Government of The People's Republic of Bangladesh

Ministry of Water Resources

Bangladesh Water Development Board

Environmental Management Framework (EMF)
(Draft Final)

River Bank Improvement Program (RBIP)

February 2015

Executive Summary

The Government of Bangladesh through the Bangladesh Water Development Board (BWDB) and with financial assistance from the World Bank (WB) is planning to initiate River Bank Improvement Program (RBIP) primarily to rehabilitate and improve the existing right bank embankment of the Brahmaputra River, and also to undertake associated activities including river bank protection and construction of a road over the embankment. The program will be implemented in phases and in the first phase, works will be carried out for the 50 kilometers (km) priority reach of the embankment; the remaining works will be implemented under subsequent phase(s).

For the priority reach of the program, the BWDB is carrying out detailed design and environmental assessment (EA[1]) in line with the national regulatory and World Bank policy requirements. For the remaining works, finalization of alignment and detailed engineering designs will be carried out under the subsequent RBIP phase(s).

The present Environmental Management Framework (EMF) has been prepared with an objective to guide the detailed environmental assessment to be carried out for the remaining works to (i) ensure all relevant environmental and social issues are mainstreamed into the design and implementation of remaining works, (ii) consider in an integrated manner the potential environmental and social risks, benefits and impacts of the RBIP and identify measures to avoid, minimize and manage risks and impacts while enhancing benefits, and (iii) ensure compliance with national and World Bank requirements. The environmental assessment will be carried out once the detail design of the embankment is finalized. Since the design of 50km of the priority reach will be available during the phase I, the environmental assessment will also be carried out for the 50 km according to the EA guidelines stated in the EMF. The EA for the remaining reach will be carried out once the detailed design is available during the preparation of subsequent phases.

Background

Brahmaputra is the Country's largest of the three rivers with highest erosion and bank movements. Prior to 1960s, over-bank spills along the 220 km stretch of the right bank of the Brahmaputra River used to cause flooding on an area of about 240,000 ha. In early 1960s, the Brahmaputra Right-bank Embankment (BRE) was built to provide protection from flooding and to foster agricultural growth in this area.

In the 1970s the embankment started to fall under sporadic river bank erosion attacks. During 1980s, the frequency of the BRE breaches by erosion increased rapidly as longer sections came within the range of rapidly eroding river bends which could cause bank-line erosion rates of several hundred meters per year in early stages of bend formation. To prevent flooding, these breaches were typically closed by local BRE retirements at about 200 meter set-backs. As a result of this minimal set-back distance the BRE has been retired several times in many places and at present perhaps only 50 km of the original BRE has remained in place. Currently, many long stretches of the BRE are very close to the river-bank line. Hence when embankment is breached at many places it is often left open as closing of such breaching is becoming impossible. Consequently, security of area

[1] In the present document, the terminologies 'environmental assessment (EA)' and 'environmental impact assessment (EIA)' have been used interchangeably.

protected by the BRE has been seriously threatened and large areas of land and cities with large population like Sirajganj are exposed to flooding.

Overview of Proposed Program

The main focus of the BRE rehabilitation work under RBIP is on its length alongside the Brahmaputra/ Jamuna River from Bangabandhu (Jamuna) Bridge to the Teesta River. Phase I of the project will cover the approximately 50-km long priority reach from Sailabari to Hasnapara. This reach has the highest historic erosion rates. The project may also include the option of a toll road (highway) associated with the flood embankment. The project's physical works will include river bank protection on portions of the western (right) bank; embankment upgrading, reconstruction and realignment, including adding drainage/control; structures (regulators); and a new road on the embankment.

Description of the Project Components and Phases

Phase I – Priority Reach: In this reach, all of the original BRE has been eroded due to widening and westward shift of the Brahmaputra. Phase I involves complete reconstruction of the flood embankment, while securing the riverbank against erosion through long guiding revetments that will incorporate current emergency works being built by BWDB. Approximately 17-km of riverbank protection will be provided in addition to upgrading 12-km existing protection.

Phase II – Remaining Reaches: The remaining reaches include 20 km of the BRE extending upstream from Jamuna Bridge to the priority reach, and 77 km extending upstream from the priority reach to the Teesta River.

Phase III – Road: The new embankment will incorporate an emergency and maintenance road. Existing service or feeder roads on embankments often consist merely of crest pavement. For better market access by the local population, a higher category of road construction is warranted that would allow for future widening to four lanes. Also, subsoil conditions indicate that a wide embankment is needed to avoid geotechnical failure from seepage. The alignment of the reconstructed BRE will therefore allow for future road upgrading according to the Asian highway standard adopted in Bangladesh.

Policy and Regulatory Requirements

A wide range of laws and regulations related to environmental issues and relevant to this project have been reviewed. A brief description of the core applicable policies and acts is presented below.

National Environmental Policy, 1992. The Policy, approved in May 1992, sets out the basic framework for environmental action together with a set of broad sectoral action guidelines. The Environmental Policy of 1992 seeks to ensure that projects do not pollute the environment or degrade resources. The Policy states that Environmental Impact Assessments (EIA) should be conducted before projects are undertaken.

Environment Conservation Act, 1995 (and Subsequent Amendments in 2000 and 2002).The provisions of the Act authorize the Director General (DG) of Department of Environment to undertake any activity he deems fit and necessary to conserve and enhance the quality of environment and to control, prevent and mitigate pollution.

Environment Conservation Rules, 1997 (and Subsequent Amendments in 2002 and 2003). These are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for among others the national Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial

effluents, emissions, noise and vehicular exhaust; categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load; procedure for obtaining environmental clearance; and requirement for undertaking IEE and EIA as well as formulating EMP according to categories of industries/development projects/activities;

Depending upon location, size and severity of pollution loads, projects/activities have been classified in ECR 1997 into four categories: Green, Orange A, Orange B and Red respectively, to nil, minor, medium and severe impacts on important environmental components (IECs).

According to the ECR 1997, 'construction/ reconstruction/ expansion of flood control embankment, polder, dike, etc.' falls under the Red category. Consequently, the proposed RBIP project falls under Red Category and requires undergoing through IEE and subsequent environmental impact assessment (EIA). The EMF will be shared with DoE for concurrence, the ToR for EIA will be shared with DoE for clearance and the EIA requires formal clearance from the Department of Environment (DoE) before the project negotiations in the subsequent phases.

World Bank Safeguard Policies: According to the World Bank requirement, the project has been classified as "**Category A**" considering the risk associated with widely involved major civil works by reconstruction and rehabilitation of the embankment, river bank improvement to protect against flooding erosion and also establish a connectivity along right bank of river Jamuna. Since the area is populated and used for cultivation widely and Jamuna has high importance of biodiversity and fisheries, certain negative environmental impacts may occur during the implementation and operational phases.

Baseline Environmental Conditions

Project Area of Influence. The influence area of the project has been derived considering the extent of flood inundation areas through digital elevation model (DEM) of the area, river network, roads and other flow barrier structures and flood extent from satellite images. However the influence Area of remaining phases might be changed with the changing of river morphology at the time of implementation; therefore this will need to be re-evaluated in each phase-specific EIA with adjustments made as necessary. The DEM used to define the initial/preliminary influence area was developed as part of the project activities based on digitization of the BWDB contour maps. Detailed topography and land elevation pattern in the study area was carried out to further refine the existing DEM. The following criteria have been considered to define the influence area: i) recent extent of flood inundation; ii) elevation of the area; iii) connectivity; iv) flow direction of water; v) road network; vi) significant habitats (eco-dynamic area); and vii) movement of inhabitants. Area of influence for each subsequent phase will be determined in respective EIA consistent with the help of above criteria and will cover the areas that will be directly or indirectly affected by the project.

Hydrology. The hydrology and inundation cycles of the study area is dominated by the Jamuna River. The River is the 240 km-long lower reach of the Brahmaputra River from the India-Bangladesh border to the confluence with the Ganges. The river originates in the northern Himalayas in Tibet, flows through China as the Yarlung Tsangpo and India as the Brahmaputra and enters Bangladesh at Noonkhawa as the Jamuna. The Teesta, Manas, Sankosh, Dharla and Dudhkumar rivers are the major tributaries of Brahmaputra. The Brahmaputra-Jamuna river system displays characteristics of a braided river and is

highly susceptible to migration and avulsion. In plan form, the river typically shows two to three channels per cross-section and a total width of 8 to 12km. The Brahmaputra/Jamuna is characterized by its widening as a consequence of the Great Assam Earthquake in 1950. In Assam, India, from its original width of 2 to 3 km it is widened along its 650km length from an average 6 to 9km and along its 250km in Bangladesh from 8 to 12km. The Jamuna has an annual average discharge of around 20,000 m^3/s at Bahadurabad. Over 75 percent of the discharge of the Jamuna river is generated from rainfall and snowmelt from upstream countries, as a result, the flow pattern is not strongly related to local precipitation.

The influence area of the project is dominated by the Jamuna river and also the Bangali, Ichamati and Hurasagar rivers to a lesser extent in the eastern part of the area. All these rivers are interconnected by numerous khals, tributaries and distributaries forming a hydrological network in the entire northwest region of Bangladesh. For example, Mahananda, Punorbhaba which are major rivers of the northwest region, are connected to the Atrai-Karatoya-Bangali system which drains to the lower Jamuna through the Hurasagar/Baral in the south east corner of the region.

Groundwater. The groundwater level varies across the year. Data for Bogra station shows that during October the groundwater level is at its highest at 3.8 m below existing ground level and lowest in April at 7m below existing ground level. However, water levels at Sirajganj and Gaibandha are slightly higher with highest water levels at 1.67 m and 1.2 m respectively.

Climate. The project area lies in the northwest part of Bangladesh where the climate is subtropical in nature with three seasons namely summer/pre-monsoon from March to May, monsoon from June to October, and winter season from November to February. Lower rainfall (1900 mm vs. national average of 2300 mm annually) makes this area both atmospherically and pedologically drier than the rest of the country. The rainy season is hot and humid with about 88 percent of the annual rainfall. The winter is predominately cool and dry. The summer is hot and dry interrupted by occasional heavy rainfall, where monsoon comes in the month of June and recedes in late October.

Topography. Topographically, this area is flat and before construction of the BRE, the area was exposed to flooding from the Jamuna River during the monsoon season. Land elevation varies from 21m to 4.7m above mean sea level (amsl) but most of the area is within 8-16 m. The area slopes gently downward from north to south and towards the east. The highest part is situated in the northern portion (Saghata, Jhumabari, and parts of Gaibandha) and the lower elevation area is in the southern portion (Sirajganj).

Biological Resources. The project area in the Brahmaputra River System falls within two of the 12 Bio-ecological Zones of Bangladesh, as designated by IUCN in 2002 (Nishat ***et al***. 2002). These are 'Major Rivers' and 'Floodplain (Teesta)'. Therefore, the ecosystem and the species composition are relatively homogeneous across the project area. The area, however, harbors some excellent habitats of the Ganges River Dolphin (***Platanista gangetica***) and wintering grounds of many migratory birds. The two newly-declared (declared in 2013) dolphin sanctuaries (Nagarbari-Mohanganj Wildlife Sanctuary – 408 ha, and Shilonda-Nagdemra Wildlife Sanctuary - 146 ha) in the downstream of the project area supports the source population of the Ganges River Dolphin.

Fish and Fisheries. The Jamuna river is an important source of fresh water fish in Bangladesh. The fish habitats of the Jamuna reflect a combination of sedimentology, depth and velocity associated with the organization of river bedforms and morphologies.

Jamuna also has huge sediment loads coming from upstream. Its sediment has high organic contents which makes the river suitable for fishes (IWFM, 2012). The Jamuna has a severe bank erosion problem and the eroded banks and scour holes are also good habitats for the adult fishes. According to Sarkar and Bain, 2007 fish fauna of the Jamuna river prefer both erosional and depositional channel habitats with depths, substrates, and current velocity. In a braided river like Jamuna, fish-favorable environment exists around the eroded bank, scour holes, deep clear water, and near shallow sand bars. Water depths of around 20 to 30m are common in rainy season. But in dry season, water depth is around 15 to 20m,which is favored by large fishes. River water is always colder than the surrounding weather, so it supports suitable habitats for different fishes. All these features make the Jamuna a unique habitat for fish regeneration.

Key Potential Impacts on important environmental and social components (IESCs)

The key potentially negative impacts and issues associated with the construction phase of the proposed program include changes in aquatic habitat because of riverbank protection works as well as from sand extraction from the river bank; changes in land form and land use because of rehabilitation of existing and construction of new embankment; land acquisition for construction of new embankment and resulting displacement of people; impacts associated with creation of resettlement sites; use of natural resources particularly river sand; health and safety risks associated with handling of hazardous materials; solid waste generation from construction activities as well as construction camp operation; air quality deterioration because of operation of construction vehicles and machinery as well as excavation activities; noise generation caused by the operation of construction machinery and vehicles; contamination and land and water caused by wastes generated from construction activities and camp operation; loss of trees that need to be removed for construction of embankment; risk of accidents associated with movement of construction vehicles and machinery; blockage of local routes caused by construction activities; and impacts on sensitive receptors such as schools.

The potentially negative impacts associated with the operation and maintenance (O&M) phase of the project include changes in river morphology caused by riverbank protection; changes in aquatic habitat caused by riverbank revetment; blockage of local routes caused by the embankment and road, effects on water bodies and associated habitats caused by disruption of hydrological and ecological connectivity between main river and internal rivers, beels and khals; noise generation and air quality deterioration caused by the vehicular traffic on the embankment road; risks of accidents associated with vehicular traffic on the embankment road; and increased usage of agro-chemicals caused by agricultural intensification due to enhanced protection against riverbank erosion and flooding. In addition, operation stage risks which need to be considered include the risk of failure or breaching of the embankment and resulting flood impacts.

Through the EIAs of the various RBIP phases, more detailed impact assessment will be carried out.

Mitigation of negative impacts. To mitigate the changes on land use, a resettlement Action Plan (RAP) has been prepared that defines the resettlement assistance and compensation to be provided to the project affectees. River sand required to build the embankment will be obtained from the river banks in an ecologically and environmentally safe manner; no soil will be obtained from the cultivation fields. Standard safety procedures will be employed to handle hazardous materials. Sound waste management systems will be implemented at the site to prevent any soil or water

contamination. Water sprinkling will be carried out where required to suppress dust emissions. Air quality monitoring will be carried out at the key locations to determine whether or not the ambient air quality is within acceptable limits. Noise barriers will be installed to protect sensitive receptors from excessive noise if required. Geo-bag launching will be carried out along short spans of river bank at a time to minimize impact on benthic fauna. Compensatory tree plantation will be carried out for the trees to be removed for the project works. Risk of accidents will be minimized by implementing health, safety, and environment (HSE) plan. Operation-stage risks to communities and the environment in the event of embankment failure will be minimized through a robust emergency preparedness and management plan. Appropriate crossing mechanisms will be provided across the embankment and revetments.

The EIAs of the various RBIP phases will present more detailed and site-specific mitigation measures.

Environmental Management System

The environmental management system presents methodology for conducting environmental assessment, determining mitigation measures, and includes mitigation and compliance monitoring plan, effects monitoring plan, capacity building plan, grievance redress mechanism, and documentation requirements.

Public Consultation and Disclosure Requirement

For all Category A (such as RBIP) and B projects the borrower should consult the project-affected groups and local nongovernmental organizations (NGOs) about the project's environmental aspects and takes their views into account. The borrower (BWDB for RBIP) should initiate such consultations as early as possible. For Category A projects, the borrower should consult these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EMF or EA are finalized; and (b) once a draft EMF or EA report is prepared. In addition, the borrower should consult with such groups throughout project implementation as necessary to address EA-related issues that affect them. During preparation of the present EMF, a total of 139 consultation meetings and 227 focus group discussions with more than 9000 participants have been carried out. Additional consultations will be carried out during the EIAs of the later phases of the project.

Findings of the Stakeholder Consultations

As part of the environmental assessment of the RBIP Phase I, consultations with the stakeholders have been carried out employing tools such as focused group discussions and consultation meetings. The consultations with the communities in the project influence area have revealed that generally people are in favor of the project though they have some concerns related to displacement and potential impacts on community structures and cultivation land. People also voiced their demand regarding connectivity between the Jamuna river and inland rivers/water channels (*khals*)/water ponds (*beels*). According to the demand of the community the technical team will incorporate a number of fish passes in the embankment. Similar consultations will be held while conducting the EIAs of the later phases of the RBIP.

Workshop: A disclosure and consultation workshop was organized during January 2015 in Dhaka to disclose the findings of the environmental assessment study of RBIP project. Representative of implementing authority, the study team, and the government officials from different departments, representatives from local government, representatives from

NGOs, local communities of different occupations, journalists, and local elite/civil society were invited to attend the national workshop. In the workshops, the participants shared their observations, views, and remarks with the study team. Appropriate suggestions and recommendations on different issues from the stakeholders of the meeting would be incorporated in the environmental assessment study especially the EA. The workshops will also help to resolve conflicting issues among stakeholders. Similar workshops will be organized at the local level as well. Furthermore, during the EIAs of the later phases, similar national and local workshops will be organized in the same manner as described above.

Publication in electronic and print media: The information on project interventions and the findings of environmental assessment will also be disclosed through newspapers and electronic media (e.g. internet, TV, and radio). The document will be disclosed in Bengali language.

Availability of the Document*:* The EMF, Environmental Assessment, documenting the mitigation measures and consultation process, will be made available for public review in both English and Bengali. The summary EA will be published on the BWDB and WB websites, and the full environmental report will be available upon request from the WB and will be accessible in BWDB website. Hard copies of the EA and EMF will be available at BWDB Divisional office.

List of Acronyms

AD	Alluvion-Diluvion
ADB	Asian Development Bank
amsl	Above mean sea level
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BP	(World) Bank Procedure
BRE	Brahmaputra Right-bank Embankment
BWDB	Bangladesh Water Development Board
CARINAM	Centre for Advanced Research In Natural Resource and Management
CC	Cement concrete
CEGIS	Center for Environmental and Geographic Information Services
CHT	Chittagong Hill Tracts
CLSC	Central land allocation committee
CPUE	Catch per unit effort
CSC	Construction supervision consultants
DC	Deputy Commissioner
DEM	Digital elevation model
DFID	Department of International Development
DG	Director General
DoArch	Department of Archeology
DoE	Department of Environment
DoF	Department of Forest
DPP	Development Project Proforma
EA	Environmental assessment
ECA	Environment Conservation Act
ECC	Environmental Clearance Certificate
ECoP	Environmental Code of Practice
ECR	Environment Conservation Rules
EHS	Environment, Health, and Safety

EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
EMIS	Environmental Management Information System
EMP	Environmental Management Plan
ERP	Emergency Response Plan
ESC	Environmental and social cell
ESU	Environmental and social unit
EQS	Environmental Quality Standards
FAP	Flood Action Plan
FGD	Focus group discussion
FHRC	Environmental Management Information System
FI	Financial intermediary
GHGs	Green House Gases
GIS	Geographical information system
GoB	Government of Bangladesh
GPP	Guidelines for People's Participation
GRM	Grievance redress mechanism
GSB	Geological Survey of Bangladesh
HH	household
HIV/AIDS	Human immuno-deficiency virus / Acquired Immune Deficiency Syndrome
HL	High land
HSE	Health, safety, and environment
IBWTA	International Boundary Waters Treaty Act
ICZM	Integrated Coastal Zone Management
IDA	International Development Association
IEC	Important environmental component
IEC	Information, Education and Communication
IEE	Initial Environmental Examination
IESC	Important environmental and social component
IPMP	International Development Association
IUCN	International Union of Conservation of Nature
IWFM	Institute of Water and Flood Management
JICA	Japan International Cooperation Agency

JMREMP	Jamuna Meghna River Erosion Mitigation Project
km	Kilometer
LL	Low land
m	meter
MHL	Medium high land
MLL	Medium low land
MoC	Ministry of Commerce
MoEF	Ministry of Environment and Forests
MoH	Ministry of Health
MoL	Ministry of Land
MoLG	Ministry of Local Governance
MoS	Ministry of Shipping
MoWR	Ministry of Water Resources
MPO	Master Plan Organization
MSDS	Material safety data sheet
NAPA	National Adaptation Program of Action
NEMAP	National Environment Management Action Plan
NEP	National Environment Policy
NFP	National Fisheries Policy
NGO	Non-governmental organization
NLDP	National Livestock Development Policy
NLUP	National Land Use Policy
NWMP	National Water Management Plan
NWP	National Water Policy
O&M	Operation and maintenance
OHS	occupational health and safety
OP	Operational policy
PD	Project Director
PHAP	Public Health Action Plan
PCR	Physical Cultural Resources
PPE	Personal Protective Equipment
PMU	Project management unit
PRSP	Personal Protective Equipment
PWD	Public Works Department

RAP	Resettlement Action Plan
RBIP	River Bank Improvement Project
RCC	Reinforced cement concrete
RD&C	Research Development and Collaboration
RHD	Roads and Highway Department
SDP	Social Development Plan
SIS	Small Indigenous (Fish) Species
TMP	Traffic management plan
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
VLL	Very low land
WARPO	Water Resources Planning Organization
WB	World Bank
WBG	World Bank Group

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1. Introduction

The Government of Bangladesh (GoB) through the Bangladesh Water Development Board (BWDB) is planning to initiate the River Bank Improvement Program (RBIP) primarily to rehabilitate and improve the existing right bank embankment of the Brahmaputra River, and also to undertake river bank protection and construction of a road over the embankment. The GoB is seeking assistance from the World Bank (WB) for this purpose.

The program will be implemented in phases and in the first phase, works will be carried out for the 50 km priority reach of the embankment; the remaining works will be implemented under subsequent phase(s). In line with the national regulatory as well as WB policy requirements, and in order to minimize the negative environmental and social impacts of the proposed interventions, the BWDB has conducted a detailed environmental impact assessment (EIA) for the priority reach of the program. An initial environmental examination (IEE) has earlier been prepared and submitted to the Department of Environment (DoE) for clearance. Both EIA and IEE are presented under separate covers.

In addition to EIA and IEE, the present Environmental Management Framework (EMF) has also been prepared to guide the detailed environmental assessments of the subsequent phases of the program to be carried out once the detailed design of the remaining works is completed.

1.1. Program Background

Bangladesh is mainly comprised of the fertile alluvial floodplains and the delta of the Ganges-Brahmaputra-Meghna river system (Brahmaputra south through Bangladesh, named as the Jamuna). These three rivers combine within the country to form the world's third largest river, the Lower Meghna, which drains into the Bay of Bengal via a constantly changing network of estuaries and tidal creeks. Bangladesh is one of the most vulnerable countries to natural disasters, mainly by upstream river floods during monsoon season and coastal cyclones from the Bay of Bengal. Floods are of recurring phenomena in Bangladesh, and in each year about 22 percent of the country is inundated. Major floods occur when upland flood flows of the three rivers converging to Bangladesh coincide and combine with the heavy monsoon rainfall. It is also difficult to regulate these flood flows as over 90 percent of their river catchments areas are outside the Bangladesh.

Brahmaputra is the Country's largest of the three rivers with highest erosion and bank movements. Prior to the construction of Brahmaputra Right-bank Embankment (BRE), over bank spills along the 220 km stretch of the right bank of the Brahmaputra River used to cause flooding on an area of about 240,000 ha. In early 1960s, the BRE was built to protect from this flooding problem and to foster agricultural growth in the protected area (see **Figure 1.1**).

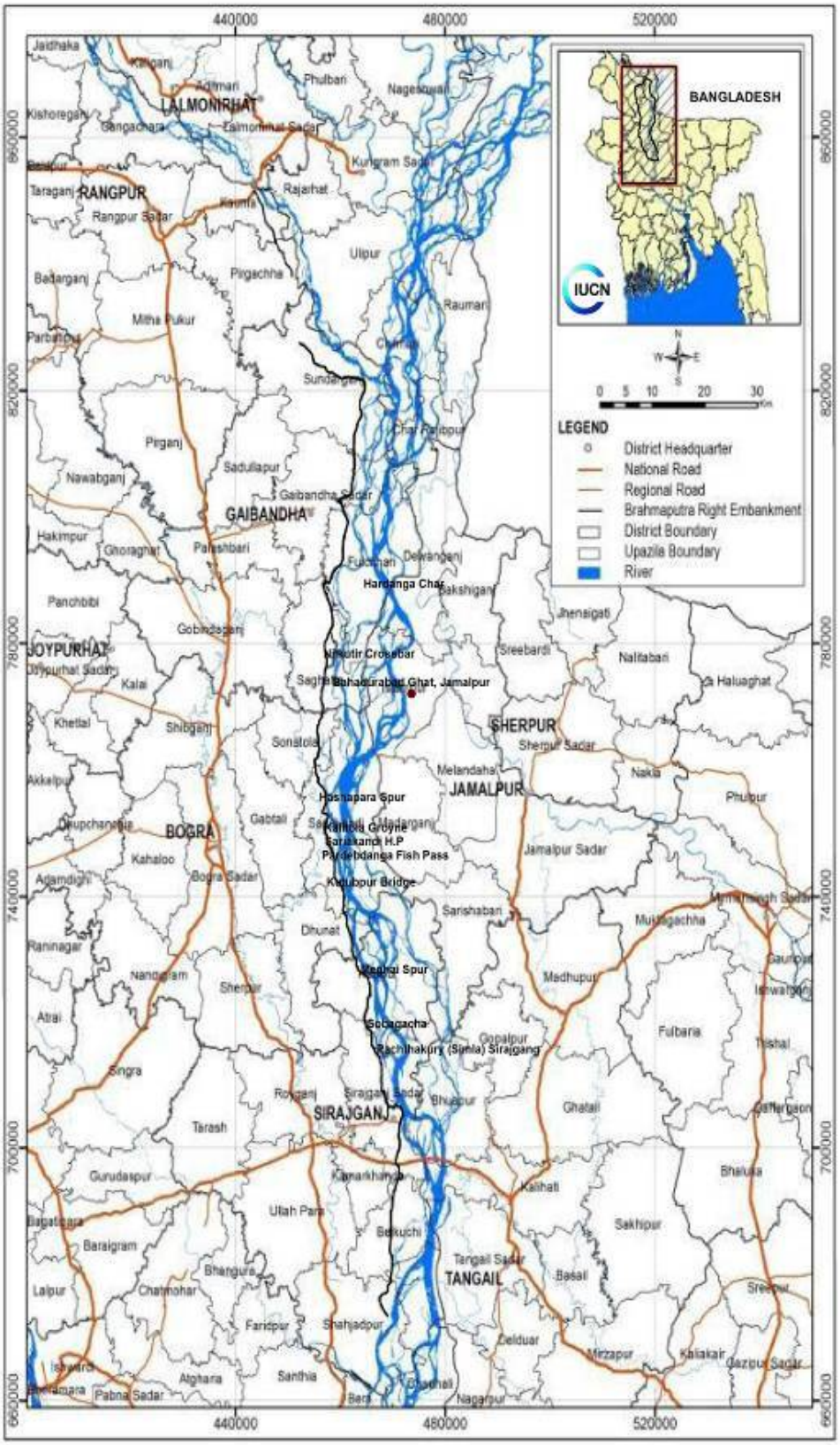

Figure 1.1: Jamuna River and Location of Brahmaputra Right-bank Embankment

The original BRE had a setback of about 1.5 km from the Brahmaputra's right bank and it was allowed to have bank erosion life of 25-30 year span. In the 1970s the embankment started to fall under sporadic erosion attacks. During 1980s, the frequency of the BRE breaches by erosion increased rapidly as longer sections came within the range of rapidly eroding river bends which could cause bank-line erosion rates of several hundred meters per year in early stages of bend formation. To prevent flooding, these breaches were typically closed by local BRE retirements at about 200 meter set-backs. As a result of this minimal set-back distance the BRE has been retired several times in many places and at present perhaps only 50 km of the original BRE has remained in place. Currently, many long stretches of the BRE are very close to the river-bank line. Hence when embankment is breached at many places it is often left open as closing of such breaching is becoming impossible. Consequently, security of area protected by the BRE has been seriously threatened and large areas of land and cities with large population like Sirajganj are exposed to flooding.

1.2. Overview of Proposed Program

The main focus of the BRE rehabilitation work under RBIP is on its length alongside the Brahmaputra/ Jamuna River from Bangabandhu (Jamuna) Bridge to the Teesta River (**Figure 1.1**). The priority works will cover the approximately 50-km long priority reach from Sailabari to Hasnapara (see **Figure 1.2**).

The project's physical works will include:

- River bank protection on portions of the western (right) bank;
- Embankment upgrading, reconstruction and realignment, including adding drainage/control;
- structures (regulators); and
- A new road on the embankment. The project may also include the option of a toll road (highway) associated with the flood embankment.

The project will also provide livelihood and resettlement support to the displaced people. Based on the field reconnaissance and the preliminary morphological assessment, the project works has been divided into three phases as shown in **Table 1.1** below.

Table 1.1: Project Phases

Description	Length (km)	Phase	Tentative Implementation Year
Embankment and riverbank protection from Jamuna Bridge to Sailabari	19	Phase II	2017 to 2022
Embankment and riverbank protection from Sailabari to Hasnapara	50	Phase I	2015 to 2020
Embankment and riverbank protection from Hasnapara to Belka	77	Phase II	2017 to 2022
Road on embankment	146	Phase III	2018 to 2023

The proposed project will be financed by WB with GoB contribution and the project has to comply with the policies and legislative requirement of the World Bank and the GoB.

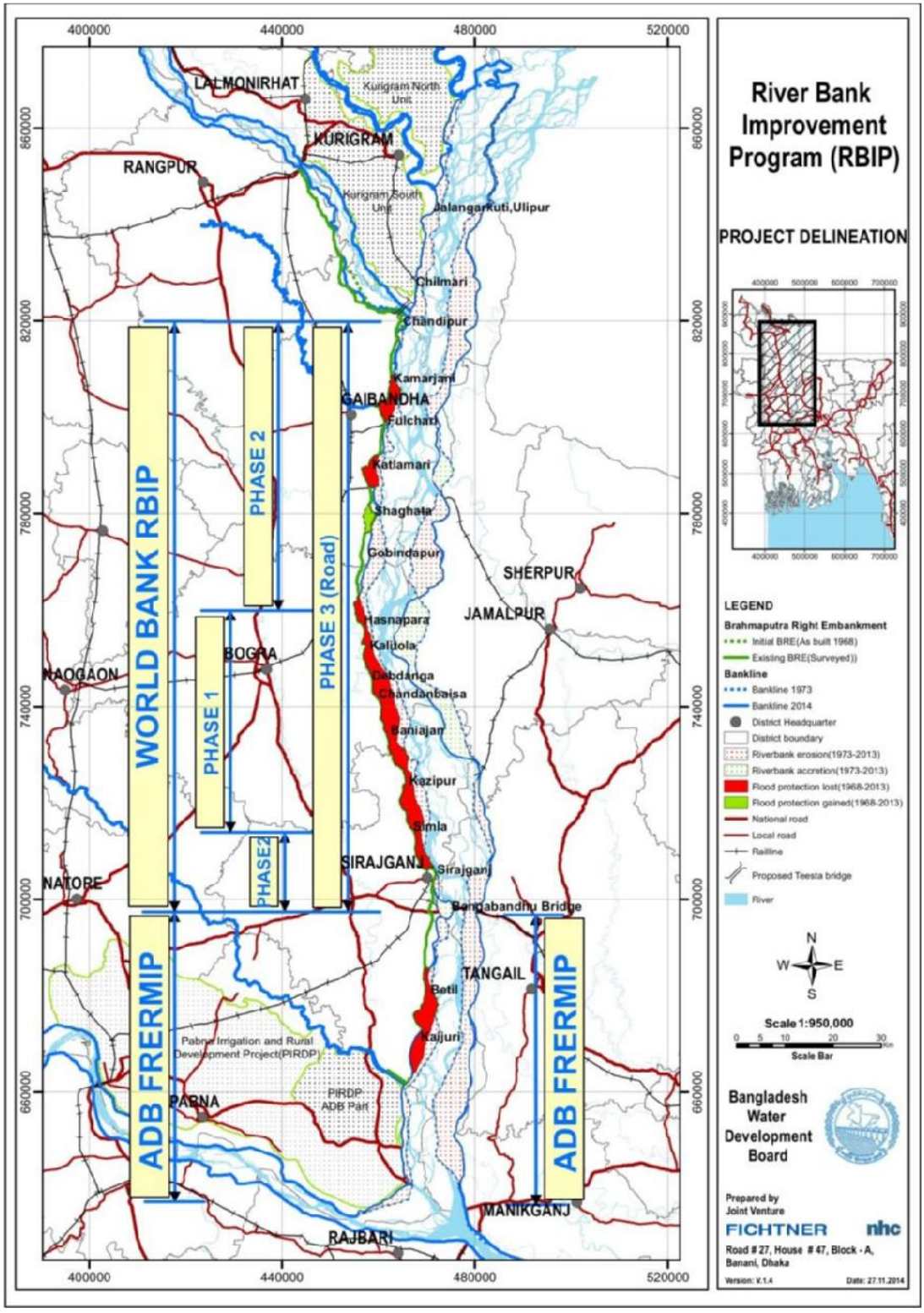

Figure 1.2: Location of Priority and Remaining Works under RBIP

1.3. Rationale of the Environmental Management Framework (EMF)

The proposed interventions of RBIP can potentially have significant impacts on the natural environment and the people living in that area. Conducting a proper environmental assessment and preparing an environmental management plan is essential to address the potentially negative impacts of the project. While the EIA that has been prepared addresses the potentially negative impacts of the Phase I of RBIP, the present EMF has been developed to:

(i) ensure all relevant environmental and social issues are mainstreamed into the design and implementation of the remaining works in subsequent phases of the RBIP,

(ii) consider in an integrated manner the potential environmental and social risks, benefits and impacts of the Project and identify measures to avoid, minimize and manage risks and impacts while enhancing benefits,

(iii) ensure compliance with national and World Bank requirements. The EMF presents potential impacts of the RBIP, mitigation, enhancement, contingency and compensation measures, environmental management and monitoring plan, and institutional framework including inter-agency cooperation for implementing EMP. The EMF will facilitate compliance with the Government of Bangladesh's policies, acts and rules as well as with the World Bank's environmental safeguard policies, and

(iv) guide conducting the detailed EIAs of the later phases of the RBIP.

1.4. Study Methodology

The present EMF has been prepared following the standard methodology consisting of the steps listed below.

- Review of the project details and meeting/discussions with the design team
- Review of the policy and regulatory requirements
- Reconnaissance field visit and initial scoping and screening to determine important environmental and social components (IESCs)
- Collecting and analysis of baseline environmental and social data with the help of secondary literature review and field data collection
- Consultations with the stakeholders including beneficiary/affected communities
- Impact assessment
- Preparing environmental management plan
- Compilation of the present EMF.

The methodology for the preparation of the EMF is presented in **Figure 1.3**.

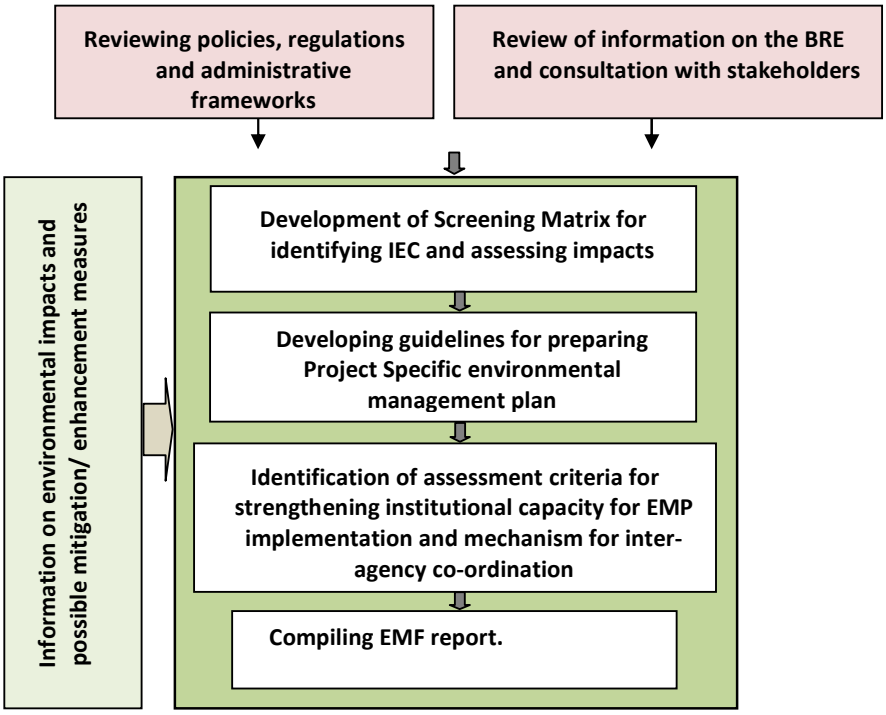

Figure 1.3: EMF Mehodology

1.5. Document Structure

Chapter 2 reviews the prevailing WB policies and national regulatory requirements relevant to environmental assessment. **Chapter 3** presents a simplified description of the project, its various components and other salient information relevant for environmental assessment. Analysis of alternatives is covered under **Chapter 4**. **Chapter 5** describes the present environmental and social conditions of the project area. Screening and assessment of potentially negative environmental and social impacts as well as the appropriate mitigation measures to address these negative impacts have been discussed in **Chapter 6**. **Chapter 7** presents the outline of the environmental management plan (EMP). **Chapter 8** describes the methodology and steps that would be involved in carrying out the assessment of the later RBIP phases. Finally, **Chapter 9** describes the consultations that have been carried out with the stakeholders and also the requirements of similar consultations to be carried out while conducting the EIAs of the later RBIP phases.

Annex A presents the terms of reference of the environmental impact assessment (EIA) to be conducted for the remaining reaches of the RBIP (a similar EIA is being carried out for the priority reach as described earlier). **Annex B** presents environmental codes of practice.

2. Policy and Regulatory Review

This Chapter presents a review of the national policy, legal, and regulatory framework relevant to the environmental and social aspects of the Project. Also reviewed in the Chapter are the WB environmental and social safeguard policies.

2.1. National Environmental Laws

The key national policies, strategies, and plans relevant to environmental management are briefly discussed below.

2.1.1. Bangladesh Environment Conservation Act (ECA), 1995

The Environmental Conservation Act (ECA) of 1995 is the main legislative framework relating to environmental protection in Bangladesh. This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. This Act has established the Department of Environment (DoE), and empowers its Director General to take measures as he considers necessary which includes conducting inquiries, preventing probable accidents, advising the Government, coordinating with other authorities or agencies, and collecting and publishing information about environmental pollution. According to this act (Section 12), no industrial unit or project shall be established or undertaken without obtaining, in a manner prescribed by the accompanying Rules, an Environmental Clearance Certificate (ECC) from the Director General of DoE.

In accordance with this Act, the RBIP will need to be cleared by DoE before commencing the project following procedures given in the Environment Conservation Rules (ECR) 1997 (discussed below). Also the Ecologically Critical Areas, defined by DoE under this act, will be considered while planning and designing of the RBIP project interventions.

2.1.2. Bangladesh Environment Conservation Act (ECA), (Amendments) 2010

The ECA 1995 was amended in 2010, which provided clarification of defining wetlands as well as Ecologically Critical Areas and included many important environmental concerns such as conservation of wetlands, hill cutting, ship breaking, and hazardous waste disposal. This amendment empowered the government to enforce more penalties than before. Moreover, affected persons were given provision for putting objections or taking legal actions against the polluters or any entity creating nuisance to affected person.

2.1.3. Bangladesh Environment Conservation Rules (ECR), 1997

The Environment Conservation Rules, 1997 were issued by the Government of Bangladesh in exercise of the power conferred under the Environment Conservation Act (Section 20), 1995. Under these Rules, the following aspects, among others, are covered:

- Declaration of ecologically critical areas
- Classification of industries and projects into four categories
- Procedures for issuing the Environmental Clearance Certificate
- Determination of environmental standards.

The Rule 3 defines the factors to be considered in declaring an area 'ecologically critical area' (ECA) as per Section 5 of ECA95. It empowers the Government to declare an area 'ECA', if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which of the operations or processes shall not be carried out or shall not be initiated in the ecologically critical area.

The Rule 7 classifies industrial units and projects into four categories depending on environmental impact and location for the purpose of issuance of ECC. These categories are: Green, Orange A, Orange B, and Red.

All existing industrial units and projects and proposed industrial units and projects, that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange-A, Orange-B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be required. A detailed description of these four categories of industries has been given in Schedule-1 of ECR'97. Apart from general requirement, for every Red category proposed industrial unit or project, the application must be accompanied with feasibility report, Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) based on approved ToR by DoE, Environmental Management Plan (EMP). As per ECR'97, water resources development projects fall under 'Red' category project. Therefore RBIP project is 'Red' category project which requires IEE, EIA and EMP for environmental clearance from DoE.

The ECR'97 describes the procedures for obtaining Environmental Clearance Certificates (ECC) from the Department of Environment for different types of proposed units or projects. Any person or organization wishing to establish an industrial unit or project must obtain ECC from the Director General. The application for such certificate must be in the prescribed form together with the prescribed fees laid down in Schedule 13, through the deposit of a Treasury Challan in favor of the Director General. The fees for clearance certificates have been revised in 2010. Rule 8 prescribes the duration of validity of such certificate (three years for green category and one year for other categories) and compulsory requirement for renewal of certificate at least 30 days before expiry of its validity.

2.1.4. Bangladesh Environment Court Act, 2010

Bangladesh Environment Court Act, 2010 has been enacted to resolve the disputes and establishing justice over environmental and social damage raised due to any development activities. This act allows government to take necessary legal action against any parties who creates environmental hazards/ damage to environmentally sensitive areas as well as human society. According to this act, government can take legal actions if any environmental problem occurs due to RBIP interventions.

2.2. Relevant National Policies, Strategies and Plans

2.2.1. National Environment Policy, 1992

The National Environment Policy (NEP) is one of the key policy documents of the Government. The policy addresses 15 sectors in all, in addition to providing directives on the legal framework and institutional arrangements. Marine environment is one of the key

sectors covered in this policy. Regarding water resource development, flood control and irrigation sector, the policy seeks to:

- ensure environmentally-sound utilization of all water resources;
- ensure that water development activities and irrigation networks do not create adverse environmental impact;
- ensure that all steps are taken for flood control, including construction of embankments, dredging of rivers, digging of canals, etc, be environmentally sound at local, zonal and national levels;
- ensure mitigation measures of adverse environmental impact of completed water resources development and flood control projects;
- keep the rivers, canals, ponds, lakes, *haors*, *baors* and all other water bodies and water resources free from pollution;
- ensure sustainable, long-term, environmentally sound and scientific exploitation and management of the underground and surface water resources; and
- conduct environmental impact assessment before undertaking projects for water resources development and management.

The Policy is applicable to the RBIP and the proposed interventions are required to comply with all the policy directives emphasizing particularly on reducing adverse environmental impacts. The EIA studies of the proposed RBIP are required to clearly address the potential impacts and propose mitigation measures.

