People's Republic of Bangladesh
Ministry of Local Government,
Rural Development and Cooperatives
Local Government Division
Local Government Engineering Department

People's Republic of Bangladesh

Preparatory Survey on the Northern Region Rural Development and Local Governance Improvement Project

Final Report Supplementary Annexes

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List of Supplementary Annexes

Supplementary Annex 1
Draft Environmental Impact Assessment report
for a 150-m bridge construction over the Gudaria River
Haluaghat Upazila, Mymensingh District

Abbreviations and acronyms

ARIPO	Acquisition and Requisition of the Immovable Property Ordinance
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
CCSAP	Climate Change Strategy and Action Plan
DC	Deputy Commissioner
DEPC	Department of Environment Pollution Control
DG	Director General
DOE	Department of Environment
DSM	Design, Supervision and Monitoring
DTW	deep tubewell
ECA	Environment Conservation Act
ECC	Environmental Clearance Certificate
ECR	Environment Conservation Rules
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ES	Environmental Specialist
FGD	Focus Group Discussion
GC	Growth Center
GRM	Grievance Redress Mechanism
HTW	hand tubewell
HYV	high yielding variety
IEE	Initial Environmental Examination
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
LCS	Labor Contracting Society
LGED	Local Government Engineering Department
LGD	Local Government Division
LLP	low lift pump
MLGRD&C	Ministry of Local Government Rural Development and Cooperatives
NEMAP	National Environmental Management Action Plan
NOC	no objection certificate
NRRDLGIP	Northern Region Rural Development and Local Governance Improvement Project
O&M	operation and maintenance
PAPs	Project affected persons
PMO	Project Management Office
REE	Regional Environmental Expert

RCC	reinforced concrete cement
RDPD	Regional Deputy Project Director
RPF	Resettlement Policy Framework
RRS	Rehabilitation and Resettlement Specialist
RRRE	Regional Rehabilitation and Resettlement Expert
STW	shallow tubewell
UE	Upazila Engineer
UNR	Union road
UZR	Upazila road
XEN	Executive Engineer

List of local terms

Aman	Rice cultivated in the monsoon season
Beel	Relatively small surface water body such as pond or small lake with static water from internal drainage system lying depression or low land and drying up in winter
Bigha	A unit of area equal to approximately 0.13 hectare
Boro	Rice cultivated in the winter season under irrigated condition
Country boat	Manually propelled rural boat, usually wooden
Decimal	a unit of area approximately equal to 40.4686 m²
Engine boat	Rural boat powered by a small diesel engine, wooden or steel construction
Ghat	A rural boat landing station, often connected to a market
Hat day	Market day
Parishad	Council

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1 Background

1.1 Background of the NRRDLGIP

The Government of Bangladesh (GOB) has made poverty reduction an important development strategy, which has declined from 58.8% in 1991-1992 to 31.5% in 2010. Poverty reduction through rural development is one of the most important issues in Bangladesh, since about 70% of the population is living in the rural areas. It is observed that poverty level is the highest in Rangpur Division (the north-west part of the country) according to the statistics in 2010. The area is left behind from development and thus development needs are high in the field of rural infrastructure and access to public services.

Taking into consideration of the above, Japan International Cooperation Agency (JICA) plans to assist the Northern Region Rural Development and Local Governance Improvement Project (NRRDLGIP) with the objective to expand access to rural and urban infrastructures and services, and improve urban governance in the northern region. The NRRDLGIP will have two main components: Component 1 (rural infrastructure development); and Component 2 (Pourashava infrastructure and governance improvement).

Component 1 will include the following infrastructure development: 1) upgrading of Upazila roads (UZR) and Union roads (UNR) including bridges and culverts; 2) rehabilitation of UZR; 3) improvement of Growth Centers and rural markets; and 4) improvement of *ghats* or boat landing stages.

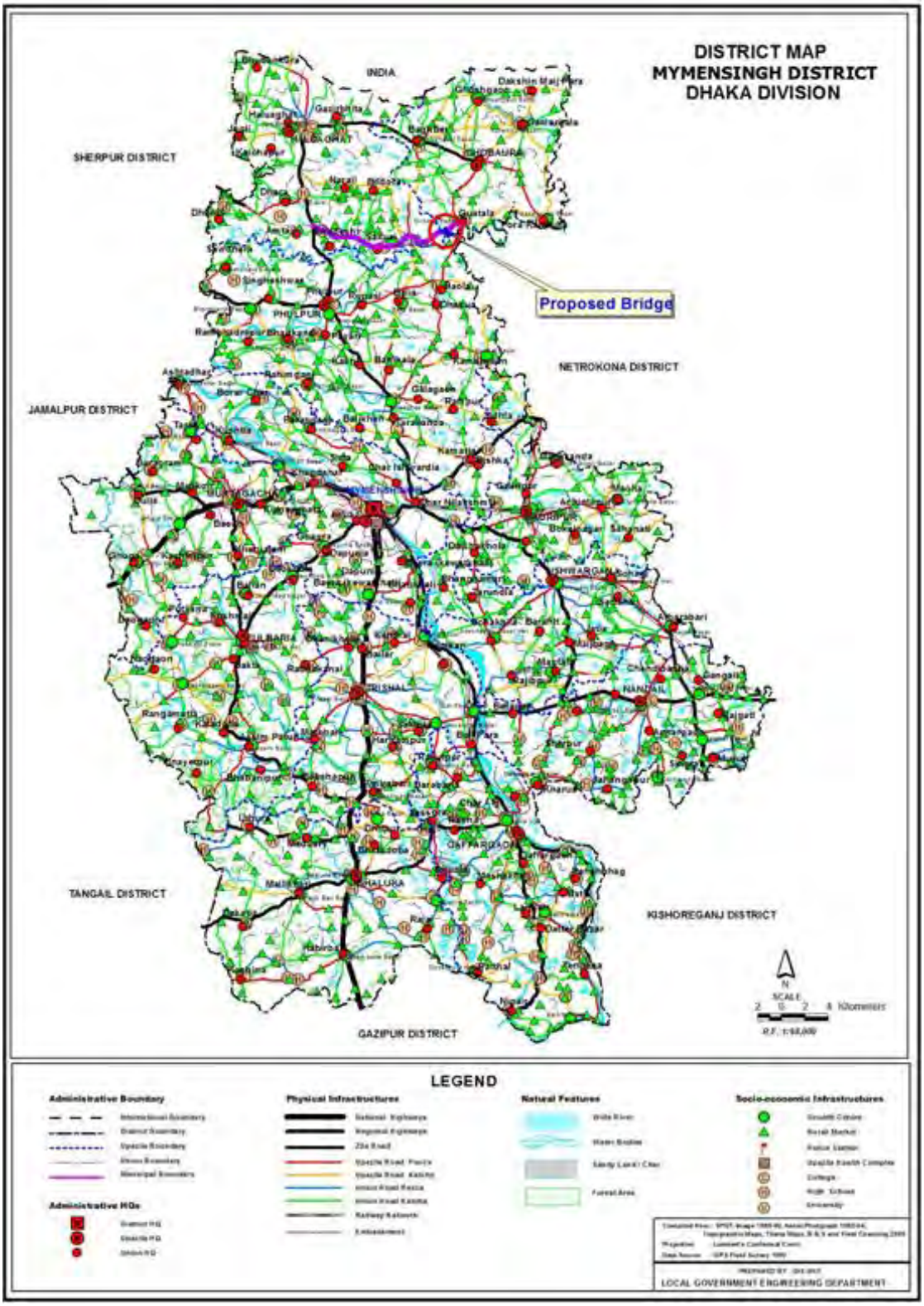
Subprojects under Subcomponent 2-1 will not be determined at the preparatory survey phase. They will be selected through participatory approaches in the implementation phase of the Project. The eligible types of infrastructure works under the subcomponent may include: 1) improvement and rehabilitation of Pourashava roads, bridges, and culverts; 2) repair, rehabilitation, and expansion of drains; 3) improvement of municipal markets; 4) construction of slaughter houses; 5) rehabilitation and expansion of water distribution network and tubewells; 6) construction of public and community toilets; 7) construction of solid waste management facilities; 8) construction of bus and truck terminals; 9) installation of streetlights; 10) establishment of parking areas; and 11) basic infrastructures for the poor.

The target area of the NRRDLGIP covers eight Districts in Rangpur Division, namely Dinajpur, Thakurgaon, Panchagarh, Rangpur, Lalmonirhat, Nilphamari, Kurigram and Gaibandha, and six Districts in Mymensingh area of Dhaka Division, namely, Jamalpur, Sherpur, Tangail, Mymensingh, Netrokona and Kishoreganj. The Bangladesh counterpart agencies are the Local Government Division (LGD) and the Local Government Engineering Department (LGED) of the Ministry of Local Government, Rural Development and Cooperatives (MLGRD&C).

1.2 Background of the environmental impact assessment

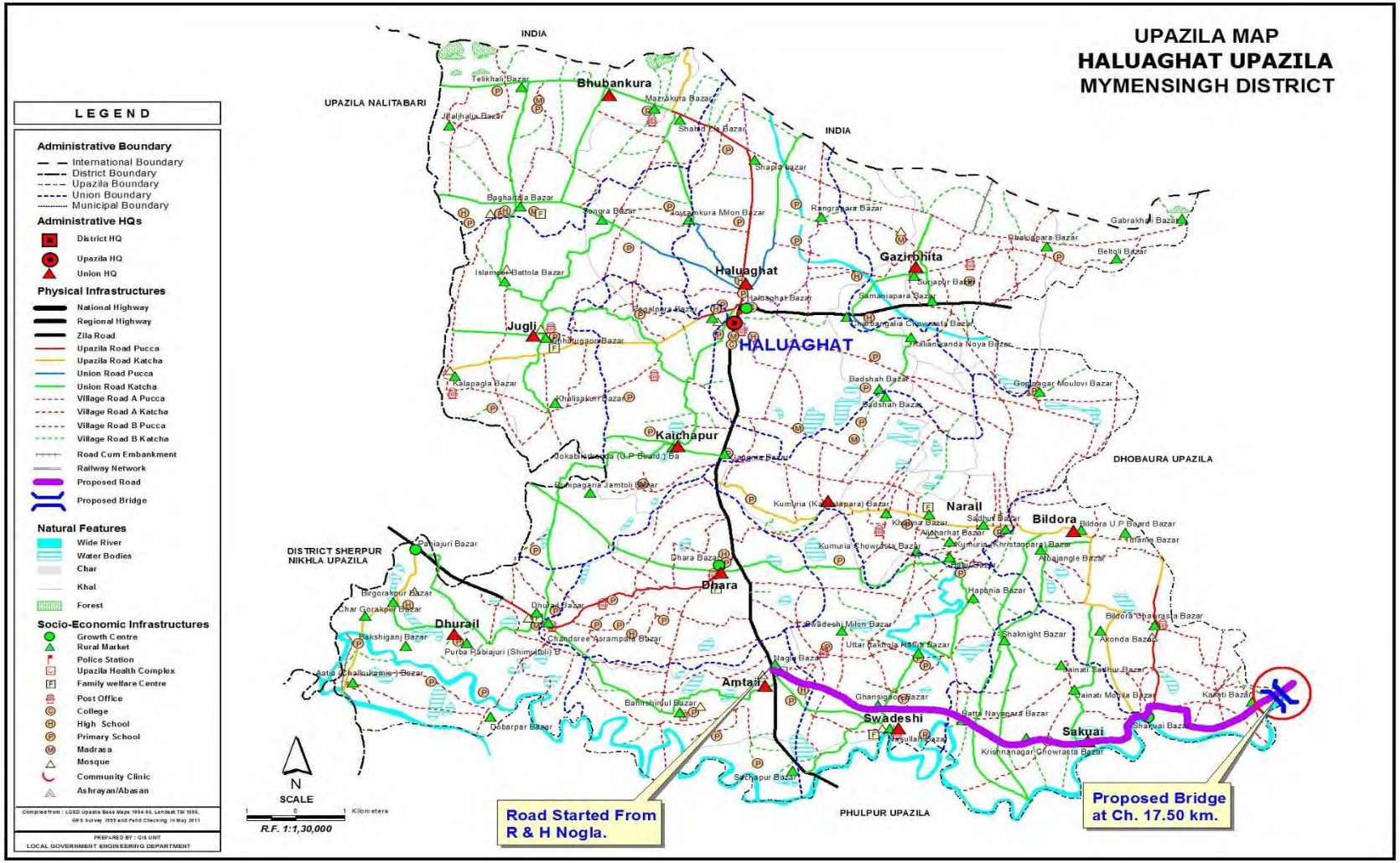
1.2.1 Description of the subproject

Under Component 1 of the NRRDLGIP, the LGED has proposed the construction of a bridge as part of a subproject under the NRRDLGIP. The proposed subproject is the improvement of the UZR of "R&H (Nagla) - Goatola GC via Shakuai GC (Road Code: 361242003)" in Haluaghat Upazila, Mymensingh District, Dhaka Division. A bridge is proposed to be constructed at the ending point of the UZR to connect the different UZR in Dobaura Upazila in Mymensingh District.



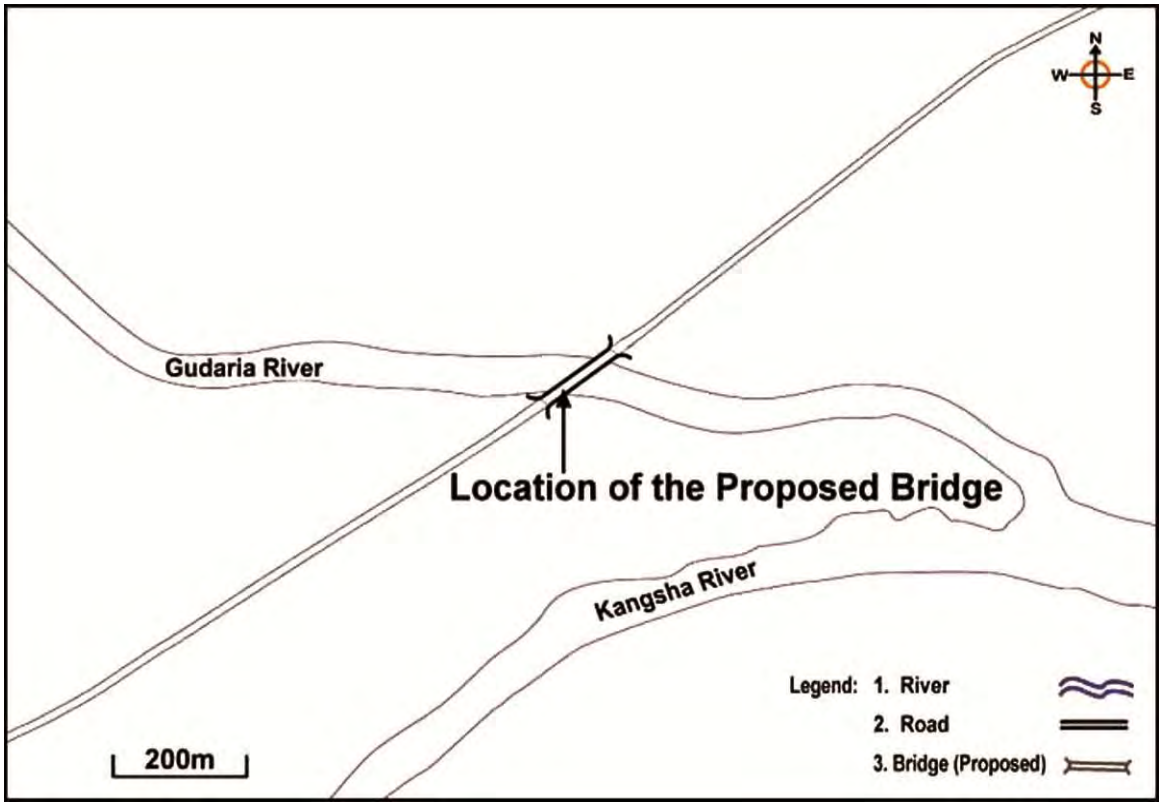
Source: LGED and Survey Team

Figure 1 Location of the proposed bridge



Source: LGED and Survey Team

Figure 2 Location of the proposed bridge



Source: Survey Team

Figure 3 Simplified drawing of the proposed bridge construction site

The proposed bridge construction site is at Futkai ferry ghat, which is located between Kailati village (latitude-25°01.391'N and longitude 90°29.097'E) of Bildora Union of Haluaghat Upazila (right bank) and Futkai village (latitude-25°01.439'N and longitude 90°29.447'E) of Goatola Union of Dobaura Upazila (left bank) in Mymensingh District, Dhaka Division. The site is located about 17.5 km east of Nagla bazar, which is about 40 km north from the center of Mymensingh Pourashava and 11 km south of Haluaghat Upazila center.

Figure 1 and Figure 2 demonstrate the location of the proposed bridge construction site, and Figure 3 shows the simplified drawing of the site. The bridge will be constructed over the Gudaria River. The Gudaria River connects with the Kangsha River at 0.7 km south-east downstream from the bridge construction site.

Current road condition

The UZR passes from Nagla bazaar to Futkai ferry ghat. The length of the UZR is approximately 17.5 km, of which about 3.84 km is earthen in the portion adjacent to the Futkai ferry ghat. About 10.20 km of the road has bituminous carpeting, and 3.47 km of the road is paved by brick. The crest width of the UZR is 5.03 m on average. This UZR will be improved under the NRRDLGIP, and the proposed bridge will be constructed as part of the UZR improvement works.

