lane section is separately considered.	
	Vertical Alignment	The existing vertical alignment will be followed in principle. • The vertical alignment of sections where the road level will be raised is separately considered.	
	Number of Lane	A two-lane road in principle. Four-lane dual carriageway at the centre of Assin Fosu township	
	Road Width	Ordinary road section (two-lanes) Carriageway width: W = 3.65 m x 2 = 7.30 m Shoulder width: W = 2.50 m x 2 = 5.00 m Ordinary road section(four-lanes) Carriageway width: W = 3.25 m x 4 = 13.00 m Shoulder width: W = 2.00 m x 2 = 4.00 m Sidewalk width: W = 2.00 m x 2 = 4.00 m Bridge section (two-lanes) Carriageway width: W = 3.65 m x 2 = 7.30 m Shoulder width: W = 0.60 m x 2 = 1.20 m Sidewalk width: W = 1.50 m x 2 = 3.00 m	To secure carriageway and shoulder width of 17.00 m (3.65 x 2 + 0.6 x 2) according to the design standard of Ghana.
	Cross Slope	Carriageway: I = 2.5% Shoulder: I = 2.5%	
Pavement	Pavement Structure	Asphalt concrete pavement	
	Design Period	20 years	
	Reliability	90%	
	Elasticity Coefficient	Elasticity coefficient of existing pavement and sub-grade are calculated based on the result of the Falling Weight Deflectometer (FWD) test	
Embankment Slope		1:1.5 or 1:2.0 depending on surrounding conditions	
Cutting Slope		1:1.0 or 1:2.5 depending on surrounding conditions	
Drainage	Box Culvert	Utilise existing culverts in principle, unless reconstruction for those with insufficient cross section	If length is insufficient, construct extension parts
	Corrugated Pipe	All corrugated pipes will be replaced by concrete pipe culverts	Due to serious deterioration and damages
	Concrete Pipe Culvert	Concrete pipe culverts with 600 mm diameter will be replaced by concrete pipe culverts of 900 mm diameter	Cross section to consider maintenance works
	Side Ditches	All side ditches will be reconstructed by road rehabilitation works	Ditches can be covered in townships
	Estimated Water Discharge Volume	Probable rainfall intensity of box culverts is set as 15 years (80% of water depth) and sensitivity analysis is made for 25 years probable rainfall intensity	
Ancillary Works	Bus Bay	Construct at least one bus bay at each township	
	Toll-plaza	Construct one toll-plaza for north-bound traffic	
	Ancillary Works	Install guardrails, traffic signs, information boards, pavement markings, pedestrian crossings, and humps (traffic calming measure) as required	
Bridge	Design Live Load	Based on the “Type B live load” of the Specification of Highway Bridges in Japan	
	Seismic Load	Design horizontal seismic coefficient of kh = 0.08 or more	
	Temperature Variation	+8°C to +51°C	
	Estimated Flood	Probable return period of 50 years	
Construction Gauge of Railway Underpass		Vertical clearance from the top of the rail: H = 6.0 m Horizontal clearance: W = 5.0 m	According to the result of discussion with the GRDA
ROW		90 m (45 m for each side)	According to the result of discussion with the GRDA

Source: Study Team

(3) Geometric Design Standard

Since the N8 is classified as a Trunk National Road, its geometric design standard should comply with the values shown in Table 33.

Table 33 Geometric Design Standard of Trunk National Roads

Item		Value		
Design speed (km/h)		100	80	60
Minimum curve radius (m)	Desirable value	700	420	220
	Absolute minimum	370	230	130
Curve radius to avoid transition curve (m)		910	580	330
Minimum curve length (m)	IA ≥ 7	170	140	100
	IA = 2	600	500	350
Minimum transition curve length (m)		56	44	33
Curve radius to avoid superelevation (m)		5,000	3,500	2,000
Vertical gradient (%)		3	4	5
Limited length to utilise the absolute minimum value of vertical gradient (m)		4% (700 m)	5% (600 m)	6% (500 m)
		5% (500 m)	6% (500 m)	7% (400 m)
		6% (400 m)	7% (400 m)	8% (300 m)
K value	Crest	64	30	14
	Sag	28	18	10
Superelevation (%)		e = (0.7)^xV^2 / 127R = 0.003858 xV^2 / R		

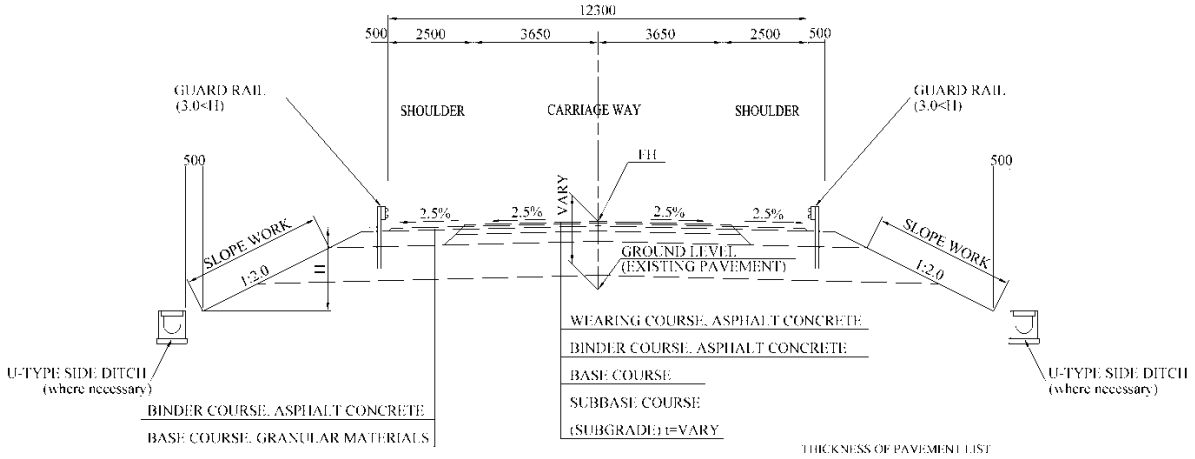
Source: Study Team

2-2-2-2 Rehabilitation of Road between Assin Fosu and Assin Praoso

2-2-2-2-1 Road and Ancillary Works

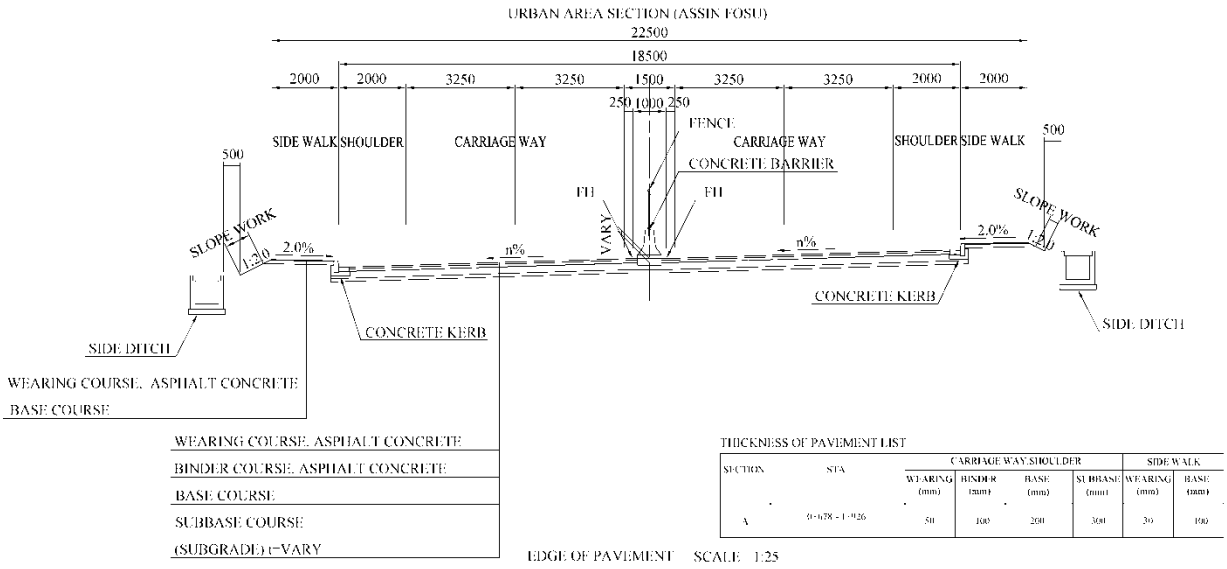
(1) Typical Cross Section

Figures 15 and 16 illustrate typical cross sections of the two-lane section and four-lane section, respectively.



Source: Study Team

Figure 15 Typical Cross Section (Two-lane Section)



Source: Study Team

Figure 16 Typical Cross Section (Four-lane Section)

(2) Vertical Alignment Plan

The vertical alignments are planned based on the following policy:

- To raise the road level at sag sections to reduce the influence of water
- To raise the road level at approach sections of crests to improve the vertical alignment based on the design speed equivalent to 60 km/h
- Sufficient thickness of wearing course and binding course of pavement to enable application of the pavement recycling method
- Sufficient overburden of cross drainages and the box culvert of the railway underpass at Assin Fosu

Table 34 shows sections where the vertical alignment will be changed, by type of improvement.

(3) Pavement Design

a) Sections for Analysing Pavement Structure

Based on the condition of the existing pavement (AC), sub-grade condition, traffic condition, Design Equivalent Single Axle Load (ESAL), and necessary structural number for the pavement, the Study Team considered to rehabilitate the pavement appropriately and rationally, by determining appropriate pavement components for each section.

First, the deflections obtained by the FWD test of pavement to be rehabilitated for the whole section of the road for the Project are statistically analysed (cumulative remainder method), and analysis units to determine pavement components are identified. The results of the FWD test and the test pit excavation to confirm the existing pavement structure are attached in Appendices 12 and 13, respectively.

Table 34 Type of Change of Vertical Alignment by Section

Section Division	Change of Vertical Alignment	Sub-section (KM)	Section Length (m)
A	Type 2	0+000 – 0+180	180
	Type 1	0+180 – 0+400	220
	Type 2	0+400 – 0+730	330
	Type 2 (four-lane section)	0+730 – 1+890	1,160
	Type 1	1+890 – 2+850	960
	Type 3	2+850 – 3+750	900
B	Type 2	3+750 – 4+000	250
	Type 3	4+000 – 4+900	900
	Type 2	4+900 – 5+700	800
	Type 3	5+700 – 6+050	350
	Type 1	6+050 – 6+750	700
C	Type 3	6+750 – 9+400	2,650
	Type 1	9+400 – 9+700	300
	Type 3	9+700 – 10+950	1,250
	Type 1	10+950 – 11+300	350
	Type 3	11+300 – 12+250	950
	Type 2	12+250 – 13+800	1,550
D	Type 1	13+800 – 14+900	1,100
	Type 3	14+900 – 17+700	2,800
E	Type 2	17+700 – 18+950	1,250
	Type 3	18+950 – 19+350	400
	Type 2	19+350 – 20+250	900
	Type 3	20+250 – 20+600	350
	Type 2	20+600 – 21+650	1,050
	Type 3	21+650 – 22+300	650
F	Type 3	22+300 – 22+500	200
	Type 2	22+500 – 23+300	800
	Type 1	23+300 – 23+600	300
	Type 3	23+600 – 24+400	800
	Type 1	24+400 – 24+900	500
	Type 3	24+900 – 25+700	800
	Type 2	25+700 – 27+450	1,750
	Type 1	27+450 – 27+850	400
	Type 2	27+850 – 28+600	750
	Type 1	28+600 – 29+100	500
	Type 2	29+100 – 29+950	850
	Type 3	29+950 – 31+201	1,251

Notes: 1) Section division (A to F) indicates the section for which the road structure was analysed.
2) Type 1 – To raise the road level at sag sections to reduce the influence of water,
Type 2 – To raise the road level at approach sections of crests to improve the vertical alignment based on the design speed equivalent to 60 km/h,
Type 3 – Pavement recycling method section

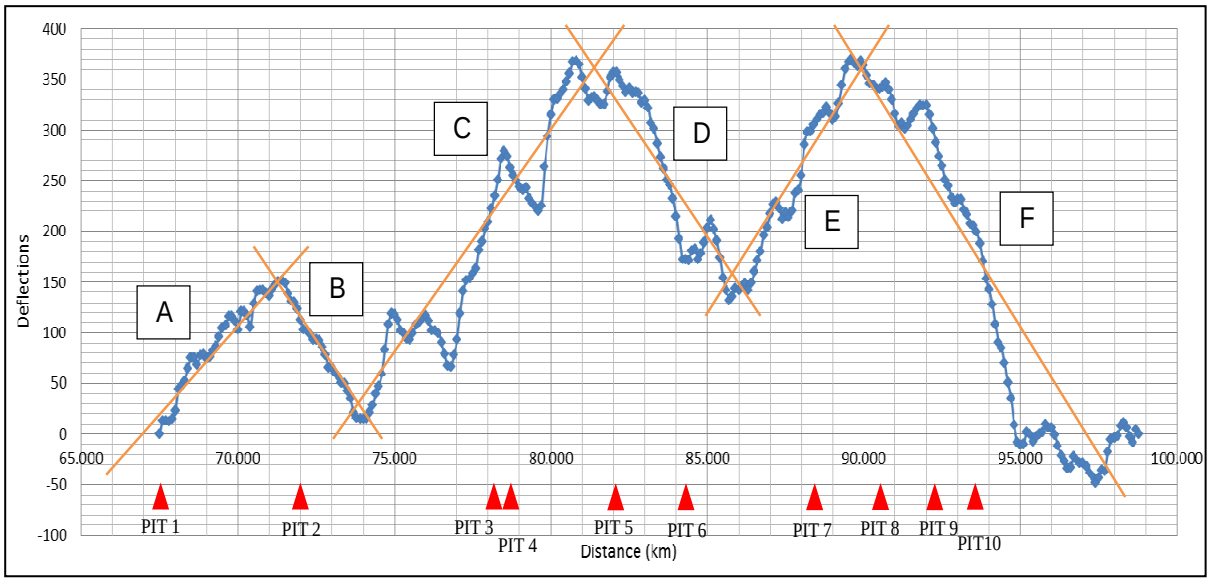
Source: Study Team

Based on discussions with the GHA, the road section for the Project is divided into six sections (Sections A to F), as shown in Figure 17 and Table 35. In this case, as the elastic modulus of each layer of the existing pavement (asphalt layer, base and sub-base) and subgrade are calculated by the programme owned by the GHA from the FWD test data (Table 36), maintenance of pavement after completion of the rehabilitation work is expected to be rationalised.

Table 35 Results of Test Pit Investigation of Existing Pavement Structure

Test Pit No.	Surface Course (m)	Base Course (m)	Sub-base Course (m)
	AC	Crushed Stone	Natural Gravel
1	0.05	0.15	0.10
2	0.05	0.25	0.20
3	0.05	0.20	0.15
4	0.07	0.15	0.15
5	0.06	0.16	0.12
6	0.05	0.15	0.15
7	0.07	0.15	0.15
8	0.07	0.20	0.20
9	0.07	0.20	-
10	0.07	0.20	0.20

Source: Study Team



Note: PIT in the figure indicates the location of a test pit for the pavement structure
Source: Study Team

Figure 17 Location of Test Pit for Existing Pavement Structure and Deflection of Pavement

Table 36 Elastic Modulus of Existing Pavement

Section	Section Length (m)	Elastic Modulus (psi)			
		Surface Course	Base Course	Sub-base Course	Sub-grade
A	3,900	217,065	74,385	37,265	19,575
B	2,500	615,380	43,355	21,750	32,770
C	7,500	459,795	57,565	28,710	29,870
D	4,300	630,170	49,735	24,940	22,620
E	4,100	319,580	47,125	23,490	17,545
F	8,900	350,175	48,865	24,360	24,360

Source: Prepared by Study Team based on the data provided by the GHA

b) Traffic condition

Table 37 shows the present (2013) and the future (2038) daily traffic volume at Assin Fosu and Assin Praso based on the results of future traffic demand forecasts. Even though the total traffic volume is much higher in Assin Fosu, there is not much difference in the traffic volume of large-size vehicles, which affects the pavement design, at both locations. Hence, the traffic volume of Assin Fosu is used as a representative value for the pavement design.

Table 37 Average Dairy Traffic Volume by Vehicle Type for the Section for the Outline Design

(unit: veh./day)

Vehicle Type		Study Section: Assin Fosu		Study Section: Assin Praso	
		Present Traffic Volume	Future Traffic Volume	Present Traffic Volume	Future Traffic Volume
		2013	2038	2013	2038
A	Passenger Car/ Taxi	10,654	19,686	1,781	3,219
B	Mini-bus	932	926	363	664
C	Bus	87	191	98	177
D	Truck	496	533	252	416
E	Semi-trailer	304	665	255	625
Total		12,473	22,001	2,749	5,101
Other than large-size vehicles (A, B)		11,586	20,612	2,144	3,883
Large size vehicles (C,D, E)		887	1,389	605	1,218

Note: Traffic volume in the table is the daily traffic volume at a certain section in both directions.
Source: Study Team

Table 38 shows the present and future (20 years after completion of the project) traffic volume by vehicle classification adopted by the GHA. It should be noted that the future traffic demand forecast was carried out for groups of vehicle classifications with the same Passenger Car Unit (PCU) values based on the results of classified traffic counts in the Study. However, the traffic volume of the vehicle classifications of the GHA, as shown in Table 38, is necessary for the pavement design.

Table 38 Traffic Volume by Vehicle Classification of GHA for the Design

(unit: veh./day)

Vehicle Classification of GHA		Present 2013	Future 2038
1	Cars/Taxis	8,736	16,163
2	Pick-up/Vans/4WD	1,918	3544
3	Small bus	804	804
4	Medium bus/ Mummy wagons	128	128
5	Large bus	87	191
6	Light truck	336	361
7	Medium truck	112	112
8	Heavy truck	47	47
9	Semi-trailer (Light)	40	81
10	Semi-trailer (Heavy)	40	85
11	Semi-trailer (Heavy)	39	80
12	Semi-trailer (Extra large)	185	405
Total		12,472	22,001

Note: Traffic volume in the table is the daily traffic volume at certain section in both directions.
Source: Study Team

c) ESAL for Pavement Design

The Load Equivalency Factor (LEF: 80 kN Axle Load Equivalency Factor) used to determine the ESAL for the pavement design is appropriately set based on the “Ghana Pavement Design Manual, 1998 (GPDM)” and the results of an axle load survey carried out by the Study Team, as shown in Table 39. The Study Team compared the average value of the LEF on trunk roads in the Central and Ashanti regions based on the GPDM, and adjusted the value of the actual axle

load survey by considering a correction value for the design, and a larger LEF was adopted.

Table 39 Load Equivalency Factor

Vehicle Classification	LEF (80 kN Axle Load Equivalency Factor)				
	GPDM		Average of Two Regions	Results of Axle Load Survey (Adjusted)*	Adopted Value
	Ashanti Region	Central Region			
Cars/Taxis	0.0012	0.0001	0.0007	-	0.0007
Pick-up/Vans/4WD	0.0056	0.0001	0.0029	-	0.0029
Small bus	0.0910	0.0906	0.0908	-	0.0908
Medium bus/ Mummy wagons	0.0088	0.0068	0.0078	-	0.0078
Large bus	0.6540	0.8612	0.7576	-	0.7576
Light truck	0.0380	0.1019	0.0700	1.5257	1.5257
Medium truck	4.4050	2.1694	3.2872	7.8445	7.8445
Heavy truck	4.0690	4.2488	4.1589	3.2134	4.1589
Semi-trailer (Light)	3.9220	3.4809	3.7015	7.8445	7.8445
Semi-trailer (Heavy)	5.5990	4.6203	5.1097	3.2134	5.1097
Semi-trailer (Heavy)	14.8690	5.0503	9.9597	9.7429	9.9597
Semi-trailer (Extra large)	-	2.9697	2.9697	9.5096	9.5096

Note: * The results of the axle load survey (adjusted value) indicate the LEF value adjusted by the values of two-axle (tandem) and three-axle (tridem) vehicles according to the AASHTO pavement design manual.

Source: Study Team

Based on the LEF and the accumulated design traffic (one direction for 20 years), the design ESAL is calculated by vehicle type and the total design ESAL is determined as 24.776 million, as shown in Table 40.

Table 40 Pavement Design ESAL

Vehicle Classification	LEF	Accumulated Design Traffic (One direction for 20 years)	Design ESAL
Cars/Taxis	0.0007	45,408,373	31,786
Pick-up/Vans/4WD	0.0029	9,961,033	28,887
Small bus	0.0908	4,314,665	391,772
Medium bus/ Mummy wagons	0.0078	679,995	5,304
Large bus	0.7576	524,505	397,365
Light truck	1.5257	1,721,523	2,626,528
Medium truck	7.8445	577,795	4,532,513
Heavy truck	4.1589	229,220	953,303
Semi-trailer (Light)	7.8445	227,395	1,783,800
Semi-trailer (Medium)	5.1097	234,330	1,197,356
Semi-trailer (Heavy)	9.9597	223,745	2,228,433
Semi-trailer (Extra large)	9.5096	1,114,528	10,598,715
Total			24,775,762 (24.776 +E6)

Source: Study Team

d) Structural number necessary for the pavement

The basic formula for the pavement structural number to determine the flexible pavement thickness defined in the Pavement Design Manual of AASHTO is as follows.

$$\log_{10}(W_{18}) = Z_R \times S_o + 9.36\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.4+\frac{1094}{(SN+1)^{5.19}}} + 2.32\log_{10}(M_R) - 8.07$$

where:

W_{18}: Number of 18kip single axle load applications (Design ESAL)
Z_R: Standard normal deviation corresponding to selected reliability (R = reliability)
S_O: Overall standard deviation
M_R: Roadbed soil resilient modulus (psi)
ΔPSI: Design serviceability loss between the default design serviceability index (P_0) and the ultimate design serviceability index (P_T)
SN: Structural number

Table 41 Structural Number Necessary for Pavement

Item	Section A	Section B	Section C	Section D	Section E	Section F
W_{18} (million ESAL)	24.776					
R (%)	90					
Z_R	-1.282					
S_O	0.45					
M_R (psi)	19,575	32,770	29,870	22,620	17,545	24,360
P_O	4.2					
P_T	2.5					
ΔPSI	1.7					
SN	**4.06**	**3.36**	**3.48**	**3.86**	**4.24**	**3.76**

Source: Study Team

e) Pavement thickness

The minimum pavement thicknesses estimated from the above calculations are shown in Table 42.

Table 42 Minimum Pavement Thicknesses

Design ESAL	AC Course	Aggregate Base Course
50,001 – 150,000	50 (2.0)	150 (6.0)
150,000 – 1,000,000	50 (2.0)	150 (6.0)
1,000,000 – 2,000,000	50 (2.0)	200 (8.0)
2,000,000 – 5,000,000	76 (3.0)	200 (8.0)
5,000,000 – 9,000,000	102 (4.0)	200 (8.0)

Source: GPDM

The coefficients of the planned pavement layers are calculated as shown in Table 43.

Table 43 Coefficients of Planned Pavement Layers

Wearing Course (Dense-grade AC)	Binding Course (Coarse-grade AC)	Base Course (Crushed Stone)	Base Course (Recycled Base)	Sub-base Course (Crusher-run)
0.44	0.34	0.14	0.22	0.08

Source: Study Team

In addition, the coefficients of the existing pavement layers are shown in Table 44.

Based on these results, the pavement thicknesses of the planned recycled base course section are calculated as shown in Table 45. The pavement thicknesses of sections to raise the level of the road are calculated as shown in Table 46.

Table 44 Coefficients of Existing Pavement Layers

Section	Coefficient of Pavement Layer		
	Wearing and Binding Course (AC)	Base Course (Crushed Stone)	Sub-base Course (Natural Gravel)
A	0.31	0.14	0.14
B	0.44	0.14	0.14
C	0.44	0.14	0.14
D	0.44	0.14	0.14
E	0.37	0.14	0.14
F	0.39	0.14	0.14

Source: Study Team (based on the results of FWD test)

Table 45 Planned Pavement Thicknesses of Recycled Base Course Section

Item		A	B	C	D	E	F
Wearing course (cm)	Dense-grade AC	5	5	5	5	5	5
Binding course (cm)	Coarse-grade AC	8	5	5	5	5	5
Recycled base course (cm)	Cement or bitumen stabilised	20	20	20	20	22	20
Sub-base course cm	Crusher run (existing)	10	25	19	16	15	27
Pavement thickness (cm)		43	55	49	46	47	57
Required pavement structural number SN		4.06	3.36	3.48	3.86	4.24	3.76
Design pavement structural number SN		4.22	4.92	5.20	4.15	4.28	4.76
Judgement (Structural number)		OK	OK	OK	OK	OK	OK

Source: Study Team

Table 46 Planned Pavement Thicknesses of Sections to Raise the Level of the Road

Section		A	B	C	D	E	F
Wearing course (cm)	Dense-grade AC	5	5	5	5	5	5
Binding course (cm)	Coarse-grade AC	10	5	5	5	10	5
Base course (cm)	Crushed stone	20	20	20	20	20	20
Sub-base course (cm)	Crusher run	30	30	30	40	30	40
Pavement thickness (cm)		43	60	60	70	65	70
Required pavement structural number SN		4.06	3.36	3.48	3.86	4.24	3.76
Design pavement structural number SN		4.25	3.58	3.58	3.90	4.25	3.74
Judgement (Structural number)		OK	OK	OK	OK	OK	OK

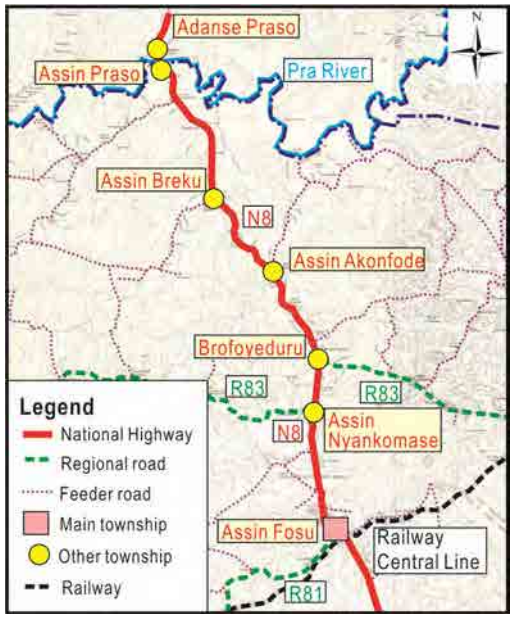
Source: Study Team

(4) Design of Intersection

a) Intersections to be considered

There are three regional roads connecting to the N8: R81 at Assin Fosu, R83 at Assin Nyankomase and R83 at Assin Brofovedure. Other than regional roads, 37 feeder roads and community roads connect to the N8, as shown in Figure 18 and Table 47.

Based on the present condition, every regional, feeder and community road connecting to the N8 is planned to be a 3-leg intersection, except for three feeder roads which will connect to the planned



Source: Study Team

Figure 18 Regional Roads Connecting to the N8 in the Section for the Outline Design

roundabouts in the centre of Assin Fosu township.

Table 47 List of Planned Intersections in the Project Area

Location (KM)	Shape of Intersection	Note	Location (KM)	Shape of Intersection	Note
0+728	Roundabout (4-legs)		14+824	3-leg intersection	
0+943	3-leg intersection		15+102	3-leg intersection	
1+068	3-leg intersection		16+563	3-leg intersection	
1+233	3-leg intersection	R81	16+603	3-leg intersection	
1-405	3-leg intersection		17+095	3-leg intersection	
1+554	3-leg intersection		17+648	3-leg intersection	
1+762	3-leg intersection		17+658	3-leg intersection	
1+774	3-leg intersection		18+297	3-leg intersection	
1+876	Roundabout (4 legs)		22+247	3-leg intersection	
1+900	3-leg intersection		23+672	3-leg intersection	
2+152	3-leg intersection		24+394	3-leg intersection	
2+719	3-leg intersection		26+953	3-leg intersection	
2+777	3-leg intersection		27+919	3-leg intersection	
3+326	3-leg intersection		29+190	3-leg intersection	
6+556	3-leg intersection		29+450	3-leg intersection	
8+555	3-leg intersection		30+834	3-leg intersection	
8+671	3-leg intersection	R83	30+882	3-leg intersection	
10+960	3-leg intersection		31+009	3-leg intersection	
11+628	3-leg intersection	R83	31+032	3-leg intersection	
12+880	3-leg intersection				

Source: Study Team

b) Roundabout

1) Reason for constructing roundabouts

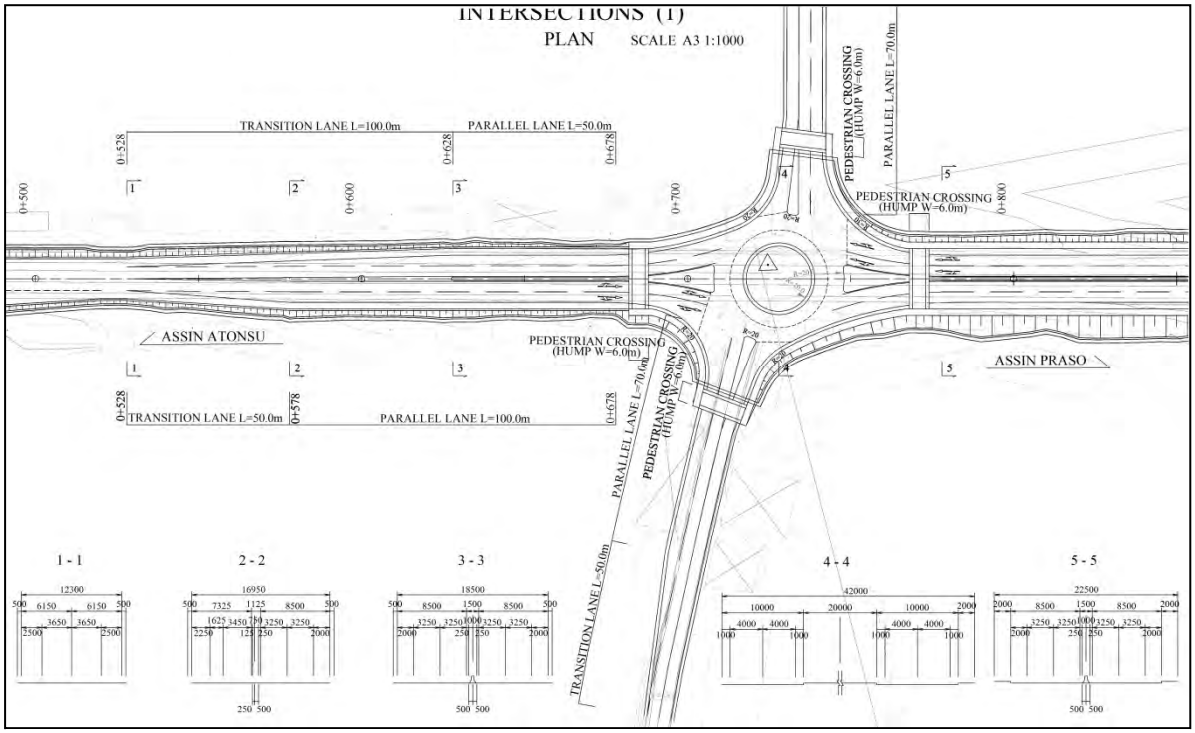
The Study Team planned a roundabout at each end of the dualised four-lane section in the centre of Assin Fosu township, based on the strong recommendation of the GHA. This recommendation is not only to allow U-turns by vehicles, particularly taxis and mini-buses, but also because: 1) roundabouts are far safer than signalised intersections; in particular, the frequency and severity of accidents at roundabouts are far lower based on traffic observations, and 2) signalised intersections might not function all the time due to power outages, causing inconvenience especially to motorists.

2) Specifications of the roundabout

The major specifications for the roundabout design are as follows:

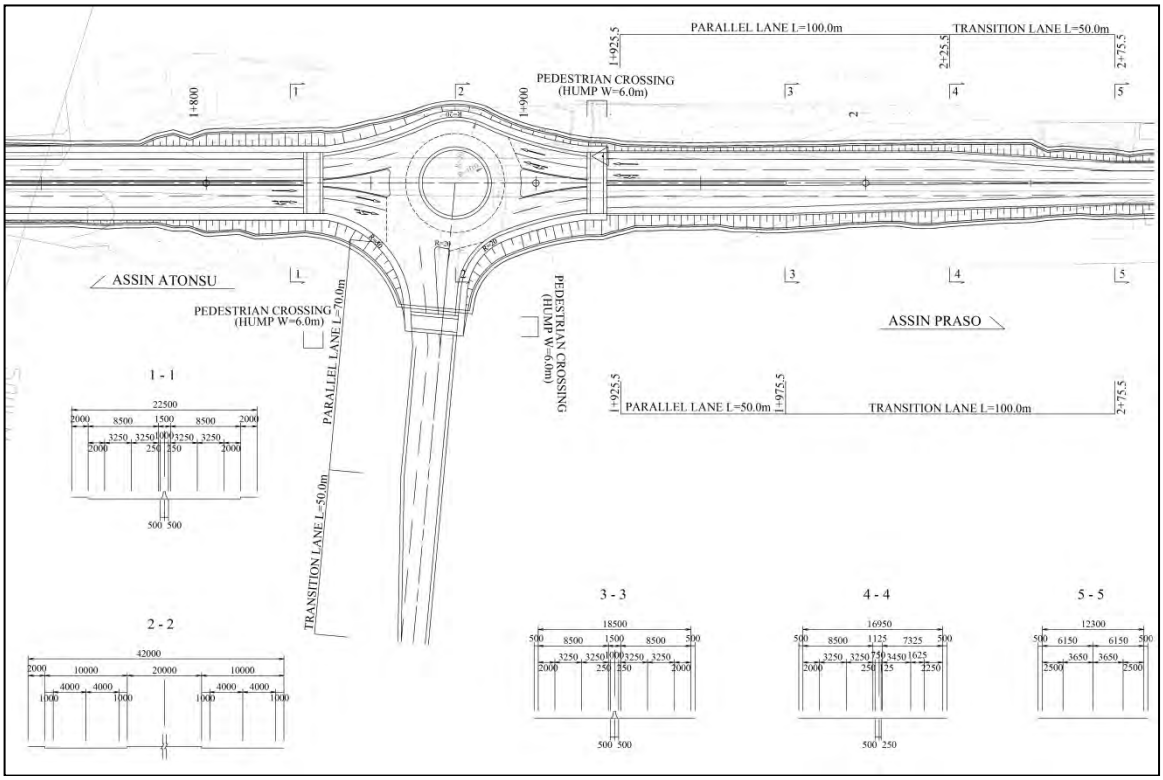
- To provide two-lanes for the circulating lanes.
- To provide 100 m of storage length for the approach lanes, and 50 m of transition length (tapered length) to increase the lane, at the transition between four-lanes and two-lanes.
- To provide 50 m of parallel section for the exit lanes, and 100 m of transition length to decrease a lane (the rate of transition to decrease a lane is 1/30).
- To provide two-lanes with a length of 70 m for the exit of a roundabout to the cross road, and 50 m of transition length.
- The design vehicles for a roundabout are a semi-trailer for the traffic from/to a main road, a truck for the traffic from a main road to a cross road, and a truck for U-turn traffic.