2.2.2. National Environment Management Action Plan, 1995

The National Environment Management Action Plan (NEMAP, 1995) identifies the main national environmental issues, including those related to the water sector. The main water related national concerns include flood damage, riverbank erosion, environmental degradation of water bodies, increased water pollution, shortage of irrigation water and drainage congestion; various specific regional concerns are also identified.

2.2.3. NationalWater Policy, 1999

Endorsed by the GoB in 1999, the National Water Policy (NWP) aims to provide guidance to the major players in water sector for ensuring optimal development and management of water. According to the policy, all agencies and departments entrusted with water resource management responsibilities (regulation, planning, construction, operation, and maintenance) are required to enhance environmental amenities and ensure that environmental resources are protected and restored in executing their tasks.

The policy has several clauses related to water resource development projects for ensuring environmental protection. Some of the relevant clauses are:

- Clause 4.5b: Planning and feasibility studies of all projects will follow the Guidelines for Project Assessment, the Guidelines for People's Participation (GPP), the Guidelines for Environmental Impact Assessment, and all other instructions that may be issued from time to time by the Government.
- Clause 4.9b: Measures will be taken to minimize disruption to the natural aquatic environment in streams and water channels.

- Clause 4.9e: Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding.
- Clause 4.10a: Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken.
- Clause 4.12a: Give full consideration to environmental protection, restoration and enhancement measures consistent with National Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP).
- Clause 4.12b: Adhere to a formal environment impact assessment (EIA) process, as set out in EIA guidelines and manuals for water sector projects, in each water resources development project or rehabilitation program of size and scope specified by the Government from time to time.
- Clause 4.13b: Only those water related projects will be taken up for execution that will not interfere with aquatic characteristics of those water bodies.

Most of the above clauses will be applicable to the RBIP.

2.2.4. National Water Management Plan, 2001 (Approved in 2004)

The National Water Management Plan (NWMP) 2001, approved by the National Water Resources Council in 2004, envisions to establish an integrated development, management and use of water resources in Bangladesh over a period of 25 years. Water Resources Planning Organization (WARPO) has been assigned to monitor the national water management plan. The major programs in the Plan have been organized under eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources. Each cluster comprises of a number of individual programs, and a total of 84 sub-sectoral programs have been identified and presented in the investment portfolio.

2.2.5. National Land Use Policy (MoL, 2001)

The National Land Use Policy (NLUP), enacted in 2001, aims at managing land use effectively to support trends in accelerated urbanization, industrialization and diversification of development activities. The NLUP urges that increasing the land area of the country may be not possible through artificial land reclamation process, which is cost-effective only in the long run. Therefore, land use planning should be based on the existing and available land resources. The policy suggests establishing land data banks where, among others, information on accreted riverine and coastal chars will be maintained. Among the 28 policy statements of NLUP, the following are relevant to RBIP:

- forests declared by the Ministry of Environment and Forests will remain as forest lands;
- reclassification of forest lands will be prevented.

The RBIP will be designed in accordance with this Strategy and will comply with the above listed requirements.

2.2.6. National Agriculture Policy, 1999

The overall objective of the National Agriculture Policy is to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure

a dependable food security system for all. The policy particularly stresses on research on the development of improved varieties and technologies for cultivation in water-logged and salinity affected areas. The policy also recognizes that adequate measures should be taken to reduce water-logging, salinity and provide irrigation facilities for crop production.

The proposed RBIP is expected to contribute to achieve the objectives of the agriculture policy.

2.2.7. National Fisheries Policy, 1996

The National Fisheries Policy (NFP), 1996 recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy particularly focuses on aquaculture and marine fisheries development.

The policy suggests following actions:

- Biodiversity will be maintained in all natural water bodies and in marine environment
- Chemicals harmful to the environment will not be used in fish shrimp farms
- Environment friendly fish shrimp culture technology will be used
- Expand fisheries areas and integrate rice, fish and shrimp cultivation
- Control measures will be taken against activities that have a negative impact on fisheries resources and vice-versa
- Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

2.2.8. National Livestock Development Policy, 2007

The National Livestock Development Policy (NLDP) has been prepared to address the key challenges and opportunity for a comprehensive sustainable development of the livestock sub-sector by creating an enabling policy framework. As livestock is one of the key assets in livelihoods of the project area, and protection of livestock from floods should be emphasized along with security of human life. The proposed RBIP interventions will contribute to the safety of livestock and thus increase livestock productivity in the project area.

2.2.9. Private Forest Policy 1994

The policy suggested for extended effort to bring about 20% of the country's land under the afforestation programs of the government and private sector by year 2015 by accelerating the pace of the program through the coordinated efforts of the government and NGOs and active participation of the people in order to achieve self-reliance in forest products and maintenance of ecological balance. The policy viewed equitable distribution of benefits among the people, especially those whose livelihood depend on trees and forests; and people's participation in afforestation programs and incorporation of people's opinions and suggestions in the planning and decision-making process. The people-centered objectives of the policy are: creation of rural employment opportunities and expansion of forest-based rural development sectors; and prevention of illegal occupation of forest lands and other forest offences through people's participation. The policy statements envisage: massive afforestation on marginal public lands through partnerships with local people and NGOs; afforestation of denuded/encroached reserved forests with

an agro forestry model through participation of people and NGOs; giving ownership of a certain amount of land to the tribal people through forest settlement processes; strengthening of the Forest Department; strengthening of educational, training and research facilities; and amendment of laws, rules and regulations relating to the forestry sector and if necessary, promulgation of new laws and rules. Thus, over time the policy has shifted somewhat from total state control to a management regime involving local communities in specific categories of forests.

Because of limited amount of forestland, the policy underscores for effective measures for afforestation in rural areas, in the newly accreted chars, and in the denuded Unclassed State Forest areas of Chittagong Hill Tract and northern zone of the country including the Barind tract. The policy also encourages the private sector participation in afforestation.

2.2.10. National Policy for Safe Water Supply and Sanitation (1998)

The National Drinking Water Supply and Sanitation Policy (1998) goal is accessibility to all of water and sanitation services within the shortest possible time at a price that is affordable to all. The Policy will be achieved through strategies formulated at various levels in consultation with the Ministry of Planning. Policy objectives are (i) to improve the standard of public health and (ii) to ensure an improved environment. Policies for rural and urban areas are presented separately as they differ in institutional aspects, content, and magnitude.

2.2.11. National Policy for Arsenic Mitigation (2004)

The National Policy for Arsenic Mitigation (2004) provides a guideline for mitigating the effect of arsenic on people and environment in a realistic and sustainable way. It supplements the National Water Policy (1998) and the National Policy for Safe Water Supply and Sanitation (1998) in fulfilling national goals related to poverty alleviation, public health, and food security.

The Policy states that access to safe water for drinking and cooking shall be ensured through implementation of alternative water supply options in all arsenic-affected areas. Arsenic mitigation activities under the Policy will focus on public awareness, alternative arsenic safe water supply, diagnoses and management of patients and capacity building. The national arsenic program is to encourage and promote research and development on the impact of arsenic on water supplies, health, food, and agriculture.12

2.2.12. National Adaptation Programme of Action (NAPA)

In 2005, the Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh has prepared the National Adaptation Program of Action (NAPA) for Bangladesh, as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized the necessity of addressing climate change and environmental issue and natural resource management. The NAPA is the beginning of a long journey to address adverse impacts of climate change including variability and extreme events and to promote sustainable development of the country. There are 15 adaptation strategies suggested to address adverse effects of climate change. Among the 15 adaptation strategies the following strategies are relevant for reducing climate change induced vulnerability:

- Construction of flood shelters, and information and assistance center to cope with enhanced recurrent floods in major floodplains
- Promotion of research on drought, flood and saline tolerant varieties of crops to facilitate adaptation in future.

The RBIP broadly contributes toward achieving g the aims and objectives of the climate change adaptation strategies.

2.2.13. Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009

The Government of Bangladesh has prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009. The BCCSAP is built on six pillars:

i. **Food security, social protection and health** to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.

ii. **Comprehensive disaster management** to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.

iii. **Infrastructure** to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit for purpose and that urgently needed infrastructures (cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.

iv. **Research and Knowledge management** to predict that the likely scale and timing of climate change impacts on different sectors of economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.

v. **Mitigation and low carbon development** to evolve low carbon development options and implement these as the country's economy grows over the coming decades.

vi. **Capacity building and Institutional strengthening** to enhance the capacity government ministries, civil society and private sector to meet the challenge of climate change.

RBIP will contribute towards achieving the objective of pillars such as (i), (ii), (iii), (iv), and (vi).

2.3. Other Relevant Acts, Laws and Rules

2.3.1. Bangladesh Wildlife (Protection and Safety) Act 2012

The Act protects 1,307 species of plants and animals, including 32 species of amphibian, 154 species of reptile, 113 species of mammal, 52 species of fish, 32 species of coral, 137 species of mollusk, 22 species of crustacean, 24 species of insect, six species of rodent, 41 species of plant and 13 species of orchid. Of these, eight amphibian, 58 reptile, 41 bird, and 40 mammal species are listed as endangered in the IUCN Red Data Book (2000). The Act mandates:

- one to three years imprisonment, a fine of BDT 50,000 to 200,000, or both, for wildlife poaching, capturing, trapping, and trading, and for the purchase of wild animals, parts of wild animals, trophies, meat or other products without license.

The Act mandates two to seven years imprisonment and BDT 100,000 to 1 million fine or both, for killing an elephant or tiger; and 12 years plus BDT 1.5 million for repeat offenders.

- five years imprisonment and BDT 200,000 fine for killing a cheetah, clouded cheetah, gibbon, sambar deer, crocodile, gavial, whale, and dolphin.
- two years imprisonment and BDT 200,000 fine for killing a wild bird or migratory bird.
- empowers the Government to create an eco-park, safari park, botanical garden, or breeding ground on any state-owned forest land, land or water-body.
- two years imprisonment for farming, woodcutting, burning, and construction on such reserves.

2.3.2. Bangladesh Wildlife (Preservation) Order (1973) and Act (1974)

The Bangladesh Wildlife Preservation (Amendment) Act 1974 regulates the hunting, killing, capture, trade and export of wild life and wild life products. It designates a list of protected species and game animals. It empowers the Government to declare areas as game reserves, wildlife sanctuaries, and national parks to protect the country's wildlife and provides the following legal definitions:

- Game reserve is defined as an area declared by Government wherein the capture of wild animals is unlawful, to protect wildlife and increase the population of important species;
- National park is defined as an area declared by Government comprising a comparatively large area of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora, and fauna in their natural state, to which access for public recreation and education, and for scientific research, may be allowed;
- Wildlife sanctuary is defined as an area declared by Government that is closed to hunting, shooting, or trapping of wild animals as an undisturbed breeding ground, primarily for the purpose of protecting all natural resources, including wildlife vegetation, soil, and water.

The Act allows Government to relax any or all specified prohibitions for scientific purposes, for aesthetic enjoyment, or betterment of scenery.

2.3.3. Protection and Conservation of Fish Act (1950)

This Act provides power to the government to: make and apply rules to protect fisheries; prohibit or regulate erection and use of fixed engines; and construction of temporary or permanent weirs, dams, bunds, embankments and other structures. The Act prohibits: destruction of fish by explosives, guns, and bows in inland or coastal areas; destruction of fish by poisoning, pollution, or effluents. The Act prescribes the seasons during which fishing is allowed, prohibits fishing during spawning periods, and specifies officials having authority to detect breaches of this Act.

2.3.4. East-Bengal Protection and Fish Conservation Act (1950) and Amendments

The East-Bengal Protection and Fish Conservation Act (1950), as amended by the Protection and Conservation of Fish (Amendment) Ordinance (1982) and the Protection

and Conservation of Fish (Amendment) Act (1995), provides for the protection and conservation of fish in inland waters of Bangladesh. These instruments define a relatively non-specific framework that simply provides a means for Government to introduce rules to protect inland waters not in private ownership. Among other things, they sanction rule-making regarding destruction of, or any attempt to destroy, fish by poisoning of water or depletion of fisheries by pollution, industrial effluent, or otherwise.

2.3.5. Protection and Conservation of Fish Rules (1985)

These Rules are in line with the overall objectives of the Fisheries Act and its amendments. Section 5 of the Rules states that, "No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters". Section 6 states, "No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters."

2.3.6. Forestry Acts

Systematic management of forests started in the 1860s after the establishment of a Forest Department in the Province of Bengal. To regulate activities within forests, rules and regulations have been formulated, amended, modified and improved upon over the years. These rules and regulations are formulated on the basis of long-existing acts and policies.

Forest legislation in Bangladesh dates back to 1865, when the first Indian Forest Act was enacted. It provided for protection of tree, prevention of fires, prohibition of cultivation, and grazing in forest areas. Until a comprehensive Indian Forest Act was formulated in 1927, several acts and amendments covering forest administration in British India were enacted and were as follows: (a) Government Forest Act, 1865; (b) Forest Act, 1890; (c) Amending Act, 1891; (d) Indian Forest (Amendment) Act, 1901; (e) Indian Forest (Amendment) Act, 1911; (f) Repealing and Amending Act, 1914; (g) Indian Forest Amendment Act, 1918; and (h) Devolution Act, 1920.

The Forest Act of 1927, as amended with its related rules and regulations, is still the basic law governing forests in Bangladesh. The emphasis of the Act is on the protection of reserved forest. Some important features of the Act are: (i) Under the purview of the Forest Act, all rights or claims over forestlands have been settled at the time of the reservation. The Act prohibits the grant of any new rights of any kind to individuals or communities; (ii) Any activity within the forest reserves is prohibited, unless permitted by the Forest Department; (iii) Most of the violations may result in court cases where the minimum fine is Taka 2,000 and/or two month's rigorous imprisonment; and (iv) The Act empowers the Forest Department to regulate the use of water-courses within Reserve Forests.

2.3.7. Forest Act 1927 (Amendment 2000)

The Forest Act of 1927 as amended in 1989 has its roots in Indian Forest Act, 1878. The Forest Act grants the government several basic powers, largely for conservation and protection of government forests, and limited powers for private forests. The 1927 version of the act was amended in 1989 for extending authority over "any [Government-owned] land suitable for afforestation".

Forest department is the main agency to implement the provisions of the Forest Act. The Act, however, does not specify any sort of institutional structure for the forest or other

land holding agencies. It also does not set out any specific policy direction for managing the forests.

Most of the forest lands under the management of forest department are areas declared to be reserved and protected forests under this act. The act empowers the government to regulate the felling, extraction, and transport of forest produce in the country.

2.3.8. Private Forest Act (PFA), 1959

The Private Forest Act of 1959 allows the Government to take over management of improperly managed private forest lands, any private lands that can be afforested, and any land lying fallow for more than three years. The Private Forest Ordinance was originally enacted in 1945, as the Bengal Private Forest Act, and was re-enacted by the Bangladesh (then East Pakistan) in 1949 before being issued as an Act in 1959. These government managed lands under this act are called "vested forests". The Forest Department manages approximately 8,500 hectares in the country as "vested forests". This area is relatively small, but the area historically affected by this law is much larger.

PFA, 1959 empowers the government to require management plans for private forests and to assume control of private forests as vested forests. Government has broad powers to write rules regarding use and protection of vested forests, and apply rules to "controlled forests," which include all private forests subject to any requirement of the Act.

2.3.9. Embankment and Drainage Act, 1952

The *East Bengal Act No. 1,* 1953 has been adapted by the People Republic of Bangladesh, by the Bangladesh Order (adaptation of Existing Laws), 1972 (President's Order No. 48 of 1972). The Act consolidates the laws relating to embankments and drainage providing provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water. The specific Sections and Articles relevant to the Project are mentioned below.

- Section 4 (1) of the Act states that the embankment, water-course, and tow-path, earth, pathways, gates, berms and hedges of the embankments shall vest in the Government of the Authority (BWDB).
- Section 56 (1) states that, person will be subject to penalty (500 taka or imprisonment… if he erects, or causes of willfully permits to be erected, any new embankment, or any existing embankment, or obstructs of diverts, or causes or willfully permits to be obstructed or diverted, any water course.
- Section 15 allows for the engineer (engineer in charge of Divisional level BWDB) for constructing new embankment or enlarging, lengthening or repairing existing embankments.
- The other sections of the Act give powers and access to the Government or Authority or Engineers to commence necessary Project activities, for land acquisition (through the Deputy Commissioner), and site clearing activities including removal of trees or houses (if necessary).

2.3.10. Bangladesh Labor Act, 2006

The Bangladesh Labor Act, 2006 provides the guidance of employer's extent of responsibility and workmen's extent of right to get compensation in case of injury by accident while working. Some of the relevant Sections are:

- ***Section 150. Employer's Liability for Compensation:*** (1) If personal injury is caused to a workman by accident arising out of and in the course of his employment, his employer shall be liable to pay compensation in accordance with the provisions of this Act; and (2) Provided that the employer shall not be so liable - (a) in respect of any injury which does not result in the total or partial disablement of the workman for a period exceeding three days; (b) in respect of any injury, not resulting in death or permanent total disablement, caused by an accident which is directly attributable to - (i) the workman having been at the time thereof under the influence of drink or drugs, or (ii) the willful disobedience of the workman to an order expressly given, or to a rule expressly framed, for the purpose of securing the safety of workmen, or (iii) the willful removal or disregard by the workman of any safety guard or other device which he knew to have been provided for the purpose of securing the safety of workmen.
- ***Section 151.*** (1) *Amount of Compensation:* Subject to the provisions of this Act, the amount of compensation shall be as follows, namely :- (a) where death results from the injury, an amount equal to fifty cent of the monthly wages of the deceased workman multiplied by the relevant factor; or an amount of fifty thousand taka, whichever is more; (b) where permanent disablement results from the injury an amount equal to sixty per cent of the monthly wages of the injured workman multiplied by the relevant factor.

2.3.11. Bangladesh National Building Code, 2006

The Bangladesh National Building Code (BNBC) clearly sets out the constructional responsibilities according to which the relevant authority of a particular construction site shall adopt some precautionary measures to ensure the safety of the workmen. According to Section 1.2.1 of Chapter 1 of Part 7, "In a construction or demolition work, the terms of contract between the owner and the contractor and between a consultant and the owner shall be clearly defined and put in writing". These however will not absolve the owner from any of his responsibilities under the various provisions of this Code and other applicable regulations and bye-laws. The terms of contract between the owner and the contractor will determine the responsibilities and liabilities of either party in the concerned matters, within the provisions of the relevant Acts and Codes (e.g.) the Employers' Liability Act, 1938, the Factories Act 1965, the Fatal Accident Act, 1955 and Workmen's Compensation Act 1923". (After the introduction of the Bangladesh Labor Act, 2006, these Acts have been repealed.)

The BNBC also stipulates the general duties of the employer to the public as well as workers. According to this section, "All equipment and safeguards required for the construction work such as temporary stair, ladder, ramp, scaffold, hoist, run way, barricade, chute, lift shall be substantially constructed and erected so as not to create any unsafe situation for the workmen using them or the workmen and general public passing under, on or near them".

The Code also clarifies the issue of safety of workmen during construction and with relation to this, set out the details about the different safety tools of specified standard. In relation with the health hazards of the workers during construction, this chapter describes the nature of the different health hazards that normally occur in the site during construction and at the same time specifies the specific measures to be taken to prevent such health hazards. According to this chapter, exhaust ventilation, use of protective

devices, medical checkups etc. are the measures to be taken by the particular employer to ensure a healthy workplace for the workers.

To prevent workers falling from heights, the Code sets out the detailed requirements on the formation and use of scaffolding. According to Section 3.9.2 of the same chapter, "every temporary floor openings shall either have railing of at least 900 mm height or shall be constantly attended". Every floor hole shall be guarded by either a railing with toe board or a hinged cover. Alternatively, the hole may be constantly attended or protected by a removable railing. Every stairway floor opening shall be guarded by railing at least 900 mm high on the exposed sides except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board except at entrance to opening. Every open sided floor or platform 1.2 meters or more above adjacent ground level shall be guarded by a railing on all open sides except where there is entrance to ramp, stairway or fixed ladder, the above precautions shall also be taken near the open edges of the floors and the roofs".

2.3.12. Other Laws

There are a number of other laws and regulations applicable which are relevant for the project. These are presented in the **Table 2.1** below.

Table 2.1: Laws and Acts

Act/Law/Ordinance	Brief description	Responsible Agency
The Vehicle Act (1927) and the Motor Vehicles Ordinance (1983)	Provides rules for exhaust emission, air and noise pollution and road and traffic safety	Road Authority
Rules for Removal of Wrecks and Obstructions in inland Navigable Water Ways (1973)	Rules for removal of wrecks and obstructions	IBWTA
The Water Supply and Sanitation Act (1996)	Regulates the management and control of water supply and sanitation in urban areas.	MoLG, RD&C
The Ground Water Management Ordinance (1985)	Describes the management of ground water resources and licensing of tube wells	Upazila Parishad
The Private Forests Ordinance (1959)	Deals with the conservation of private forests and afforestation of wastelands.	MoEF
The Antiquities Act (1968)	Describes the preservation of cultural heritage, historic monuments and protected sites	DoArch

2.4. International Treaties Signed by GoB

Bangladesh has signed most international treaties, conventions and protocols on environment, pollution control, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation, and the Kyoto protocol on climate change. An overview of the relevant international treaties signed by GoB is shown in **Table 2.2**.

Table 2.2: Treaty or Convention and Responsible Agency

Treaty	Year	Brief Description	Relevant Department
Protection of birds (Paris)	1950	Protection of birds in wild state	DoE/DoF
Ramsar Convention	1971	Protection of wetlands	DoE/DoF
Protocol Waterfowl Habitat	1982	Amendment of Ramsar Convention to protect specific habitats for waterfowl	DoE/DoF
World Cultural and Natural Heritage (Paris)	1972	Protection of major cultural and natural monuments	DoArch
CITES convention	1973	Ban and restrictions on international trade in endangered species of wild fauna and flora	DoE/DoF
Bonn Convention	1979	Conservation of migratory species of wild animals	DoE/DoF
Prevention and Control of Occupational hazards	1974	Protect workers against occupational exposure to carcinogenic substances and agents	MoH
Occupational hazards due to air pollution, noise & vibration (Geneva)	1977	Protect workers against occupational hazards in the working environment	MoH
Occupational safety and health in working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	MoH
Occupational Health services	1985	To promote a safe and healthy working environment	MoH
Convention on oil pollution damage (Brussels)	1969	Civil liability on oil pollution damage from ships	DoE/MoS
Civil liability on transport of dangerous goods (Geneva)	1989	Safe methods for transport of dangerous goods by road, railway and inland vessels	MoC
Safety in use of chemicals during work	1990	Occupational safety of use of chemicals in the work place	DoE
Convention on oil pollution	1990	Legal framework and preparedness for control of oil pollution	DoE/MoS
Vienna convention	1985	Protection of ozone layer	DoE
London Protocol	1990	Control of global emissions that deplete ozone layer	DoE
UN framework convention on climate change (Rio de Janeiro)	1992	Regulation of greenhouse gases emissions	DoE
Convention on Biological Diversity (Rio de Janeiro)	1992	Conservation of bio-diversity, sustainable use of its components and	DoE

Treaty	Year	Brief Description	Relevant Department
		access to genetic resources	
International Convention on Climate Changes (Kyoto Protocol)	1997	International treaty on climate change and emission of greenhouse gases	DoE
Protocol on biological safety (Cartagena protocol)	2000	Biological safety in transport and use of genetically modified organisms	DoE

2.5. Implication of GoB Polices, Acts and Rules on RBIP and their Classification

The legislations relevant for environmental assessment for RBIP are the Environmental Conservation Act 1995 (ECA'95) and the Environmental Conservation Rules 1997 (ECR'97). Department of Environment (DoE), under the Ministry of Environment and Forest (MoEF), is the regulatory body responsible for enforcing the ECA'95 and ECR'97. According to the Rule 7 (1) of the Environmental Conservation Rules 1997; for the purpose of issuance of Environmental Clearance Certificate (ECC), every industrial units or projects, in consideration of their site and impact on the environment, will be classified into the four categories and they are: Category I (green), Category II (Orange-A), Category III (Orange B) and Category IV (Red). According to the categorization, all construction/reconstruction/expansion of flood control embankment/polder/dykes falls under Red Category. Therefore RBIP falls under the '**Red**' category.

It is the responsibility of the proponent to conduct an EIA of development proposal, the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate rests on DoE. The procedures for "Red" Category include submission of:

- An Initial Environmental Examination (IEE)
- An Environmental Impact Assessment (EIA)
- An Environmental Management Plan (EMP)

Environment clearance has to be obtained by the respective implementing agency or project proponent (private sector) from Department of Environment (DoE). The environmental clearance procedure for Red Category projects can be summarized as follows:

Application to DoE → Obtaining Site Clearance → Applying for Environmental Clearance → Obtaining Environmental Clearance → Clearance Subject to annual renewal.

The Department of Environment (DoE), the technical arm of the Ministry of Environment and Forest (MoEF) is the regulatory body and the enforcement agency of all environmental related activities. Like all other projects, this project also needs to meet the requirement of the DOE. An environmental assessment (EA) study needs to be undertaken for obtaining the environmental clearance. As per ECR 1997, the proposed RBIP falls under the Red Category and hence, necessitates a full-scale EIA. Steps to be followed for obtaining Environmental Clearance Certificate (ECC) in connection with the construction/ reconstruction / extension of bridges over 100 meter in length (under Red Category) from DOE are outlined in **Figure 2.1**. Public participation or consultation is not a condition in the ECR 1997 and or EIA Guidelines, however, DOE prefers the

proponent to engage in public participation and put conditions while providing site clearance or during the approval of the EIA TOR.

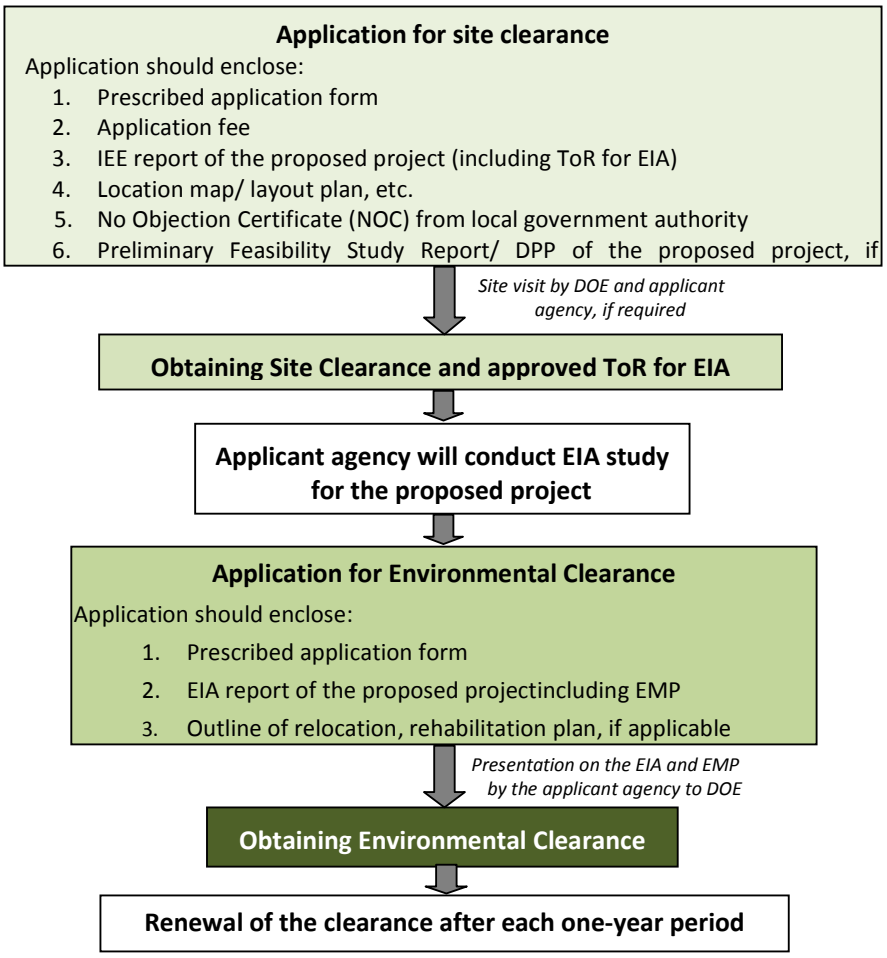

Figure 2.1: Process of obtaining Clearance certificate from DoE

2.6. World Bank's Environmental Safeguard Policies

The World Bank has developed a number of Safeguard Policies to ensure that all possible impacts are considered and mitigation measures are spelled out prior to the implementation of any proposed project. These policies ensure that the quality of operations is uniform across different settings worldwide. If the decision is taken that a Safeguard Policy should be applied, mitigation measures and plans must be developed and in place before the implementation of a proposed project.

The Bank requires environmental screening and classification for all investment projects[2] (including ones financed by Trust Funds, Project Preparation Facilities and Guarantees) proposed for Bank financing, to help ensure that they are environmentally and socially sound and sustainable. Screening and classification take into account the natural environment (air, water, and land); human health and safety; social aspects (involuntary resettlement, Indigenous Peoples); cultural property; and trans-boundary and global environmental aspects.

The objectives of environmental screening and classification are: to evaluate the environmental risks associated with a proposed operation; to determine the depth and breadth of Environmental Assessment (EA); and to recommend an appropriate choice of EA instrument(s) suitable for a given project. The Bank recognizes that environmental screening and classification is not absolute and involves professional judgment on a case by case basis. When screening, careful consideration needs to be given to potential environmental impacts and risks associated with the proposed project. Judgment is exercised with reference to the policy expectations and guidance; real impacts on the ground; and established regional and Bank-wide precedence and good practice.

2.6.1. Environmental Assessment (OP/BP 4.01)

EA requirement. The World Bank requires environmental assessment (EA) of projects proposed for Bank support to ensure that they are environmentally sound and sustainable, and thus to improve decision making. The Bank Policy OP/BP 4.01 considers that EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA takes into account the natural environment (air, water and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples and physical cultural resources); and trans-boundary and global environmental aspects. The Bank Policy also envisages that the borrower Government is responsible for carrying out the EA and the Bank advises the borrower on the Bank's EA requirements.

The present EMF has been prepared in compliance with this OP/BP.

EA classification. The World Bank classifies the proposed project into one of the four categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. These categories are defined below.

> ***Category A:*** A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works.
>
> ***Category B:*** A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas--including wetlands, forests, grasslands, and other natural habitats--are less adverse than those of Category A projects.
>
> ***Category C:*** A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.
>
> ***Category FI***: A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary (FI), in subprojects that may result in adverse environmental impacts.

The proposed RBIP has been classified as Category A, since some of the potential impacts are likely to be significant and diverse.

2.6.2. Natural Habitats (OP 4.04)

The Policy describes the conservation of natural habitats, like other measures that protect and enhance the environment, to be essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank also supports, and expects borrowers to apply a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank- promotes and supports natural habitat conservation and improved land use by financing projects designed to integrate into national and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitats.

The activities under the proposed program could potentially alter the natural habitat hence this policy is triggered. Habitat restoration and enhancement measures will be included in the project design to mitigate and or compensate any adverse impacts on the natural habitat.

2.6.3. Physical Cultural Resources (OP 4.11)

The World Bank's general policy regarding cultural properties is to assist in their preservation, and to seek to avoid their elimination. The specific aspects of the Policy are given below. [2]

- The Bank normally declines to finance projects that will significantly damage non-replicable cultural property, and will assist only those projects that are sited or designed so as to prevent such damage.
- The Bank will assist in the protection and enhancement of cultural properties encountered in Bank-financed projects, rather than leaving that protection to chance. In some cases, the project is best relocated in order that sites and structures can be preserved, studied, and restored intact in situ. In other cases, structures can be relocated, preserved, studied, and restored on alternate sites. Often, scientific study, selective salvage, and museum preservation before destruction is all that is necessary. Most such projects should include the training and strengthening of institutions entrusted with safeguarding a nation's cultural patrimony. Such activities should be directly included in the scope of the project, rather than being postponed for some possible future action, and the costs are to be internalized in computing overall project costs.
- Deviations from this policy may be justified only where expected project benefits are great, and the loss of or damage to cultural property is judged by competent authorities to be unavoidable, minor, or otherwise acceptable. Specific details of the justification should be discussed in project documents.

[2] Excerpts from the OPN 11.03.WB Operational Manual. September 1986.

- This policy pertains to any project in which the Bank is involved, irrespective of whether the Bank is itself financing the part of the project that may affect cultural property.

This OP is not triggered by Phase 1 (i.e. priority reach) since no cultural or archaeological resources are known to exist in the vicinity of the Project nor have any such resources been identified during field investigations. However, the EIAs to be carried out for subsequent phases of the program will include full assessments of any cultural heritage that may be affected, and appropriate mitigation measures will be identified in the detailed EMPs as required. In addition, 'chance find' procedures will be included in the EMPs for all project phases.

2.6.4. Forests (OP/BP 4.36)

This Policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty. The Bank believes that forests are very much essential for poverty reduction and sustainable development irrespective of their location in the world. The Bank assists borrowers with forest restoration activities that maintain or enhance biodiversity and ecosystem functionality. The Bank also assists borrowers with the establishment and sustainable management of environmentally appropriate, socially beneficial, and economically viable forest plantations to help meet growing demands for forest goods and services. The Bank does not finance projects that, in its opinion, would involve significant conversion or degradation of critical forest areas or related critical natural habitats. Furthermore, the Bank does not finance projects that contravene applicable international environmental agreements.

This OP is not triggered since the proposed program is not located in any forested area and will therefore not have any direct impact on forests.

2.6.5. Projects on International Waterways (OP 7.50)

Projects on international waterways may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections.

This Policy is triggered since Brahmaputra/Jamuna is an international waterway. However, as Bangladesh is the most downstream country of the Brahmaputra/ Jamuna River and the proposed program is not expected to adversely change the quality or quantity of water flow to the other riparians, the notification requirement is waived.

2.6.6. Pest Management (OP/BP 4.09)

Through this OP, the WB supports a strategy that promotes use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides. Rural development and health sector projects have to avoid using harmful pesticides. Other pesticides can be used, but only as an element of an Integrated Pest Management Plan (IPMP) that emphasizes environmental and biological controls.

Though increase in agriculture production hence an increased usage of chemical pesticides and fertilizers is not included in the project objectives, such a consequence of the project cannot be ruled out. Hence this policy is triggered.

2.6.7. Indigenous Peoples (OP 4.10)

For purposes of this Policy, the term 'Indigenous Peoples' is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:[3]

- self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and
- an indigenous language, often different from the official language of the country or region.

The OP defines the process to be followed if the project affects the indigenous people.

The social impact assessment of the RBIP indicates that there are no indigenous communities residing in the project area and therefore, no impacts on them are expected under the project. This has been confirmed in the priority reach where investments will be carried out under the proposed program. Therefore this OP is not triggered for the proiority reach.This finding will be further reviewed through the detailed assessments to be carried out during project implementation for the subsequent phases.

2.6.8. Involuntary Resettlement (OP/BP 4.12)

The WB's experience indicates that involuntary resettlement under development projects, if unmitigated, often gives rise to severe economic, social, and environmental risks: production systems are dismantled; people face impoverishment when their productive assets or income sources are lost; people are relocated to environments where their productive skills may be less applicable and the competition for resources greater; community institutions and social networks are weakened; kin groups are dispersed; and cultural identity, traditional authority, and the potential for mutual help are diminished or lost. This policy includes safeguards to address and mitigate these impoverishment risks.[4]

The overall objectives of the Policy are given below.

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.
- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

[3] Excerpts from the OP 4.10.WB Operational Manual. July 2005.

[4] Excerpts from WB OP 4.12.WB Operational Manual. December 2001.

Since the proposed program will involve land acquisition as well as displacement of houses and other assets, a Resettlement Action Plan (RAP) has been prepared, under a separate cover, in accordance with this Policy.

2.6.9. Projects in Disputed Areas (OP 7.60)

Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the borrower and one or more neighboring countries. In order not to prejudice the position of either the Bank or the countries concerned, any dispute over an area in which a proposed project is located is dealt with at the earliest possible stage.

The Bank may proceed with a project in a disputed area if the governments concerned agree that, pending the settlement of the dispute, the project proposed for country A should go forward without prejudice to the claims of country B. [5]

This OP is not triggered since no part of the Project area is located in any disputed territory.

2.6.10. Safety of Dams (OP 4.37)

The Policy seeks to ensure that appropriate measures are taken and sufficient resources provided for the safety of dams the WB finances. However this OP is not relevant since the proposed program does not involve construction of dams. Nonetheless, while the embankments do not qualify as 'dams', many of the same risks and concerns associated with potential dam failure are also relevant in the context of the embankments. The project has therefore convened an international Panel of Experts to provide guidance on diverse project aspects including technical, environmental and social. The technical reviews to be provided by the panel will look at embankment safety aspects and provide guidance to BWDB on design aspects to minimize structural risks of breaching or failure of the embankments. Safety monitoring and emergency management plans will also be developed and implemented through the project.

2.6.11. World Bank Policy on Access to Information

This BP deals with the World Bank policy on disclosure of information. It is a mandatory procedure to be followed by the borrower and Bank and supports public access to information on environmental and social aspects of projects.

Once finalized, the EMF and Bengali translation of its executive summary will be disclosed to the public and will also be available on the official website of the BWDB. EMF will also be sent to the WB InfoShop.

2.6.12. Environment, Health and Safety Guidelines

The Environment, Health, and Safety (EHS) Guidelines[6]contain the performance levels and measures that are generally considered to be achievable in new facilities or project by existing technology at reasonable costs. These Guidelines will be applicable to the Project.

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[5] Excerpts from the OP 7.60.WB Operational Manual. November 1994.

[6] EHS Guidelines available at: http://www.gcgf.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES

2.6.13. Applicable World Bank Policies

The project is classified as a Category A project, due to the complexity of environmental issues associated with project activities involving major civil works by reconstruction and rehabilitation of the embankment to protect against inundation. Since the area is of high economic value and ecological sensitivity, certain negative environmental impacts may occur during the implementation and operational phase of the project. There may be localized impacts on the natural habitats especially on the fish spawning areas during the implementation of the civil works.

The environment assessment (OP/BP 4.01), natural habitats (OP/BP 4.04), pest management (OP/BP 4.09), involuntary resettlement (OP/BP 4.12) and international waterways (OP/BP 7.5) have been triggered for the proposed operation. Although no direct impacts on physical cultural resources are expected, screening mechanism incorporated into the EA process will identify places and or objects of archeological, paleontological, historical, religious, or unique natural values. Physical cultural resources (OP/BP 4.11) are considered in the environmental framework preparation. The status of the environmental and social safeguard policies of the World Bank is provided below in **Table 2.3**.

Table 2.3: Triggering the World Bank Policies

Directive	Policy	Triggered	Comments
Environmental Assessment	OP/BP 4.01	Yes	As the Project falls into Category A, a full EIA has to be carried out (an EIA of the priority reach of the project is being carried out; similar EIAs will be carried out for subsequent reaches or phases). It is also the basis of this EMF document.
Natural Habitats	OP/BP 4.04	Yes	The project has potential to cause conversion of habitat and impair associated ecological functions by: altering aquatic habitat through placing geo-bags and concrete blocks along the river bank; disturbing aquatic habitat during sand extraction from river banks; changing/interrupting ecological connectivity between main Jamuna river and inland smaller rivers, water ponds (beels), and water channels (khals). Appropriate mitigation and control measures have been included in the project design and EIA to address these potential impacts.
Indigenous Peoples	OP 4.10	No	Not triggered since no Indigenous People or ethnic minorities are living in the area.
Physical Cultural Resources (PCR)	OP 4.11	No	Not triggered since no PCR are known to exist in the project corridor. Chance find procedures will nonetheless be included in the environmental management plan (EMP).
Involuntary Resettlement	OP/BP 4.12	Yes	Triggered. About 1,200 ha of land will be needed for the construction of about 183 km long embankment and about 50,000 people are likely to be directly affected because of this land take. A Resettlement

Directive	Policy	Triggered	Comments
			Action Plan (RAP) has been developed in line with relevant national laws and World Bank OP 4.12 to guide the planning and implementation of necessary compensatory measures.
Forests	OP/BP 4.36	No	Not triggered since the project activities will not impact any forests or associated resources. However, a total of 335,500 trees will need to be cut along the 50-km priority zone alone. Compensatory tree plantation will be carried out to mitigate this impact.
Pest Management	OP 4.09	Yes	Triggered. Although no agro-chemicals will be used in any of the project activities, the project may induce intensification of cultivation in the area because of increased protection against riverbank erosion and flooding. This intensification of cultivation can in turn potentially increase usage of agro-chemicals. To address this eventuality, linkages will be developed with the already on-going IPM initiatives in the region.
Safety of Dams	OP/BP 4.37	No	Not triggered since no dams are involved under the project.
Projects in International Waterways	OP/BP/ GP 7.50	Yes	The Project is located on an international waterway and will require a riparian notification consistent with World Bank.
Projects in Disputed Areas	OP/BP 7.60	No	Not triggered since no disputed areas exist in or around the project area.
Access to Information			World Bank has developed a new approach to the disclosure of information, transparency and sharing of knowledge. The public will have access to a broad range of information about project in preparation and implementation. The EMF, EIA report, and RAP will be disclosed on BWDB website and also sent to WB InfoShop. Consultations have been held while conducting EIA and preparing EMF as well as RAP. A consultation and disclosure workshop was held in Dhaka on 25 January 2015. The EIA Executive Summary will be translated in Bangla and placed on BWDB website and also in relevant offices in the project area.

Public consultation and disclosure requirements by World Bank

The Bank reaffirms its recognition and endorsement of the fundamental importance of transparency and accountability to the development process. Accordingly, it is Bank's policy to be open about its activities and to welcome and seek out opportunities to explain

its work to the widest possible audience. According to 'OP 4.01: Environmental Assessment' of World Bank, the following conditions applies to the RBIP.

Consultations. For all Category A (e.g. RBIP) and B projects the borrower should consult the project-affected groups and local nongovernmental organizations (NGOs) about the project's environmental aspects and takes their views into account. The borrower should initiate such consultations as early as possible. For Category A projects, the borrower should consult these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower should consult with such groups throughout project implementation as necessary to address EA-related issues that affect them.

Disclosure. For a Category A project, the borrower should provide relevant information on project interventions in a timely manner prior to consultation and in a form and language that are understandable and accessible to the groups being consulted. The borrower should provide a summary of the proposed project's objectives, description, and potential impacts for the initial consultation. For consultation after the draft EA report is prepared, the borrower should provide a summary of the EA's conclusions. In addition, for a Category A project, the borrower makes the draft EA report available at a public place accessible to project-affected groups and local NGOs. The borrower also ensures that EA reports for Category A subprojects are made available in a public place accessible to affected groups and local NGOs. The document needs to be translated into Bengali. Public availability of the EA report for Category A project in the borrowing country and official receipt by the Bank are prerequisites to Bank appraisal of these projects.