On the left bank of the Futkai ferry ghat, there is another UZR going to the Goatola bazar or Growth Center (GC). The road is then connected to Dobaura Upazila. The portion from the Futkai ferry ghat and the Goatola GC is earthen, and the remaining part is paved by bitumen.

As described earlier, there is a small ferry ghat, called the "Futkai ferry ghat", at the proposed bridge

site over the Gudaria River. Many people living in Bildora Union of Haluaghat Upazila, situated on the right bank, routinely cross the Gudaria river to reach Goatola GC located on the left bank. They cross the river by ferry service for selling and buying agricultural products and groceries, attending educational institutions, going hospitals and clinics, and other various socioeconomic reasons. Therefore, the proposed bridge construction will contribute to the improved connectivity between the both banks, and to the enhancement of the livelihood conditions.

No residential house and settlement have been found nearby the ghat along the existing alignment of the UZR, though some agricultural land and wetlands are found along the alignment. A view of the proposed bridge construction site is shown in Image 1.

Image 1 View of the proposed bridge construction site

Proposed bridge

The width of the Gudaria River at the proposed bridge construction site is 112 m according to the LGED road inventory. However, the field survey observed that the possible length of the proposed bridge would be approximately 150 m, taking into account the expected specifications of the proposed bridge, possible locations of bridge abutments, and soil and geological conditions of the bank.

The alignment of the bridge is expected to be almost linear connecting the existing road alignments of the two UZRs on both banks of the river. Along the alignment, approach roads will be constructed for the proposed bridge. The bridge will be constructed basically in accordance with the LGED road design standards for rural roads. The LGED Design Unit has also provided the Survey Team with the guidance on the current bridge design practices. The latest guidance on bridge design is shown in Table 1.

Table 1 Latest guidance on bridge design

Design loading criterion	AASHTO-LFRD-HL-93 – this supersedes the H20S16 loading specified previously
Carriageway width	5.5 m, i.e., double lane, is standard to allow for future growth of traffic. 7.32 m to be used for more important roads with higher traffic levels
Footpath	0.65 m width on each side of the carriageway. Increased to 1.0 m width on each side of the carriageway for more important roads
Girder web width	450 mm
Deck slab thickness	200 mm
Railings	1,050 mm height, posts 200 mm x 200 mm reinforced cement-concrete (RCC), bars 150 mm X 150 mm RCC
Cast-in-situ piles	Minimum diameter 500 mm, maximum diameter 1,200 mm Minimum pile depth 15 m, maximum pile depth 55 m Pile cap should be 500 mm above the lowest water level
Pier geometry	For normal water flow, two circular columns Where skewed, one column For height greater than 12 m, single H type
Concrete strength	25 MPa, except for pre-stressed girders 35 MPa
Mild steel reinforcement rod	60 grade

Source: Communication with LGED Design Unit

However, it should be noted that the detailed design of the proposed bridge has not been determined yet at the preparatory survey phase. The detailed design will be determined after the commencement of the NRRDLGIP.

1.2.2 Necessity of environmental impact assessment

Since the estimated length of the proposed bridge is over 100m, the Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) on the bridge construction is required as per the Environmental Conservation Rules 1997.

The IEE and EIA have been conducted from July to September 2012 under the Preparatory Survey for the NRRDLGIP. They are carried out on the assumption that the bridge will be constructed as per the LGED's design standard for rural road and the latest guidance from the LGED Design Unit shown in Table 1.

However, it should be kept in mind that the detailed design survey for the proposed bridge will be carried out after the commencement of the NRRDLGIP, and thus the design has not been determined yet at the preparatory survey phase. It is therefore required, when the design is determined, this draft EIA report should be updated and finalized according to it.

2 Environmental policy and regulations

2.1 National policy

2.1.1 National Environmental Policy 1992

The National Environmental Policy, formulated in 1992, sets the policy framework for environmental action, in combination with a set of broad sectoral guidelines. It emphasizes the following:

- Maintenance of the ecological balance and overall development of Bangladesh through conservation and improvement of the environment;
- Protection of Bangladesh against natural disasters;

- Identification and control of the activities related to pollution and degradation of the environment;
- Environmentally sound environment;
- Environmentally sustainable use of all natural resources; and
- Active association with all environmental related international initiatives to the maximum possible level.

2.1.2 National Environmental Management Action Plan 1995

The National Environmental Management Action Plan (NEMAP) is based on a nationwide consultation program, intended to develop the Environmental Policy and the National Conservation Strategy into an implementable strategy. It constitutes a synthesis of the Government's and people's perception of the key environmental issues and actions required to address them. It also outlines respective sectoral and environmental policies for 12 identified sectors. NEMAP also provides an overview of the existing institutional issues and actions to meet the objectives of sustainable development and environmental management. It is a wide ranging plan which builds on and extends the statements set out in the National Environment Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2000, and sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP has the following objectives:

- Identification of key environmental issues affecting Bangladesh
- Identification of actions necessary to halt or reduce the rate of environmental degradation
- Improvement of the natural and build environment
- Conservation of habitats and biodiversity
- Promotion of sustainable development
- Improvement in the quality of life of the people

2.2 National legislation

2.2.1 Background

The early concern for the state of the environment in Bangladesh goes back to the passing of the water pollution act in 1974, under which a small unit was established in the Department of Public Health Engineering to monitor the quality of surface and ground water. The Government promulgated the Environment Pollution Control Ordinance in 1977 and established the Environment Pollution Control Board responsible for formulating policies and proposing measures for implementing them. In 1982, the Department was renamed as the Department of Environment Pollution Control (DEPC) consisting of four Divisional offices in Dhaka, Chittagong, Khulna, and Bogra.

In 1989, the DEPC was again renamed as the Department of Environment (DOE), placed under the newly formed Ministry of Environment and Forest.

2.2.2 Environment Conservation Act 1995 (subsequent amendments in 2000 and 2002)

The Environment Conservation Act (ECA) 1995 is the main legal framework on environmental conservation in Bangladesh. The main objectives of the ECA are: 1) conservation and improvement of the environment; and 2) control and mitigation of pollution in the environment. To achieve these objectives, the ECA focuses on the following items:

1) Declaration of Ecologically Critical Areas (Section 5)
2) Regulations of emissions from vehicles (Section 6)
3) Issuance of environmental clearances (Section 12)

4) Formulation of environmental guidelines (Section 13)
5) Regulation of development activities' discharge permits (Section 20)
6) Promulgation of standards for the quality of air, water, noise and soil (Section 20)
7) Promulgation of standard limits for waste discharge (Section 20)

The ECA also stipulates the establishment of the DOE and the power and functions of the Director General (DG) for carrying out the purposes of the ECA (Section 3 and 4). For instance, the DG who is appointed by the Government of Bangladesh may issue directions of prohibition or regulations on an industry, undertaking or process when he or she considers it necessary for environmental conservation. In addition, according to Section 12 of the ECA, all development projects must obtain an Environmental Clearance Certificate (ECC) from the DG of the DOE.

2.2.3 Environment Conservation Rules 1997 (subsequent amendments in 2002 and 2003)

The Environment Conservation Rules (ECR) 1997, which was issued by the Ministry of the Environment and Forest, spells out the detailed procedures and requirements for the enforcement of the ECA. The ECR was promulgated in exercise of the powers conferred by Section 20 of the ECA, stating that the government is empowered to make rules for carrying out the purposes of the ECA. The subjects relevant to environmental assessment are as follows:

1) Considerations for the declaration of Ecologically Critical Areas (Rule 3)
2) Classification of projects (Rule 7)
3) Procedures to obtain ECCs (Rule 7)
4) Requirements for IEE and EIA (Rule 7)
5) Determination of environmental quality standards for air, water, noise, odor and other components of the environment (Rule 12)
6) Determination of standards for waste discharge and gaseous emissions from industry or development projects (Rule 13)

Rule 3 defines the factors to be considered in declaration of Ecologically Critical Areas such as wetlands and forest areas as per Section 5 of the ECA. It also empowers the government to specify the activities which cannot be continued or initiated in an Ecologically Critical Area.

Rule 7 provides a classification for development projects into four categories depending upon their environmental impact and location. These categories are labeled as: 1) Green; 2) Orange A; 3) Orange B; and 4) Red. Classified projects shall obtain an ECC for each category in accordance with the requirements stipulated in the ECR. Table 2 illustrates the documents for each category which are required to be submitted to the Division Officer of the DOE for an application for the ECC.

All development projects that are considered to be low-polluting are classified in the Green category, and shall automatically be granted an ECC after the submission of the application with the necessary documents. Projects that are considered to be potentially polluting are classified as Orange A, Orange B, and Red categories in order of the magnitude of the potential environmental impact, and are required to obtain first a Site Clearance Certificate, and thereafter an ECC after the submission of the application form and other required documents according to their categories in Table 2.

Apart from the general requirements and the Environmental Management Plan (EMP), for projects classified as Orange B and Red category projects, the application shall also be accompanied with an IEE or EIA report on the basis of the terms of reference approved by the DOE, respectively.

Table 2 Requirements by environmental categories

Category	Requirements
Green	General information, no objection certificate (NOC) from the local authority, etc.
Orange-A	General information, NOC, etc.
Orange-B	IEE, EMP, NOC, etc.
Red	EIA, EMP, NOC, etc.

Source: Environment Conservation Rules (1997)

According to Item 68 of Section D, Schedule 1 of the ECR, construction, reconstruction, and extension of bridges over 100 meters in length are classified as "Red" category. Thus, IEE and EIA are mandatory for the proposed bridge construction, whose length will be approximately 150 m.

2.2.4 Acquisition and Requisition of the Immovable Property Ordinance 1982

The Acquisition and Requisition of the Immovable Property Ordinance (ARIPO) 1982 and the subsequent amendments made during 1993 and 1994 constitute the legal framework that governs all cases of land acquisition in Bangladesh. The Acquisition and Requisition of Immovable Property Rules 1982 were issued under Section 46 of the ARIPO stipulating that the government is empowered to make rules for carrying out the purposes of the ARIPO.

Land acquisition below 50 *bigha* (about 6.7 hectare) is handled by the Division Commissioner, and that of over 50 *bigha* by the Ministry of Land. Regardless of the size of land to be acquired, it is Deputy Commissioner (DC) who determines market price of the assets based on the approved procedure, and pays one hundred and fifty percent of the assessed value as compensation. Section 10A inserted by the amendment in 1994 made provisions for payment of crop compensation to tenant cultivators.

However, the ARIPO does not cover project-affected persons (PAPs) without titles of ownership record. For example, informal settlers or squatters, occupiers, and informal tenants and lease-holders without legal documents will not be compensated under the ARIPO. Also, it does not ensure replacement value of the property acquired. The two issues should be considered in the proposed bridge construction, namely the PAPs without titles should be compensated, and the compensation should be based on the replacement values of the property.

2.3 JICA Guidelines for Environmental and Social Considerations (2010)

According to the JICA Guidelines for Environmental and Social Considerations (hereinafter the "JICA Guidelines"), the following conditions should be met in principle:

- When assessment procedures already exist in host countries, and projects are subject to such procedures, project proponents must officially finish those procedures and obtain the approval of the government of the host country.
- EIA reports (which may be referred to differently in different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to the local residents, written materials must be provided in a language and form understandable to them.
- It is required that EIA reports be made available to the local residents of the country in which the project to be implemented. The EIA reports must be available at all times for perusal by project stakeholders such as residents and copying must be permitted.

- In preparing EIA reports, consultation with stakeholders, such as local residents, must take place after sufficient information has been disclosed. Records of such consultation must be prepared.
- Consultations with relevant stakeholders, such as local residents, should take place if necessary throughout the preparation and implementation stages of a project. Holding a consultation is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared.

It is desirable that EIA reports cover the items enumerated (in short) as follows:

- Policy, legal and administrative framework
- Project description including a map showing the project site
- Baseline data
- Environmental impact
- Analysis of alternatives
- EMP
- Consultation

2.4 LGED Environmental Guidelines

The LGED published the "Environmental Guidelines for the LGED Projects" (hereinafter the "LGED Guidelines") in 2008, as part of its goal to implement all development projects in an environmentally sound and sustainable manner. If a project follows the LGED Guidelines, it will meet all requirements of the GOB and its financing partners, including JICA. The guidelines outline required procedures and formats for IEEs and EIAs for rural infrastructure development and urban sector projects. For example, procedures such as analysis of alternatives, public consultations, and preparation of EMPs are included in the suggested outline of the EIA report. Thus, it can be concluded that conduct of an IEE and EIA in accordance with the LGED Guidelines would generally satisfy the requirements of the JICA Guidelines.

3 Baseline environmental conditions

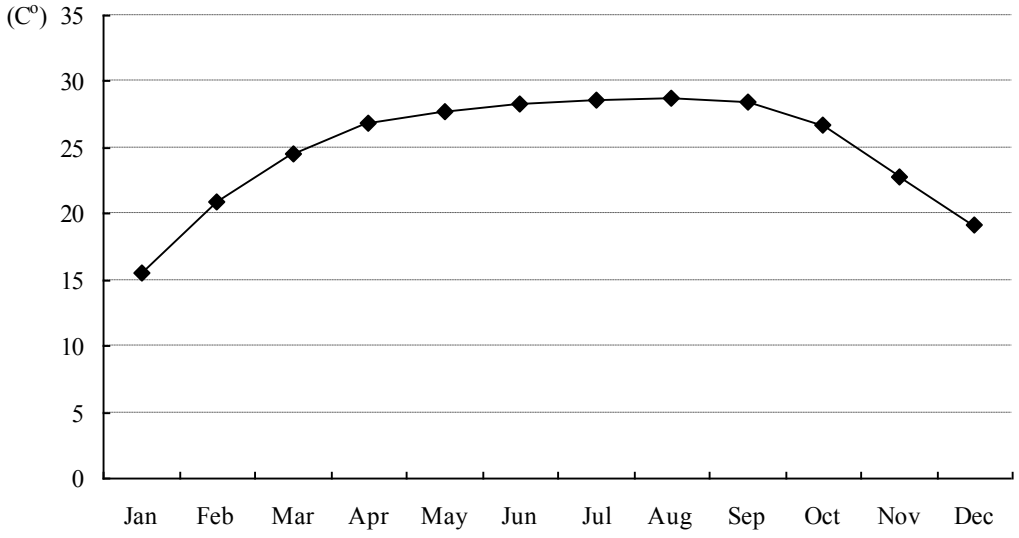
3.1 Physical environment

3.1.1 Climate

The subproject area has a typical monsoon climate with three main seasons, summer (March to May), monsoon (June to October), and winter (November to February). The summer is generally hot with occasional moderate to heavy rainfall. The monsoon is generally humid with 80% of annual rainfall. The winter is generally cold with less humidity.

The nearest meteorological station of the Bangladesh Meteorological Department (BMD) from the subproject site is the station of the Mymensingh branch of the BMD. Meteorological data from 2001 to 2011 were collected from the station. The climate conditions of the subproject site are described below.

Temperature
Mean monthly temperature in Mymensingh in the last 10 years (2002-2011) is given in Figure 4. December and January are the coolest months with average monthly temperature of below 20º C, while the period from May to September is the hottest with average monthly temperatures ranging from 26 to 30°C. The maximum monthly temperatures recorded at Mymensingh are 37.5°C (May, 2006). The minimum monthly temperatures recorded at Mymensingh are 5.4°C (January, 2001 and January, 2003).

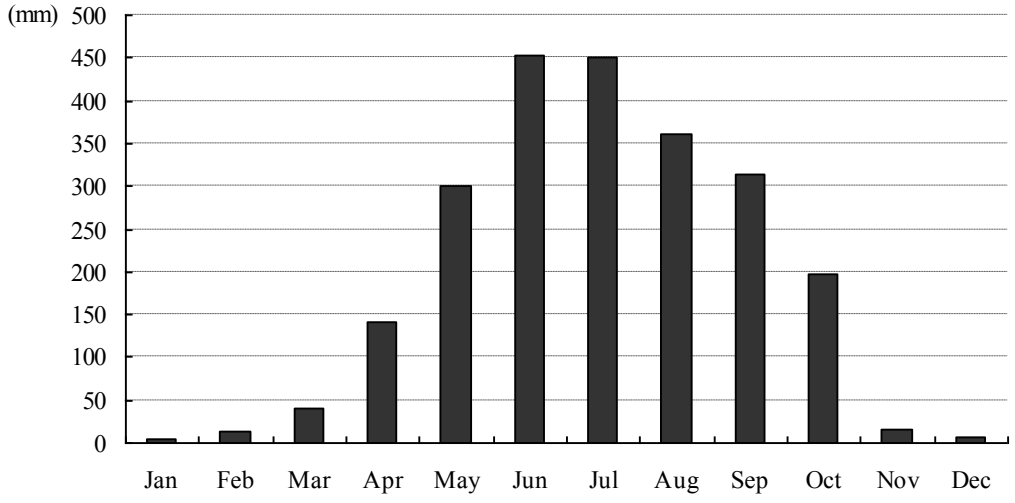


Source: Bangladesh Meteorological Department

Figure 4 Mean monthly temperature in Mymensingh in last 10 years (2002-2011)

Rainfall

Annual rainfall of Mymensingh varies from 1,662 to 3,193 mm, during 2001 to 2011. Average monthly rainfall data in the last ten years in Mymensingh is given in Figure 5. In general, May to October is the rainy season, and the maximum rainfall takes place during June and August. June and July are the wettest months with the highest monthly rainfall of about 450 mm on average, but the rainfall during these months sometimes exceeds 750 mm. From November to February is the driest period with almost no rainfall.