Figures 19 and 20 show drawings of the roundabouts planned to be installed at both ends of the dualised section.



Source: Study Team

Figure 19 Planned Roundabout at the Start of the Dualised Section (KM 0+700)

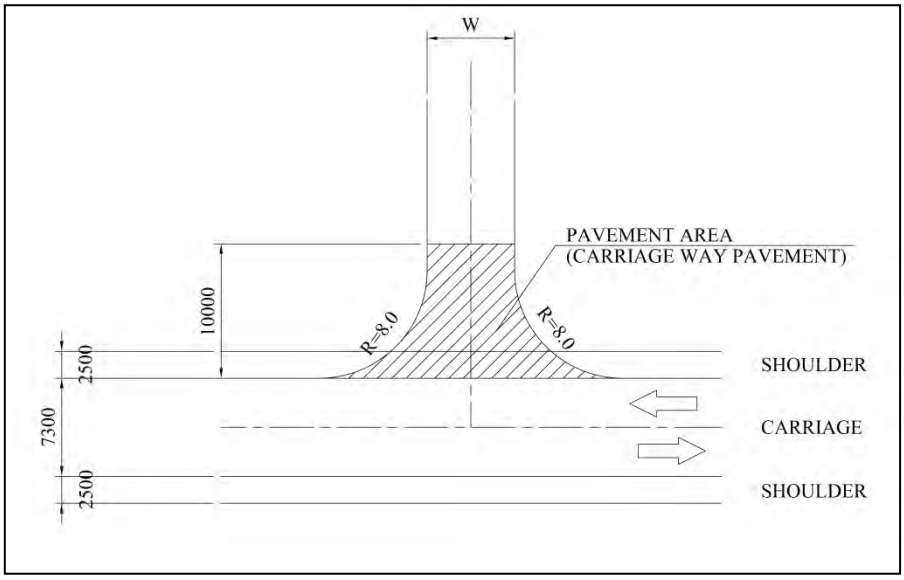


Source: Study Team

Figure 20 Planned Roundabout at the End of the Dualised Section (KM 1+900)

c) Other intersections

The specifications for intersections other than roundabouts mentioned above are 3-leg intersections; 10 m from the edge of the N8 carriageway is planned to be paved by the same pavement structure, as shown in Figure 21.



Source: Study Team

Figure 21 Specification of Standard Type 3-leg Intersection

(5) Retaining Wall

In order to minimise the effect on permanent structures along the road, the Study Team plans to install small gravity type retaining walls near permanent structures.

(6) Bus Stop

The Study Team plans to construct a bus stop at each community along the N8. The specifications of the bus stops are as follows:

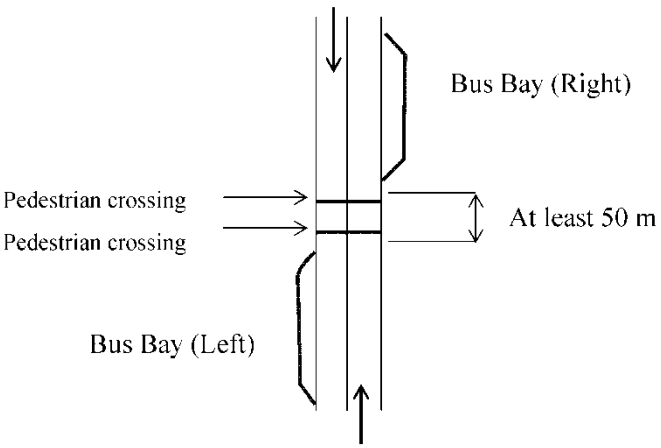
- According to the design standard of the GHA, the bus bays are cement concrete pavement. The structure of the pavement is 20 cm of concrete slab and 15 cm of base course (well graded crushed stone).
- The bus bays will be constructed in a staggered arrangement, as shown in Figure 22 with a mounted-up type (hump) pedestrian crossing installed between two bus bays.
- The locations of communities where a bus stop will be constructed are shown in Figure 23.

(7) Steps

In order to secure access from houses and commercial facilities to the Project road, the Study Team plans to install steps where required.

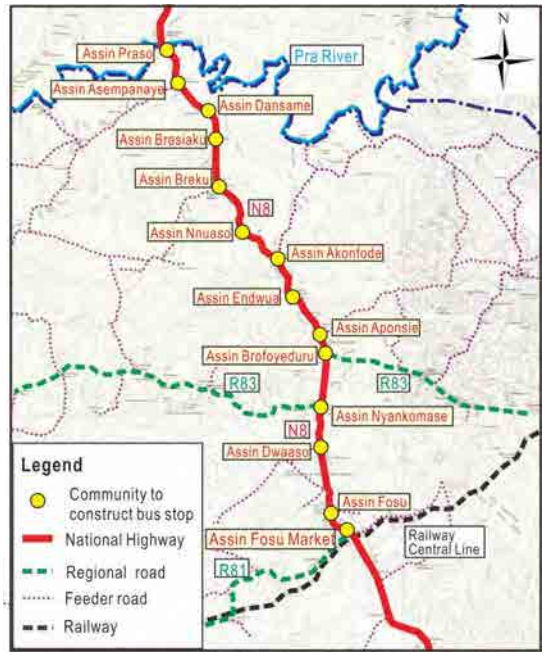
(8) Toll-plaza facility

The Study Team plans to install a toll-plaza at the south of Assin Praso township, which will collect tolls only from vehicles travelling north. According the results of future traffic projections, the ADT in 2038 at this location is 2,325 veh./day, consisting of 69 buses/day, 238 trucks/day, and 312 semi-trailers/day.



Source: Study Team

Figure 22 Arrangement of Bus Bays



Source: Study Team

Figure 23 Locations of Communities where a Bus Stop Will Be Constructed

These traffic volumes of large-size vehicles are used for the design of the pavement; the pavement structure of the inter-locking block pavement is calculated as follows:

- Inter-locking block: Standard type (8 cm thickness)
- Sand 2 cm
- Base course (cement stabilised): 20 cm
- Sub-base course: 40 cm

This inter-locking block pavement is used only on the northbound carriageway.

(9) Median

For the dualised four-lane section at the centre of Assin Fosu township, the Study Team plans to install a “New Jersey Style Median Barrier”, which is widely used in Ghana, in order to minimise the width of the median in the urban area. In addition, the Study Team plans to install guard fence on the median in order to prevent disorderly crossing of the road by pedestrians.

(10) Guardrails

Guardrails are required where there is a high embankment of more than 3 m and at other necessary sections. Guardrails are located at the outside shoulders of 2.5 m.

(11) Pedestrian Crossing on Hump

The speed of vehicles travelling through populated areas is likely to be one of the most important safety issues; one of the main problems will be conflict between vehicles and pedestrians, so driving speed of vehicles should be reduced. This should be done by using speed humps and/or a raised carriageway with pedestrian crossings. Humps should be used on roads with a speed limit of 50 km/h or less through towns or village areas with many pedestrians on the roads. The humps should be constructed as trapezoidal humps (4.0 m in width and 75 mm in

height) at pedestrian crossings.

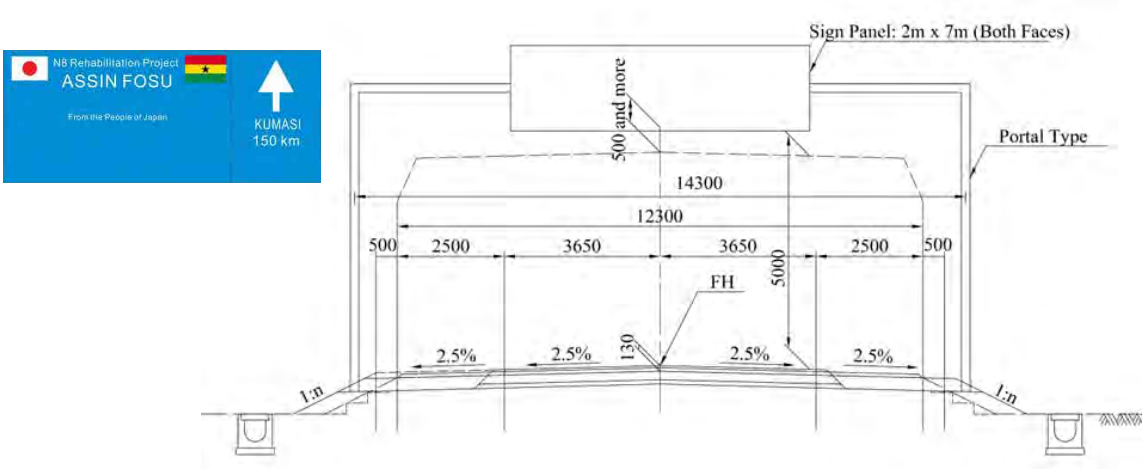
(12) Road Signs and Pavement Markings

The following road signs will be placed in appropriate locations:

- Danger Warning signs such as Hump Ridge, Pedestrian Crossing, and Crossing Road
- Regulatory signs such as Maximum Speed Limit
- Mandatory signs such as Give Way (major road ahead)
- Guidance signs such as destination directions

Appropriate pavement markings are provided to control traffic movement, and to warn and guide motorists and pedestrians. Generally, a broken guiding line is provided as a centreline where the sight distance is adequate. Where the sight distance is inadequate, a continuous full marked centreline is provided. Edge line markings are also provided on both sides of the road.

In addition, overhead type guide signs with gate type support, as shown in Figure 24, will be installed near the railway underpass bridge at Assin Fosu and a toll plaza at Assin Praso.



Source: Study Team

Figure 24 Overhead Type Guide Signs with Gate Type Support

(13) Delineator

The Study Team plans to install delineators at curve sections where visual guidance for drivers is necessary at night, by putting reflective material or painting reflective paint either on guide posts or guard rails.

(14) Street Lighting

The Study Team plans to install street lightings at sections shown in Table 48. The lighting system consists of a pole with light-emitting diodes (LED) as the light source, which has a long operating life.

Table 48 Locations of Street Lighting

Sections with Continuous Lighting	
Sections where street lightings are installed at present	3,850 m
a) Dualised four-lane section (install at the centre)	KM 0+750 – KM 1+830
b) two-lane section (install at one side)	KM 0+0 – KM 0+680 KM 1+930 – KM 3+850
Sections with Spot Lighting	
Roundabout (2 locations)	Near KM 0+680 – KM 0+780
	Near KM 1+830 – KM 1+930
Toll-plaza (1 location)	Near KM 30+100
Okyi River Bridge	2 sets (solar type street light)

Source: Study Team

(15) Pedestrian Overpass Bridge

As a median with a guard fence to prevent random crossing will installed on the dualised four-lane section in the centre of Assin Fosu township, it is necessary to provide ways for pedestrians to cross the Project road. Therefore, the Study Team plans to construct one pedestrian overpass bridge in front of New Assin Fosu market, to secure the safety of pedestrians when crossing the road. In addition, two at-grade pedestrian crossings are also planned at about 300 m on each side of the pedestrian overpass bridge to avoid splitting the community of Assin Fosu township. The outline of the pedestrian overpass bridge is as follows:

- Location of overpass bridge: KM 1+270
- Structure: Steel pedestrian overpass bridge
- Width: On the pedestrian bridge: 2.10 m, Steps with a slope: 2.10 m, Steps: 1.50 m
- Clearance under the girder: 5.95 m (construction gauge of GHA 5.50 m + clearance)

2-2-2-2-2 Drainage Facilities

(1) Drainage Plan

The Study Team used the probable design return period of precipitation shown in Table 49 when preparing the drainage plan, according to the Ghana Road Design Guide, 2009.

Table 49 Probable Design Return Period of Precipitation

Drainage Facility	Probable Design Return Period of Precipitation	Note
Road drainage, side ditches, etc.	5 years	
Box culvert, pipe culvert	15 years	Conducted sensitivity analysis for return period of 25 years

Source: Ghana Road Design Guide, 2009

The Study Team measured the catchment area of each river used for the flow calculation from 1:50,000 scale topographical maps. Then, the inlet time was calculated based on the catchment area by the following equation:

$$t_c = \frac{58.5 \times L}{A^{0.1} \times S_0^{0.2}}$$

where:

t_c: Inlet time (minutes)
L: Flow length (km)

A: Catchment area (km^2)
Se: Gradient of flow channel (m/km)

(2) Box Culverts for Drainage

Table 50 shows the installation plan for box culverts for drainage. The inner cross-section of the box culverts that change in cross-sectional shape is calculated by comparing the maximum discharge volume Q15y (15-year rainfall intensity) and the allowable quantity of flow Q80% (80% of depth), and sensitivity analysis by comparing the maximum discharge volume Q25y (25-year rainfall intensity) and the allowable quantity of flow Q100% (100% of depth).

Table 50 Installation Plan for Box Culvert

Location (KM)	Cross-Section (Inner Section)	Note
0 + 196	1 - 2.0m × 2.0m	Extension of existing box culvert
2 + 478	1 - 3.0m × 2.0m	New installation (Change from a pipe culvert)
6 + 546	1 - 2.0m × 2.0m	New installation (Change from a pipe culvert)
8 + 93	1 - 3.0m × 2.5m	New installation (Change cross-sectional shape)
11 + 127	1 - 2.0m × 2.0m	New installation (Change from a pipe culvert)
12 + 255	1 - 4.0m × 4.0m	Extension of existing box culvert
16 + 198	2 - 3.5m × 3.5m	New installation (Change cross-sectional shape)
22 + 463	2 - 3.0m × 3.0m	Extension of existing box culvert
26 + 527	1 - 2.5m × 2.5m	Extension of existing box culvert
28 + 861	1 - 2.5m × 2.5m	New installation (Change cross-sectional shape)

Note: The culverts that are changed from pipe culverts are based on the request of the GHA.
Source: Study Team

(3) Pipe Culverts for Drainage

Table 51 shows the installation plan for concrete pipe culverts for drainage.

Table 51 Installation Plan for Pipe Culverts

Location (KM)	Cross Section (mm)	Location (KM)	Cross Section (mm)	Location (KM)	Cross Section (mm)
1 + 147	1-φ1000	9 + 550	1-φ1000	20 + 300	1-φ1000
1 + 310	1-φ1000	10 + 176	1-φ 900	20 + 400	1-φ1000
1 + 372	1-φ1000	10 + 419	1-φ 900	20 + 750	1-φ1000
1 + 889	1-φ1000	11 + 830	1-φ1000	21 + 389	1-φ1000
2 + 165	1-φ1200	13 +0 20	1-φ1000	22 + 563	2-φ1200
2 + 619	1-φ1000	13 +089	1-φ1000	23 +011	1-φ1000
2 + 975	1-φ1000	13 + 595	1-φ1000	23 + 486	2-φ1200
3 + 745	1-φ1000	14 +063	1-φ1200	23 + 950	1-φ 900
4 + 293	1-φ1000	14 + 409	1-φ1000	24 + 752	1-φ1500
4 + 562	1-φ 900	14 + 725	1-φ1000	25 + 872	1-φ1000
4 + 902	1-φ 900	15 + 305	1-φ 900	27 + 165	1-φ1200
5 + 665	1-φ1000	17 +002	2-φ1000	27 + 541	1-φ1000
6 + 223	1-φ1000	17 + 869	1-φ1200	27 + 666	1-φ1000
7 + 709	1-φ1000	18 + 412	1-φ 900	30 +035	1-φ1000
8 + 830	1-φ1000	19 + 253	1-φ1500	31 +190	1-φ1000

Source: Study Team

(4) Roadside Ditches

- Roadside ditches with dimensions of 0.7 m × 0.7 m will be installed by the cast-in-place method at suitable locations in a community.

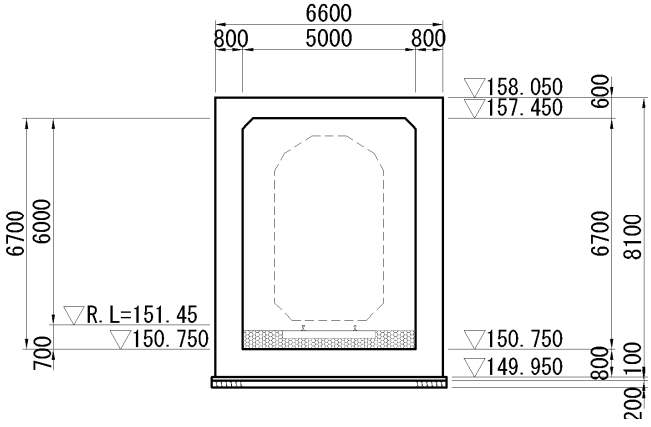
- There are no side ditches along the existing road outside of communities at present. However, the Study Team plans to install U-shape precast ditches at locations where water drainage at the toe of slopes is necessary, such as at sag sections, to raise the road level.
- Side ditches will be installed at locations where surface damage was identified by the road damages survey (including the sections mentioned above where the road level will be raised).
- Side ditches will be installed at locations where deflection of road structures was particularly large according to the results of the FWD survey.
- L-shape side ditches will be installed for the mount-up curb on the dualised four-lane section, and L-shape ditches and side ditches at the toe of slopes will be connected at intervals of about 30 m by vertical ditches.
- In order to prevent pooling of rain water beside the concrete barrier of the median at locations with cant on the dualised four-lane section, drain holes will be installed at intervals of about 20 m to 30 m.

2-2-2-2-3 Design of Box Culvert for the Railway Underpass

(1) Study of Cross-section of the Box Culvert

As shown in Figure 5, the inner cross-section of the box culvert for the railway underpass bridge was determined according to the construction gauge required by the GRDA.

Furthermore, considering the live load of a locomotive on the railway track and the live load of vehicles on the top slab, the cross-section of the box culvert is determined as shown in Figure 25. The assumptions are that PC sleepers are used and ballast of crushed stone is laid on the bottom slab of the box culvert.



Source: Study Team

Figure 25 Cross-section of the Box Culvert for the Railway Underpass

(2) Position to Construct the Box Culvert

Based on the discussion with the GRDA, the horizontal position of the expected centre line of the box culvert is planned to be the same as that of the existing railway track. Also, the vertical alignment of the top of the rail of the expected track in the box culvert is planned to be flush with the top of the rail of the existing railway track.

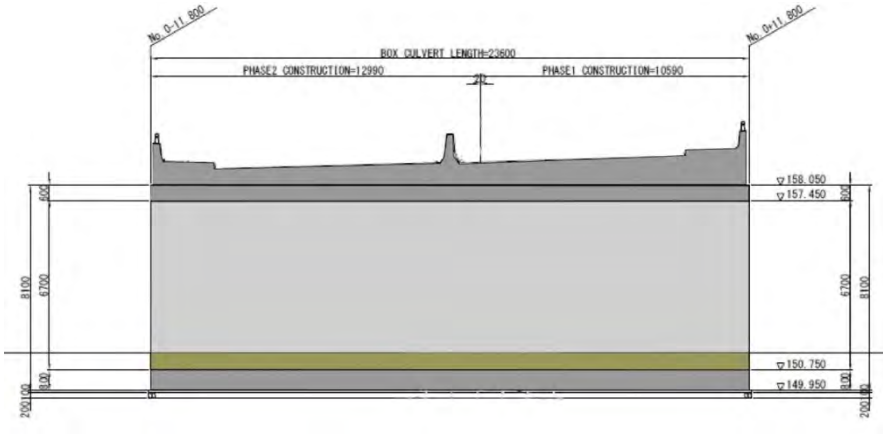
(3) Geological Condition under the Box Culvert

According to the results of the geotechnical investigation, the geological condition of the soil under the box culvert is a relatively hard layer, hence the box culvert is planned to be direct

foundation.

(4) Earth covering of the box culvert

The thickness of earth covering of the box culvert will directly affect the vertical alignment of the road in the rehabilitation section. The Study Team discussed this with the Bridge Division of the GHA, and the thickness of earth covering is planned so as to secure the thickness of the base course, in order to avoid effects on the vertical alignment of the road rehabilitation section, as shown in Figure 26.



Source: Study Team

Figure 26 Relation between the Box Culvert for Railway Underpass and Cross Section of N8

(5) Stage Construction Plan

Based on the results of site observation, there is no appropriate road that can be used as a detour around the existing railway underpass bridge in Assin Fosu. In a case to reconstruct two-lane bridge, it is necessary to allow traffic to flow, such as by providing a temporary bridge. However, the rehabilitation of the N8 in the centre of Assin Fosu township is planned to widen the road to four-lanes, including reconstruction of the railway underpass bridge. Therefore, the Study Team has planned the stage construction method by utilising the existing railway underpass bridge, without a temporary bridge, as shown in Figure 27.

2-2-2-3 Reconstruction of Okyi River Bridge (Assin Andoe)

(1) Typical Cross-Section

Typical cross-sections of the bridge and approach roads are planned as shown in Figure 28.

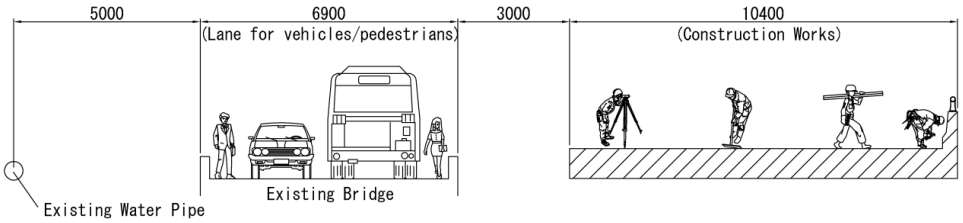
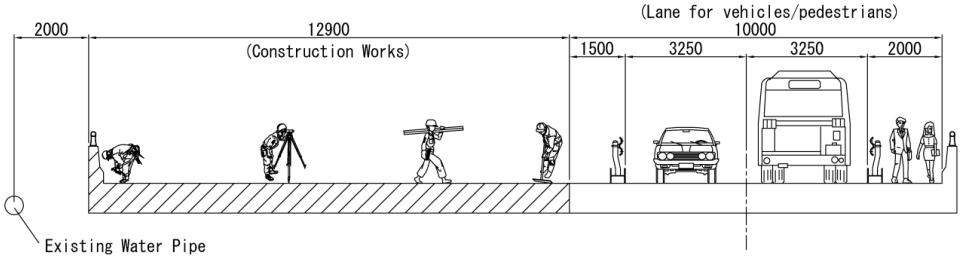
(2) Horizontal Alignment

As described in the Basic Policy, it is desirable to reconstruct the bridge at the same position as the existing four continuous box culverts, considering the horizontal alignment of approach roads on both sides of the existing box culverts.

(3) Hydraulic Condition

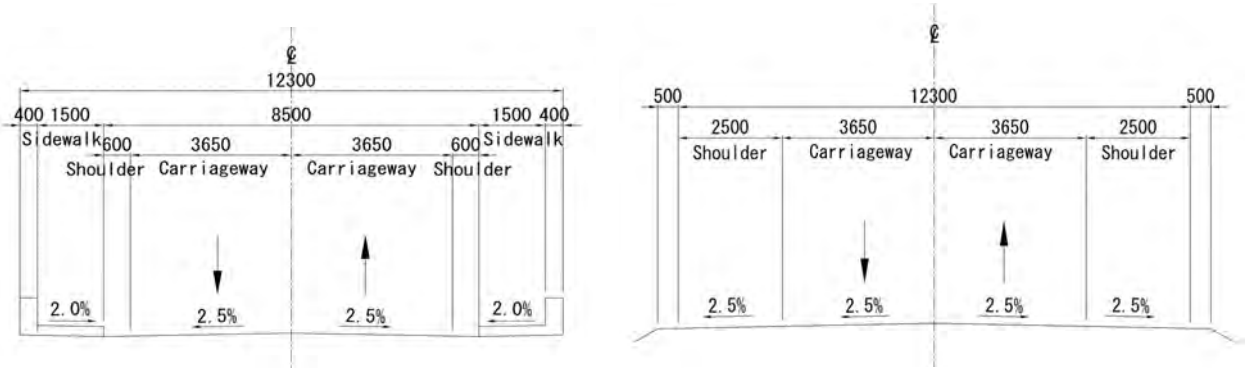
The design flood discharge was estimated as 342.64 m^3/s based on the following conditions:

- Catchment area: 367.11 km^2
- Probable return period of precipitation: 50 years (bridge)

Step-1	Construction Part	To construct a new box culvert at the eastern side of the existing bridge
	Secure Traffic	Existing bridge
	Conceptual Plan	
Step-2	Construction Part	To demolish the existing railway underpass bridge and construct a new box culvert at the same position
	Secure Traffic	A new box culvert constructed in the Step-1
	Conceptual Plan	

Source: Study team

Figure 27 Stage Construction of Box Culvert for the Railway Underpass in Assin Fosu



Bridge Section **Approach Road Section**

Source: Study Team

Figure 28 Typical Cross Section of Okyi River Bridge

Design rainfall intensity: 16.8 mm/h

- Design flood discharge: 342.64 m^3/sec

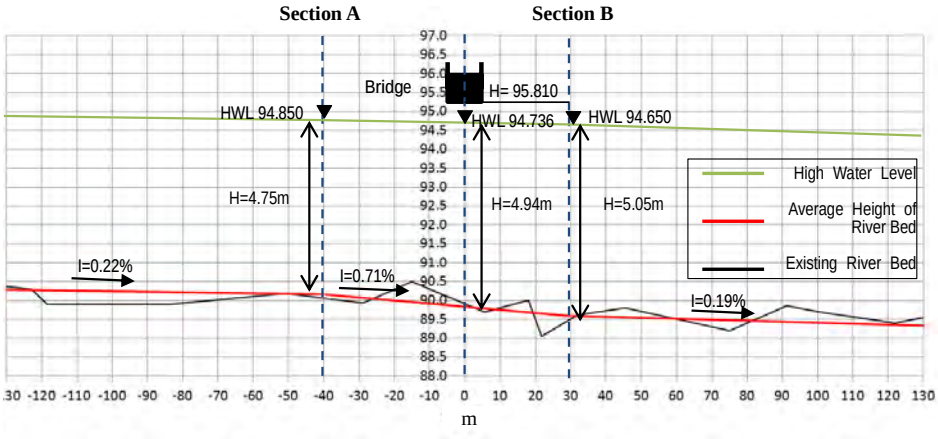
In order to estimate the planned high-water level at the location where the bridge will be constructed, river cross-sections on the upstream and downstream sides of the existing box culverts were estimated as shown in Table 52 and Figure 29, and the planned high-water level on both sides of the existing culverts were calculated using Manning's Formula.

Table 52 Results of Hydraulic Analysis of Upstream (Cross-section A) and Downstream (Cross-section B) Sides

Item			Cross-section (1)	Cross-section (2)
Cross-section	A	m^2	124.7	132.1
Water depth	H	m^2	4.75	5.05
Hydraulic mean depth	R	m^2	2.97	3.08
Multiplier	n		0.035	0.035
Channel gradient	i	%	0.22	0.19
Current velocity	v	m/s	2.77	2.63
Flow rate	Q	m^3/s	345	348

Note: The river cross-sections (1) and (2) are estimated as a river-bed width of 12 m with gradient of 1:3, and a river-bed width of 11 m with gradient of 1:3, respectively.

Source: Study Team



Source: Study team

Figure 29 Channel Gradient and High-water Level

As a result, the high-water level at the bridge site is determined as H = 94.736 m, based on the estimated high-water level on the upstream side as H = 94.850 m and on the downstream side as H = 94.850 m.

- Estimated high-water level at the planned bridge site: HWL = 94.736 m

Then, the water discharge capacity at the bridge site is calculated as 391 m^3/s, which exceeds the design flood discharge of 343 m^3/s, as shown in Table 53.

Table 53 Water Discharge Capacity at Bridge Site

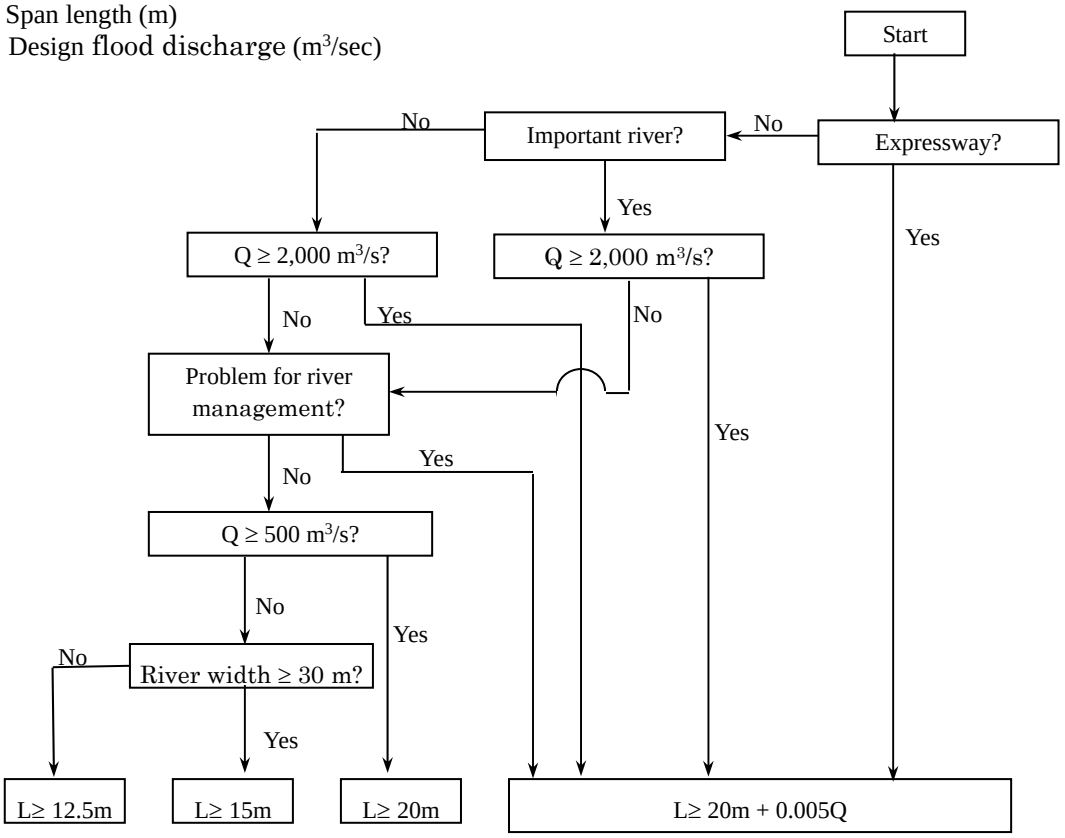
Item			Bridge Location	Note
Cross-section	A	m^2	78.6	Excluding bridge cross-section
Water depth	H	m^2	4.94	
Hydraulic mean depth	R	m^2	2.97	
Multiplier	n		0.035	
Channel gradient	i	%	0.71	
Current velocity	v	m/s	4.98	
Flow rate	Q	m^3/s	391	> 343 OK

Source: Study Team

(4) Method to Determine the Span Length

Figure 30 shows the process of determining the span length.

L: Span length (m)
Q: Design flood discharge (m^3/sec)



Source: Study Team

Figure 30 Process to Determine the Span Length of the Bridge

As a result of this process, the span length of the Okyi River Bridge is determined as shown in Table 54.

Table 54 Span Length of Okyi River Bridge

Item	Okyi River Bridge
Classification of road	National Road
Important river	No
Design flood discharge Q (m^3/sec)	343
Q ≥ 2000 m^3/s	No
Problem for river management	No
Q ≥ 500 m^3/s	No
River width 30 m or more	No
Standard span length	L ≥ 12.5 m
Determined span length	12.5 m

Source: Study Team

At this stage, a single span prestressed concrete (PC) bridge could be considered as an alternative to eliminate obstruction of the river cross section by suspended objects. However, this PC bridge requires an erection girder and the construction cost is estimated to be 35% higher than a 2-span RC bridge, thus a single span PC bridge is judged to be inappropriate for this bridge.

(5) Selection of Bridge Type

a) Selection of superstructure type

According to the determined span length of the bridge (L = 12.5 m), three alternative types of bridge and their suitability for the construction conditions in Ghana are compared, as shown in Table 55.

Table 55 Comparison of Alternative Superstructure Types

Alternative	Evaluation	Judgement
Alternative 1 2-Continuous Box Culvert	• Selected as an alternative because it is the same type as the existing structure. • It exceeds the general applicable maximum span (10 m). • The scale of structure becomes very large as a box culvert. Hence, it is necessary to consider the effects of variations of temperature and drying shrinkage, which are not considered in the ordinary design. • River diversion works are complicated, since concrete for the sole plate of a box culvert is placed on the riverbed.	Not applicable
Alternative 2 2-span Continuous Portal Rigid-frame RC Slab Bridge	• Selected as an alternative to omit void pipes, which is an issue for construction, of a hollow slab type bridge. • In order to supplement the reduced applicable span length due to omission of void pipes, a pier and superstructure are combined to allow a span length of 12.5 m. • The structure could be excessively affected by variations of temperature and drying shrinkage, since it is a rigid-frame structure. • In order to minimise the effects of variations of temperature and drying shrinkage, the substructure becomes excessively large.	Not applicable
Alternative 3 2-span Continuous T-Girder Rigid-frame RC Slab Bridge	• Selected as an alternative to omit void pipes, which is an issue for construction of a hollow slab type bridge. • In order to supplement the reduced applicable span length due to omission of void pipes, a pier and superstructure are combined to allow a span length of 12.5 m. • In order to solve the structural problems of Alternative 2, effects of variations of temperature and drying shrinkage are eliminated by installing movable shoes on abutments. • As the space between substructures can be used as a river diversion watercourse, river diversion work is easy.	Applicable

Source: Study Team

As a result of comparison, Alternative 3, a 2-span continuous T-girder rigid-frame RC slab bridge, is selected as a suitable type of bridge, which has the structural capability for expansion and contraction of the superstructure with variations of temperature and drying shrinkage, and better workability in the river.

b) Selection of substructure type

A suitable type of substructure can be determined from the relation between the height of each substructure, as shown in Table 56.

- As for the abutments, their height is about 7.5 m, hence the reverse T-style abutment, which is a commonly used abutment type, is selected.
- As for the pier, either a column (1) or rigid-frame (2) pier, which is rectangular in section, is not desirable because the pier is constructed in the river. Also, a pile bent type pier (3) is not desirable because of the necessity of measures against scouring. Hence, the elliptical type pier (4) is selected, even though the height of the pier is slightly shorter than the applicable range.