3. Project Description

This Chapter provides an overview of the proposed program activities; detailed project description will be included in the EIA reports of the priority reach and subsequent RBIP phases when detailed engineering designs are available.

3.1. Background

The Jamuna is one of the most important rivers of Bangladesh and dominates the hydrology and inundation cycles of the flood plains of Bangladesh. The river originates in the northern Himalayas in Tibet, flows through China as the Yarlung Tsangpo and India as the Brahmaputra and enters Bangladesh as the Jamuna. The Brahmaputra-Jamuna river system displays characteristics of a braided river and is highly susceptible to migration and avulsion. In plan form, the river typically shows two to three main channels per cross-section and has an average width of 12 km in Bangladesh.

In the 1960s, the 220 km Brahmaputra Right-bank Embankment (BRE) was constructed from Kaunia in Rangpur district to Bera in the Pabna district, to protect the surrounding area from flooding of the Jamuna (Brahmaputra) river and to improve agricultural production in the area **(Figure 1.1)**. Around 180km of the embankment follow the Brahmaputra/Jamuna right bank, while 40km of embankment was built along the Teesta right bank. The Teesta is the main tributary of the Jamuna river in Bangladesh with its flow controlled by barrages in Bangladesh and India.

Prior to the BRE construction, overbank spills regularly caused flooding to some 240,000 ha of fertile floodplain land. Originally the BRE had a setback distance of about 1.50 km from the Jamuna river bankline. Over the years the embankment has been increasingly under attack from westward shifting of the river and consequent bank erosion, causing the embankment to breach at several locations. After such breaches, the embankment had to be retired from its original alignment and reconstructed. The retired embankments were typically constructed with around a 200 meter setback distance to prevent flooding. In many places, the embankment has been retired several times.

Under the Flood Action Plan (FAP 1), a Master Plan was prepared in 1994 to protect the BRE against ongoing riverbank erosion (Halcrow, 1994). The study included an assessment of river processes and physical and hydraulic modeling of various river training structures. The study proposed constructing a series of hard point structures along the existing bankline to limit future erosion. The structures were typically about 800 meters long and it was proposed that they be spaced 2.5 km apart along the right bank. It was recognized that erosion might continue between the structures, albeit at a slower rate, and where this occurred, the embankment could still need to be retired.

Recent History

After completion of the Master Plan hard points were constructed at Sirajganj, Sariakandi, and Mathurapara, and a groyne was installed at Kalitola from 1995 to 1998. The structures were heavily damaged, first in 1998 and 1999 and repeatedly later, and have required ongoing maintenance and re-construction. Due to the high cost of the “hard points”, the BWDB developed alternatives since the mid-1990s. While protruding spurs did not work satisfactorily, the BWDB has turned to guiding revetments since the mid-2000s, which have demonstrated a lower failure rate and protect the embankment better against steadily reducing overall setback distances to the river.

Bank erosion has continued to attack the BRE, causing it to breach frequently and at different locations. Presently, only 41 kilometers of the original BRE remains intact upstream of Jamuna Bridge, and the overall setback distance is steadily reducing with more and more embankment length being within the reach of annual average erosion rates. Consequently, the integrity of the BRE is threatened and large areas of rural and urban areas are increasingly being exposed to the risk of flooding.

3.2. Proposed Interventions

3.2.1. Program Rationale

Bangladesh, as the lowest riparian country of the Brahmaputra-Ganges river basin, lacks control over the basin and has to adapt to externally imposed basin changes. Natural processes associated with the continuing mountain-building process of the Himalaya and the annual monsoon rainfall on their southern mountain slopes, have built and continue building the delta that constitutes the major part of Bangladesh. This process is driven by some of the highest river flows and sediment loads in the world, mostly transported through Bangladesh into the Bay of Bengal during the four-month monsoon period from June through September. Besides being unable to control the physical environment, Bangladesh also lacks political influence over basin developments, including land-use changes and the construction of dams in India and China. Given the very high and growing population density, climate change poses additional future threats through projected increases in river flows, sediment loads, and sea levels.

Feeding the rapidly growing population of Bangladesh over the last half-century called for systematic reduction of flood risks to agricultural land, but until this now was constrained by large-scale river instability. Nevertheless, a quest for food self-sufficiency has resulted in some control and regulation to achieve multiple and increasingly high-yield crops. The key elements are: (i) flood risk reduction through the construction of embankments to control water levels during the monsoon season; and (ii) upgrading of irrigation infrastructure to enable a major second crop during the dry season. River instability and widening, however, has caused increasing destruction of flood embankments since the later 1970s and has also affected the irrigation schemes. At first, the reasons for this increased instability were not understood, but the Government also did not have sufficient resources or appropriate technologies to arrest large-scale riverbank erosion. A better understanding of river processes, together with low-cost technologies for riverbank protection, was developed only after 1990.

As of 2014, Bangladesh was in a transition from "fire-fighting" local riverbank erosion to developing a more comprehensive program for riverbank protection and river stabilization. The BWDB developed a promising bank protection technology from the early 1990s until 2010, based on experimentation with a number of technologies, often donor-supported. The method recommended in the Board's Guideline for Riverbank Protection (2010), involves long guiding revetments along similar lines of those in high-energy reaches of the lower Mississippi River, USA. In support of larger-scale river stabilization, the BWDB experimented with capital dredging within the scope of a feasibility study,[7] and the two main funders of water projects - the World Bank and the

[7] Feasibility Study of Capital Dredging and Sustainable River Management in Bangladesh, draft final report, April 2014. This study estimates that 311 km of long guiding revetments could protect both riverbanks along the 220-km long Brahmaputra/Jamuna course from the Indian border to the confluence with the Ganges. The riverbank protection would be supplemented by an annual dredging volume of 146

Asian Development Bank - have launched major initiatives[8]. Given that the annual average cost of capital dredging amounts to 30 times the annual BWDB budget, the need is recognized for a phased river stabilization program and for riverbank protection and land reclamation to be viewed as a joint process.

One critical length is the 150-km BRE north of Jamuna Bridge, which protects around 200,000 ha of the grain-growing Northwestern Region against flooding. Riverbank erosion in this area has continuously displaced the floodplain population since 1973, so that by 2014 around 100,000 squatters were living on the embankment, of which about 40,000 were located in a 50-km priority reach. These people have lost their land and livelihood, some having had to relocate up to seven times. The fear of riverbank erosion and major flooding has a strong negative impact on riparian residents, who generally have high poverty levels, low health, and crowded low-quality dwellings with restricted access to civic amenities and roads. Their overwhelming demand is to stop riverbank erosion and forced retirement of embankments, which cuts ever more deeply into long-established communities.

BWDB has taken some first steps towards flexible management of these processes, but is currently inhibited by a rigid administrative framework focused on implementation of exactly pre-defined works, a process that cannot deal adequately with the vagaries of the river system. Several mitigating approaches have been considered or implemented, including: (i) flexible financing through a framework DPP with block allocation of funds, (ii) modernized guidelines for standardized riverbank protection, (iii) participatory maintenance arrangements on different levels, and (iv) establishment of a new river management wing within BWDB. The bank-supported RBIP and can support the BWDB in achieving the required flexibility in dealing with large-scale river stabilization and to follow a "learning-by-doing" approach to identify an optimal river corridor and a range of suitable technical solutions to be implemented in phases. The use of pilot works plays a fundamental role in developing new technical approaches, and also in limiting the personal liability of design and construction staff.

3.2.2. Program Objectives

The overall objectives of the RBIP are to reconstruct the BRE and secure it against erosion. Arresting erosion is the primary interest of the local population living alongside the riverbank. Secondary objectives are to: (i) develop the local area to catch up with the rest of the country and reduce poverty; and (ii) strengthen BWDB's capacity as a competent agency for mitigation of flooding and bank erosion within an overall strategy for Integrated Flood Risk Management.

While reduction of riverbank erosion and flooding risks will have positive impacts on development of the area in general, the rehabilitation of erosion victims presently squatting on more than 90 percent of the embankment length will directly benefit a large population that is neglected by current disaster response mechanisms.

million cubic meters - which amounts to roughly one third of the annual sediment load of the Brahmaputra River.

[8] ADB: Flood and Riverbank Erosion Risk Management Investment Program (FRERMIP) covering the central Brahmaputra System from Jamuna Bridge to Chandpur, study from 2012 to 13, loan effective since mid-2014; and the World Bank's current River Bank Improvement Program (RBIP), covering the northern part of the Brahmaputra system in Bangladesh between Jamuna Bridge and Indian border, study from 2012 until 2015, loan expected at the end of 2015.

The specific objectives of the Riverbank Improvement Program (RBIP) are: (i) to reduce riverbank erosion along 150 km of the right (western) bank of the Brahmaputra/Jamuna River from the Teesta River to the Jamuna Bridge; (ii) provide a reliable flood embankment with roadway; (iii) rehabilitate the population squatting on existing embankments; and (iv) initiate institutional change within BWDB to provide long-reach stabilization work and maintain it jointly with local communities. The performance indicators associated with these objectives and the associated timeframe are given below.

Table 3.1: Performance Indicators and Timeframes

Indicator	Level	Timeframe
Impact	Overarching or higher order goals: Millennium Development Goals, 6th Five-Year Plan, "a world free of poverty"	Five years after program end
Outcome	Dominant issues of water sector and people's livelihoods, such as erosion and flood protection, irrigation expansion etc.	At program end
Output	Detailed results from individual program components or activities, such as embankment construction, training, formation of stakeholder groups	During program implementation

3.2.3. Program Boundaries

The BRE protects central parts of Bangladesh's north-western zone from Brahmaputra/Jamuna River flooding. It is delineated to the north by the Kurigram Irrigation Project, North and South Units, which provide around 36km of embankments along the Brahmaputra/Jamuna towards the Indian border, and in the south by the Pabna Irrigation and Rural Development Project (PIRDP), which provides around 30km of embankment line to the confluence with the Ganges. The BRE starts at the Teesta Bridge at Kaunia and follows the right bank of the Teesta River for 40km to its confluence with the Brahmaputra/Jamuna. The Teesta River forms the southern boundary of the Kurigram Irrigation Project. From the Teesta confluence the BRE follows the Jamuna River for around 180km to the south until it reaches the Hurasagar/Baral River, where it ends. The Hurasagar/Baral forms the northern boundary of the PIRDP. **Figure 3.1** shows the BRE as the central part of the Brahmaputra/Jamuna right bank flood protection. The BRE influences around 297,000 ha of land. Since its establishment at the end of the 1960s, around 21,000 ha of flood-protected land were eroded along the BRE, and only 61km of the originally 178-km embankment along the Brahmaputra/Jamuna were still in place in 2014.

The RBIP covers the central and northern part of the BRE in the Sirajganj, Bogra, and Gaibandha Districts, and can be extended to the Kurigram Irrigation Project's North and South Units over a new bridge across the Teesta River in future (**Figure 3.2**). The 40-km BRE section along the Teesta River has been omitted due to its low risk of flooding since construction of the Teesta Barrage in 1990. A 50-km priority reach (Phase 1 works) extends from Simla, about 8km upstream of Sirajganj, to Hasnapara approximately 10km upstream of Sariakandi, covering the central part of the BRE. The remaining 97km will be addressed in Phase 2, while the embankment along the whole length will be provided with a highway standard road in Phase 3. The short 20-km long southern reach between Simla and Jamuna Bridge was left out, as the BWDB is currently constructing interventions there to reclaim some of the lost floodplain land. It is planned to align the new embankment over the reclaimed land under Phase 2.

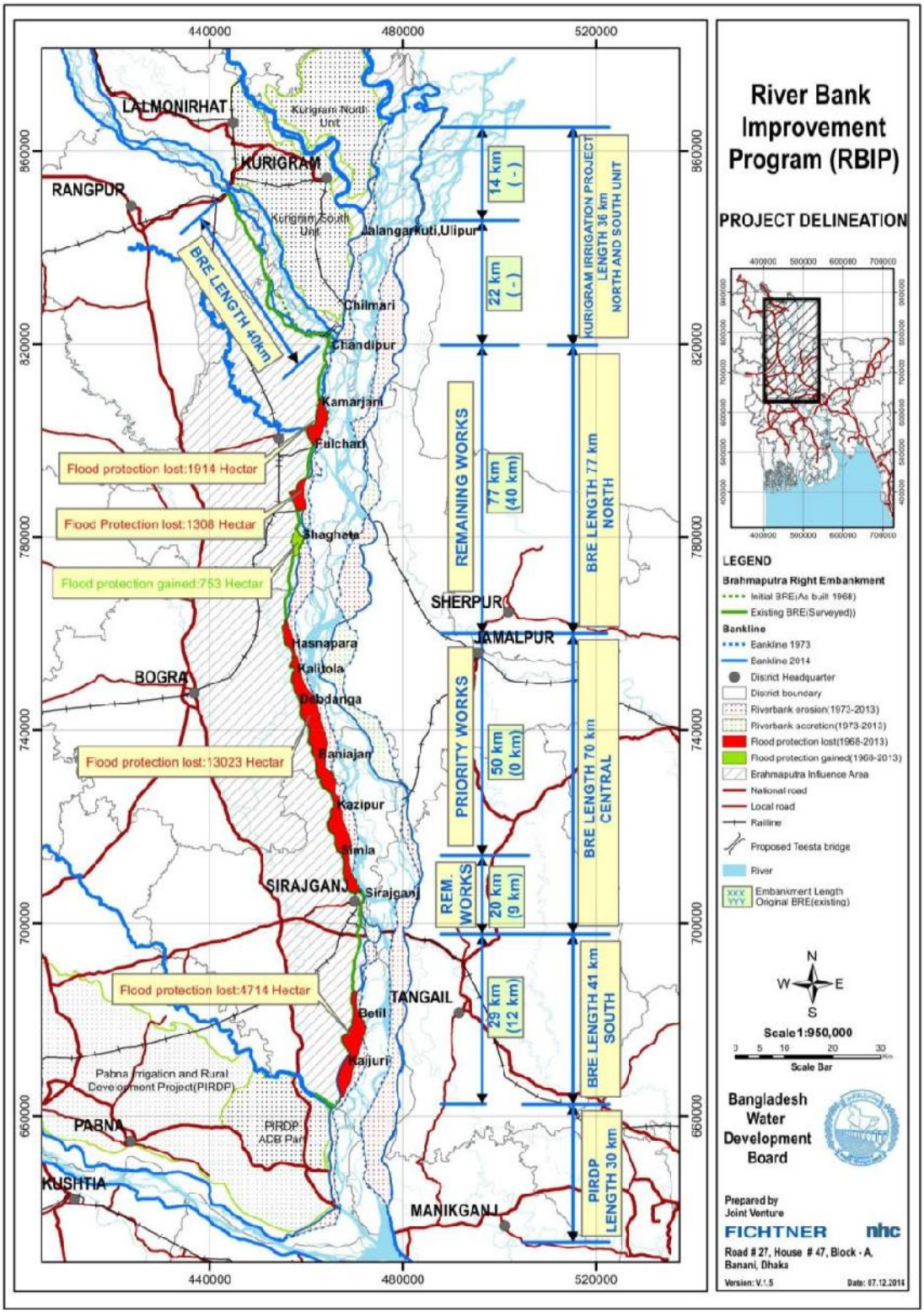


Figure 3.1: BRE and Adjacent Areas

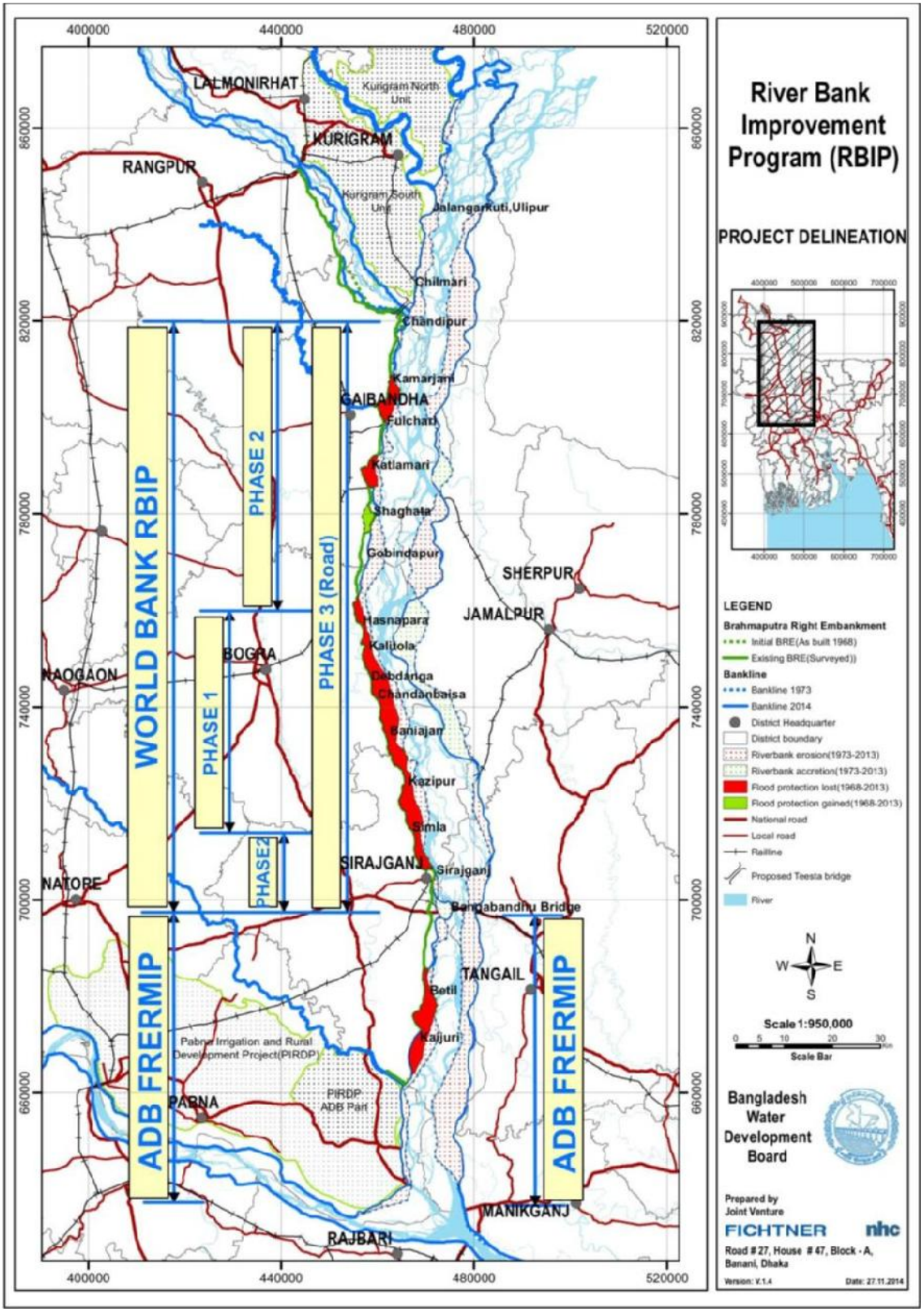


Figure 3.2: Program Delineation

3.3. Program Area, Work Sequencing, and Key Components

3.3.1. RBIP Area and Selection of Priority Reach

The RBIP starts with the rehabilitation of the existing around 150km long Brahmaputra Right Embankment (BRE) from the Teesta River to the Jamuna Bridge while the future ADB support under FRERMIP will cover the 140km length from Jamuna Bridge to Chandpur. The 70km BRE reach from Jamuna Bridge to Hasnapara is under heavy erosional attack with frequent embankment breaching and retirements. Out of this, the 50-km length between Hasnapara and Simla is designated as a priority reach for the following reasons:

- Erosion rate: Over the 42-year period 1973 to 2014 the Brahmaputra/Jamuna eroded an average 3.3km wide strip into the floodplain with peak erosion exceeding 5 km. In comparison the average erosion rate along the whole BRE was 1.9km from 1973 to 2014.
- Embankment breaching: The embankment setback distance has reduced from typically 1.5 km in 1973 to 390m in 2014. About 33 percent of the existing BRE is situated within 200m from the riverbank. With annual erosion rate of 150m in one year and 250m in two years in 10 percent of the cases the embankment is at a high risk of erosion. About 86 percent of the embankment retirements between 1995 and 2013 occurred in this reach, and the annual risk of a breach is 67 percent. The embankment has been retired typically five times and as much as nine times up to 3.5km to the west of the historic embankment line.
- Risk of inundation: The floodplain slopes to the west towards a network of smaller streams draining the terrain behind a natural levee built by the river. A sequence of several breaches of the BRE would inundate substantial parts of the floodplain to levels not experienced since its completion. Numerical modeling indicates that the flooded area due to breaches would average nearly 50,000 ha annually, as opposed to 15,000 ha in the remaining (Phase II) areas upstream.
- Risk of avulsion: The Bangali River flows closely to the Brahmaputra riverbank in the Sariakandi area. Over a length of some 15 km it is located as close as 350 m to the Brahmaputra bankline, a distance that could be eroded in one year. Avulsion of the Brahmaputra into the Bangali during a higher flood could cause widespread destruction.
- Limited bank protection: The riverbank is insufficiently protected against embankment breaching with currently only 12km provided with riverbank protection work. Over the last four decades some 20,000 ha of land has been lost due to erosion and breaches - corresponding in area to a large irrigation project.

Table 3.2 summarizes key project interventions in the priority and remaining reaches. Interventions in the priority reach will be designed in detail, whereas those in the remaining reaches will be tentative as based on the existing river morphology - their final design will depend on the amount of river change between now and the detailed design phase and the desired level of reclamation and river training identified during the first year of Phase I.

Table 3.2: Summary of physical interventions

Intervention	Priority Reach	Remaining Reach
Reconstructed BRE	50.00 km	87.00 km
New Riverbank Protection	18.01 km	25.00 km
Upgraded Revetment	18.55 km	5.40 km
Upgraded Spur	6	-
Upgraded hard point	-	1
Upgraded Groyne	1	-
Upgraded cross bar	-	4
Regulators	2	14
Fish Passes	4	-
Culverts	2	-
Bridges	0	1

3.3.2. The Phased Program

The complex task of attempting to stabilize the largest braided sand-bed river in the world within one of the densest populated countries of the world demands a phased approach. The proposed program consists of three phases of typically 5 years each, with on average 2 years of overlap, as follows:

- **Phase I – Priority Reach:** In this reach, all of the original BRE has been eroded due to widening and westward shift of the Brahmaputra. Phase I involves complete reconstruction of the flood embankment, while securing the riverbank against erosion through long guiding revetments that will incorporate current emergency works being built by BWDB. Approximately 17km of riverbank protection will be provided in addition to 12km existing, the remaining areas being shielded by upstream protection.
- **Phase II – Remaining Reaches:** The remaining reaches include 20 km of the BRE extending upstream from Jamuna Bridge to the priority reach, and 77 km extending upstream from the priority reach to the Teesta River. The two areas are distinctly different as indicated below:

- In the southern 20 km, upstream and downstream of the exposed Sirajganj Town Protection, BWDB is currently reclaiming some lost floodplain land where the river has outflanked Sirajganj Town and the western guide bund of Jamuna Bridge. Phase II activities will support the existing riverbank protection where required and construct a new embankment parallel to the new bankline, to secure the reclaimed land against flooding.
- In the northern 77 km the BRE is heavily populated and its crest level is too low for the future design flood. The embankment is subject to riverbank erosion in several places, although not at the scale of the priority reach. The river's main channel runs alongside the left bank, with mostly flood channels and attached chars alongside the right bank. Some reclamation of lost floodplain land can be considered as part of Phase II.

- Phase II also focuses on reconstruction of the BRE and securing it against riverbank erosion. While this preparatory study is based on riverbank protection along the present bankline, we recognize the need for a concept of comprehensive river stabilization, in line with the recommendation from the IPOE. The extent and type of riverbank erosion protection will be decided on the basis of a river training and reclamation study component encompassing the whole Brahmaputra River from the Indian border to the Jamuna Bridge. This river training study will precede the updated feasibility study component and detailed design of the remaining works and allow considering the option of reclaiming lost floodplain land and realigning the BRE over the reclaimed land.
- Efforts should be made to understand flooding processes on the floodplain. The BRE provides flood protection to around 6 percent (220,000 ha) of the Northwestern Region (3,433,500 ha), a region that produces 34 percent of the country's food grains. Growing road connections interfere with natural flooding and drainage paths and have led to noticeable changes since the time of BRE construction. Future sustainable development depends on a better understanding of residual flood risks, which requires two-dimensional flood modeling. In combination with depth-duration-damage curves, such modeling will enable the production of flood risk maps that identify areas and assets at risk during events of various frequencies, so providing input for land-use zoning and development of a Master Plan.
- **Phase III – Road:** The new embankment will incorporate an emergency and maintenance road. Existing service or feeder roads on embankments often consist merely of crest pavement. For better market access by the local population, a higher category of road construction is warranted that would allow for future widening to four lanes. Also, subsoil conditions indicate that a wide embankment is needed to avoid geotechnical failure from seepage. The alignment of the reconstructed BRE will therefore allow for future road upgrading according to the Asian highway standard adopted in Bangladesh. Three development stages are envisaged as base case as described below, with alternative construction and operation models to be studied at the beginning of Phase I to identify the best way forward:
- The 50-km length of embankment constructed in Phase I will be provided with a "construction road" on the country-side berm.
- After completion of the reconstructed embankment, a two-lane highway on the country side will provide local connectivity and also establish an interregional link from the Jamuna Bridge to the new Teesta Bridge near Chilmari, connecting the northern districts of Kurigram and Lalmonirhat. An initial traffic count indicates that this road would be economically feasible as it would shorten the travel distance between Jamuna Bridge and the northwestern districts[9] from about 187 to 150 km. The new road would also cater to diverted traffic from Chilmari port. An origin and destination survey indicates that about 50 percent of the traffic on the existing route is through traffic that would be diverted. Non-through traffic will continue to use the existing route.

[9] Gaibanda, Lamonirhat, Thakargaon, Dinajpur, Panchagarh, Nilmaphar

- The highway would start construction shortly after completing the reconstruction of the priority reach and will be opened one year after completion of the Phase II BRE. Various toll road options will be considered, to cover both road and embankment maintenance - but not the investment cost for the embankment, as indicated by initial estimates.
- Traffic forecasts indicate that after 20 years the increased traffic could justify a four-lane highway for interregional traffic. This highway could be separated from the existing road network and accessible to it at a few locations, but otherwise bridged for uninterrupted interregional communication. Local communication would be provided through an extended network of feeder or service roads, established at that time through the continuous road program of the local government.

Figure 3.3 shows the schedule of the three phases of the RBIP.

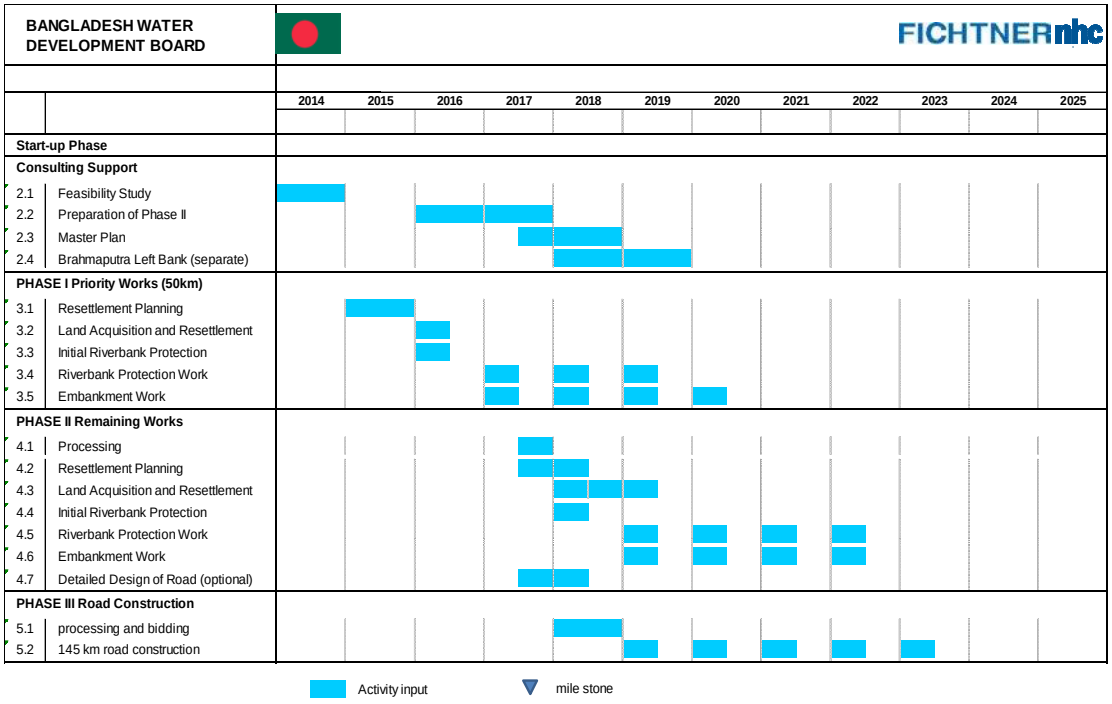


Figure 3.3: Outlines the Overall RBIP Schedule

3.3.3. Flood Embankments

The Alignment Planning

The planned change from repeated retirements to a permanent, drivable embankment along stable riverbanks demands higher design standards for the reconstructed BRE. Modern flood embankments that both keep out flood water and provide emergency road access normally have two parts: (i) a higher, riverside part for flood resistance, including an impermeable cover layer, wave protection, and freeboard, and (ii) a lower country-side part incorporating a road and designed to reduce seepage through the embankment body or the underlying subsoil. In Bangladesh, both original BRE and reconstructed sections

have similar profiles, with the country-side berm having been used as a bullock-cart trail until the mid-1980s. As of 2014 this berm was mostly occupied by squatters.

The proposed reconstructed BRE alignment has been selected on the basis of a multi-criteria assessment of alternative solutions, following a seven-step process that covers both technical and non-technical aspects (Figure 4-1 of the Feasibility report). Technical criteria came first: a safe setback distance and a cross-section suitable for all expected loads, followed by design speed and environmental requirements and optimizing protection to the local population while minimizing land acquisition and resettlement impacts. The high number of squatters on the existing embankment required additional land for resettlement villages and in many cases led to an alignment parallel to the existing embankment and bypassing dense settlements, which gained widespread approval from the local population. Final adjustments were made in the field, bypassing locally important sites. **Figure 3.4** explains a number of alignment issues on one example of the detailed project maps, with the explanations given in **Table 3.3** below.

Table 3.3: Explanations of Map in Figure 3.4

Number	Description
1	New embankment alignment with widening in places for road intersections
2	Existing embankment (green line) situated close to the eroding riverbank.
3	Eroded land between 2013 (date of satellite picture) and early 2014 (orange bankline)
4	Predicted erosion line based on CEGIS 2014 erosion prediction (dashed black line)
5	Minimal alternative (yellow line) following the existing embankment and being widened to the river side.
6	New embankment aligned over an attached char.
7	Protected char with planned riverbank protection in light blue
8	Hard point proposed by FAP 1 in the early 1990s following the then bankline.
9	Destroyed riverbank protection built in the early 2000s (dashed yellow line)
10	Homesteads on the floodplain

The final alignment has been setback from the embankment at a safe distance of minimum 100m to account for local bank failure but aligned as closely as possible to provide maximum protection.

The length and land acquisition requirements are provided in **Table 3.4**.

Table 3.4: Key Parameters of the BRE

	Phase II Jamuna Bridge to Simla	Phase I Simla to Hasnapara	Phase II Hasnapara to Teesta	Total Jamuna Bridge to Teesta
Length				
Existing BRE	20	53	74	147
New BRE	17	50	70	137
Footprint				
New BRE	110ha	340ha	435ha	885ha
Already acquired	10ha	50ha	100ha	160ha

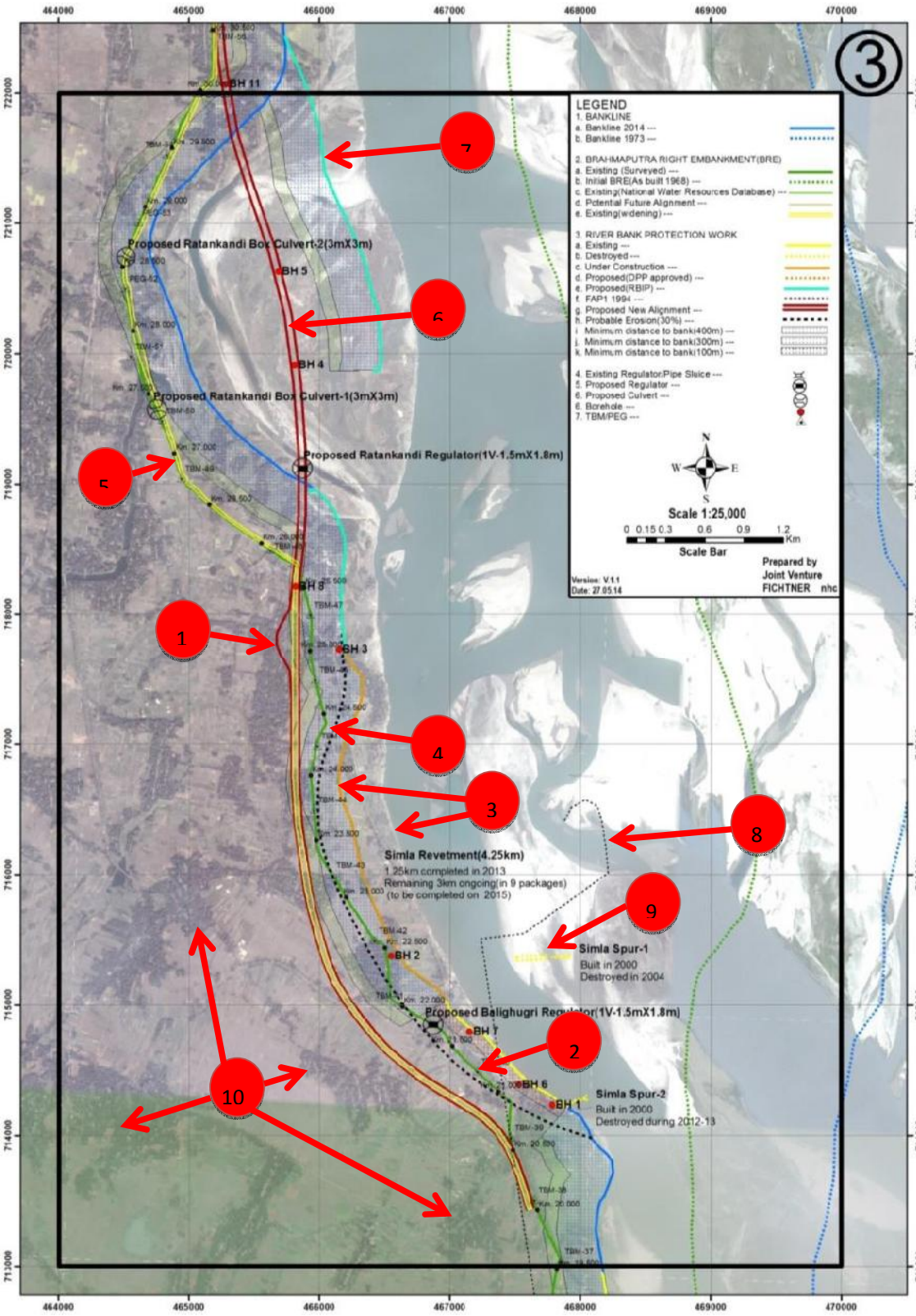


Figure 3.4: Detailed map with explanation (see explanations in Table 3.3)

Embankment Design

The proposed new embankment incorporates the following design features (more details are provided in the Feasibility report):

- The crest level will be raised to the 100-year flood level including climate change addition for 30 years plus 1.5 m freeboard.
- Along around 40 percent of the length of the reconstructed BRE in the priority reach, an impermeable membrane will be placed to separate subsoil and embankment body (as the cohesive topsoil layer is insufficiently thick).
- The new embankment is designed for load combinations including earthquake, rapid drawdown, and seepage. Seepage control requires a wide embankment body and two separate drainage systems to drain seepage and rainwater. The drainage system and outlet structure are designed to prevent entry of rodents and facilitate regular flushing.
- The core of the embankment will consist of dredged sand, to avoid additional borrow pits on the densely populated floodplain. Surficial cladding will use selected cohesive soil from the toe excavation and the existing embankment line, which will be cut along about 40 percent of the length of the new alignment.
- Both toe lines will be protected from encroachment by placing open cell pavers along the river side and planting trees on the country side, so that farmers cannot plough into the protective clay layer.
- The crest of the embankment will be covered with open cell pavers to allow vegetation growth, fix the crest level, and discourage through traffic.
- A countryside berm will initially accommodate a two-lane construction road for emergency and local access, connected in eight places to the local road network. In other places crossings will allow the local population to access the river. The unoccupied part of the berm will have suitable vegetation coverage to discourage unauthorized settlement.

The standard design water level for the main rivers in Bangladesh has a 100-year return period. Climate change predictions indicate a slight increase in water levels such that 30 years into the future, the 100-year level will correspond to the present 200-year level. Morphological modeling, used to evaluate the water levels associated with a future 100-year discharge, indicate that water levels higher than indicated by statistical analysis should be used - specifically to account for a future protected riverbank. A comparison of water levels for key locations is provided in **Table 3.5**. Finally, a freeboard of 1.5 m will be added to the new design water level to account uncertainty in flood statistics, wave run-up, morphological changes, local settlements or subsidence etc. In terms of statistics, the 500-year flood level is estimated to be 0.5 m above the design flood level (DFL), which would still be below the crest of the embankment. The safety of the embankment against failure from overtopping, either from waves or extreme peak flows, is further increased by the wide paved road on the country side, which protects against retrogressive failure and sudden breach.

Table 3.5: Comparison of Design Water Levels and Embankment Crest Levels

Location	Existing 100-year DFL [m+PWD]	Existing crest level [m+PWD]	RBIP 100-yearDFL [m+PWD]	RBIP crest level [m+PWD]
Jamuna Bridge, West Guide Bund Northing: 699500	15.00	16.50	15.27	16.77
Sirajganj Town Protection Northing: southern end 704500 Northing: northern end 707000	15.75	16.75	15.79	17.29
Sariakandi (Kalitola) Northing: 752800	19.77	20.85	20.25	21.75
Kamarjani Northing:804000	22.90	23.50	NA	NA

The constructed embankment will also have the following features:

- The height in the priority will range from 2.6 to 9 m.
- The footprint will range from 40 to 90 m, mostly from 60 to 70m;
- The setback distance from the river will range from 100 to 700m, with 50 percent of the length below 400 m. The minimum distance of 100 m has been selected for geotechnical reasons: in case the riverbank fails locally, the failure boundary needs to be far enough from the embankment to avoid compromising the flood protection and road.
- The cross-section will be uniform. Old embankments will be cut off and any suitable material will be used as cladding.
- The country-side slope allows for future super-elevation of a four-lane highway.

The alignment of the new road has been fixed for the priority reach, with construction expected to start at the end of 2015. The alignment along the remaining lengths, while fixed tentatively for budgeting purposes, is subject to uncertainties over the future course of action – whether to follow the existing bank or to reclaim lost floodplain land.

3.3.4. The Construction Road

The reconstructed BRE will be provided with a road for four main purposes: (i) reliable road access facilitates emergency response; (ii) regional connectivity of the local population provides additional development impetus and helps fighting poverty, (iii) the northern districts of Kurigram including border posts to Assam, India profit from enhanced interregional connectivity to and from Dhaka, and (iv) potentially an alternate route for connectivity of the South Asian Sub-regional Economic Cooperation (SASEC).

Based on future traffic forecasts and the geotechnical need for a wider embankment, the proposed embankment cross-section along the 50km priority reach allows for a future four-lane highway, reducing the need for future land acquisition. The typical cross section is between 60 and 70m wide including a 2.5m wide strip between land acquisition boundary and embankment toe line as buffer. The countryside toe has been established based on a four-lane highway layout with super-elevation, in order to avoid later

additional land acquisition. About 90 percent of the land for the reconstructed embankment in the priority reach needs to be acquired, as the existing embankment is mostly within an unsafe distance to the riverbank.

The priority reach will be provided with a construction road to facilitate the movement of construction vehicles, BWDB inspection teams, slow moving traffic, and maintain largely non-motorized connectivity to the local population. The sand for the embankment construction requires stockpiling at dedicated areas, such as the char area to be partially reclaimed in the south of the alignment (refer to Point 6 on **Figure 3.4**). During construction the sand is transported, spread and compacted along the long linear alignment. The construction road facilitates this transport, accelerates construction progress, and reduces the need for a large number of intermediate stockpiles. The construction road will consist of a two-lane, 6.2m wide road of 200mm crushed bricks ("water-bound macadam") on 300mm sub-base with uniform side slope towards the countryside for improved drainage. The alignment follows the centerline of a future 7.3m wide two-lane highway with 2m wide shoulders. The unused part between construction road and toe drain alongside the embankment crest will be planted with shrubs and trees to discourage settlement. **Figure 3.5** shows the cross section of the construction road and the potential two-lane highway.

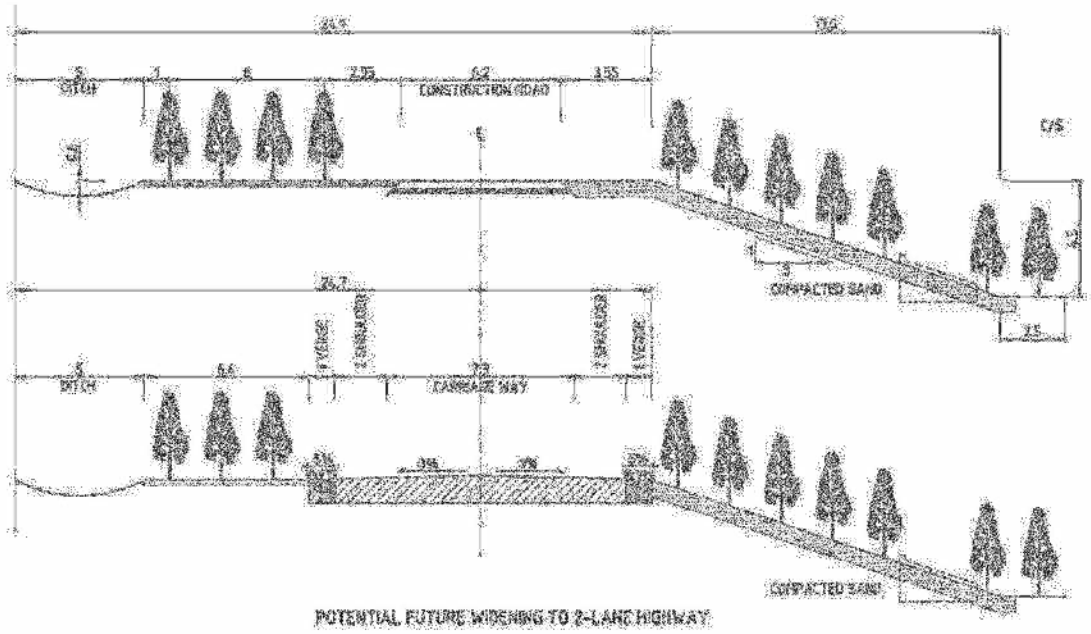


Figure 3.5: Two lane construction road following alignment of future two-lane highway standard road

Twenty crossings of different types will connect the construction road with the local road network and permit the local population to cross the embankment. Eight large crossings connect the embankment to the network of paved roads. Four T-junctions connect roads from the countryside and four elevated intersections pass over the embankment. Twelve small crossings with limited works, also termed "community infrastructure", connect local roads, parts of the existing embankment, but also individual settlements to the new embankment wherever required to maintain and improve the connectivity. These crossings do not allow large motorized vehicle access.