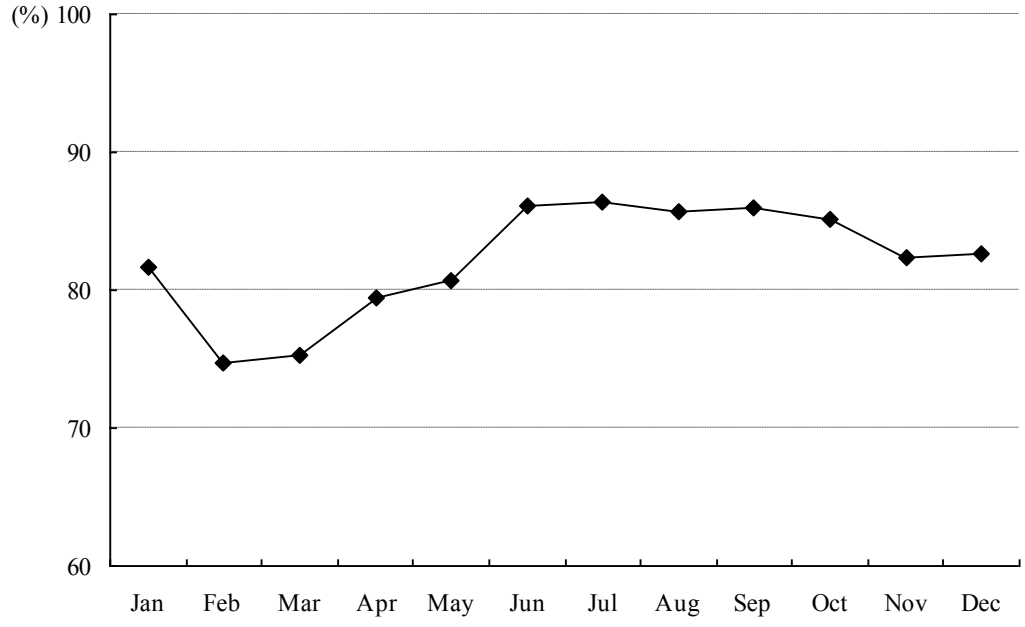
Source: Bangladesh Meteorological Department

Figure 5 Mean monthly rainfalls in Mymensingh in last 10 years (2002-2011)

Humidity

Annual humidity of Mymensingh is quite static from June to January, ranging from 80% to 90% during 2001 to 2011. The highest humidity corresponds to the rainy season between June and October. The maximum monthly humidity was about 90%, recorded in July 2002, August 2008 and September 2004.

Low humidity prevails in February and March, and the mean monthly humidity was less than 80%.



Source: Bangladesh Meteorological Department

Figure 6 Mean monthly humidity in Mymensingh in last 10 years (2002-2011)

Wind Speed

Annual wind speed and direction in Mymensingh vary each month. April, May and June have a higher mean wind speed than the other months of the year. On the other hand, a low wind flow was observed during October to February. Wind flows mainly from east and north-east during November to January with some from north-west, whereas it flows from east to south-east during February to October. The highest wind was recorded as 4.5 knots/hour in April 2001.

3.1.2 Topography, geology and soils

The topography of the proposed bridge construction site is almost flat, and the altitude is approximately from 5 m to 15 m above sea level. It is gently undulating landscape of flood plain ridges. The soil consists of the recent and sub recent alluvial sediments which are mainly medium to fine textured on or near the surface. In terms of physiographic aspect, the proposed bridge site belongs to older piedmont alluvial plain.

It occupies nearly level piedmont plain gently sloping southwards. It is crossed by some narrow higher ridges and underlain by clayey deposits which sometimes bury Brahmaputra alluvium within 40 inches. The topography appears, at least partly buried basin landscape of the Older Brahmaputra floodplain.

The soils are loamy to clayey in texture, where mainly two crops are grown annually, i.e., Transplanted Aman[1] (both local variety and high yielding variety) grown during rainy season (mainly August to mid-December) and Boro[2] (high yielding variety) grown during dry season (mainly mid-December to May). In some areas, Transplanted Aman is followed by various rabi crops.

[1] Aman is paddy crops grown during the rainy season, mainly between August and December.
[2] Boro is paddy crops grown during the dry season (mainly mid-December to May).

3.1.4 Surface water hydrology

The proposed bridge will be constructed on the Gudaria River at location of existing Futkai ferry ghat. The Gudaria River falls to the Kangsha River at 0.7 km south-east and the flow discharges subsequently to the Dhanu river of the Meghna basin area.

The Gudaria River is formed of numerous streamlets originating from hills of Meghalaya State of India and it is flashy in nature. The important streamlets flowing into the river are, the Gangina, Ramkali, Paiddajuri, Bhoraghat, Jam nadi and Netai.

The Gudaria River flows about 10 months a year, and usually dries up between late February and early April, depending on the annual variations of rainfalls in the catchments area. Data from the nearest rainfall station shows the area has the maximum rainfalls in July varying from 497 mm to 801 mm on average. The Gudaria River suffers from flash flood almost every year usually in June, July and August when river banks go under water. There is also severe flood every 10 to 15 years interval which causes more inundation, e.g., in 1988 water level rose to 2.5 feet (0.76 m) in Futkai village on the left bank, and 2.0 (0.61m) in Kailati village on the right bank respectively, compared with the homestead level. Similarly in 1998, water level rose to 1.5 feet (0.46 m) and 1.0 foot (0.31 m) in Futkai village on the left bank and Kailati village on the right bank respectively. Such data are summarized in Table 3.

Table 3 Data on the highest flood level in 1988 and 1998

Flood year	Location	Depth of flooding above homestead level	Duration of flooding
1988	Village-Futkai	2.5 feet (0.76 m)	15-18 days
	Village-Kailati	2.0 feet (0.61 m)	
1998	Village-Futkai	1.5 feet (0.46 m)	15-22 days
	Village-Kailati	1.0 foot (0.31 m)	

Source: Data collected through FGD

3.1.5 Ground water

Ground water is widely used for both drinking and irrigation purposes in the subproject area. The depth of the hand tubewells (HTWs) for drinking water in the area varies from 40 feet to 120 feet (12.23 to 36.70 m).

The discharge of HTWs for drinking, which have less depth than deep tubewells (DTWs) for irrigation, gets substantially reduced in the irrigation season. Water quality and discharge characteristics of HTWs are given in Table 4.

Table 4 HTWs for drinking water in the subproject area

Depth of HTW	Discharge level	As- Contamination	Fe-Contamination	Related information
40-50 feet (12.23-15.29 m)	Discharge is severely reduced during irrigation season	30% of HTWs have As-contamination beyond tolerance limit (>0.05 mg/l)	Have high iron contamination	Discharge of the HTWs are affected by operation of DTWs for irrigating Boro during February to April
50-120 feet (15.29-36.70m)	Discharge is reduced during irrigation season	30% As-contamination beyond tolerance limit (0.05 mg/l)	Have less iron contamination having depth >85 feet (25.99m)	

Source: Data collected through FGD

According to the laboratory test of HTWs by the Haluaghat Upazila DPHE laboratory, it is found that the water quality is within permissible limit as per contents of arsenic, iron and chloride. The data is

shown in Table 5.

Table 5 Laboratory analytical data of HTW water

Sample number	Arsenic (BDS permissible limit=up to 0.05 mg/l)		Iron (BDS permissible limit=0.3-1.0 mg/l)		Chloride (BDS permissible limit=150-160 mg/l)	
	Content	Method	Content	Method	Content	Method
1	0.004	AAS	0.34	AAS	15	ASS
2	0.003		0.41		13	
3	0.003		0.80		10	
4	0.003		0.21		11	
5	0.004		0.80		15	

Source: Upazila DPHE, Haluaghat
Legend: AAS: Atomic absorption spectrophotometry; BDS: Bangladesh drinking water standard

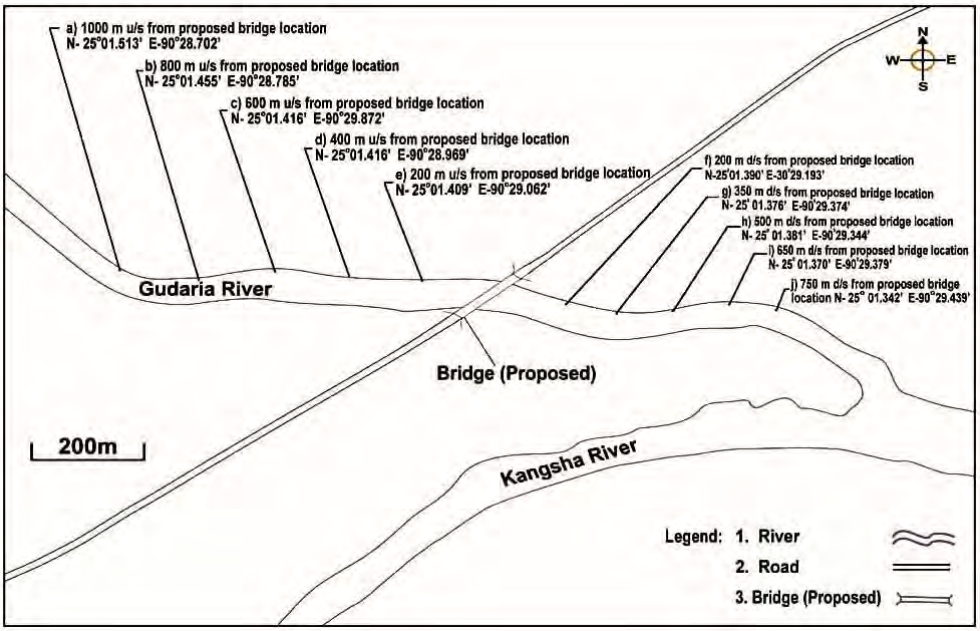
The ground water aquifer depth depends on the rate of discharge and recharge of water. Overexploitation of ground water would affect the water discharge capacity, which would affect availability of both drinking and irrigation water. Thus, required measures, including less use of ground water, are to be undertaken for maintenance of a balanced aquifer level.

3.1.6 River morphology

The Gudaria River is a flashy river composed of numerous streamlets coming from Meghalaya State of India. The important streamlets feeding the river are, Gangina, Ramkali, Paiddajuri, Bhoraghat, Jamnadi and Netai.

The river causes flush-flooding during peak monsoon months (mainly in July and August) and occasionally during early monsoon period (May and June), depending mainly on the onrush of rain water coming from the catchments areas of Meghalaya State of India. The monsoon flood damages the transplanted Aman crops. This requires the re-plantation of Aman, and eventually leads to increase in the cost of cultivation and reduction of yield. The monsoon flooding is, thus, increasing vulnerability of the farmers in the area.

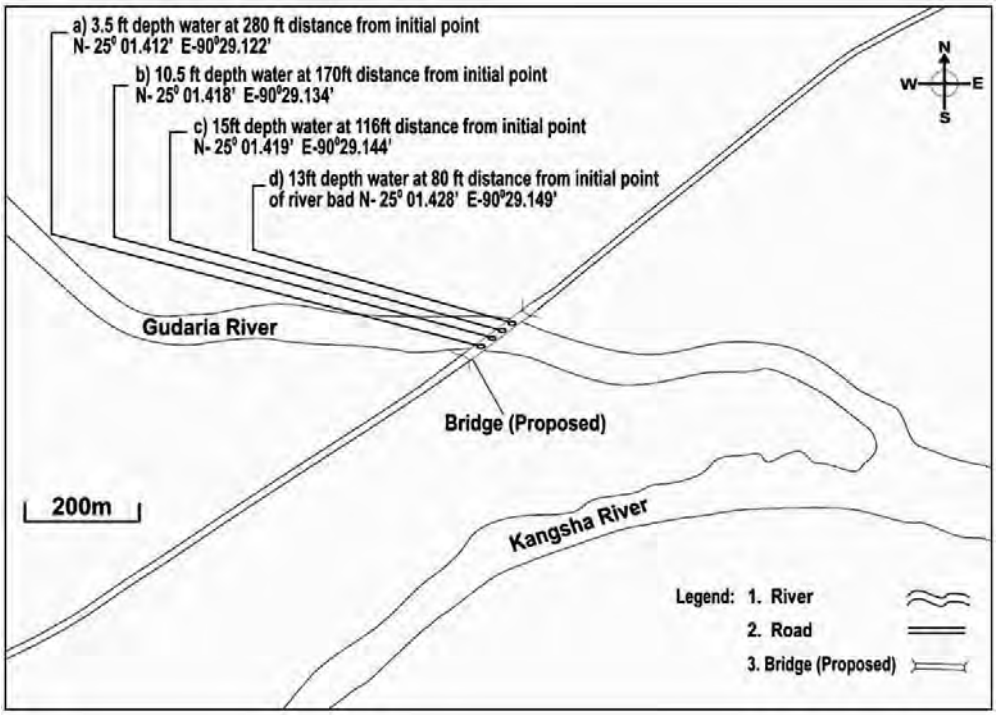
Although the river banks are often flooded every year, almost no change of the river course has been observed during the last 10, 20 and 30 years, according to the local consultation meetings. Local people stated that the river banks are stable, and no outstanding erosion is visible within 1,000 m upstream and 750 m downstream where the river meets the Kangsha River. For the further verification of the status of erosion and river bank stability, five sites of upstream at distances of about 200 m intervals, and five sites for downstream at distance of 150 m intervals have been sampled in the survey (Figure 7). No severe erosion has been observed from the survey. The images of different places in both upstream and downstream of the proposed bridge site are indicated in Attachment 2 to this Supplementary Annex.



Source: Survey Team

Figure 7 Locations on U/S and D/S of Gudaria River for river bank stability

Depth of the Gudaria River has been measured at four sample spots within the river flows (Figure 8 and Image 2). The measured depths are indicated in Table 6.



Source: Survey Team

Figure 8 Locations for river (Gudaria) depth measurement along the proposed bridge alignment

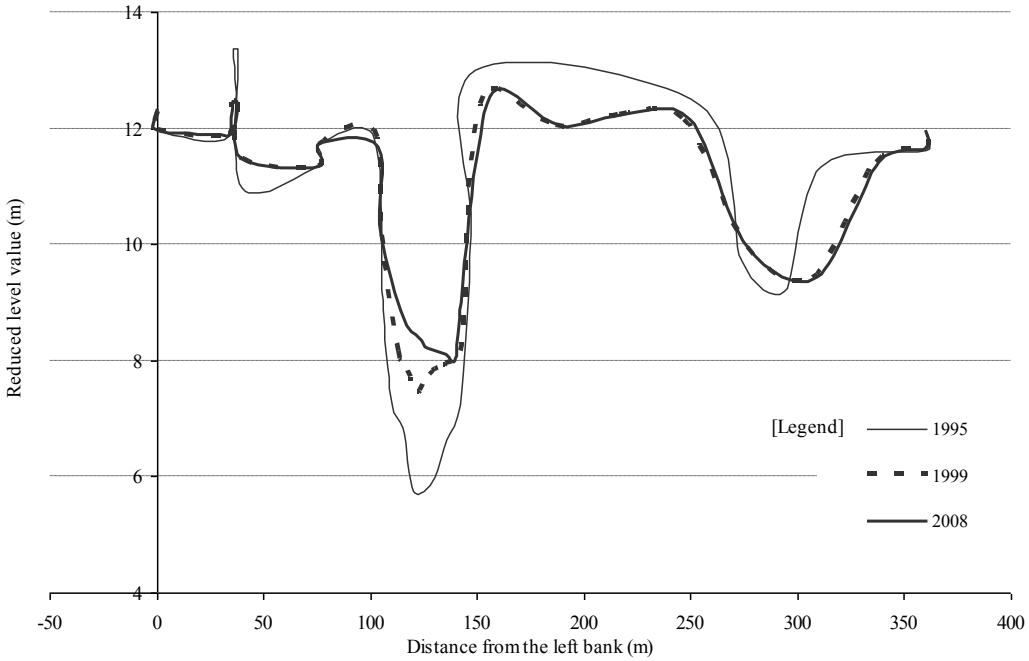
Image 2 Depth measurement of the Gudaria River

Table 6 Data on depth of the Gudaria River

Distances from right bank of the Gudaria River	Location	Depth	Date of measurement
80 feet (24.46m)	Latitude 25°01.428'N Longitude 90°29.149'E	13.00 feet (3.98m)	August 30, 2012
116 feet (35.47m)	Latitude 25°01.419'N Longitude 90°29.144'E	15.00 feet (4.59m)	August 30, 2012
180 feet (55.05m)	Latitude 25°01.418'N Longitude 90°29.134'E	10.42 feet (3.19m)	August 30, 2012
280 feet (85.63m)	Latitude 25°01.412'N Longitude 90°29.122'E	3.75 feet (1.15m)	August 30, 2012

Source: Field Survey

The cross section data of the Gudaria River was not available. However, the data of the river Bhogai-Kangsha at Haluaghat Upazila, which is connected at the downstream of the proposed bridge site, has been collected from the Bangladesh Water Development Board (BWDB). The river cross-section chart in selected years from 1995 to 2008 at the point code of rmbh9, which is approximately 500 m southeast from the proposed bridge site, is given in Figure 9.