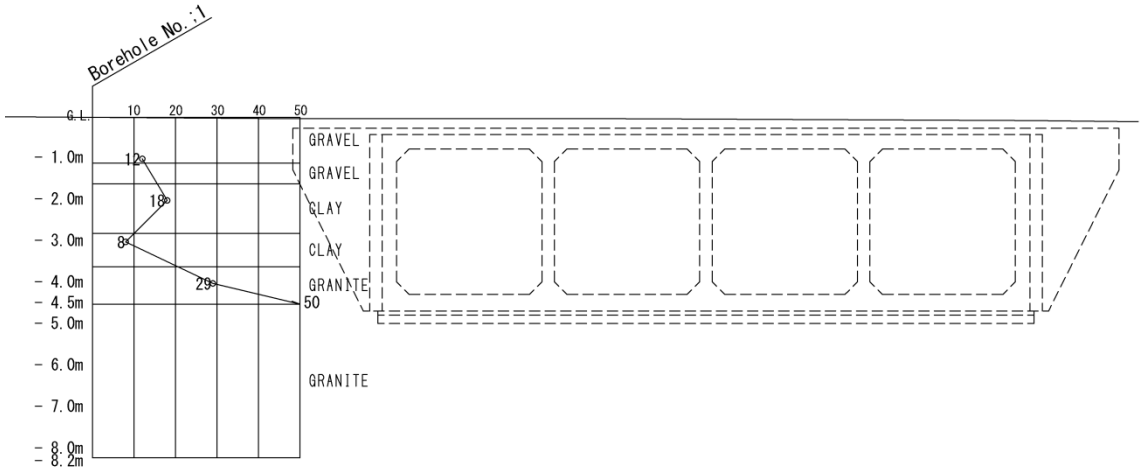
Table 56 Comparison of Substructure Types

Substructure type		Applicable height (m) 10 20 30	Characteristics
Abutment	Gravity type		With shallow support ground, the gravity type is suitable for direct foundations.
	Reverse T-style		Used in many bridges. Suitable for direct foundations and pile foundations.
	Buttressed type		Suitable for tall abutments.
	Rigid frame type		Suitable for tall abutments and construction of a road behind an abutment
	Box type		Suitable for tall abutments with soft bearing layer in order to reduce vertical load
Pier	Column type		Economical for a relatively high pier. It may obstruct water discharge during a flood.
	Rigid-frame type		It is applicable for a relatively tall and wide bridge. It may obstruct water discharge during a flood.
	Pile bent type		Most economical type of pier, but it is not applicable for a bridge with a large horizontal force. Also, it is necessary to consider measures against scouring in the river.
	Elliptical type		It is applicable for a high pier with large external force for a bridge.

Source: Study Team

c) Foundation type

According to the result of the geotechnical investigation just beside the existing 4-continuous box culverts, as shown in Figure 31, the bearing layer (rock layer) was found at the riverbed of the existing Okyi River. Hence, the direct foundation, which is the most economical type, is selected.



Source: Study Team

Figure 31 Result of Geotechnical Investigation beside the Existing 4-continuous Box Culvert

d) Pavement on the bridge deck

Hot-mixed AC pavement with a thickness of 8 cm is planned to be applied on the bridge

deck.

(6) Planning of Approach Roads of the Bridge

a) Vertical alignment plan

The Study Team has determined the vertical alignment of the approach roads of the planned bridge (bridge length 25 m, abutment positions KM 1+585 and 1+835) in order to minimise the effects for houses along the road. A clearance of 1.0 m under the bridge girders above the design high-water level (H = 94.736 m) is secured.

b) Pavement design

Table 57 shows the present and future traffic volumes on the N8 at Assin Andoe village based on the results of future traffic demand forecasts.

Table 57 Average Daily Traffic Volume by Vehicle Type at Assin Andoe

(unit: veh./day)

Vehicle Classification of GHA		Present 2013	Future 2038
1	Cars/Taxi	1,338	2,900
2	Pick-up/Vans/4WD	1,200	2,599
3	Small bus	490	880
4	Medium bus/ Mummy wagons	50	85
5	Large bus	91	208
6	Light truck	134	262
7	Medium truck	91	179
8	Heavy truck	39	73
9	Semi-trailer (Light)	3	3
10	Semi-trailer (Medium)	40	90
11	Semi-trailer (Heavy)	42	94
12	Semi-trailer (Extra large)	219	492
Total		3,737	7,865

Note: Traffic volume in the table is daily traffic volume at certain section for both directions.

Source: Study Team

The design ESAL is calculated by vehicle type and the total design ESAL is determined as shown in Table 58.

Table 58 Pavement Design ESAL of Approach Roads of Okyi River Bridge

Vehicle Classification	LEF	Cumulative Design Traffic (One direction for 20 years)	Design ESAL
Cars/Taxi	0.0007	8,002,625	5,602
Pick-up/Vans/4WD	0.0029	7,184,843	20,836
Small bus	0.0908	2,595,150	235,640
Medium bus/ Mummy wagons	0.0078	249,113	1,943
Large bus	0.7576	562,465	426,123
Light truck	1.5257	749,528	1,143,555
Medium truck	7.8445	513,008	4,024,291
Heavy truck	4.1589	207,138	861,466
Semi-trailer (Light)	7.8445	10,950	85,897
Semi-trailer (Heavy)	5.1097	243,638	1,244,917
Semi-trailer (Heavy)	9.9597	255,683	2,546,526
Semi-trailer (Extra large)	9.5096	1,341,375	12,755,940
Total			23,352,736 (23.352+E6)

Source: Study Team

The required structural numbers for the pavement based on the design ESAL are as shown in Table 59.

Table 59 Structural Numbers for the Pavement for Approach Roads of Okyi River Bridge

Item	Connection with existing road – Road level raised by 30 cm*	Road level raised by 30 cm – Connection with the bridge**
W_{18} (million ESAL)	23.353	
R (%)	90	
Z_R	-1.282	
S_O	0.45	
M_R (psi)	30,450	16,500
P_O	4.2	
P_T	2.5	
ΔPSI	1.7	
SN	**3.42**	**4.29**

Note: * The elastic modulus of the section between the connection with the existing road and road level raised by 30 cm is based on the result of the FWD survey.
** The elastic modulus of the section between the road level raised by 30 cm and the connection with the bridge is based on the result of laboratory tests of materials from a possible borrow pit.
Source: Study Team

The minimum pavement thickness of the approach roads of the bridge is estimated from the above calculation results as shown in Table 60.

Table 60 Planned Pavement Thickness for the Approach Roads of the Bridge

Section		Connection with existing road – Road level raised by 30 cm	Road level raised by 30 cm – Connection with the bridge
Wearing course (cm)	Dense-grade AC	5	5
Binding course (cm)	Coarse-grade AC	10	10
Base course (cm)	Crushed stone	20	20
Sub-base course (cm)	Crusher run	0	35
Existing base course	Crusher run	32	-
Pavement thickness (cm)		67	70
Required pavement structural number SN		3.42	4.29
Design pavement structural number SN		4.32	4.41
Judgment (Structural number)		OK	OK

Note: The existing pavement (5 cm) of the section to be improved will be totally demolished.
Source: Study Team

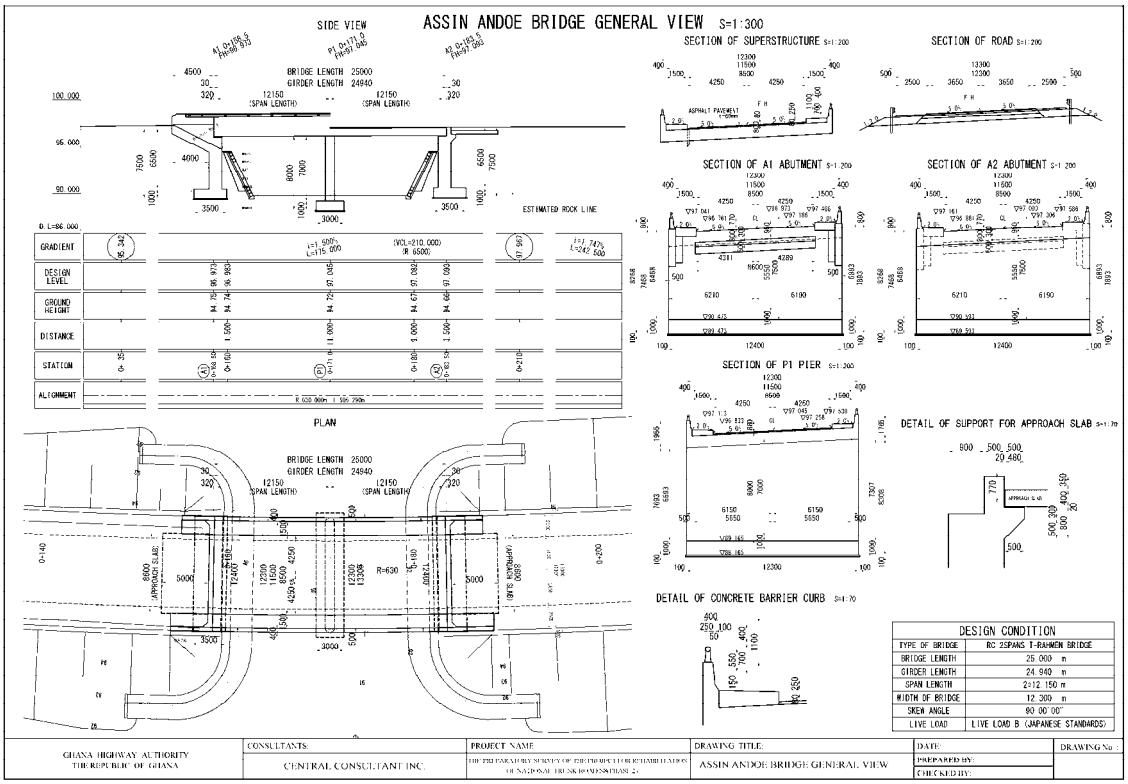
(7) Basic Plan for Okyi River Bridge

Based on the above results of the study, the project to reconstruct the Okyi River Bridge is summarised in Table 61, and the general plan of the bridge is shown in Figure 32.

Table 61 Outline of Project to Reconstruct the Okyi River Bridge

Item	Detail	Contents or Quantity
Scope of the Project		(1) Reconstruction of Okyi River Bridge (2) Rehabilitation of approach roads and abutment protection
Alignment	Horizontal	R = 630 m
	Vertical	Vertical gradient on the bridge = 1.5% - 1.74%
Structural Details	New bridge	Bridge length: L = 25.0 m Bridge width: W = 12.3 m Skew angle: θ = 0° Bridge surface area: A = 307.5 m^2 Superstructure type: 2-spans Continuous T-Girder Rigid-frame RC Slab Bridge Superstructure erection method: Erection beam method Abutment: Two reverse T-style abutments, Height = 7.5 m Pier: One elliptical type pier, Height = 7.5 m Foundation: Direct foundation Pavement on bridge surface: A = 212.5 m^2, Hot mixed AC pavement (t = 8.0 cm)
	Approach roads	Total road width: W = 9.7 m Length: A1 abutment side = 178.5 m, A2 abutment side = 315.5 m Pavement of carriageway: Hot mixed AC pavement (t = 15 cm) Pavement of shoulder: Hot mixed AC pavement (t = 10 cm)
	Approach cushion	Total width: W = 8.6 m Length: L = 5.0 m
	Embankment protection	Position: Slope around the abutments Measure: Stacking gabions

Source: Study Team



Source: Study Team

Figure 32 General Plan of Okyi River Bridge

2-2-3 Outline Design Drawings

Based on the plan described above, the Study Team conducted the outline design. The outline design drawings are listed in Table 62 and are attached in the Drawings.

Table 62 Outline Drawings

Assin Fosu – Assin Praso (L = 31.2 km)		Reconstruction of Okyi River Bridge	
1	Location plan	1	Location plan
2	Horizontal and vertical alignment plans	2	Horizontal and vertical alignment plans
3	Typical cross-section	3	Typical cross-section
4	Intersection plans	4	General plan of bridge
5	General plan of toll-plaza	5	General plan of approach road
6	General plan of railway underpass	6	General plan of drainage facilities
7	General plan of box culverts	7	General plan of retaining wall
8	General plan of retaining wall	8	General plan of road safety devices
9	General plan of road safety devices	9	General plan of steps
10	General plan of steps	10	Detour plan (Reference)
11	General plan of bus stop		
12	General plan of approach roads		
13	General plan of street lightings		
14	General plan of other ancillary works		
15	General plan of pedestrian overpass bridge		

Source: Study Team

2-2-4 Implementation Plan

2-2-4-1 Construction Policy/Procurement Policy

As the Project will be executed under the Grant Aid scheme of Japan, the construction policy includes the following:

- A realistic and reliable construction plan will be created by employing appropriate construction methods in consideration of the geological, precipitation and inundation conditions.
- In order to help revitalise the regional economy, create job opportunities, and promote technology transfer, it is desirable to maximise the utilisation of local engineers and labourers, and local materials and construction equipment for the execution of the Project.
- The GoG needs to complete the land acquisition of the ROW and resettlement prior to the execution of the Project, as the responsibility of the recipient country. The GoG also needs to secure land (for temporary buildings, detours, borrow pits, compensation for land and agricultural products, and exploitation right of quarry site) after the commencement of the construction work.
- The GoG needs to arrange exemption from import taxes, domestic taxes, value added taxes, etc. related to the execution of the Project, including for the procurement and import of materials and construction equipment related to the construction works.
- A network for close communication between the GHA, consultant and contractor must be set up to enable the Project to proceed smoothly.

2-2-4-2 Important Considerations for Construction and Procurement

The important points to consider for the execution of the Project are shown below.

(1) Safety during the Construction Period

- The construction works should be carried out while minimising the effects on traffic. When construction occupying one side of the existing road is unavoidable, the contractor should assign traffic controllers and install appropriate signboards for the work, road signs and traffic safety devices to prevent traffic accidents. The contractor should also secure a passageway for pedestrians, and clearly demarcate the construction area to prevent outsiders from entering it.
- The contractor should assign traffic controllers at exits from temporary buildings and borrow pits to an ordinary road.
- The construction plan must take into consideration sudden inundation during the rainy season, as it may be necessary to suspend the construction work.
- The security situation in Ghana is relatively stable, but theft is rife. Therefore, the contractor should assign guards at temporary buildings and construction equipment storage depots.
- The contractor should encourage an attitude of safety among operators of construction vehicles and equipment, and clearly instruct drivers to obey the speed limit for construction vehicles.

(2) Environmental Protection during Construction

- In order to suppress dust generation by construction vehicles and equipment, the contractor should sprinkle water. It is also necessary to minimise the generation of dust by restricting the speed of construction vehicles.
- The contractor should avoid carrying out construction works in the early morning and at night to minimise the impact on residents of noise and vibration caused by construction equipment.
- The contractor should conduct final disposal of concrete, waste oil, used tyres, and sludge and sewage from construction yards.
- The consultant should indicate items requiring compliance with environmental protection in the construction specifications, and supervise the contractor to ensure compliance with those items during the construction period.

(3) Compliance with the Labour Laws in Ghana

- The contractor must comply with the present labour laws in Ghana, respect appropriate working conditions and employment customs, avoid disputes with workers, and secure the safety of workers.

(4) Construction Method of Recycled Cement and Asphalt Stabilised Base Course on the Road

This construction method is attracting most attention for technology transfer in the Project. The method involves crushing the existing asphalt pavement, mixing it with the base course together with cement and bitumen, and rolling-compacting them to form the base course. Since this method requires precise quality control, construction equipment (stabiliser) should be procured from outside Ghana, and an experienced operator from Japan or another country

should operate the equipment. Also, the contractor should train Ghanaian operators, and should consider organising observation tours for GHA engineers, local contractors, students studying civil engineering, etc., since this method is new in Ghana.

2-2-4-3 Classification of Construction/Procurement and Installation

For the execution of the Project, the allocation of undertakings of the GoJ and GoG is as shown below.

(1) Undertakings of the GoJ

1) Construction of the road rehabilitation works of the N8 between Assin Fosu and Assin Praso with a length of about 32 km, as the Project for the cooperation programme, shown in the "Basic Plan"
2) Reconstruction of the bridge at Assin Andoe (Okyi River Bridge)
3) Construction and demolition of temporary yard (site office, plant, etc.)
4) Assuring the safety of ordinary traffic and pedestrians during construction
5) Measures to prevent environmental pollution during the construction period
6) Procurement, import and transportation of construction materials and equipment indicated in the "Construction materials and equipment procurement plan", re-exportation of imported construction equipment and temporary materials
7) Carrying out the detailed design, preparation of bidding and contract documents, assistance for the tender process, and supervision of construction, indicated in the "Construction supervision plan", including monitoring of the environmental management plan

(2) Undertakings of the GoG

1) Acquisition and clearance of necessary lots of land (ROW, temporary site office, borrow pits) and provision thereof to the Project without compensation, smooth resettlement of residents and relocation of houses, shops and utilities (underground pipes and overhead lines) affected by the Project
2) Issuance of identification cards to person related to the Project and stickers on vehicles used for the construction.
3) Provision of a site for disposing of soil and construction debris near the Project road without compensation
4) Ensuring exemption from customs duties, internal taxes and other fiscal levies imposed by the GoG
5) Provision of logistical assistance for entering, staying and leaving Ghana for persons (from Japan and other countries) related to the Project
6) Implementation of Banking Arrangements (B/A) (opening of an account, and preparation of the Authorisation to Pay (A/P)), and bearing of commissions paid to the bank for banking services (advisory commission of A/P and payment commission)

2-2-4-4 Construction Supervision Plan and Procurement Management Plan

(1) Construction Supervision Plan

As the Project is to be executed with the Grant Aid scheme of Japan, the basic policy of the construction supervision works should consider the following:

- As the quality of construction works will affect the life and durability of completed facilities, quality management is the most important issue, necessitating construction supervision
- Following quality management, controls on progress, safety, and payment are also important issues.
- In order to complete the Project within the contract period, the Contractor and the Consultant should hold weekly meetings, and discuss problems and their solutions. Both parties will also inspect the construction site.
- The person in charge of the Client (GHA), the Contractor and the Consultant should hold a monthly meeting at the site office, and discuss problems and their solutions. If there is a problem that cannot be solved by the level of person in charge, the Contractor and the Consultant will promptly hold a meeting with higher-level officials of the GHA, and request the GHA to solve the problem.
- As several works will be executed at several locations, the Consultant will assign construction supervisors at each work location at a suitable timing. In addition, the Consultant should employ local engineers as assistants, and will make efforts to transfer technologies related to construction supervision such as controls on quality, progress, and safety.
- The Consultant should manage documentation, such as instructions to the Contractor, records of minutes of every meeting, and reports to the Client. Every report to the Client and the Contractor should be made in writing.

(2) Construction Supervision Works by Consultant

The major work items included in the contract with the consultant are described below.

a) Stage of preparation of tender documents

The Consultant will carry out the detailed design of each facility based on the Final Report of the Preparatory Survey. Then, the Consultant will prepare the tender documents, and obtain approval for the following deliverables:

- Design report
- Design drawings
- Tender documents

b) Stage of tendering for construction

After the signing of the Exchange Note (E/N), the GHA (Client) will make a contract with the Consultant for the construction supervision, and the Consultant will assist the GHA with the tender procedure for construction works. At this time, the Client will be represented by the

GHA. The GHA will select a construction company from Japan (Contractor) through a competitive tender with a public announcement, with the assistance of the Consultant. The representative selected by the GoG, who will attend the competitive tender and then the contract signing for the construction works, should have authorisation for all matters related to the contract for the construction. The Consultant will assist the GHA with the following works:

- Public announcement of tender
- Evaluation of prequalification (P/Q)
- Opening of tenders and evaluation of tenders
- Negotiation for the contract

c) Stage of construction supervision

Through the contract with the Contractor selected by the tender with the GHA, which is the representative of the GoG, the Consultant will issue the order to start the work to the Contractor, and will then commence the construction supervision works. In the construction supervision works, the Consultant will directly report on the progress of construction works each month to the GHA, the Embassy of Japan in Ghana and the JICA Ghana Office, and send a monthly report to relevant authorities, if required. The Consultant will supervise construction and suggest and propose improvement measures regarding management matters, such as work progress, quality control, safety measures, and payment, and engineering matters related to construction works.

Furthermore, the Consultant will conduct inspections for defects one year after completion of the construction supervision works. The consulting service will terminate with this inspection.

(3) Staff Assignment Plan

Staffs necessary for the detailed design stage, tendering for construction works stage, and the construction supervision stage, and their respective responsibilities are shown below.

a) Detailed design stage

1) Chief Consultant: Responsible for managing technical and administrative matters, and responding to the Client regarding the detailed design.
2) Highway Engineer: In charge of the final calculation of the alignment of the whole section of the Project road, determination of typical cross-section, study of slope works, preparation of design drawings and quantity calculation.
3) Pavement Engineer: In charge of pavement design of the whole section of the Project road, preparation of design drawings and quantity calculations.
4) Road Structure Engineer: In charge of design of road drainage structures for the whole section of the Project road, preparation of design drawings and quantity calculation.
5) Bridge Engineer: In charge of design of the railway underpass box culvert at Assin Fosu, and superstructure and substructure of the Okyi River Bridge, structural calculation, preparation of design drawings and quantity calculation.
6) Construction Planning and Cost Estimation Engineer: In charge of preparation of

construction plan, and estimation of the project cost based on the quantities in the detailed design and unit construction cost.

7) Tender Document Specialist: In charge of preparing the tender documents.

b) Stage of tendering for construction

The Consultant will assist the GHA by finalising the P/Q document and tender documents, conducting the P/Q evaluation, and evaluating the tender for the construction works.

1) Chief Consultant: Responsible for supervising consulting services for assisting the tendering process.
2) Highway Engineer: In charge of approval of the tender documents and assisting the evaluation of tenders.

c) Stage of construction supervision

1) Chief Consultant: Responsible for supervising consulting services for the construction supervision (including supervising road earth works, drainage works and road ancillary works).
2) Resident Engineer: Leader of the construction supervision at the site, and reporting and coordinating the monthly progress of construction works to the related authorities of the GoG.
3) Pavement Engineer: In charge of supervising pavement works.
4) Bridge Engineer: In charge of supervising earth works and concrete works of the railway underpass culvert at Assin Fosu and the Okyi River Bridge.

2-2-4-5 Quality Control Plan

Based on the technical specifications and the construction supervision plan, the Consultant should carry out several types of quality control and work progress control. The major work types are earth works, pavement works and construction of structures. Therefore, the Consultant should carry out the quality control for selection of materials and quality control at the construction sites, as listed in Table 63.

Table 63 List of Quality Control Items (1)

Type	Item	Class	Control Item	Contents of Test/Control	Inspection Timing/Frequency
Structure	Concrete	Material	Cement	Quality certificate	Before construction and when changing material
				Table of composition	
			Admixture for concrete	Conformity with standard	- ditto -
			Water	Content of toxic substance	- ditto -
			Fine aggregate	Specific gravity in oven-dry state	- ditto -
				Coefficient of water absorption	
				Sieve analysis	
				Decantation test (75μm sieve)	
				Clay lump	
				Stability	
				Alkali aggregate reaction	
			Coarse aggregate	Specific gravity in oven-dry state	- ditto -
				Coefficient of water absorption	
				Sieve analysis	
				Abrasion loss	
				Decantation test (75μm sieve)	
				Clay lump	
				Stability	
				Alkali aggregate reaction	
		Mixture, Construction	Ready-mixed concrete	Slump	Each construction
				Air content	
				Temperature of ready-mixed concrete	
				Chloride content	
				Compressive strength (7 days, 28 days)	Appropriate timing
	Reinforcing bar	Material	Reinforcing bar	Quality guarantee of material	Before construction and when changing material
				Tension and bending tests	
Earth work	Embankment and backfill	Material	Embankment section and backfill	CBR	- ditto -
				Compaction	
				Sieve analysis	
			Sub-grade and backfill	CBR	- ditto -
				Compaction	
				Sieve analysis	
				Plasticity index	
				Decantation test (75μm sieve)	
		Construction	Embankment section and backfill	Compaction	Appropriate timing
				Moisture content	
				Finishing height	
			Sub-grade and backfill	Compaction	- ditto -
				Moisture content	
				Finishing height	
				Proof rolling	At completion

Source: Study Team

Table 63 List of Quality Control Items (2)

Type	Item	Class	Control Item	Contents of Test/Control	Inspection Timing/Frequency
Pavement	Base course	Material	Sub-base course	Modified CBR	Before construction and when changing material
				Compaction	
				Sieve analysis	
				Plasticity index	
				Abrasion loss	
			Base course	Modified CBR	- ditto -
				Compaction	
				Sieve analysis	
				Plasticity index	
				Liquid limit	
				Abrasion loss	
		Construction	Sub-base course	Compaction	Appropriate timing
				Moisture content	
				Proof rolling	At completion
			Base course	Compaction	Appropriate timing
				Moisture content	
				Proof rolling	At completion
	AC pavement	Material	Asphalt	Quality certificate	Before construction and when changing material
				Table of composition	
			Coarse aggregate	Sieve analysis	- ditto -
				Specific gravity	
				Water absorption	
				Abrasion loss	
				Stability	
				Content of light stone pieces	
				Content of long and aggregate shape stones	
			Fine aggregate	Sieve analysis	- ditto -
				Specific gravity	
				Water absorption	
				Plasticity index	
				Stability	
		Mixture	AC Mixture (Hot mixture)	Stability	- ditto -
				Flow value	
				Porosity	
				Intensity	
				Immersion stability	
		Plant	AC Mixture	Particle size (2.36mm sieve)	Each construction
				Particle size (75μm sieve)	
				Content of asphalt	
				Temperature	
		Construction	AC Mixture	Compaction	- ditto -
				Temperature	
				Visual inspection	

Source: Study Team

2-2-4-6 Procurement Plan for Materials and Construction Equipment

In the case of procurement in Ghana, materials and construction equipment will be procured from major cities such as Tema, Accra and Kumasi. In the case of procurement from Japan or a third country, Tema Port should be the gateway port, since there is no regular container liner route to Takoradi Port at present. Then, materials and construction equipment unloaded at Tema

Port will be transported by road to the temporary yard. In view of the distance of 223 km from Tema Port to the candidate temporary yard at Assin Fosu, it may take a total of about two months for marine transportation, customs clearance and road transportation, for materials and construction equipment procured from Japan.

(1) Materials

Aggregate (for concrete and base course), soil from borrow pits (for embankments and sub-base course), timber and cement can be procured in Ghana, while all other materials should be imported. Therefore, the procurement policy for materials is as follows:

- If imported materials are constantly supplied to the local market and their qualities satisfy the requirements, those materials should be procured in Ghana.
- If it is impossible to procure materials in Ghana, those materials will be procured from either Japan or a third country. In this case, the supplier should be reliable and able to deliver the required quality and quantity within the limited period.

a) Soil from borrow pits (for embankment and sub-base course)

It is necessary to open borrow pits along the Project road, from which soil material for embankments and sub-base course will be procured. Even though there is a borrow pit currently in use near Assin Praso, the Study Team identified several candidate locations of borrow pits at the minimum interval of about 10 km along the Project road, so the average transport distance of soil materials is considered to be 5 km.

b) Aggregate (for concrete and material for base course)

There is one quarry site located about 25 km north of Assin Praso, which was used in the Phase I Project. The owner of this quarry site has agreed to supply crushed stone as required. Since the quality of material from this quarry site is much better than that from other quarry sites, the Study Team intends to use aggregate from this site.

c) Straight asphalt

There are oil refinery plants in the industrial area near Tema Port which can produce straight asphalt. Therefore, straight asphalt will be procured from some major oil companies who can supply it.

d) Asphalt emulsion

There is an existing asphalt emulsion plant located between Assin Praso and Kumasi, and asphalt emulsion was supplied from this plant to the construction of the Phase I Project. In addition, this plant continuously produces and supplies asphalt emulsion to the local market. Except for straight asphalt, other chemical substances used for the asphalt emulsion are imported from Europe, etc. and are of sufficient quality. However, this plant has no experience of producing nonionic asphalt emulsion, which is normally used for soil stabilisation for base course in Japan, hence due consideration is necessary when selecting the type of asphalt emulsion used for soil stabilisation in the Project.

e) Cement

Ghana Cement (GHACEM) is the major cement company in Ghana and has cement factories in Tema and Takoradi that produce and sell cement. The cement produced by GHACEM is of sufficient quality and was used for the construction of a PC bridge in the Phase I Project. Even though there are other imported cement products with good quality in the local market, it is practical to use the cement produced by GHACEM, which can provide a stable supply.

f) Steel materials (reinforcing bar, steel shapes)

There is a distributor in Ghana which procures steel materials from the South African factory of Arcelor Mittal, the world's largest producer of steel, and so reinforcing bar and steel shapes can be procured. However, there are slight differences in specifications compared with the Japanese specifications, hence due consideration is necessary when selecting steel materials.

g) Wood (plywood for concrete formwork)

The Study Team confirmed the production of wood in Ghana. Sawn wood can be used for temporary works, but surface-treated plywood used for concrete formwork is mostly imported by project contractors. Therefore, the Study Team intends to procure all plywood for concrete formwork from Japan.

Table 64 Possible Origin of Supply of Major Construction Materials

Type of Material	Origin of Supply			Reason to Procure from Japan
	Ghana	Japan	Third Country	
Soil from borrow pit	X	-	-	
Aggregate	X	-	-	
Straight asphalt	X	-	-	
Asphalt emulsion	X	-	-	
Cement	X	-	-	
Chemical additives for concrete	X	X	-	Even though chemical additives are available in Ghana, high-efficiency additives are scarce. Therefore, it is necessary to design the mix in advance and select appropriate chemical additives.
Reinforcing bar and steel shapes	X	X	X	If steel shapes match the requirements of the plan, it is necessary to procure steel shapes from Japan.
Guardrails	X	-	X	It is possible to procure materials that comply with international standards from South Africa.
Rubber shoes	-	X	-	Impossible to procure in Ghana.
Expansion joints	-	X	-	- ditto -
Steel member for erection	-	X	-	Difficult to procure in Ghana, as there is little experience of constructing PC bridges.
Plywood for concrete formwork	-	X	x	All plywood for concrete formwork to be imported into Ghana.
Diesel oil	X	-	-	
Petrol	X	-	-	
Street lighting	-	X	-	Impossible to procure in Ghana.
Large traffic sign boards	-	X	-	Impossible to produce in Ghana, including supporting poles.
Steel members for pedestrian overpass bridge	-	X	-	The Study Team could not confirm a fabricator.

Source: Study Team

(2) Construction Equipment

It is possible to procure general-purpose equipment such as bulldozers, backhoes, motor graders, dump trucks and compressors in Ghana. Regarding truck cranes, it is possible to procure ones with a capacity of 40 tonnes; however, it is impossible to procure truck cranes with larger capacity, rough terrain cranes or crawler cranes. Furthermore, since there is no experience of the pavement recycling method in Ghana, there is no stabiliser used for this method, hence a stabiliser should be procured from Japan or a third country.

Table 65 summarises the possible origin of supply of major construction equipment and reason to procure from Japan (third country).

Table 65 Possible Origin of Supply of Major Construction Equipment

Type of Equipment	Origin of Supply			Reason to Procure from Japan
	Ghana	Japan	Third Country	
Dump truck (2 t, 4 t, 10 t)	X	-	-	
Bulldozer (20 t, 32 t)	X	-	-	
Backhoe ($0.35\ m^3$, $0.60\ m^3$, $1.2\ m^3$)	X	-	-	
Trailer (25 t, 35 t)	X	-	-	
Truck crane (max. 40 t)	X	-	-	
Truck crane (over 40 t)	-	X	-	Not in general use and procurement in Ghana is difficult.
Rough terrain crane	-	X	-	Impossible to find in Ghana.
Crawler crane	-	X	-	Procured from overseas for other projects.
Pile-driver	-	X	-	- ditto -
Large-size breaker (600 – 800 kg, 1,300 kg)	X	-	-	
Mobile concrete pump	X	-	-	
Concrete plant	-	X	-	Difficult to procure mobile plant in Ghana.
Cooling plant	-	X	-	I impossible to procure in Ghana.
Agitator car	-	X	-	Difficult to procure in Ghana.
Stabiliser	-	X	-	Does not exist in Ghana.
Motor grader	X	-	-	
Road sprinkler	X	-	-	
Asphalt finisher	X	-	-	
Tyre roller	X	-	-	
Vibratory roller	X	-	-	
Road surface cutter	X	-	-	
Generator	X	-	-	
Submersible pump	X	-	-	

Source: Study Team

2-2-4-7 Soft Component Plan

There is no soft component plan in the Project.

2-2-4-8 Implementation Programme

(1) Condition

There are two rainy seasons in the Project area, with average monthly precipitation exceeding 150 mm between 2003 and 2012 concentrated between March and June, and September and October. In addition, there are records of monthly precipitation exceeding 100 mm in July and

November. As high rainfall is expected for 8 months, the Study Team prepared a plan to improve the work efficiency during the rainy season, rather than concentrating works only in the dry season.

(2) Coefficient of Suspension of Works

In preparing the work plan, a coefficient of suspension of works of 1.35 is applied, based on the "Manual of Cost Estimation in the Preparatory Survey, Supplementary Volume (Civil Engineering Field" (Provisional Version), (March 2009).

(3) Summary of Construction

a) Rehabilitation of 31.2 km of road between Assin Fosu and Assin Praso (two-lane road at present)

- Dualisation to four-lanes road in the centre of Assin Fosu township
- Reconstruction of the railway underpass bridge at Assin Fosu
- Construction of a pedestrian overpass bridge at Assin Fosu
- Rehabilitation of drainage facilities
- Construction of a toll-plaza at Assin Praso township
- Construction of bus bays (bust stop)
- Other ancillary works

b) Reconstruction of Okyi River Bridge at Assin Andoe

(4) Construction Period

Considering the preparatory works (land acquisition, construction of a temporary yard, and procurement of construction equipment and plans), the construction period is set at about three years, as shown in Table 66.

Table 66 Project Implementation Schedule (Draft)

	Item	1	2	3	4	5	6	7	8	9	10	11	12						
Detailed Design	Work in Ghana																		
	Work in Japan																		
	Tender process																		

	Work Item	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
Construction Works	Preparatory works/ Procurement of materials and construction equipment																		
	Reconstruction of bridges																		
	Reconstruction of drainage facilities																		
	Earth works																		
	Pavement works																		
	Ancillary works																		
	Cleaning-up																		

Source: Study Team

2-3 Obligations of Recipient Country

The GoG should arrange the following matters for the execution of the Project.