3.3.5. Regulators and Fish Passes

The reconstructed embankment will enhance the environment through a number of regulators and fish passes. The existing embankment, especially in the priority reach hermetically seals the floodplain from the flood flows carrying fertile sediment and fish. Water passage is important for a number of reasons:

- Recharging the groundwater: the passage of floodwater through dedicated khals contributes largely to groundwater recharge. As opposed to the impermeable floodplain, small rivulets, locally called khals contribute largely to the ground water recharge, as they penetrate through the surficial clay layer into the porous underlying sand strata. Closing passage ways through embankments leads to the degradation of the khals and reduced infiltration. This does not only negatively impact on wetlands but also the groundwater table used for local irrigation.
- Supplementary irrigation: Regulators or fish passes allow substitution of low rainfall through flood flows and therefore provide supplementary irrigation. Regulators are commonly opened during normal flood seasons to provide additional water to the rice cultivation but also to entrain some of the fertile silt and clay. Regulators are effective for water levels above flood level in order to inundate the rice fields.
- Fish migration: It is widely recognized that further enhanced agriculture and fish productivity depends on a mix of rice and fish culture. Fish also provides an important part of the protein intake of poor people. Increased fish production requires the passage of fish eggs, fingerlings, and fry from river to the floodplain during the period April to June and the return of adult fish after the monsoon in October. It is important to recognize that eggs and fingerlings drift with the flowing water and cannot swim, while fish fry can move on its own. Fish passes are designed to be effective for water levels typically 2m below flood plain level to allow fish migration through khals starting from May.

3.3.6. Riverbank Protection

Of a range of options for protecting the riverbank, guiding revetments incorporating sand-filled geo-textile bags (geo-bags) are the preferred solution for the high-energy main channel that is presently eroding the right bank in the priority reach and the downstream area to the Jamuna Bridge. The selection process, including designs for alternative solutions and cost estimates, is summarized in Annex A of the Feasibility report, River Engineering Feasibility Designs. The selection of revetments is based on three key considerations:

- Protection of Infrastructure alongside the riverbank: A main purpose of riverbank protection is to assure the integrity of the BRE and other infrastructure alongside the riverbank. Consistent protection is best provided by continuous revetments. To provide equivalent protection, intermittent works such as “hard points” or spurs require greater embankment setback distances with additional riverbank erosion and more displacement of the local population.
- Avoidance of erosion caused by the protection works themselves: Numerical modeling indicates that a frequent cause of failure is outflanking by the river at the curved upstream end of protection works. Short works such as hard points or spurs tend to cause rapid, deep scouring during initial river attack, which worsens over time due to increasing protrusion into the flow as outflanking proceeds.

Long guiding revetments produce less severe flow disturbances and typically only about half the total scoured depth resulting from short protrusions.

- Stability of Cover Layers: It is difficult to protect the upstream curvature of hard points or the head of spurs from failure under the high shear stresses of accelerating flow in these locations. Computational fluid dynamics with turbulence modeling of cover layers, in combination with recent turbulence theory, demonstrates that the common apron system of relying on single-layer rock or concrete block aprons must fail, and that in the absence of filters, many layers of rock are required to prevent wash-out of the underlying fine soil. Flexible geo-bags incorporate filter properties perform better as they leave much less gaps through which the subsoil can be eroded.

Guiding revetments have proven sustainable since their first use in 1998 at Sirajganj, especially after the upstream termination was strengthened with a wide apron of geo-textile bags. Subsequently the BWDB placed nearly 30 km of geo-textile bag revetments systematically on underwater slopes between 2004 and 2011. Another 40 km or so were placed using a simpler construction method. In the design of the river training works for Padma Bridge from 2009 to 2011, geo-bag revetment design was developed further: in the immediate vicinity of the bridge the geo-bags were to be covered with a multiple rock layer to increase longevity and robustness, while in upstream areas thicker geo-bag revetments without rock cover were proposed. In the present RBIP case, however, the largely agricultural areas to be protected do not warrant the high cost of rock cover, which would require rock to be imported and paid for in foreign currency. Therefore, as in the upstream areas of Sirajganj Town Protection and Padma Bridge, multiple layers of heavy, filter-tight geo-bags are proposed.

Along the 145 km length of the BRE approximately 55 km of riverbank protection will be required, of which approximately 25 km will be in the priority reach. This includes rehabilitation of approximately 15 km of existing protection, of which 10 km is in the priority reach. **Figure 3.6** shows the proposed locations of riverbank protection. Given the uncertainties associated with future river plan forms, the priority works have a higher level of confidence, as construction is expected to start during the dry season 2015/16. The remaining works, estimated to start three or four years after commencement of Phase I, will be subject to changes associated with (i) river channel shifts, and (ii) consideration of an approach more oriented to river training.

Besides having the best performance record, long guiding geo-bag revetments also reduce impacts on channel and char patterns, since they do not protrude into the flow or deflect the channel into char areas, but rather have a stabilizing influence on the near-bank channel. Unprotected riverbanks tend to show an alternating pattern of erosion and deposition, leading to a meandering planform where the near-bank channel is sometimes deflected into the central part of the river. Long guiding revetments prevent this and result in a channel flowing parallel to the riverbank, with indirect stabilization of the adjacent river islands. Also, the low water channel alongside long revetments tends to be slightly deeper than the natural channel, which assists inland navigation[10].

[10] After constructing the 10 km long revetment upstream of the Hurasagar, the dredging volume in the downstream channel to the Baghabari port dropped to around 30,000 m³ annually from 100,000 earlier.

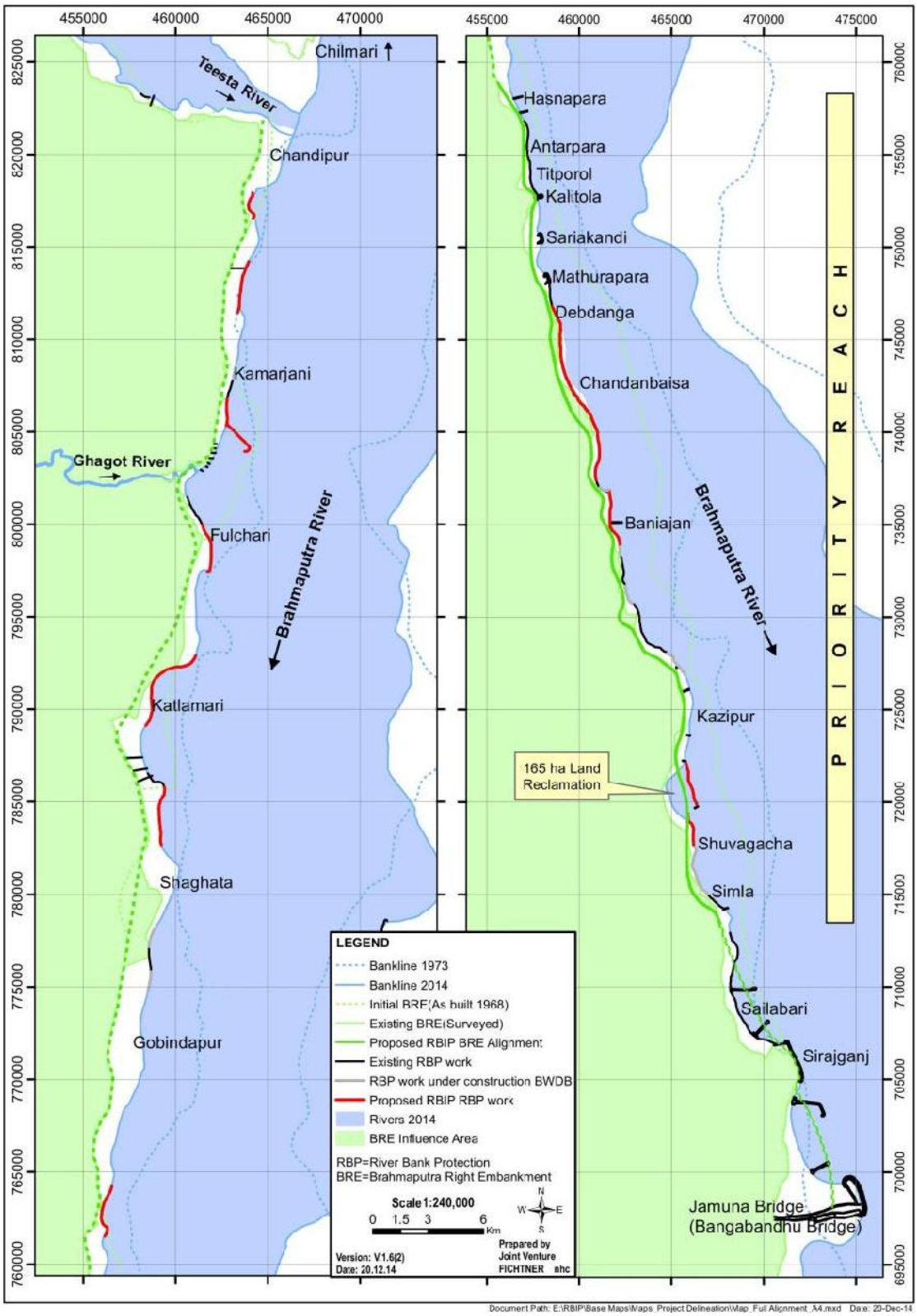


Figure 3.6: Estimated riverbank protection from the Teesta River downstream to Jamuna Bridge

Construction of riverbank protection involves the following three components, from floodplain level to deepest bed level (**Figure 3.7**):

- Wave protection built above low water level, consisting of concrete blocks placed on a geo-textile filter layer.
- Underwater slope protection consisting of three layers of sand-filled geo-bags large enough to be stable under design flow velocities, and providing a tight cover layer including filter properties.
- Toe aprons consisting of multiple layers of geo-bags for self-launching in case of scour.

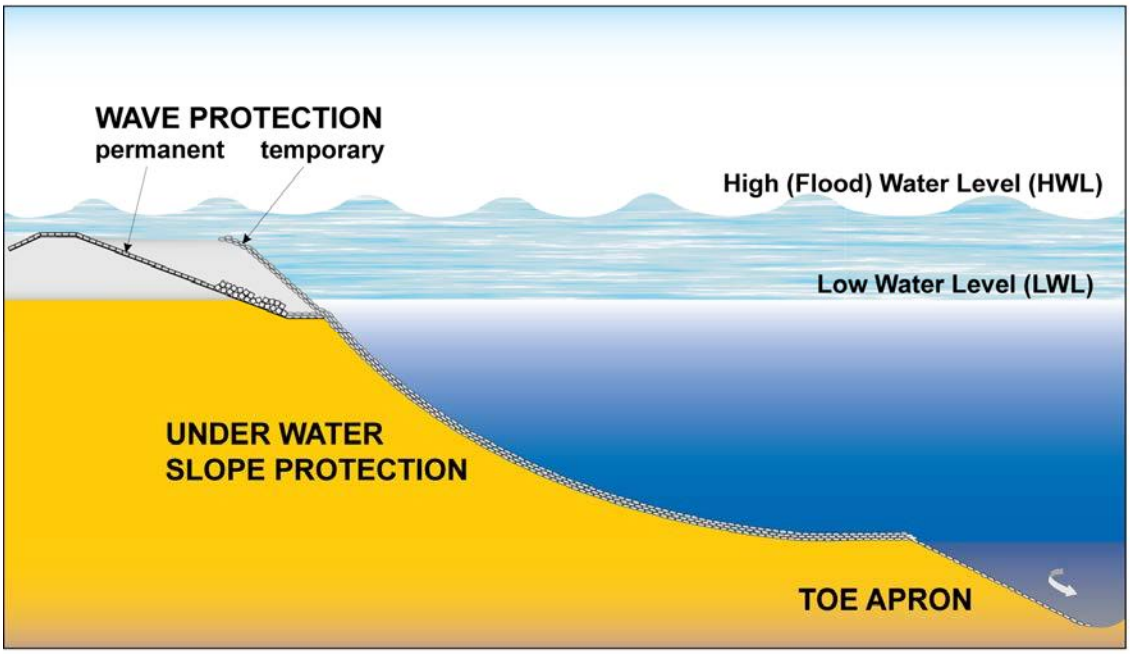


Figure 3.7: The three elements of riverbank protection

The following sections provide details about the work above and below water.

Above water protection

Above-water wave protection covers the zone from 2m below low water and floodplain level and allows access to the water. Concrete blocks with a 40 x 40 cm base over a geo-textile filter are generally used in this zone (**Figure 3.8**). The block thickness is selected to resist maximum flood velocities and lifting forces from wave action and is generally around 20 to 30 cm. Near the floodplain level, alternating rows of thicker and thinner blocks are used to reduce wave run-up. Below low water level, 30 cm concrete cubes are dumped in multiple layers over a geo-textile filter ending on a bench that marks the transition to the underwater slope protection.

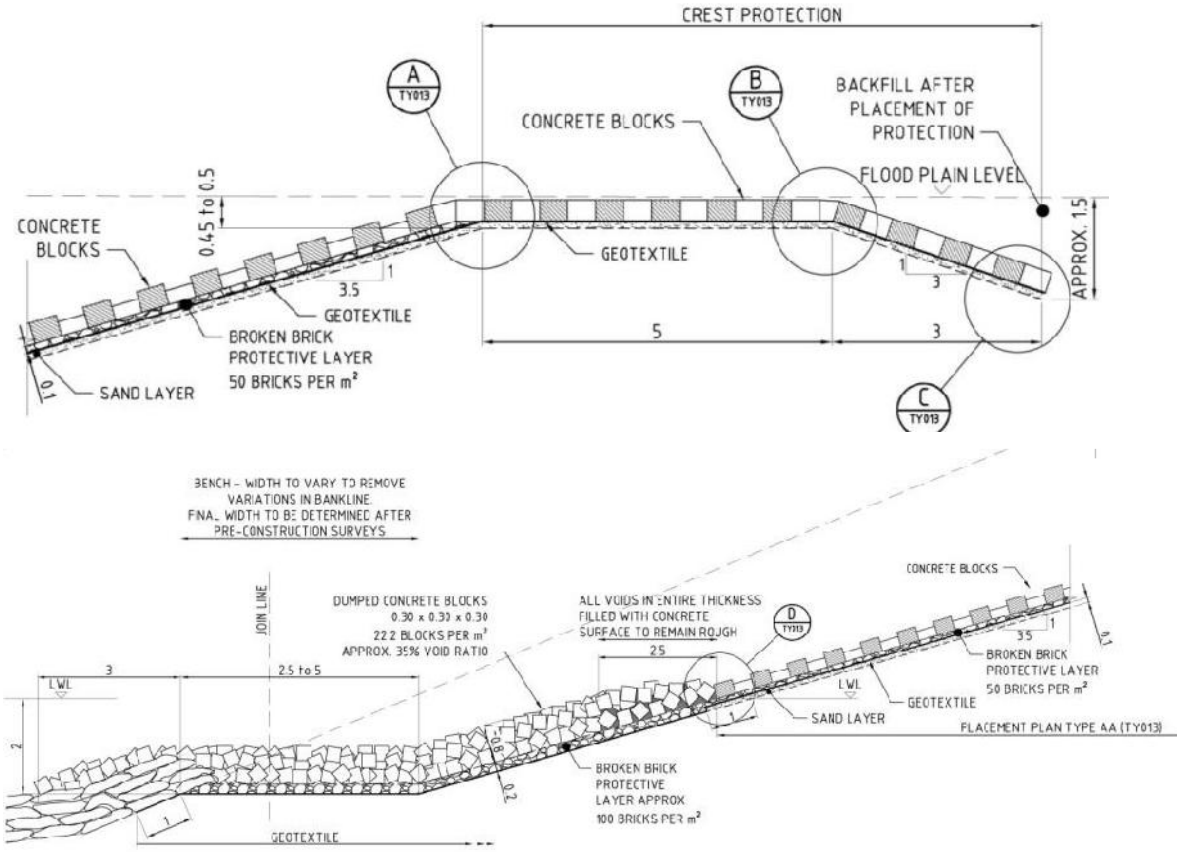


Figure 3.8: Typical cross section of the upper slope treatment

The amount of concrete in the wave protection layer can be reduced if interconnected elements are used. Grout-filled mattresses are a viable alternative, as the grout consists of cement and sand that is available on site. Such mattresses have been built at the Meghna Bridge and downstream of the Hurasagar River. They have the added advantage of reducing construction time, as the grout hardens within hours - in one season many kilometers of revetment can be built, even under water, whereas several seasons are required for concrete blocks. **Table 3.6** compares the two alternatives. The design for the priority works incorporates 3 km of grout-filled mattresses, to verify their applicability to RBIP and to prepare for future larger-scale implementation as proposed for the remaining works.

Table 3.6: Comparison of cover layer alternatives above low water level

	Concrete blocks	**Grout filled mattress**
Construction	➢ Large casting yards on the floodplain, ➢ added traffic for supplying the materials from far distance, ➢ preparation one year ahead of placement, ➢ sensitive to water level rises ➢ depending on manual labor for transport and placement	➢ Very fast in one season and one construction sequence starting under water and moving up the slope, ➢ Reduced transport of materials as mostly dependent on river sand ➢ Batching plant and transport mixers reduce local labor force

	Concrete blocks	Grout filled mattress
Performance	➢ Robust, proven all over Bangladesh, ➢ Low value and low risk of theft ➢ Risk of damages from anchors	➢ Experience at two locations since the end of the 1990s and 2006 without major issues, ➢ low value and low risk of theft ➢ some types are sensitive to localized damages from anchors

Underwater Slope Protection

Two problems with riverbank protection in Bangladesh are difficult to overcome:

- The highly dynamic river morphology can result in large river changes between the low-flow dry season when construction is feasible and the flood season when it is inhibited by high discharges, velocities, and sediment transport rates.
- Bangladesh has no rock quarries, except for one granite mine that can provide only limited quantities of smaller crushed rock largely unsuitable for riverbank protection.

Given the lack of rock and the good experience with initial geo-bag placements, the selected underwater slope protection design for RBIP consists of four layers of systematically dumped sand-filled geo-bags. Geo-bags of 250 kg weight will be used for standard revetment sections, with greater weights for strengthening of existing protruding structures such as spurs. The bags are placed by systematic dumping from barges precisely positioned in the river, to cover the underwater slope from the inner edge of the apron to the riverbank.

Underwater Toe Protection with Aprons

Riverbank protection in these highly mobile rivers depends on self-launching toe aprons that can respond flexibly to river-bed deepening by scour. The method was developed in the subcontinent in the late 19th century and was first applied to protect the piers of railway bridges against local scour. Due to lack of underwater observations, aprons were wrongly believed to produce multiple-layer coverage after launching, but when they were investigated in physical models after failure of a guide bund at Harding Bridge in the 1930s, it was found that only single-layer coverage resulted. This was confirmed after 2000 by diving observations and physical model tests in The Netherlands, Canada, and Bangladesh associated with the Jamuna Bridge, JMREMP, and Padma Bridge projects.

Recent experience demonstrates that flexible geo-bags incorporating filter properties perform better than hard materials for underwater bank protection in Bangladesh river conditions. Four main milestones in their development were as follows:

- After the 1988 flood, the World Bank-supported Flood Damage Restoration Project placed sand-filled geo-bags of around 900 kg weight as filter material under large concrete blocks for Chandpur Town Projection Works. This installation has performed well to date.
- In 1996, the Flood Action Plan, Component 21, built a revetment test section incorporating sand-filled geo-bags as apron material. This protection still performs well.
- After an upstream failure in 1998, the World Bank-financed Sirajganj Town Protection was repaired with a wide apron consisting of three sizes of sand-filled

geo-bags, termed cushions (20 kg), pillows (250 kg), and mattresses (900 kg). Although Sirajganj Town Protection continues to fail along downstream areas protected solely by concrete block or rock aprons, the areas with geo-bag aprons have remained stable. This is one of the most turbulent areas in the Bangladesh rivers, due to prominent protrusion of the upstream corner of the Town Protection.

- In the JMREMP project, falling aprons consisting of multiple layers of geo-bags were placed along 17 km of riverbanks in the lower Jamuna. The observed underwater slopes have inclinations of 1V:2H and are geo-technically stable.

Over the last decade, it has been found that three levels of safety can be achieved with increasingly larger footprints:

- Emergency protection dumped from the riverbank: This is widely applied to provide protection for one flood season. After the first flood it is usually upgraded to the next level.
- Above- and underwater slope protection: The methodology was developed under JMREMP in 2004 and later expanded under the Secondary Town Protection Project. Systematic coverage of the slope, secured by an apron, keeps deep toe scour far enough from the bankline and does not destabilize the slope. More recent studies for Padma Bridge showed that to cope with rare earthquake loading and associated flow slides, the apron needs to be widened to ensure that flat slopes following flow slides do not penetrate into the upper slope.
- Dredged slopes to levels near design scour levels: The highest level of safety can be achieved through flat dredged slopes that are stable when subjected to design earthquakes. However, this expensive work has limited stability because the fine non-cohesive soils of Bangladesh liquefy easily at earthquake intensities corresponding to a 50- to 100-year return period. Nevertheless, these flat man-made slopes provide a higher level of safety than the usual natural slopes of the riverbanks. There seem to be no practical ways to improve the stability of riverbanks subject to increased earthquake loads.

Riverbank protection designs for the RBIP are made with a wide apron to account for larger earthquake and potential flow slides during the lifetime.

3.4. Resources Requirements

3.4.1. Material Requirements and their Sources

The construction materials required for embankment, road, river bank revetment, and other project components will include earth, geo-bags, hard rock, sand, geo-textile, stone-chips, brick chips, asphalt, cement, steel for concrete reinforcement, road furniture, and other accessories. Some of these materials will be obtained from within the project influence area: sand from the river bank and earth from the existing embankment. Other materials such as cement, steel, and brick chips will be procured from local/national markets, whereas some of the materials such as hard rock and asphalt may have to be imported. See **Table 3.7** for the key construction materials and their approximate quantities needed for the first phase of RBIP (priority reach). *The quantities of construction materials required for the subsequent phases will be determined during the detailed design of those works and included in the EIAs of those phases.*

Table 3.7: Construction Materials (Priority Reach)

	Description	Approximate Quantity	Source
Embankment			
1	Sand	12 million m^3	River
2	Clay	24,000 m^3	Existing land of proposed alignment, old embankment
3	Brick chips	80,000 m^3	Local supply
4	Concrete blocks	17,000 m^3	Constructed at site
5	Stone Chips	180,000 m^3	Local Supply
6	Geo-textile (3mm thick)	55,600 m^2	Imported/Local Supply
New River bank Protection			
1	CC blocks (Slope protection)	58,000 m^3	Constructed at site
2	CC blocks (underwater)	1,064,700 m^3	Constructed at site
3	Geo-bags (250kg and 800 kg)	3,285,336	Imported/Local Supply
4	Geo-textile	156,000 m^2	Imported/Local Supply
5	Sand	5 million m^3	River
Up grading existing protective work			
1	CC block	960,000 m^3	Constructed at site
2	Geo-textile (3mm thick)	402,000 m^3	Imported/Local Supply
3	Sand	6 million m^3	Local Supply
Structures			
1	Cement	900 ton	Local supply
2	Sand	1,440 m^3	River
3	Stone chips	7500 m^3	Local supply
	Steel	500 ton	Local supply

3.4.2. Manpower Requirements

During the construction phase, technical and non-technical man power will be required in sizeable numbers. These will include engineers, technicians, supervisors, surveyors, mechanics, foremen, machinery operators, drivers and skilled and unskilled labor. **Table 3.8** presents the manpower requirement during the Phase I; ***estimates for the subsequent phases will be provided in the EIAs of those phases.*** Local community will be able to avail some employment opportunities during this phase.

Table 3.8: Required Manpower during Construction (Priority Reach)

Category	Persons (Approximate)
Engineer	15
Machinery Operators	40
Mechanics	4

Category	Persons (Approximate)
Surveyors	8
Skilled Laborers	50
Un-skilled Laborers	150

During the O&M phase, the regular staff of the BWDB will carry out the monitoring, repair, and maintenance works.

3.4.3. Construction Machinery

A sizeable number of construction machinery and equipment would be needed for the construction activities of RBIP. A tentative list of these machinery and equipment is presented below **(Table 3.9).**

Table 3.9: List of Construction Equipment and Machinery

1	Bulldozer
2	Dump-truck
3	Pay loader
4	Excavator
5	Barge
6	Engine Boat
7	Vibrator
8	Compactor
9	Mixture Machine
10	Mixing Plant
11	Truck
12	Tractor
13	Generator
14	Total station
15	De-watering system
16	Water-pump

3.4.4. Construction Camps

Construction camps for each construction site are to be established by the contractor. The contractor will select the location of the camp through consultation with the local union parishad chairman and the local community. Moreover, they will have to obtain permission from the authorized BWDB representative. Tube wells may be installed in the labor camps premises for obtaining water for drinking and other purposes. For sanitation, latrines will be constructed along with septic tanks for safe disposal of sewage.

Location of these camps is not known at this stage however the key criteria to be used while selecting the sites are listed below.

- Community consultations will be carried out to select the camp sites
- Cultivation fields will be avoided as far as possible

- Government-owned lands will be given priority while selecting the camp sites
- If private land is used for camp sites, a fair rent will be paid to the land owner.
- Camps will not be establishes near sensitive receptors such as schools
- Camps will not be established near any sensitive habitat
- Camps will not be established that could affect any *khal*, *beel* or river.
- Camp sites will be approved by construction supervision consultants.

3.5. Operational and Maintenance Requirements

The BWDB receives fund from the government under the annual development program (ADP) for operation and maintenance of its infrastructure under different projects. Records indicate that the BWDB has been receiving on average about 17 percent of the total requirement for O&M, which reveals that the BWDB could not respond to all maintenance needs. For attaining sustainable maintenance of multipurpose project like proposed RBIP, the allocation for O&M in the ADP to be adequate as per actual need or there need to find a way to involve the beneficiaries directly in contributing to O&M. In RBIP, provision for toll collection from the highway can recover a good part of the maintenance cost of the project. It may be noted here that funds available for maintenance are often less than optimal, so it is important to make the best use of available funds and estimates of O&M components should be well supported by appropriate justification.

O&M works of proposed RBIP can be divided into three categories described below.

(a) Routine Maintenance: Routine maintenance includes preventative activities such as repair of small holes and rain cuts in embankments, removal of weeds and sediments from approach canal of regulators, repair of displaced blocks if any in the slope of the bank revetment work, petty repair of the pavement and a forestation of highway. The objective of routine maintenance is to keep overall flood protection system including all its elements in good functional order thereby reducing the need of periodic maintenance eventually avoiding high rehabilitation costs. The works are simple, generally inexpensive and cost effective and may need to be carried out round the year, almost continuously or as and when required.

(b) Periodic Maintenance: This is less frequent than routine maintenance and is likely to include re-sectioning of embankment, re-excavation of approach canal of regulators, rehabilitation of gates and gate lifting devices of regulators, repair of sliding of bank protection work, and maintenance of highway pavement after rainy season. BWDB engineering personnel will identify periodic maintenance works during surveys and inspections or on information from its field staffs.

(c) Emergency Maintenance: This type of maintenance is similar to periodic maintenance, but involves a potentially catastrophic situation that would likely cause significant damage to the infrastructure if not repaired immediately. Emergency maintenance may include breach closure in embankment, repair of major sliding of bank revetment work which if not taken care on emergency basis may cause further damage of the adjacent bank revetment work, arresting of unintentional erosion upstream and downstream of the existing bank revetment work, and repair of loose apron of the regulators. A component of the BWDB O&M budget should be set aside for natural or human caused calamities. Necessary funding and authorization to execute emergency maintenance should be readily available whenever required.

3.5.1. O&M Requirement of Bank Protection Structures

Bank revetment work is a major component of the project. The life and security of the project largely depend on the performance of the erosion protection works. It has been observed that inadequate monitoring of the completed work and lack of proper O&M activities due to limited funding provisions cause greater damage to the bank protection. Hence regular monitoring and proper O&M activities of bank protection work must be ensured to keep the project functional. O&M of new river bank protection as well as upgrading existing protection will be required to keep the work sustainable. Based on the Flood Plan Coordination Organization (FPCO) guidelines of May 1992, annual O&M cost for the proposed river bank protection should be around ten percent of the capital cost.

3.5.2. O&M Requirements of Embankment

Maintenance of embankment cum road is another most important item of activities of the project. It is necessary and cannot be avoided because it helps preserving the infrastructure in good and functional condition, protects investments and prevents high rehabilitation costs. BWDB O&M staffs will regularly visit the embankment cum road and detect the weak sections, gullies, slips, sign of squatter settlements, cultivation of perennial cash crops, cuts in the embankments to accommodate homesteads, embankment subsidence and erosion and requirement of repair maintenance work in the road pavement etc. Based on the above observations O&M estimate will be prepared for execution. As per FPCO guidelines the annual O&M cost of this component is five to six percent of the capital cost.

3.5.3. O&M Requirements of Regulators

The proposed regulators would be subjected to variable flows, the most severe of which are likely to occur during high Jamuna stages. Therefore, it is essential that regular inspections take place, so that any damage or any irregularities will be noticed within reasonable time. Measures for rectification can then be taken, so that the damage will be contained. FPCO guidelines suggest to keep three percent of the capital cost as annual O&M cost for this component.

3.6. Project Costs (to be updated)

Initial estimates show the total cost of RBIP is US$ 914.1 million as a whole, of which physical works account for US$ 581.3 million – as shown on **Tables 3.10** and **3.11**.

Table 3.10: Initial cost estimates of RBIP (in USD)(to be updated)

Work Item	Priority	Remaining	Priority + Remaining
New river bank protection	73.5	171.5	245.0
Upgrade existing protection	35.2	38.5	73.7
Embankment-road	72.5	142.5	214.7
Regulator	6.1	11.8	17.9
Bridge	0	30.0	30.0
Subtotal, Physical works	187.3	394.0	581.3
Land acquisition river bank	19.7	45.9	65.6

Work Item	Priority	Remaining	Priority + Remaining
protection			
Land acquisition embankment-road	54.7	96.2	150.9
Other costs (20% contingency)	37.5	78.8	116.26
Total	**299.2**	**614.9**	**914.1**

Table 3.11: Priority physical works, initial cost estimates (in USD)(to be updated)

Work Item	Quantity	Cost (USD)
New river bank protection	15 km	73.5
Upgrade existing protection	16 km	35.2
Embankment-road	50 km	72.5
Regulator	15	6.1
Subtotal, Physical works		187.3
Land acquisition river bank protection	90	19.7
Land acquisition embankment-road	25	54.7
Other costs (20% contingency)		37.5
Total		**299.2**

4. Analysis of Alternatives

This Chapter presents a summary of the analysis of alternatives carried out during the EIA of the Phase I. A similar in-depth analysis will be carried out during the EIAs of subsequent phases of the RBIP.

4.1. Overview

Various alternatives have been considered in siting and design of the project components. All these alternatives are evaluated considering social and environmental aspects as well as technical and financial aspects. The criteria considered for comparative evaluation of various alternatives is given in **Table 4.1**.

Table 4.1: Criteria for evaluation of alternatives

Main Criteria	Sub Criteria
Technical Aspects	• Robustness, • constructability, • geology, • degree of protection, • scour, • maintenance requirements, • history of performance, etc.
Financial Aspects	• Construction cost and • maintenance cost
Environmental Aspects	• Project footprints, • material requirements, • impact on river flows and channels, • impact on flood plains and erosion, • impact on chars, • impact on left bank, • impact on aquatic and terrestrial habitats, • impact on fish and fish migration • safety, etc.
Social Aspects	• Land acquisition, • Resettlement • Impacts on navigation • Impacts on char people • Socioeconomic impacts

In addition to the 'no project' alternative, the following alternatives are evaluated for RBIP using the criteria presented in **Table 4.1**:

- River Bank Protection Alternatives
- Embankment and Road Alternatives
- Regulator Alternatives
- Resettlement Sites Alternatives

4.2. No Project Alternative

The 'no-project' alternative is likely to result in continuation of the losses summarized in the sections below. Based upon these projected losses, the it can be concluded that the 'no-project' alternative is not a preferable option.

4.2.1. Damages from Jamuna Right Bank Erosion

Annual damages from Jamuna right bank erosion and cost of these damages are summarized as follows:

- About 200 ha of land, including about 104 ha of agriculture land, will be lost annually to the river and total value of these land lost is estimated to be about BDT 1.18 billion (US$ 15.1 million). The affected land also includes about 22 ha of water bodies that provide habitat for floodplain aquatic species and spawning grounds for migratory fish species.
- About 1,105 residential structures (93.5 percent structures are adobe/mud walled) will be lost annually to the river and total value of these structures is estimated to be about BDT 0.15 billion (US$ 1.9 million). The relocation cost of the households is estimated to be about BDT 16.6 million (US$0.20 million).
- About 5.7 non-residential structures such as schools and shops will be lost annually to the river and total value of these structures is estimated to be about BDT 9.8 million (US$ 0.13 million).

4.2.2. Damages from Breach of BRE

Breaches of the embankment cause flooding of the floodplains damaging the standing Aman paddy, livestock, houses, and other social and physical infrastructure, and livelihood of the local communities. Historical data on annual flood damages of last 27 years was collected from local government offices and a summary of extent of these damages are presented below. It can be expected that without the project scenario, the extent of damages will be similar in future.

- About 7,000 ha of Aman paddy (main crop in flood season) is completely damaged and about 4,900 ha are partially damaged annually. Total average annual value of damaged crop is estimated to about BDT 669 million, (US$8.6 million).
- About 396 animals are lost each year and value of these animals estimated to be about BDT 4 million (US$ $50,000).
- About 51,735 houses are damaged each year. About 80 percent of these houses are semi-permanent structures that are partially damaged and remaining 20 percent are temporary structures that are fully damaged. Value of these damages on structures is estimated to be about BDT 7.2 billion (US $113 million). In addition the values of moveable assets (furniture, appliances, food, etc.) that are damaged with the houses are estimated to be about BDT 1.47 billion (US $18 million).
- About 130 km of paved road, and 148 km of unpaved road would be damaged each year if there is no project. Similarly, on an average each year about 9.3 bridges and culverts will be fully damaged, while 6.3 bridges and culverts will be partially damaged. Without the project the anticipated average annual loss will be about BDT 1.5 billion (US$19.5 million).

4.3. Alternatives for River Bank Protection

The concept of providing systematic protection started with the development of "hard points" in the early 1990s as part of the Flood Action Plan, Component 1 (FAP1). With the exception of construction at two locations, the technically demanding and expensive FAP1 strategy was not implemented by BWDB and alternative strategies were developed. As an alternative, the BWDB developed and implemented lower cost "groynes" from the end of the 1990s until the mid-2000s. While these were initially successful, eventually most of these groynes failed due to increasing protrusion and river attack. After repeated failures, BWDB gradually abandoned these groynes. From the early 2000s BWDB pilot-tested and implemented low-cost "revetment" based on earlier FAP1 and FAP21 technologies. The technology was incorporated into the Guidelines for Riverbank Protection 2010, and is the most inexpensive and sustainable one. It has proven stable along 17km of riverbanks in the Brahmaputra/Jamuna. These long-guiding revetments are systematically replacing the other options when those fail. These three options are considered for analysis of alternatives. In addition, one more alternative of building revetments in to the river is also considered. The comparative analysis is summarized in **Table 4.2** (details are available in the EIA of the RBIP, Phase I).

Table 4.2: Analysis of River Bank Protection Alternatives

	Option 1 Hard Points	**Option 2 Revetment at Riverbank**	**Option 3 Revetment in the River**	**Option 4 Groynes**
Technical Aspects				
New riverbank protection	2.5 km	16 km	50 km	15 km
Strengthening of existing protection works	15 km	15 km	0 km	15 km
Degree of protection	Limited protection Partial protection with erosion between hard points, specifically under angular attack	Consistent protection Revetments will not cover all of the riverbank leaving some areas in natural conditions, downstream of convex curvatures, which are naturally protected	Full protection Complete coverage of the sensitive fill built into the main channel	Limited protection Similar to Option 1
Constructability	Medium complexity Dredging requirement for termination points, cross bar located on floodplain	Low complexity Simple construction along the existing riverbank, making use of proven technologies	High complexity Massive dredging and fill operation followed by challenging compaction under water and dredging of flat riverbanks for slope protection. Revetment	Medium complexity Same as option 1

	Option 1 Hard Points	Option 2 Revetment at Riverbank	Option 3 Revetment in the River	Option 4 Groynes
			construction similar to Option 3	
Robustness	Low Deep scouring and high turbulence are the main reasons for failure of riverbank protection	High Long guiding revetments are associated with minor scouring and smooth parallel flow	High Long guiding revetments are associated with minor scouring and smooth parallel flow	Low
Scour	High 6 0 m is the scour depth Scour is high at end section and the structure is unsafe. Out flanking of structure is another major problem. Some erosion occurs between the hard points and embankment may need to be retired due to embayment.	Low 30m is the depth of the scour Less scour compared to hard point or groyne. Holds existing shore line with systematic protection. Minimal impact to other sections of the river. Adaptive measure for river bank protection.	Low 30m is the depth of the scour Unconsolidated soil is likely to cause repeated failure of revetment.	High 60m is the depth of the scour
Loading	High High localized increase in flow velocities and turbulence, deep, fast scouring	Low Small increase in flow velocities, scour depth half of the scour of hard points	Low Small increase in flow velocities, scour depth half of the scour of hard points	Medium
Maintenance requirements	High The design and function and hard points inherently create severe hydraulic conditions that the structure must accommodate. On this basis, hard points are subject to more risk, which is reflected by higher maintenance and emergency repair costs.	Low	Low	High Similar to hard points. In some cases, maintenance costs of groynes and hard points can equal or exceeded the original construction costs
History of performance along Jamuna	Repeated failures The hard point structures experienced	No failures	No experience	Repeated failures Problems are similar to hard

	Option 1 Hard Points	Option 2 Revetment at Riverbank	Option 3 Revetment in the River	Option 4 Groynes
	considerable damage due to repeated undermining by scour. The main problems were associated with the deep scour at the upstream end due to outflanking and geotechnical stability problems associated with the dependency on launching aprons on curved slopes.			points
Financial Aspects				
Construction cost (without cost of land acquisition)	Medium 290M Capital cost is high since the design has to cater to deepest scour. The cost also depends on the spacing of the hard points and is higher than for Option 2.	Low 115M Consistent revetments are the lowest cost option	High 635M The complete revetment has to be built not allowing to make use of the existing revetments	Medium 229M Groynes and hard points are constructed further into the river channel where geotechnical conditions are less favourable, which adds to the construction costs and increases the risk of failure
Maintenance cost	High 2 to 10% of construction cost	Low 0.4% of construction cost	High 2 to 10% of construction cost	High 2 to 10% of construction cost
Environmental Aspects during Construction				
Project Footprints	High Footprints are higher compared to other options due to higher crest elevations (e.g. 17.3m at Sirajganj compared 12.5 m for revetment), higher size of aprons (100m width compared to 50 m width for embankment) and higher surface area	Low Lower footprints compared to other options. Crest level of revetment is equal to floodplain level (12.5 m at Sirajganj)	High Higher footprints due to new construction of entire 50 km of revetment in to the river	Higher Footprints are similar to hard rock due to similar crest level and apron size.

	Option 1 Hard Points	Option 2 Revetment at Riverbank	Option 3 Revetment in the River	Option 4 Groynes
	of structure			
Impact on Chars during construction	Medium While the initial construction along the riverbank does not impact on the river, later erosion between the hard points leads to a marginal increase in chars and shoals	Low The continuous revetment does not add or reduce the space for the river. However, the revetment attracts flow and leads to a stable channel along the riverbank and stabilizes the char and shoal pattern opposite to the bank.	High The construction into the river reduces the overall area for chars. After construction the effects are similar to Option 2.	High The construction into the river reduces the overall area for chars.
Material requirements	High The crest of the hard point is about 5 m higher than the guiding revetment, which adds considerably to the material requirements compared to the guiding revetment	Low Low material requirements compared to other options. Material from the existing embankment can be used for construction of new embankment	High Higher material requirements due to new construction of entire embankment and also requirement of huge dredging (42 million cubic meters) for filling of associated new embankment	High Similar to hard points
Impact on aquatic habitat	Limited impacts Some benthic fauna may be impacted during construction	Limited impacts Some benthic fauna may be impacted during revetment installation.	Significant impacts on aquatic fauna are likely because of works inside the river	Medium impacts on aquatic fauna are likely because of works inside the river
Environmental Aspects during O&M				
Impact on right bank	High About 117 ha on right bank would be eroded, at locations where there is no existing protection due to embayment between the hard points.	Low No impact on the right bank	Low No further erosion of river bank. Some additional land will in fact become available because of the riverbed reclamation	High About 221 ha of right bank land will be eroded where there is no protection works due to erosion between groynes
Changes in char patterns	Low The hard points do not impact on the char pattern	Medium The char pattern gets more stabilized which might lead to higher land use and reduced area for wildlife	High The char area is reduced due to the increase in land along the riverbank and based on the need to dredge around 42 million cubic metres of	Low

	Option 1 Hard Points	Option 2 Revetment at Riverbank	Option 3 Revetment in the River	Option 4 Groynes
			sand from the chars for filling the area alongside the riverbank	
Changes to river channels	Low The increasing protrusion of the hard points leads to a more pronounced "meandering" channel pattern	Low The continuous protection straightens the channels along the riverbanks	Medium After pushing the main channel into the river the result is similar to Option 2	Low
Changes to river flow patterns	High Turbulence and flow velocities increase with increasing protrusion	Low A slight increase due to the smoother protected bank is compensated by a reduction due to a more stable larger channel	Low Same as Option 2	High Same as hard points
Changes in river depth	Low Apart from localized scour holes no fundamental change	Medium The channel along the bankline will be deeper overall than unprotected channels.	Medium Similar to Option 2	Low Similar to hard points
Changes in flow velocities	High 5.8 m/s Turbulence and flow velocities increase with increasing protrusion	Low 3.7 m/s No significant change	Low Same to Option 2	High 5.8m/s Similar to Option 1
Impact on aquatic habitat	High Changes in flow patterns, velocities and scouring will have an impact on the aquatic habitat along the hard point	Low Revetment works may provide good habitat conditions for fish due to regulation of channel flows. Geo-bags and concrete blocks may also provide suitable habitat conditions for benthic fauna	Low Similar to Option 2	High Similar to Option 1
Social Aspects				
Land acquisition	Medium Land acquisition on floodplains is required in addition to land along the	High While no land required on the floodplain longer reaches along the	Low No floodplain land required	Medium Similar option 1

	Option 1 Hard Points	Option 2 Revetment at Riverbank	Option 3 Revetment in the River	Option 4 Groynes
	bankline. While the land for revetments is low value and located along the low water line, hard points make use of higher value land on the floodplain for the connection with the existing embankment line.	riverbank where land has little economic value		
Resettlement	Medium On floodplain and to be considered for known erosion between hard points	Medium The high risk area along the existing bankline is sparsely populated, often mainly by squatters	Low No resettlement	Low
River access	Medium Not good at eroding banks between hard points but easy at the hard points	High The river is easily accessible over the mildly sloping revetment	High Same as Option 2	
Protection from future erosion	Medium The limited protection and known outflanking lead to additional erosion of land between the hard points.	High Consistent protection along the riverbank	High Same as Option 2	Medium Same as Option 1
Protection of the embankment	Medium The limited protection entails the risk of outflanking and erosion of the embankment	High Safety margin to the embankment on consolidated floodplain reduces the risk of embankment erosion	Medium The new fill is susceptible to liquefaction under earthquake which leads to an increased risk of embankment failure	Medium Same as Option 1
Changes to navigation	Low The turbulent flow around increasingly exposed protrusions does not improve navigation conditions	High The smooth parallel flow along a pronounced channel encouraged by the revetment improves navigation.	High Same as Option 2	
Displacement of char people	Low Construction along	Low The revetment does	Medium The reclamation of	

	Option 1 Hard Points	Option 2 Revetment at Riverbank	Option 3 Revetment in the River	Option 4 Groynes
	the riverbank and future outflanking lead to potentially slightly increased char area	not impact on the char area	riverbank goes at the cost of char area.	
Conclusion	Not recommended Not a preferred option because of technical difficulties, high environmental impacts and also high initial as well as recurring costs compared to other options.	**Recommended** Preferred option because of lower costs, limited environmental impacts, and substantial social benefits.	Not recommended Not a preferred option because of high costs, technical difficulties, and significant environmental impacts.	Not recommended Same as Option 1.