Source: BWDB

Figure 9 Bhogai-Kangsha River cross-section for 1995-2008 (at point of rmbh9)

The cross section of the Bhogai-Kangsha River indicates that the river bed level has varied to some extent from 1995 to 2008, mainly because of the increased sedimentation. This implies that surrounding areas along the rivers of the proposed bridge site are prone to be affected by the sedimentation.

Figure 9 also indicates that the erosion level of the bank of the Kangsha River has not been so severe from 1995 to 2008. This implies that the soil conditions in the surrounding area of the proposed bridge site are relatively stable, and not exposed to the risk of severe soil erosion.

3.2 Biological environment

Field-level data and information on existing biological environment were collected mainly through focus group discussion (FGD) with local stakeholders. This section will provide the details of data and information on biological environment at or in the vicinity of the proposed bridge site.

3.2.1 Aquatic habitat and fish

The aquatic system around the proposed bridge site consists of the Gudaria River, including direct and indirect flow, inundation of the Kangsha River in the vicinity of the site, borrow pits, *beel* or low-level crop land, and ponds and other wetlands.

The aquatic life includes aquatic plants (flora) and animals (fauna). Aquatic flora includes Kochuri pana (water hyacinth), Dhol kalmi, Helencha, Shapla, Singara, Vat, etc. Among fauna, various kinds of fish, frogs, snail, tortoise and a few water birds are found in the area, although most of them are decreasing in numbers.

According to the local population, various kinds of fish are available in the Gudaria River, as a wide variety of fish migrate from the Kangsha River. In the cultivated areas, various fish species are also available, especially in the monsoon season. Some cultured species are also found in the river, which

come to the river from closed water bodies when flooded. A list of the fish species available in the area is enclosed in Table 7.

However, some fish species are on a decreasing trend. Local people including those catching fish by themselves pointed out that some fish species such as Nandail, Ritha (Rita rita), Bacha (Eutropiichthus vacha), Vetki (Lates calcarifer), Kaon and Mohashoul (Tor tor) are found on rare occasions.

According to the Fishery officer at Haluaghat Upazila, fish species like Shoul (Channa straitus), Shing (Heteropneustes fossilis), Magur (Clarius batrachus), Pabda (Ompok pabda), and Bacha (Eutropiichthys Vacha), have decreased. However, the officer also stated that the construction of the proposed bridge will not have a significantly adverse effect on fish production and availability.

3.2.2 Terrestrial habitat and life

The terrestrial system in the vicinity of the proposed bridge site has a variety of flora and fauna, but they are decreasing in general. Many species of wildlife have been decreasing as the area has been populated and developed for many years.

It is observed that quick growing timber trees such as mahogany, rain tree, and sissoo are extensively grown in the area for quick commercial returns. In terms of fruit trees, a few species like mango and jackfruit are increasing, but they are on a decreasing trend in general. Plantations of fruit species like olive, kola, and lebu are increasing. In general, the diversity of trees species has been decreasing.

3.2.3 Biodiversity

It is a common environmental understanding that biodiversity has been on a decreasing trend, threatening extinction of many species, and causing imbalance in the natural environment. During the FGD with the local population, it has been confirmed that the proposed bridge site has also seen a reduction trend of many species to some extent. For example, many amphibians, reptiles, mammals and birds, and some indigenous tree species like medicinal plants have been decreasing, because of overexploitation, excessive human habitation, development of agricultural lands, lack of local people's awareness, and other human-related factors.

A field survey has been carried out to find out the type and extent of existing flora and fauna at and in the vicinity of the proposed bridge construction site. Information on existing wildlife, such as amphibians, reptiles, birds, fish, and mammals as well as trees, flowers, and other plants, has been collected through FGDs with the local population. A total of 13 FGDs have been conducted in the vicinity of the proposed construction site, and flora and fauna which were listed by local people at more than 30% of FGDs were picked up in this section. Then, the information on flora and fauna has been cross checked with the IUCN Red List of Threatened Species[3] to confirm the conservation status.

Some fruit or timber trees, growing faster and bringing about economic benefits, are generally increasing. Those fruit trees include mango, jackfruit, peara, lichi, jalpai, and lebu, and such timber trees include mahogany, rain tree, akashmoni, shishu, and shegun.

Open water fish has been reducing in general, mainly because of the excessive catching by local people and reduction of fish habitat. Many fish species that can be cultured, on the other hand, are increasing in the area, as are common in other parts of the country.

The reduction trend of biodiversity can be reversed by increasing people's awareness on the importance

[3] IUCN (2012) *IUCN Red List of Threatened Species*. Version 2012.1. <www.iucnredlist.org> accessed on 31 August 2012.

on biodiversity and its preservation, and establishing eco-parks or sanctuaries.

Fish

Table 7 shows the list of fish species in the river, beel and other wetlands of the area. According to IUCN (2012), out of the listed fish species, only *Cyprinus carpio* or common carp is categorized as "Vulnerable." The wild population of *Cyprinus caipio* is considered vulnerable, but the species has also been widely domesticated in the area. The species have been introduced in the area mainly for fish culture. Thus extinction of the species in the area is unlikely.

Amphibians and other aquatic species

Table 8 is the list of amphibians and other aquatic species in the area. According to IUCN (2012), no threatened species are found in the area.

Table 7 List of fish species in the river, beel, and wetland of the area

Bangladesh name	Scientific name	English name
Kajli	*Ailiichthys punctata*	Jamuna ailia
Mula	*Ambltpharyngodon mola*	Indian carplet
Koi	*Anabas tesudineus*	Climbing perch
Catla	*Catla catla*	Major carp
Taki	*Channa punctatus*	Snakehead
Chanda	*Chanda ranga*	Glass perch
Shoul	*Channa striatus*	Snakehead
Magur	*Clarioas batrachus*	Catfish
Grass carp	*Ctenopharyngodon idellus*	Grass carp
Carpio	*Cyprinus carpio*	Common carp
Chapila	*Gadusia chapra*	Herrings
Shing	*Heteropneustes fossilis*	Stinging catfish
Silver carp	*Hypophthalmichthes molotrix*	Silver carp
Kali baus	*Labeo calbasu*	Major carp
Ghonia	*Labeo gonius*	Kuria labeo
Rui	*Labeo rohita*	Major carp
Chingri	*Macrobrabrachium malcolmsoni*	Prawn
Baem	*Mastacembelus armatus*	Zig zug eel
Ayre	*Mists aor*	Long whiskered catfish
Gulsha	*Mystus cavacius*	Gangetic mystus
Tengra	*Mystis vittatus*	Days mystus
Fali	*Natopterus notopterus*	Feather backs
Pabda	*Omok pabda*	Pabdha catfish
Chela	*Onygaster phulo*	Chela
Batashi	*Pscudeutropicus atberinoides*	Indian potashi
Puti	*Puntius stigma*	Barb
Rita	*Rita rita*	River catfish
Boal	*Wallago attu*	Giant catfish

Source: Field data collection through FGD conducted in August 2012

Table 8 List of amphibians and other aquatic species in the area

Bangladesh name	Scientific name	English name
Kuno Bang	*Bufo melanostictus*	Common Toad
Bang	*Rana cyanophytes*	Skipper Frog
Sona Bang	*Rana tigrina*	Bull frog
Joke	-	Leech
Shamuk	-	Snail

Source: Field data collection through FGD conducted in August 2012

Reptile

Table 9 is the list of reptiles found in the area. According to IUCN (2012), no endangered species are found except for *Ophiophagus hannah* or king cobra, which has been rated "Vulnerable." However, the habitat of the species is usually forest or densely vegetated area, and such area is not observed at the proposed bridge site. Thus it is considered that the risk of negative impacts of the proposed bridge construction on the species is almost nil.

Table 9 List of reptiles in the area

Bangladesh name	Scientific name	English name
Dudh raj	*Elapheradiata*	Trinket snake
Matia Sap	*Enhydris enhydris*	Water snake
Kochchop	*Kachuga tecta*	Tortoise
Kasim	*Lissemys punctata*	Flap-shell turtle
Gokhra sap	*Naja naja*	Cobra
Shonkho chura	*Ophiophagus hannah*	King kobra
Daraj sap	*Ptyas mucosus*	Rat snake
Gui shap	*Varanus bengalensis*	Monitor lizard
Dhora sap	*Xenochrophis piscator*	Water snake
Bhing raj	-	

Source: Field data collection through FGD conducted in August 2012

Mammal

Table 10 is the list of mammals in the proposed bridge construction site. No species have been found to be threatened according to IUCN (2012). However, a few local people pointed out that there were *Lutra lutra* or otters in the area. Habitats of these mammals should be carefully conserved.

Table 10 List of mammals in the area

Bangladesh name	Scientific name	English name
Shial	*Canis aurcus*	Jackal
Badur	*Cynoptwerus spinex*	Short nosed fruit bat
Beji	*Herpestes edwardsi*	Mongoose
Idur	*Mus booduga*	Field mouse
Chika	*Suncus murinus*	Shrew
Khatash	*Viverine malaccensis*	-
Khek shial	*Vulpes bengalensis*	Fox

Source: Field data collection through FGD conducted in August 2012

Bird

Table 11 shows the list of birds which can be observed in the area. According to IUCN (2012), no birds have been found to be threatened.

Table 11 List of birds in the area

Bangladesh name	Scientific name	English name
Jhuti salikh	*Acridotheres fuscus*	Jungle myna
Bhat salikh	*Acridotheres tristis*	Common myna
Mach ranga	*Alcedo atthis*	Common kingfisher
Kana bok	*Ardeola grayii*	Pond heron
Hutum	*Athena brama*	Spotted owlet
Pati kak	*Corvus splendens*	House crow
Boro kak	*Corvus macrorynchos*	Jungle crow
Doyel	*Copsychus saularis*	Magpie robin
Finge	*Dicrurus macrocercus*	Black drongo
Kokil	*Eudynamys scolopacca*	Koel
Moyna	*Gracula religiosa*	Indian myna
Sada bok	*Igretta garzetta*	Small heron
Holud pakhi	*Oriolus xanthornus*	Black-hooded oriole
Kutum pakhi	*Oriolus chinensis*	Black-naped oriole
Tuntuni	*Orthotomus sutorius*	Tailor bird
Choroi	*Passer domesticus*	House sparrow
Babui	*Ploceus philippinus*	Baya weaver bird
Tiya	*Psittacula krameri*	Parakeet
Bulbul	*Pycnonotus jacosus*	Red-vented bulbul
Ghugu	*Streptopelia chinensis*	Spotted dove
Gu Shalik	*Sturnus contra*	Pied myna
Pecha	*Tyto alba*	Owl
Kobutar	*Columba livia*	Pigeon
Sharosh	*Grus antigone*	Crane

Source: Field data collection through FGD conducted in August 2012

Trees

Table 12 and Table 13 are the lists of fruit trees and timber or other trees respectively. According to IUCN (2012), *Delonix regia* or flame tree has been identified as "Vulnerable." However, *Delonix regia* is endemic to Madagascar, and was introduced into the area by humans many years ago. Thus it is considered that there is the least concern of the extinction of the species.

Table 12 List of fruit trees in the area

Bangladesh name	Scientific name	English name
Aam	*Mangifera indica*	Mango
Jam	*Syjygium grandis*	Black berry
Kathal	*Artocarpus heterophyllus*	Jack fruit
Lichu	*Lichi cinensis*	Litchi
Jambura	*Citrus grandis*	Pomelo
Narikel	*Cocos nucifera*	Coconut

Bangladesh name	Scientific name	English name
Pepe	*Carica papaya*	Papaya
Kul	*Zizyphus mouritania*	Jujube
Khejur	*Phoenix sylvestris*	Date tree
Tal	*Borassus flabellifer*	Palm tree
Peara	*Psidium guajava*	Guava
Bel	*Aezle marmelos*	Wood apple
Supari	*Areca catechu*	Betel nut
Dalim	*Punica granatum*	Pomegranate
Kola	*Musa Spp.*	Banana
Amra	*Spondias Pinnata*	Hog-plum
Jalpai	*Elaeocarpus robustus*	Olive
Kamranga	*Averrhoea carmobola*	Star fruit
Tentul	*Tamarindus indicus*	Tamarind-tree
Lebu	*Citrus aurantifolia*	Lemon
Boroi	*Zizyphus jujuba*	Berry

Source: Field data collection through FGD conducted in August 2012

Table 13 List of timber or other trees in the area

Bangladesh name	Scientific name	English name
Akashmoni	*Acacea moniliformis*	Akashmoni
Koroi	*Albizia procera*	Koroi
Shil koroi	*Albizia lucida*	
Kadam	*Anthocephalus chinesis*	Kadam
Pitraj	*Aphanamixis polystachya*	
Kathal	*Artocarpus heterophylus*	Jack fruit tree
Shishu	*Dalbergia sisso*	Sissoo
Krishnachura	*Delonix regia*	Flame tree
Eucalyptus	*Eucalyptus citriodora*	Eucalyptus
Bot	*Ficus religiosa*	Banyan tree
Gamari	*Gmelina arborea*	
Mandar	*Rrythrina variegata*	Coral tree
Raintree	*Samanea saman*	Rain tree
Mehagony	*Swietenia mahogoni*	Mahogany
Jam	*Syjygium grandis*	Black berry tree
Shegun	*Tectona grandis*	Teak
Lombu	-	-

Source: Field data collection through FGD conducted in August 2012

Medicinal plant

Table 14 is the list of medicinal plants in the area. According to IUCN (2012), no medicinal plants have been found to be threatened.

Table 14 List of medicinal plants in the area

Bangladesh name	Scientific name	English name
Bel	*Aegle marmelos*	Wood apple
Nim	*Azadirachta Indica*	Margosa
Bandar lathi	*Cassia fistula*	
Jaistha modhu	*Glycyrrhiza*	
Tulshi	*Ocimumsanctum*	Holyn basil
Amlaki	*Phyllathus embelica*	
Arjun	*Terminalia arjuna*	Arjun
Bohera	*Terminalia belerica*	
Horitaki	*Terminalia chebula*	

Source: Field data collection through FGD conducted in August 2012

Crops and vegetables, and flowers

Table 15 and Table 16 are the lists of crops and vegetables, and flowers respectively. No such species has been threatened according to IUCN (2012).

Table 15 List of crops and vegetables in the area

Bangladesh name	Scientific name	English name
Dheros	*Abelmoschus esculentus*	Lady's finger
Lal shak	*Amaranthus*	
Pui shak	*Basella alba*	Pui shak
Chal kumra	*Benincasa hispida*	Gourd
Morich	*Capsimum frutescens*	Chili
Kochu	*Colocasia esculenta*	Kachu
Paat	*Corchorus olitorius*	Jute
Sosha	*Cumis sativus*	Cucumber
Misti kumar	*Cucurbita maxima*	Sweet gourd
Misti alu	*Ipomoea batatas*	Sweet potato
Lau	*Lagnaria siceraria*	Pumpkin
Khesari	*Lathyrus sativus*	Pigeon pea
Moshur	*Lens culinaris*	Lentil
Tishi	*Linum usitatissimum*	Lin seed
Korola	*Momordica chantea*	Bitter gourd
Paddy	*Oryza sativa*	Paddy
Akh	*Saccharum officinarum*	Sugarcane
Til	*Sesamum indicum*	Sesame
Palong shak	*Spinacea oleracea*	Spinach
Alu	*Solanum tuberosum*	Potato
Chichinga	*Trichosanthes anguina*	Snake gourd
Gom	*Triticum aestivum*	Wheat
Dhundul	*Xylocarpus granatum*	
Bhutta	*Zea mays*	Maize
Sorisha		Mustard

Source: Field data collection through FGD conducted in August 2012

Table 16 List of flowers in the area

Bangladesh name	Scientific name	English name
Shimul	*Bombax ceiba*	
Pata bahar	*Codiacum variegatum*	Croton
Gondho raj	*Gardenia jasminoides*	Gardenia
Joba	*Hibiscus rosa-sinensis*	China rose
Beli	*Jasminum sarrbac*	
Shapla	*Nymphaea nouchali*	Water lily
Nil padda	*Nymphaea stellata*	
Shefali/Sheuli	*Nyctanthes arboriristis*	
Golap	*Rosa centifolia*	Rose
Tagar	*Tabernaemontana divaricate*	
Ganda	*Tagetes patula*	Marigold
Rajani gondha	*Pollenthes tuberosa*	Tuberose

Source: Field data collection through FGD conducted in August 2012

3.3 Pollution control

3.3.1 Air quality

Air quality of the proposed bridge construction site is considered to be better at present as few motor vehicles, mainly motor cycles, pass through the area, which often go across the river via the ferry boats. Motor vehicles of the other types like cars or trucks seldom pass through the area, and they cannot go across the river for the lack of a ferrying facility. However, the number of motor vehicles may increase after the construction of the bridge.

At present there are some DTWs and shallow tubewells (STWs) for irrigating Boro, the paddy crops grown in winter or the dry season by irrigation. Most of tubewells are run by generators, and thus affect the air quality slightly. There is no brick-making field at or in the vicinity of the proposed bridge site.

Usually the motor vehicles emit carbon dioxide through fuel combustion. Some fuels remain un-burnt or partially burnt, resulting in the emission of hydrocarbons and other organic compounds, together with carbon monoxide and carbon soot. Some nitrogen is oxidized to form various forms of nitrogen oxides. Carbon monoxide and oxides of nitrogen have an adverse implication on health. The proposed bridge site is located in rural areas, and pollutants will be scattered over a wide range of rural area and will not be concentrated.