2-3-1 General Matters related to the Grant Aid Project of the GoJ

- Providing data and information necessary for the implementation of the Project
- Securing land necessary for the implementation of the Project (ROW, construction site, temporary yard, and material and equipment storage site)
- Clearing the ground of each construction site prior to execution of the construction work
- Opening an account with a bank in Japan under the name of the GoG and issuing the authority to pay (A/P)
- Unloading cargoes promptly at Tema Port, which is the unloading point in Ghana and taking measures to exempt them from taxes and customs duties
- Exempting Japanese companies and individuals concerned with the Project from customs duties, local taxes and other taxed imposed in Ghana in relation to the outputs and services supplied under the contract attested
- Based on the contract approved or in relation to the services provided, permitting persons concerned with the Project to enter and stay in Ghana in order to implement relevant work
- Granting permits and other authorities, where necessary, in relation to the implementation of the Project
- Maintaining, managing and preserving the facilities to be built under the project properly and effectively
- Bearing all expenses other than those financed by Japan's grant aid scheme within the scope of the Project

2-3-2 Matters Unique to the Project

The GoG should complete the following matters prior to the start of construction works:

- Removing facilities and resettling residences affected by the construction work
- Securing additional land necessary for the Project other than the land for the existing ROW
- Relocation of electric poles and cables, optical fibre cables, water supply pipes and street lightings affected by the construction works
- Providing and clearing land for the temporary yard
- Providing soil dumping areas and waste disposal sites
- Assigning traffic policemen during the construction period (centre of Assin Fosu township)

Also, the GoG should carry out the following matters during the construction work:

- Observing the entire construction site during the construction period
- Supervision by officers of the GoG during the construction period

2-4 Project Operation Plan

The GoG will be responsible for operation and maintenance (O&M) of the Project. The O&M after completion of the Project is classified as: routine maintenance carried out every year,

and periodic maintenance carried out once every few years. The following O&M will be required for the Project.

(1) Routine Inspection and Maintenance

- Cleaning and weed control within the ROW
- Removal of sand and dirt, and cleaning of side ditches and culverts
- Maintenance of road ancillary works, such as repainting of pavement markings, and repairing traffic signs, guardrails, etc.
- Removal of sand and dirt around the bearing shoes of the Okyi River Bridge

(2) Periodic Maintenance

- Repair of pot-holes in the pavement by patching works approximately every 5 years
- Pavement overlay works approximately every 10 years
- Repainting of steel railings and replacement of the expansion joint of the Okyi River Bridge

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

2-5-1-1 Costs Borne by the GoJ

The project will be implemented in accordance with Japan's Grant Aid scheme and the costs will be determined before concluding the Exchange Note for the project.

2-5-1-2 Costs Borne by the GoG

Table 67 Costs Borne by the GoG

Division by Project Cost Item	Amount to be Borne (USD)	Converted to JPY (JPY thousand)
(1) Cost for environmental considerations (including resettlement of residences, land acquisition, and compensation for agricultural loss)	528,085	528,085
(2) Cost for relocation of electrical pole and cables	799,686	799,686
(3) Cost for relocation of water supply pipes	1,060,405	1,060,405
(4) Cost for relocation of optical fibre cables	824,881	824,881
(5) Cost for relocation of street lightings	210,876	210,876
(6) Cost for cleaning of land for the temporary yard	14,723	14,723
Total	3,438,656	3,438,656

Source: Study Team

2-5-1-3 Conditions of Cost Estimation

- Cost estimation timing: March 2014
- USD exchange rate: USD1.0 = JPY 104.18 (three-month average from February 2014)
- GHS exchange rate: GHS = JPY 45.65 (three-month average from February 2014)
- Construction period: 36 months
- Others: The Project will be implemented according to the Guideline for Grant Aid Cooperation issued by the GoJ. The above estimated project cost will be revised by the GoJ prior to the E/N.

2-5-2 Operation and Maintenance Costs

- Annual maintenance works of road: about USD 11,000 (about JPY 1,144 thousand)
- Annual maintenance works of bridges: about USD 400 (about JPY 42 thousand)
- Cost of rehabilitating pavement by patching works every 5 years: about USD 9,000.- (about JPY 936 thousand)
- Cost of rehabilitating pavement by overlay works every 10 years: about USD 110,000.- (about JPY 11,440 thousand)
- The converted average annual O&M cost will be about USD 24,200 (about JPY 2,521 thousand)
- Since, this cost is about 0.9% of the annual allocation of the road maintenance budget for the GHA Central Region Office of USD 2.7 million (about JPY 279 million), it is considered that adequate O&M of the Project road is possible.

Table 68 Major Maintenance Items and Costs

Category	Frequency	Parts to be Inspected	Contents of Work	Estimated Cost		Notes
				USD	JPY thousand (equivalent)	
Maintenance within ROW	Twice a year	ROW	Cleaning, weed control	8,000	832	
Maintenance of side ditches and culverts	Twice a year	Side ditches and culverts	Removal of sand and dirt			
Maintenance of road ancillary works	Once a year	Road markings, etc.	Repainting, repair	3,000	312	
Maintenance of bridge	Twice a year	Bearing shoes	Removal of sand and dirt	400	42	
Total of annual necessary O&M costs				11,400	1,188	
Maintenance and repair of pavement	Once every 5 years	Pavement surface	Repair of pot holes, etc.	9,000	936	
Maintenance and repair of pavements	Once every 10 years	Pavement surface	Overlay	70,000	7,280	Expected to be 5% of total area of pavement
		Pavement surface of shoulder	Rehabilitation	40,000	4,160	
Annual average equivalent of O&M costs				24,200	2,521	

Note: Exchange rate USD1.0 = JPY104.18

Source: Study Team

CHAPTER 3
PROJECT EVALUATION

Chapter 3 Project Evaluation

3-1 Preconditions

Preconditions necessary for the execution of the Project are as follows:

1) Prior to signing the exchange note, the GoG should allocate budget necessary for land acquisition, compensation for resettlement, relocation and demolition of structures and utilities, renting and clearance of land for the temporary construction yard, and securing of borrow pits, which should be completed before commencement of the construction works.
2) The GoG should complete land acquisition, compensation for resettlement, relocation and demolition of structures and utilities, renting and clearance of land for the temporary construction yard, and securing of borrow pits before commencement of the construction works.
3) Resettlement of vendors doing business along the N8 in the centre of Assin Fosu township should be implemented according to the Resettlement Action Plan prepared by the ANMA.
4) The GHA should submit the EIA Report to the EPA in order to obtain the environmental permit (valid for 18 months), and A-RAP to the LVB, EPA and related local municipal/district assembly, who will participate in the resettlement process.
5) In order to implement the relocation and demolition of electric cables, water supply pipes, optical fibre cables and street lightings smoothly, the GHA should conclude contracts with related agencies and companies, and the relocation and demolition works of these utilities should be completed before commencement of the construction works.
6) The GHA should obtain permits for usage of borrow pits and quarry site(s) necessary for the construction works, before commencement of the works.
7) According to the present regulation in Ghana, the Interim Waiver for tax exemption is no longer effective. Hence, the contractor is required to apply for tax exemption to the Ghana Revenue Authority, and the application will be deliberated in the congress and the cabinet.
8) In order to ensure traffic safety during construction, the contractor should prepare appropriate traffic control measures, while the GHA should organise a traffic safety campaign for road users and local residents.

3-2 Necessary Inputs by Recipient Country

In order to develop and sustain the effects of the Project, the GoG should provide the following necessary inputs:

1) In order to secure smooth implementation of the Project, the GoG should secure the necessary budget described in [2-5-1 Costs Borne by the GoG] in this report, before commencement of the construction works.
2) Within items mentioned in 1), it is required to secure without fail the land for the construction yard, etc. before commencement of the construction works.
3) In order to carry out processes related to the environmental and social considerations

smoothly and appropriately, the GHA will set up a team of environmental and social specialists in the GHA headquarters.

4) The GHA should assign two engineers to be stationed at the site office, in order to appropriately adjust the construction works to local conditions, to ensure smooth implementation of the Project, by explaining and responding to local residents, and to transfer technologies to them.

5) The GHA should assign a person in the GHA HDQ, who will be in charge of administration works (taxes, compensation for land acquisition, etc.) in order to ensure smooth implementation of the Project.

6) In order to ensure adequate maintenance of the project road after completion, the GHA should secure necessary staff and annual budget for maintenance works, which are described in [2-4 Major Maintenance Items and Costs] in this report.

3-3 Important Assumptions

The following are important assumptions for developing and sustaining the effects of the Project:

1) The GHA shall strictly control overloaded vehicles running on the trunk road, to maintain the road condition of the N8.

2) In order to avoid traffic congestion occurring again in the centre of Assin Fosu township after completion of the Project, the related authorities, particularly the ANMA, shall take necessary actions against illegal parking and illegal vendors along the N8.

3) In order to secure traffic safety after completion of the Project, a traffic safety campaign for road users and local residents shall be carried out.

4) Overhead information signs will be installed at the entrance of the centre of Assin Fosu township and at the toll plaza in Assin Praso. After installation of these signs, controls against over-height cargo vehicles shall be strictly enforced for the sake of traffic safety.

3-4 Project Evaluation

3-4-1 Relevance

Implementation of the Project under the Japanese Grant scheme is judged as relevant from the following points of view:

(1) Beneficiaries of the Project

The Central Region, Ashanti Region and Western Regions are directly influenced by the N8. The total population of these three regions is about 4.7 million (2010), accounting for about 18% of the total population of the nation. Indirectly, the entire population of 24.22 million of Ghana and people in neighbouring landlocked countries (Burkina Faso, Niger and Mali) will benefit from the Project.

(2) Necessity of the Project

As pavement deterioration and damage have worsened over the section of about 30 km between Assin Praso and Assin Fosu on the N8, it has become difficult to maintain the road

condition by annual routine maintenance works, and some sections in particular are inundated during the rainy season, obstructing traffic. Furthermore, the present ADT at Assin Fosu township is high at 12,473 veh./day on the whole stretch of the N8, and many taxis, waiting passengers, and pedestrians cause chronic traffic congestion.

According to traffic projections for 2038, the traffic volume on the railway underpass bridge at Assin Fosu will reach 22,000 veh./day, exceeding the maximum traffic capacity of the 2-lane road. Also, since the traffic load will exceed the proof stress of the pavement, the speed of deterioration and damage to the pavement will accelerate. Under these circumstances, it is desirable to implement the Project at an early stage.

(3) Conformity with the Medium-Term and Long-Term Development Plans and Higher Plan in Ghana

In the transport sector of the Transport Sector Development Programme and the Ghana Shared Growth Development Agenda 2010–2013, major targets are the formulation of a transport network to contribute to sustainable growth and socio-economic development, and the establishment of transport hub in West African countries. Thus, the preservation and development of transport infrastructure are positioned as important development themes. Based on these national development plans, the MRH, under the Road Sector Development Programme 2010–2013, placed priority on the N8 as an important policy.

(4) Conformity with the Cooperation Policy and Principles of Japan

Under the country assistance policy for Ghana, “Infrastructure (electricity and roads) is selected as one of the priority areas, and Japan assists Ghana in infrastructure development in areas such as transportation, especially roads, utilising Japanese technological capability to the maximum extent. Rehabilitation and reconstruction of facilities, such as roads and bridges, are directly related to achieving the relevant priorities.”

(5) Operation and Maintenance after Completion of the Project

Since the Ghanaian side will be able to operate and maintain the facilities after completion of the Project with their own resources, manpower and technology, advanced technology and considerable budget will not be needed.

3-4-2 Effectiveness

(1) Quantitative Effects

Table 69 shows the quantitative effects that are considered to be generated by implementation of the Project.

(2) Qualitative Effects

The qualitative effects that are considered to be generated by implementation of the Project are as follows:

1) Rehabilitation of the national trunk road will help strengthen and stabilise the transport capacity of logistics connecting the coastal area of Ghana, and central and northern areas as well as neighbouring landlocked countries.

Table 69 Quantitative Effects of the Project

Index	Base Year (2013)	Target Value (2021) [3 years after completion of the Project]
1. Average daily traffic volume (veh./day)		
Assin Fosu	12,473	14,361
Assin Praso	2,749	4,546
2. Travel speed for the project section (between Assin Fosu and Assin Praso)	30’15”	22’30”

Source: Study Team

2) Road closures due to inundation of the road during the rainy season will be eliminated, and access to markets and public services by residents of local communities will be secured.
3) Dualisation of the road and railway overpass bridge at the centre of Assin Fosu township will solve chronic traffic congestion and improve traffic safety by sidewalks and intersections.
4) Even though Ghana has reduced the poverty headcount ratio since 1991, the ratio based on USD 2.00/day was still as high as 51.8% in 2006. One of the qualitative effects of rehabilitating the N8 is expected to be alleviation of the poverty ratio, especially of local residents living along the N8.

APPENDICES

Appendices

Appendix 1 Member List of the Study Team

Table A1 Member List of the Study Team

Responsibility	Name	Organisation
Team Leader	Hiroshi SUMIYOSHI	Senior Resident Representative, Japan International Cooperation Agency, Ghana Office
Team Leader/Study Coordination	Jitsuya ISHIGURO	Advisor, Infrastructure and Peacebuilding Department, Japan International Cooperation Agency
Chief Consultant/Road Planning	Hikaru NISHIMURA	Central Consultant Inc.
Deputy Chief Consultant/Highway and Pavement Design	Shigeru ANDO	Central Consultant Inc.
Road Damages Survey	Shinya TOYOSAKI	Central Consultant Inc.
Bridge and Structure Design	Shinichi UEDA	Central Consultant Inc.
Environmental and Social Considerations	Tomomi FUJITA	Central Consultant Inc.
Natural Condition Survey	Noboru SHIMIZU	Eight-Japan Engineering Consultants Inc.
Construction and Procurement Planning/Cost Estimation	Jiro NISHITANAKA	Central Consultant Inc.

Source: Study Team

Appendix 2 Study Schedule

(1) Study Schedule of the First Site Survey in Ghana

Table A2 Study Schedule of the First Site Survey in Ghana (1st Phase)

No.	M	D	Day	Itinerary	Lodging	Study Contents
1	10	5	Sa	Ando and Shimizu left Tokyo	On the plane	
2		6	Su	Ando, Shimizu arrived Accra	Accra	Preparation of site survey
3		7	Mo	Toyosaki left Tokyo	-ditto-	Courtesy call to MRH and GHA by Sumiyoshi and Ando
4		8	Tu	Toyosaki arrived Accra Nishitanaka left Tokyo	-ditto-	Preparation of site survey
5		9	We	Nishimura started work in Accra Nishitanaka arrived Accra	-ditto-	Data collection and preparation of natural condition surveys
6		10	Th	Accra <–> Project site on N8	-ditto-	Courtesy call of EOJ, Site survey
7		11	Fr		-ditto-	Data collection
8		12	Sa	Ueda left Tokyo	-ditto-	Data compilation
9		13	Su	Ueda arrived Accra	-ditto-	-ditto-
10		14	Mo	Accra -> Cape Coast	Accra, Cape Coast	Data collection, Site survey
11		15	Tu		-ditto-	-ditto-
12		16	We		-ditto-	Discussion with JICA HDQ (Sumiyoshi, Nishimura, Ando)
13		17	Th	Accra -> Cape Coast	Cape Coast	Site survey
14		18	Fr	N8 -> Accra (Sumiyoshi)	Accra, Cape Coast	-ditto-
15		19	Sa	Cape Coast -> Accra (1 member)	-ditto-	-ditto-
16		20	Su	Cape Coast -> Accra (4 members)	-ditto-	-ditto-
17		21	Mo		-ditto-	Data collection, site survey
18		22	Tu	Cape Coast -> Accra (1 member)	-ditto-	Sub-contract of topographical survey (1) and geotechnical survey, Commencement of FWD test
19		23	We	Fujita left Tokyo	-ditto-	Explanation and discussion of ICR, Site survey
20		24	Th	Fujita arrived Accra	-ditto-	Data collection, Site survey
21		25	Fr		-ditto-	Discussion and signing of M/D, Site survey
22		26	Sa	Accra -> Cape Coast Shimizu left Accra	-ditto-	Sub-contract of traffic survey, Supervision of natural condition survey, Site survey
23		27	Su		-ditto-	Supervision of natural condition survey, Site survey
24		28	Mo	Shimizu returned to Tokyo	-ditto-	-ditto-
25		29	Tu		-ditto-	-ditto-
26		30	We		-ditto-	-ditto-
27		31	Th		-ditto-	-ditto-
28	11	1	Fr		-ditto-	Sub-contract of topographical survey (2) and EIA survey
29		2	Sa		-ditto-	Supervision of sub-contracted surveys, Site survey
30		3	Su	Accra -> Kumasi (Nishimura, Fujita) Toyosaki left Accra	Accra, Cape Coast, Kumasi	-ditto-
31		4	Mo	Kumasi -> Cape Coast (Nishimura, Fujita)	Accra, Cape Coast	Data collection at GHA Ashanti Regional Office, Site survey
32		5	Tu	Cape Coast -> Accra Toyosaki returned to Tokyo	-ditto-	Data collection at GHA Central Regional Office, Site survey
33		6	We	Fujita left Accra Accra -> Cape Coast (Nishitanaka)	-ditto-	Data collection
34		7	Th	Nishimura left Accra	-ditto-	-ditto-
35		8	Fr	Ando and Ueda left Accra Fujita returned to Tokyo	Cape Coast	-ditto-
36		9	Sa	Cape Coast -> Accra (Nishitanaka)	Accra	
37		10	Su	Ando and Ueda returned to Tokyo	-ditto-	Data compilation
38-45		11-18	Mo-Mo		-ditto-	Data collection and compilation
46		19	Tu	Nishitanaka left Accra		
47		20	We		On the plane	
48		21	Th	Nishitanaka returned to Tokyo		

Source: Study Team

Table A3 Study Schedule of the First Site Survey in Ghana (2nd Phase)

No.	M	D	Day	Itinerary	Lodging	Study Contents
1	12	1	Su	Ando left Tokyo	On the plane	
2		2	Mo	Ando and Shimizu arrived Accra	Accra	Data collection, Supervision of laboratory tests
3-7		3-7	Tu-Sa		-ditto-	-ditto-
8		8	Su	Accra -> Cape Coast	Cape Coast	Site survey, Investigation of borrow pits and quarry site
9-14		9-14	Mo-Sa		-ditto-	-ditto-
15		15	Su	Cape Coast -> Accra	Accra	Site survey
16-18		16-18	Mo-We		-ditto-	Data compilation
19		19	Th	Ando left Accra	-ditto-	-ditto-
20		20	Fr	Shimizu left Accta	On the plane	
21		21	Sa	Ando returned to Tokyo	On the plane	
22		22	Su	Shimizu returned to Tokyo		

Source: Study Team

(2) Study Schedule of the Second Site Survey in Ghana

Table A4 Study Schedule of the Second Site Survey in Ghana

No.	M	D	Day	Itinerary	Lodging	Study Contents
1	12	1	We	Nishimura left Japan	On the plane	
2		27	Th	Nishimura arrived Accra	Accra	Preparation of site survey
3		28	Fr		-ditto-	Explanation of draft outline design drawings to GHA, Courtesy call to JICA Ghana Office
4	3	1	Sa		-ditto-	Data compilation
5		2	Su		-ditto-	-ditto-
6		3	Mo	Fujita left Japan	-ditto-	Courtesy call to EOJ
7		4	Tu	Fujita arrived Accra Ando left Tokyo	-ditto-	Data collection
8		5	We	Ando arrived Accra Nishimura left Accra	-ditto-	-ditto-
9		6	Th		-ditto-	-ditto-
10		7	Fr	Nishimura returned to Tokyo	-ditto-	-ditto-
11		8	Sa	Accra -> Cape Coast	Cape Coast	Site survey
12		9	Su		-ditto-	-ditto-
13		10	Mo		-ditto-	-ditto-
14		11	Tu	Cape Coast -> Accra (Ando)	Accra, Cape Coast	-ditto-
15		12	We		-ditto-	Site survey, Data collection
16		13	Th	Ando left Accra	Cape Coast	Site survey
17		14	Fr		-ditto-	-ditto-
18		15	Sa	Ando returned to Tokyo	-ditto-	-ditto-
19-22		16-19	Su-We		-ditto-	-ditto-
23		20	Th		-ditto-	Assist public forum conducted by GHA
24-26		21-23	Fr-Su		-ditto-	Site survey
27		24	Mo	Cape Coast -> Accra	Accra	
28		25	Tu	Fujita left Accra	On the plane	
29		26	We		On the plane	
30		27	Th	Fujita returned to Tokyo		

Source: Study Team

(3) Study Schedule of the Third Site Survey in Ghana

Table A5 Study Schedule of the Third Site Survey in Ghana

No.	M	D	Day	Itinerary	Lodging	Study Contents
1	11	20	Th	Nishimura and Ando left Tokyo	On the plane	
2		21	Fr	Nishimura and Ando arrived Accra	Accra	Preparation of site survey
3		22	Sa	Accra -> Assin Fosu	Accra, Assin Fosu	Site survey
4		23	Su	Ishiguro left Tokyo Assin Fosu -> Accra	Accra	Site survey
5		24	Mo	Ishiguro arrived Accra	-ditto-	Discussion in JICA Ghana Office
6		25	Tu		-ditto-	Explanation and Discussion of DOD to GHA
7		26	We		-ditto-	Courtesy call to MRH and MOF
8		27	Th		-ditto-	Discussion of M/D
9		28	Fr	Ishiguro and Ando left Accra	-ditto-	Signing of M/D, Courtesy call to EOJ
10		29	Sa	Ishiburo and Ando returned to Tokyo Nishimura continued to another study in Accra	-ditto-	Data compilation

Source: Study Team

Appendix 3 List of Parties Concerned in the Recipient Country

Table A6 List of Parties Concerned in the Recipient Country (1)

Ministry of Roads & Highway (MRH)	
Mr. Daniel D. Darku	Chief Director
Mr. G. J. Brocke	Director, P & P (Policy and Planning)
Mr. Francis O. M. Digber	Director, M & E
Mr. F. N. K. Ashong	Director, RSIM (Research, Statistics and Information Management)
Mr. Cletus Kugbila	Director of Procurement
Mr. Francis Nudze	Deputy Director of Procurement
Mr. Francis Ahlidza	Deputy Director of M & E
Ms. Josephine Menu	Legal Officer
Mr. Gense K. Addison	Principal Engineer of Planning
Ms. Equa Eqqah	Senior Engineer of Planning
Mr. Kwasi Ayyemcm Boakye	Engineer
Ghana Highway Authority (GHA)	
Mr. Michael A. Abbey	Chief Executive
Mr. Joe Fred Peseo	AG. DY. Chief Executive (Development)
Mr. Francis Hammond	AG. DY. Chief Executive (Administration)
Mr. Addo Sitsofe David	Director of Planning
Mr. Sitsofe David Addo	Director of Planning
Mr. Owusu Sekyere Antwi	Director of Bridge（前職）
Michael Okine	Director of Bridges
Mr. Bonne Acquah	Director of Material
Mr. Maame Osei Akuanoch	Director of Maintenance
Mr. Ebenefer A Mills	Director of Design and Survey
Mr. David Hammono	Director of Contracts
Mr. Mallam Issah Ishak	Director of Quantity Surveying
Mr. T. K. Oppong Baah	Network Planning Manager（前職）
Mr. Oduro Amoakohene	Engineer of Planning
Mr. Kingsley Osae-Boateng	Maintenance Manager
Mr. Gordon A. Amartey	Highway Design Manager (S/Sector)
Ms. Rita Ohene Sarfoh	Chief Engineer
Ms. Hildo Annan	Assistant Manager
Mrs. Faustina Oppong Yeboah	Senior Engineer
Mr. Bernard Owusu	Senior Engineer
Mr. Abraham Steele Dadzie	Assistant Engineer
Mr. Ruth Mensah	Senior Technical Engineer
Mr. Paul Y. A. P. Duah	Highway design Manager (N/Sector)
Mrs. Mercy Payne	Axle Load Control Manager
Ms. Olivia Oppong	Senior Engineer of Design and Survey
GHA Central Region Office	
Mr. Michael Okine	Director（前職）
Mr. John Arthur-Amissah	Regional Maintenance Manager, Central Region
GHA Ashanti Region Office	
Mr. Joseph Atsu	Direcot
Mr. Eric Odosu	Engineer
Ministry of Finance and Economic Planning (MFEP)	
Mr. David Quist	Head of Japan Desk
Mr. Kwadwo Awua-Peasah	Director, ERM-Bilateral
Ministry of Transport (MoT)	
Mr. Sisi Ocran	Director of Policy and Planning
Ghana Railway Development Authority (GRDA)	
Mr. A. A. Sadique	Ag. Chief Executive
Ministry of Tourism (MoTr)	
Mr. Reaben Kwadzofio	Tourism Office

Table A6 List of Parties Concerned in the Recipient Country (2)

Regional Coordinating Council, Central Region	
Mr. Frank Oberg-Dapaah	Chief Regional Economic Planning Officer
Regional Coordinating Council, Ashanti Region	
Mr. Joseph Donkor	Regional Economic Planning Officer
Assin North Municipality Assembly	
Mrs. Dorcas Hutchful Aldoo	Co-ordinating Director
Mr. Charles C. Lartey	Deputy Director
Assin South District Assembly	
Mr. Richard Blevi	Co-ordinating Director

Source: Study Team

Appendix 4 Minutes of Discussions for Presentation of Inception Report

MINUTES OF DISCUSSIONS
ON THE PREPARATORY SURVEY (OUTLINE DESIGN STUDY)
ON THE PROJECT FOR REHABILITATION OF NATIONBAL TRUNK ROAD N8 (PHASE 2)
IN THE REPUBLIC OF GHANA

In response to a request from the Government of the Republic of Ghana (hereinafter referred to as "Ghana"), the Government of Japan decided to conduct a Preparatory Survey for Outline Design (hereinafter referred to as "the Survey") on the Project for Rehabilitation of National Trunk Road N8 (Phase 2) (hereinafter referred to as "the Project"), and entrusted the Survey to Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent a Preparatory Survey Team for Outline Design (hereinafter referred to as "the Team") to Ghana. The Team is headed by Mr. Hiroshi Sumiyoshi, Deputy Representative, JICA Ghana Office and is scheduled to stay in the country from 6th October to 20 December 2013.

The Team held a series of discussions with the officials of the Government of Ghana and conducted a field survey at the Project area. In the course of the discussions, both sides have confirmed the main items described in the attached sheets. The Team will proceed to further works and prepare the Preparatory Survey Report.

Accra, 25th October, 2013

Hiroshi Sumiyoshi
Team Leader
Preparatory Survey Team
Japan International Cooperation Agency

Dr. D. D. Darku
Chief Director
Ministry of Roads and Highways
Republic of Ghana

Kwadwo Awua-Peasah
Director of External Resource
Mobilisation (Bilateral) Division
Ministry of Finance
Republic of Ghana

M. A. Abbey
Chief Executive
Ghana Highway Authority
Republic of Ghana

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve land transport efficiency between Kumasi, Accra and Takoradi, thereby contributing to economic and social development of Ghana.

2. Project Site

The Project site is in Central Region as shown in Annex-1.

3. Responsible and Implementing Organizations

The responsible agency of the Project is the Ministry of Roads and Highways (hereinafter referred to as "MRH"). The implementing agency of the Project is the Ghana Highway Authority, (hereinafter referred to as "GHA"). The organization chart is shown in Annex-2.

4. Items requested by the Government of Ghana

4-1. The requested items in the application letter dated 6 May 2013 were as follows.

(1) Rehabilitation of the Yamoransa-Assin Praso section (100km)
(2) Rehabilitation of the Bekawai-Anwiankwanta section (15km)
(3) Road widening and rehabilitation of the Anwiankwanta-Kumashi section (10km)

4-2. As a result of discussions, it was confirmed that the outline design covers rehabilitation of the road section between Assin Praso and Assin Fosu. JICA will assess the appropriateness of the project component(s) recommended by the Survey and will report the findings to the Government of Japan. The implementation of the Project will be decided by the Government of Japan.

5. Japan's Grant Aid Scheme

5-1. The Ghanaian side understands the Japan's Grant Aid Scheme and the necessary measures to be taken by the Government of Ghana as explained by the Team and described in Annexes-3 and -4.

5-2. The Ghanaian side will take the necessary measures, as described in Annex-5, for the smooth implementation of the Project.

6. Schedule of the Survey

6-1. The Team will proceed with further studies in Ghana until 20 December, 2013.

6-2. JICA will prepare a draft final report in English and dispatch a mission to Ghana in

order to explain its contents around May, 2014.

6-3. When the contents of the report are accepted in principle by the Government of Ghana, JICA will complete the final report in English and send it to the Government of Ghana around July, 2014.

7. Environmental and Social Considerations

7-1. The Team explained that all JICA-financed project shall comply with the JICA Guidelines for Environmental and Social Considerations (April, 2010) (the "Guidelines"). The Project is tentatively categorized as Category B because the project is not considered as a large-scale roads and bridges sector project; is not located in a sensitive area; has none of the sensitive characteristics under the Guidelines; and is not likely to have significant adverse impact on the environment.

7-2. The Team explained that JICA conducts an environmental review in accordance with the project category and refers to the environmental checklist for the road sector as attached in the Guidelines.

7-3. Both sides confirmed that Environmental Permit is necessary for the Project in accordance with the Environmental Assessment Regulations of the Government of Ghana, and that GHA shall obtain the permission for the Project through the following procedures.

1) GHA shall submit to the Environmental Protection Agency (EPA) a Regulation Form for screening in line with the Environmental Impact Assessment (EIA) procedure. GHA shall report to the JICA Ghana office the result of the screening conducted by EPA.
2) GHA shall prepare a scoping and a draft EIA report in accordance with the response by EPA and also with a support from the consultant members of the Team.
3) GHA shall submit the draft EIA report to EPA, complete necessary procedures for EIA and obtain the Environmental Permit before the commencement of the Project. GHA shall report the result of the EIA to JICA Ghana office.

7-4. GHA shall bear the expenses of the EIA procedures except the draft EIA report and the draft Resettlement Action Plan (RAP) prepared by the consultant members of the Team.

7-5. GHA shall secure the necessary land for the Project in accordance with the Ghanaian law. The expenses of the procedures and compensation to the Project Affected Persons (PAPs) shall be borne by GHA. GHA shall hold meetings and/or negotiate with land owners and confirm the consensus on the expropriation and/or temporally use of land necessary for the Project by the end of the Survey (May, 2014). GHA shall report the results to JICA Ghana office.

7-6. The consultant members of the Team shall provide GHA with necessary information of outline design, before May, 2014 for GHA to smoothly carry out the abovementioned procedures.

8. Other Relevant Issues

8-1. The following undertakings should be taken by GHA at its expenses before the commencement of the Project:

(1) Acquisition of necessary land for the Project;
(2) Relocation of existing utilities (power, telecommunication lines, water lines, etc.);
(3) Removal of existing road structures and bridges if applicable;
(4) Securing and clearance of temporary yard and land for detour; and
(5) Securing of the site for borrow pit and disposal area.

8-2. GHA shall secure enough budget and personnel necessary for the maintenance of the road sections rehabilitated by the Project.

8-3. GHA ensured that there is no overlap of similar support by other development partners for the Project.

8-4. The Ghanaian side shall provide necessary counterpart personnel to the Team during the period of Survey in Ghana.

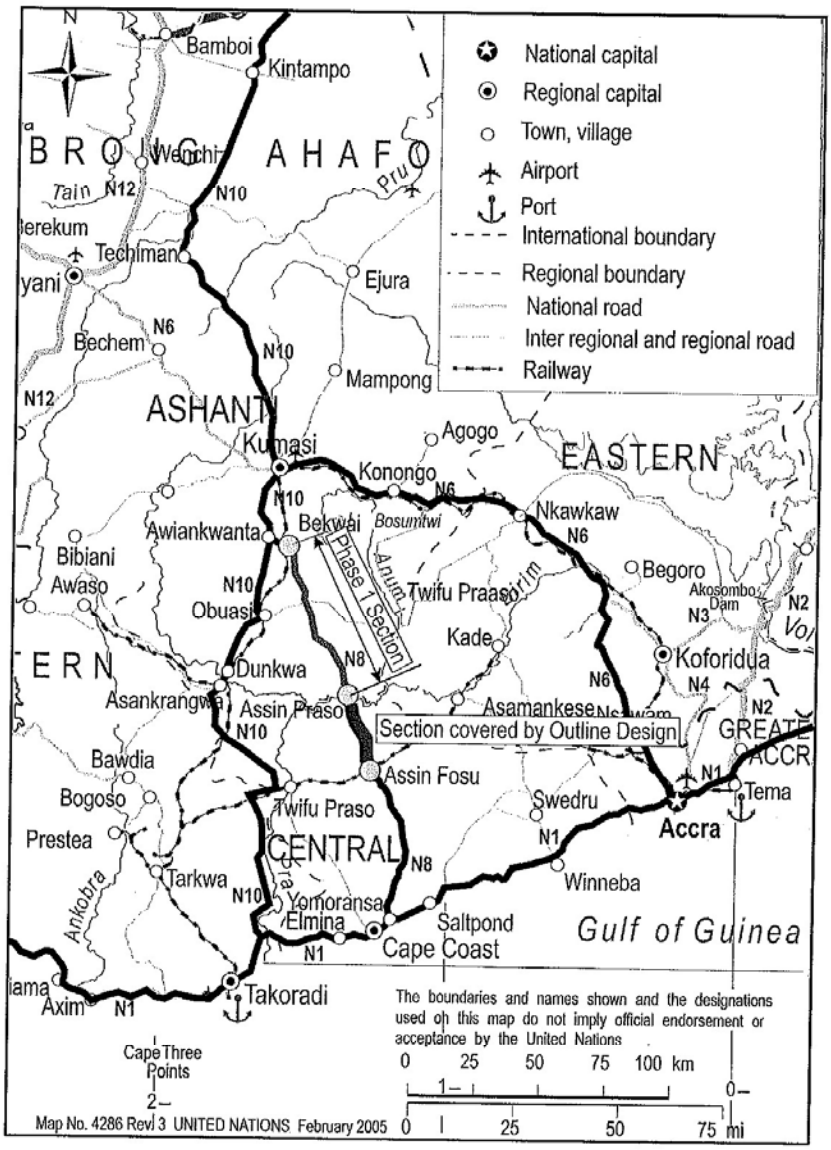
8-5. In a previous Japanese grant aid project, tax exemption for Japanese contractors/consulting firms delayed for years. This may hamper quality contractors' willingness to participate in similar projects in the country. The Ghanaian side shall look at this issue and expedite the tax exemption process for future grant aid projects.

8-6. The Team conveyed a concern for delayed project delivery which might occur due to untimely land acquisition and resettlement. Both sides confirmed to periodically share information on preparation status and schedule of the Project to expedite actions to be taken by both sides.

8-7. The Ghana side conveyed its concerns about the non-participation of Ghanaians in previous projects. The Ghana side requested the Team to make due consideration for local content in the Project. The Team replied that the request of the Ghana side is difficult to treat from the view of Japan's Grant Aid rule, but would convey the request for consideration.