4.4. Embankment and Road Options

BWDB is mandated to build roads on flood embankments. It is common, world-wide practice to provide emergency access alongside flood embankments in order to provide better access to the area during emergencies. The embankment built under this program will have provision of a higher standard than the emergency roads alongside flood embankments due to its use for regional and inter-regional connectivity. Currently, annual repair maintenance allocation of the BRE is insufficient even to attend regular maintenance work. If the proposed road would be a toll road, then there will be a scope for revenue generation, which can be used for future maintenance of the project.

The comparative analysis of the various options considered for the embankment and road is summarized in **Table 4.3** (details are available in the EIA of the RBIP, Phase I).

Table 4.3: Analysis of Embankment and Road Alternatives

	Option 1 Widening existing embankment	Option 2 Reconstructed embankment, 2 lane road	Option 3 Reconstructed embankment, 4 lane road	Option 4 Reconstructed embankment, 4 lane road in river
Technical Aspects				
Length of embankment	50 km widening of existing embankment	32 km reconstruction of existing embankment 18 km new realignment	32 km reconstruction of existing embankment 18 km new realignment	50 km of new alignment
Degree of protection	Low Does not provide full seepage safety and is not stable for typical	High Fully complies with stability requirements	High Same as Option 2	Medium construction on recent fill is associated with higher seepage and liquefaction risk

	Option 1 Widening existing embankment	Option 2 Reconstructed embankment, 2 lane road	Option 3 Reconstructed embankment, 4 lane road	Option 4 Reconstructed embankment, 4 lane road in river
	loading combinations			than old consolidated floodplain
Mobility within the local area	Medium Local connection over the embankment crest	High Good local connection	Medium Dedicated road with limited number of overpasses	Medium Similar to Option 3
Regional mobility	Low Slow connection over winding embankment	High Fast connection over straight road	Medium Connection through feeder roads to toll entry points	Medium Same as Option 3
Interregional connectivity	Low Not attractive for through traffic	Medium Direct interregional link	High Direct dedicated link	High Same as Option 3
Constructability	Low complexity Simple construction	Low complexity Simple construction making use of proven technologies	Low complexity Same as Option 2	High complexity Massive dredging and fill operations
Maintenance requirements	Low	Medium Road and sluice gates require higher maintenance	Medium Same as Option 2	High Work on fill requires locally higher maintenance
Financial Aspects				
Construction cost	Low	Medium	High High road coast	High
Cost recovery for O&M of embankment	Nil No option to collect toll.	High Dedicated toll stations can recover a good part of the maintenance cost	Medium Lower than Option 2 as the road maintenance is higher	Low Lower than Option 3 as the road maintenance is higher
Environmental Aspects				
Project Footprints	Low Width of embankment is about 25m	Medium Width of embankment is 51.5 m	High Width of embankment is 62m	High Width of embankment is 62m
Material requirements for construction	Low Only fill is required for widening	Medium	High Higher embankment and fill compared to	High Similar to Option 3 but additional efforts, such as

	Option 1 Widening existing embankment	Option 2 Reconstructed embankment, 2 lane road	Option 3 Reconstructed embankment, 4 lane road	Option 4 Reconstructed embankment, 4 lane road in river
			Option 2 due for four lane road, fencing, and local road connections with dedicate overpasses	stone columns for compaction of the unconsolidated fill under the embankment
Impact on aquatic habitat	Medium	Low Low impacts due to construction of regulators to maintain ecological connectivity between river and floodplains	Low Same as Option 2	High
Additional flood protected land	None	Medium 165 ha of reclaimed char land	Medium Same as Option 2	High 1980ha of reclaimed land along the riverbank
Segregation of landscape	Low The standard embankment does not pose a major dividing element at all places	Medium A two lane highway is more difficult to cross but allows easy river access at all places	High A fenced four lane highway	Medium Same as Option 3
Social Aspects				
Amount of land required	Low Maximum use of existing land	Medium Partial use of existing land	High Wider than Option 2 and therefore more land required	High Same acquisition as for Option 3.
Number of people displaced	Medium Displacement of squatters and some new acquisition	Medium Higher than Option 1 due to the overall wider footprint	High Wider footprint than Option 2 due to the wider road	Low No displacement as built on newly filled land on river
Access to the river	High No major obstacle	Medium Crossing the highway could locally reduce the access	Low Access is limited to the locations of overpasses	Low Same as Option 3
Impact of traffic on community	Low Low traffic volume and speed	High Faster and mixed traffic with increased noise, accidents etc.	Medium Segregated traffic with reduced accident risk but higher noise levels	Medium Same as Option 3
Conclusion	Not recommended	Not Recommended Though this option has less environmental footprints and less cost compared to Option 3,	Recommended	Not recommended

	Option 1 Widening existing embankment	Option 2 Reconstructed embankment, 2 lane road	Option 3 Reconstructed embankment, 4 lane road	Option 4 Reconstructed embankment, 4 lane road in river
		recognizing the future development needs in the fast growing communication sector – this option is not recommended		

4.5. Alternatives for Embankment Materials

Construction of embankment and road requires huge amounts of earth fill. The following sources are considered as the sources of borrow material for earth fill:

- Alternative 1: Entire embankment is constructed with soil excavated from the floodplains and agriculture land.
- Alternative 2: Embankment to be constructed with dredged sand from the river bank and soil cladding.

Constructing the embankment with soil (Alternative 1) is a technically viable and perhaps the least cost option. However the soil will have to be either transported from long distances or obtained from the local areas thus significantly affecting the already scarce cultivation lands. Hence this option is not being considered for embankment construction.

The cost of Alternative 2 could be slightly higher than the other option discussed above. However the biggest advantage of this option is that it will avoid any adverse impacts on the cultivation lands of the area. There could be some localized and temporary impact on the aquatic habitat/fauna during the sand extraction from river bank and these impacts can be minimized with the improved sand extraction methodology and locating the extraction points away from the sensitive aquatic habitats. Alternative 2 is recommended for as source of earth fill primarily to avoid any impacts on the floodplain agriculture lands.

The source of cladding material of the embankment is usually extracted from the floodplain agriculture lands. In the RBIP, the material from the unused embankments will be used as cladding material.

4.6. Alternatives for Regulators

During Construction of BRE a good numbers of regulators were built on the embankment to provide lateral fish migration between the river and floodplains and also to provide drainage and supplementary Irrigation facilities. But most of them were engulfed into the Jamuna river due to erosion. During retirement or re-construction of BRE those engulfed regulators were not rebuilt and at those regulator points the natural channels were closed permanently. As a result the natural connectivity has been lost and there have been some problems with the natural drainage and supplementary irrigation. Following three alternatives were considered to address the problems:

Alternative 1: No new regulator and no rehabilitation of fish pass. This is the least cost option, avoiding any capital cost as well as any environmental and social impacts associated with the construction/rehabilitation activities. This option however is likely to have adverse impact on the ecological connectivity of the area with the main Jamuna

river, resulting in reduced fish production and hence reduced livelihood for the local population

Alternative 2: rehabilitation of existing regulators and fish pass. This option will result in capital cost associated with rehabilitation works, in addition to environmental and social impacts associated with the rehabilitation works. This option will eventually result in restoration of ecological connectivity that has been lost because of the dysfunctional regulators

Alternative 3: Rehabilitation of existing regulators and fish pass, and construction of additional regulators. This option will obviously result in higher capital and O&M costs compared to the second option discussed above. The environmental and social impacts associated with the construction activities will also be higher than those associated with the second option. However this option will enhance the fish production from the floodplains and hence enhance the livelihood of local fishermen. Therefore this option has been preferred over the other alternatives. Total seven regulators and two culverts will be constructed/ rehabilitated in the priority reach. Moreover, the lost connectivity of the natural channel system will be re-established by re-excavation of the links under project condition.

4.7. Alternatives for Resettlement Sites

The project requires resettlement of about 5,732 households. Based on the recent experiences in Bangladesh on similar projects on embankment rehabilitation and Padma Bridge, the following four alternatives are considered for planning of resettlement sites:

- Alternative1: No Resettlement Site (RS). Affected households (hh) will be encouraged to relocate on their own with eligible compensation and assistance from the project and provision for additional incentives.
- Alternative 2: Large RS sites (for 300 to 500 hhs) to be development by the project
- Alternative 3: Small Group (10 to 20 hhs) relocation by members of extended families
- Alternative 4: Small RS Site – within the same area with access to existing civic amenities

A comparative evaluation of these alternatives is presented in **Table 4.4**. All alternatives, exception Alternative 2 on development of large resettlement sites will be followed up under RBIP.

Table 4.4: Analysis of Resettlement Site Alternatives

	No RS Site	Large RS Sites	Small Group	Small RS Site
Technical	Reduce further acquisition of land for resettlement sites; people choice their own place of choices within the vicinity of the existing	Involve massive acquisition of land affecting new set of households s requiring resettlement	No land acquisition needed. People move on their own on residual land and/or buy land for resettlement	Minimum LA for RS site development; available BWDB land may be used in some instances

	No RS Site	Large RS Sites	Small Group	Small RS Site
	communities.			
Financial	Cost of building construction sites will be avoided	Expensive; about $1 million per sites (4 to 5 sites) would be required	No additional costs to the project except for provision of support of amenities such as tube-well and access roads	Low costs in RS site development; on site minimum amenities
Environmental	Minimal environmental issues in such relocation, because there is no major concentration or cluster in one site.	Many environmental issues related to large sites – water, sewerage, sanitation, health etc.	No or very limited environmental impacts	Minimum environmental impacts
Social	People with residual land and/or support from kin/relatives will have easier time to resettle; those without land will have hard time finding a place to relocate.	Cyclical impacts and displacement; fragmentation of social and community ties; host village issues	Well integrated new community in the resettled villages/settlement; no potential conflict; due monitoring of relocation for eligible social programs	Limited or no disruption due to relocation; access to already existing amenities – no host area issues
Conclusion	This is a preferred option expressed by many affected households on the ROW, including those to be relocated from the embankment.	To be avoided as much as feasible due to linear project over 50 km	Encouraged with incentive such as additional cash - to take own decision on resettlement	Encouraged, because many affected households expressed their desire to remain within their own community

5. Description of Environment

This chapter describes the existing environmental and socio-economic conditions of the project influence area. This description has been prepared with the help of secondary literature review and field data collection carried out during the EIA study of the Phase I of RBIP. This description will be updated, expanded, and verified as appropriate while conducting the EIAs of the subsequent phases.

5.1. Project's Area of Influence

The influence area of the project has been derived considering the extent of flood inundation areas through digital elevation model (DEM) of the area, river network, roads and other flow barrier structures and flood extent from satellite images. However the influence Area of remaining phases might be changed with the changing of river morphology at the time of implementation; therefore this will need to be re-evaluated in each phase-specific EIA with adjustments made as necessary. The DEM used to define the initial/preliminary influence area was developed as part of the project activities based on digitization of the BWDB contour maps (1960-1964). Detailed topography and land elevation pattern in the study area was carried out to further refine the existing DEM. The following criteria have been considered to define the influence area:

- Floodplain area: The extent of flood plain area that will be protected from the floods by the flood embankments (BRE) has primarily been considered as the project influence area. This area has been derived based on the latest satellite maps and GoB topographic maps through digital elevation model (DEM).
- Flood Inundation: The extent of flood inundation caused by breaches of BRE. Satellite maps were analyzed for August-September, 2014 to understand the extent of flooding from breaches and internal rivers like the Dharla, Dudhkumar, Teesta, Karotoya, Bengal, Ichamati, and Hurasagar.
- Connectivity: The area is crisscrossed with a network of khals (water channels) which carry flood waters from Jamuna to the internal rivers on the western side of the project influence area. All these rivers are interconnected by numerous khals, tributaries and distributaries forming a hydrological network in the entire northwest region of the Country. For example, Mahananda and Punorbhaba that are major rivers of the northwest region, are connected to the Atrai-Karatoya-Bengali river system which drains to the lower Jamuna through the Hurasagar/Baral in the south east corner of the region.
- Lateral Fish Migration: Some fish species of Jamuna, such as major carps, undergo lateral migration from Jamuna to floodplains for spawning. The migratory routes have been affected by the BRE and the proposed interventions also have a potential to affect these lateral migratory routes. Therefore the extent of lateral migration from Jamuna to floodplains has been included in the project influence area. The other type of fish migration in Jamuna is longitudinal migration between upstream and downstream (e.g. hilsa migration from sea to Jamuna). Since the BRE and proposed interventions will not have any impacts on the longitudinal migratory routes, these areas are not included in the project influence area.
- Road network: Road network and other flow barrier structures have been considered. The western boundary of the influence area is thus the Dhaka-Bogra

highway which impedes flood waters to flow westward. The southern boundary is defined as Jamuna bridge since it will be connected with the project road.

- Significant Habitats (Eco-dynamic area): There are many significant ecological habitats in the project area especially in the chars. The project will not have any impact on the chars. However, the nearest chars were also considered to be a part of the influence area.
- Movement of inhabitants – Areas and routes that are used as resource harvest, communication, and livelihood by the local communities have been included in the project influence area.
- Project footprints: Also included in the project influence area is the footprint of the project and its ancillary facilities, temporary construction areas and worker camp sites, borrow areas, access roads to the project facilities for transport of material, and also the areas that will be affected by the emissions from construction and by operation of traffic.

Figure 5.1 shows the project influence area and its immediate surroundings.

Area of influence for each subsequent phase will be determined in respective EIA consistent with the above criteria and will cover the areas that will be directly or indirectly affected by the project.

5.2. Baseline - An Overview

For proper environmental assessment (as a part of IEE and EIA), it is very important to adequately assess the baseline condition before the project takes place, so as to understand which phenomena existed before project implementation and which could be impacts from project activities. The baseline assessment allows to provide timely input to project designs to reduce potentially adverse environmental impacts. It can also be used to reassure the public and decision makers that key environmental issues have been identified and will be monitored during project implementation The characteristics of "environmental baseline" would depend on:

- Nature of the project location,
- Nature/ extent of a project and its likely impact,
- Influence area of the project.

For systematic recording of data, baseline environment is usually classified into physicochemical environment, biological environment, and socio-economic environment; and important features/parameters under each category are identified and measured/ recorded during baseline survey. The following sections provide guideline on identification of important features/parameters and collection of sub-project specific environmental baseline data. Each phase or subproject-specific EIA should provide an updated overview of baseline conditions according to these parameters for the whole project area (reflecting any changes on the ground since this preliminary baseline for the full project area was established at the time of preparation of this document), as well as a detailed analysis specific to the influence area of that phase.

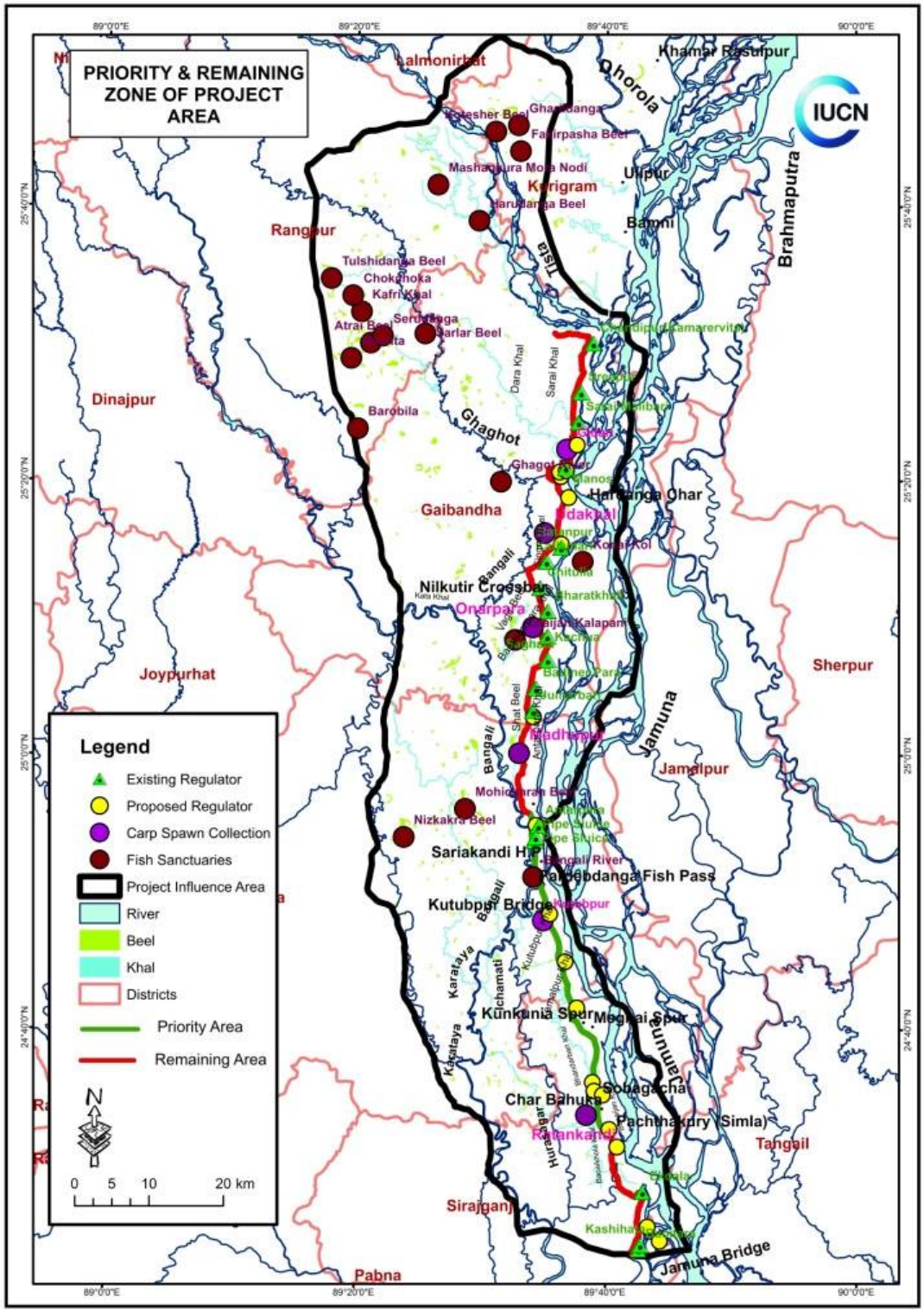


Figure 5.1: Project Influence Area

The lands of the project influence area are part of the Karotoya-Bangali and the Active Brahmaputra-Jamuna flood plain. The eastern part of the area has broad floodplain ridges

and almost level basins. While the land adjacent to Jamuna river and the *chars* (shoals or river islands) comprises of a belt of unstable alluvial land constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. About 41 percent of the total 459,159 ha is available for agriculture. The rest of the land is occupied by settlement (37 percent), homestead forestry, bamboo plantations (11 percent) and; chars and water bodies (12 percent).

Bangladesh is a highly populated country and its reflection is present in the four project districts, viz. Kurigram, Gaibandha, Sirajganj and Bogra. The population of Kurigram was 1.79 million in 2001. The population density was 780 per sq-km. Among nine Upazilas of Kurigram, the Raumari Upazila had the highest population while the Char Razibpur Upazila had the lowest.[11] On the other hand, Gaibandha had a population of 2.48 million in 2001. The density of population was 981 per sq-km. Among seven, the Gobindaganj Upazila had the highest and Fulchari had the lowest population[12]. The population of Sirajganj in the census of 2011 was 3 million. Among the four districts the scale of urbanization is higher in Bogra district, and it has 12 municipalities. Urban population is 0.59 million. Sirajganj has six municipalities and 0.32 million urban population. Gaibandha has three municipalities and 0.19 million people. Kurigram has three municipalities and 0.27 million urban population.

5.3. Physical Environment

5.3.1. Brahmaputra River Overview

The hydrology and inundation cycles of the study area is dominated by the Jamuna River. The River is the 240 km-long lower reach of the Brahmaputra River from the India-Bangladesh border to the confluence with the Ganges. The river originates in the northern Himalayas in Tibet, flows through China as the Yarlung Tsangpo and India as the Brahmaputra and enters Bangladesh at Noonkhawa. The Teesta, Manas, Sankosh, Dharla and Dudhkumar rivers are the major tributaries of Brahmaputra. Downstream of Teesta, at Dewanganj, the Old Brahmaputra originates on the left bank of the Brahmaputra and main channel flows as Jamuna until it reaches Aricha, where it combines with the Ganges to form the Padma river. The Brahmaputra-Jamuna river system displays characteristics of a braided river and is highly susceptible to migration and avulsion. In plan form, the river typically shows two to three channels per cross-section and a total width of 8 to 12 km. The Brahmaputra/Jamuna is characterized by its widening as a consequence of the Great Assam Earthquake in 1950. In Assam, India it has widened along its 650km length from an average 6 to 9km and along its 250km in Bangladesh from 8 to 12km.

The Jamuna has an annual average discharge of around 20,000 m^3/s at Bahadurabad transit. Over 75 percent of the discharge of the Jamuna river is generated from rainfall and snowmelt from upstream countries, as a result, the flow pattern is not strongly related to local precipitation.

Table 5.1 shows the seasonal mean discharge values of the Jamuna river from 1976 to 2011 at Bahadurabad transit station. The mean monthly flow discharges of Jamuna are shown in **Figure 5.2** at Bahadurabad transit station. The river usually peaks in July when the average maximum discharge is about 50,000 m^3/s and flow reduces in the dry season

[11] BBS (2011), *Census of Agriculture 2008, Kurigram Series*, Ministry of Planning, GOB.

[12] BBS (2011),*Census of Agriculture 2008, Gaibandha Series*, Ministry of Planning, GOB; BBS(2007), *Census of Agriculture and Economic Census of 2001 & 2003, Zila Series Gaibandha*, Ministry of Planning, GOB.

with average lowest in February at 4700 m^3/s. Historical analysis displays an increasing trend of average annual peak flows at Bahadurabad in Jamuna river. The lowest and highest flows recorded during 1976 to 2011 are: 3,178 m^3/s on 24 February 2001 and 102,535 m^3/s on 09 September 1998.

This data will be updated to reflect more current flow data at the time of carrying out of each additional phase specific EIA. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

Table 5.1: Seasonal Mean Discharge (1976 - 2011) of Jamuna

Season	Jamuna River (Bahadurabad Transit)
	m^3/s
Dry (December-February)	6014
Pre-Monsoon (March-May)	10,300
Monsoon (June-September)	39,700
Post-Monsoon (October-November)	18.760

Source: Bangladesh Water Development Board

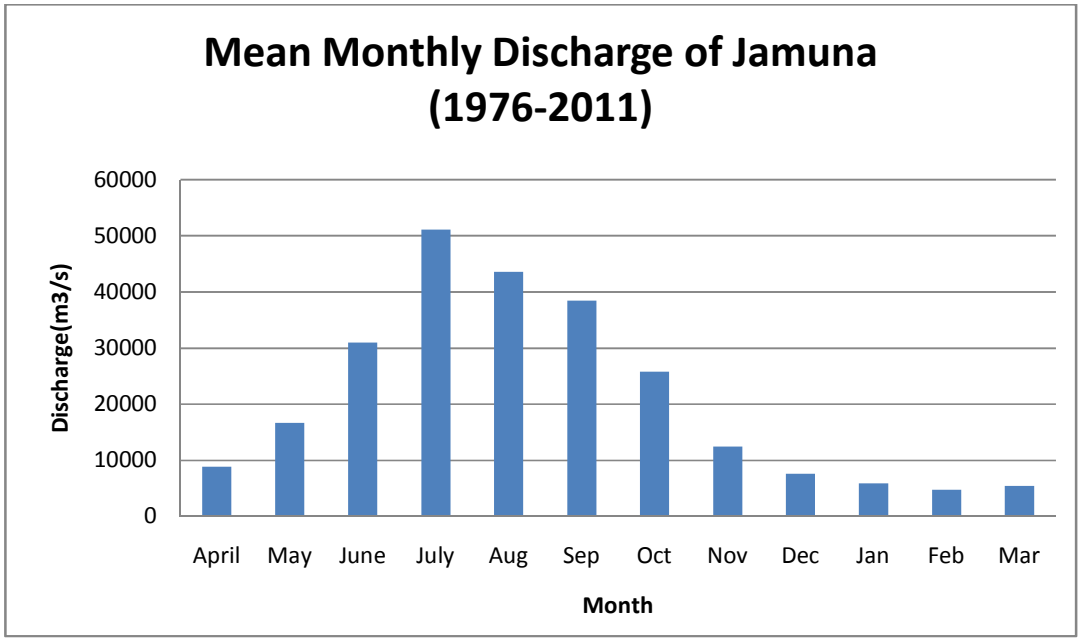


Figure 5.2: Mean Discharge of the Jamuna river (1976-2011) (*Source: BWDB)*

Secondary data on water level were also collected for the Jamuna at Sirajganj. The data shows that the water level in the Jamuna river varies from 15.11m to 6.05m. The highest water level occurs in July which has an average monthly water level of 13m and the lowest in February with average water levels. **Table 5.2** shows the average values of water levels of the Jamuna in different seasons (1945 to 2013).

Table 5.2: Water Levels of Jamuna (1945-2013)

Season	Jamuna River (Sirajganj station)
m+PWD[13]	
Dry (December-February)	7.4
Pre-Monsoon (March-May)	8.8
Monsoon (June-September)	12.5
Post-Monsoon (October-November)	10

Source: Bangladesh Water Development Board

Flood frequency analysis was also conducted on the long-term historical water level data recorded at Sirajganj, Kazipur and Mathurapara. The two stations at Sirajganj and Mathurapara span the extent of the Priority Reach. The record length at Maturapara is considerably shorter than at the other stations. The results are summarized in **Table 5.3** for the three stations. The upper and lower 95 percent confidence limits show the range in the estimates is typically ± 0.4 m of the mean values. These results indicate that during extreme floods, the water level increases by about 4.3 m between Sirajganj and Mathurapara. The long-term average annual minimum water level in the Priority Reach is 6.9 m PWD at Sirajganj, and 10.5m PWD at Mathurapara.

Table 5.3: Water level (m) frequency analysis at gauging stations

Station	50-year	100-year	200-year
Sirajganj	15.1	15.3	15.5
Kazipur	16.8	16.9	17.0
Mathurapara	19.1	19.5	19.8

5.3.2. Climate

The project influence area lies in the northwest part of Bangladesh where the climate is sub-tropical in nature with three seasons namely summer/pre-monsoon from March to May, monsoon from June to October, and winter season from November to February. Lower rainfall makes this area both atmospherically and pedagogically drier than the rest of the country. The rainy season is hot and humid with about 88 percent of the annual rainfall in the area. The winter is predominately cool and dry. The summer is hot and dry interrupted by occasional heavy rainfall, whereas monsoon comes in the month of June and recedes in late October. Meteorological data such as rainfall, temperature, humidity and wind speed were collected from Bangladesh Meteorological Division (BMD) and analyzed for assessing local climate that are directly related to water resources of the study area.

Temperature

Temperature data of Bogra station for the period 1948-2010 has been used for this report. The data shows that the monthly maximum temperature varies from 25ºC to 35ºC. Maximum temperature occurs in the month of April and minimum temperature in January. Monthly minimum temperature ranges from 21ºC to 30ºC. The average temperature during monsoon is about 34º C. **Figure 5.3** shows the monthly maximum,

[13] Public Works Department datum. A horizontal datum applied by PWD, BWDB and others. It is defined by a network of SOB and BWDB benchmarks with a specified elevation above PWD. Its zero level is located 0.46 m below the Mean Sea Level (MSL) defined in 1909.

mean and minimum temperature at Bogra station. This data will be updated to reflect more current temperature data at the time of carrying out of each additional phase specific EIA. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

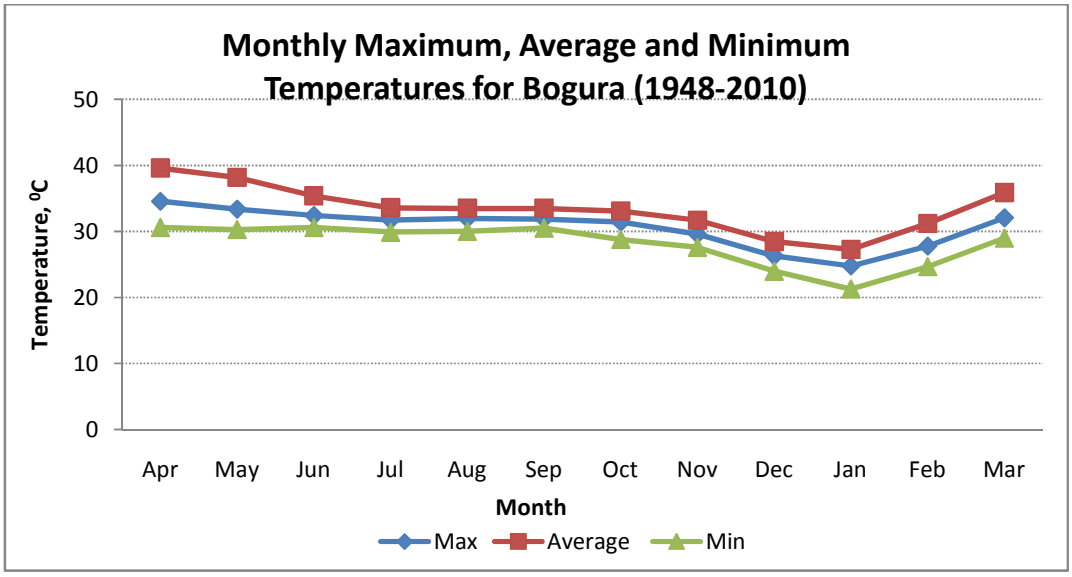


Figure 5.3: Monthly Temperature Data for Project Area (Source: Bangladesh Meteorological Department - BMD)

Yearly data of average, maximum and minimum temperature have also been analyzed for the same station (from 1948-2010 and shown in **Figure 5.4**.

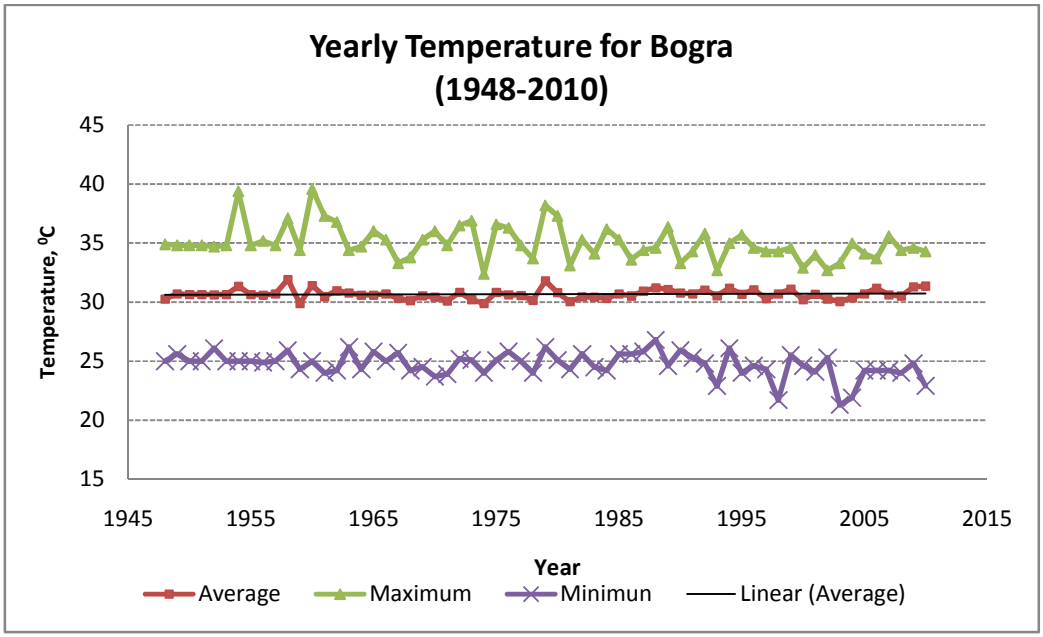


Figure 5.4: Yearly Average Temperature in Project Influence Area (Source: BMD)

Precipitation

The northwest region of Bangladesh can be considered as the driest region of Bangladesh. Average annual rainfall in this region is around 1900 mm is below the average of Bangladesh, which is around 2300 mm. Mean annual rainfall in the project influence area (represented by Bogra station) is approximately 1705 mm/year.

Figure 5.5 shows the average monthly rainfall for 1950-2010 recorded from Bogra station**.** Almost 74 percent of rainfall occurs from June to September and little or no rainfall from November to February. During pre-monsoon (March-May) cumulative rainfall is 276mm, in monsoon (June-September) total rainfall is 1267 mm and; post monsoon and dry season contributes 187mm rainfall. The maximum recorded monthly rainfall was 371 mm/ month. This data will be updated to reflect more current precipitation data at the time of carrying out of each additional phase specific EIA. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

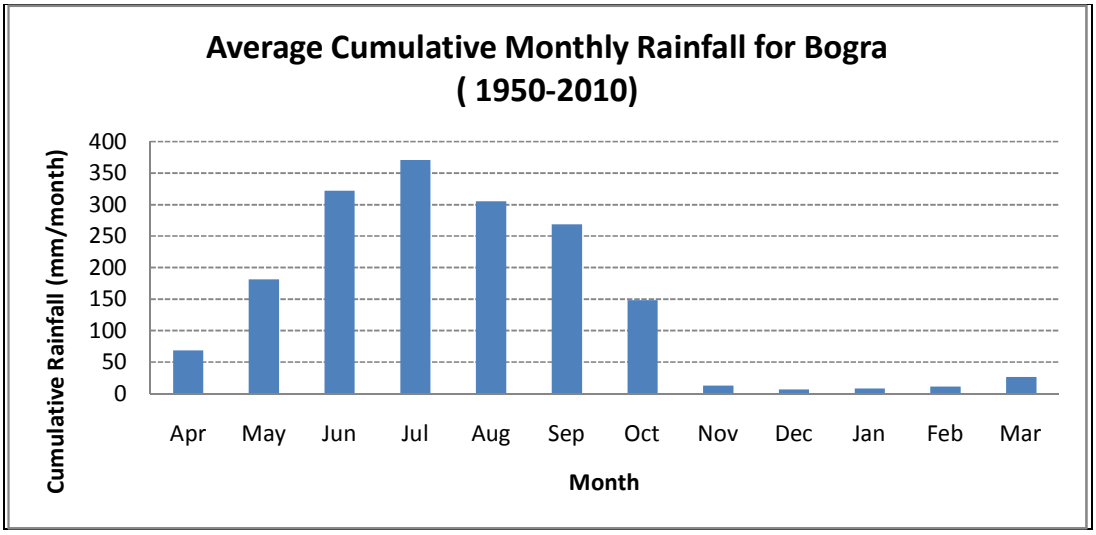


Figure 5.5: Average Cumulative Rainfall for Bogra (Source: BMD)

Wind Speed

Figure 5.6 shows the average monthly wind speed at Bogra station. The highest value occurs in April and the lowest in November. This data will be updated to reflect more current wind speed data while conducting EIA of each additional phase. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

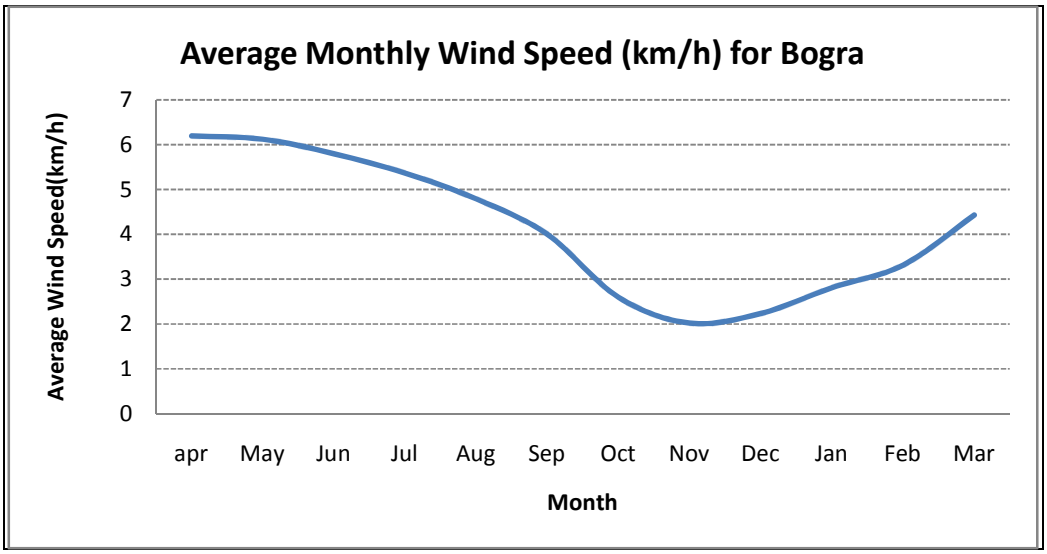


Figure 5.6: Average Monthly Wind Speed in Bogra (Source: BMD)

Humidity

Humidity data was also collected from BMD for Bogra station for the period 1950-2010. The relative humidity is highest during monsoon at 86.3 percent in July. **Figure 5.7** shows the relative humidity for Bogra station. This data will be updated at the time of conducting EIA of each additional phase. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

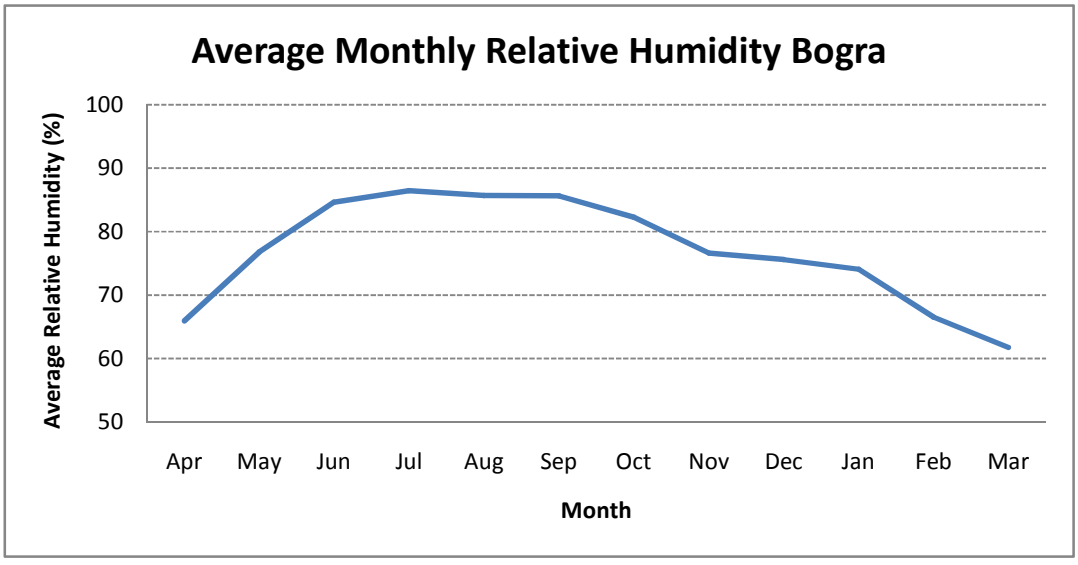


Figure 5.7: Average Monthly Relative Humidity in Bogra (Source: BMD)

5.3.3. Topography

Topographically, this area is flat and before construction of the BRE, the area was exposed to flooding from the Jamuna River during the monsoon season. **Figure 5.8** shows the topography of the project influence area as rendered by a digital elevation

model. Land elevation varies from 21m to 4.7m amsl but most of the area is within 8-16 m. The area slopes gently downward from north to south and towards the east. The highest part is situated in the northern portion (Saghata, Jhumabari, parts of Gaibandha) and the lower elevation area is in the southern portion (Sirajganj). While conducting the EIA of the subsequent phases of RBIP, site-specific topography will be assessed using the same methodology.