In the survey, air quality around the proposed bridge construction site was tested. Air was comparatively clear when sampled because of heavy rain in the previous night and morning. The average temperature during starting and ending of the sampling was 28.5^{o}C, and the average humidity was 91%. The result of air quality data is presented in Table 17.

Table 17 Air quality test results at the proposed bridge site and applicable air quality standards

Parameters of air quality	Sample location		Standard limit set by the ECR, 1997			
	Left bank	Right bank	For Different uses			
			Industrial	Commercial	Residential	Sensitive
PM 2.5 (mg/m^3)	0.015	0.018	-	-	-	-
PM 10 (mg/m^3)	0.035	0.018	-	-	-	-
SPM 10 (mg/m^3)	10.15	10.25	500	400	200	100
CO (mg/m^3)	750	755	5000	5000	2000	1000
NO (mg/m^3)	125	122	100*	100*	80*	30*
NO_2 (mg/m^3)	0	0				
SOx (mg/m^3)	65	66	120**	100**	80**	30**
Pb (ng/m^3)	0.85	0.85	-			

Source: Field collection and laboratory test
Note 1) Date of sampling is 8 August 2012.
Note 2) Sampling location on the right bank is latitude 25°1'391"N and longitude 90°29'097"E, and on the left bank is latitude 25°01.434'N and longitude 90°29.137'E
Note 3) *Values for NO_x; **Values for SO_2

It is found, by comparing with the standard limit set by the DOE, that SPM and CO are within permissible limits for all purposes. NO has higher value than NO_x, although NO_2 content is nil. The values for PM 2.5, PM 10 and Pb are yet to be set. These test data will be used as reference information when conducting the post-construction monitoring.

3.3.2 Water quality

The quality of surface water may be affected during and after construction of the proposed bridge. There is also a slight possibility that the construction work may change the quality of groundwater.

Considering such risks, tests of existing surface water and groundwater have been conducted on important parameters to verify their present qualities. A total of ten water samples were tested under this EIA. These test data will be baseline information which can be referred to in the post-construction monitoring at the proposed bridge site. The results are indicated for comparing in the future and their results are indicated in Table 18.

Table 18 Water quality test results of surface and ground sources at the proposed bridge site

Sample location		DO (mg/l)	BOD (mg/l)	COD (mg/l)	pH	EC (µs/cm)	TSS (mg/l)	TDS (mg/l)	Turbidity (JTU)
Left bank of the river	latitude 25°01.407'N longitude 90°29.124' E	6.52	10	16	5.61	94	128	41.6	39.02
HTW water in village Kailati	latitude 25°01.322'N longitude 90°29.116'E	7.34	5	8	5.83	262	0	86	50.00
Beel water in village Futkai	latitude 25°01.465'N longitude 90°29.23'E	6.81	10	12	6.33	231	64	77.1	12.60
Pond water in village Futkai	latitude 25°01.512'N longitude 90°29.212' E	5.59	12	13	6.30	291	71	95.8	9.29
HTW water in village Futkai	latitude 25°01.550'N longitude 90°29.174' E	7.35	6	9	6.28	366	0	126	4.23
Right bank of the river	latitude 25°01.434'N longitude 90°29.137'	7.04	10	13	6.45	92	112	44.7	16.74
Pond water in village Kailati	latitude-25°01.291N longitude 90°28.601'E	6.60	12	13	6.52	67	64	28.6	6.42
Fishery pond in village Kailati	latitude-25°01.124'N longitude 90°28.681'E	7.57	14	14	6.39	85	24	32.3	3.33
HTW water in village Kailati	latitude-25°01.048'N longitude 90°28.705'E	6.43	5	8	6.31	356	0	121	10.19
Pond water in village Kailati	latitude-25°01.048'N longitude 90°28.705'E	5.09	12	13	6.44	154	61	60.1	14.01

Source: Field collection and laboratory test
Note: Sampling date is 8 August 2012
Legend: BOD: biochemical oxygen demand; COD: chemical oxygen demand; DO: dissolved oxygen; EC: electrical conductivity; HTW: hand tubewell; JTU: Jackson Turbidity Unit; TDS: total dissolved solids; TSS: total suspended solids

Standards for surface water quality, which are set by the ECR, 1997, are indicated in Table 19.

Table 19 Standard for surface water quality set by the ECR, 1997

Parameters	Unit	Drinking water	Recreation purpose	Fishery purpose	Industrial use	Irrigation purpose	For animals and birds	Coastal water quality
DO	mg/l	6	4-5	4-6	5	5	4-6	6
BOD	mg/l	< 0.2	3	6	10	10	NYS	NYS
COD	mg/l	4	4	NYS	3-10	NYS	1000	NYS
pH	-	6.5-8.5	6.0-9.5	6.5-8.5	6.0-9.5	6.0-8.5	5.5-9.0	6.0-9.0
EC	ms/cm	0	500	800-1000	NYS	750	NYS	NYS
TSS	mg/l	10	20	25	75	NYS	NYS	75
TDS	mg/l	1000	NYS	NYS	1500	2000	5000	NYS
Turbidity	JTU	5	NYS	10	NYS	5	NYS	NYS

Source: ECR 1997

Legend: BOD: biochemical oxygen demand; COD: chemical oxygen demand; DO: dissolved oxygen; EC: electrical conductivity; HTW: hand tubewell; JTU: Jackson Turbidity Unit; NYS: not yet set; TDS: total dissolved solids; TSS: total suspended solids

Ten water samples in total were collected of which three were from HTWs used for drinking water mainly. According to the test results, it is found that water samples of all the HTWs exceed the standards for drinking water in DO, BOD, COD, and EC. In terms of pH, all samples indicate relatively acidic values. Two samples from HTWs have a higher turbidity level, although all have lower TSS and TDS contents within the standards. Thus, it is concluded that the water quality of the HTWs as drinking water is not totally good at present.

Four water samples from ponds were collected and tested. It has been found that DO of two pond samples are within the standards for fishery and for animals and birds. BOD of all pond water is above permissible limits for fishery. COD of all pond water exceed the standards except the one for animals and birds. The figures of pH are within permissible limits for fishery, animals and birds. TDS is within permissible limits for animals and birds, and turbidity of three ponds is within limits for fishery purpose.

Water of the Gudaria River has been collected at two sample locations. It is found that both samples have higher contents of DO for fishery, and irrigation, and use for animals and for birds. They also indicate higher BOD values for fishery, but within standards for irrigation. COD values indicate their suitability for animals and birds. Values of pH of both the sample are within the range for animals and birds, although one has a lower value for fishery and irrigation. EC of both samples are within the standards fishery and irrigation purposes. TSS of both samples fails to meet the standards for any purpose, whereas TDS are within the standards for irrigation and animals and birds. Test results of turbidity show that water of the Gudaria River has higher content for fish and irrigation purposes.

One sample from beel was collected. The sample has higher content of DO for fish, irrigation and for animals and birds. The sample water has higher value of BOD for fish, although within the standards for irrigation. Its COD value indicates that the water is suitable to be used for animals and birds. The value of pH is within the standards for fishery, irrigation, and for animals and birds. EC value of the sample is within the standards for fishery and irrigation. TSS is higher for fish and TDS value is within the standards for irrigation and for animals and birds. The turbidity of the beel water has higher value for both fish and irrigation purposes.

3.3.3 Noise level

The current noise level at the proposed bridge site is quite low, as few motor vehicles pass through the

area. Presently some motorcycles cross the river through the existing ferry boat service. Since no other motor vehicles like cars and busses can pass thorough the ferry service, very few of such vehicles are observed in the area. In addition, there are some DTWs, STWs and low-lift pumps (LLPs) in the area which operate in the irrigation season, mainly from January to April. However these have not created significant noise.

The noise level will become higher during bridge construction as the number of heavy machinery items used for the construction work will increase.

Moreover, the noise level will also become higher after the construction of the bridge since various types of vehicles will pass through the proposed bridge. The noise level will vary depending on the traffic volume, vehicle type, road surface conditions, and other factors.

The current noise level along the proposed bridge construction site on the Gudaria River has been measured. Four noise levels were measured, i.e., two each on both banks of the Gudaria River, and two each in the morning and the evening. Results of noise level measurement are presented in Table 20. The data can be used as a bench mark of noise level before the bridge construction, and can be referred to in the post-construction monitoring.

Table 20 The current noise level at the proposed bridge construction site

Sample location		Noise level (dBA) (measurement time)	Standard limit (dBA)	Observation
West side of Gudaria river	Latitude 25°01.407'N Longitude 90°29.124' E	45 (10.30 a.m.)	The standard limit ranges between 50 dBA at daytime and 40 dBA at night in the residential areas (the ECR, 1997).	The sound levels are within standard noise level.
East side of Gudaria river	Latitude 25°01.434'N Longitude 90°29.137'	48 (5.50 p.m.)		
Near village Kailati	Latitude 25°01.322'N Longitude 90°29.116'E	47 (11.00 a. m.)		
Near village Futkai	Latitude 25°01.434'N Longitude 90°29.137'	50 (6.00 p.m.)		

Source: Field collection and laboratory test
Note: Measurement date is August 7, 2012

Table 21 shows the standards of noise for different areas/classes as stipulated in the ECR, 1997.

Table 21 Tolerable limit of noise in Bangladesh

Area types	Unit	Tolerable limit at day time	Tolerable limit at night time
Areas require high level of silence like hospital, schools etc.	dBA	45	35
Residential areas	dBA	50	40
Mixed areas for residence, commercial and industrial purposes	dBA	60	50
Commercial areas	dBA	70	60
Industrial areas	dBA	75	70

Source: ECR 1997

The area largely belongs in the residential category. According to ECR, 1997, the maximum standard for residential areas is 50 dBA in the daytime and 40 dBA in the nighttime. The results of the noise measurement range between 40 to 50 dBA. Thus the area appears to be free from noise disturbance at present.

3.3.4 Bottom sediment quality

River bed materials will be re-excavated to some extent during construction of the proposed bridge, which would be used for the filling of the approach roads, and/or river training works, depending on the plan of construction works. Thus the quality of the river sediments should be suitable to be used for such purposes.

Moreover, sediments quality may change after the construction of the bridge. For the purpose to collect baseline information, two samples of river bed materials were collected. The concentrations of five heavy metals were tested. Their results are indicated in Table 22.

Table 22 River bed sediment quality at the proposed bridge site

Sample Location	Zn (mg/kg)	As (mg/kg)	Hg (mg/kg)	Mn (mg/kg)	Cd (mg/kg)
Eastern side of Gudaria River	45.5	2.15	0.15	621	0.65
Western side of Gudaria River	42.8	2.21	0.27	624	0.56
Standard limit	300.0	20.0	2.0	not yet set	2.0

Source: Field collection and laboratory test
Note 1: The standard limits of the United States Environmental Protection Agency are indicated here as a reference, as no standards for sediments have been set in Bangladesh
Note 2: Measurement date is August 8, 2012

No standard for river bed sediment has been set in the ECR, 1997 and other regulations in Bangladesh. Therefore, the standard limit set by the United States Environmental Protection Agency (USEPA) is quoted for this EIA, which is widely followed in Bangladesh.

The sample test result indicate that the contents of heavy metals of zinc, arsenic, mercury and cadmium in river bed sediments are found within the standard permissible limits, though the limit for manganese is not yet set.

3.4 Socioeconomic environment

3.4.1 Socioeconomic profile

The proposed bridge is to be constructed as part of the UZR subproject in Haluaghat Upazila. The bridge will connect the areas of Haluaghat Upazila with Dobaura Upazila, and significantly benefit the people living in Haluaghat Upazila, because they often commute to market, schools, and hospitals in Dobaura Upazila through the ferry service.

Various secondary data and information on Haluaghat Upazila are presented in Table 23. The information has been collected mainly from the Bangladesh Bureau of Statistics (BBS) and interviews conducted during the field survey.

Table 23 Socioeconomic profile of Haluaghat Upazila

Item	Data/information
Basic statistics	
Total area	358 km^2
Total population	290,043 (male:142,632; and female:147,411
Population of ethnic minority	14,071 (male: 7,130; and female: 6,941)
Population increase rate	1.53%
Population density/ km^2	811
Total number of Union	12
Total number of mouza/villages	mouza:146; village: 210
Drinking water and sanitation	
Number of operative HTWs	1,699
Number of tara pump	1,269
Number of super tara pump	9
Ring HTW	28
Sanitation latrine coverage	78.63%
Agricultural information	
Main agricultural crops	Paddy, wheat, jute, lentil (mushuri), potato, cucumber (shosha), and bitter gourd (korola)
Net agriculture land	27,100 ha
Areas of government-owned land	5,763 ha
Total irrigated area	22,100 ha
Number of irrigation equipment	DTW: 234; STW: 3,914; LLP :294
Total food production	156,293 MT
Total food demand	47,521 MT
Infrastructure status	
Total road length	927.45 km
Paved road (pucca)	125.55 km
Un-paved road (kutcha)	801.19 km
Railway and river ways	Nil
Number of hat or bazaar	30

Source: BBS and field data collection

Peoples' need for crossing the Gudaria River

The field survey and FGDs confirmed that many people living on the right bank in the Haluaghat Upazila will be benefitted from the proposed bridge construction. In fact, the proposed project site is closer to the center of Dobaura Upazila on the left bank than that of Haluaghat Upazila, and thus people frequently cross the Gudaria River through the ferry service. They are going to Dobaura Upazila for buying and selling agricultural or daily products, attending schools, and taking medical services. Thus, if the proposed bridge is constructed, these people will be able to visit Dobaura Upazila more conveniently.

With respect to schools, due to the existing gap over the Gudaria River, students face difficulties in going to local schools, madrashas, and a college, most of which are located in Goatola bazaar and the center of Dobaura Upazila. The students, especially female ones, can seldom attend their educational institutions in time due mainly to the shortage of boats, although no ferrying fee is taken from the students and the teachers. Timely and regular attendance in examination is also a concern for the

students living on the right bank. Therefore, severe dissatisfaction exists among them for the lack of a smooth transportation system over the Gudaria River.

The medical perspective may have severer implications. Patients cannot attend hospitals and health centers located on the right bank timely, as there is no ferry boat service after 10:00 p.m. There was a case in which a patient died consequently on the river bank recently. Such case is not uncommon in the area according to local people.

People living on the left bank, i.e., Dobaura Upazila, also have strong demand for the construction of a bridge over the Futkai ferry ghat in order to have direct road communication with Haluaghat Upazila. This will also contribute to the establishment of easy and time-saving road communication with the center of Mymensingh Pourashava. By the construction of the proposed bridge, local people will be able to transport various goods to the other side of the river more easily, e.g., transporting agricultural products to Sakuai and Batra bazaar.

The construction of the proposed bridge will, therefore, have significant positive impacts on socioeconomic conditions of local people on the both banks. Local people living in Bildora Union of Haluaghat Upazila will be able to easily communicate to Dobaura Upazila, and vice versa.
If the bridge is not constructed, the roadway transportation of goods and passengers from the right bank to the left, mainly from Bildora Union of Haluaghat Upazila to Goatola bazar and Dobaura Upazila bazar, will remain inconvenient. This will cause significant dissatisfaction among the local people.

Local people currently pay BDT 4 (BDT 2 for each way) for one person to cross the river. This results in higher costs for carrying goods and materials to the Goatola bazar on the right bank, and eventually affects the socioeconomic conditions of the local people.

According to the field survey and FGDs, a bridge over the Gudaria River is found as a long term demand of the local people living on both sides of the river. They expressed total support and cooperation for the construction of the proposed bridge.

3.4.2 Agriculture

The proposed bridge construction site and the surrounding areas are quite fertile with high productivity of agricultural crops. Paddy crops such as Aman (monsoon paddy) and Boro (winter paddy) are the main crops in the area. The other crops frequently observed in the area include wheat, jute, maize, mustard, lentil (mushuri), pigeon pea (khesari), potato, sweet potato and various kinds of vegetables like cucumber (shosha), bitter gourd (korola), snake gourd (chichinga), brinjal (begun), common gourd (lau), sweet gourd (kumra) and various leafy vegetables like amaranthus and spinach.

In particular, cucumber (shosha) is a popular crop in the area, mainly for selling to markets in Mymensingh and Dhaka. However, due to the lack of communication facility, local farmers find it hard to sell the crop.

Drought in the dry season is the major obstacle in agriculture production, when irrigation facilitates will be used for growing Boro. Seasonal flush flood in the monsoon season damages Aman almost every year, and the re-plantation of Aman is common in the area. The re-plantation increases the cost of cultivation, creating vulnerability for the farmers of the area.

3.4.3 Present mode of communication

Currently the ferry service operates at the proposed bridge construction site every day. Two boats operate at the Futkai ferry ghat, i.e., a large country boat and an engine boat. The former, which can

accommodate about 25 to 30 people, operates from 7:00 a.m. to 10:00 p.m. every day, while the latter operates only on weekly market days or hat days, i.e., Friday and Monday. The view of the Futkai ferry ghat is shown in Image 3.

Image 3 Present situation of Futkai ferry ghat at the right bank

At present, the Futkai ferry ghat is leased annually, and the lessee arranges one country boat for providing the ferry service. The fare for the ferry is BDT 2 per person each way. For motor cycles or rickshaws, the fare is BDT 5April to mid-February. In the dry season when the river gets dry, the ferry service ceases, and people cross the river by walking. After the drying, the lessee places some wood or bamboo planks on the muddy river bed, and people have to pay the same fare when they walk on the planks.