Annex-1 Project Site
Annex-2 Organization Chart of MRH and GHA
Annex-3 Japan's Grant Aid
Annex-4 Flow Chart of Japan's Grant Aid Procedures
Annex-5 Major Undertakings to be taken by Each Government

Annex-1


National capital
Regional capital
Town, village
Airport
Port
International boundary
Regional boundary
National road
Inter regional and regional road
Railway
Bamboi
Kintampo
BRONG AHAFO
Wenchi
Tain
N12
N10
Techiman
Ejura
Bechem
N6
Mampong
ASHANTI
Kumasi
Agogo
EASTERN
Konongo
Nkawkaw
Bekwai
Bosumtwi
Awiankwanta
Bibiani
Awaso
Phase 1 Section
Anum
Twifu Praaso
Begoro
Akosombo Dam
N3
N2
Obuasi
Kade
Koforidua
Dunkwa
N8
N4
Asankrangwa
Assin Praso
Asamankese
Section covered by Outline Design
GREATER ACCRA
Bawdia
Assin Fosu
Tema
Bogoso
Twifu Praso
Swedru
Accra
Prestea
CENTRAL
N1
Tarkwa
Winneba
Ankobra
Yamoransa
Elmina
Saltpond
Gulf of Guinea
Cape Coast
Takoradi
Axim
Cape Three Points
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations
0 25 50 75 100 km
0 25 50 75 mi
Map No. 4286 Rev 3 UNITED NATIONS February 2005

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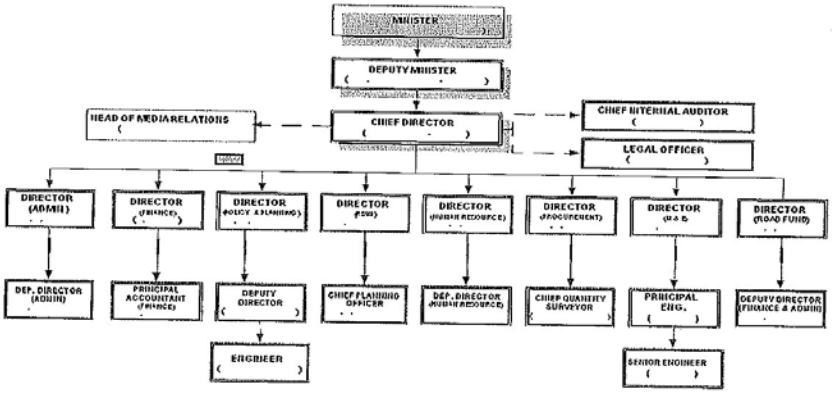
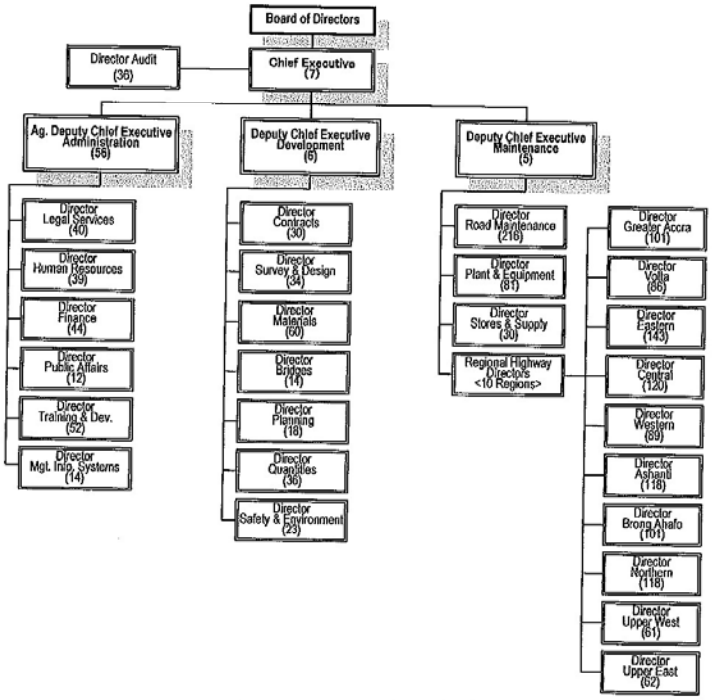
Annex-2



MRH - organization chart



GHA – organization chart

Annex-3

JAPAN'S GRANT AID

The Government of Japan (hereinafter referred to as "the GOJ") is implementing the organizational reforms to improve the quality of ODA operations, and as a part of this realignment, a new JICA law was entered into effect on October 1, 2008. Based on this law and the decision of the GOJ, JICA has become the executing agency of the Grant Aid for General Projects, for Fisheries and for Cultural Cooperation, etc.

The Grant Aid is non-reimbursable fund provided to a recipient country to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for its economic and social development in accordance with the relevant laws and regulations of Japan. The Grant Aid is not supplied through the donation of materials as such.

1. Grant Aid Procedures

The Japanese Grant Aid is supplied through following procedures :

- Preparatory Survey
  - The Survey conducted by JICA
- Appraisal &Approval
  - Appraisal by the GOJ and JICA, and Approval by the Japanese Cabinet
- Authority for Determining Implementation
  - The Notes exchanged between the GOJ and a recipient country
- Grant Agreement (hereinafter referred to as "the G/A")
  - Agreement concluded between JICA and a recipient country
- Implementation
  - Implementation of the Project on the basis of the G/A

2. Preparatory Survey

(1) Contents of the Survey

The aim of the preparatory Survey is to provide a basic document necessary for the appraisal of the Project made by the GOJ and JICA. The contents of the Survey are as follows:

- Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of relevant agencies of the recipient country necessary for the implementation of the Project.
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, financial, social and economic point of view.
- Confirmation of items agreed between both parties concerning the basic concept of the Project.
- Preparation of a outline design of the Project.

- Estimation of costs of the Project.

The contents of the original request by the recipient country are not necessarily approved in their initial form as the contents of the Grant Aid project. The Outline Design of the Project is confirmed based on the guidelines of the Japan's Grant Aid scheme.
JICA requests the Government of the recipient country to take whatever measures necessary to achieve its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization of the recipient country which actually implements the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country based on the Minutes of Discussions.

(2) Selection of Consultants

For smooth implementation of the Survey, JICA employs (a) registered consulting firm(s). JICA selects (a) firm(s) based on proposals submitted by interested firms.

(3) Result of the Survey

JICA reviews the Report on the results of the Survey and recommends the GOJ to appraise the implementation of the Project after confirming the appropriateness of the Project.

3. Japan's Grant Aid Scheme

(1) The E/N and the G/A

After the Project is approved by the Cabinet of Japan, the Exchange of Notes(hereinafter referred to as "the E/N") will be singed between the GOJ and the Government of the recipient country to make a pledge for assistance, which is followed by the conclusion of the G/A between JICA and the Government of the recipient country to define the necessary articles to implement the Project, such as payment conditions, responsibilities of the Government of the recipient country, and procurement conditions.

(2) Selection of Consultants

In order to maintain technical consistency, the consulting firm(s) which conducted the Survey will be recommended by JICA to the recipient country to continue to work on the Project's implementation after the E/N and G/A.

(3) Eligible source country

Under the Japanese Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased. When JICA and the Government of the recipient country or its designated authority deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country. However, the prime contractors, namely, constructing and procurement firms, and the prime consulting firm are limited to "Japanese nationals".

(4) Necessity of "Verification"

The Government of the recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by JICA. This "Verification" is deemed necessary to fulfill accountability to Japanese taxpayers.

(5) Major undertakings to be taken by the Government of the Recipient Country

In the implementation of the Grant Aid Project, the recipient country is required to undertake such necessary measures as Annex.

(6) "Proper Use"

The Government of the recipient country is required to maintain and use properly and effectively the facilities constructed and the equipment purchased under the Grant Aid, to assign staff necessary for this operation and maintenance and to bear all the expenses other than those covered by the Grant Aid.

(7) "Export and Re-export"

The products purchased under the Grant Aid should not be exported or re-exported from the recipient country.

(8) Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account under the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). JICA will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to JICA under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay and payment commissions paid to the Bank.

(10) Social and Environmental Considerations

A recipient country must carefully consider social and environmental impacts by the Project and must comply with the environmental regulations of the recipient country and JICA guidelines for environmental and social considerations.

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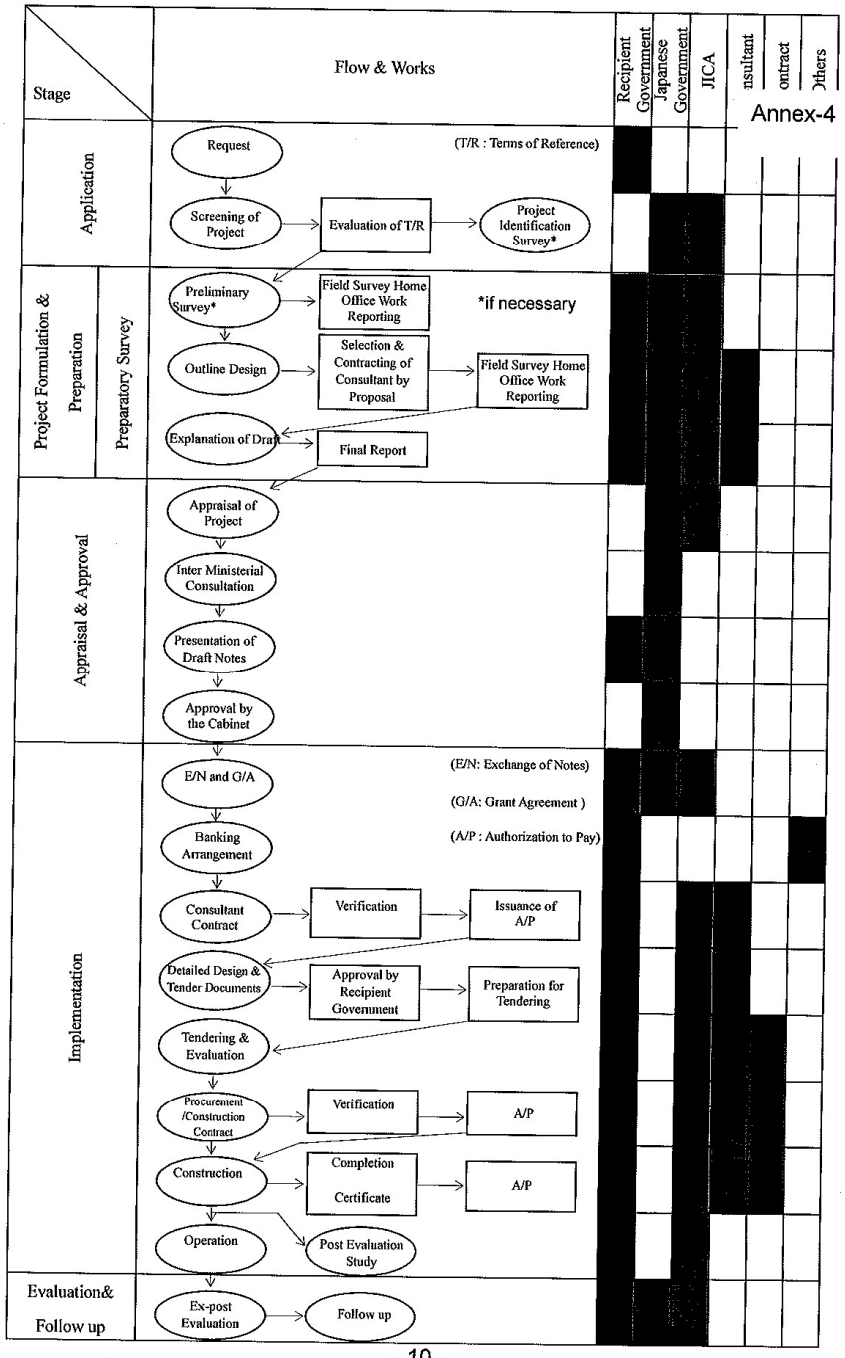
FLOW CHART OF JAPAN's GRANT AID PROCEDURES

Annex-4



Annex-5

Major Tasks to be Undertaken by Each Government

No.	Items	To be covered by Grant Aid	To be covered by the Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To bear the following commissions to the Japanese bank for banking services based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
5	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine/Air/Land transportation of the products from Japan to the recipient country	●	
	2) Tax exemption and customs clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
6	To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the Verified Contract, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
7	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts		●
8	To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant Aid		●
9	To bear all the expenses, other than those to be borne by the Grant Aid, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

(B/A : Banking Arrangement, A/P : Authorization to Pay)

Appendix 5 Minutes of Discussions for Presentation of Draft Outline Design Report

MINUTES OF DISCUSSIONS
ON
THE PREPARATORY SURVEY
FOR
THE PROJECT FOR REHABILITATION OF NATIONAL TRUNK ROAD N8
PHASE 2
IN
THE REPUBLIC OF GHANA
(Explanation of Draft Outline Design Report)

On the basis of the preparatory survey started in October 2013, the Japan International Cooperation Agency (hereinafter referred to as "JICA") prepared a Draft Outline Design Report (hereinafter referred to as "the Report") on the Project for Rehabilitation of National Trunk Road N8 Phase 2 (hereinafter referred to as "the Project").

The Preparatory Survey Team, headed by Mr. Jitsuya Ishiguro, Advisor, Team 2, Transportation and ICT Group, Infrastructure and Peacebuilding Department of JICA, explained to and consulted with the Ghana Highway Authority (hereinafter referred to as "GHA") and the concerned officials of the Government of Ghana on the contents of the Report.

As a result of discussions, both sides confirmed the main items described in the attached sheets.

Accra, 27th November, 2014

Jitsuya Ishiguro
Leader
Preparatory Survey Team
Japan International Cooperation Agency

Kwadwo Awua-Peasah
Director
External Resource Mobilization (Bilateral) Division
Ministry of Finance
Republic of Ghana

Dr. D. D. Darku
Chief Director
Ministry of Roads and Highways
Republic of Ghana

M. A. Abbey
Chief Executive
Ghana Highway Authority
Republic of Ghana

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ATTACHMENT

1. Components of the Draft Outline Design Report

1.1. The Ghanaian side agreed and accepted in principle the contents of the Report explained by the Team. As a result of the Survey the Team examined and found out the best solutions therefore the main components of the Project consist of following construction works.

a) Rehabilitation of the N8 between Assin Fosu and Assin Praso (L=31.2 km)
b) Reconstruction of four continuous box culverts to a bridge (within the total length of road rehabilitation, the length to reconstruct a bridge is L = 25.0 m) across the Okyi River on the N8 in Assin Andoe, located about 20 km south of Assin Fosu.

1.2 The Study Team requested the Ghanaian side to submit comments for the Draft Outline Design Report by 19th December, 2014. The Ghanaian side promised to submit comments in due date..

2. Cost Estimation for the Project

2.1. The Japanese side explained to the Ghanaian side the rough estimate of the Project Cost described in Annex-1; however, the final Project Cost described in the Exchange of Note (hereinafter referred to as "E/N") would be appraised by the Government of Japan (hereinafter referred to as "GOJ").

2.2. Both Sides further confirmed that the Project Cost in Annex-1, and details of the construction works in the Report should never be duplicated and/or disclosed to any third parties until all the contracts for the Project are concluded.

3. Undertaking by the Ghanaian Side

3.1. The Ghanaian side will undertake the following arrangement/work for the Project listed in Annex-2 at its own expenses based on the contents of the Report.

The Team explained that the necessary land acquisition for the project implementation and relocation of public services and facilities at the Project site must be concluded prior to the bidding.

3.2. The Ghanaian side agreed to report to the JICA Ghana office the procedure of the undertakings by the Ghanaian side until all the works to be done. Report shall be in accordance with the progress chart in Annex-5.

4. Operation and Maintenance of the Facilities

4.1. The Ghanaian side will secure enough staff and budgets necessary for operation and

maintenance of the facilities constructed by the Project. The annual operation and maintenance costs are estimated and shown in the table below. Refer to the Report for further details.

Category	Frequency	Parts to be Inspected	Contents of Work	Estimated Cost		Notes
				US$	JPY thousand (equivalent)	
Maintenance within ROW	Twice a year	ROW	Cleaning, weed control	8,000	832	
Maintenance of side ditches and culverts	Twice a year	Side ditches and culverts	Removal of sand and dirt			
Maintenance of road ancillary works	Once a year	Road markings, etc.	Repainting, repair	3,000	312	
Maintenance of bridge	Twice a year	Bearing shoes	Removal of sand and dirt	400	42	
Total of annual necessary O&M costs				11,400	1,188	
Maintenance and repair of pavement	Once every 5 years	Pavement surface	Repair of pot holes, etc.	9,000	936	
Maintenance and repair of pavements	Once every 10 years	Pavement surface	Overlay	70,000	7,280	Expected to be 5% of total area of pavement
		Pavement surface of shoulder	Rehabilitation	40,000	4,160	
Annual average equivalent of O&M costs				24,200	2,521	

4.2. The project includes facilities to ensure traffic safety such as sign posts, guardrail, bus stops and a pedestrian bridge to mitigate traffic accident risks. There is also a risk that overloading trucks would exceed designed live load which would cause earlier rehabilitation and shorter life. The Team explained and the Ghanaian side agreed that taking necessary actions to have the road users respect regulations is fundamental to maintain the facility and to ensure road safety.

5. Environment and Social Considerations

5.1. GHA and the JICA Mission confirmed the information on environmental and social considerations including major impacts and relevant mitigation measures summarized in the Environmental Checklist attached as Annex-3. GHA confirmed that they will inform JICA of any major changes which may affect environmental and social considerations made for the Project by revising the Checklist in a timely manner.

5.2. GHA and the JICA Mission confirmed environmental monitoring will be conducted by the Environmental protection Agency (EPA)/GHA in accordance with the Environmental Monitoring Plan (EMP) described in the Preparatory Survey Report. The Contractor will execute the EMP as part of the project.

5.3. GHA confirmed that the results of environmental monitoring will be provided to JICA as a part of Monthly Progress Report by filling in the monitoring results reporting form for construction attached as Annex-4 on a quarterly basis until the completion of the project, provided that there is no outstanding issue regarding the environmental and social considerations during operation of the Project.
In case JICA finds that there is need for improvement in a situation with respect to environmental considerations after the agreed monitoring period, JICA may request to extend the period of monitoring and reporting until JICA confirms the issues have been properly addressed in accordance with the agreement between GHA and JICA.

5.4. GHA agreed JICA's disclosure of provided monitoring results in the monitoring form (Annex-4) on its website.

6. Japan's Grant Aid Scheme

6.1. The Ghanaian side fully understood and reconfirmed the scheme of the Japan's Grant Aid and the necessary measures to be undertaken by the Ghanaian side, which was explained by the Japanese side and agreed as the Minutes of Discussion signed on 25 October 2013. The Team intimated that the application for the Grant Aid for the project will be placed before the Japanese Cabinet around December 2016. The meeting proposed the need to review the design and cost estimates before implementation.

7. Schedule of the Study

7.1. JICA will complete the Final Report of the Preparatory Survey both in Japanese and English, in accordance with the confirmed items and send it to the Ghanaian side around January 2015.

8. Disclosure of Information

8.1. Both Sides confirmed that the study results excluding the Project cost will be disclosed to the public after completion of the Preparatory Survey. All the study results including the Project cost will be disclosed to the public after all the contracts for the Project are concluded.

9. Understanding of relevant organizations

9.1. During the survey both Sides jointly held a public hearing in order to share the information for smooth implementation of the Project.
9.2. GHA will continuously take actions to educate the users of the infrastructures covered by the project to ensure road safety and proper use.

Annex-1: Project Cost Estimation
Annex-2: Major undertakings to be taken by the Government of Ghana
Annex-3: Environmental Checklist

Annex-4: Environmental Monitoring Form
Annex-5: Progress chart for the undertakings by the Ghanaian side

This Page is closed due to the confidentiality.

Annex -2: Major undertakings to be taken by the Government of Ghana

No.	Items
1*	To secure following lands necessary for the implementation of the Project and to clear the site within six (6) months after signing of the E/N (for Detailed Design) between the GOJ. - land for the bridges and roads. (Refer to the Draft Outline Design Report for the locations of the plots) - temporary yards for construction, material storage and site offices. - borrow pits and quarries and payment for the materials from the site. - plant yard - disposal of waste and land waste.
2	To provide facilities for distribution of electricity, water supply and drainage and other incidental facilities necessary for the implementation of the Project outside the site.
3*	To relocate utilities and facilities which may be obstacles to the construction in the project site within six (6) months after signing of the E/N (for Detailed Design) between the GOJ. (Refer to the Draft Outline Design Report for the locations)
4	To ensure prompt unloading and customs clearance of the products at ports of disembarkation in the recipient country and to assist internal transportation of the products.
5	To ensure that customs duties, internal taxes and other fiscal levies, which may be imposed in the recipient country with respect to the purchase of the products and the services be exempted.
6	To accord Japanese physical persons and / or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the recipient country and stay therein for the implementation of the Project.
7	To ensure that the Facilities be maintained and used properly and effectively for the implementation of the Project.
8	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project.
9	To ensure security for the personnel assigned to the Project and ensuring security at the Project site and temporary yards which include arrangement for traffic control for detouring to the project site.
10	To bear the following commissions paid to the Japanese bank for banking services based upon the B/A - Advising commission of A/P - Payment commission
11	To give due environmental and social consideration in the implementation of the Project. - To conduct environmental monitoring. - To assign person(s) in charge of land acquisition until the completion of resettlement.
12	To obtain all necessary permits such as Development Consent from ECD and etc., to coordinate and share necessary information with the organizations concerned regarding the method of construction of the bridges and roads.
13	To cooperate in solving potential troubles with the local people or any third party in connection with the execution of the Project.

(B/A: Banking Arrangement, A/P: Authorization to Pay)

* Marked items are regarded as preconditions to proceed to a bidding stage.

Annex-3: Environmental Checklist

Table A3 Environmental Checklist (1)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports already been prepared in the official process? (b) Have EIA reports been approved by the 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) N (b) N (c) N (d) N	(a) The EIA report will be prepared in the official process. (b) The report will be submitted by the GHA to be approved by the Ministry of Environment, Science and Technology. (c) No particular condition will be required for approval of the EIA. (d) No other authority will be involved in the approval of the EIA.
	(2) Explanation to the Local Stakeholders	(a) Have the contents of the project and the potential impacts been adequately explained to the local stakeholders based on appropriate procedures, including information disclosure? Has the understanding of local stakeholders been obtained? (b) Have the comment from stakeholders (such as local residents) been reflected in the project design?	(a) Y (b) Y	(a) Two stakeholder meetings for each component have been held during the EIA study. (b) The EIA study is in progress and the opinions of stakeholders in the stakeholder meeting have been reflected in the report.
	(3) Examination of Alternatives	(a) Have alternative plans for the project been examined with social and environmental considerations?	(a) Y	(a) Three alternative analyses including the zero option from technical, economic and environmental and social considerations have been conducted in the EIA study.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from project-related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Will any mitigating measures be taken? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) N (b) N	(a) Although dust dispersal from construction equipment during construction activities is expected, it will be mitigated through appropriate mitigation measures. (b) No significant air pollution is expected during the operational phase.
	(2) Water Quality	(a) Is there a possibility that soil runoff from bare land 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) N (b) N	(a) There is no large volume of cut-and-fill in the construction activities. Although there will be some partial and small volume of cut-and-fill, no significant impact on the current land form resulting in outflow of soil is expected. No outflow of soil is expected during the operational phase. (b) Since the designed alignment basically follows the existing one, no negative impact on water resources such as wells is expected.
	(3) Wastes	(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) An appropriate waste disposal system will be implemented using the same waste disposal site as the previous relevant road rehabilitation project.
	(4) Noise and Vibration	(a) Do noise and vibrations from vehicles and train traffic comply with the country's standards?	(a) Y	(a)Mitigation measures will be implemented in line with the environmental regulation of Ghana for noise and vibration.

Table A3 Environmental Checklist (2)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
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) No negative impact on protected areas is expected since there is no protected area adjacent to the project site designated by the GoG.
	(2) Ecosystem	(a) Does the project site encompass primaeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accidents of wildlife and livestock? (e) Is there a possibility that installation of roads will cause impacts, such as destruction of forests, poaching, desertification, reduction of wetland areas, and disturbance of ecosystems due to the introduction of exotic (nonnative invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In case the project site is located in an undeveloped area, is there a possibility that the new development will result in extensive loss of natural environments?	(a) N (b) N (c) – (d) – (e) N (f) N	(a) No primaeval forests, tropical rain forests, or ecological valuable habitats exist around the project site as the designed road follows the existing road alignment. (b) No protected habitats of endangered species have been confirmed. (c) No significant negative impact on the ecosystem is expected. (d) No significant negative impact on habitat fragmentation and migrating wild life or livestock is expected since the project involves rehabilitation of the existing road. (e) There will be no destruction of forests, poaching, desertification, or reduction of wetland areas since no such relevant elements subject to negative impact were confirmed. (f) The project will not be implemented in an undeveloped 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) Although construction of a bridge pier in the river will affect river water flow, significant negative impact on the existing water flow as well as high water line is not expected since the project includes widening the river section at the point where the road crosses. Additionally no negative impact on ground water at the site is expected since the construction activities will not include pumping up of ground water.
	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut-and-fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) N (c) N	(a) Since the designed alignment follows the existing road, no slope failures and landslides are expected. (b) No large volume of cut-and-fill is planned for the construction activities. (c) No significant modification of land form by construction activities is expected. Installation of road side drainage is designed to avoid soil outflow related to the rehabilitated road.

Table A3 Environmental Checklist (3)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimise the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in a document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organisational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i) Y (j) Y	(a) – (j) Although involuntary resettlement is expected, the ARAP will be developed in parallel to the EIA with the cooperation of the GHA following JICA's environment and social consideration guideline.
	(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? (b) Is there a 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 a possibility that diseases, including infectious diseases, such as HIV will be brought due to the influx of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there a 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 a possibility that roads will impede the movement of inhabitants? (f) Is there a possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	(a) Y (b) Y (c) N (d) N (e) Y (f) N	(a) Since there is a possibility of traffic congestion during construction of the temporary bridge and single-lane road, traffic control signboards will be used to avoid traffic congestion during the construction activities. (b) No significant negative impact on the regional residents after the rehabilitation of the road is expected. (c) Mitigation measures in the form of training will be implemented to prevent the expected spread of infectious disease due to the influx of construction workers. (d) Although traffic congestion is expected at the diversion point, the counter measures described in "(a)" will be implemented and the volume of traffic accidents is expected to decrease after the project due to smooth traffic flow. (e) Since the project involves rehabilitation of the existing road, no impediment to residents movement is expected. (f) No sun shading or radio interference is expected since the project will not include the construction of any high object such as bridges associated with these impacts.
	(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 local archaeological, historical, cultural or religious heritage affected by the project has been confirmed through the EIA study.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) Y	(a) Replantation of street trees to restore the road landscape is planned when these trees need to be cut.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) – (b) -	(a) and (b) No ethnic minorities and indigenous people have been found through the EIA study.

Table A3 Environmental Checklist (4)

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(6) Working Conditions	(a) Is the project proponent 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 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 programme, 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 do not threaten the safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Supervision of construction contractors concerning labour laws will be implemented. (b) Supervision of construction contractors concerning appropriate safety measures will be implemented. (c) A safety management plan will be developed with supervision of construction contractors. (d) Safety measure for regional residents and project officers as well as the natural environment will be implemented with supervision of construction contractors.
5 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	(a) Supervision of construction contractors regarding all kinds of pollution will be implemented. (b) No adverse impacts on the natural environment are expected. (c) No significant negative impact on the social environment during the construction activities is expected.
	(2) Monitoring	(a) Will the proponent develop and implement a monitoring programme for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring programme? (c) Will the proponent establish an adequate monitoring framework (organisation, 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?	(a) Y (b) Y (c) Y (d) Y	(a) Monitoring of the conditions of air, water, noise, vibration, waste disposal and accidents will be conducted based on the ARAP. (b) The monitoring programme will be carried out based on the EMP. (c) Monitoring will be conducted based on EIA and ARAP covering the monitoring framework. (d) A monitoring report will be compiled regarding the EMP in the EIA report.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). (b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) – (b) -	(a) – (b) No items related to forestry project were found through the EIA study.
	Notes on Using Environmental Checklist	(a) If necessary, the impacts on transboundary or global issues should be confirmed. If necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) -	(a) No significant negative impact on transboundary or global issues is expected.

Note: 1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made. In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).

2) The environmental checklist provides general environmental items to be checked. It may be necessary to add or delete items taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Source: Study Team

Annex-4: Environmental Monitoring Form

(1) During Construction

The latest results of the below monitoring items shall be submitted to the lenders as part of Quarterly Progress Report throughout the construction phase.

(1) Planning Phase

Preparation of Resettlement Sites (where necessary)

No.	Explanation of the site (e.g. Area, no. of resettlement HH, etc.)	Status (Completed (date) / not complete)	Details (e.g. Site selection, identification of candidate sites, discussion with PAPs, development of site, etc.)	Expected Date of Completion
1				
2				

Public Consultation

No.	Date	Place	Contents of the consultation / main comments and answers

Resettlement Activities	Planned Total	Unit	Progress in Quantity			Progress in %		Expected Date of Completion	Responsible Organisation
			During the Quarter	Till the Last Quarter	Up to the Quarter	Till the Last Quarter	Up to the Quarter		
Preparation of RAP									
Employment of Consultants		Man-month							
Implementation of Census Survey (including Socioeconomic Survey)		-							
Approval of RAP		-							
Finalisation of PAPs List		No. of PAPs							
Progress of Compensation Payment		No. of HHs							
Lot 1		No. of HHs							
Lot 2		No. of HHs							
Lot 3		No. of HHs							
Lot 4		No. of HHs							
Progress of Land Acquisition (All Lots)		ha							
Lot 1		ha							
Lot 2		ha							
Lot 3		ha							
Lot 4		ha							
Progress of Asset Replacement (All Lots)		No. of HHs							
Lot 1		No. of HHs							
Lot 2		No. of HHs							
Lot 3		No. of HHs							
Lot 4		No. of HHs							
Progress of Relocation of People (All Lots)		No. of HHs							
Lot 1		No. of HHs							
Lot 2		No. of HHs							
Lot 3		No. of HHs							
Lot 4		No. of HHs							

(2) During Construction

The latest results of the below monitoring items shall be submitted to the lenders as part of Quarterly Progress Report throughout the construction phase.

Construction Phase

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
Number and contents of formal comments made by the public	
Number and contents of responses from Government agencies	

2. Pollution

- Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
SO_2	$\mu g/m^3$ (24h)					20		Biannual
NO_2	$\mu g/m^3$ (1h)					200		Biannual
PM_{10}	$\mu g/m^3$ (24h)					50		Biannual

- Water Quality

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
pH	-					6-9		Biannual
SS	mg/l					50		Biannual
Coliform bacteria	MPN /100ml					400		Biannual
Oil	mg/l					10		Biannual

- Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Noise Level Leq	dB A					55 (day)		Biannual

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventry record of using anti-vibration device	Details of survey results, such as findings		Monthly

- Waste

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventry record of waste disposal (volume, methodology)	Details of survey results, such as findings		Monthly

3. Social Environment

- HIV/AIDS and other STDs

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
HIV/AIDS and other STDs	Incidences per 1000 inhabitants		Biannual

4. Other

- Traffic Accidents

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventory record of traffic accident	Details of survey results. such as findings		Monthly

(3) During Operation

The latest results of the below monitoring items shall be submitted to the lenders on biannual basis for the first two years of operation.

Operation Phase

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period	Frequency
Number and contents of formal comments made by the public		Upon receipt of comments/complaints
Number and contents of responses from Government agencies		

2. Pollution

- Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
SO_2	mg/m^3					20		Annual
NO_2	mg/m^3					200		Annual
PM_{10}	mg/m^3					50		Annual

- Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Noise Level Leq.	dB (A)					55 (day)		Biannual

3. Other

- Traffic Accidents

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventory record of traffic accident	Details of survey results. such as findings		Monthly

Annex-5: Progress chart for the undertakings by the Ghanaian side

Undertakings	Year / Month	2015 3	6	9	12	2016 3	6	9	12	2017 3	6	9	12	2018	2019	2020
Project Implementation (Grant Aid Scheme)	Echange Note and Grant Agreement									▼	▼					
	Detailed design										═	═	═			
	Tender notice												▼			
	Contract with contractor													▼		
	Construction works													━	━	━
Securing budget	Approval of budget								▽				▽			
	Available timing for payment									▽				▽		
Land Acquisition & Compensation for Structures	Agreement with land owners						╌	╌	╌							
	Payment of compensation for lands anc structures									╌	╌	╌				
	Resettlement of traders along Assin Fosu township (by Assin North Municipal Assembly)	╌	╌	╌	╌											
Environmental and Social Cosiderations	Submission of EIA report to Environment Protection Agency (EPA)							▽								
	EPA issues environmental permit for project implementaiton								▽							
	Submission of Abbreviated Resettlement Action Plan to Land Valuation Board, EPA and Municipal/District Assembly						▽									
Relocation of Utilities	Discussion with utility companies to prepare contract								╌							
	Contract with utility companies for relocation									▽						
	Relocation of utilities										╌	╌				
Provision of Temporary Construciton Yard	Negotiation with land owners								╌							
	Contract for land rent									▽						
	Removal of existing structures from the yards										╌					
Provision of Borrow Pits and Quarries	Contract with borrow pits and quarry owners											▽				
Provision of Waste Disposal Area	Acquisition of approval of soil and consruciton waste disposal site owner											▽				
Paynent of bank commission	Open bank account and arrange Authorization to Pay									▼			▼			

Appendix 6 Technical Notes and Response for the Design Review Comments

Appendix 6-1 Technical Note for Discussions of Road and Bridge: November 2013

MINUTES ON PRESENTATION ON PREPARATORY SURVEY ON THE REHABILITATION OF NATIONAL ROAD NO.8 (PHASE 2) HELD ON 6TH NOVEMBER, 2013 AT GHANA HIGHWAY AUTHORITY, BOARDROOM, HEAD OFFICE-ACCRA

JICA STUDY TEAM

IN ATTENDANCE:

1	Michael A. Abbey	Ag. Chief Executive Officer	GHA
2	Joe – Fred Peseo	Ag. Dy. Chief Executive (Dev)	GHA
3	Addo Sitsofe David	Director of Planning	GHA
4	Oduro Amoakohene	Engineer GHA	GHA
5	Franklin T.-Nolly	Engineer	GHA
6	John Arthur-Amissah	Regional Maintenance Manager-C/Coast	GHA
7	Kingsley Osae-Boateng	Maintenance Manager	GHA
8	Owusu Sekyere-Antwi	Director of Bridges	GHA
9	Gordon A. Amartey	Highway Design Manager(S/Sector)	GHA
10	Rita Ohene Sarfoh	Chief Engineer	GHA
11	Faustina Oppong –Yeboah	Senior Engineer	GHA
12	Bernard Owusu	Senior Engineer	GHA
13	Abraham Steele-Dadzie	Assistant Engineer	GHA
14	Ruth Mensah	Senior Technician Engineer	GHA
15	Paul Y.A.P. Duah	Highway Design Manager(N/Sector)	GHA
16	Hakira Nishimura	Chief Consultant	JICA
17	Shigeru Ando	Road & Pavement	JICA
18	Hajime Usukura	Assistant Resident Representative	JICA
19	Shinichi Veda	Bridge Designer	JICA
20	Jiro Nishitanaka	Cost Estimation	JICA

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1.0 Commencement

The meeting began at 11:20am and was chaired by the Chief Executive Officer (Ag.) of Ghana Highway Authority (GHA), Michael Abbey (Mr.).