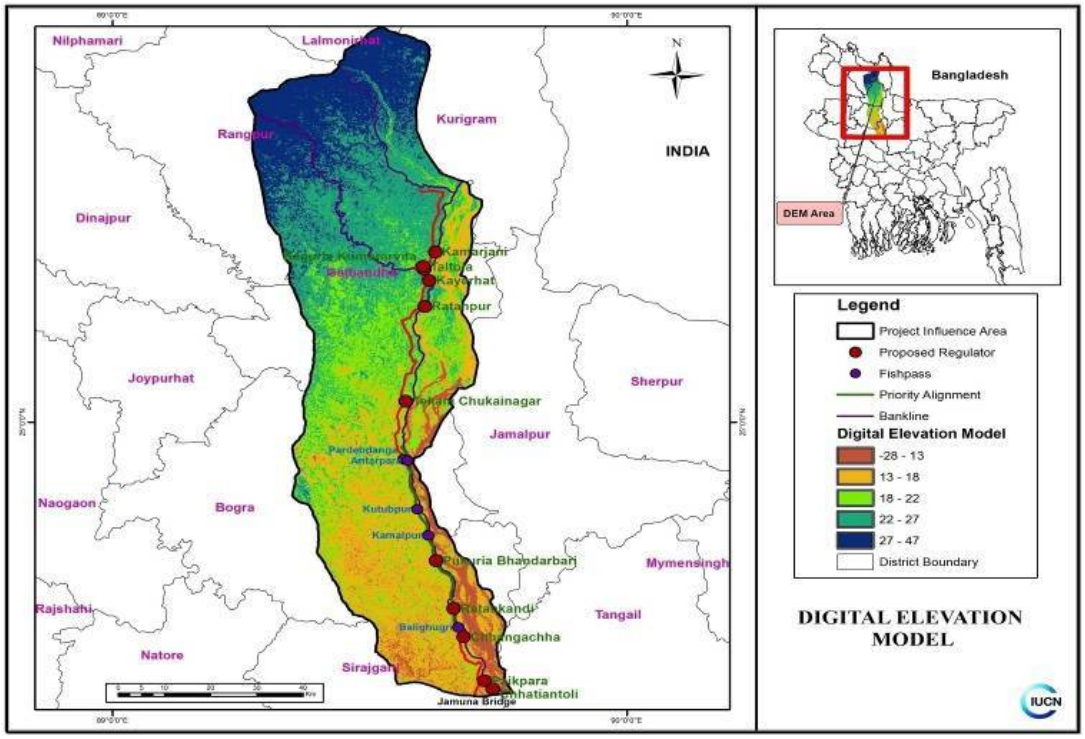


Figure 5.8: Digital Elevation Model of the Project Influence Area

5.3.4. Floodplains

The lands of the project are a part of the Karotoya-Bangali and the Active Brahmaputra-Jamuna flood plain (Asiatic Society, 2006). The eastern part of the area has broad floodplain ridges and almost level basins. While the land adjacent to Jamuna river and the chars comprise of a belt of unstable alluvial land constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. About 53 percent of the total project influence area of 268,466 ha is available for agriculture. The rest of the land is occupied by settlement, homestead forestry, bamboo plantations and chars and water bodies. This data will be updated to reflect more current data on the floodplain, at the time of carrying out EIA of each additional phase. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

5.3.5. Charland (Shoals or River Islands)

Chars or river islands/shoals are an important feature of a braided river like the Jamuna. Analysis of time series satellite images of 1973 to 2000 show that over 99 percent of the area within the riverbanks of the Jamuna had been char at one time during the 27-year period. Chars are variable in time and space in terms of its geographic location. It survives through the constant interplay of erosion and accretion. The same analysis shows that about 75 percent of the chars remained between one and nine years, while

only about 10 percent lasted for 18 years or more (Asiatic Society, 2006). It is important to note that as far as duration of existence is concerned, there are mainly three types of chars: dead, mature, and running or existing chars. The dead chars are usually permanent land formations; mature chars have not faced any major change for 10-15 years and existing or running chars face regular changes due to the action of the river and continuously emerge and submerge. The emergence and erosion determines the intensity of vulnerability in the 'chars'. Typically a new char land require at least 10 years of continuous survival before it becomes habitable for human being.

Field investigations during 1-15 September 2014 have identified 159 chars of various sizes. Of these 68 chars exist in the priority area from Sirajganj to Sariakandi. This data will be updated to reflect more current data on the chars at the time of carrying out of each additional phase specific EIA, with a focus on the chars within the phase-specific influence area, as well as an overall view within the full project area. Changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

5.3.6. Hydrology and Floods

5.3.6.1. Surface Water Resources

The influence area of the project is dominated by the Jamuna river and also the Bengali, Ichamati and Hurasagar rivers to a lesser extent in the eastern part of the area. All these rivers are interconnected by numerous channels (khals), tributaries and distributaries forming a hydrological network in the entire northwest region. For example, Mahananda, Punorbhaba which are major rivers of the northwest region, are connected to the Atrai-Karatoya-Bengali system which drains to the lower Jamuna through the Hurasagar/Baral in the south east corner of the region. Surface water bodies of the project influence area are shown in **Figure 5.9.**

At the northern boundary of the project influence area is the Teesta, which is a major tributary of the Brahmaputra. The braided Teesta River is the largest fan river in Bangladesh originating in Sikkim, India and avulsed into its present course at the end of the 18th century. Before avulsing, the Teesta flowed through today's Atrai as one of three channels, draining the western areas of Bangladesh into the Ganges.

Other types of surface water resources include beels, wetlands and natural canals or khals. These were identified from field investigations and images downloaded from Google Earth. **Table 5.4** shows the distribution of surface water bodies in the project influence area.

Table 5.4: Rivers in the Project Influence Area

Upazila Name	River Name	Area (Hectares)
Sirajganj sadar, Sherpur, Sariakandi, Roygang, Kazipur, Gabtali, Dhunat, Bogra Sadar	Jamuna	10,677
	Karataya	839
	Hurasagar	39
	Ichamati	87
	Bangali	869
Grand Total		**12,511**

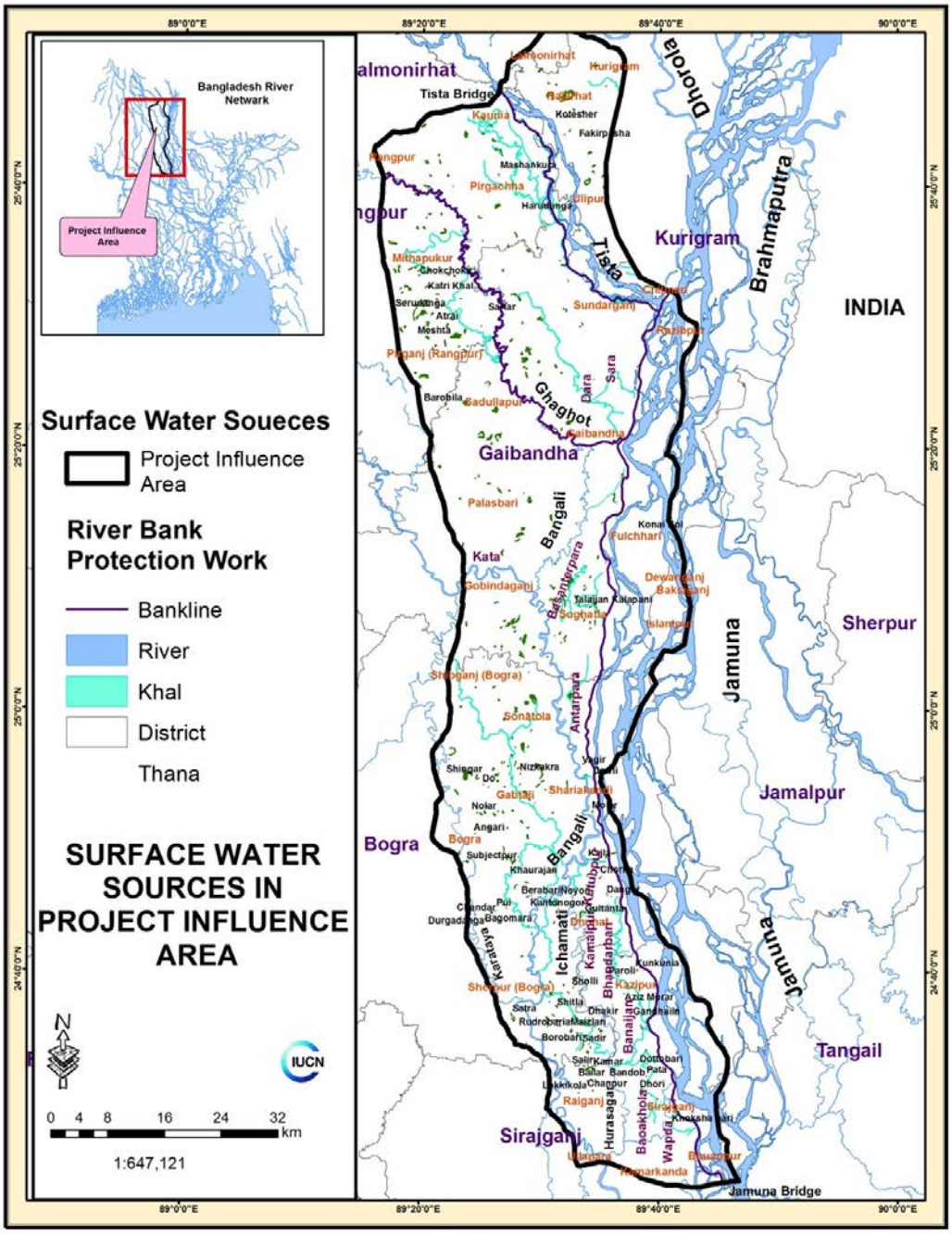


Figure 5.9: Rivers and Khals of the Project Influence Area

Field investigations show that there are around 18 khals in the project influence area. The average water level of the khals during monsoon varies from 3m to 4.5m and width of the khals varies between 20m to 35m. According to local informants many of these khals become disconnected at places in the dry season. The river and khal network is shown in **Figure 5.9** and names given in **Table 5.5.**

Table 5.5: Khals of the Project Influence Area

District	Upazila	Name of Canal/Khal
Sirajganj	Sadar	WAPDA Khal, Bahuka khal, Baliaghugri khal, Doi Vanger khal
	Kazipur	Halot khal, Meghai khal
Bogra	Dhunat	Shimulbari khal, Madhob Danga
	Sariakandi	Kata khal, Kuripara canal, Shalukar canal, Char bati canal
Gaibandha	Fulchari	Gopaldoba
	Sadar	Kamarjani khal, Dara/Canal
Kurigram	Chilmari	Gidari canal, Anantapur canal
	Sadar	Girainodi/Khal

This data on surface water bodies will be updated to reflect more current data at the time of carrying out of each additional phase specific EIA. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

5.3.6.2. Jamuna Tributaries

River flow data for major tributaries of Jamuna in the project influence area such as Teesta, Bengali at Khanpur and Hurasagar at Baghabari has been collected from Bangladesh Water Development Board and analyzed to describe the baseline situation.

Teesta River

The average maximum discharge of Teesta has not changed over time with the highest recorded peak reaching 8,710m³/s in 1987, while the dry season flow has drastically reduced as result of barrage operations. Two barrages regulate the dry season flow, one since 1985 in India and another since 1990 in Bangladesh and result in increasing sediment load due to the extraction of water for irrigation purposes. The river reacts somewhat flashy to high local rainfalls during the monsoon season. Data given in **Figures 5.10** and **5.11** shows that the maximum monthly average discharge of the Teesta for 1973-1985 was 2,459 m^3/s and for 2000-2009 maximum average discharge was 1,499 m^3/s. The reduced discharge can be attributed to barrages on the Teesta at Gojoldoba in West Bengal, India and at Dalia in Bangladesh. The maximum average water level is 28.6m PWD.

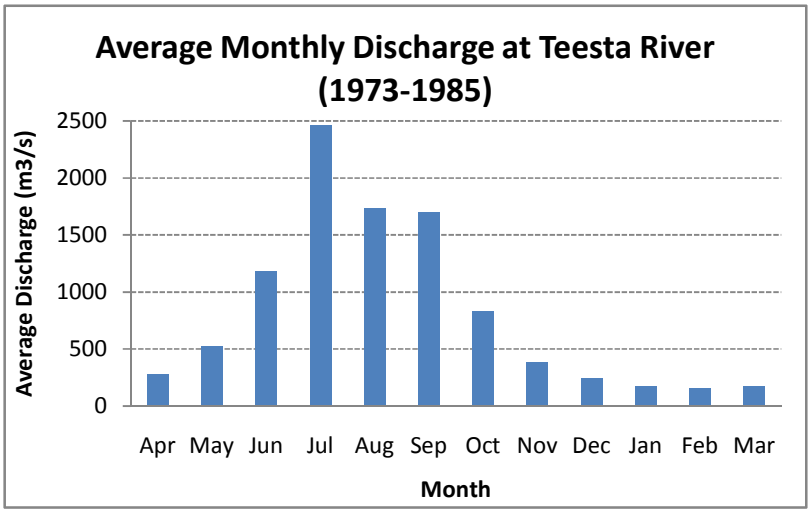


Figure 5.10: Average Monthly Discharge of the Teesta River (*Source: BWDB)*

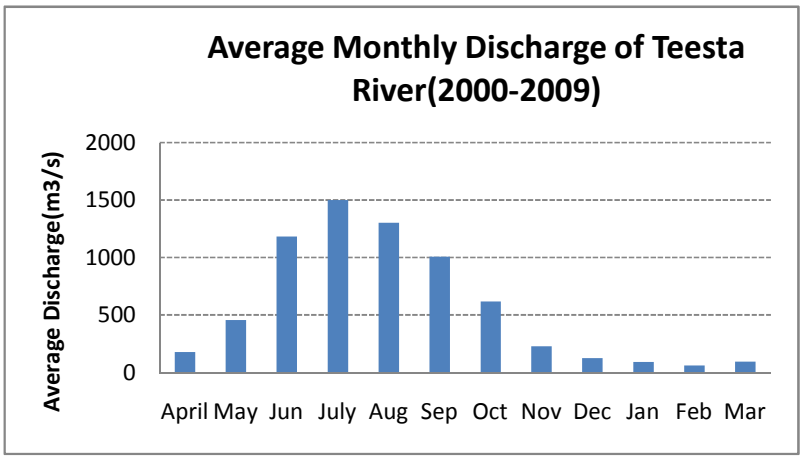


Figure 5.11: Average Monthly Discharge of the Teesta River (*Source: BWDB)*

Bangali River

Discharge data at Khanpur station for the period 1985-2007 show that the maximum monthly average discharge of the Bengali river is 350 m^3/s and the river peaks in July. In the dry season especially in the beginning of April the flow reduces drastically. The maximum monthly average water level is 12m (PWD). **Figure 5.12** shows the average discharge of the Bengali River.

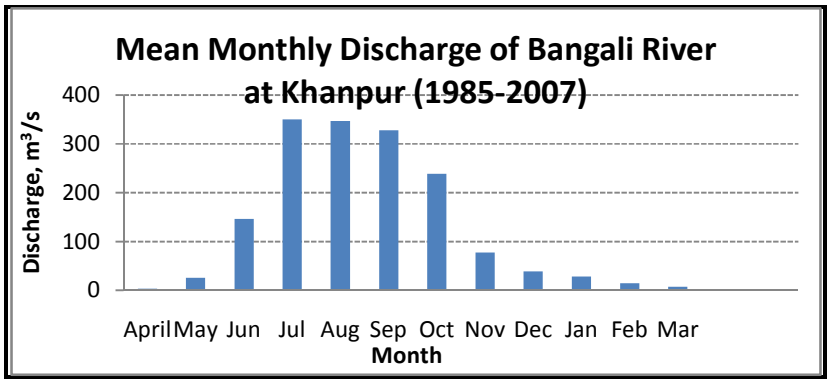


Figure 5.12: Average Monthly Discharge of the Bengali River (*Source: BWDB)*

Hurasagar River

Discharge data at Baghabari station for the period 2000-2006 show that the maximum monthly average discharge of the Hurasagar river is 284.4 m^3/s and the river peaks in September. In the dry season especially in the beginning of April the flow reduces drastically. The maximum monthly average water level is 6.3m (PWD). **Figure 5.13** shows the average discharge of the Hurasagar River.

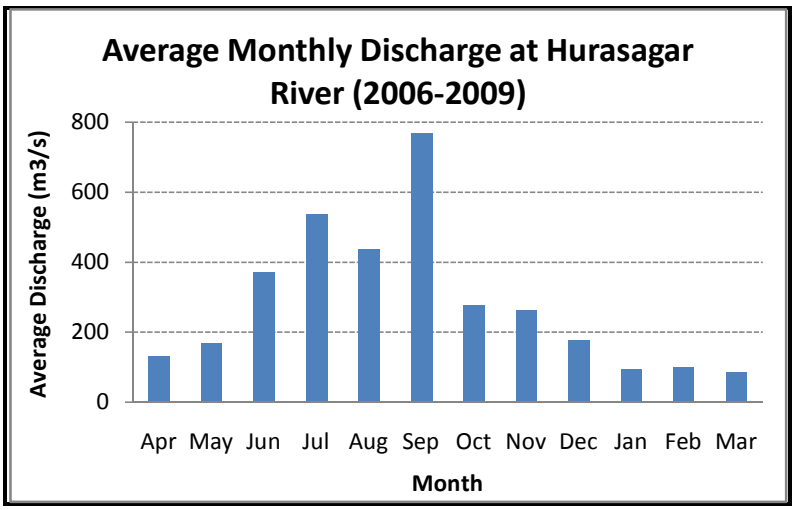


Figure 5.13: Average Monthly Discharge of the Hurasagar River *Source: (BWDB)*

5.3.6.3. Floods

Each year in Bangladesh about 26,000 sq. km, that is around 18 percent of the country is flooded (Nandan, 2014) In fact, the Bengali language distinguishes between the normal floods of the rainy season, which are locally known as barsha, and the more harmful floods of abnormal depth and timing, which are termed bonna (Nishat et al, 2011). During severe floods, the affected area may exceed to 55 percent of the total area of the country. In the event of catastrophic floods, it has been anticipated that about two-thirds of the country can get affected (Ahmad et al., 2000).

The hydrology and inundation cycles of almost 40 percent of the flood plains in Bangladesh are influenced by the Jamuna. As a result, the major floods that have occurred over the years can be linked to high water levels in the river. **Table 5.6** gives a picture of the extreme flood events that have occurred in recent years and **Table 5.7** extent of flooding of some years for the Jamuna.

Table 5.6: Some Notable Flood Disasters of Bangladesh

Event	Impact
1954 Floods	Affected 55% of the country.
1974 Floods	Moderately severe, over 2000 deaths, affected 58% of country, followed by famine with over 30000 deaths.
1984 Floods	Inundated 52520 km^2, damage estimated at US$ 378 million.
1987 Floods	Inundated over 50000 km^2**,** estimated damage US$ 1.0 billion, 2055 deaths.
1988 Floods	Inundated 61% of country, estimated damage US$ 1.2 billion, more than 45 million homeless, between 2000-6500 deaths.

Event	Impact
1998 Floods	1100 deaths inundated nearly 100000 km^2, rendered 30 million people homeless, damaged 500000 homes, heavy loss to infrastructure, estimated damage US$ 2.8 billion.
2004 Floods	Inundation 38%, damage US$ 6.6 billion, deaths 700, affected people 3.8 million.

(Source: Hossain, 2006)

Table 5.7: Comparison of Major Flood Impacts in the Jamuna

Year	Flood Duration (Days)	Flooded Area(km^2)	Flood Level (m)
1988	27	89,970	-
1998	66	100,250	20.37 m
2004 (up to 31 July, 2004)	16	56,000	20.18m

The 1998 flood has the highest published discharge (103,129 m^3/s) on the Jamuna River, at Bahadurabad, followed by the flood in 1988 (98,300 m^3/s). However, the 1998 peak water level at Bahadurabad was lower than in 1988. Both floods have shown extensive inundation of the region. For the Bangali river, the highest discharge (915 m^3/s) and water level (14.66m PWD) were also measured in 1998. The highest water level in the Hurasagar river is recorded at 12.55m PWD in 2012. The highest water level of the Jamuna river at Sirajganj corresponding to 100 year flood is 15.5 mPWD based on historic flow. However, flood damage is mostly related to the accidental breaches that occur in the flood embankments along the Jamuna, rather than the severity of the flood event. Since, flood embankments (BRE) along the Jamuna has been designed to protect the project influence area from normal as well as extreme floods, flooding in the flood protected areas is primarily due to breaches in the embankments along the Jamuna which dominates the inundation cycle of the area. The Bengali-Ichamati-Hurasagar rivers are meandering rivers and have very limited capacity to drain out the flood discharge during the times of peak flows. Again, the water levels of the Jamuna are much higher than the internal rivers. Combination of both these factors causes flooding and drainage congestion in the Bengali-Atrai-Hurasagar rivers, especially the lower reaches. Even in dry years, large areas of land are inundated from rainfall and river flooding.

This data will be updated to reflect more current data regarding floods at the time of carrying out of each additional phase specific EIA. Additions will be noted and any trends (for example, apparent increase or decrease in frequency of major flood events, highest discharge / maximum flood level, changes to the cause, extent and pattern of impact/damage, etc) shall be discussed/analyzed for relevance to the project.

5.3.7. Navigation in River and Khals

The Jamuna river is categorized as Class II[14] by Bangladesh Inland Water Authority (BIWTA, 1991), which means the river remains navigable throughout the whole year and

[14]The navigable waterways are assigned to four Classes that define the level of service to be guaranteed taking into account the economic importance of the river as well as the technical and financial capacity to maintain the level of service.

links major inland ports or places of economic importance to Class-I routes. **Figure 5.14** shows the available average draft in the Jamuna is 1.75m across the river and recent surveys show the minimum available water depth in the river from Sirajganj to Bahadurabad is 1m to 1.3m and from Bahadurabad to Chilmari is a 1.2m to 2.2m (Mishra and Hussain, 2012).

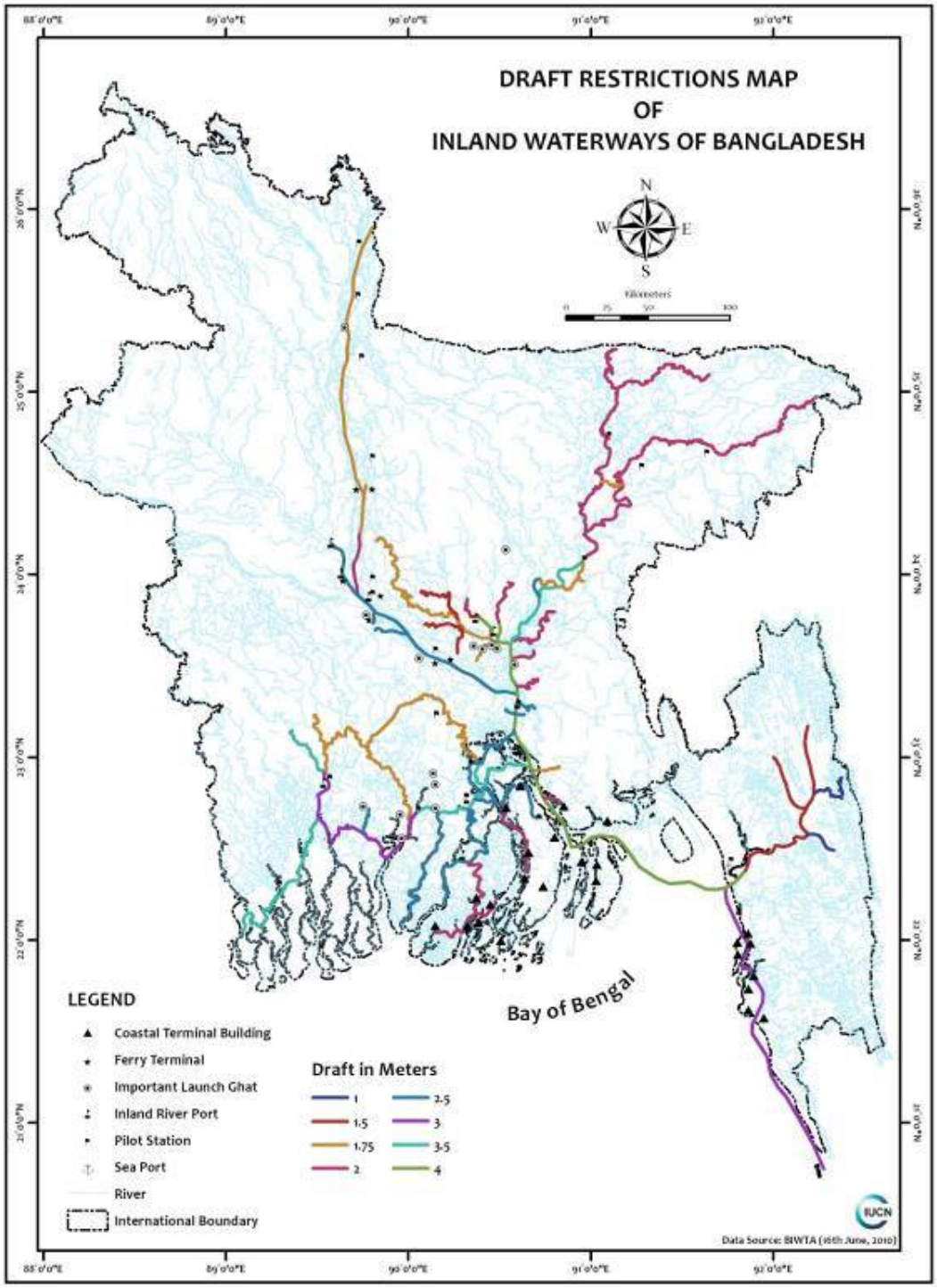


Figure 5.14: Draft Restriction of Inland Waterways of Bangladesh

The Jamuna river is also a part of the India-Bangladesh protocol route and the route is used by cargo vessels to carry goods to Pandu in India. At the local level, people from charlands use the river to access the mainland mainly for earning livelihood, education and healthcare purposes. Smaller mechanized boats are used mainly for carrying people and goods and also for fishing activities.

Bengali and Ichamoti are comparatively small rivers hence navigation activities are less than that of the Jamuna river. The internal lakes/khals like Banaijan khal, Baoikhola khal, Shimulbari khal, kata khal, and Wapda khal of the project influence area are suitable for the movement of mostly small non-motorized boats only. The depth is around 3m to 3.2m in monsoon drying up to less than 1m and becoming un-navigable in dry season.

The data on inland navigation will be updated while conducting EIA of each additional phase.

5.3.8. Erosion and Sediment Loading

The banks and the charlands of the Jamuna river are highly susceptible to erosion and erosion processes are complex, with the magnitude and rate of erosion varying temporally and spatially.

Studies show erosion along the right and left bank have caused the river to widen at most places (Sarker, 2009). This is due to the Great Assam Earthquake in 1950. In Assam, India it widened along its 650km length from an average 6 to 9km and along its 250km in Bangladesh from 8 to 12km. The associated riverbank erosion is on average around 2 km at each bank. In other rivers, for examples in the Teesta, since the early 2000s very low overall erosion rates are recorded.

Long-term pattern of bank erosion along the entire Jamuna River over the period 1973 to 2012 show that the greatest erosion on the right bank of the river has occurred between approximately Sirajganj and Mathurapara. This corresponds to the RBIP's priority reach for rehabilitation and upgrading of the BRE. The annual erosion rate increases with the annual maximum flood discharge (CEGIS, 2009), although the rate of erosion along the left bank is more sensitive to the annual maximum discharge than along the right bank due to morphological characteristics of the river. **Figure 5.15** shows the pattern of bank erosion and channel width changes using digitized banklines compiled from satellite imagery. The digitized data sets extend over a distance of 85 km upstream of Jamuna Bridge and show bank positions at 500 m intervals along both the left and right banks of the river.

Sedimentation is also a problem in the project influence area. The Brahmaputra-Jamuna system is one of the most heavily sediment-laden large rivers of the world and a large part of this sediment is deposited in the flood plains. A part of this sediment is fine sand which is heavier than clay and silt and is deposited on the river bank as the flood waters recede, renders the land uncultivable. On the other hand, fertility of cropland will increase when nutrient rich silt and clay particles from river water are deposited on flood plains. The khal system is also choked with very fine sediments, especially when there is not enough discharge to remove the deposits and causes the bed level to rise and reduces their conveyance capacity

From Assam (India), the Brahmaputra carries a huge load of sediment acquired from the rain-soaked Himalayan tributaries. In fact, with a suspended sediment load of 13 million tonnes per day during the flood season, the river is considered to be one of the most heavily sediment-laden large rivers of the world (Nishat, 2014).The typical bed material

of the Jamuna River is fine sand. Most of the bed material transport occurs in suspension mode. Analysis of bed material load as measured by the BWDB from 1966 to 1989 showed that the sediment load in the Jamuna River had reduced more substantially during the 1980s than in the late 1960s (Delft Hydraulic and DHI, 1996c. Sarker and Thorne (2006) related the change in bed material load in the Jamuna River to the propagation of sediment wave through the Brahmaputra-Jamuna-Padma-Lower Meghna River system due to the huge landslides in the Himalayas caused by the Great Assam Earthquake of 1950.

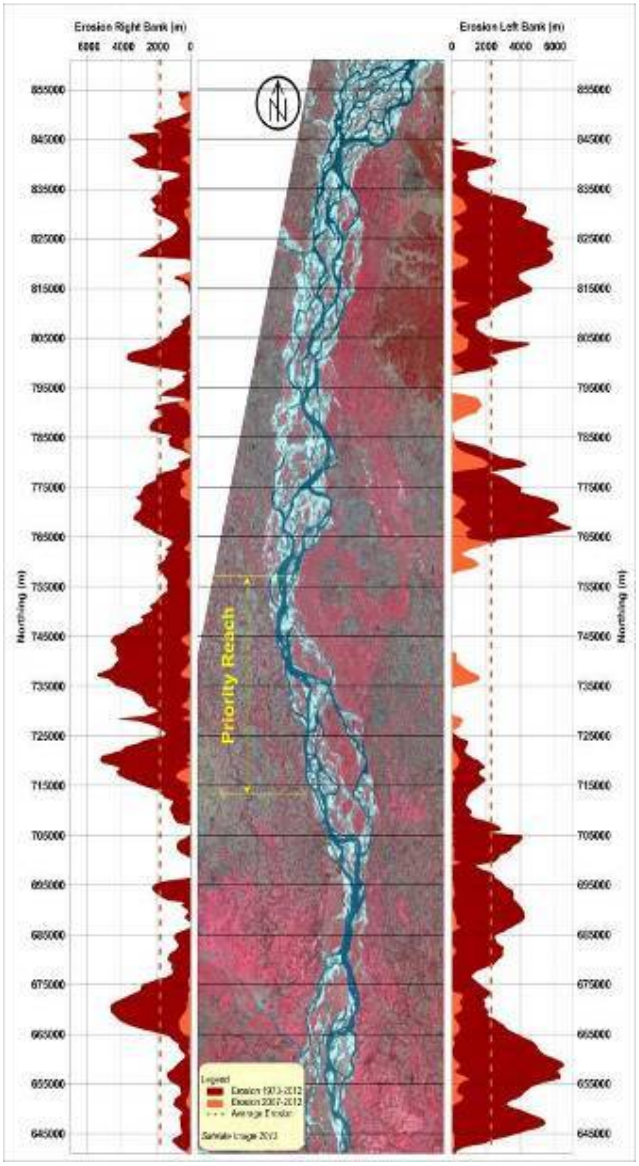


Figure 5.15: Pattern of bank erosion on Jamuna River, 1973 to 2013 (Source: Fichtner, 2014)

5.3.9. Geology and Hydrogeology

5.3.9.1. Soils

The soils in this region are usually grey silt loams and silty clay loams on ridges and grey or dark grey clays in basins. Sample collections from project area show that in Sirajganj,

along the bank soil consists of alluvial deposit of non-cohesive materials of loose to medium dense silty fine sand mixed with trace amount of mica up to the depth of 20.0 m from the existing ground level. In Bogra and Gaibandha up to Teesta river the upper deposits consist of loose to medium dense non-cohesive materials of fine sand mixed with varying amount of silt and mica. The soils in the bore holes collected from embankment and road consists of non-cohesive and cohesive deposits of fine sand and clayey silt mixed with trace amount of mica. The drainage qualities of the soils at upper region are low to medium in non-cohesive materials and very poor to poor in cohesive deposits.

5.3.9.2. Geology

The project study area is situated in the Brahmaputra-Jamuna basin, that is why the geology is dominated by quaternary sediments deposited by the Ganges-Padma and Brahmaputra-Jamuna-Teesta and their numerous tributaries and distributaries. The area is underlain by Tertiary and Quaternary sediments and recent alluvial deposits originating in the foothills of the Himalaya. The stratification of the sediments is generally composed of non-cohesive materials of sand and silt with patched of cohesive deposit of clay.

Bangladesh is situated in a seismically active region of the world. The seismic zoning map of Bangladesh proposed by Geological Survey of Bangladesh (GSB) and incorporated in the Bangladesh National Building Code the project area lies within Zone I which corresponds to high risk to earthquakes (BNBC, 2006).

5.3.9.3. Groundwater

The groundwater level varies across the year. Data for Bogra station shows that during October the groundwater level is at its highest at 3.8 m below existing ground level and lowest in April at 7m below existing ground level. However, water levels at Sirajganj and Gaibandha are slightly higher with highest water levels at 1.67 and 1.2 respectively. **Figure 5.16** compares the groundwater levels for Bogra, Sirajganj and Gaibandha stations.

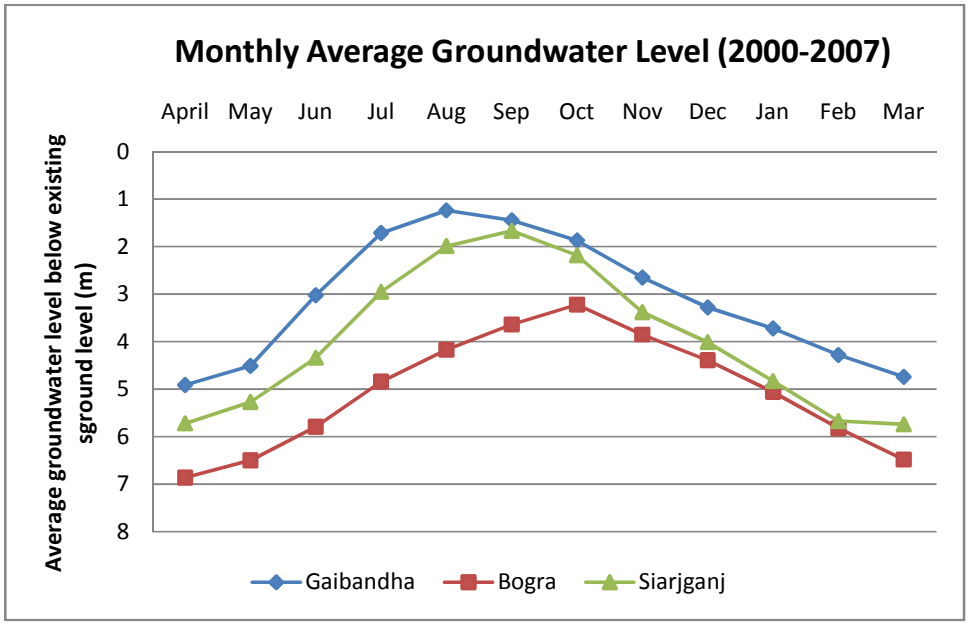


Figure 5.16: Monthly Average Groundwater Level at Gaibandha, Bogra and Sirajganj (Source: BWDB)

This data will be updated to reflect more current groundwater data at the time of carrying out of each additional phase specific EIA. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.

5.3.10. Landuse and Land Cover Analysis

Land use maps were generated based on analysis of satellite images of April, 2014 and verified through field investigation during September 2014. Details of present land use / land cover of the area are illustrated in **Table 5.8** and **Figure 5.17**. *This data will be updated under each additional phase specific EIA, with a view to the overall trends in land use as well as the specific land uses within the phase-specific reach. Any changes observed from this initial view will be noted and the trends shall be discussed/analyzed for relevance to the project.*

Table 5.8: Types of Land Use in Project Influence Area

Type of Land Use	Area in ha
Agricultural land	187,457
Settlement	167,948
Homestead forestry, bushes, bamboo plantations	47,,948
Charland/ sand	55,806
Total	**412,206**

The distribution of land types for agriculture is shown in **Table 5.9**. This land type classification is based on depth of inundation during monsoon season due to normal flooding on agriculture land. There are five land types: High Land (HL, flooding: depth 0-30 cm); Medium Highland (MHL, flooding depth: 30-90 cm); Medium Lowland (MLL, flooding depth: 90-180 cm); Low Land (LL, flooding depth: 180-360 cm); and Very Lowland (VLL, flooding depth: above 360 cm) (MPO, 1986). This data will be updated while conducting EIA of each additional phase of the RBIP.

Table 5.9: Land Types in Project Influence Area

Location	Cultivable land (%)	Land type by flood water level (area in %)					Total
		High land	Medium High land	Medium Low land	Low land	Water body	
Sirajganj	67	28	41	25	3	3	100
Bogra	70	25	51	16	6	3	100
Gaibandha	74	31	34	25	9	2	100
Kurigram	69	20	38	29	11	2	100
All	70	26	41	24	7	2	100

Source: Upazila Agricultural Officer, DAE

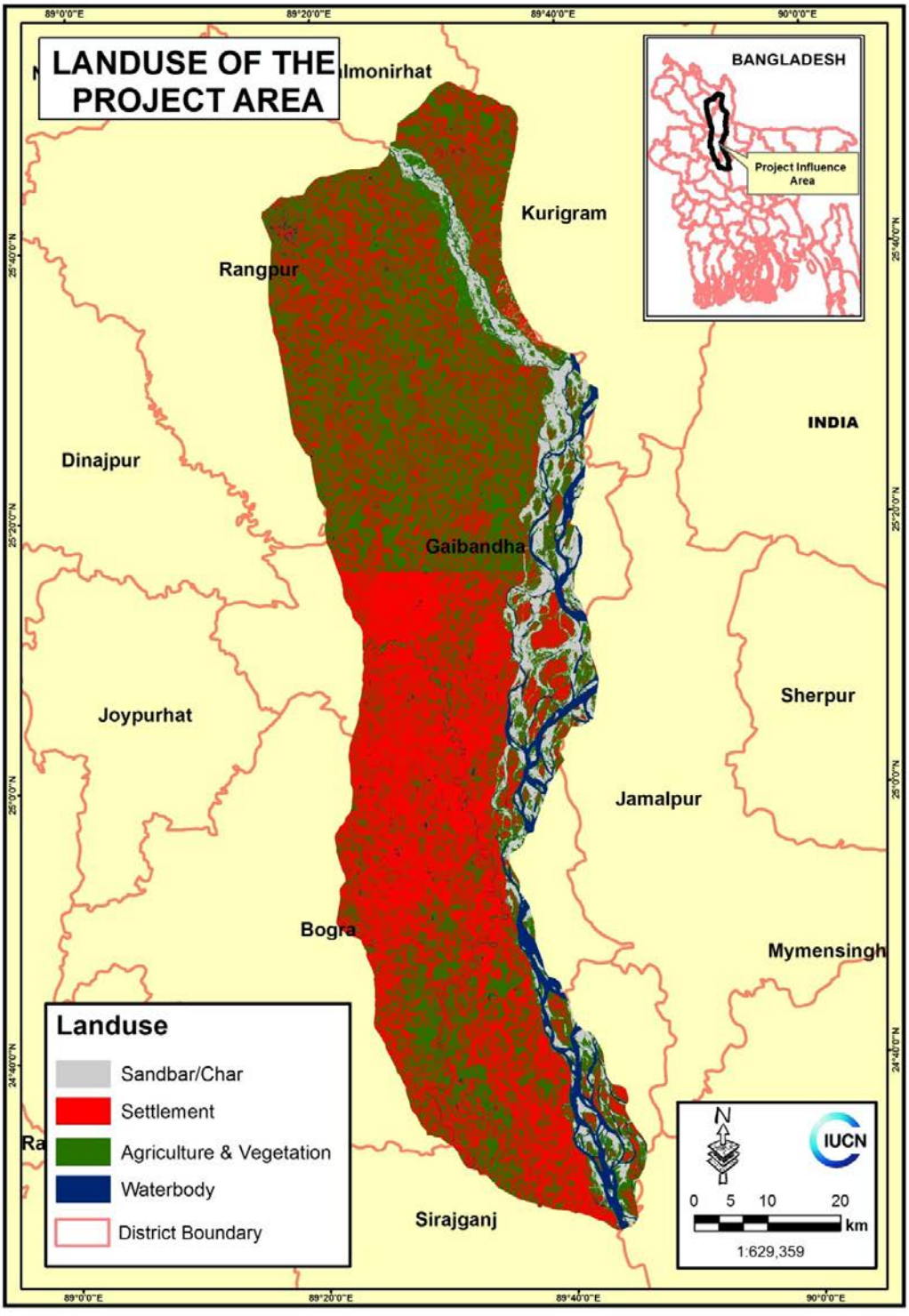


Figure 5.17: Land Use in the Project Influence Area

5.3.11. Quality of Environment

In order to understand the quality environment primary and secondary data and information has been used. The primary investigation includes assessment of air quality and noise; and sampling of surface water, groundwater and soil which were later tested in laboratories for certain parameters. Primary data for these parameters will be included in the EIA reports of the priority reach as well as the subsequent phases of the RBIP.

5.3.11.1. Ambient Air Quality in the Project Influence Area

Air quality of an area impacts human health, especially sensitive populations such as children, the elderly, and individuals suffering from respiratory diseases. There are no major industries in the project influence area. Taking this into account, the key air quality parameters (suspended particulate matter -SPM, oxides of sulfur - SOx, and oxides of nitrogen - NOx) were analyzed from samples collected over an 8 hour period at each sampling site. Test results (**Table 5.10**) show the parameters are within the standard values set by Ministry of Environment and Forests for five of the locations. However, SPM measured at Jumarbari, Saghata, Gaibandha and Sariakandi Hard Point, Bogra exceeds the national standards and WBG EHS standards (**Tables 5.11** and **5.12**).

Table 5.10: Ambient Air Quality Parameters in Project Influence Area

Sampling Location*	Classification of the Area	Suspended Particulate Matter (µg/m^3)	Sulfur Dioxide (µg/m^3)	Nitrogen Oxides (µg/m^3)
Jumarbari, Saghata, Gaibandha	Commercial and mixed	811	Not detected	8.39
Bharatkhali, Saghata, Gaibandha	Residential and rural	260	Not detected	6.54
Baoitara, Saidabad, Sirajganj	Commercial and mixed	593	Not detected	11.90
Ratankandi, Ratankandi, Sirajganj	Commercial and mixed	298	Not detected	7.14
Singrabari, Kazipur, Sirajganj	Residential and rural	261	Not detected	6.35
Sariakandi Hard Point, Sariakandi, Bogra	Commercial and mixed	1,188	Not detected	10.56
Anantapur, Ulipur, Kurigram	Commercial and mixed	375	Not detected	7.56

Source: IUCN Field survey, 4-10 November 2014

Table 5.11: Bangladesh Standards for Ambient Air Quality

Category	Area	Suspended Particulate Matter	Sulfur Dioxide	Nitrogen Oxides
		($\mu g/m^3$)		
Ka	Industrial and mixed	500	120	100
Kha	Commercial and mixed	400	100	100
Ga	Residential and rural	200	80	80
Gha	Sensitive	100	30	30

Note: The averaging period is counted as per 8-hour

Source: Schedule-2, Rule 12, Environment Conservation Rules of 1997 (Page 3123, Bangladesh Gazette, 28 August 1997. Translated from Bengali.

Notes:

1. Sensitive area includes national monuments, health resorts, hospitals, archaeological sites, educational institutions
2. Any industrial unit located not at a designated industrial area will not discharge such pollutants, which may contribute to exceed the ambient air quality above in the surrounding areas of category 'Ga' and 'Gha'.
3. Suspended particulate matters mean airborne particles of diameter of 10 micron or less.