According to the information collected by FGD, many people and a variety of vehicles cross the Gudaria River from the left bank to the right and vice versa. The average numbers of people and various vehicles crossing the river by the ferry boats are given in Table 24.

On an average approximately 3,500 to 4,000 people move across the river in general, but the number increases to the range from 6,000 to 7,000 on weekly hat days of Friday and Monday. On these hat days, an engine boat also operates to provide ferrying service, in addition to the country boat.

Table 24 Average number of passengers and vehicles crossing the Gudaria River at Futkai ghat

Type	On general day	On weekly hat days (Friday and Monday)	Remarks
Passengers	3,500-4,000	6,000-7,000	Numbers of people and vehicles are the cumulative total numbers, moving from the left bank to the right and vise versa
Rickshaw	120-150	Higher than general days	
Motor cycle	100-120	Higher than general days	
Bicycle	400-500	Higher than general days	
Rickshaw van	40-50	Higher than general days	

Source: Field data collection through FGD conducted in August 2012

Six boatmen are currently engaged in boatmanship for ferrying, and they would lose their job after the proposed construction of the bridge. However, it is found that the lessee expressed satisfaction on the proposal for the bridge construction, and he stated that various businesses are possible after the construction of the bridge. Thus the impacts could be minimized.

Communication to other areas by boat is not a common practice in the area, although some large boats operate in the Gudaria River for buying and transporting agricultural crops. Road communication is the sole means of communication in the area.

Construction of the proposed bridge and the improvement of the UZR will bring about significant economic and social benefits to the local people. It helps the people by providing time-saving and easy travel means and lowering the transportation cost. Potential benefits will include but not be limited to increased access to markets, generation of employment opportunities, and improved access to educational and health services. Thus construction of the proposed bridge has various development effects on the area.

The proposed bridge construction will also establish direct road communication to nearby towns and economic centers. The communication with Mymensingh town as well as Dobaura Upazila in particular will significantly improve.

3.4.4 Land price

The price of land in the area is quite high as the availability of saleable land is scarce. The data collected through FGD is presented in Table 25.

Table 25 Land price of the area near the proposed bridge site

Land Types	Flooding category	Present price (BDT/decimal)
Agricultural land	High land (Flooded up to 0.3 m)	12,000-14,000
	Medium high land (Flooded from 0.3 to 0.9 m)	10,000-12,000
	Low land (Flooded >0.9 m)	6,000-10,000
Settlement land	High land (not flooded)	15,000-16,000

Source: Field data collection through FGD conducted in August 2012
Note 1: Flooding Classification is based on the nationally accepted land classification defined by the Ministry of Agriculture.
Note 2: Decimal is a unit of area approximately equal to 40.4686 m².

3.4.5 Cultural and religious heritage

No culturally and religiously important sites are found at the proposed bridge construction site, according to the FGDs conducted in August 2012.

4 Analysis of alternatives

In determining the location and detail design of the proposed bridge, various factors such as the existing road alignment, soil conditions of the embankments, river morphology, opinions of local people, expected financial return will be considered as well as environmental and social aspects. Points to consider in this EIA are discussed below.

4.1 Existing road communication network

The proposed bridge construction site is located at the gap of two UZRs on the Gudaria River. Both UZRs end at the gap. Thus, if the proposed bridge is constructed over the gap, the two UZRs will be directly connected by the bridge. Therefore, the place where the existing alignments of the two UZRs are linearly extended is selected for the proposed bridge construction site.

People in the area currently use the UZRs as the only means of road communication to the present ferry ghat. The right bank UZR is connected to Nagla bazar, which has direct connections to Mymensingh town in the south and Haluaghat in the north. On the other hand, the left bank UZR is connected to Goatola bazar and then to Dobaura Upazila. There exists no alternative road network for the people in the area to go to the adjacent two Upazila centers, and to Mymensingh town and other economic centers.

It is therefore concluded that, taking into account the existing road network, the proposed bridge site will be appropriate.

4.2 River morphological conditions and engineering design

The morphological survey, based on field observations of different sample points and changes in cross-section at a nearby river, revealed that the proposed bridge construction site is not an erosion prone area. The interviews with local people, in particular the elderly and teachers, also revealed that the streamline of the river has been relatively stable at the proposed bridge site.

Initial site observation by the engineering consultant also confirmed that the proposed site is the feasible location for the bridge construction, though the locations of the bridge abutments should be further studied at the detailed design phase.

It is therefore concluded that, from the engineering perspectives, the current proposed bridge site will be appropriate.

4.3 Local people's opinions

The Futkai ferry ghat is the only ferry ghat on the Gudaria River connecting the two UZRs. From both sides of the ghat, the UZRs will go to nearby Upazila centers, Mymensingh town, and other economic centers. Local people stated during FGDs and interviews that the proposed bridge site is the most suitable, and the sole site for bridge construction for connecting the two UZRs.

4.4 Recommendations

At present, the proposed bridge site is considered the most appropriate location of the bridge construction. This site was also accepted by the local population. Final selection of the site for the proposed bridge will be done at the detail design phase.

5 Identification of environmental and social impacts

Based mainly on the result of the IEE, field observations and literature surveys conducted during the EIA, environmental and social impacts to be caused by the proposed bridge construction have been identified. The identified environmental and social impacts cover physical, ecological and socioeconomic environment by phases of pre-construction, construction, and post-construction or operation and maintenance (O&M). The pre-construction activities include land acquisition and resettlement among others. The construction activities include construction of the main bridge and related facilities including approach roads, and river training works. The O&M activities involve the maintenance of the bridge and approach roads.

5.1 Potential environmental and social impacts

Summary of the high and moderate significant environmental impacts to be caused by the proposed bridge construction are presented in Table 26.

Table 26 Description of potential environmental and social impacts

Stage	Potential impact
Air quality	
Pre-construction	No or negligible impacts
Construction	Small amount of air pollutants will be emitted due mainly to the operation of vehicles and heavy machineries for construction works. Dust will be generated by construction work, especially earth moving work.
O&M	Air pollutants from motor vehicles will increase after the construction of the bridge, since the traffic volume of motor vehicles on the bridge and UZRs is expected to increase compared with the current traffic volume.
Water quality	
Pre-construction	No or negligible impacts
Construction	The quality of the river water is expected to be affected by the proposed bridge construction works. The works include the dredging activities, installment of bridge abutments, and construction of approach roads. They will cause soil runoff, and eventually turbid water. Such risk will increase if the works are carried out during the rainy season. There is also a risk of accidental spillage of fuels, lubricants, chemicals, solvents and construction waste into the river water, resulting in the pollution of the river.
O&M	There is a low risk of the accidental spillage of chemicals and resulting water quality deterioration during the periodic maintenance.
Soil erosion	
Pre-construction	No or negligible impacts
Construction	Bridge construction will involve dredging activities at the river bed, the construction of bridge abutments, and the construction of approach roads on the banks. These works will cause soil erosion unless appropriate measures are undertaken. The risk of soil erosion will significantly increase if the works are implemented in the rainy season.
O&M	Soil erosion may occur along the approach roads especially in the rainy season if the maintenance works are not properly undertaken.
Noise and vibration	
Pre-construction	No or negligible impacts
Construction	During the construction phase, noise and vibration will be generated. Noise from heavy machinery and construction vehicles, and works such as pile driving and dredging may temporarily disturb nearby residents, although the impacts are short-term.

Stage	Potential impact
O&M	A certain level of noise is anticipated at the operational phase, since the traffic volume of motor vehicles on the bridge and UZRs will increase to some extent after the construction of the bridge.
Bottom sediments	
Pre-construction	No or negligible impacts
Construction	Construction works will involve dredging activities and the installation of abutment bridges at the river bed. These works may cause disturbance of bottom sediments. There is also a risk of contamination of bottom sediments by accidental spilling of construction materials such as bituminous materials and other petro-chemicals.
O&M	There is a low risk of the accidental spillage of chemicals and resulting bottom sediment contamination during the periodic maintenance.
Waste	
Pre-construction	No or negligible impacts
Construction	Civil works for the bridge construction will generate a certain amount of wastes such as unused construction materials during the construction phase. Solid and liquid wastes will also be generated from labor camp. Such wastes may negatively affect the surrounding environment if they are left untreated at the construction sites or labor camp.
O&M	Small amount of wastes may be generated from periodic maintenance works, but the impacts are limited.
Ecosystem and wetland	
Pre-construction	No or negligible impacts
Construction	Construction work will inevitably involve the removal of trees and vegetation. The scale of tree and vegetation clearance is expected to remain limited. On the other hand, there is no risk of affecting valuable ecosystems such as primeval forests, protected areas, and others. Such ecosystems are not found in the vicinity of the proposed bridge site.
O&M	No or negligible impacts
Wildlife	
Pre-construction	No or negligible impacts
Construction	Construction works such as dredging and pile driving may cause the habitat loss or disturbance of some wildlife species. Many wildlife species are found during the field survey in the area. Although a few of them were found threatened according to IUCN (2012), all of them will not require significant considerations as described in Section 3.2.3.
O&M	Some adverse impacts on wildlife species around the bridge site may be anticipated due to the constructed bridge-related structures and increased traffic volumes. Such impacts, however, can be mitigated by re-vegetation and re-planting of trees.
Fish and aquatic life	
Pre-construction	No or negligible impacts
Construction	Construction works, in particular pile driving and dredging works, will disturb the movement of fish species temporarily. Habitats of some fishes may be affected by such works.
O&M	Low adverse impacts on fishes and aquatic life around the bridge site may be anticipated due to the constructed bridge-related structures and increased traffic volumes.
Regional hydrology and drainage	
Pre-construction	No or negligible impacts
Construction	Construction works will include dredging for river training and the construction of bridge structures over the river. This will have temporary influence on the regional hydrology mainly during the civil works. Storage of soils, sand, and construction materials along the river may impede natural drainage temporarily. This typically occurs if the works are undertaken during the rainy season.

Stage	Potential impact
O&M	There is minor risk of drainage congestion due to the approach roads if sufficient drainage capacity has not been ensured.
Topography and geology	
Pre-construction	No or negligible impacts
Construction	Topography will be slightly changed due to earth cutting works for the construction of approach roads and other related structures, but such impacts are considered very minor.
O&M	No or negligible impacts
Land acquisition and involuntary resettlement	
Pre-construction	No involuntary resettlement is expected as no residences and structures exit at the proposed bridge construction site. Small portions of agricultural land may need to be acquired due to the proposed bridge mainly for the construction of the approach roads, but the scale of the land acquisition will be confirmed after the determination of the detail design of the bridge. Land acquisition process should be completed prior to the commencement of construction activities.
Construction	There is a possibility that the temporal occupation of agricultural lands or other lands for the storage of construction materials and equipment, or construction of labor camps.
O&M	No or negligible impacts
Employment and poverty reduction	
Pre-construction	Land acquisition may adversely affect the livelihoods of local people.
Construction	Positive impacts on local employment and poverty reduction are expected in general. The proposed bridge construction will provide local people, in particular vulnerable groups, with employment opportunities. Ferry services are operating at the proposed bridge site, and six boatmen are working for the service. They will lose their current employment.
O&M	The proposed bridge will significantly improve access to nearby markets, schools, medical centers, and other necessary places. Thus the impacts of the bridge construction are generally considered positive. Local people will also benefit from the increased employment opportunities for the O&M of the bridge.
Agriculture	
Pre-construction	Acquisition of agricultural lands may be necessary depending on the detail design of the proposed bridge, and thus certain impacts are anticipated.
Construction	Some agricultural lands may be temporarily occupied for the storage of construction materials and equipment, and the construction of labor camps. This will negatively affect the agricultural production temporarily.
O&M	No or negligible impacts
Landscape	
Pre-construction	No or negligible impacts
Construction	The bridge structures to be constructed will change the landscape around the proposed site, but local people accept the change and no objections were raised in the FGDs.
O&M	After the construction of the bridge, there may be a risk of people's gathering and squatting on the embankments around the bridge, and this may affect the landscape beauty.
Religious and cultural heritage	
All phases	No or negligible impacts
Gender equity	
Pre-construction	No or negligible impacts
Construction	Positive impacts are expected due to the provision of employment opportunities to Labor Contracting Society (LCS) which mostly consists of local poor women.

Stage	Potential impact
O&M	The proposed bridge will improve the access of women and other local people to schools, medical centers and other various public services. Some poor women may have employment opportunities for the maintenance works.
Transport safety and road accidents	
Pre-construction	No or negligible impacts
Construction	The risk of road accidents will increase during the construction works because of 1) increased transport of construction materials and equipment, heavy machinery and construction vehicles, and construction labors, and 2) use of the machinery, vehicles and equipment at the construction site.
O&M	Due to the improved road connectivity between Haluaghat Upazila and Dobaura Upazila, the traffic volume on the UZRs will increase, and thus there is an increasing risk of road accidents.
Health, safety and hygiene	
Pre-construction	No or negligible impacts
Construction	Construction workers may be involved in any accidents at work sites. There is an increased risk that infectious diseases such as HIV/AIDS could spread as a result of the inflow of construction workers or the construction of labor camps. Hygienic conditions around the construction site may be deteriorated unless proper measures are undertaken.
O&M	As a result of the improved access of local people to the health services, there are positive impacts on the public health of local population.

5.2 Considerations for climate change

Bangladesh is one of the most vulnerable countries in the world to climate risks (World Bank 2010[4]). It is anticipated that climate change will cause increase in the frequency and intensity of floods and storm surge. At the proposed bridge construction site, climate change may pose the increased risk of damage to the bridge and related structures. To address such climate change impacts, the GOB endorsed the Climate Change Strategy and Action Plan (CCSAP) in 2009. The CCSAP is built on the following six themes: 1) food security, social protection and health; 2) comprehensive disaster management; 3) infrastructure; 4) research and knowledge management; 5) mitigation and low carbon development; and 6) capacity building and institutional strengthening.

Under the NRRDLGIP, the theme of infrastructure of the CCSAP should be taken into account particularly. Due considerations for increasing climate risks should be, therefore, given to the design of the proposed bridge so that the climate risk can be minimized or mitigated to the extent possible. More specifically, securing sufficient height of the bridge and approach road embankments, and ensuring sufficient stability for the bridge abutment places must be considered to adapt the increased risk of floods.

6 Environmental management plan

6.1 Concept of environmental management plan

The Environmental Management Plan (EMP) has been prepared based on the findings of the previous sections, as a critical component of the environmental management system, to ensure avoiding, minimizing, or mitigating all the identified environmental impacts. The methodology to be followed for the preparation of EMP will consist of the following steps.

[4] Economics of Adaptation to Climate Change: Bangladesh (World Bank, 2010)

- Identification of key environmental and social impacts to be caused by the proposed bridge construction
- Elaboration of mitigation measures for the identified impacts
- Development and clarification of environmental and social monitoring mechanism
- Establishment of the institutional mechanism to implement the mitigation measures and environmental and social monitoring
- Identifying responsibilities of various agencies involved in the bridge construction subproject
- Estimate of budget requirements for implementation of mitigation and monitoring measures

The EMP largely consists of three components: 1) action plan for mitigation measures against identified impacts caused by the subproject; 2) environmental and social monitoring plan; and 3) institutional mechanism for the EMP.

6.2 Important principles of EMP

In implementing the EMP, the following principles should be properly taken into account.

Information disclosure, consultation and participation
In the process of the detail design of the proposed bridge, subproject information should be disclosed to local stakeholders. A series of consultation meetings with stakeholders should be held to incorporate their perceptions into the subproject plans, and eventually to minimize or mitigate adverse impacts of the subprojects.

All information shall be presented in a local language which is understandable to local stakeholders. For illiterate people, suitable other communication methods such as briefing them, holding discussions and meetings, radio and television broadcasting shall be used.

As part of the mechanism to know the perception of local stakeholders, a grievance redress mechanism (GRM) shall be established at the LGED Haluaghat Upazila office to receive and address the grievances of local stakeholders about environmental and social issues. The focal person of the GRM will be appointed, and local stakeholders will be appropriately informed of the GRM.

Special consideration to vulnerable groups
Special attention will be given to vulnerable groups so that the proposed bridge construction will not significantly affect their livelihoods. Vulnerable groups include the female-headed households, households below the poverty line, elderly-headed households, the landless, and indigenous people.

Such vulnerable groups, especially women-headed households and the poor households, will be prioritized for the employment in construction and maintenance works

Implementation and monitoring
Implementation arrangement for the EMP shall be established to implement necessary mitigation measures and monitoring activities. The implementation arrangement will include adequate human resources and budget to implement the EMP.

Adequate budgetary support should be fully committed by the government, and made available to cover the costs for environmental and social management of the proposed subproject. Appropriate reporting, monitoring, and evaluation mechanisms regarding environmental and social considerations will be established and implemented as part of the project management system.

6.3 Action plan for implementing mitigation measures

For the implementation of the EMP for the proposed bridge construction, appropriate mitigation measures should be undertaken to avoid, minimize, and mitigate adverse environmental and social impacts. More specifically, the actions listed in Table 27 should be properly carried out.