2.0 Opening

The Chief Executive of GHA, welcomed members to the meeting. He acknowledged the presence of the JICA study team.

Persons present included representatives of:

- Ghana Highway Authority
- JICA study team

He subsequently invited the leader of the JICA study team to do a presentation on their study.

3.0 Issues

The presentation which centered on the Design Standards and Specifications on the road project. The team was of the view that both GHA and JICA should reach a consensus on the design standards and specification. The details of the team's presentation are outlined below:

3.1 Road Design Conditions and Specifications

- The design speed JICA chose was 80km/h. they were going to use the same specifications as used for the Phase 1.the shoulder had a width of 2m or 2.5m.
- The standard road surface slope was 2.5% for carriageway and 3.0% for the shoulder.
- The right-of- way was 60m for existing N8.

3.2 Bridge Design Conditions and Applied Design Standard

For the live loads the study team is using the Japan's specification of highway bridges and BD37/01 of BS.JICA chose a return period of 50 years for medium span bridge and 15 years of culverts.

3.3 Toll Plaza

Outlined below are the issues raised by the team about the Toll Plaza:

- No official request was made to JICA to install toll plaza at Assin Praso to alter existing toll collection plaza on the carriageway
- It is necessary to agree between JICA and GHA for installation of toll plaza in the Phase 2 section and coverage by the Phase 2.
- It is also necessary to determine exact location, number of booths and type of pavement.

4.0 Comments, Questions and Answers

Mr. Paul Duah emphatically told the study team that the shoulder and the road surface slope should be 2.5m since the phase 1 brought problems when they used the 2.5m. Also right of way was also changed from 60m to 90m by following the design guide but Mrs Rita Ohene-Sarfoh , told the team that the wording should have been Construction Width instead of Right- of- Way if they want to maintain the width.

Mrs Rita Ohene-Sarfoh, proposed that all the culverts should have head walls and the drains within settlement should be U or J drain. The Chairman also added that speed tables should be added to the traffic calming measures.

After several deliberations the staggered form of Tool Plaza was adopted. In all one will be at central region and the other will be at Ashanti region. Road fund will be funding the later.

Mr.Owusu made a correction on the return period from 15 years to 25years for culvert and 5years for side drains.

The Chairman proposed to the study team to consider a dual carriage at Assin Fosu township and this was endorse by all members present.

JICA responded that they will consider it if GHA will secure the land but first they will do their studies.

JICA proposed and showed a giant sign post to be erected at the bridge side .They will put the Ghana and Japan flag on the sign post. Mr. Amartey added that they should add the millage to it.

JICA told all in attendance that GHA will bear the cost of the Environmental Impact Assessment. The Chairman requested for the additional cost.

Mrs. Rita Ohene-Sarfoh, GHA emphasized that the study team should be able to accept at most two counterpart Staff from GHA for purpose of technology transfer.

6.0 Conclusion from the Meeting

The meeting agreed on the following:

- A design speed of 100km/h should be used, however, 80km/h can be used for rolling terrains.
- Intermittently slabbed side drains should be used in towns.
- Culverts should have head walls.
- A return period of twenty five (25) should be used for the culvert design.
- The shoulder width should be 2.5m for the whole road section.
- A separator should be used if a dual carriageway is adopted.
- JICA should stick to their proposed bridge standards.
- A staggered Toll Booth was adopted; one at Central region and the other at Ashanti region. The latter will be sponsored by the Road Fund.

- Draft EIA, RAP, Draft Final Report and Safety Audit will be submitted by the team in March, 2014. However, GHA will bear the cost for the Safety Audit.
- That a sign post bearing Japan and Ghana flags with the mileage should be erected at the bridge location.
- At least two Engineers should be attached to the JICA project for practical exposure.

5.0 Closing

Without further questions, the meeting was moved for closure. The Chairman thanked everybody for their presence.

The meeting closed at 12.25am

MICHAEL A. ABBEY
AG. CHIEF EXECUTIVE
GHANA HIGHWAY AUTHORITY
CHAIRMAM

HAKIRA NISHIMUHA
JICA STUDY TEAM
CHIEF CONSULTANT

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Appendix 6-2 Technical Note for Discussions of Railway Underpass Bridge: November 2013

MINUTES ON PRESENTATION ON PREPARATORY SURVEY ON THE REHABILITATION OF NATIONAL ROAD NO.8 (PHASE 2) HELD ON 6TH NOVEMBER, 2013 AT GHANA HIGHWAY AUTHORITY, BOARDROOM, HEAD OFFICE-ACCRA

JICA STUDY TEAM

IN ATTENDANCE:

1	Michael A. Abbey	Ag. Chief Executive Officer	GHA
2	Joe – Fred Pesco	Ag. Dy. Chief Executive (Dev)	GHA
3	Addo Sitsofe David	Director of Planning	GHA
4	Oduro Amoakohene	Engineer GHA	GHA
5	Franklin T.-Nolly	Engineer	GHA
6	John Arthur-Amissah	Regional Maintenance Manager-C/Coast	GHA
7	Kingsley Osae-Boateng	Maintenance Manager	GHA
8	Owusu Sekyere-Antwi	Director of Bridges	GHA
9	Gordon A. Amartey	Highway Design Manager(S/Sector)	GHA
10	Rita Ohene Sarfoh	Chief Engineer	GHA
11	Faustina Oppong –Yeboah	Senior Engineer	GHA
12	Bernard Owusu	Senior Engineer	GHA
13	Abraham Steele-Dadzie	Assistant Engineer	GHA
14	Ruth Mensah	Senior Technician Engineer	GHA
15	Paul Y.A.P. Duah	Highway Design Manager(N/Sector)	GHA
16	Hakira Nishimura	Chief Consultant	JICA
17	Shigeru Ando	Road & Pavement	JICA
18	Hajime Usukura	Assistant Resident Representative	JICA
19	Shinichi Veda	Bridge Designer	JICA
20	Jiro Nishitanaka	Cost Estimation	JICA

1.0 Commencement

The meeting began at 10:08am and was chaired by the Ag. Chief Executive of Ghana Highway Authority (GHA), Michael Abbey (Mr.).

2.0 Opening

The Chief Executive of GHA, welcomed members to the meeting. He acknowledged the presence of the JICA study team and the Chief Executive officer of Ghana Railway Development Authority (GRDA), Mr. A.A Sadique.

Persons present included representatives of:

- Ghana Highway Authority
- Ghana Railway Development Authority
- JICA study team
- Ministry of Transport

He subsequently invited the leader of the JICA study team to do a presentation on their study.

3.0 Issues

The presentation which lasted nine (9) minutes centered on the Reconstruction of Overpass on the Railway at Assin Fosu. The team was of the view that a culvert that will house new single rail track was the best option now but this was strongly opposed by members from GHA and GRDA. The details of the team's presentation are outlined below:

3.1 Traffic Congestion and Safety Challenges at Assin Fosu

- The existing Road Carriageway over the Railway Bridge at Assin Fosu has a total width of 6.5m which is narrow. It causes a bottleneck and poses critical safety issues as it has no pedestrian sidewalk.
- The road at Assin Fosu is characterized by serious vehicular and pedestrian traffic congestion especially on market days (Tuesdays and Fridays).
- The roadside stalls, stopping and turning vehicles and the commercial activities along the road impede traffic flow.

3.2 Determination of Road section for JICA's Project

The Study Team had proposed the road section from Assin Praso (from end of Phase 1 project) to Assin Fosu (at the police barrier, 1.2km south from Assin Fosu Railway Bridge) for outline design.

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3.3 Reconstruction Planning of Railway Bridge at Assin Fosu

Outlined below are the issues raised by team about the bridge:

- The existing railway underpass is 6.5m (width) x 14.2m (length).
- It is narrow and one of bottlenecks for both vehicular and pedestrian traffic.
- MOT and GRDA have plans to develop all rail lines including the Central Line from single track to double tracks but has no funds to start any time soon.
- GRDA has reserved their right-of-way for the future development of railway.

3.4 Proposal for Reconstruction of Railway Overpass

The team proposes a single track box culvert for the railway due to the following reasons:

- Double tracking of the Central Railway line which crosses the road at Assin Fosu is uncertain.
- Construction of structure for double track would require resettlement of some permanent structures for the construction of retaining wall.
- The team intends to produce an economical output/design for the Grant Aide/Scheme.
- An additional cell can be added in future if the need arises.

4.0 Comments, Questions and Answers

Mr. A.A Sadique, firmly and precisely stated that construction of a single track railway line contradicts to the Authority's policy of changing all single track lines to double railway lines.

He further stated that the right-of-way (30m on both sides of rail centre line) for the development of the railway has been preserved; hence compensation should not be a problem.

He proposed that at worst a design for two cell box culverts should be prepared to cater for the alignment and loop lines in the future development of the railway. The cell can be constructed by JICA and the other later by GRDA.

The JICA team however was of the opposing view stating that it is not justifiable to construct a culvert for two tracks now as the second is not needed now.

Mr. Addo Sitsofe David, Director of Planning, GHA proposed co-financing between JICA and Ghana Government in constructing the project. Mr. M. A. Abbey clarified that co-financing is not possible with JICA sponsored projects. ``

Mr. Joe-Fred Peseo, Dy CEO, GHA, asked Mr. A.A Sadique if GRDA has a development plan to cater for the expansion. Mr Sadique answered yes but stated they are financially crippled to stick to their planned activities.

Mrs. Rita Ohene-Sarfoh, GHA emphasized that the provision of the double cell culvert to house two tracks is the best. According to her, the social impact problems can be mitigated.

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There was then a call from Mr. Sitsofe on the Study Team to financially justify why double cell culvert is not feasible. This was endorsed by entire members from the other side.

Mrs. Rita Ohene-Sarfoh also called on the Study Team to provide all the possible design options vis-a-vis their cost to enable the stake holders make a better decision.

Mr. Gordon Amartey, Southern Sector Design Manager, GHA, was of the view that it is retrogressive to replace a bridge with a single cell box culvert and therefore called on JICA to rescind their decision.

Mr. M. A. Abbey called on the team to provide estimate for the two options presented to aid in final decision making. He endorsed the construction of the double cell culvert but suggested that the non-functional one be buried.

JICA insisted that they don't give grant from their tax payer's money to solve future problems but current critical issues. GHA and GRDA were not happy with the comment. They were of the view that JICA should provide satisfactory service and not to create future problems such as cutting the road in the near future for further expansion works. They unanimously called on JICA to reconsider their decision to favour the recipient, Ghana.

GHA and GRDA finally succumbed to JICA's proposition to construct a single cell box culvert to house a single railway.

5.0 Conclusion from the Meeting

The members agreed on the following:

- that the rail underpass should be a single cell. However, GHA appealed to JICA to consider the double cell to cater for future developments.
- that a dual carriageway be consider for Assin Fosu township to solve the traffic problem.

6.0 Closing

The Chairman called for introduction of members present at the meeting which was duly done. Without further questions, the meeting was moved for closure. The Chairman thanked everybody for their presence.

The meeting closed at 11.11am.

MICHAEL A. ABBEY
AG. CHIEF EXECUTIVE
CHAIRMAN
GHANA HIGHWAY AUTHORITY

HAKIRA NISHIMURA
JICA STUDY TEAM
CHIEF CONSULTANT

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Appendix 6-3 Response for the Design Review Comments

JICA Study Team for Preparatory Study
on Rehabilitation of National Trunk Road No. 8 (Phase 2)
Central Consultant Inc. and Eight-Japan Engineering Consultant Inc.

26th June, 2014
Ref. No. N8P2-23

Mr. M. A. Abbey
Chief Executive
Ghana Highway Authority

Re: Final Response for the Design Review Comments

Dear Sir,

Thank you very much for your cooperation for the execution of the Study. Also, we appreciate for your letter dated 25th June, 2014.

Regarding the design review comments, we have review out design as well as discussions with engineers of the GHA as well as JICA HDQ, we have concluded the our response for your comments, as attached.

We appreciate your understanding for the Study Team.

Yours faithfully
JICA Study Team

Hikaru NISHIMURA
Chief Consultant

cc: Deputy Chief Executive (Development)
Director of Road Safety and Environment
Director of Planning
Director of Survey and Design
Director of Bridges
Manager of EMU

Response for the Design Review and Road Safety Audit by the Study Team

Design Review

	Comment by the GHA	Response by the Study Team
A. General	1. Chainage format should in thousands and not hundreds	We will follow the instruction
	2. The cover page should mention the project length and specific location of project (Assin Fosu – Assin Praso N8 Km 67.01 to Km 98.21)	We will follow the instruction
	3. A legend explain all abbreviations used should be provided	We will follow the instruction
B. Geometric Design		
I. Plan	1. The consultant should provide alternative alignment which by-passes Assin Fosu town as agreed with management at one of the pre-commencement meetings.	The Study covers only rehabilitation of existing N8, not bypass. There was no such agreement.
	2. The consultant should provide comparative amalyses of the alternative alignment based on factors such as cost, environmental/social impact and safety as was done for the Asutsuare Junction – Asikuma Junction road project.	The Study cover only rehabilitation of existing N8, not like Eastern Corridor F/S
	3. We note that radii below the desirable minimum have been used at chainages 2+500, 14+750, 17+250, 29+650 and 30+350. Please explain why radii above the desirable minimum cannot be used at these sections.	We follow the existing horizontal alignment and adopted design speed of 80 km/h on rolling terrain, as agreed between GHA and us on 8th November, 2013.
	4. North arrow and labelled grid lines should be shown on plan.	We will follow the instruction
	5. Junction destination names should be shown on plan.	We will follow the instruction
	6. Plan scale should be 1:2500.	A3 size: 1/5000, A1 size: 1:2500
II. Profile	1. Vertical alignment details falling below the minimum requirement for a design speed of 100 kph are shown in table 1 attached. All affected section should be revised accordingly.	The Study Team and the GHA agreed on 6th November “A design speed of 100 km/h should be used, however, 80 km/h can be used for the rolling terrains. Hence, a design speed of 80 km/h was used for those terrain sections.
	2. Vertical curve between chainages 24+400 – 24+950 should be raised to an average height of 0.6 m to minimize the effect of capillary action.	We will follow the instruction
	3. The Consultant should check the possibility of reducing the levels of the finished profile between chainages 1+100 – 1+350 in Assin Fosu town. The high fill will deface the adjoining properties and consequently reduce their commercial/economic value.	We will follow the instruction

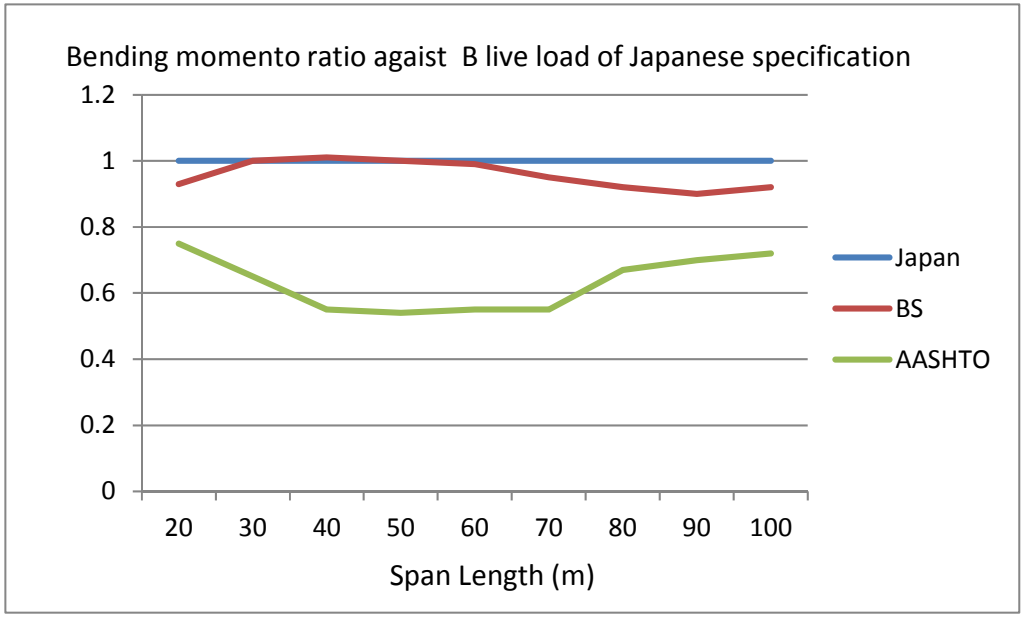
III. Typical Cross Sections	1. Typical cross section of areas with guardrails should be provided	We will follow the instruction
	2. Side slopes should be 1:3 for embankment less than 1 m, 1:2 (with guardrails) for embankment ranging 1 m – 3 m and 1:1.5 (with guardrails) for embankment greater than 3 m.	In order to minimize effects for houses along the road and stabilized slope point of view, we adopted 1:2.0 (slope of existing road is 1:1.5)
	3. All embankment should be protected with stone pitching (in towns) and grassing (out of town)	We have planned to grassing outside of towns and either stone pitching or installation of retaining wall to avoid effects for permanent structures in towns.
	4. Shoulder width in Assin Fosu should be 2.5 m,	GHA and the Study Team agreed to have the minimum value of 2.0 m in Assin Fosu to minimize the effects for the roadside permanent structures.
	5. A shoulder width of 2.5 m should be provided on the right hand side of typical cross section (6).	We will follow the instruction
IV. Intersection	1. All exit lanes at the Assin Fosu roundabouts should be two lanes for about 70 m before tapering over a length of about 50 m into a single lane.	We will follow the instruction
	2. Specific details should be provided for major intersection at chainages 0+723, 1+300, 8+670, 11+628, 17+650 and 29+200.	We will follow the instruction
	3. All access roads should be properly adjoined to the main road (pave and lined). The length of the access road to be improved as part of this project should be determined by site condition but not less than10 m.	We will follow the instruction
	4: Two roundabouts at Assin Fosu The proposed locations of the two roundabouts were analyzed. The following are the merits and demerits: Merit: 1) Better organized traffic flow as compared to the existing situation, 2) Reduction in traffic congestion. Demerits: 1) Provision for pedestrian crossing is inadequate, 2) Conflict at intersection of lorry station/market due to direct access. i. Functionality of these roundabouts is dependent on peripheral roads which are in poor condition and none was selected for improvement under this project, ii. Circulatory lane width of 3.25 m is inadequate and should be increased 4 m to cater for trucks. iii. The length of 300 m between the roundabouts could create grid lock due to high traffic volume. It is therefore inadequate.	We will follow the instruction
	Recommendations The roundabout should be relocated from the proposed position of km 1+235 and 1+5554 to km 0+700 and 1+900 respectively. The dual carriageway should extend about 100 m beyond the roundabouts and tapered over a length of 50	We have changed location of roundabouts as your recommendations.

	m into a single lane. This will ensure a better organized traffic flow and reduce congestion.	
	Consider a grade separated pedestrian crossing. An underpass could be less expensive than overpass.	Since there are frequent inundation during rainy season in Assin Fosu, pedestrian under pass is not desirable. We have carry out a pedestrian bridge in front of the market. JICA has big concern about separation of communities by 4 lane divided road (1.2 km) and recommend us to provide some at-grade pedestrian crossings from social impact point of view
	To reduce conflict at Station/Market access points and others, provide access point on minor peripheral roads.	It is out of scope of the Study
	Peripheral Road: Key peripheral roads should be identified for improvement under this project. E.g. the link between the two proposed roundabout and the Twifo-Praso road.	We will identify important peripheral road, but preparation of improvement plan is out of scope of the Study.
	Circulatory lane widths of roundabout should be increased to 4 m to cater for truck swept paths.	We will follow the instruction
V. BUS BAY	Bus bays should be located in the centre of the towns where they will be properly utilized and also staggered so that vehicles leaving the bay will not face each other as shown below.	We will follow the instruction
	The length of the parallel section of the bus bays should be based on parking studies by not fixed.	We will study more in detailed design, if it is necessary.
	Separators should be provided for all bus bays with the parallel width consequently increased to a minimum of 5.5 n as shown below (GHA Road Design Guide 1991)	To refer other projects and consider the speed limit of towns (50 km/h), we designed as 3.5 m of bus bay without separator, according to the Road Design Guide.
	A distance of 500 m between two consecutive bus bays is recommended in Assin Fosu township. However, the exact positions should be determined by the parking studies.	We will study more in detailed design, if it is necessary.
C. DRAINAGE		We will study more in detailed design, if it is necessary.
I. Hydrological and Hydraulic analysis	Topographical maps with catchment are demarcations should be provided.	As the river bed gradient and river cross section at upper and lower stream are almost similar, we calculated water discharge capacity using Manning Formula.
	Inlet control method should be used to calculate the capacity of the existing pipe and box culverts.	We will follow the instruction
	Inventory of existing culverts should be provided.	We have prepared the inventory results in the Draft Report

	Culvert schedule should include existing ones. (It is not clear whether they are being maintained or demolished). Table 2 provides a schedule of recommended culvert sizes and additional culvert locations.	We will follow the instruction
	Side ditch type sizes should be specified.	We will include in the detailed design
	Side drains should be provided for all towns. Table 3 provides a schedule of recommended start and end chainages of side drains as well as new provision in the towns.	We will follow the instruction
II. Drainage Structure	Drawing no. 32: Provide bending schedule for the U type side ditch.	We will include in the detailed design
	Pipe culvert on drawing no. 33: The drawing should explain whether the surround concrete for the pipe culvert is half way or total surround.	We will follow the instruction
	Drawing no. 40: The bending schedule for the Guard fence should be provided.	We will follow the instruction
	Headwalls, apron and wing walls: The height of the headwalls should be determined for each culvert at specific locations and it should not be a fixed height as indicated on drawing nos 35 – 38. Provide nominal reinforcement for apron, wind walls headwalls.	We will include in the detailed design. Nominal reinforcement will be prepared in this stage.
III. Access Pipe Culverts	Drawing no. 39 All access culverts should be provided with a headwall. The minimum length of access culverts should be 8000 mm. Provide bending schedule for the reinforcement for the access pipe culvert.	We will follow the instruction Bending schedule for the reinforcement will be provided in this stage
D. Structure		
I. Assin Fosu Railway Underpass	i. General plan and cross section provided for the culvert was not readable.	We have changed colour of drawing to be readable.
	ii. Provide a typical cross section showing the dimensions for the width of the carriageway, footpath and concrete parapet on the culvet.	We will follow the instruction
	iii. Provide dimensions of the support (corbel) for the approach slab (see cross section B-B on drawing no. 31)	We will follow the instruction
	iv. Identify the material placed at the bottom slab to support the railway sleepers (see cross section B-B on drawing no. 31)	We will follow the instruction
	v. What material are the sleepers for supporting the railway track made of?	We consider PC sleeper
	vi. We recommend that railway underpass should be designed according to the latest version of BS5400 and BD37/01 (and not Load T – Japanese standards), else the Consultant should show the relationship between the Japanese Standards – Load T and that of BS5400 and BD37/01.	Please refer the end of this paper.
	vii. It is our understanding that the detail structural design for the box culvert is yet to be submitted to us.	We will include in the detailed design
	viii. The strength of concrete to be used for all box culverts should be a least 30 N/mm2 and the strength of reinforced steel shold be at least 460 N/mm2 or its equivalent.	We will follow the instruction
II. Box Culvert	Detailed design for the box culvert on chainages 80+93, 161+98 and 288+61 should be submitted for our review.	We will provide then soon

III. Proposed Bridge over River Lkye at Assin Andoe	i. Computation for hydrological and hydraulic analysis use in determining the maximum flow depth of 3,50 m as well as the hydraulic capacity of the bridge should be submitted.	We will include hydrological computation in the Draft Report.
	ii. The Consultant should provide the geotechnical investigation report use in determining the location of the spread footing.	We will include geotechnical conditions in the Draft Report.
	iii. Approach slab should be shown on the general arrangement drawing	We will follow the instruction
	We recommend that railway underpass should be designed according to the latest version of BS5400 and BD37/01 (and not Load B – Japanese standards), else the Consultant should show the relationship between the Japanese Standards – Load T and that of BS5400 and BD37/01.	Please refer the end of this paper.

A comparison of the design bending moment caused by a live load indicates that the bending moment ratio by live load defined in the Specification for Highway Bridges in Japan (Japan Road Association) exceeds that defined in BS5400 for each span length of up to 100 m



Road Safety Audit

	Comment by the GHA	Response by the Study Team
Vertical Curves	Recommendations • The major control for safe operation on crest curve is the provision of sufficient sight distances for the design speed. Minimum stopping sight distances should be provided for all the vertical curves. Consideration should therefore be given to the provision of minimum lengths of crest curves slated for the project roadway. • Sag vertical curves should be designed according to comfort criteria. • Profiles with successive short vertical curves, particularly between Chainages 18+000 and 19+00, should be avoided.	We will follow the instruction base on the design speed in accordance with topographical conditions (rolling terrain).
Lay By	Recommendations • Consideration should be given to the rearrangement of all lay by that are sited in the opposite direction. Staggering of the lay bys in the "Left-Right" orientation and separated by a buffer of at least 50 meters has the highest safety benefit. • All lay bys should be located beyond intersections to enhance visibility splays of approaching drivers on minor roads • Lay bys should be located beyond pedestrian crossings to avoid stopped vehicles masking pedestrian • As much as possible lay bys should be located in straight sections. • Parking studies should be undertaking in all communities to determine the dimensions of lay bys required to handle the present and future traffic.	We will follow the instruction
Roundabouts	Recommendations • For safety purpose, the number of lanes on the exit of the secondary roads should be the same as the number of lanes on the circulatory road. Consideration should be given to the provision of an auxiliary lane (at least 100m - inclusive of the parallel and taper lengths) along the exit lane to accommodate two vehicles. A transition section with two lanes has higher safety benefit in addition to the pavement markings. Traffic Congestion is also reduced with the application of this arrangement.	We will follow the instruction
Uncontrolled Parking on Roadway at Assin Fosu	Recommendations • With the dualization of a section of the roadway in the Central Business District and lack of parking facilities for the proposed scheme, it is most likely that more commercial vehicles will park on the outer lanes of the dual carriageway after the project implementation. Although regulatory traffic signs can be employed, the violation of such traffic offences in recent years and the general driver attitude will warrant the need to provide dedicated parking facilities to accommodate the high parking demand in the vicinity. Consideration should therefore be giving to a comprehensive parking study to generate parking facilities acceptable for use by all drivers in the community and beyond.	Assin North Municipal Assembly is undertaking to construct a new lorry station after relocation of the local markets along the national highway in the central area of Assin Fosu. This can be considerably contributed to systematic traffic parking and flows at Assin Fosu.
Uncontrolled Pedestrian crossing at	Recommendations • Consideration should be given to the provision of additional metallic fencing on the New Jersey Barrier (similar to the one provided on the N1) to prevent pedestrian from climbing the concrete median.	We will follow the instruction

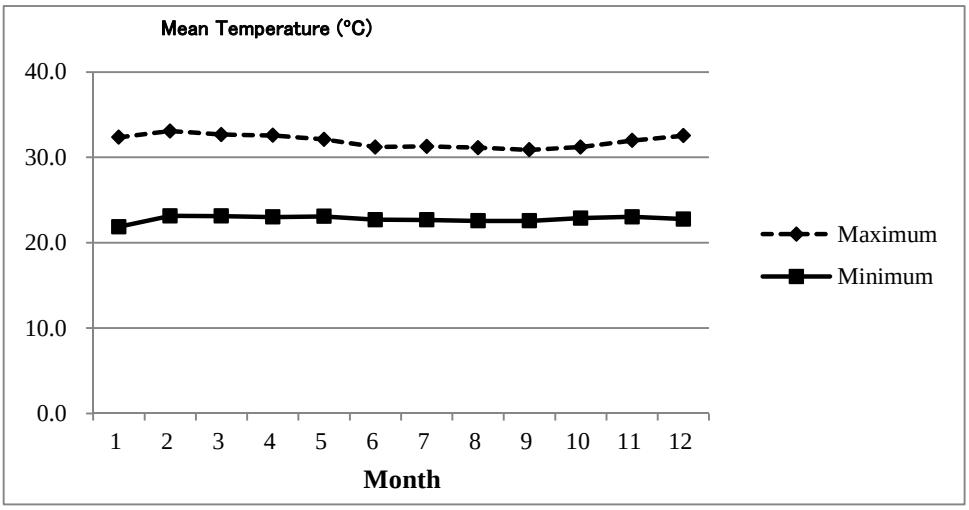
Assin Fosu	• Provision of street lighting should be considered to increase driver perception of pedestrians and other road users. This arrangement will enhance driver and pedestrian response time to appropriate evasion situation.	
Climbing Lane	Recommendations • The provision of climbing lane (roadway between Chainage 15+140 and 15+900) may be particularly beneficial.	Existing vertical gradient is 3.0% and its length is 768 m. According to the design criteria for design speed 80 km/h (rolling terrain), this section is not required for any climbing lane.

Appendix-7 Results of Natural Condition Surveys

Appendix 7-1 Results of Meteorological Condition Surveys

(1) Temperature

The monthly average temperature at the Assin Fosu meteorological observatory of the Ghana Meteorological Agency (GMA) between 2003 and 2012 was lowest in January (21.9ºC) and the maximum temperature was highest in February (33.1ºC). As a whole, the differences in temperature between each month are limited and steady.



Source: GMA

Figure A1 Maximum and Minimum Temperature (Average of 2003 – 2012)

(2) Precipitation

a) Monthly precipitation

Monthly precipitation at the Assin Fosu and Twifo Praso meteorological observatories of the GMA between 2003 and 2013 are shown in Tables A7 and A8.

Table A7 Monthly Precipitation at Assin Fosu Meteorological Observatory

(Unit: mm)

Assin Fosu	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
2003	52.0	86.7	145.5	237.7	276.3	133.0	70.3	69.8	54.3	372.8	162.4	59.1	1,719.9
2004	44.1	98.7	185.6	132.2	111.9	80.6	170.2	113.5	390.1	188.7	61.2	57.9	1,634.7
2005	1.8	82.7	211.3	218.0	99.2	261.3	16.1	30.3	78.6	271.7	95.8	79.9	1,446.7
2006	58.7	83.5	139.8	277.5	271.7	210.8	73.6	54.8	201.3	339.7	69.4	37.3	1,818.1
2007	62.4	54.0	147.1	238.0	267.6	337.5	191.3	60.8	173.1	405.5	116.6	39.4	2,093.3
2008	0.0	69.8	151.4	81.6	n.a.	n.a.	82.6	107.6	169.5	94.7	40.4	106.5	n.a.
2009	0.0	171.0	121.6	112.5	146.9	452.8	144.4	43.2	43.9	106.4	109.2	5.4	1,457.3
2010	61.0	81.6	275.7	191.1	181.3	292.9	67.1	132.9	213.3	192.3	129.2	17.4	1,835.8
2011	33.1	164.2	136.3	140.3	126.6	174.0	121.3	77.3	243.9	190.8	86.6	15.5	1,509.9
2012	4.3	33.6	55.8	134.4	226.2	326.6	215.9	26.9	126.2	218.2	155.6	90.6	1,614.3
Average	31.7	92.6	157.0	176.3	197.5	252.2	115.3	71.7	169.4	238.1	102.6	50.9	1,610.4

Source: GMA

Table A8 Monthly Precipitation at Twifo Praso Meteorological Observatory

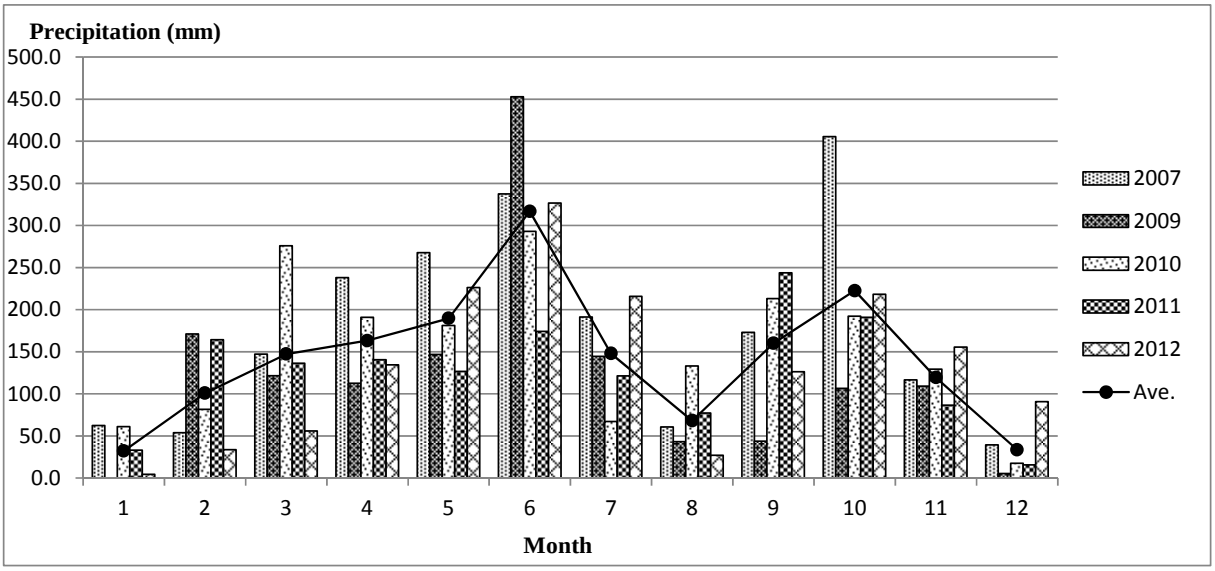
(Unit: mm)

Twifo Praso	Month												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
2003	51.4	53.2	66.4	198.7	222.5	227.6	97.7	70.0	90.3	89.7	110.9	10.4	1,288.8
2004	91.4	53.2	135.0	n.a.	138.5	122.0	137.9	81.4	292.1	177.7	82.2	89.3	n.a.
2005	11.1	70.1	228.8	218.4	192.9	154.7	65.0	28.5	75.8	317.5	125.0	46.6	1,534.4
2006	56.8	71.0	137.8	103.0	190.0	214.8	62.4	58.2	177.3	175.6	60.2	14.1	1,321.2
2007	0.0	45.1	170.2	157.3	218.4	287.0	174.9	63.0	186.7	251.9	177.4	42.5	1,774.4
2008	15.1	65.4	178.0	115.7	419.7	265.1	259.3	109.1	95.5	89.4	50.0	98.3	1,760.6
2009	1.6	96.2	83.7	115.7	152.3	232.9	114.6	32.1	43.7	117.3	167.6	73.8	1,231.5
2010	55.9	135.1	123.4	143.1	160.3	131.2	51.6	197.2	139.0	149.6	142.1	100.8	1,529.3
2011	48.3	114.2	132.5	187.3	189.8	226.6	66.1	60.7	200.1	165.3	69.2	18.1	1,478.2
2012	4.7	75.3	131.3	45.3	176.8	353.2	155.7	21.0	103.2	191.1	89.9	98.5	1,446.0
Average	33.6	77.9	138.7	142.7	206.1	221.5	118.5	72.1	140.4	172.5	107.5	59.2	1,476.5

Source: GMA

The average yearly precipitation at Assin Fosu varied between 1,446.7 mm in 2005 and 2,093.3 mm in 2007. The average yearly precipitation at Twifo Praso varied between 1,231.5 mm in 2007 and 1,774.4 mm in 2007.