Table 5.12: Ambient Air Quality (WBG EHS Standards)

Averaging period	Suspended Particulate Matter	Sulfur Dioxide	Nitrogen Oxides
	($\mu g/m^3$)		
24 hrs	50	500	200

Source: World Bank Group Environmental, Health, and Safety (EHS) Guidelines

Sources of Air Pollution

The main sources of pollution in Jumarbari (market place), Saghata, Gaibandha and Sariakandi, Bogra include the local vehicles especially trucks, *karimons* and *nasimons* (locally manufactured small three-wheelers). In Jhumerbari, the location of air quality measurement is near union parishad which is situated in Bazar. Surrounding area is an overcrowded place extensive dust emission. The measurement was done in the evening when the market started and people began to gather.

In Sariakandi Hard Point, the measurement was taken at the stopping point of *nasimons*; in addition, various types of motor boats and launches were also sailing in the river – causing air quality deterioration.

5.3.11.2. Ambient Noise Levels in Project Influence Area

Vehicular traffic on road is the key source of noise in the study area. Measurements were taken in seven locations and are shown in **Table 5.13**. The measured noise values are within the prevailing standards set by DoE and WB (**Tables 5.14** and **5.15**).

Table 5.13: Noise Levels in Project Influence Area

Sampling Location	Category of the area	Date	Noise(dBA) (Day)	Noise(dBA) (Night)
Jumarbari, Saghata, Gaibandha	Commercial and mixed	04/11/14	34-36	30-32
Bharatkhali, Saghata, Gaibandha	Residential and rural	04/11/14	34-38	31-33
Baoitara, Saidabad, Sirajganj	Commercial and mixed	07/11/14	36-38	32-34
Ratankandi, Ratankandi, Sirajganj	Commercial and mixed	07/11/14	34-36	30-32
Singrabari, Kazipur, Sirajganj	Residential and rural	08/11/14	36-38	31-34
Sariakandi HP, Sariakandi, Bogra	Commercial and mixed	09/11/14	46-51	46-48
Anantapur, Ulipur, Kurigram	Commercial and mixed	10/11/14	34-37	30-33

Source: IUCN Field survey, 4-10 November 2014

Table 5.14: Noise Quality Standards of Bangladesh

	Area Category	Standard Values (dBA)	
		Day	Night
Ka	Silent Zone	45	35
Kha	Residential area	50	40
Ga	Mixed area (basically residential and together used for commercial and industrial purposes)	60	50
Gha	Commercial area	70	60
Umma	Industrial area	75	70

Source: Schedule 4, Rule-12, Environment Conservation Rules, 1997 (Page 3127, Bangladesh Gazette, 28 August 1997, trans. from original Bengali).

Notes:

1. Daytime is considered as the time between 6 am to 9 pm.
2. Nighttime is considered as the time between 9 pm to 6 am.
3. Silent zones are areas up to a radius of 100 m around hospitals, educational institutes, and Government-declared special establishments. Use of vehicular horns, other signals, and loudspeakers are prohibited in silent zones.

Table 5.15: World Bank Group EHS Standards for Noise

Area Category	Standard Values (dBA)	
	Day (07:00-22:00)	Night (22:00-07:00)
Residential, institutional, educational area	55	45
Commercial and industrial area	70	70

Source: World Bank Group Environmental, Health, and Safety (EHS) Guidelines

5.3.11.3. Surface Water Quality

The surface water quality in the project influence area is influenced by the hydrological and water quality conditions of Jamuna river and upstream rivers such as Teesta, Karotoya, and Atrai. Data on water quality parameters were collected from primary and secondary sources and analyzed. Data for four surface water quality parameters was collected from BWDB stations at Bahadurabad for the Jamuna. The values of the parameters from BWDB and their standard values set by the DoE are shown in **Table 5.16** and **Table 5.17** respectively.

Table 5.16: Surface Water Quality of Rivers in Project Influence Area (2006)

Station Name	Season	pH	DO (mg/l)	TDS (mg/l)	EC (µS/cm)
Teesta River					
Teesta Bridge	Wet Season	7.2	7.6	54	87
	Dry Season	7.0	6.0	50	75
Brahmaputra River					
Near Jamalpur	Wet Season	6.85	6.2		90
	Dry Season	7.1	5.0		110
Jamuna River					
Nandina	Wet Season	7.1	4.0		108
	Dry Season	7.7	3.5		150
Jamuna Bridge	Wet Season	7.7	6.2	48	87
	Dry Season	8.7	7.1	85	75
Jamuna Fertilizer	Wet Season	6.5	6,8		123
	Dry Season	7.12	5.5		256

Source: Bangladesh Water Development Board

Table 5.17: Bangladesh Water Quality Standards

	Best Practice based Classification	Parameters			
		pH	BOD (mg/l)	DO (mg/l)	Total coliform (number /100)
1	Source of drinking water for supply only after disinfecting	6.5–8.5	2 or less	6 or above	50 or less
2	Water usable for recreational activity	6.5 – 8.5	3 or less	5 or more	200 or less
3	Source of drinking water for supply after conventional treatment	6.5 – 8.5	6 or less	6 or more	5000 or less
4	Water usable by fisheries	6.5 – 8.5	6 or less	5 or more	-
5	Water usable by various process and cooling industries	6.5 – 8.5	10 or less	5 or more	5000 or less
6	Water usable for irrigation	6.5 – 8.5	10 or less	5 or more	1000 or less

Source: Environmental Conservation Rule (ECR)'97

Notes:

1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.
2. Electrical conductivity for irrigation water – 2250 □mhos/cm (at a temperature of 25 °C); Sodium less than 26 percent; boron less than 0.2 percent.

Table 5.18 presents the water quality measured during field investigations at selected locations of the project influence area. Surface water and ground water quality is represented by some selected parameters, which are crucial for drinking purpose, agricultural activities, industries and to maintain optimum aquatic environment. The standard values of these indicators set by the Department of Environment, Bangladesh are also shown for comparison purposes.

Table 5.18: Water Quality in Project Influence Area

Sample Location	Water Quality Parameters					
	Temperature (°C)	TDS (ppm)	EC (µS/cm)	BOD_5 (mg/l)	DO (mg/l)	pH
Banaijan Khal, Kuralia, Ratankandi, Sadar, Sirajganj	27.4	262	526	12.6	4.27	7.25
Ichamoti river, Baliaghugri, Changacha, Sadar, Sirajganj	27.6	250	416	22.4	2.2	7.33

Sample Location		Water Quality Parameters					
		Temperature (°C)	TDS (ppm)	EC (µS/cm)	BOD_5 (mg/l)	DO (mg/l)	pH
Deulibeel, Antarpara, Sariakandi Union, Sariakandi, Bogra		27.4	135	262	15.9	2.95	7.3
Bangali River, Pardevdanga, Kutubpur, Sariakandi, Bogra		27.5	62	105	4.25	6.25	7.32
Ghagot River, Pochakhuria, Gidari, Sadar, Gaibandha)		27.7	87.2	133	12.0	3.85	7.18
Standard Value (Bangladesh)	Irrigation	20-30	-	-	10 or less	5.0	7.0-8.5
	Fishing	20-30	-	-	6 or less	4.0-6.0	6.7-9.5

Source: IUCN field survey, 12 October 2014, period of analysis: 19/10/2013 to 03/11/2014 by Bangladesh *Council of* Scientific *& Industrial Research (BCSIR).*

Water Temperature

The temperature of water bodies affects fish habitats and their oxygen holding capacity. The mean temperature of the water bodies in the project influence area ranges from 27.4 to 27.7°C (**Table 5.18**) in October. This value lies within the DoE standards for both irrigation and fish habitats.

Taste and Odor

The taste and odor of water bodies have been found to be agreeable and unobjectionable.

pH

The hydrogen ion concentration of water is expressed by its pH value. A pH value of 7 indicates a neutral solution, neither alkaline nor acidic. In most of the water bodies of the area, the pH range is found well within the DoE standards.

Dissolved Oxygen (DO)

Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. Decrease in DO values below the critical level of 3 mg/l causes death of most fishes and other aerobic aquatic organisms. DO is relatively lower in the dry season than in the wet season. The values of DO of Bengali and Bangshi rivers in the project influence area (measured in the month of October) was within 4-6 mg/l, which complies with the DoE standards for irrigation as well as for fisheries and aquatic life. However, DO for water samples from Ichamati river, Deuli Beel and Ghaghot river are below the standard. In Ichamati river and Deuli Beel, the water level during sampling was very low and many habitats within the vicinity account for the low DO levels. Gaibandha city is located on the banks of the Ghaghot river and untreated waste from this municipality is main reason for low DO levels.

Conductivity

Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Discharges to streams can change the conductivity depending on their make-up. A failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity. EC as a water quality indicator is useful for estimating the amount of minerals, assessing the effect of diverse ions on chemical equilibrium, physiological effects on plants or animals, and corrosion rates. It is an indirect measure of the TDS (TDS = 640 × EC), the effects of which have been discussed above. The values of EC inside the polder ranged between 0.105mS/cm and 0.526mS/cm. The low values of EC indicate that the water bodies inside the project influence area are fresh water.

BOD_5

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The term also refers to a chemical procedure for determining this amount. This is not a precise quantitative test, although it is widely used as an indication of the organic quality of water. The highest BOD_5 recorded in the samples is from Bangali river at 22mg/l and Deuli beel at 15.9mg/l and indicates moderate pollution. The rest of the samples are below 15mg/l.

Total Dissolved Solids (TDS)

Dissolved solids are also important to aquatic life by keeping cell density balanced. However water containing excessive dissolved solids adversely affects drinking water. Continuous use of such water may cause a general loss of condition, weakness, scouring, reduced production, bone degeneration and ultimately death. TDS may influence the toxicity of heavy metals and organic compounds for fish and other aquatic life. The natural range of TDS concentration in the water bodies of the project influence area are between 62 mg/l and 262 mg/l.

5.3.11.4. Groundwater Quality

The groundwater quality parameters, measured in the area during the month of September, were found to comply with the drinking water quality standards set by DOE. Tetrimetric method was used to measure the water quality parameters for ground water. The ground water quality of the area is presented in **Table 5.19**.

Table 5.19: Groundwater quality in the Project Influence Area

	Groundwater Quality Parameters				
	pH	Chloride (mg/l)	Iron (Fe) (mg/l)	Bicarbonate (mg/l)	TDS(mg/l)
Tube-well, 120 feet, Baliaghugri, Changacha, Sadar, Sirajganj	7.15	1.74	0.16	284	322
Tube-well, 50 feet, Pardevdanga, Kutubpur, Sariakandi, Bogra	7.15	2.34	2.76	297	289

Source: IUCN field survey, October 2014

According to local stakeholders, all drinking water tube-wells within the project influence area have been analyzed for arsenic by Department of Health Engineering (DPHE). However, none of the tube-wells have been marked 'red' which means traces of arsenic in groundwater have not been detected.

5.3.11.5. Soil Quality

Soil samples were collected from deep channels, shallow channels and banks of the Jamuna at seven different locations. The collected soil samples were analyzed for pH, moisture content, nitrogen, phosphorus, potassium and sulfur; the analysis results are given in **Table 5.20.**

Table 5.20: Analysis of Soil Samples collected from Project Influence Area

Sample ID	pH	Moisture Content	Texture	Total Nitrogen (ppm)	Total Phosphorus (ppm)	Total Potassium (ppm)	Total Sulfur (ppm)
Antarpara (Country Side)	7.29	31.17 %	Silty Clay Loam	710	710	4270	5720
Antarpara (Embankment)	7.44	7.08 %	Silt Loam	890	730	3960	3540
Antarpara (Right Bank, River Side)	7.30	28.22 %	Silt Loam	1050	640	5440	4540
Antarpara (Deep channel of Jamuna)	7.77	22.15 %	Fine Sand	380	660	1890	1650
Antarpara (Left Bank, Char)	7.32	24.50 %	Silt Loam	830	670	5000	4280
Baliaghuri (Country Side)	7.39	20.92 %	Silt Loam	1190	750	4720	5450
Baliaghuri (Embankment)	7.40	10.69 %	Silt Loam	890	740	3510	3760
Baliaghuri (Right Bank, River Side)	7.48	20.26 %	Silt Loam	820	760	4400	4930
Baliaghuri (Deep channel of Jamuna)	7.62	20.15 %	Fine Sand	490	450	1160	1460
Baliaghuri (Left Bank, Char)	7.42	22.27 %	Loamy Fine Sand	440	600	3350	2740
Pukuria (Country Side)	7.32	25.23 %	Loam	650	620	4540	4410
Pukuria (Embankment)	7.43	20.36 %	Loam	940	580	4670	3890
Pukuria (Right	7.15	28.22 %	Sandy	690	570	4980	5670

Sample ID	pH	Moisture Content	Texture	Total Nitrogen (ppm)	Total Phosphorus (ppm)	Total Potassium (ppm)	Total Sulfur (ppm)
Bank, River Side)			Clay Loam				
Pukuria (Deep channel of Jamuna)	7.96	21.50 %	Fine Sand	790	450	1310	1500
Pukuria Left Bank, Char)	7.39	17.84 %	Silt Loam	710	710	4270	5720

Methodology / Instruments:

01	pH = pH meter	05	Sulfur = Turbidimetric method
02	Moisture Content = Moisture Analyzer	06	Total Potassium = Flame Photometer
03	Texture = Hydrometer method	07	Phosphorus = Vanadomolybdophosphoric yellow color method in nitric acid system
04	Total Nitrogen = Kjeldahl method		

The soil samples were also tested for pesticide residues (including dieldrin, endrin, DDT, and aldrin) by gas chromatography method and results came out negative indicating soil samples to be of adequate quality.

5.4. Biological Environment

This section describes the existing biological environment of the project influence area. This description has been prepared with the help of secondary literature review and field data collection carried out during the EIA study of the Phase I of RBIP. *This description will be updated, expanded, and verified as appropriate while conducting the EIAs of the subsequent phases.*

5.4.1. Overview: State of Biodiversity

Bangladesh has a rich biological heritage, because of its location in the subtropical belt, at the confluence of two biotic realms, namely 'Indo-Himalayas' and 'Indo-China'. The distributional ranges of many species typical to each of these two biotic realms have overlapped in Bangladesh. This makes the country's biodiversity exceptionally rich (**Table 5.21**).

Table 5.21: Biodiversity in Bangladesh and in Project Influence Area

Taxon	Species in Bangladesh (Number)	Species in Project Influence Area	
		(Number)	% of the Country's Total
Fauna	**1051**	**331**	**31.5**

Taxon	Species in Bangladesh (Number)	Species in Project Influence Area	
		(Number)	% of the Country's Total
Mammals	128	25	20
Birds	706	255	36
Reptiles	168	36	21
Amphibians	49	15	31
Flora	**7095**	**67**	**0.944**
Algae	3,600		
Bryophytes	290		
Pteridophytes	200		
Gymnosperms	5	2	40
Angiosperms	3,000	512*	17

Source: IUCN-Bangladesh 2000, Consultant Ecological Survey, Khan 2014, Hassan 2003.

In the past, several surveys were conducted to know the biodiversity status of Bangladesh, but there was no such attempt in the project influence area despite the fact that the area is situated near the 'Himalayan Hotspot' which is one of the important biodiversity hotspots among the 35 biodiversity hotspots of the world (Conservation International 2014). Therefore, a detailed baseline survey is required, covering all the seasons and all the habitat types, so that the actual status of biodiversity in the project influence area is known.

The project influence area falls within two of the 12 Bio-ecological Zones of Bangladesh, as designated by IUCN in 2002 (Nishat*et al.* 2002). These are 'Major Rivers' and 'Floodplain (Teesta)' (**Figure 5.18**). Therefore, the ecosystems and the species composition are relatively homogeneous across the project influence area (**Table 5.22**). The area, however, harbors some excellent habitats of the Ganges River Dolphin (*Platanista gangetica*) and wintering grounds of many migratory birds. The two newly-declared (declared in 2013) dolphin sanctuaries (Nagarbari-Mohanganj Wildlife Sanctuary - 408.11 ha, and Shilonda-Nagdemra Wildlife Sanctuary - 146.00 ha) in the downstream of the project influence area support the source population of the Ganges River Dolphin. These sanctuaries were declared under the Wildlife (Conservation and Security) Act, 2012. Since both are newly established, no management plan has yet been prepared and implemented, but the areas get the protection on the basis of the Clauses 13-16 of the Wildlife Act.

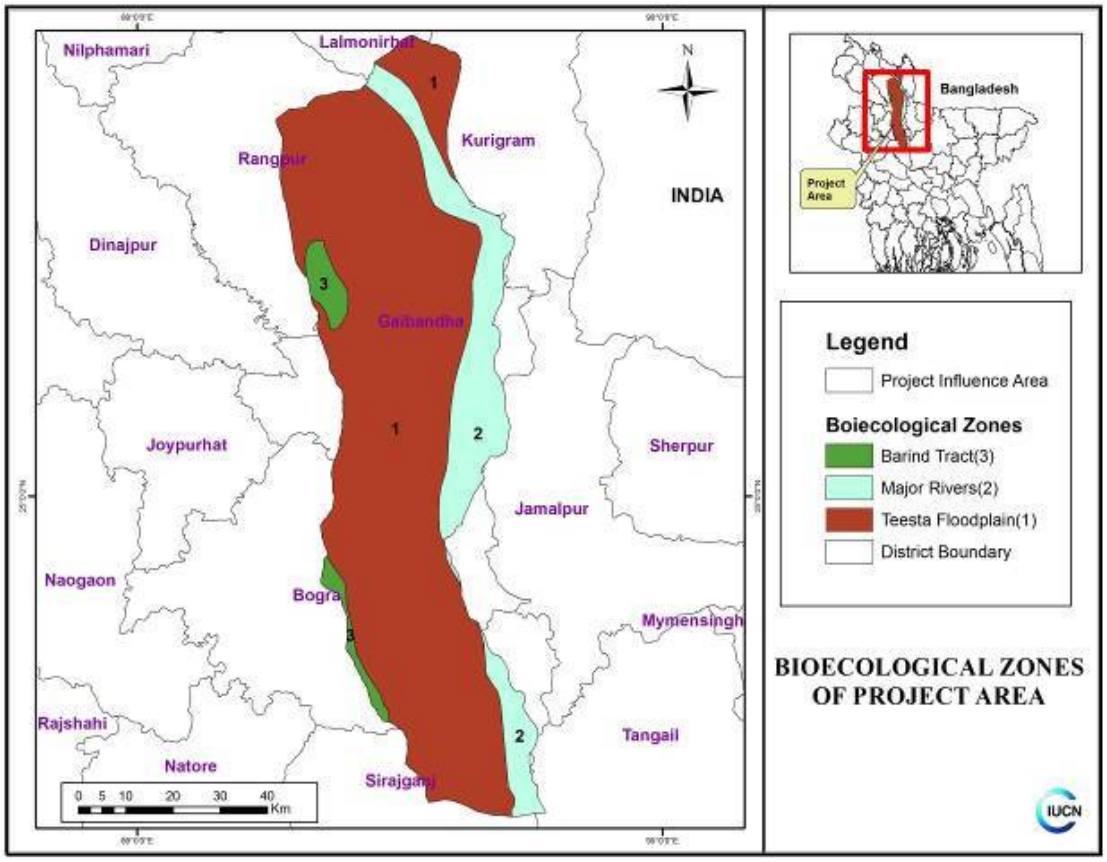


Figure 5.18: Bio-ecological Zones in the Project Influence Area

Table 5.22: Notable floral and faunal diversity of two Bio-ecological Zones ['Major Rivers' and 'Floodplain (Teesta)']

Bio-ecological Zone	Notable Flora	Notable Fauna
Major Rivers	Binna Ghash (*Vetiveria zizanioides*), Kansh (*Saccharum spontaneum*), Ghagra (*Xanthium indicum*), Ban Palang (*Rumex meritimus*)	Ganges River Dolphin (*Platanista gengetica*), Bengal Fox (*Vulpes bengalensis*), Greater Bandicoot Rat (*Bandicota indica*), River Lapwing (*Vanellus duvaucelii*), Black-bellied Tern (*Sterna acuticauda*), Sand Lark (*Calandrella raytal*), Spot-billed Duck (*Anas poecilorhyncha*), Small Pratincole (*Glareola lactea*), Cantor's Softshell Turtle (*Pelochelys cantorii*), Gharial (*Gavialis gangeticus*), Ganges Softshell Turtle (*Aspideretes gangeticus*), Median Roofed Turtle (*Kachuga tentoria*), Jerdon's Bull Frog (*Hoplobatrachus crassus*), Skipper Frog (*Euphlyctis cyanophlyctis*)
Floodplain	Aam (*Mangifera indica*), Kanthal (*Artocarpus heterophyllus*), Kalo	Five-striped Palm Squirrel (*Funambulus pennanti*), Jungle Cat (*Felis chaus*),

Bio-ecological Zone	Notable Flora	Notable Fauna
(Teesta)	Jam (*Syzygium cumini*), Litchu (*Litchi chinensis*), Bhant (*Clerodendrum viscosum*), Danda Kalash (*Leucus aspera*), Jiban (*Trema orientalis*), Pitali (*Trewia nudiflora*), Barun (*Crataeva nurvala*), Hijal (*Barringtonia acutangula*), Kachuripana (*Eichhornia crassipes*), ShadaShapla (*Nymphaea nouchali*), Panchuli (*Nymphoides indicum*), Singara (*Trapa bispinosa*), Bara Nukha (*Monochoria hastata*), Foxtail (*Rhynchostylis retusa*), Rasna (*Vanda roxburghii*)	Tomb Bat (*Taphozous saccolaimus*), Darter (*Anhinga melanogaster*), Brown Fish Owl (*Ketupa zeylonensis*), Black Francolin (*Francolinus francolinus*), Sand Lark (*Calandrella raytal*), Three-striped Roofed Turtle (*Kachuga dhongoka*), Brown Roofed Turtle (*Kachuga smithii*), Dark-bellied Marsh Snake (*Xenochrophis cerasogaster*), Slender Work Snake (*Typhlops porrectus*), Ornate Microhylid (*Microhyla ornata*), Red Microhylid (*Microhyla rubra*)

(Source: Nishat *et al.* 2002)

Ecosystem Diversity

Broadly the ecosystem in the project influence area can be divided into two groups: i) freshwater aquatic, and ii) terrestrial. The aquatic ecosystem is mostly rivers and other natural wetlands that can be further divided into lentic and lotic depending on the flow of water. The terrestrial ecosystem, on the other hand, includes both human-induced (villages and crop fields) and natural (riparian grasslands, reed-lands and sandbars) areas.

Threatened Species

Though the project influence area does not support any globally threatened species of plants, it has five species of plants that are nationally threatened, which are:

- Sarpogandha or Indian Snakeroot (*Rauvolfia serpentina*),
- Haritaki (*Terminalia chebula*),
- Jay Ghash (C*ymbopogon osmastonii*),
- *Gastrodia zeylanica* and
- *Limnophila cana* (according to the *Red Data Book of Vascular Plants of Bangladesh* by Khan *et al.* 2001).

The bio-ecological zones between Jamuna and Padma (**Figure 5.18**) carry a number of threatened species of vertebrates (**Table 5.23**). Among them the Ganges River Dolphin is most significant. The project influence area also supports a healthy population of this globally and nationally threatened species. A total of nine species of globally threatened vertebrate (wildlife) occur in the area. In terms of nationally threatened species, as many as 32 vertebrate wildlife and 22 freshwater fish are known to occur in the project influence area. For the threatened wildlife other than the Ganges River Dolphin, the population is either small or is supported only during winter periods such as migratory birds.

Table 5.23: Globally and Nationally Threatened Species of Vertebrates in Project Influence Area

Name of Species	Global Status	National Status
MAMMALS		
Ganges River Dolphin (*Platanista gangetica*)	Endangered	Endangered
Jackal (*Canis aureus*)	-	Vulnerable
Jungle Cat (*Felis chaus*)	-	Endangered
Fishing Cat (*Prionailurus viverrinus*)	Vulnerable	Endangered
Common Mongoose (*Herpestes edwardsi*)	-	Vulnerable
Common Palm Civet (*Paradoxurus hermaphroditus*)	-	Vulnerable
Large Indian Civet (*Viverra zibetha*)	-	Endangered
Small Indian Civet (*Viverra indica*)	-	Vulnerable
BIRDS		
Comb Duck (*Sarkidiornis melanotos*)	-	Critically Endangered
Brown Fish Owl (*Ketupa zeylonensis*)	-	Vulnerable
River Lapwing (*Vanellus duvaucelii*)	-	Endangered
Black-bellied Tern (*Sterna acuticauda*)	Vulnerable	Endangered
Darter (*Anhinga melanogaster*)	-	Vulnerable
Lesser Adjutant (*Leptoptilos javanicus*)	Vulnerable	Endangered
REPTILES		
Gharial (*Gavialis gangeticus*)	Endangered	Critically Endangered
Median Roofed Turtle (*Pangshura tentoria*)	-	Endangered
Indian Eyed Turtle (*Morenia petersi*)	Vulnerable	Vulnerable
Ganges Softshell Turtle (*Aspideretes gangeticus*)	Vulnerable	Endangered
Peacock Softshell Turtle (*Nilssonia hurum*)	Vulnerable	Endangered
Asiatic Softshell Turtle (*Chitra indica*)	Endangered	Critically Endangered
Spotted Flapshell Turtle (*Lissymis punctata*)	-	Vulnerable
Bengal Monitor (*Varanus bengalensis*)	-	Vulnerable
Yellow Monitor (*Varanus flavescens*)	-	Endangered
Common Vine Snake (*Ahaetulla nasutus*)	-	Vulnerable
Indian Rat Snake (*Ptyas mucosa*)	-	Vulnerable
Common Wolf Snake (*Lycodon aulicus*)	-	Vulnerable
Common Krait (*Bungarus caeruleus*)	-	Endangered
Banded Krait (*Bungarus fasciatus*)	-	Endangered
Monocled Cobra (*Naja kaouthia*)	-	Vulnerable
Spectacled Cobra (*Naja naja*)	-	Endangered

Name of Species	Global Status	National Status
AMPHIBIANS		
Ornate Microhylid (*Microhyla ornata*)	-	Vulnerable
FISH		
Humped Featherback (*Notopterus chitala*)	-	Endangered
Grey Featherback (*Notopterus notopterus*)	-	Vulnerable
Indian Grass Barb (*Chela laubuca*)	-	Endangered
Kalbasu (*Labeo calbasu*)	-	Endangered
Olive Barb (*Puntius sarana*)	-	Critically Endangered
Firefin Barb (*Puntius ticto*)	-	Vulnerable
Necktie Loach (*Botia dario*)	-	Endangered
Long-whiskered Catfish (*Aorichthys aor*)	-	Vulnerable
Giant River-catfish (*Aorichthys seenghala*)	-	Endangered
Assamese Batasio (*Batasio tengana*)	-	Endangered
Rita (*Rita rita*)	-	Critically Endangered
Pabdah Catfish (*Ompok pabda*)	-	Endangered
GaruaBacha (*Clupisoma garua*)	-	Critically Endangered
BatchwaBacha (*Eutropiichthys vacha*)	-	Critically Endangered
ShilondiaVacha (*Silonia silondia*)	-	Endangered
Pungas (*Pangasius pangasius*)	-	Critically Endangered
Gangetic Goonch (*Bagarius yarrellii*)	-	Critically Endangered
Elongate Grass-perchlet (*Chanda nama*)	-	Vulnerable
Indian Glassy Fish (*Pseudambassis ranga*)	-	Vulnerable
Mottled Nandus (*Nandus nandus*)	-	Vulnerable
Giant Snakehead (*Channa marulius*)	-	Endangered
Tire-track Spinyeel (*Mastacembalus armatus*)	-	Endangered

(Source: BirdLife International 2014, IUCN 2014, IUCN-Bangladesh 2000)

Critical Natural Habitats

In the project influence area there is no legal or officially proposed Protected Area. However there are some area with high conservation value such as char land where migratory bird inhabit each year and some spot of Jamuna river where dolphin population was found. Among the available habitats, however, the most notable are parts of the river (unpolluted, deep and rich in fish) that are hotspots (i.e. high density areas) for the Ganges River Dolphin and the uninhabited 'Char' lands that are the shelters of thousands of migratory winter birds and the nesting grounds of many resident birds like wild ducks and terns. Based on the field visits and on the FGDs in and around the project influence area, the high density areas for dolphins and winter birds were marked (**Figures 5.19** and **5.20**).

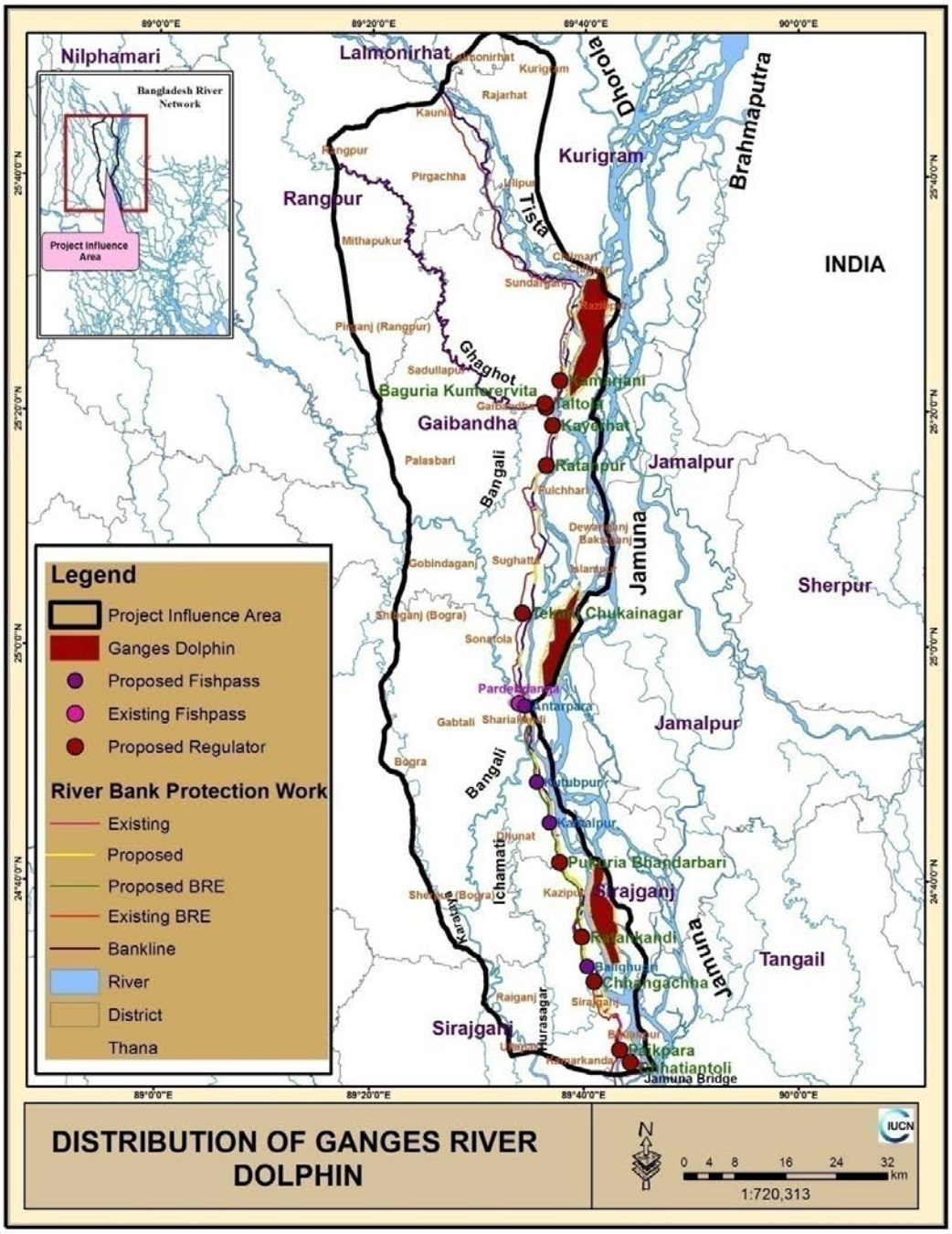


Figure 5.19: Distribution (i.e. high density areas) of Ganges River Dolphin in the Project Influence Area (marked with red shade).

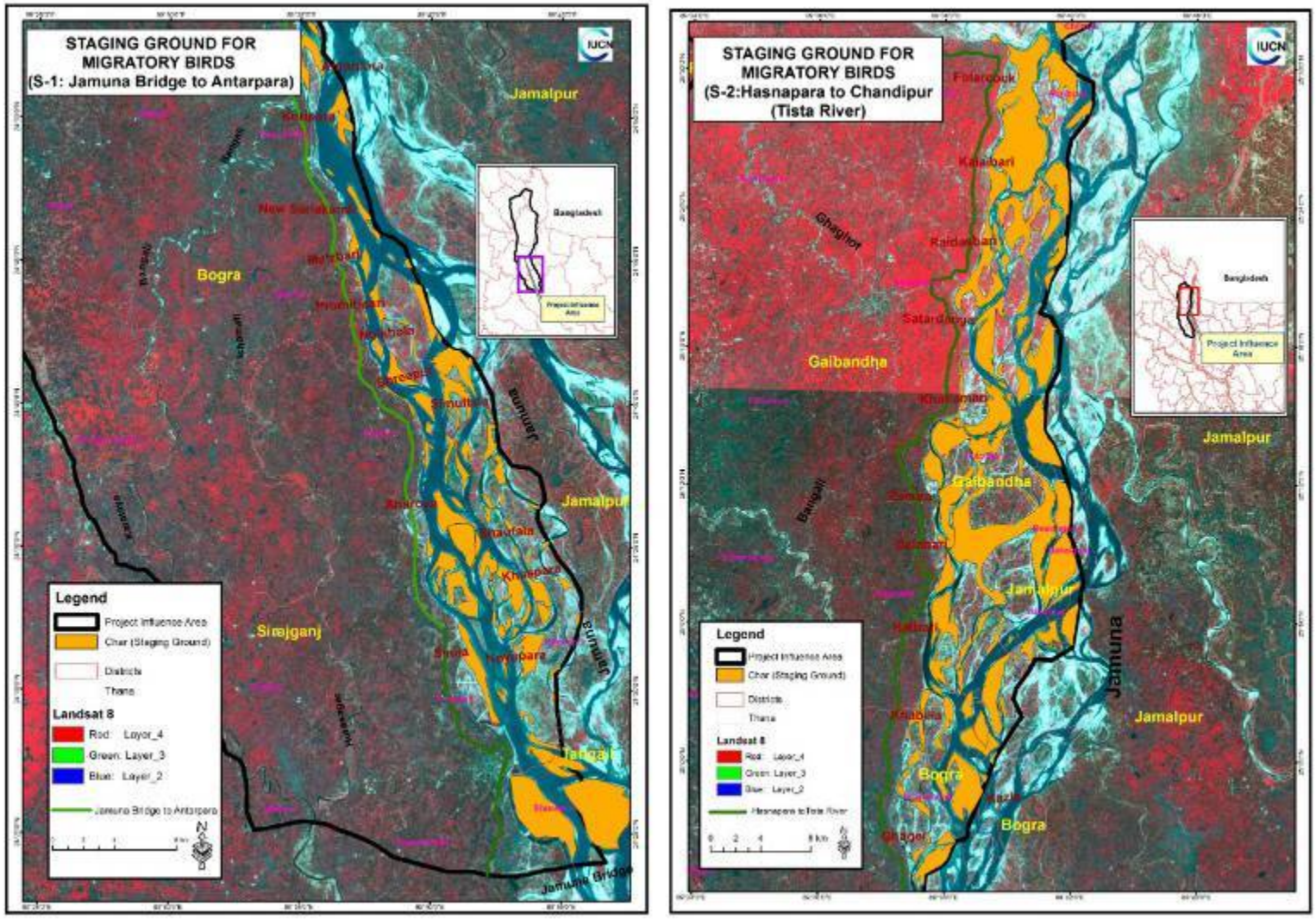


Figure 5.20: Wintering/Staging Grounds for Migratory Winter Birds in the Project Influence Area (marked with orange color)

5.4.2. Project influence Area Ecosystems

Most of the project influence area is under some kind of human influence, because very high population pressure, which includes new settlements and expansion of agriculture even in remote 'Char' lands of the river. The total area of ecosystem in the project influence area is 268,466 ha, of which the agricultural land (about 53 percent) and the settlement (about 29 percent) are very dominant (see **Figure 5.17** and **Table 5.8**).

5.4.2.1. Human Influence

The people living in the project influence area exert high regressive influence on the surrounding ecosystems. Most of the people living in that area possess a sub-standard primitive life style. Their main source of livelihood is agriculture. Vast areas of stable and unstable floodplains have been subjected to the regression of tillage, mostly due to extensive agricultural activities. Such activities of the local people have seriously jeopardized the natural vegetation. There is no sign of natural succession, rather retrogation of the natural vegetation is commonly seen.

Since the unstable areas are subjected to frequent erosions, the local people do not plant any long rotation species in these areas. Very often fast growing species on a very short rotation cycle are planted in these areas. Commonly used species is Eucalyptus, which not only deplete the soil but also impairs the wildlife diversity, especially of the birds in the rural areas. Our FGDs and consultation meetings it transpired that the local people in the unstable zones has their choice for fast growing species whereas those in stable zones has their choice for long rotation horticultural species such as jackfruit and mango. Under this given scenario, the project may bring in opportunities of planting more of the long rotation species such as tamarind, mahogany, and may also induce 'social forestry' programs. Such type of initiatives is likely to help the local people to develop their socio economic condition and improve biodiversity as well. In the stable floodplains people build houses and plant long rotation horticultural and timber species. The planted horticultural species are used by people in many ways and allows small pockets of natural vegetation in the interspaces of the planted trees, particularly in the backyards of the homesteads.

5.4.2.2. Terrestrial Ecosystems

The terrestrial ecosystem in the project influence area is dynamic and is heavily influenced by the water flow of the mighty Brahmaputra-Jamuna River System. It is dominated by the agricultural landscape and homestead areas (see **Figures 5.21** and **5.22**), but there are also vast areas of Char lands that are covered by sun grass, reeds and other natural vegetation. Strong bond exists between the terrestrial and aquatic ecosystems through the food chain and the exchange of energy. The terrestrial ecosystems are often shaped and controlled by the flow of the river, and sometimes even engulfed by the riverbank erosion. In the terrestrial ecosystems all along the project influence area the proportional areas with canopy cover and the crop cover are inversely correlated (R^2 = -0.779) in all 12 Upazila of the project influence area (**Figure 5.23**). It indicates that the crop cover areas gradually convert into canopy cover, because canopy cover is seen in the permanent floodplains around human settlements. This is relatively a recent trend, probably due to the high demand of land for cultivation. Thus agriculture is getting extended even to the new fragile floodplains. These floodplains are mostly under agricultural use and tree planting is minimal.

Figure 5.21: Homestead Vegetation in the Project Influence Area

Figure 5.22: Agricultural land and Planted Exotic Eucalyptus Trees in the Project Influence Area

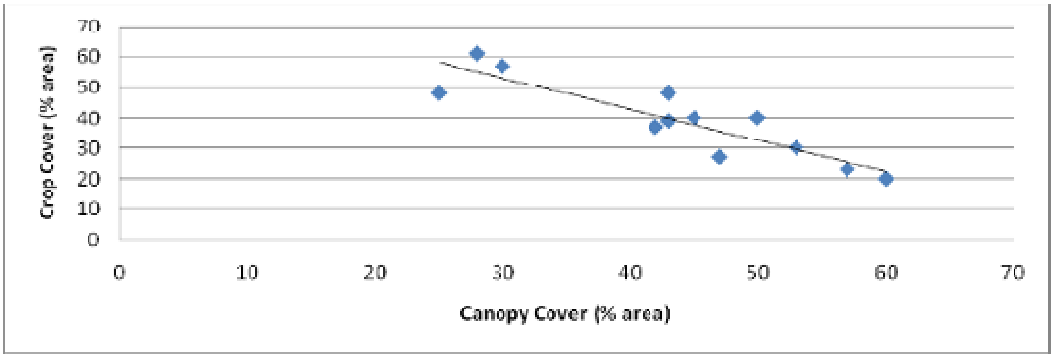


Figure 5.23: Strong Negative Linear Relationship between Canopy Cover and Crop Cover across 12 Upazila of the Project Influence Area

5.4.2.3. River-Charland-Wetland Ecosystems

The most important ecosystems in terms of biodiversity are the river-char-wetland ecosystems with natural vegetation and mudflats (see **Figure 5.24**) that support a wide variety of wildlife, particularly the migratory winter birds.

Figure 5.24: Charland Ecosystem in the Project Influence Area

River Ecosystem

The Jamuna River and its tributaries provide three important functions:

- Habitat for numerous species of vertebrates and invertebrates. Most of those species are found throughout Jamuna and also other rivers and floodplain systems in the country; for them the project influence area is not a critical biotope. For a number of endangered species, however, the area might have special value. Various fish breeding and nursing grounds are located close to the area. The fresh water aquatic ecosystem of Brahmaputra–Jamuna River and its tributaries are the lifeline of the Ganges River Dolphin and some threatened species of turtles.
- Corridor for migratory species, including fish (to and from breeding and nursing grounds) and birds (using the river as migration guidance). For numerous non-migratory species the river systems provide an opportunity for survival of fragmented or isolated communities. The corridor function of rivers for plant seeds and spores is important as well.
- Production of harvestable organisms, mainly fish. The Jamuna is fished throughout the year by professional and temporary fishermen with a variety of gear.

Charland Ecosystem

Charlands (shoals) are newly accreted lands from river deposits. The Jamuna main channel is constantly shifting within its active floodplain, eroding and depositing large areas of new charland in each flooding season. If new charlands do not erode quickly, they are colonized by pioneer vegetation (especially *Crotolaria retusa, Phragmites karka, Saccharum spontaneum and Ipomoea sp.*). Dense growth of these tall grasses starts anchoring the loose deposits and accelerates further silt deposition. Subsequently, either natural succession (by other grasses, bushes and finally trees) or human activities result in development of habitable land. The ecological importance of these charlands is considerable; they provide:

- Habitat. Young, vegetated charlands form a major habitat for the Bangladeshi vertebrate fauna: mammals, birds, reptiles and amphibians. The areas are relatively free from noise and other disturbances, whereas the mixed vegetation and the large number of water bodies support a rich hunting, feeding and roosting habitat. A range of waterfowl, both local and migratory, are directly or ecologically dependent on charland ecosystems. In winter, migratory birds roam in these chars and some resident birds use these charlands as their breeding

grounds. Charlands having less or no human interference harbor rich bird diversity. In the project influence area based on our FGD we found that 'charland' which is situated at least 10-12 km away from countryside harbor a good number of bird species, probably due to less human disturbances.