Table 27 Action plan for implementing EMP of the proposed bridge construction

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implementation	Supervision/ Monitoring
Pre-construction phase					
Legal requirement	• Obtain all necessary clearances and approvals including Environment Clearance Certificate prior to the commencement of any construction work.	Dhaka	Before the commencement of construction	XEN, PMO, ES, RRS	PMO, ES, RRS
Land acquisition	• Complete all necessary land acquisition in accordance with the Resettlement Policy Framework prior to the commencement of any construction works. • Avoid or minimize the area of land to be acquired. • Provide compensation and other assistance to PAPs in accordance with the RPF.	Proposed bridge construction site	Before the commencement of construction	DC, XEN, UE, RRRE, INGO	PMO, RRS
Navigation	• Plan and design navigation clearance for boat pass under the bridge (approximately 3m above the highest flood level)	Proposed bridge construction site	Before the commencement of construction	XEN, PMO, ES	PMO, ES
Environmental clause in the contract	• Incorporate environmental clauses in bid and contract document	Dhaka	Before bidding or contract	XEN, ES	PMO, ES
Construction vehicles and machinery	• Trial run of contractor's vehicles and machinery to confirm that their conditions, and that pollutant emission and noise level will not cause serious damages to the surrounding environment.	Proposed bridge construction site, or vehicle depot	Before the commencement of construction	Contractor	PMO, ES, XEN
Construction phase					
Training for engineers and contractors	• Provide training on environmental and social considerations to concerned engineers and contractors.	LGED District office, LEGD Upazila office	Before the commencement of construction	XEN, REE, RRRE	PMO, ES, RRS

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implemen-tation	Supervision/ Monitoring
Air quality	• Ensure that construction vehicles and heavy machineries to be used for the bridge construction are maintained periodically, and their exhaust gases are within acceptable limit. • Water should be sprayed on the construction site, in particular excavation sites, brick crushing site, asphalt mixing sites, to minimize the effects of dust. • Asphalt mixing plans and concrete batching plants should be sufficiently sealed, and be equipped with dust removal device. • Vehicles carrying construction materials shall be covered to prevent the spill off. • Provide masks to construction workers if dust content is high. • Monitor the air quality around the construction site every six months during the construction period. If the quality exceeds the air quality standards or baseline air quality data, take further preventive measures.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE
Water quality	• Train construction workers on safe handling of petro-chemicals such as bituminous materials to prevent spillage or leakage to the Gudaria River or other water bodies. • Vehicle maintenance and refueling should be confined to the designated areas with sealing to prevent the spillage of lubricants and fuels. Waste petro-chemicals must be properly collected, stored and disposed of, according to GoB regulations. • Restrict disposal of any construction waste into the river or nearby water bodies. • Monitor the surface water quality every six months during the construction period. If the quality exceeds the water quality standards or baseline water quality data, take further preventive measures. • Prevent soil erosion, which may result in water quality degradation, by implementing the measures described in the “soil erosion” section below.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implemen-tation	Supervision/ Monitoring
Soil erosion	• Earthworks should be restricted to the dry season. • Minimize vegetation clearance at the construction site. • Test the embankment soil properly, and compact it to ensure stability. Grass turfing and tree-planting on batter slopes should be undertaken to prevent soil erosion. In particular, approach road embankments need to be properly compacted and covered by grass or trees. • Undertake measures against temporary or permanent erosion and sediment control measures, such as the installation of palasiding and placement of sand-filled bags, if any sites are identified vulnerable to erosion.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE
Noise and vibration	• Ensure that construction vehicles and heavy machineries to be used for the bridge construction are maintained periodically and their exhaust gases are within acceptable limits. • Carry out construction works during daytime hours. • Inform nearby residents in advance of the schedule of construction works. • Arrange ear plugging or ear muff if noise level at the construction site is severe. • Monitor the noise level every six months during the construction period. If the level exceeds the permissible levels or baseline noise level data, take further preventive measures.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE
Bottom sediments	• Undertake measures described in the “water quality” section to prevent spillage or leakage of petro-chemical materials to the Gudaria River. • Monitor the bottom sediment quality every six months during the construction period. If the level exceeds the permissible levels or baseline bottom sediment level data, take further preventive measures.	Proposed bridge construction site, in particular, the river bed of the Gudaria river	During construction period	Contractor, XEN, REE	PMO, ES, REE

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implementation	Supervision/ Monitoring
Waste	• Clean up the construction waste and unused materials regularly during the construction works. All such waste shall be cleared and removed after the completion of construction works. It is necessary to incorporate an article regarding the appropriate disposal of wastes into the contract with contractors. • Prepare composting facilities of all green or biodegradable waste where appropriate.	Proposed bridge construction site, and work camp	During construction period	Contractor, XEN, REE	PMO, ES, REE
Ecosystem and wetlands	• Clearly mark the areas to be cleared before the clearing work commences. Clearing of vegetation shall not occur outside of the designated areas. • Minimize vegetation and tree clearance, and re-vegetate and re-plant trees over the cleared land. • Avoid disposal of any construction material including soils into nearby water bodies.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE
Wildlife	• Minimize vegetation and tree clearance to conserve habitats of wildlife, and re-vegetate and re-plant trees over the cleared land. • Create awareness on wildlife conservation among construction workers and local people.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE
Fish and aquatic life	• Avoid or minimize the construction activities, especially pile driving and dredging, during the peak fish migration and spawning period. i.e., April and May, and return period, i.e., September and October. • Earthwork should be restricted to the dry season. • Avoid complete closing of the river channel that affects migration and production of fish and aquatic life. Alternative drainage should be ensured. • Avoid or minimize the filling of low floodplain areas around the bridge site. • Prevent noise and disturbances by construction works to conserve the habitats of fish and other aquatic flora and fauna.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implementation	Supervision/ Monitoring
Regional hydrology and drainage	• Avoid complete closing of the river channel by providing alternative drainage, if dredging is necessary for river training. • Install a sufficient number and capacity of functional culverts and other drainage facilities. • Select the appropriate place for the storage of soils and other construction materials to avoid disturbance of natural drainage. • Dispose of construction materials and equipment appropriately so that they do not impede the local drainage.	Proposed bridge construction site	During construction period	Contractor, XEN, REE	PMO, ES, REE
Land acquisition	• Minimize temporal occupation of agricultural lands or other lands. • Provide compensation and other assistance to PAPs in accordance with the RPF.	Proposed bridge construction site	During construction period	Contractor, DC, XEN, UE, RRRE, INGO	PMO, RRS
Employment and poverty reduction	• Plan of bridge construction should be explained well in advance to ferry-related workers so that they have sufficient time to find new income generating means. • Provide employment opportunities, mainly for semi-skilled or unskilled labor, to local people under the LCS scheme. Priority will be given to PAPs and vulnerable groups. • Consult with local people on the mitigation measures against possible disturbance of local livelihoods, such as the restriction of work hours of construction activities. • Inform local people of the schedule of construction works.	Proposed bridge construction site	During construction period. Explanation to ferry-related workers should be done during detailed design phase.	Contractor, DC, XEN, UE, RRRE	PMO, ES, REE
Agriculture	• Same as the “land acquisition” section.	Same as the left	Same as the left	Same as the left	Same as the left
Gender equity	• Employ poor women, preferably in earthwork through the LCS scheme, which will contribute to women empowerment.	Proposed bridge construction site	During construction period	Contractor, XEN	PMO, ES
Transport safety and road accidents	• Provide construction workers with safety equipment such as gloves and protective gears. • Install warning signs, guards, speed breakers and other preventive facilities at the construction site. • Undertake road safety measures, including safety education to construction workers, to minimize road accident risks.	Proposed bridge construction site	During construction period	Contractor, XEN	PMO, ES, REE

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implementation	Supervision/ Monitoring
Health, safety and hygiene	• Provision of first aid box, safe drinking water and sanitary latrine for the construction workers. • Provide construction workers and local people with basic information on infectious diseases including HIV/AIDS.	Proposed bridge construction site	During construction period	Contractor, XEN	PMO, ES, REE
Post-construction phase					
Air quality	• Monitor air quality around the bridge and along the improved UZRs. The first monitoring should be done 6 months after the completion of the bridge. • If the monitoring result exceeds the air quality standards or baseline air quality data, periodical monitoring should be continued every year.	Near the bridge on the both banks	During O&M period	XEN, REE	PMO, ES
Water quality	• Monitor the water quality of the Gudaria river and other nearby water body. The first monitoring should be done 6 months after the completion of the bridge. • If the monitoring result exceeds the water quality standards or baseline water quality data, periodical monitoring should be continued every 6 months.	Near the bridge on the both banks	During O&M period	XEN, REE	PMO, ES
Noise and vibration	• Monitor the noise and vibration level around the bridge and along the improved UZRs. The first monitoring should be done 6 months after the completion of the bridge. • If the monitoring result exceeds the noise quality standards or baseline noise level data, periodical monitoring should be continued every year.				
Soil erosion	• Undertake proper maintenance work on the embankment of the approach roads and improved UZRs.	Road embankment	During O&M period	Contractor, XEN, REE	PMO, ES
Bottom sediment	• Monitor the bottom sediment quality of the river bed of the Gudaria river. The first monitoring should be done 1 year after the completion of the bridge. • If the monitoring result exceeds the bottom sediment quality standards of USEPA or baseline sediment quality data, periodical monitoring should be continued every year.	Road embankment	During O&M period	XEN, REE	PMO, ES
Waste	• Dispose of the wastes generated under the maintenance work.	Bridge	During O&M period	Contractor, XEN, REE	PMO, ES

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implemen-tation	Supervision/ Monitoring
Tree-planting and re-vegetation	• Conduct tree-planting and turfing of all appropriate sites with trees and grasses in order to compensate the loss of biodiversity in course of construction activities. Selection of indigenous species is preferred. • Undertake proper measures for watering, fertilizing and nursing of trees/ plants/ grasses to till growing up sufficiently.	Near bridge and approach road	Immediately after the completion of construction work	Contractor, XEN, REE	PMO, ES
Wildlife	• Create awareness on wildlife conservation among local people. • Check the conditions of vegetation in the areas where re-vegetation and replanting of trees were conducted. If planted trees and vegetation are found decaying or in bad conditions, re-vegetation and replanting of trees should be done again.	Bridge	During O&M period	XEN, REE	PMO, ES
Fish and aquatic life	• Same as the "wildlife" section.	Bridge	During O&M period	XEN, REE	PMO, ES
Regional hydrology and drainage	• Conduct proper maintenance of the approach road and other structures on a regular basis to prevent the drainage congestion.	Approach road and bridge	During O&M period	XEN, REE	PMO, ES
Landscape	• Prevent road embankment and nearby vacant places from squatting or construction of commercial structure.	Bridge and approach road	During O&M period	XEN, REE	PMO, ES
Road transport and accident	• Provide traffic signs, speed breakers, marking, and other road safety facilities to prevent road accident. • Provide education and publicity of road safety to local people (as part of road safety activity under the NRRDLGIP).	Approach road and bridge	During O&M period	XEN, UE	PMO, ES

Issues/ Environmental impact	Mitigation measure/ action	Location	Timing	Responsible organization	
				Implementation	Supervision/ Monitoring
Cleaning and rehabilitation of work site	• Remove all construction materials from the construction site. Materials, including but not limited to unused construction materials, petro-chemicals, oil and lubricant, cement, and brick, and residues and packages of these materials. They should be carefully treated and removed from the site after the completion of the bridge construction. • Dispose of all wastes properly, including those from construction works and from the labor camp. Dumping into the nearby water bodies should be strictly prohibited. • Rehabilitate the labor camp site so that the area will not pose unhygienic risks for local residents. • All borrow pits should be rehabilitated by filling soils or other measures.	Bridge, approach road, and labor camp	Within 1 month of the completion of construction works	Contractor, XEN	PMO, ES

Note 1: DC: Deputy Commissioner; ES: Environmental Specialist; DOE: Department of Environment; INGO: Implementing NGO; LCS: Labor Contracting Society; PAP: Project affected persons; PMO: Project Management Office; REE: Regional Environmental Expert; RPF: Resettlement Policy Framework; RRRE: Regional Rehabilitation and Resettlement Expert; RSS: Rehabilitation and Resettlement Specialist; UE: Upazila Engineer; XEN: Executive Engineer

Note 2: The contractor of the construction work will take necessary actions with guidance and assistance of the LGED XEN, PMO, and ES and RRS.

The PMO is responsible for ensuring that 1) all required mitigation measures are properly informed to relevant Engineers and the Design, Supervision and Management (DSM) consultants; 2) bidding documents contains all required mitigation measures to be implemented during construction work; 3) no objection certificate from local stakeholders is obtained prior to granting any civil work contract; 4) monitoring on the progress of the EMP, and elaboration of progress reports; 5) additional measures against unexpected impacts if identified; 6) coordination with relevant government departments and local stakeholders; and 7) additional environmental assessment if there is significant changes in the subproject design and location.

In order to ensure the contractors' compliance with the EMP, the LGED needs to consider the following actions in the process of all construction bidding and contract: 1) a set of environmental pre-qualification for potential bidders; 2) budgeted items for the implementation of the EMP; 3) environmental and social factors to be taken into account by bid reviewers, 4) environmental clauses to be incorporated into contract, and 5) the full EIA and IEE reports to be made available for potential bidders.

6.4 Environmental and social monitoring

Based on the key environmental and social impacts and mitigation measures described in the previous sections, the environmental and social monitoring mechanism for the proposed bridge construction is proposed below.

6.4.1 Concept of environmental and social monitoring

Monitoring on adverse impacts and mitigation measures is a key component of the EMP. The objectives of the environmental and social monitoring are the following.

- Check environmental and social impacts caused by the proposed bridge construction
- Verify compliance with the mitigation measures proposed in the individual examinations of subproject sites as well as IEE and/or EIA
- Verify compliance with compensation and resettlement measures proposed in ARAPs and the RPF
- Check the effectiveness and adequacy of the proposed mitigation measures
- Take additional measures if the proposed measures are found to be inadequate
- Take necessary measures if unexpected problems emerge

(1) Key environmental and social monitoring items

Key environmental impacts to be monitored for the proposed bridge construction are described in Table 28.

Table 28 Environmental and social monitoring for the proposed bridge construction

Environmental Impact/ Issue	Mitigation Measures	Location	Timing	Responsible Organization	
				Implement -ation	Supervision/ Monitoring
Pre-construction phase					
Environmental clearance	• Verify compliance with the conditions attached to the ECC by DOE	Dhaka	Prior to the construction work	XEN, PMO, ES, RRS	PMO, ES, RRS
Land acquisition	• Confirm the scale of land acquisition • Check the compliance of the required land acquisition with the RPF • Check whether compensations are completed in accordance with the RPF	Bridge construction site	Prior to the construction work	DC, XEN, PMO, RRRE	PMO, ES, RRS
Construction phase					
Air quality	• Confirm whether measures to minimize dust such as spraying water are properly undertaken • Confirm the change in air quality in the vicinity of the proposed bridge construction sites every six months	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Water quality	• Check whether earthworks are undertaken in the dry season • Check whether bituminous materials and other construction materials are treated properly • Check whether construction wastes are properly collected, stored, and disposed of • Confirm the change in water quality in the vicinity of the proposed bridge construction sites every six months	The Gudaria river and other water bodies near bridge construction site	During construction work	XEN, REE	PMO, ES
Soil erosion	• Check whether earthworks are undertaken in the dry season • Check whether soil protection measures, e.g., such as soil compaction and minimization of vegetation clearance, are properly undertaken • Check whether regular maintenance of the protection measures is undertaken	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Noise and vibration	• Check whether construction works are conducted during daytime hours • Check whether local residents are informed of the work schedule • Confirm the change in noise level in the vicinity of the proposed bridge construction sites every six months	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Bottom sediment	• Check whether bituminous materials and other construction materials are treated properly • Confirm the change in substances contained in the bottom sediments in the vicinity of the proposed bridge construction sites at the pre- and post subproject phases	The Gudaria river and other water bodies near bridge construction site	During construction work	XEN, REE	PMO, ES
Wastes	• Check whether construction sites are cleaned by contractors • Check whether facilities such as garbage bins and waste disposal sites are installed properly • Check whether wastes are treated and disposed of properly by responsible entities	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES

Environmental Impact/ Issue	Mitigation Measures	Location	Timing	Responsible Organization	
				Implement -ation	Supervision/ Monitoring
Ecosystem	• Check whether conservation measures, such as minimization of vegetation clearance and re-vegetation, are properly undertaken	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Regional hydrology and drainage	• Check whether earthworks are undertaken in the dry season • Check whether construction materials are properly stored to avoid disturbance of local hydrology • Check whether the capacity of drainage facilities of approach roads is adequate • Check whether alternative drainage is provided when dredging works are implemented	The Gudaria river and bridge construction site	During construction work	XEN, REE	PMO, ES
Land acquisition	• Check whether the land acquisition process has been properly implemented, focusing on compensation, restoration and rehabilitation assistance, and special attention to vulnerable groups • Confirm the perceptions of PAPs on the proposed bridge construction, including grievances or any other request	Construction site for bridge and approach roads	During construction work	DC, XEN, REE	PMO, ES
Living and livelihoods	• Check whether there are people who may lose income sources, such as workers on ferries • Check whether such people are informed well in advance • Check whether consultations with such people are sufficiently held	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Safety and health	• Check whether potential safety hazards and health issues are explained to construction workers • Check adequate equipment to prevent accidents is provided to construction workers	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Unexpected impacts	• Check whether impacts which have not been expected are caused by the construction works	Construction site for bridge and approach roads	During construction work	XEN, REE	PMO, ES
Post-construction phase					
Environmental Monitoring	• Undertake a periodic environmental monitoring on air quality, water quality, noise level, sediments, 6 months after the completion of construction of the bridge. • If any of the monitoring results of the above parameters exceed environmental quality standards or baseline data, continue the monitoring on the parameter(s).	Bridge and connecting UZRs	6 months after the completion, and every year if required	XEN, Environmen -tal expert to be recruited	PMO, ES
Soil erosion	• Check the conditions of embankment to evaluate adequacy of soil protection measures	Approach roads	After the completion of the work	XEN, UE	PMO, ES
Regional hydrology and drainage	• Check whether regional hydrology is disturbed by the bridge construction • Check whether the capacity of drainage facilities is adequate	Bridge and connecting UZRs	After the completion of the work	XEN, UE	PMO, ES

Environmental Impact/ Issue	Mitigation Measures	Location	Timing	Responsible Organization	
				Implement -ation	Supervision/ Monitoring
Living and livelihoods	• Confirm the perceptions of PAPs on the bridge construction subproject	Bridge and connecting UZRs	6 months after the completion of the work	XEN, UE	PMO, ES
Land acquisition	• Confirm the perceptions of PAPs on the bridge construction subproject • Check whether PAPs have any complaints	Approach roads	6 months after the completion of the work	XEN, UE	PMO, RRS
Safety and health	• Check whether safety measures such as the installation of a sufficient number of warning signs are undertaken • Confirm the perceptions of local residents	Bridge and connecting UZRs	After the completion of the work	XEN, UE	PMO, ES
Operation and maintenance	• Check whether the bridge, approach roads, and other structures are properly maintained on a regular basis	Bridge approach roads	After the completion of the work	XEN, UE	PMO, ES

Source: Survey team

(2) Monitoring indicators for key environmental parameters

Environmental monitoring on key parameters is necessary, as described in the previous section, during the construction and post-construction phases. The monitoring aims to check the adverse impacts of the proposed bridge construction. Possible environmental parameters, including air, noise, water, and sediments, and location and sampling frequency are presented in Table 29.