As shown in Figure A2, the rainy season in the project area starts in March and ends in July, and starts again in September and ends in November; rainfall is very limited in January, and no rainfall was recorded in some years.



Note: Data of 2008 is not used because data for two months are missing.
Source: GMA

Figure A2 Monthly Fluctuation of Precipitation between 2007 and 2012 at Assin Fosu

b) Maximum daily precipitation

Tables A9 and A10 show the maximum daily precipitation between 2003 and 2012 at the Assin Fosu and Twifo Praso meteorological observatories. The maximum daily precipitation exceeded 80.0 mm on 12 days at Assin Fosu and 7 days at Twifo Praso in the last 10 years and the highest daily precipitation of 151.2 mm was recorded in June 2012 at Twifo Praso.

Table A9 Maximum Daily Precipitation for Last 10 Years (Assin Fosu)

(Unit: mm)

Assin Fosu	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
2003	37.4	35.3	31.8	85.6	55.0	42.4	34.3	25.3	17.2	99.0	32.2	19.5
2004	26.2	30.1	34.4	67.7	55.5	37.8	111.5	59.5	48.7	59.8	32.4	28.9
2005	1.8	30.2	59.5	50.1	36.3	98.2	9.8	12.7	40.8	81.6	20.6	62.0
2006	50.4	30.4	26.2	45.6	48.4	62.5	26.3	28.4	49.8	87.8	24.8	37.3
2007	54.6	44.9	67.4	80.7	126.1	48.6	80.6	21.6	46.9	92.5	28.1	38.0
2008	0.0	33.1	37.2	36.6	n.a.	n.a.	33.4	39.8	37.8	32.7	20.0	24.7
2009	0.0	35.3	57.3	32.8	66.9	96.4	25.8	10.3	20.9	23.2	42.6	3.6
2010	20.7	29.7	59.2	58.2	42.4	55.7	29.3	50.6	49.1	42.2	39.5	7.0
2011	17.5	54.4	54.8	36.0	32.5	56.0	50.0	30.2	88.5	73.0	17.4	15.5
2012	4.3	13.8	21.6	48.2	67.4	68.7	55.5	13.4	39.0	37.2	44.9	29.6

Source: GMA

Table A10 Maximum Daily Precipitation for Last 10 Years (Twifo Praso)

(Unit: mm)

Twifo Praso	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
2003	34.6	15.9	21.4	42.0	35.1	82.3	56.7	40.6	36.8	41.0	24.2	6.4
2004	81.7	37.3	37.4	n.a.	30.2	47.3	53.7	19.8	56.4	33.0	14.9	39.5
2005	11.0	28.1	90.2	36.5	54.8	38.6	50.2	11.3	31.3	49.9	20.5	27.0
2006	24.0	31.2	37.2	25.7	45.3	49.5	22.1	18.7	41.2	38.6	21.1	13.9
2007	0.0	22.1	52.1	37.3	32.3	75.5	69.1	14.7	39.0	25.0	42.6	16.9
2008	15.1	26.3	56.7	49.2	97.3	50.3	116.2	40.4	14.5	19.9	21.0	40.5
2009	1.6	66.0	22.9	49.2	95.1	68.8	29.9	6.9	10.9	25.1	36.5	36.3
2010	27.6	39.3	28.8	43.2	46.3	43.5	21.0	71.1	50.2	31.1	34.7	34.4
2011	19.6	70.8	24.3	70.4	81.9	60.0	29.6	20.9	56.0	32.7	34.1	10.1
2012	4.7	47.7	31.2	15.9	30.1	151.2	41.3	9.7	21.0	42.9	38.3	47.2

Source: GMA

(3) Wind Direction and Velocity

According to the data of the GMA, the prevailing winds are from the west during the rainy season at Assin Fosu, and tend to come from the north during the dry season. The maximum wind speed between 2003 and 2010 was 6 knots (about 3.1 m/s).

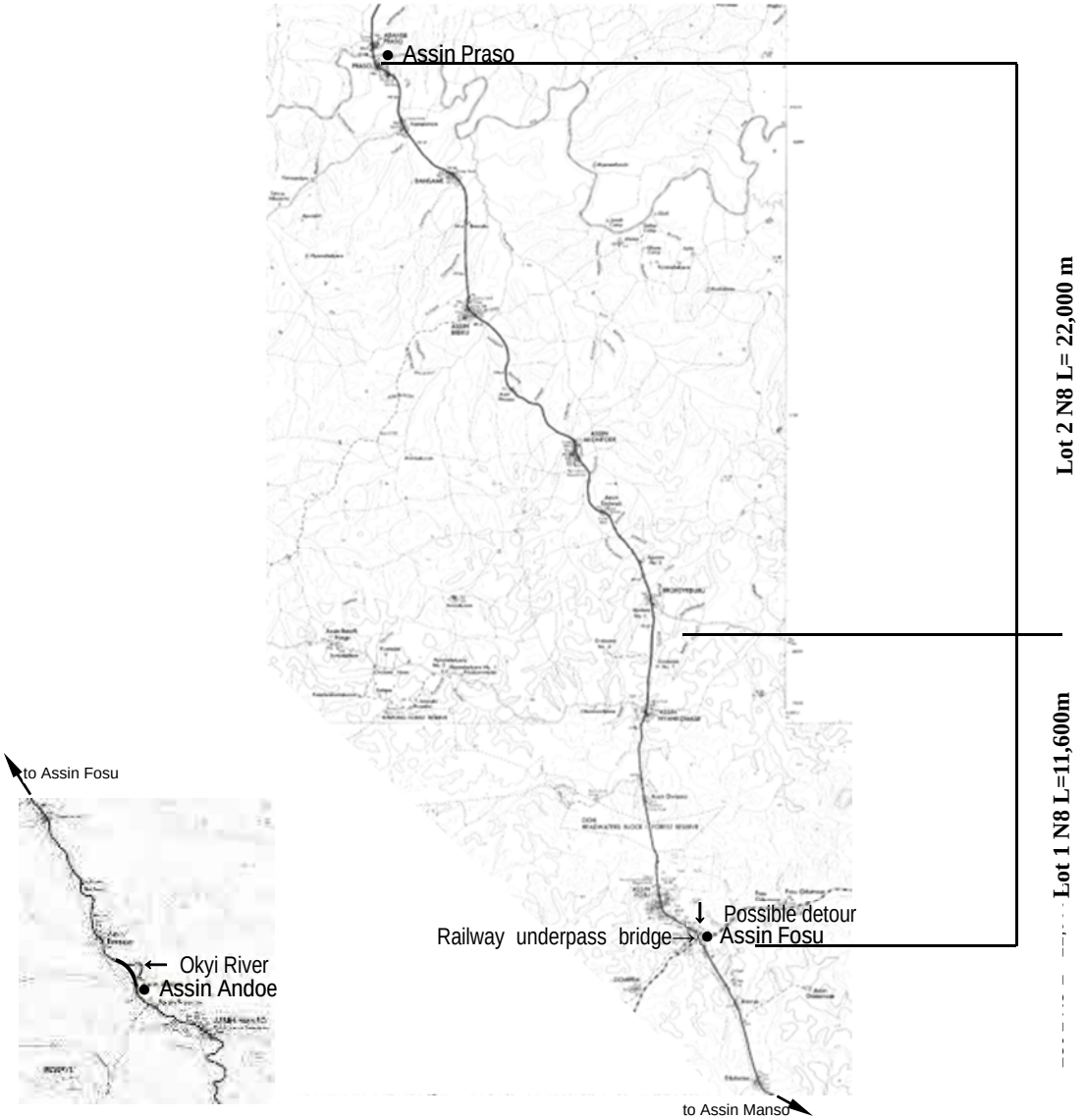
Appendix 7-2 Scope of Topographical Surveys

The Study Team conducted topographical surveys along the N8 and a possible detour at Assin Fosu (scale of 1/1000), and detailed topographical surveys around the existing railway underpass bridge at Assin Fosu and the four-continuous box culverts across the Okyi River near Assin Andoe (scale of 1/200) as shown in Table A11 and Figure A3.

Table A11 Scope of Topographical Surveys

	Specifications and Scale		Quantity (m^2)
Lot 1	Topographical survey: Scale 1/1000	Along the N8: L = 11,600 m, W = 50 m	580,000
		Possible detour at Assin Fosu: L = 1,400 m, W = 30 m	42,000
	Detailed topographical survey: Scale 1/200	Railway underpass bridge at Assin Fosu: L = 100 m, W = 100 m	10,000
		Four-continuous box culverts across the Okyi River: L = 1,000 m, W = 100 m	100,000
Lot 2	Topographical survey: Scale 1/1000	Along the N8: L = 22,000 m, W = 50 m	1,100,000

Source: Study Team



Source: Study Team

Figure A3 Area of Topographical Surveys

Appendix 7-3 Results of Geotechnical Investigations

The Study Team conducted geotechnical investigations by mechanical borings adjacent to the existing railway underpass bridge at Assin Fosu and the existing four-continuous box culverts on the Okyi River in Assin Andoe; the results are shown in Tables A12 and A13, respectively. Also, Table A14 shows the detailed positions (coordinates) of the boreholes for the geotechnical investigations.

Table A12 Results of Geotechnical Investigation adjacent to the Existing Railway Underpass Bridge at Assin Fosu

Depth (m)	Type	SPT Test		備 考	Classification				Plasticity Index					Swell
		N	Recovery (m)		Gavel (%)	Sand (%)	Fines (%)	Type	LL (%)	PL (%)	PI (%)	Note	Type	(%)
0.0 - 0.40m	ds1			Moist medium dense brown clayey gravelly、Medium to coarse grained SAND with occasional cobbles	14	59	27	SF-G	36.0	15.0	21.0		CL	27.5
1.0 - 1.45m	SPT1	33	0.53	Dry medium dense mottle (reddish brown, yellowish, whitish, greyish) clayey SAND with pockets of gravels	0	72	28	SF	45.0	28.0	17.0		ML	38.5
2.0 - 2.45m	SPT2	25	0.50		1	36	63	FS	34.0	28.0	6.0		ML	23.5
3.0 - 3.45m	SPT3	19	0.52	Moist medium dense mottle (yellowish, reddish brown, whitish) coarse grained highly weathered GRANITE	1	34	65	FS	51.0	36.0	15.0		MH	42.6
4.0 - 4.45m	SPT4	15	0.54		0	46	54	FS	48.0	37.0	11.0		ML	38.4
5.0 - 5.45m	SPT5	18	0.40		1	46	53	FS	46.0	32.0	14.0		ML	36.5
6.0 - 6.45m	SPT6	12	0.54		2	49	49	FS (SF)	41.0	31.0	10.0		ML	31.6
8.0 - 8.45m	SPT8	50	0.30	Moist dense mottle (yellowish, whitish, blackish, greyish) coarse grained slightly decomposed and highly weathered	3	70	27	SF	32.0	23.0	9.0		CL	27.8
9.0 - 9.45m	SPT9	22	0.54	Moist medium dense mottle (greyish, whitish, blackish, yellowish) coarse grained slightly decomposed and highly weathered GRANITE	2	65	33	SF	40.0	31.0	9.0		ML	33.1
10.0 -10.45m	SPT10	38	0.20		2	65	33	SF						35.0
11.0 -11.45m	SPT11	23	0.55		10	63	27	SF-G	32.0	23.0	9.0		CL	20.5
12.0 -12.45m	SPT12	30	0.38		4	66	30	SF	35.0	30.0	5.0		ML	22.5
13.0 -13.45m	SPT13	24	0.25		30	56	14	SG-F						
14.0 -14.45m	SPT14	50	0.20	Moist medium dense mottle (greyish, whitish, blackish, yellowish) coarse highly weathered GRANITE	7	47	46	SF-G						

Note: Digging length of rock layer from -14.5 m was 2.7 m
Source: Study Team

Table A13 Results of Geotechnical Investigation adjacent to the Existing Four-continuous Box Culverts across the Okyi River

Depth (m)	Type	SPT Test		備 考	Classification				Plasticity Index					Swell
		N	Recovery (m)		Gavel (%)	Sand (%)	Fines (%)	Type	LL (%)	PL (%)	PI (%)	Note	Type	(%)
0.0 - 1.10m	ds1			Moist medium dense greyish reddish brown medium to coarse grained sandy GRAVEL with occasional cobbles	74	17	9	GS-F	25.0	19.0	6.0		ML	5.6
1.0 - 1.45m	SPT1	12	0.43	Moist medium dense brownish grey sandy clayey GRAVEL with traces of quartzites	34	34	32	SFG	37.0	23.0	14.0		CL	3.6
2.0 - 2.45m	SPT2	18	0.24	Moist medium dense yellowish brown gravelly CLAY	19	44	37	SFG	34.0	20.0	14.0		CL	5.6
3.0 - 3.45m	SPT3	8	0.20	Moist firm to stiff reddish brown yellowish gravelly CLAY with traces of mica	15	28	57	FSG	58.0	36.0	22.0		MH	4.5
4.5 - 4.90m	SPT4	29	0.20	Moist medium dense mottle (whitish, blackish, greyish) coarse grained highly weathered GRANITE	6	74	20	SF-G						

Note: Digging length of rock layer from -4.9 m was 3.3 m

Source: Study Team

Table A14 Positions of Boreholes and Digging Length

Borehole	Position and Coordinates	Digging Length
No. 1	Railway underpass bridge at Assin Fosu (N 005 °41.703', W 001°16.477')	17.2 m
No. 2	Four-continuous box culverts across the Okyi River (N 005°32.188', W 001°11.026')	8.2 m

Source: Study Team

Appendix 8 RAP Related to the Construction of New Market Prepared by ANMA

ASSIN NORTH MUNICIPAL ASSEMBLY

In case of reply the number and date of this letter should be quoted

REPUBLIC OF GHANA

Office of the Municipal Assembly
Post Office Box 99
Assin Fosu, C/R
Ghana – W/A

Our Ref: ANMA/G.8/VOL.II/94

Your Ref.:.....

4TH APRIL 2014

RESETTLEMENT OF TRADERS ALONG THE ASSIN FOSO TOWNSHIP

The Assin North Municipal Assembly, per its mission, to facilitate the improvement of quality of life of the people within the Assembly's jurisdiction through equitable provision of services for the total development of the Municipal within the context of good governance has initiated the need to open the new market to accommodate traders and those who apply their trade along the main highway within the Fosu Township.

This initiative has been necessitated because of the danger it poses to road users and other motorists who use the Highway.

Due to this, a five (5) member committee has been inaugurated to ensure the opening of the new market. Among their Terms of Reference (TOR), they are to decongest the main highway and resettle the affected traders at the new market and an open space behind the National Health Insurance.

A resettlement Action Plan has been drawn to effect the decongestion on the road, thus, all temporary structures erected on the sides of the road will be removed and as such affected traders will be resettled at the new market. Also, all temporal permits which were issued for those temporal structures along the main highway in Fosu in 2013 and will expire in June 2014, will NOT be renewed.

In view of this, the Assembly is assuring your outfit that all the necessary legal steps would also be taken to ensure that the traders do not erect temporary structures along the said road.

Please find attached the resettlement action plan that will be undertaken by the Municipal Assembly, Market Committee, Works department, Physical and Planning Units and the Police.

Thank you and counting on your usual co-operation.

For: MUNICIPAL CHIEF EXECUTIVE
(CHARLES LARTEY)
ASSISTANT DIRECTOR

THE TEAM LEADER
JICA STUDY TEAM
JICA

ASSIN NORTH MUNICIPAL ASSEMBLY
RESETTLEMENT ACTION PLAN

ITEM	ACTIVITY	TIME FRAME	ACTION-BY
1	Survey (Socio Economic) of temporal structures along Fosu township	2 weeks (14-28 April,2014)	Mun. Works Department/Market Committee/Mun. Planning Unit
2	Consultative meeting with stakeholders to be affected by the resettlement.	7th May 2014	Assin North Municipal Assembly
3	Development of eligibility criteria for different types of impacts	12th May-19th May, 2014	Mun. Works Department/Market Committee/Mun. Planning Unit
4	Provision of alternatives	3rd June – 5th August, 2014	Mun. Planning Unit/Physical Planning Dept/Works Department
5	Actual implementation of resettlement	4th – 5th October, 2014	Mun. Works Dept/ Market Committee/ Police Task force
6	Monitoring and Evaluation	6th October -	Municipal Assembly/Market Committee

Appendix 9 Sample Monitoring Form

(1) Planning Phase

Preparation of Resettlement Sites (where necessary)

No.	Explanation of the site (e.g. Area, no. of resettlement HH, etc.)	Status (Completed (date) / not complete)	Details (e.g. Site selection, identification of candidate sites, discussion with PAPs, development of site, etc.)	Expected Date of Completion
1				
2				

Public Consultation

No.	Date	Place	Contents of the consultation / main comments and answers

Resettlement Activities	Planned Total	Unit	Progress in Quantity			Progress in %		Expected Date of Completion	Responsible Organisation
			During the Quarter	Till the Last Quarter	Up to the Quarter	Till the Last Quarter	Up to the Quarter		
Preparation of RAP									
Employment of Consultants		Man-month							
Implementation of Census Survey (including Socioeconomic Survey)		-							
Approval of RAP		-							
Finalisation of PAPs List		No. of PAPs							
Progress of Compensation Payment		No. of HHs							
Lot 1		No. of HHs							
Lot 2		No. of HHs							
Lot 3		No. of HHs							
Lot 4		No. of HHs							
Progress of Land Acquisition (All Lots)		ha							
Lot 1		ha							
Lot 2		ha							
Lot 3		ha							
Lot 4		ha							
Progress of Asset Replacement (All Lots)		No. of HHs							
Lot 1		No. of HHs							
Lot 2		No. of HHs							
Lot 3		No. of HHs							
Lot 4		No. of HHs							
Progress of Relocation of People (All Lots)		No. of HHs							
Lot 1		No. of HHs							
Lot 2		No. of HHs							
Lot 3		No. of HHs							
Lot 4		No. of HHs							

(2) During Construction

The latest results of the below monitoring items shall be submitted to the lenders as part of Quarterly Progress Report throughout the construction phase.

Construction Phase

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period
Number and contents of formal comments made by the public	
Number and contents of responses from Government agencies	

2. Pollution

- Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
SO_2	µg/m^3 (24h)					20		Biannual
NO_2	µg/m^3 (1h)					200		Biannual
PM_{10}	µg/m^3 (24h)					50		Biannual

- Water Quality

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
pH	-					6-9		Biannual
SS	mg/l					50		Biannual
Coliform bacteria	MPN /100ml					400		Biannual
Oil	mg/l					10		Biannual

- Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Noise Level Leq.	dB A					55 (day)		Biannual

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventry record of using anti-vibration device	Details of survey results, such as findings		Monthly

- Waste

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Invenry record of waste disposal (volume, methodology)	Details of survey results, such as findings		Monthly

3. Social Environment

- HIV/AIDS and other STDs

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
HIV/AIDS and other STDs	Incidences per 1000 inhabitants		Biannual

4. Other

- Traffic Accidents

Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventory record of traffic accident	Details of survey results, such as findings		Monthly

(3) During Operation

The latest results of the below monitoring items shall be submitted to the lenders on biannual basis for the first two years of operation.

Operation Phase

1. Response/Actions to Comments and Guidance from Government Authorities and the Public

Monitoring Item	Monitoring Results during Report Period	Frequency
Number and contents of formal comments made by the public		Upon receipt of comments/complaints
Number and contents of responses from Government agencies		

2. Pollution

- Air Quality (Ambient Air Quality)

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
SO_2	mg/m^3					20		Annual
NO_2	mg/m^3					200		Annual
PM_{10}	mg/m^3					50		Annual

- Noise

Item	Unit	Measured Value (Mean)	Measured Value (Max)	Country's Standards	Standards for Contract	Referred International Standards	Measurement Point	Frequency
Noise Level Leq.	dB (A)					55 (day)		Biannual

3. Other

- Traffic Accidents

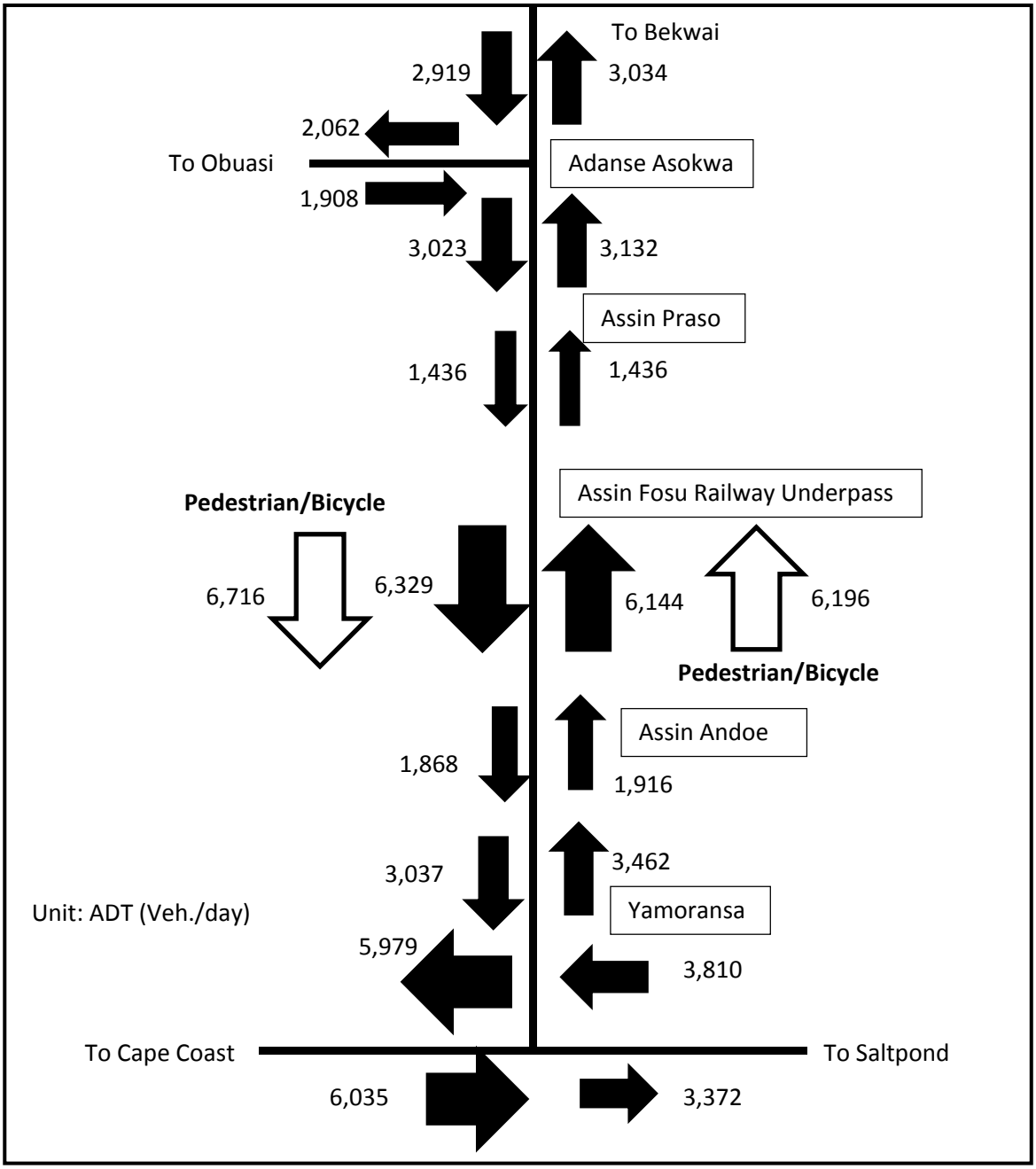
Monitoring Item	Monitoring Results during Report Period	Measures to be Taken	Frequency
Inventory record of traffic accident	Details of survey results, such as findings		Monthly

Appendix 10 Results of Future Traffic Projection

(1) Results of Future Traffic Demand Projection

a) Results of sectional and intersection traffic volume counting surveys

The Study Team conducted directional traffic flow counting at two intersections and the manual classified counting (MCC) of traffic at seven locations (24 hours counting only on the Assin Fosu railway underpass bridge), and the roadside O/D interview survey at two locations, in order to identify the present and future bottlenecks on the N8.



Source: Study Team

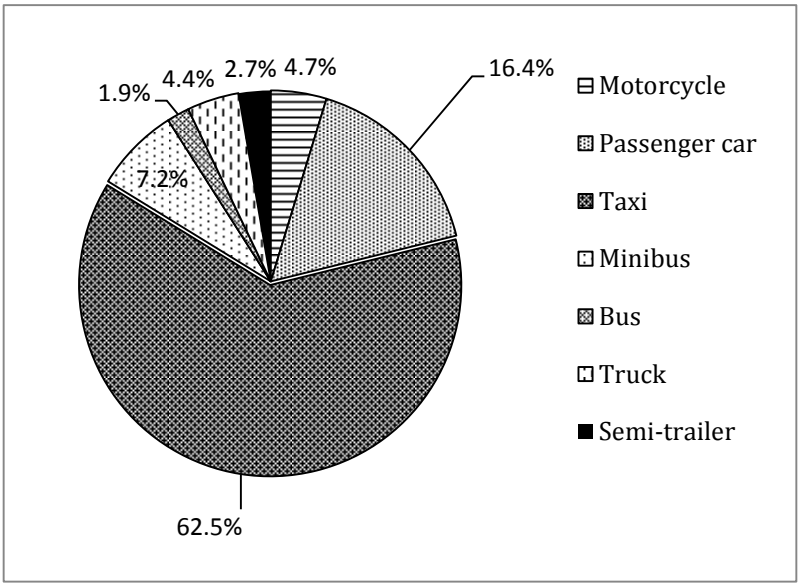
Figure A4 Present Daily Traffic Volume on the N8

The traffic volume obtained from each counting station was converted into the average daily traffic (ADT) considering the day/night ratio of traffic obtained from the MCC station on the

Assin Fosu railway underpass bridge, a daily fluctuation rate and a monthly fluctuation rate obtained from the toll collection result by the GHA at the Pra River bridge at Assin Praso. The present traffic volume on the N8 is shown in Figure A4.

It should be noted from the results of the traffic volume counting survey that the vehicular traffic for both directions on the Assin Fosu railway underpass bridge was 11,184 veh./day, while the number of pedestrians and bicycles was also high at 12,912. This present traffic situation is considered to be one of the main causes of the chronic traffic congestion at the centre of the Assin Fosu township.

Furthermore, Figure A5 illustrates the vehicle composition of the present traffic on the railway underpass bridge and the very high ratio of taxis (62.5%), which are mainly internal traffic in the Assin Fosu township; those taxis greatly influence the traffic congestion.



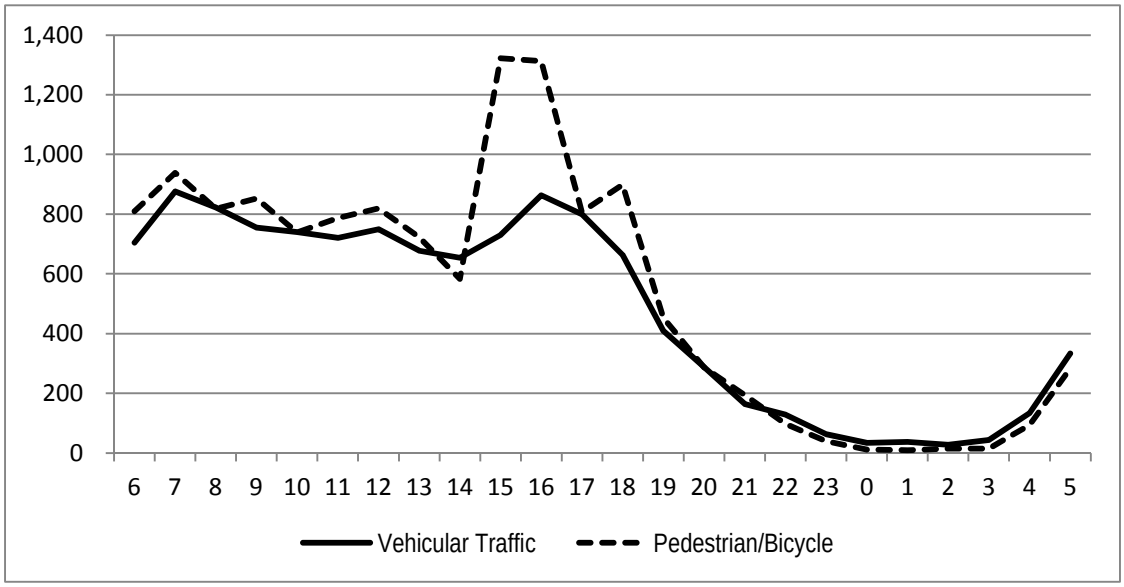
Source: Study Team

Figure A5 Vehicle Composition of Traffic on the Assin Fosu Railway Underpass Bridge

Figure A6 illustrates the hourly fluctuation of traffic on the railway underpass bridge in Assin Fosu. There are particular peak hours of pedestrians and bicycle traffic between 14:00 and 16:00 with 1,350 people and bicycles per hour, when students go back from school, and those pedestrians (mainly students) cross the railway underpass bridge with a high risk of conflicts with vehicular traffic as there is no sidewalk.

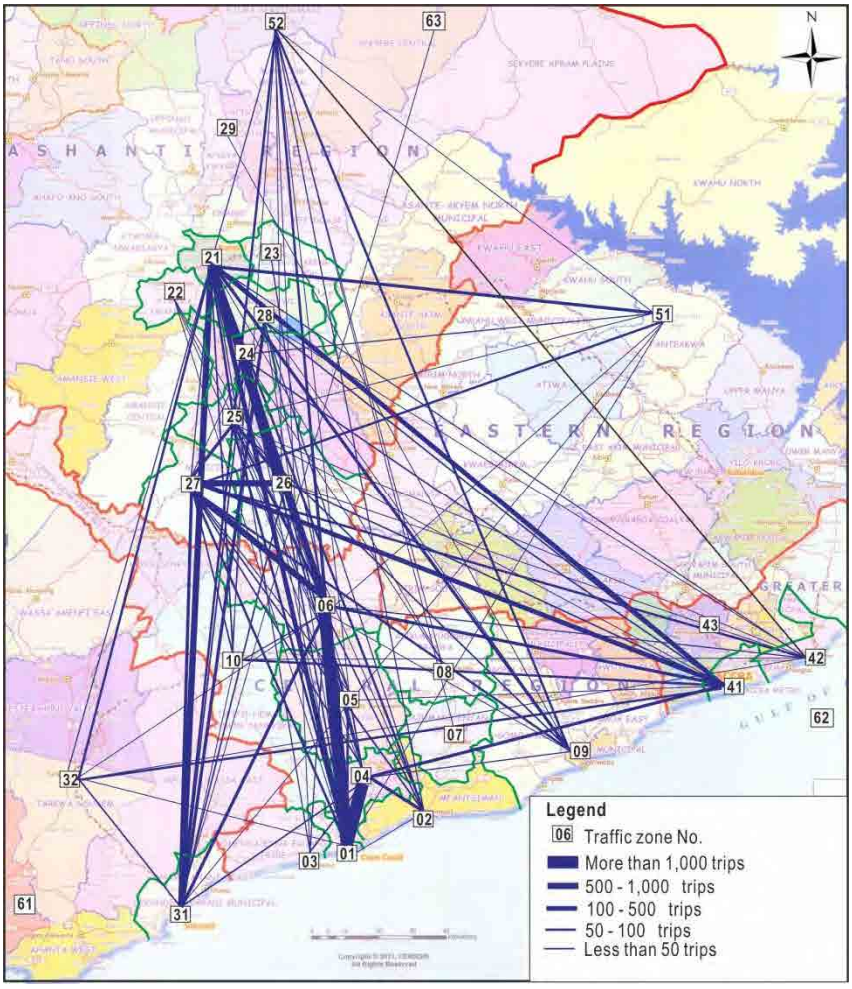
b) Results of roadside O/D interview survey

For the MCC survey, the Study Team conducted the roadside O/D interview survey at Yamoransa intersection and Adanse Asokwa intersection, both on the N8, on the same day, in order to grasp the situation of medium and long-haul traffic on the N8. As a result, the major trips on the N8 are between Cape Coast and Assin North, and Kumasi and Assin North, and the trip generation/attraction volume in Assin North, particularly Assin Fosu township, is predominant on the N8, as shown by the desired lines of trips of the present traffic in Figure A7.



Source: Study Team

Figure A6 Hourly Fluctuation of Traffic on the Railway Underpass Bridge in Assin Fosu



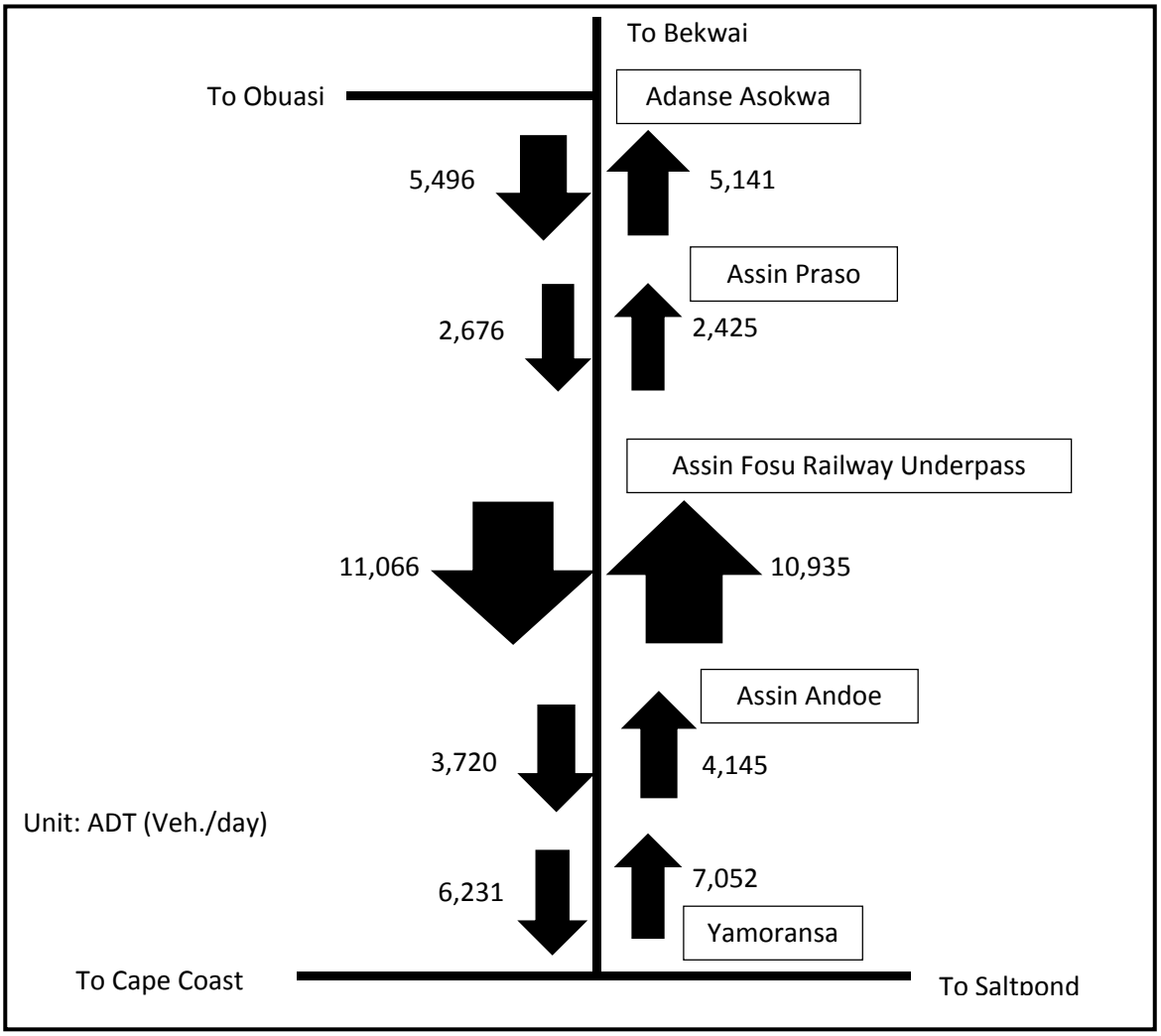
Source: Study Team

Figure A7 Present Desired Lines of Trips on the N8

c) Results of future traffic demand forecast

In the Study, the future traffic demand was forecasted by passenger vehicles and freight

vehicles, based on the results of the roadside O/D interview survey. In this case, the target year of the forecast was set as 2038, 20 years after completion of the Project, and the same method of the recent "Preparatory Survey on Eastern Corridor Development Project" was used, i.e., expansion of generated traffic volume, by using the future population growth rate (1.83 times) estimated by the Ghana Statistical Service (GSA) for passenger traffic, and the GDP growth rate (1.723 times) determined by the IMF for freight traffic. Then, based on the projected O/D matrix in 2038, the future traffic volumes on the N8 for 2021 (3 years after completion of the Project) and 2038 were assigned on the network. Since taxi traffic in the centre of Assin Fosu township is considered to be already saturated even at present, the internal traffic in Assin Fosu in 2038 is assumed to be the same as at present.



Source: Study Team

Figure A8 Results of Future Traffic Assignment on the N8 in 2038

Figure A8 illustrates the results of the future traffic assignment in 2038, while Table A15 shows the future traffic demand on the N8 in 2021 and 2038.

Table A15 Results of Future Traffic Volume Projection at each Traffic Survey Point

1) Results of Future Traffic Projection at Yamoransa Intersection

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	1,990	1,687	3,148	2,618	4,250	3,533
Minibus	1,049	975	1,420	1,319	1,918	1,786
Bus	34	29	62	95	84	127
Truck	163	186	338	318	439	426
Semi-trailer	156	95	361	359	361	359
Sub-total	3,392	2,972	5,329	4,709	7,052	6,231
Total of both directions		6,364		10,038		13,283

2) Results of Future Traffic Projection at Assin Andoe Community

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	1,308	1,230	2,231	1,833	3,009	2,475
Minibus	244	296	298	415	406	564
Bus	43	48	61	91	88	121
Truck	135	129	224	169	285	231
Semi-trailer	139	123	273	249	357	329
Sub-total	1,869	1,826	3,087	2,757	4,145	3,720
Total of both directions		3,695		5,844		7,865

3) Results of Future Traffic Projection on Assin Fosu Railway Underpass

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	5,368	5,286	7,268	7,155	9,447	9,141
Minibus	351	581	422	697	642	1,065
Bus	44	43	48	75	79	112
Truck	244	252	287	302	414	436
Semi-trailer	137	167	243	215	353	312
Sub-total	6,144	6,329	8,268	8,444	10,935	11,066
Total of both directions		12,473		16,712		22,001

4) Results of Future Traffic Projection at Assin Praso Township

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	893	888	1,077	1,308	1,453	1,766
Minibus	193	170	260	255	353	311
Bus	44	54	56	134	69	108
Truck	128	124	186	176	238	178
Semi-trailer	116	139	224	237	312	313
Sub-total	1,374	1,375	1,803	2,110	2,425	2,676
Total of both directions		2,749		3,913		5,101

5) Results of Future Traffic Projection at Asanse Asokwa Intersection

Vehicle Type	Present Traffic Volume (2013)		Future Traffic Volume (2021)		Future Traffic Volume (2038)	
	North Bound	South Bound	North Bound	South Bound	North Bound	South Bound
Passenger car/ Taxi	1,545	1,532	1,865	2,258	2,514	3,047
Minibus	912	955	1,232	1,438	1,670	1,749
Bus	58	29	74	72	92	118
Truck	231	207	337	295	431	298
Semi-trailer	161	126	312	215	434	284
Sub-total	2,907	2,849	3,820	4,278	5,141	5,496
Total of both directions		5,756		8,098		10,637

Source: Study Team

It is clear from these figures and tables that the future traffic volume on the Assin Fosu

railway underpass bridge will be 22,001 veh./day, exceeding the traffic capacity of the 2-lane road. As a result, it is concluded that dualisation will be required in the central area of Assin Fosu township.

(2) Travel Speed

a) Results of travel speed survey

The Study Team conducted the travel speed survey between Yamoransa and Bekwai by section. Table A16 shows the results of the survey. Even though the average travel speed on sections rehabilitated under the Phase 1 Project is 92.2 km/h, the travel speeds of other sections without rehabilitation, i.e. between Assin Praso and the north of Assin Fosu township, and Assin Fosu police barrier and Yamoransa are about 77 km/h. In addition, the average travel speed between the north of Assin Fosu township and the railway underpass bridge was 22 km/h, even though the maximum speed on this section is 50 km/h, showing evidence of traffic congestion in this section.

Table A16 Results of Travel Speed Survey

Location	Distance (km)	Average Travel Time	Average Travel Speed (km/h)
Bekwai			
|	67	43’37”	92.2
Assin Praso			
|	27	22’55”	77.1
North of Assin Fosu Township			
|	2.2	5’30”	22.0
Assin Fosu Railway Underpass Bridge			
|	1	1’50”	33.2
Assin Fosu Police Barrier			
|	65.6	50’51”	77.4
Yamoransa			

Source: Study Team

b) Estimation of travel speed and travel time after completion of the Project

After completion of the rehabilitation of the N8 under the Project, the travel speed of the ordinary 2-lane road section between Assin Praso and the north of Assin Fosu township is assumed to increase to 90 km/h, which is the same level of travel speed as the road section rehabilitated under the Phase 1 Project. On the other hand, since many crossing pedestrians are expected on the planned dualised section in the centre of Assin Fosu township, the travel speed on this section is assumed to be 40 km/h, less than the maximum speed limit in urban areas. As rehabilitation of the worst damaged section south of the railway underpass bridge is planned, the travel speed on the remaining section up to the Assin Fosu police barrier is assumed to be the maximum speed limit in urban areas of 50 km/h.

Based on these assumed travel speeds for each section of the Project road, the average travel time between Assin Praso and the Assin Fosu police barrier is expected to be shortened from 30’15” at present to 22’30” after completion of the rehabilitation of the N8 under the Project, as shown in Table A17.

Table A17 Results of Estimated Travel Speed and Travel Time

Location	Distance (km)	Assumed Travel Speed (km/h)	Estimated Travel Time
Assin Praso			
|	27	90.0	18’00”
North of Assin Fosu Township			
|	2.2	40.0	3’18”
Assin Fosu Railway Underpass Bridge			
|	1	50.0	1’12”
Assin Fosu Police Barrier			

Source: Study Team

Appendix 11 Results of Visual Inspection of Pavement

In order to supplement the results of the road surface inspection carried out by the GHA, the Study Team conducted a detailed visual inspection of the pavement on the N8 between Assin Praso and Yamoransa, with cooperation from the Material Division of the GHA. For the visual inspection, the Study Team referred to the method of the visual inspection carried out by the GHA, and evaluated damages on the road. Since the section for evaluating the road surface condition by the GHA is large (evaluation of 10 to 20 km of road section as a unit), the Study Team modified the method to evaluate the road surface at intervals of 100 m and estimated the degree of damage. In this survey, a Study Team member visually inspected the road surface by walking (Assin Praso to Assin Fosu) and from a slow-moving vehicle (Assin Fosu to Yomaransa), accompanied by an engineer from the Material Division of the GHA.

Regarding the inspection method, the Study Team referred to the "GHA Road Maintenance Operation Manual – Road Condition Survey Revised Manual (October 2003)" prepared under the GHA GTZ Road Maintenance Project. The degree of damage of the road surface ("degree of damage" and "scale of damage") was recorded by type of damage, and a score was calculated by combining both factors. The criteria for evaluating the degree of damage on the road surface are shown in Table A18.

Table A18 Criteria for Evaluating Degree of Damage

Type of Damage	Degree of Damage	Scale of Damage
Alligator crack	Light: Width of crack is less than 6 mm Medium: Width of crack is less than 12 mm Severe: Width of crack is 12 mm or more	Per length 1–15%: Limited part 16–30%: Continuous part More than 30%: Most parts
Difference in level	Light: Difference in level is less than 20 mm Medium: Difference in level is 20–50 mm Severe: Difference in level is more than 50 mm	
Rutting	Light: Depth is less than 10 mm Medium: Depth is 10–25 mm Severe: Depth is more than 25 mm	
Bituminous flashing and bleeding	Light: Aggregates at the main part of the carriageway are not covered by bituminous emulsion Medium: Aggregates on the wide part are not covered by bituminous emulsion Severe: Aggregates are not covered at all by bituminous emulsion	
Detached aggregate	Light: Some aggregates have detached Medium: Many aggregates have detached and the surface condition is rough Severe: Most aggregates have detached and the surface condition is very rough	
Transverse cracking	Light: Width of crack is less than 6 mm Medium: Width of crack is less than 12 mm Severe: Width of crack is 12 mm or more	
Longitudinal cracking	Light: Width of crack is less than 6 mm Medium: Width of crack is less than 12 mm Severe: Width of crack is 12 mm or more	
Damages on pavement edge	Light: Less than 200 mm Medium: 300–500 mm Severe: 500 mm or more	
Lowering of pavement edge	Light: Difference of level 25–50 mm Medium: Difference of level 50–100 mm Severe: Difference of level 100 mm or more	
Pothole	Score 1: Area less than 10 m^2/km Score 2: Area 10–30 m^2/km Score 3: Area 31–50 m^2/km Score 4: Area 50 m^2/km or more	

Source: Study Team

Based on the criteria mentioned above, the degree of damage was calculated by the following matrix using the damage condition recorded by the visual inspection:

Table A19 Weighting Matrix to Calculate Degree of Damage

Scale of damage / Degree of damage	Limited Parts 1–15% of length	Continuous Parts 16–30% of length	Most Parts More than 30% of length
Light degree	1	2	3
Medium degree	4	5	6
Severe degree	7	8	9

Source: Material Division, GHA

According to this matrix, the Study Team weighted each type of damage and calculated the weight of each type of damage for each section for the investigation.

Table A20 Weight of Each Type and Scale of Damage by Visual Inspection

Type of Damage	Degree of Damage	Scale of Damage		
		Limited Parts	Continuous Parts	Most Parts
Alligator crack	Light	5	6	7
	Medium	7	8	9
	Severe	9	11	11
Difference in level	Light	5	7	8
	Medium	8	9	10
	Severe	10	12	12
Rutting	Light	3	4	5
	Medium	5	6	7
	Severe	7	8	9
Bituminous flashing and bleeding	Light	0	1	1
	Medium	1	2	2
	Severe	2	3	3
Detached aggregate	Light	1	2	3
	Medium	3	4	5
	Severe	5	6	6
Transverse cracking	Light	1	2	3
	Medium	3	4	5
	Severe	5	6	6
Longitudinal cracking	Light	2	3	4
	Medium	4	5	6
	Severe	6	7	7
Damages on pavement edge	Light	4	5	6
	Medium	6	7	8
	Severe	8	9	9
Lowering pavement edge	Light	4	5	6
	Medium	6	7	8
	Severe	8	9	9
Pothole	Level 1	6		
	Level 2	9		
	Level 3	11		
	Level 4	14		

Source: Material Division, GHA

On the other hand, IRI values obtained by an IRI measurement vehicle are classified into scores as shown in Table A21, and the total evaluation score of each section for the evaluation

was calculated by using the following equation. For the Study, no IRI measurement was conducted, and instead, the latest IRI measurement result, conducted by the GHA in 2013, was used.

Table A21 Calculation of Damage Score based on IRI Value

IRI Value	Score
4–6	5
6–7	8
7 or more	12

Source: Material Division, GHA

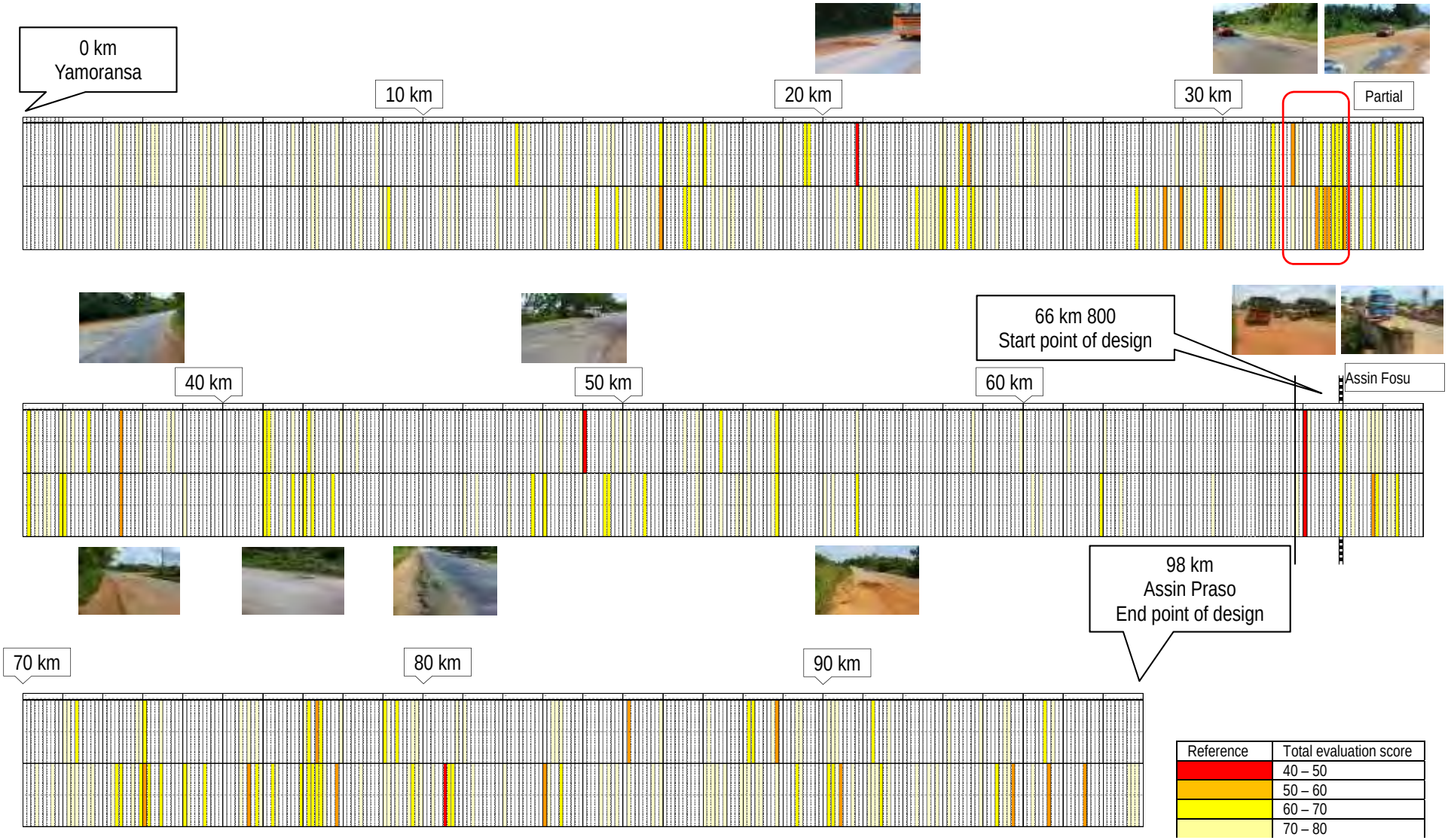
The equation used to calculate the total evaluation score for each evaluation section is as follows:

Total evaluation score = 100 – (Σ [Score of damages by visual inspection] + Score based on IRI Value)

The results of the detailed visual inspection of the road surface are shown in Figure A9; the Study Team confirmed that damages to the road surface for the section selected for the Project have worsened. Particularly, the damages on the road section south of Assin Fosu township (67 km from Yamoransa) are the worst on the N8. At this location, the asphalt concrete layer has totally disappeared and this section has become the most critical point, as vehicle travel speed has fallen below 10 km/h.

Based on the results of visual inspection, damage has worsened in many sections adjacent to sags. The main causes of damage are insufficient drainage, and once the pavement has deteriorated, water penetrates through generated cracks and damage worsens further at sags where drainage water is concentrated.

Based on the results of the visual inspection, the damage condition, particularly at sags where damage is severe, is summarised in Table A22. Alligator cracks have been generated and worsened in many cases. Even though the alligator cracks have been maintained by patching, due to the poor quality of materials, bituminous flashing, difference in level with corrugation shape, and rutting have also be generated.



Source: Study Team

Figure A9 Results of Detailed Visual Inspection for Road Damages

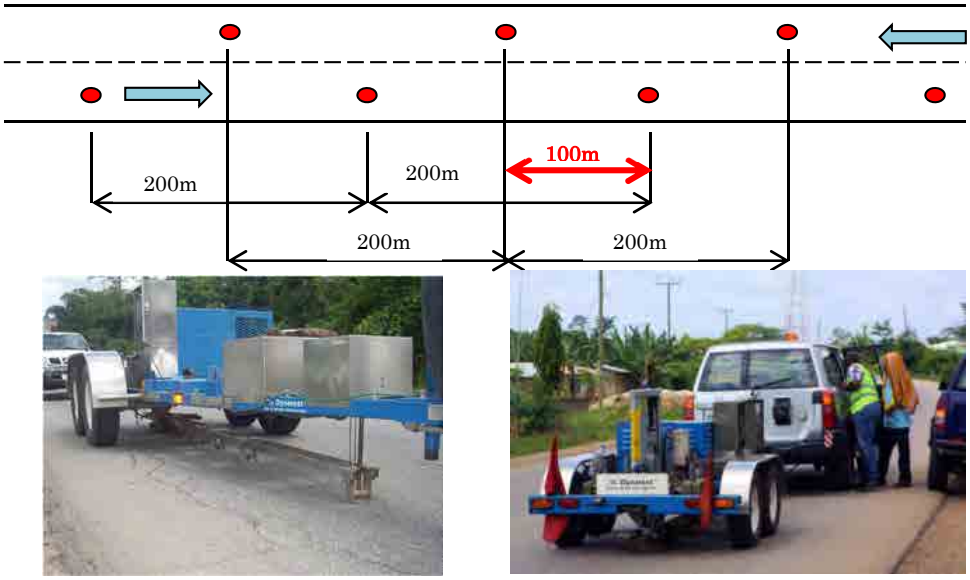
Table A22 Damage Condition on Section between Assin Fosu and Assin Praso

Km Post	Total Evaluation Score	Damage Condition
3+000	43	Even though this location is vertically a gentle sag, there is not much difference in level with the surrounding ground level, and the side and cross drainages are improper, thus drain water from the surrounding area runs over the road surface. The surface course has totally disappeared and the base course is bumpy, so vehicles have to reduce speed.
2+100	56	This location is a gentle sag in an urbanised area. Even though this section was maintained by patching, due to the poor quality of materials, bituminous flashing, alligator cracks and potholes have occurred.
2+500	62	There is a gradient of 5% for about 800 m, ending in a sag. There are alligator cracks. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing and a difference in level with a corrugated shape have occurred.
5+6050	67	This section is a gentle sag on an approach to an urbanised area. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing, alligator cracks and rutting have occurred.
6+265	55	This section is a sag with a gentle vertical alignment, and there is an exit from a filling pump. Alligator cracks have worsened. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing, a difference in level with a corrugated shape and rutting have occurred. Also, there are large potholes of 2×2 m in size.
9+550	63	This section is a sag section with a vertical downgrade of about 5% from both sides. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing, alligator cracks and potholes of 2×2 m in size have occurred.
10+600	66	This section is a gentle sag at the edge of a hill where there is a beverage factory. Alligator cracks have worsened. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing, a difference in level with a corrugated shape, medium rutting and potholes have occurred.
11+130	58	Both sides of this point are a downgrade of about 5% to a sag. Alligator cracks have worsened. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing, a difference in level with a corrugated shape, and medium rutting have occurred.
12+340	63	This point is at a sag on the 4x4 box culvert installed on a small river. There is a difference in level of about 5 cm between the box culvert and earth work sections, and alligator cracks have occurred adjacent to those level gaps.
13+200	65	This point is at a gentle sag where two RC pipes of 1 m diameter are installed. Alligator cracks have occurred on the top of the RC pipes. Even though patching maintenance was done, a difference in level with a corrugated shape has occurred.
14+146	44	This point is a sag at a stream in hilly terrain. Even though patching maintenance was done, due to the poor quality of materials, bituminous flashing, alligator cracks, a difference in level with a corrugated shape, and rutting have occurred. Also, there are large potholes of 2×2 m and 1.5×1.5 m in size.
18+385	60	This point is a sag at a stream in hilly terrain. Alligator cracks have worsened. Even though patching maintenance was done, a difference in level with a corrugated shape, and plastic flow to form a bump at the end of the pavement, were observed.
21+400	65	This point is a sag from a steep downgrade of about 5.5% from the start point side. Even though patching maintenance was done, due to the poor quality of materials, a difference in level with a corrugated shape, potholes, and plastic flow to form a bump at the end of the pavement were observed.
23+450	57	This point is a sag with a gentle vertical alignment. Large alligator cracks with a length of 300 m have worsened. There is a large difference in level caused by complete damage of the surface layer over 5×2 m at the centre of the carriageway. In addition, there are many potholes and driving comfort has drastically decreased.
24+650	71	This point is a sag from a steep downgrade of about 5.0% from the start point side. Alligator cracks have worsened, and several small potholes have formed.
25+850	75	This point is a sag from a steep downgrade of more than 5.0% from the start point side. Alligator cracks have worsened, and several small potholes have occurred.
27+650	68	This point is a sag from a steep downgrade of about 5.5% from the end point side. Alligator cracks have worsened, and there is a relatively large difference in level with 3×3 m on the carriageway caused by complete damage of the surface layer.
28+850	57	This point is a sag on gentle terrain in the south of Assin Praso community. The patched surface layer was detached and a hollow section of about 30 m in length, together with worsened alligator cracks and several pot hotels, has formed.

Source: Study Team

Appendix 12 Results of FWD Test Results

In the Study, the Study Team borrowed FWD measurement equipment from the Material Division of the GHA, and measured the deflection by non-destructive inspection for the whole section requested for the Study. Deflection was measured by the FWD Test for each 200 m section for the whole stretch, and conducted for the other direction, and the deflection was analysed for each 100 m pitch.



FWD Measurement Equipment and Actual Measurement

Source: Study Team

Figure A10 Method of FWD Test

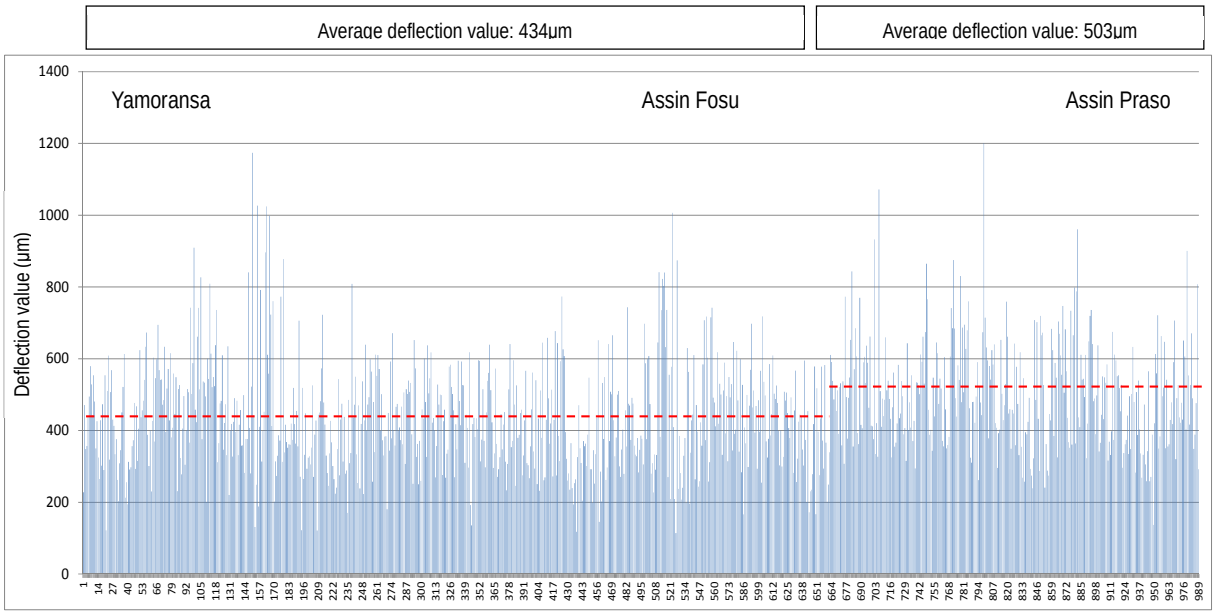
Based on the FWD measurement test, the average deflection between Assin Fosu and Assin Praso was 503 μm, while it was 434 μm between Assin Fosu and Yamoransa. Since the standard value of allowable deflection in Japan is based on the loading of 49 kN (40 kN in Ghana), and a simple comparison cannot be done, the bearing capacity of the pavement is considered to be insufficient on average, referring to the Japanese standard.

Also, there are nine locations between Assin Praso and Assin Fosu where the deflection value is particularly high. Within these nine locations, five of them are located at sags or where box culverts are installed, where water easily accumulates and the deflection value tends to become bigger.

Table A23 Road Alignment at Locations where Deflection Values are Large (Between Assin Praso and Assin Fosu)

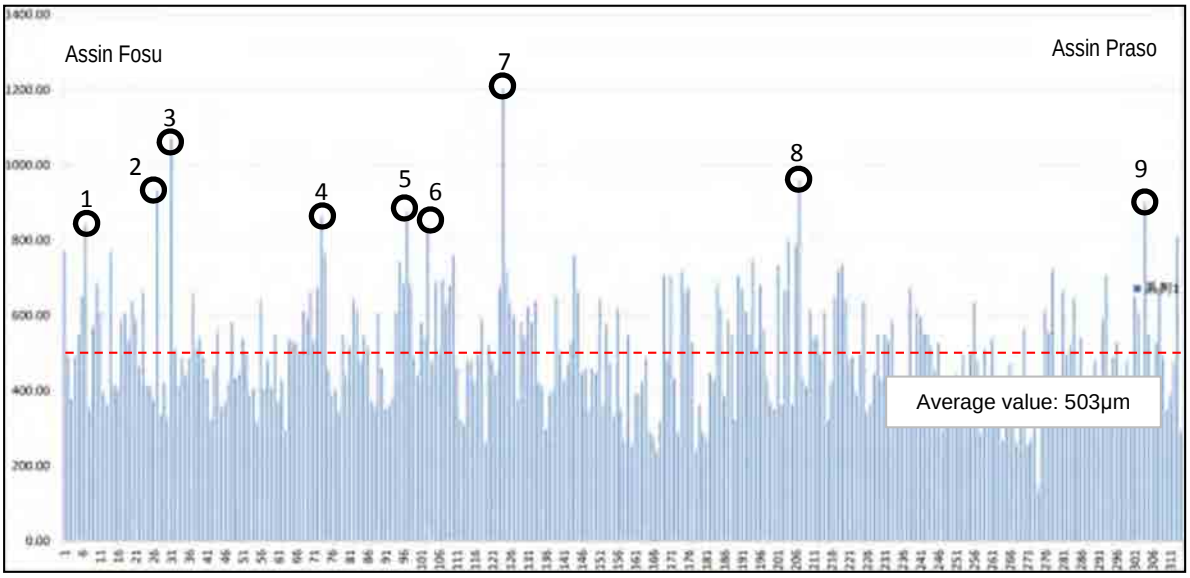
Location where Deflection Value is Very Large (800 μm or more)	1	2	3	4	5	6	7	8	9
1) At sag section		✔			✔	✔	✔		
2) At locations with a culvert		✔	✔		✔	✔	✔		
3) Other than the above (locations where influence of water is expected due to surrounding terrain)	✔			✔				✔	✔

Source: Results of FWD Test carried out by the Study Team



Source: Results of FWD Test carried out by the Study Team

Figure A11 Results of the FWD Test (Deflection Value)



Note: According to the standard value of allowable deflection in Japan, the deflection for the daily design traffic volume of pavement of 1,000–3,000 veh./day is 400 μm.

Source: Results of FWD Test by the Study Team

Figure A12 Present Situation of Deflection Value between Assin Praso and Assin Fosu

Appendix 13 Results of Confirmation of Existing Pavement Structure

The Study Team conducted test pit excavations to confirm the existing pavement structure of the Project Road. Table A24 shows the existing pavement structure, while Tables A25 and A26 show the results of material tests for the base and sub-base, and subgrade, respectively.

Table A24 Present Structure of Pavement

No.	Distance from Assin Fosu Railway Bridge (km) km	Surface Layer (Asphalt Concrete) m	Base Course (Crushed Stone) m	Sub-Base Course (Crusher Run) m
1	-1.05	0.05	0.15	0.10
2	5.60	0.05	0.25	0.20
3	10.80	0.05	0.20	0.15
4	11.30	0.07	0.15	0.15
5	14.70	0.06	0.16	0.12
6	17.00	0.05	0.15	0.15
7	20.90	0.07	0.15	0.15
8	23.30	0.07	0.20	0.20
9	24.80	0.07	0.20	-
10	26.20	0.07	0.20	0.20

Source: Study Team

Table A25 Results of Material Tests for Base and Subbase Courses

Crush Stone Base / Natural Gravel Subbase

Trial Pit No.	Layer	Thickness (m)	Moisture Content (%)	Classification Gavel (%)	Sand (%)	Fines (%)	Type	Layer	Thickness (m)	Moisture Content (%)	Classification Gavel (%)	Sand (%)	Fines (%)	Type	Atterberg Limits LL (%)	PL (%)	PI (%)	Note	Type
TP 1	Base	0.15	1.9	73	23	4	GS	Subbase	0.10	6.4	63	19	18	GFS	31.0	15.0	16.0		CL
TP 2	Base	0.25	1.1	75	21	4	GS	Subbase	0.20	6.0	69	18	13	GS-F	34.8	20.5	14.3		CL
TP 3	Base	0.20	1.0	74	21	5	GS-F	Subbase	0.15	7.1	73	9	18	GF-S	38.2	17.4	20.8		CL
TP 4	Base	0.15	1.0	74	20	6	GS-F	Subbase	0.15	8.2	63	12	25	GF-S	47.8	31.3	16.5		ML
TP 5	Base	0.16	1.1	72	24	4	GS	Subbase	0.12	8.9	70	12	18	GF-S	41.6	22.9	18.7		CL
TP 6	Base	0.15	1.4	68	29	3	GS	Subbase	0.15	9.5	74	12	14	G-FS	37.8	31.3	6.5		ML
TP 7	Base	0.15	3.2	72	25	3	GS	Subbase	0.15	8.1	55	21	24	GFS	41.2	22.5	18.7		CL
TP 8	Base	0.20	1.8	73	21	6	GS-F	Subbase	0.20	6.6	56	23	21	GFS	35.4	24.3	11.1		ML
TP 9	Base	0.20	2.1	74	22	4	GS	Subbase	-	7.0	56	24	20	GFS	34.4	21.3	13.1		CL
TP 10	Base	0.20	0.9	63	33	4	GS	Subbase	0.20	7.9	71	16	13	GS-F	33.6	22.7	10.9		CL

Source: Study Team

Table A26 Results of Material Tests for Subgrade

Trial Pit No.	Layer	Thickness (m)	Moisture Content (%)	Classification Gavel (%)	Sand (%)	Fines (%)	Type	Atterberg Limits LL (%)	PL (%)	PI (%)	Note	Type	Compaction Test OMC (%)	MDD (g/cm3)	CBR Test 93% (%)	95% (%)	98% (%)	100% (%)
TP 1	Subgrade	0.10	14.6	45	30	25	GFS	25.4	15.5	9.9		CL	8.0	2.06	23	27	35	40
TP 2	Subgrade	-	5.0	31	32	37	SFG	42.3	32.5	9.8		ML	9.5	2.00	33	42	50	55
TP 3	Subgrade	0.83	11.9	12	31	57	FS-G	59.6	44.8	14.8		MH	11.2	1.81	19	20	22	23
TP 4	Subgrade	-	15.1	47	28	25	GFS	44.8	34.9	9.9		ML	8.2	1.98	27	35	47	55
TP 5	Subgrade	1.20	11.2	28	24	48	GFS	57.8	30.0	27.8		CH	10.5	1.92	23	26	27	29
TP 6	Subgrade	0.15	18.8	44	34	22	GFS	Non-Plastic					8.5	1.92	17	19	21	22
TP 7	Subgrade	0.86	12.4	33	30	37	GFS	Non-Plastic					12.0	1.90	9	9	10	14
TP 8	Subgrade	0.23	7.1	60	13	27	GF-S	51.2	37.4	13.8		MH	10.5	1.99	34	37	42	46
TP 9	Subgrade	0.93	7.4	70	13	17	GF-S	Non-Plastic					11.0	2.02	14	14	17	22
TP 10	Subgrade	-	9.3	59	26	15	GFS	27.1	23.7	3.4		ML	7.5	2.14	23	23	24	25

Source: Study Team