Table 29 Environmental parameters to be monitored

Component	Parameters	Location	Sampling and testing year
Air quality	SPM, PM10, PM2.5, Pb, Cd, CO and NOx	At the junction points of entry of the bridge	• 6 months after the commencement of the construction work. The monitoring will continue every 6 months during the construction phase. • 6 months after the completion of the construction for 2 to 3 times every year, after which the monitoring may need to be continued if required
Noise quality	Noise level	At the junction points of entry of the bridge	• 6 months after the commencement of the construction work. The monitoring will continue every 6 months during the construction phase. • 6 months after the completion of the construction for 2 to 3 times every year, after which the monitoring may need to be continued if required
Water quality	DO, BOD, COD, pH, EC, TSS, TDS, Turbidity	Sampling points along the river and nearby water bodies	• 6 months after the commencement of the construction work. The monitoring will continue every 6 months during the construction phase. • 6 months after the completion of the construction for 3 to 4 times every 6 months, after which the monitoring may need to be continued if required
Sediment and soil	Zn, As, Hg, Mn, Cd	Area covered with sediment/ silt of the river	• 6 months after the commencement of the construction work. The monitoring will continue every 6 months during the construction phase. • 1 year after the completion of the construction for once, after which the monitoring may need to be continued if required

Source: Survey team

With respect to air quality and noise level, the proposed construction site is currently not suffering from these two parameters, since the site is basically located in the rural area where there are not many motor

vehicles and no industrial factories. The frequency of the monitoring on air and noise, therefore, does not need to be high.

For these two parameters, the environmental monitoring should be done after six months of the commencement of the construction work. The monitoring on air and noise during the construction work will, then, continue every six months until the completion of the bridge construction. After the completion of the bridge, the first post-construction monitoring will be implemented after six months of the completion. The monitoring activity will be conducted every year to obtain two or three samples. If all the monitoring results are found within the air or noise quality standards, or not significantly exceeding the baseline data collected during this EIA study, then it is unnecessary to continue the monitoring. If the monitoring results are beyond the standards or baseline data, then it is necessary to continue the monitoring, and explore further mitigation measures.

Similarly in terms of water quality, the water of the Gudaria River is not polluted by any industrial units, and the risk of water pollution by the construction work is not high. Therefore the frequency does not need to be high either. Thus, the monitoring on water quality at the construction phase is the same as those on air quality and noise level. However, in terms of post-construction monitoring on water quality, it is proposed that the frequency of the monitoring will be every six months. This is because the seasonal change of the water quality of the river is considered high, and both the dry and rainy seasons must be covered.

In terms of the sediments, since the influence on the sediments of the river bed will be usually emerged at the slower rate, the monitoring frequency regarding the sediments can be longer than the other three parameters. Thus the timing of the monitoring on the sediments at the post-construction phase is proposed one year after the completion of the bridge construction, while the monitoring during the construction phase will be conducted in the same manner as the other three parameters.

6.5 Institutional arrangement for environmental management system

6.5.1 Implementation mechanism

The LGED, as the executing agency, is responsible for the environmental and social considerations. However, few members in the LGED have sufficient capacity to handle environmental and social considerations. Therefore, the Project Management Office (PMO) shall establish an internal section for environmental and social considerations to ensure that proper environmental and social measures are undertaken. Consultants with expertise in environment and social considerations will be assigned to the internal section.

Table 30 presents the responsibilities of relevant entities at respective phases of the subproject in which the proposed bridge is constructed. The District Executive Engineer (XEN) of the LGED Mymensingh District Office bears the responsibility for environmental and social issues. The DSM consultant team, especially, the Environmental Specialist (ES) and Rehabilitation and Resettlement Specialist (RRS) to be assigned in the PMO, and the Regional Environmental Expert and Regional Rehabilitation and Resettlement Expert in Mymensingh region will assist the District XEN.

The Regional Deputy Project Director (RDPD) of Mymensingh area or XEN at the LGED Mymensingh Regional Office will supervise the activities of the Mymensingh District XEN, in terms of the identification of potential impacts, elaboration of mitigation measures, and monitoring. The Mymensingh District XEN and Haluaghat and Dobaura Upazila Engineers shall assist the consultants in conducting the

field surveys. These Upazila Engineers, the Haluaghat Upazila Engineer in particular, shall also be responsible for the supervision of contractors to ensure compliance with the Environmental Framework, RPF, IEE and/or EIA, and ARAP. Complaints from local residents should also be received by these Upazila Engineers and transferred to the PMO via the Mymensingh District XEN. The PMO, under the assistance of the ES and RRS, shall be responsible for supervising overall activities related to environmental and social issues.

In each quarter, the Mymensingh District XEN shall conduct monitoring and fill in the prescribed monitoring form. The District XEN will submit it to the Regional Deputy Project Director of Mymensingh Region, who will subsequently submit it to the PMO.

Table 30 Responsibilities of relevant entities for the subproject

Responsibility	Pre Construc-tion	Construc-tion	Operation
LGED District Office in Mymensingh			
District Executive Engineer in Mymensingh			
• Responsible for identification of potential impacts and elaboration of mitigation measures	X		
• Responsible for conducting environmental and social monitoring activities	X	X	X
• Supervise and assist UEs in supervising contractors		X	X
• Receive complaints transferred from UEs and send it to PMO		X	X
Project Management Office (PMO)			
Assistant engineer in charge of environmental and social monitoring			
• Supervise overall activities for identification of potential impacts and elaboration of mitigation measures	X		
• Supervise overall activities for environmental and social monitoring	X	X	X
• Supervise DSM consultants in elaborating an environmental and social monitoring plan	X		
• Supervise and assist DSM consultants in conducting activities for identification of impacts, elaboration of mitigation measures, and environmental and social monitoring	X	X	X
DSM consultants (Environmental Specialist and Resettlement & Rehabilitation Specialist)			
• Assist the PMO in supervising overall activities for identification of impacts, elaboration of mitigation measures, and of environmental and social monitoring activities	X	X	X
• Assist Mymensingh District XEN and Regional DSM consultants in conducting activities for identification of impacts, elaboration of mitigation measures, and monitoring	X	X	X
• Elaborate an environmental and social monitoring plan	X		
LGED Regional Office in Mymensingh			
Regional Deputy Project Director in Mymensingh			
• Supervise the monitoring activities of the Mymensingh District XEN	X	X	X
DSM consultants (Regional Environmental Specialists and Regional Resettlement Specialists)			
• Assist Mymensingh District XEN in conducting activities for identification of impacts, elaboration of mitigation measures, and monitoring	X	X	X
Haluaghat and Dobaura Upazila Offices			
Upazila Engineers (UEs) in Haluaghat and Dobaura Upazila			
• Supervise contractors to ensure compliance with IEE and/or EIA and ARAP		X	X
• Assist Mymensingh District XEN and DSM consultants in conducting activities for identification of impacts, elaboration of mitigation measures, and monitoring, especially in conducting sample field survey	X	X	X
• Receive complaints from local residents about environmental and social issues regarding the NRRDLGIP and send them to the Mymensingh District XEN		X	X

[Legend] DSM: Design, Supervision and Monitoring; ES: Environmental Specialist; PMO: Project Management Unit; RRS: Rehabilitation and Resettlement Specialist; UE: Upazila Engineer, XEN: Executive Engineer

6.5.2 Grievance redress mechanism

The LGED shall establish a mechanism to receive local people's grievances about the environmental and social issues, and to seek resolutions to them. The grievance redress mechanism (GRM) should address the grievances promptly, using an understandable and transparent process with special considerations to vulnerable groups including women, children, the elderly, the poor, minority groups at no cost and without retribution. The GRM should not impede access to the country's judicial or administrative remedies. Local stakeholders should be appropriately informed about the GRM.

Grievances shall be first brought to the LGED Haluaghat or Dobaura Upazila offices. The focal persons to receive grievances need to be appointed in these offices, and disclosed to the public. This GRM shall be informed to the PAPs and local stakeholders in such occasions as public consultations.

Grievances lodged at the LGED Haluaghat or Dobaura Upazila offices shall be first addressed by the Upazila Engineers supported by the Regional Environmental Expert or Regional Rehabilitation and Resettlement Expert. Grievances not resolved by the LGED Upazila offices shall be brought to the LGED Mymensingh District office. The Mymensingh District XEN under the assistance of the DSM consultants at the regional level will address those unresolved grievances. Grievances not redressed by the Mymensingh District XEN will be brought to the PMO, which shall address them with the assistance of the DSM consultants in the PMO. Grievances not redressed by the PMO, then, shall be sent to and addressed by the Inter-ministerial Steering Committee (ISC). Further grievances will be referred to the appropriate courts of law.

Generally, the grievances lodged at the ground level will be brought to the upper level on a quarterly basis, and included in the project quarterly reports. However, particularly important grievances should be immediately transferred to the upper levels when they are found not to be resolved at the present level.

7 Public consultation

7.1 Conduct of public survey

Consultation with local people is an important part at all stages of development activities. It ensures people's participation at all levels, i.e., in planning, designing, implementation, and operation and maintenance of the subproject.

In light of this, a series of consultations with local people has been carried out on various environmental and social issues related to the proposed bridge construction. Detailed discussions were held with people residing in areas on both sides of the Gudaria River, who potentially benefit from and/or are affected by the construction of the proposed bridge. 13 FGDs in total have been carried out in the vicinity of the proposed bridge in August 2012. A list on location of FGDs with date/time, numbers of participants, their occupation patterns have been enclosed as Attachment 1 to this Supplementary Annex.

In addition to FGDs, detail discussions with local people were also made on the issues of suitable location of the proposed bridge, erosion and shifting status of the river during field verification at the site.

7.2 Findings of the public consultation

In almost all consultation meetings, when local people were informed about the plan of the proposed bridge

construction, they were reluctant to believe initially since such promises were made on several occasions for the construction of a bridge on Futkai, in the past. However, after they were informed of and explained about the plan and the expected new project, they rendered all types of cooperation required for collecting data and information necessary for the EIA study. They had high expectations for the proposed bridge.

During the FGDs, local people were informed of various potential environmental and social hazards such as noise disturbance, dust and air pollution, temporary and permanent occupation of lands, and deployment of labor force, part of which they were already aware of. They stated that such negative impacts would not cause significant harm to their livelihoods. They also expected that the concerned authority would take proper measures to minimize or mitigate the severe adverse effects.

Local people demonstrated positive responses to the proposed bridge construction, irrespective of the rich and poor, young and old, and male and female. According to the local people, the proposal for bridge construction is a long-standing issue in the area, but it has never been realized, resulting in a big disappointment among them.

Local people also believed that the importance of the area would be elevated and various economic activities would be started in the area after the bridge construction. They expected increased opportunities for income generation, and the economic activities around the area would be accelerated. Moreover, local people also showed strong expectation for the increased opportunities for employment for physical unskilled or semi-skilled labor in the construction work.

The potential affected persons such as the boatmen and the lessee of the Futkai ferry ghat, expressed their opinions which are in favor of bridge construction. Even farmers owning the lands in the vicinity of possible construction site were in favor of the proposed bridge construction. However they also requested proper and sufficient compensation and other mitigation measures.

According to the local people, the banks of the Gudaria River have been stable, and the river has not been shifting for long. Thus the risk of erosion caused by the river flow is very small.

It has been mentioned that the Gudaria River is flashy in nature and the river banks go under water for 15-20 days almost every year. According to FGDs, during the high flood of 1988, surrounding homesteads were flooded up to 0.76 meter. Since the movement of larger size boat, having height of 1.5-1.8 meter, for purchasing agricultural products from the village areas to nearby markets is quite a common practice in the area. Thus, local people requested a reasonable bridge height so that the boat movement under the bridge is continued even during the high flood season.

Image 9.1 Public consultation in the vicinity of the proposed bridge site

Image 9.2 Public consultation in the vicinity of the proposed bridge site

Attachment 1 List of consultation meetings

Primary data and information on environmental and social issues were collected by the Survey Team in the village areas located near the proposed bridge construction site. Local people residing in both sides of the Gudaria River are consulted. The consultations were held mainly in the form of the Focus Group Discussion (FGD), as it is considered a good tool for people's participation. The locations, dates, time, number of respondents and their occupational patterns are given in Table A-1.

Table A-1 Location, date, and attendance number of FGDs

No	Location	Date & time	Number of attendance	Occupation			
1	Village- Kailati Ghoria Para Union- Bildora	03 Aug 2012 9.30 a.m.	16	Farmers: Businessmen: Service holder:	6 4 1	Students: Village Doctor:	4 1
2	Village- Futkai Union- Goatola	04 Aug 2012 10.00 a.m.	22	Farmers: Businessmen: Service holders:	8 5 1	Students: Fishermen: Social Workers:	4 2 2
3	Village-Izara Para	04 Aug 2012 12:00 a.m.	20	Farmers: Businessmen: Service holder:	8 5 1	Students: Retired Teacher: Imam:	4 1 1
4	Goatola UP	05 Aug 2012 10:00 a.m.	13	Farmers: Businessmen:	7 6		
5	Goatola Bazar (west)	05 Aug 2012 12:30 p.m.	16	Farmers: Businessmen: Service holder:	6 8 1	Wage labor:	1
6	Kailati Purba Para	06 Aug 2012 10:30 a.m.	11	Farmers: Businessman: Service holders:	4 1 2	Students:	4
7	Kailati bazar	08 Aug 2012 10:15 a.m.	16	Farmers: Businessmen: Service holders:	8 3 3	Teacher: Carpenter(wood):	1 1
8	Outi Chairman Bari, UP- Bildora	09 Aug 2012 11:30 a.m.	9	Farmers: Businessmen:	5 3	Driver:	1
9	Gobindapur Road Crossing	09 Aug 2012 1:30 p.m.	12	Farmers: Businessmen:	4 7	Carpenter(wood):	1
10	East Soluakanda, UP- Bildora	09 Aug 2012 3:30 p.m.	15	Farmers: Businessmen:	9 3	Students:	3
11	Village-Shaliakanda (Madhyapara)	10 Aug 2012 9:30 a.m.	18	Farmers: Businessman:	6 8	Student: Fishermen: UP Member:	1 2 1
12	Village-Naliakandi	10 Aug 2012	10	Farmers:	10		
13	Village-Shakuai	13 Aug 2012	11	Farmers: Businessmen:	8 2	Student:	1

Source: Field survey

Attachment 2 Images of river banks of the Gudaria River

Image A-1 Proposed bridge site (latitude 25°1.391'N and longitude 90°29.097'E)

Image A-2 River bank in 1000 m upstream (latitude 25°01.513'N and longitude 90°28.702'E)

Image A-3 River bank in 800 m upstream (latitude 25°01.455'N and longitude 90°28.785'E)

Image A-4 River bank in 600 m upstream (Latitude 25°01.416'N and longitude 90°29.872'E)

Image-A-5 River bank 400 m upstream (Latitude-25°01.416'N and longitude 90°28.969'E)

Image A-6 River bank 200m downstream (Latitude-25°01.390'N and longitude 90°29.193'E)

Image A-7 River bank in 350m Downstream (latitude 25°1.376'N and longitude 90°29.274E)

Image A-8 River bank in 500 m downstream (latitude 25°01.381'N and longitude 90°29.334'E)

Image A-9 River bank in 650 m downstream (Latitude 25°01.370'N and longitude 90°29.379'E)

Image A-10 River bank in 800 m downstream (latitude 25°01.455'N and longitude 90°28.785'E)