- Reproduction area. This represents the foremost ecological importance of charlands and their submerged extensions (wetlands and shallow riverine areas). Aquatic reptiles (among which the endangered turtles) lay their eggs in the sandy beaches, mostly between December and February. For many riverine fish and crustacean species the shallow submerged parts of the charlands are indispensable breeding and nursing grounds.
- Settlement and livelihood. Given the shortage of land in Bangladesh, stabilized charlands are quickly occupied by farmers and fishermen, profiting from the natural richness of these new and fertile lands.

5.4.3. Vegetation

The vegetation in the project influence area can be divided into planted and natural vegetation. The common tree species are 39 in number. They are commonly Eucalyptus, Acacia, Jackfruit, and Mango. The relative diversity of major plant species across 12 Upazila in the project influence area (based on samples taken) exhibits that four Upazilas (Sirajganj Sadar, Kazipur, Sariakandi and Gaibandha Sadar) possess higher tree diversity over the others (**Figure 5.25**). Based on the direct observations and FGDs, a total of 66 plant species were identified that are commonly seen, of which there are 39 trees, 24 herbs and shrubs, and 3 bamboo. The relative abundance, out of the 36 species; 14 are Very Common, 14 Common, 8 Uncommon, and no Rare species.

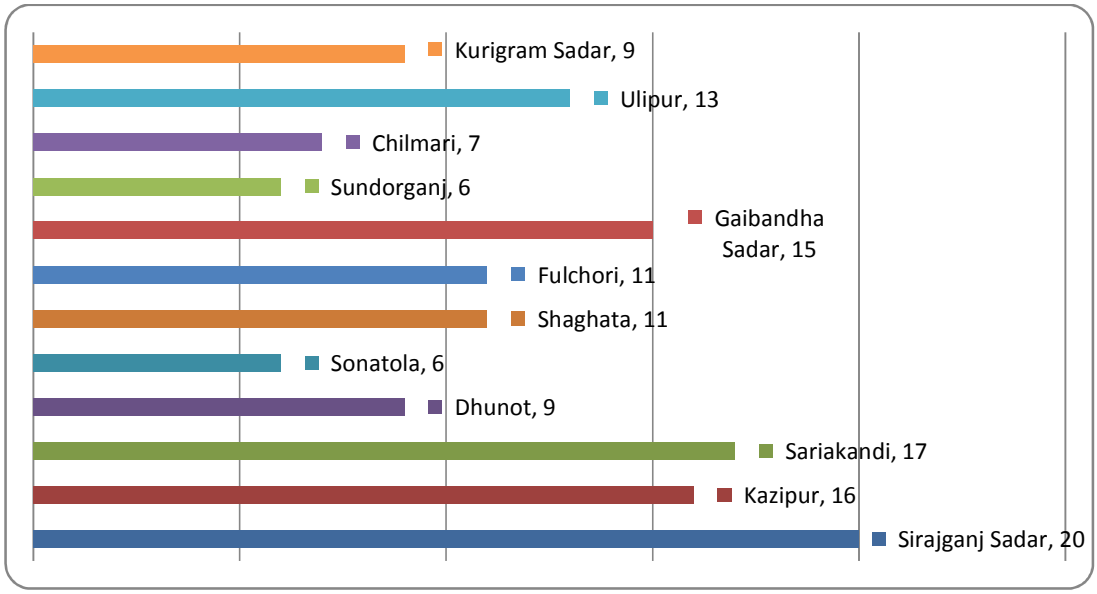


Figure 5.25: Relative Diversity of Major Plant Species across 12 Upazilas of the Project Influence Area (based on the presence of major plant species in quadrats)

5.4.3.1. Terrestrial Vegetation

In the terrestrial ecosystems, the trees are normally found in the homesteads, settlements and along the embankment. The trees of different species were counted in the random quadrats in all the 12 Upazilas of the project influence area. It is evident that both the diversity and density of the tree species vary across 12 Upazilas. There are timber trees to meet the needs of timber and the fruiting trees to provide food, but there are many other trees that are used for various purposes. Some of them are used for medicinal and construction purposes. These tree and shrub species help people to meet their daily needs by providing fuel wood, and fruits. Among all these species Jackfruit is one of the most popular species because of its multi output. As this species provide fruit, fuel wood, fodder and timber as well. But it is less in number where flood is very frequent and land formation change in every year. Based on FGD it was found that the three main purposes of planted trees are fruit, firewood and timber production (**Figure 5.26**), but it slightly varies across the 12 Upazilas. In the open and uncultivated areas the plants that are normally seen are Binna Ghash (*Vetiveria zizanioides*), Kansh (*Saccharum spontaneum*), Chhan (*Impera tacylindrica*), Ghagra (*Xanthium indicum*), Ban Palang (*Rumexmeritimus*), Kolmi (*Ipomoea*spp.), and legumes.

In the agricultural fields, on the other hand, the common cultivated crops are paddy (*Oryza sativa*), wheat (*Triticum aestivum*), jute (*Corchoruscapsularis*), sugarcane (*Saccharumofficinarum*), potato (*Solanumtuberosum*), mustard (*Brassica campestris*), ground-nut (*Terminalia catappa*), pea (*Pisum sativum*) and a wide variety of seasonal vegetables. Wide variety of paddy is cultivated in different season, synchronizing with the water condition. More than one crop is cultivated in most of the agricultural fields. The fields might remain barren for short periods of time between the cropping seasons.

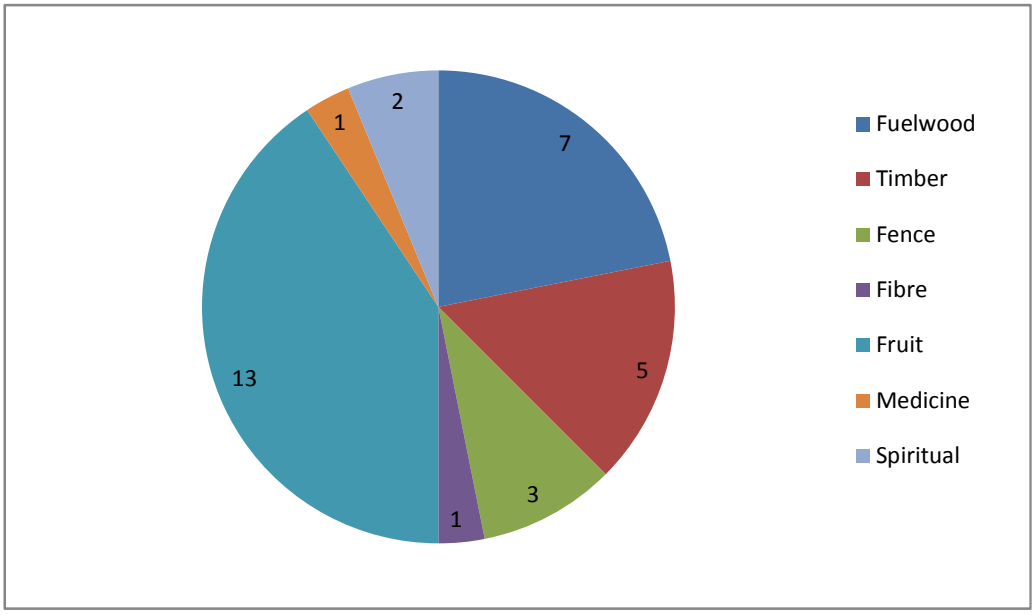


Figure 5.26: Principal uses of 33 major plants in the project influence area based on FGD

5.4.3.2. Aquatic Vegetation

The aquatic vegetation is mostly seasonal and is flourished when there is plenty of water during the wet season (see **Figure 5.27**). There is, however, some aquatic species like Hijal (*Barringtonia acutangula*) that are not seasonal and can survive during the dry season as well. The common aquatic plants in the project influence area include Kachuripana (*Eichhornia crassipes*), Shada Shapla (*Nymphaea nouchali*), Panchuli (*Nymphoides indicum*), Singara (*Trapa bispinosa*) (Nishat *et al.* 1993, Nishat *et al.* 2002). Species like 'Kachuripana' grow well in the stable aquatic environment where water flow is less or absent. In the project influence area this species is very abundant in pond and lake. On the other hand, aquatic vegetation is absent in the mighty Jamuna-Brahmaputra River, but still there are some aquatic vegetation where water flow is less.

Figure 5.27: Aquatic Vegetation

5.4.3.3. Exotic Species

The two very common tree species in the project influence area are exotic species, viz. Acacia (*Acacia* spp.) and Eucalyptus (*Eucalyptus* spp.). These were introduced in the area and rapidly became popular, because these grow fast and can be harvested in several years. These are particularly popular in the charlands and riverbanks, because these areas are prone to erosion, so long-rotation trees are not preferred.

5.4.4. Wildlife

Diverse wildlife species, particularly birds, are known to occur in the project influence area. Based on the direct observation, FGD and secondary sources a total of 89 vertebrate wildlife species were identified that are commonly seen, including 7 amphibian, 11 reptile, 62 bird, and 9 mammal species (see detailed list of species in the Baseline report). The relative abundance shows that a total of 38 species are Very Common, 31 Common, 15 Uncommon, and 5 are Rare.

Most of the wildlife species that were recorded in the project influence area were recorded in all Upazilas, but some species were recorded in a few Upazilas only. It is possible that all Upazilas have these species, but further surveys are required to confirm the Upazila-wise records. Based on FGD in 12 Upazilas of the project influence area it was found that the relative diversities of vertebrate wildlife species vary across 12 Upazilas. The highest relative diversity was reported from Sariakandi Upazila (see **Figure 5.28**).

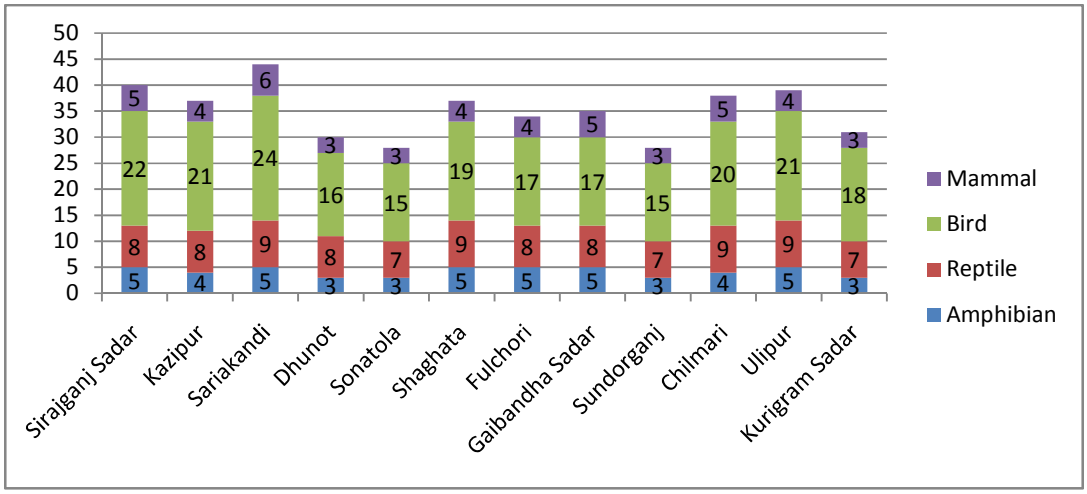


Figure 5.28: Relative Diversity of Common Vertebrate Species across 12 Upazilas of the Project Influence Area (based on FGD)

5.4.4.1. Mammals

The mammalian species diversity and density are relatively low in the project influence area, because a large proportion of the area is wetlands of some kind that are not suitable for terrestrial mammals. The mammals that occur in and around wetlands are common and widespread. A total of 25 species of mammal are known to occur in the project influence area (list is provided in the Baseline report). The most notable is the Ganges River Dolphin that occurs all along Brahmaputra River, including the major tributaries, but there are some hotspots where it is more common (**Figure 5.19**) (CARINAM 2011, FHRC 2013). Discussions during the FGDs have revealed that the dolphin number is declining due to accidental death to fishing nets, human disturbance and pollution.

Other common mammals of the area are Small Indian Mongoose (Herpestes auropunctatus), Golden Jackal aureus), Indian Flying Fox (Pteropus giganteus), Jungle Cat (Felis chaus), Asian Palm Civet (Paradoxurushermaphroditus), and many species of rats and mice. Ganges River Dolphin (Platanista gangetica; global status: Endangered) is also abundant in some specific location. Some of the above-mentioned mammals occasionally hunt the domestic chicken and duck, and are often killed by angry villagers. Therefore, their population trends are showing the signs of decline.

Ganges River Dolphin

The most notable species of the project influence area which is globally considered as threatened species. This species (**Figure5.29**) is available in Ganga-Brahmaputra River system. In project influence area the species is frequently found in some point of

Sirajganj, Bogra and Kurigram. Snout is long thinned; belly is rounded with large flippers. This species uses its eyes to locate object though it has no lens. It cannot breathe in water and surface every 30-120 seconds for breathing. Female is larger than males. Female attain sexual maturity at the age of ten. The Ganges River Dolphin will breed in a similar way to other dolphins, which includes breeding during the beginning of the year, and remaining pregnant for an average of 10 – 12 months. The diet includes a variety of fish and invertebrates. Globally, the number of their population is ranged from 1200-1800.

FGD and Field survey were conducted to assess the distribution and status of Ganges River Dolphin. FGD was conducted during August-September and the vessel-based dolphin survey was conducted in November, 2014 as this is the period of minimum river discharge when dolphins are easiest to count within the project time. Survey was started from Sirajganj Hard Point, Sirajganj to Antarpara, Bogra. The survey was conducted within the priority area. 50 collinear transects of 1 km was established to cover river width and sampled the area as followed by Bashir ***et al.*** 2010. A motor boat with a constant speed between 6-9 km/hour was maintained in upstream and downstream direction following the deepest channel with a zig-zag pattern from bank to bank. A boat-based line-transect method as described by Smith & Reeves, 2000b and Kreb & Budiono, 2005 was adopted in which transects were sampled by five observers at a time with three Primary Observers stationed with different direction (right, left and front), one data recorder and one rear observer (observing 180^0 behind the survey vessel). Positions of observers were rotated every 30 minutes to avoid fatigue.

Figure 5.29: Ganges River Dolphin

At the time of each sighting, GPS location, time, and age category (e.g. adults, calves) of the individual was recorded. Survey track and location of dolphin was plotted in the GIS map. A dolphin group was defined as dolphins no more than 2 km apart, within an area of similar hydrological characteristics. Group sizes were evaluated with a best, high and low estimate of numbers to incorporate a degree of uncertainty. A low and best estimate of zero was used if the sighting was unconfirmed or if there was a possibility that the dolphin was following the vessel and might have already been counted. A 15 minute stoppage was made in areas of high dolphin abundance to make a more accurate group size estimate. All sightings were confirmed by a second observer. The observers took

extreme care to eliminate repeated dolphin counts considering their spatio-temporal array and beak morphology (Mohan *et al*., 1997).

The survey was conducted dual times to get the accurate data on the abundance and group size of Ganges River dolphin. On first survey the vessel based dolphin survey was conducted towards upstream direction and on the second survey it was conducted towards downstream direction.

The entire 50 km of priority area was surveyed, though we started our survey from Sirajganj Hard Point which in outside of priority area. A total of 19 dolphins were encountered in the field survey considering their three groups.

A zone (Transect-3) from Kutubpur to Bhandarbari (24°48'16.80"N to 24°43'30.66"N and 89°35'54.53"E to 89°37'28.63"E) was found with high abundance of dolphin population which is 3 dolphins per km (see **Table 5.24, Figures 5.19** and **5.30**). About 64 percent of total dolphin population was encountered from this zone. On the other hand, dolphin population was very low in Transect-1 which is ranging from Shubgacha to Pachthakuri under Sirajganj District. In general, the encounter rate of Ganges River Dolphin in the project influence area is 0.38 dolphin per km.

Table 5.24: Distribution of Ganges River Dolphins in the Jamuna River

Location	GPS Coordinate	No. of Dolphin			Total	Transect Length (km)	Encounter Rate (dolphin/km)	Average Distance from proposed Alignment (km)
		Adults	Calves	Total				
Transect-1: Shubgacha to Pachthakuri (District: Sirajganj)	24.54406N-89.68383E	1	0	2	19	4	0.5	0.9
	24.54542-89.68214	1	0					
Transect-2: Meghai (District: Sirajganj)	24.66419N-89.65692E	1	0	5		4	1.25	1.2
	24.66142N-89.65692E	2	1					
	24.66419N-89.6575E	1	0					
Transect-3: Kutubpur to Bhandarbari (District: Bogra)	24.78267N-89.60917E	1	0	12		4	3	1.4
	24.785N-89.60775E	2	1					
	24.79718N-89.60211E	2	1					
	24.79983N-	2	0					

Location	GPS Coordinate	No. of Dolphin			Total	Transect Length (km)	Encounter Rate (dolphin/km)	Average Distance from proposed Alignment (km)
		Adults	Calves	Total				
	89.59967E							
	24.80092N-89.59917E	1	0					
	24.79826N-89.60109E	2	0					

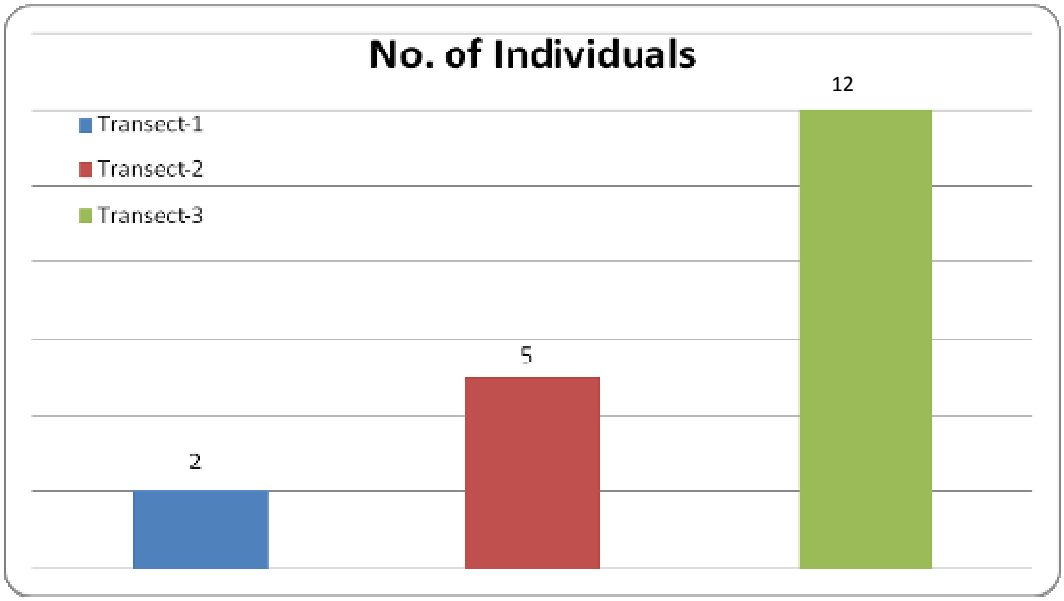


Figure 5.30: Relative Abundance of Ganges River Dolphin in Three Transects

5.4.4.2. Birds

Huge congregation of migratory winter birds can be seen during November-March in the floodplains of Brahmaputra River (see **Figure 5.31**). Winter birds from the Himalayas, Central Asian highlands and faraway places like Siberia move to relatively warm swampy lands in Bangladesh including the project influence area to escape the freezing cold, and feed on various animal and plant food that are abundant in the mudflats, sandflats, rice fields and other areas. Birds start arriving from early November and stay till March-April. An estimated 500,000 birds of about 150 species (mainly ducks, waders and warblers) travel to Bangladesh each winter.

Figure 5.31: Flock of Water Birds

A total of 255 species of bird are known to occur in the project influence area (see Table 5.8), of which a significant proportion is migratory winter birds. Some common migratory species include Ruddy Shelduck (Tadorna ferruginea), Northern Pintail (Anas acuta), Gadwall (Anas strepera), Common Sandpiper (Actitis hypoleucos), Wood Sandpiper (Tringa glareola), and Little Stint (Calidris minuta) (list are provided in the Baseline report). Wide variety of breeding resident birds also occur in the aquatic and terrestrial ecosystems of the project influence area, viz. Lesser Whistling Duck (Dendrocygna javanica), Little Egret (Egretta garzetta), Pied Kingfisher (Megaceryle lugubris), Sand Lark (Calandrella raytal), Zitting Cisticola (Cisticola juncidis), Black Drongo (Dicrurus macrocercus), Oriental Magpie Robin (Copsychus saularis), Red-vented Bulbul (Pycnonotus cafer), Spotted Dove (Streptopelia chinensis), Large-billed Crow (Corvus macrorhynchos) and House Sparrow (Passer domesticus), and Whiskered Tern (Chlidonias hybridus) (see **Figure 5.32**), (Source: transect data and Asian Waterbird Census 2014). The FGD in the project influence area recorded that all ducks and geese, whether winter visitor or breeding resident, were showing declining trend due to illegal hunting for meat.

Figure 5.32: Flock of Whiskered Tern - a common bird in the project influence area

5.4.4.3. Reptiles

Since most of the reptiles are moisture-loving species, the project influence area is the home of many reptiles of medium and small sizes. A total of 36 species of reptiles are known to occur in the area (list are provided in the Baseline report).

Some common reptiles of the area are Common Garden Lizard (Calotes versicolor), Common Skink (Eutropis carinatus), Common House Gecko (Hemidactylusfrenatus), Checkered Keelback (Xenochrophis piscator), Binocellate Cobra (Naja naja), Peacock Softshell Turtle (Nilssonia hurum), Spotted Flapshell Turtle (Lissemys punctata) and Bengal Monitor (Varanus bengalensis) (Hasan et al. 2014). Common Garden Lizard and Common Skink were frequently sighted in the project influence area. On the other hand, Peacock Softshell Turtle and Spotted Flapshell Turtle are very rare in the project influence area. At the time of FGD people informed about the presence of turtles long time ago, and the turtles appear to be disappearing from the project site. Binocellate Cobra (**Figure 5.33)** is the common reptile in the project influence area. Other than turtles, the lizards and snakes do not show any significant trend of decline. Description of two threatened reptiles, Peacock softshell turtle and gharial, is presented below.

Figure 5.33: Binocellate Cobra - a Common Reptilian the Project Influence Area

Peacock Softshell Turtle

The Peacock Softshell Turtle (*Nilssonia hurum*; global status: Vulnerable) has a distinctive soft-shell that is beautifully marked with dark olive green carapace reticulated with black (**Figure 5.34**). Carapace is also adorned with a narrow rim and numerous broken ridges. Its head is dark green to black with numerous yellow spot. They are oviparous and breeding activities take place in winter. Nesting takes place from December to March in chars. They inhabit in all major rivers of Bangladesh. They are currently rare in the project influence area.

Figure 5.34: Peacock Turtle

Gharial (Gavialis gangeticus)

The only large reptile in the area is the Gharial (*Gavialis gangeticus*) (**Figure 5.35**), which is extremely rare. It is a globally and nationally threatened species. Few decades ago it was a common species in the Ganges-Brahmaputra River System, but the population sharply declined due to the lack of food (fish), accidental killing by fishing nets and destruction of eggs by domestic dogs (Khan 1982). Today, it is one of the rarest species of wildlife in Bangladesh and there have been no report of its nesting since 1980s. It is possible that the individuals (mostly juvenile and young) that are rarely seen in the Ganges-Brahmaputra River System come from the neighboring India and Nepal.

Gharial is categorized as 'Critically Endangered' according to IUCN Red List which means species is at high risk of extinction. After 2010 gharial was not recorded from the Jamuna-Brahmaputra river channel. In 2009 and 2010 gharial was encountered only two spot of Jamuna-Brahmaputra river channel (**Figure 5.36**) (CARINAM 2010). At the time of Dolphin Survey in project influence area, the team also searched for Gharials. But there was no evidence of the presence of this animal. Again at the time our Baseline survey during August and September several FGD was conducted and people confirmed that after 2011 they had not seen any Gharials in the Jamuna-Brahmaputra River. On the basis of these FGD and primary survey we can conclude that currently there are no Gharials in the project influence area.

Figure 5.35: Gharial- at its natural Habitat (Source- ARKIVE)

Figure 5.36: Distribution map of Gharials in 2010 (Source: CARINAM 2010)

5.4.4.4. Amphibians

The stagnant water bodies and the moist terrestrial areas offer vast habitats for amphibians. Therefore, the amphibians are very common in the project influence area. A total of 15 species are known to occur (list are provided in the Baseline report). Among the amphibians, only the frogs and toads are found in the area. Some common species are Skipper Frog (Euphlyctis cyanophlyctis), Cricket Frog (Fejervarya spp.), Indian Bull Frog (Hoplobatrachus tigerinus), and Common Toad (Duttaphrynus melanostictus) (Hasan et al. 2014). See **Figure 5.37** for an amphibian species of the area. Since there is no notable threat to amphibians and there is no hunting for meat, none of the frog species show the trend of decline, which was recorded during the FGD.

Figure 5.37: Cricket Frog - a Common Amphibian in the Project Influence Area

5.4.4.5. Terrestrial Invertebrates

Wide varieties of terrestrial invertebrates are known to occur in the project influence area as well as in entire Bangladesh, but there is no information on their diversity and abundance in the literature. The warm and humid climate of the country is favorable to lower organisms, especially the insect and spider fauna. The project influence area is similar to other areas of the country in terms of having diverse terrestrial invertebrate communities. Detailed invertebrate surveys were not carried out in the project influence area but a general assessment was made of invertebrate taxa in the area. A number of species of earthworms (eg, *Dendrobena* spp., *Apporectoda* spp., *Lumbricus* spp.) exist in the area. They play a vital role in maintaining the humus of the soil and help the nitrogen and oxygen to penetrate the soil through its holes. There are many species of grasshoppers (order: Orthoptera) that cause a lot of damage to the crops. Other common invertebrates include many species of butterflies, dragonflies, spiders, and beetles.

5.4.5. Ecosystem Services

Ecosystem services are the benefits that the people harness from the ecosystems. These may be tangible or intangible. The tangible benefits are direct and possess some sort of physical entity, such as edibles, fiber, construction materials, etc. The intangible benefits are indirect and need a little thinking to perceive those, such as perennial stream flows, clean water, oxygen supply, climate regulations, microclimatic impacts, aesthetic values of the landscapes, etc. According to 'The Economics of Ecosystems and Biodiversity' (TEEB), ecosystem services can be divided into four categories, which are presented here under.

1. **Provisioning services**

These are mainly products obtained from ecosystems. These products will include:

- food (including seafood and game), crops, wild foods, and spices
- raw materials (including lumber, skins, fuel wood, organic matter, fodder, and fertilizer)
- genetic resources (including crop improvement genes, and health care)
- water
- minerals (including diatomite)
- medicinal resources (including pharmaceuticals, chemical models, and test and assay organisms)
- energy (hydropower, biomass fuels)
- ornamental resources (including fashion, handicraft, jewelry, pets, worship, decoration and souvenirs like furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.)

Bangladesh context:

Under the Bangladesh context, a few of the examples of such provisioning services rendered by the ecosystems are as under. The water bodies such as rivers, haors, baors, beels, wetlands etc. produce fishes, crabs, shrimps, etc. The agro-eco systems provide the cereals, spices, jute, cotton, vegetables, fruits, etc.. The forest ecosystems provide timber, fuel-wood, game animals, bamboos, canes, poles, etc. which is the provisioning services of these ecosystems.

Project Context:

The major provisioning services that are provided by the ecosystems in the Project Influence Area (PIA) are:

- The agro-ecosystems (agricultural areas) provide rice, wheat, oil seeds, spices, fruits, jute, etc.
- The freshwater ecosystems provide clean ground water and surface water that are used for drinking and irrigation purposes. The water bodies such as the rivers, beels, ponds, wetland areas, etc. provide fishes, crabs, shrimps
- Raw materials obtained from this ecosystem include bamboos, fruits, medicinal plants, timber and fuel-wood

2. **Regulating services**

Regulating services are the "benefits obtained from the regulation of ecosystem processes". These include:

- carbon sequestration and climate regulation
- waste decomposition and detoxification
- purification of water and air
- pest and disease control

Bangladesh context:

The forest ecosystem in Bangladesh extended over 17 percent of the country transpires out huge quantities of water to the atmosphere. This water has a significant contribution in the rain fall at least on regional context. It is known that the North Western region of the country receive less rain fall than the South Eastern part of the country, which has some relation with the regional ecosystem variability, especially with respect to tree cover. The Barind tract of Bangladesh gets cooler during the winter months than the Chittagong area. In a small country like, this sort of climatic variability refers to the climate regulatory aspects of its ecosystem services.

Bangladesh in general, is tropical and receives a reasonable quantity of rain fall. These features of the ecosystems of the country facilitate waste treatment as the regulating services of its ecosystems.

Bangladesh is endowed with the world largest contiguous mangrove forest, the Sundarban. The cyclone that lashed over Chittagong (non-Sundarban) area on November 12, 1970 had a speed of 224 Km per hour and had a death toll of 0.5 million lives. Another cyclone 'SIDR', having a speed of 210 to 230 Km per hour, hit Sundarban first and then passed over the human habitations on November 15, 2007, had a death toll of 3363 numbers of human lives. The SEALS project (being implemented by the Forest Department) document has revealed that the intangible benefit of Sundarban, only with respect to the saving human lives, is about 8 billion euro. Sundarban as a "buffer zone" in the context of 'regulating services' of ecosystem is providing this intangible benefits from this given ecosystem.

Project Context:

In the project influence area the rural agricultural practices, in many locations have adopted agro-forestry, wherein tree species have been planted especially along the boundary of the agricultural plots. These trees through evapo-transpiration cause an impact on the climate regulation. Besides these the project influence area has large water bodies, which have some role on climate regulation at local level. The ecosystems in the project influence area have the biodegrading capability, which helps natural waste treatment. The flowing rivers in the project influence areas also help to remove the wastes downstream.

3. Support Services

Ecosystem services "that are necessary for the production of all other ecosystem services". These include services such as nutrient recycling, primary production and soil formation. These services make it possible for the ecosystems to provide services such as food supply, flood regulation and water purification.

Bangladesh context:

The nutrient cycling is a universal phenomenon for almost all of the natural ecosystems in Bangladesh. This prevails not only in hill forest but also in salt forest, fresh water wetland forest, mangrove forest, etc. Besides these most of the water bodies (except Buriganga) this sort of nutrient cycling is there. Biologically Mediated Habitats such as mangroves (Sundarban, coastal afforestation areas,) fresh water forests, such as Ratargul reserved forest (in Sylhet district), Tamguar haor in Sunamgonj district, etc. provide the support services by providing breeding and nursery grounds for large fish population of variety of species.

Project Context:

The project influence area posses many small rivulets that connect the Brahmaputra river with inland beels, depressions that retain water especially during the dry periods. These water bodies will act as spawning grounds for the fish and act as migratory routes for the fish from river to floodplains.

Besides these the leaf chlorophyll in the project implementation area, through the process of photosynthesis continuously using the carbon dioxides from the air and releasing oxygen. This service of the existing ecosystems in the project influence area is maintaining the air quality. The organic matter in the upper layers of the soil is enhancing its water holding capacity of the existing ecosystems and thereby a better water regime. The roots of the aquatic plants of the existing ecosystems are holding the water pollutants and thereby enhancing and maintaining the quality of the surface water. In addition, the vegetation covers also somewhat regulate the natural hazards such as high wind speeds, erosion, etc. Some of beetles, especially 'lady bird beetle' commonly seen in the ecosystems of the project influence area, feed on many vegetable pests of which aphids are common.

4. Cultural services

Cultural services of ecosystems refer to nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences. These include:

- cultural (including use of nature as motif in books, film, painting, folklore, national symbols, architect, advertising, etc.)
- spiritual and historical (including use of nature for religious or heritage value or natural)
- recreational experiences(including ecotourism, outdoor sports, and recreation)
- science and education (including use of natural systems for school excursions, and scientific discovery)

Bangladesh context:

The Dublar Char ecosystem, under the Sundarban (Khulna), provides the ecosystem services which are of the type of "cultural services", by hosting a colorful Puja, which attracts a large number of tourists. Bangladesh has about 37 Protected Areas. Most of these attract tourists from the whole country, whereas Sundarban attract a sizable number of foreign tourists as well.

Project Context:

Jamuna and its charland ecosystem is a natural scenic spots with lot of recreational value. Charland ecosystem of project influence area plays an important role by allowing thousands of migratory birds to visit the ecosystem. This phenomenon enhances the biodiversity values of the ecosystem and enhances its eco-tourism values, which may even generate revenues. The other attraction in the project influence area is presence of globally endangered 'Ganges River Dolphin'.

5.4.6. Threats to Ecosystem

Both the terrestrial and aquatic ecosystems of the project influence area face formidable anthropogenic threats. Excessive and uncontrolled use of various agrochemicals is the biggest threat to the local ecosystems. Moreover, there are reports of disease outbreaks, human-wildlife conflict and pollution.

5.4.6.1. Use of Agrochemicals

In the terrestrial ecosystems of the project influence area, particularly in the agricultural lands, many pesticides, fertilizers (such as urea) and growth hormones are used indiscriminately in the agricultural fields. All these chemicals are incorporated to the food chain and are gradually deposited to the higher trophic level through biological magnification. As a consequence, not only the local wildlife, but also the humans are suffering from adverse effects of these agrochemicals.

5.4.6.2. Potential Vectors of Diseases

Many birds are known to serve as vectors of highly pathogenic H5N1 and some other contagious diseases that can be transmitted to humans with fatal consequences. On the other hand, Nipah Virus (NiH) is known to be carried by fruit bats and is transmitted to humans through the date juice or fruits, contaminated by bats, that are consumed by people. Moreover, anthrax outbreaks to cattle are occasionally reported. The germs can be transmitted through the wild animals that feed on the carcass of infected cattle.

5.4.6.3. Other Threats

In the project influence area there are many reports of human-wildlife conflict. People kill snakes, whether they are poisonous or not, because of the innate fear for snakes. Poisonous snakes (particularly cobras and kraits) are responsible of deaths of some people every year. Similarly, Golden Jackal, Jungle Cat and Common Palm Civet are killed by people due to the perception that these animals kill and eat a lot of domestic chicken and ducks. They do kill some, but more often they kill the rodents that are very harmful to crops.

The Ganges River Dolphin is often killed accidentally in the fishing nets, particularly in illegal gill nets (see **Figure 5.38**). The fat of the dolphin is believed to have the power to cure pain (which has no scientific basis), so there are people to buy dead dolphins. Even the meat is used as baits for large fish and crabs. Since it is rather difficult to purposely kill dolphins, and it is more gainful to catch fish than to kill dolphins, people usually do not kill dolphins purposely.

Figure 5.38: Ganges River Dolphin Accidentally Killed by Fishing net in Project Influence Area

5.4.7. Fish and Fisheries

5.4.7.1. Summary of the fish and fisheries baseline

The Jamuna is an important source of fresh water fish in Bangladesh. In a braided river like Jamuna, fish favorable environment generally exists around the river banks, braided channels, scour hole, deep clear water, and near shallow chars. The river has about 220 km long embankment along the right bank and other structures such as Bangabandhu Bridge, hard points, spurs and revetments (hard and soft) which play an important role in shaping the characteristics of different fish habitats dependent on the Jamuna river. Both capture and culture fisheries types exist in the project influence area. Among capture fisheries habitats main river channels, natural and manmade *khals*, connected seasonal wetlands (*beel*), associated flood plains, streams/creeks in riverine islands and embayments (*koles*) are important.

Total fish habitat area (in ha) of the study area is about 54,987 ha. Besides, about 56 ha culture ponds also exist in the project influence area. Wetlands and canals at the country side and embayments in the charlands play major role in sustaining the fish production of the Jamuna River. These habitats - most of which have been formed due to the complex hydro-morphological characteristics of the river - provide food and shelter for various species fishes. Others rivers that exist in the project influence area are Bangali river, Ichamati river, Hurasagar river, Ghagot river, Manosh river, Alai river, Dudhkumar river and Teesta river which are connected either directly or through different *khals* with the Jamuna river forming a fish movement network in the entire area. The eddy counter-current system at the junction of two rivers (tributary and main river) also provide an ideal place for fish assemblages. The confluences are also the passageways for upstream fish migration. The project influence area also has numerous seasonal and perennial

beels/wetlands, some of which are connected with these rivers through the internal stream networks. Beels act as feeding and breeding grounds for many riverine species. However, beels do have a residential fish population as well. Besides, a considerable amount of seasonal floodplain area exists within the project influence area.

Annual total fish production of the project influence area has been estimated at 8501.92 metric ton. River contributes the largest share of this production followed by floodplain, beels and koles. Fish production from khals/streams is insignificant as most of those are either dried up during peak dry season or remain closed by flood control structures. Hilsa constitutes about 27 percent of Jamuna catch. Other major species of fish catch in Jamuna include major carps and cat fishes (about 1 percent each), and shrimps-prawns (4 percent). However, fish production of the Jamuna river has been declining continuously until recently, primarily because of increased fishing pressure and a decrease in the extent of floodplain habitats caused by the construction of flood control, drainage and irrigation systems, and the consequent obstruction of movement of fry and fingerlings from rivers.

More than 3500 fishermen have been identified during the catch assessment survey along the right bank. Fishing is one of the available livelihood opportunities for most of the landless people of the project influence area. The people that lose their lands because of the riverbank erosion generally resort to fishing as their livelihood means. A total of about 1800 fishing crafts have been found during catch assessment survey.

Huge number of stagnant water bodies in chars and river channels support a habitat of rich fish biodiversity. Rahman and Akhter (2007) identified 156 fish species of which, 89 are commercially important and 53 are rare in the river. Jamuna river is renowned for its high diversity of the small indigenous fish species (SIS). Large Hilsa is only available up to Sirajganj. Out of 54 threatened fishes of the country 29 were found in the project influence area during field investigation. Six principal carp spawn collecting sites have been established along the Brahmaputra-Jamuna mainly on its right bank. Carp spawn collection has been decreasing remarkably over the last three decades. Other areas of conservation significance in the Jamuna river found during the field survey are Simlar kole, Mothiar kul/ Pachthakuri kole, Pukuria kole, Sariakandi kole, Boishakhi kole, Chunia para kole, Taltola kole and Kazlar kole. These areas are generally at a distance of 0.5 to 4 km from the embankment alignment. Besides, Department of Fisheries (DoF) has notified several fish sanctuaries in the countryside.

The major migratory fish of the Jamuna is Carps, Cat fishes and Hilsa. Hilsa migrates into Jamuna during March-May from Bay of Bengal through the Meghna and the Padma rivers. Carp fishes migrate upstream and laterally to the inundated floodplains adjacent to the river channel during the late dry season or early rainy season in order to spawn in the nutrient-rich waters. The eggs and larvae of these species drift downstream and enter the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young migrate to the main river channel in order to avoid the harsh conditions of the floodplain during the dry season. The Brahmaputra stock of carp fishes is the largest stock in Bangladesh. Upstream migration of adult major carps in the Jamuna/Brahmaputra River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the Southwest monsoon, and continues until the end of July. Connecting *khals* between main rivers and other water bodies are vital for sustaining successful fish migration at different seasons. Field survey has identified five migration routes of the priority area are as follows: i) Jamuna to Icamoti river through Baliaghugri regulator; ii) Jamuna to Bangali river through Sariakandi fish

pass; iii) Jamuna to Dauli beel to Bangali river through Antarpara regulator; iv) Jamuna to Manos river through proposed Kamalpur fish pass; and v) Jamuna to Bangali river via Kutubpur khal through proposed Kutubpur fish pass. Among these five, Sariakandi fish pass is now almost silted up. Other four fish migration routes are partially obstructed due to the existing regulators/BRE. The embankment along the right bank of Jamuna river acts as barrier and has disconnected large area of floodplain since 1965. This dis-connectivity has brought changes in the natural ecosystem dependent on the river hydrology resulting in great loss of biodiversity and natural resources, ultimately affecting the livelihood and wellbeing of the communities.

5.4.7.2. Jamuna River - A suitable habitat of fresh water fishes

The Jamuna is a large braided river having a length of 260km in Bangladesh with an average width of 11.8km. The annual average flow is 20,000 m^3/sec with a maximum estimated discharge of 100,000 m^3/sec. The average flood water slope of the river is 7.5 cm/km and the average median size bed material is 0.20mm (CEGIS, 2009).It is an important source of fresh water fish in Bangladesh. Braided nature of the river provides suitable fish habitat as the typical fish assemblage in a river requires a high variability of depth, flow velocity and substrates. The high species richness and diversity in braided rivers can be explained by small-scale habitat mosaics encompassing aquatic habitats as well as riverine forests (**Figure 6.39**), and by multiple sub-surface exchange areas (Tockner et. al., 2006). Braided channels were also shown to provide more favorable shelter and nursing conditions for fish larvae and juveniles by mitigating high velocities during floods, by maintaining relatively shallow areas of flow, and by significant adjustments in the thermal region (Sukhodolov et. al., 2009).

The fish habitats of the Jamuna reflect a combination of sedimentology, depth and velocity associated with the organization of river bedforms and morphologies. Jamuna also has huge sediment loads coming from upstream. Its sediment has high organic contents which makes the river suitable for fishes (IWFM, 2012). The Jamuna has a severe bank erosion problem and the eroded banks and scour holes are also good habitats for the adult fishes. According to Sarkar and Bain, 2007 fish fauna of the Jamuna river prefer both erosional and depositional channel habitats with depths, substrates, and current velocity. In a braided river like Jamuna, fish favorable environment exists around the eroded bank, scour hole, deep clear water, near shallow sand bar and some other places. Average depth of the river ranges from 60 to 90 feet is common in rainy season and decreased to average 40 to 50 feet in dry season which is favored by large fishes. River water is always colder than the surrounding weather, so it supports suitable habitats for different fishes. All these make the Jamuna a unique habitat for fish regeneration.

The river has about 220 km long embankment along the right bank and other structures such as Bangabandhu Bridge, hard points, spurs and revetments (hard and soft) which play an important role in shaping out the characteristics of different fish habitats. However, for the construction of the different riverine structures the fish of the river decline day by day. Tsai and Ali (1985) carried out a study on open water carp fisheries management. They recorded a decline in Padma, Brahmaputra and Upper Meghna stocks of major carps. According to them, the reasons for decline were construction of embankments, sedimentation and over fishing for Brahmaputra stock.

Figure 5.39: Dense shrubs along the banks of the Jamuna river chars–preferred feeding ground for fish offsprings

5.4.7.3. Fish habitat

Type, area and distribution

Both capture and culture fisheries types are exist in the study area. Among capture fisheries habitats main river channels, canals (natural and manmade khals), connected seasonal wetlands (*Beel*), associated flood plains, streams/creeks in riverine islands and embayments (*Kole*) are important. Average depth of river channels is 10-15 meter, canals 3-4 meter, embayments 2-7 meter and wetlands 1-4 meter respectively. Total fish habitat area (in ha) of the study area is about 54,987.42 ha, of which 68 percent rivers followed by flood plain (21 percent), beel (6 percent) and Kole (5 percent) as given the **Table 5.25**. Wetlands and canals in the country side and embayments in the charlands are playing major role in sustaining the fish production of the Jamuna River (**Figure 5.40**). These habitats facilitate food and shelter grounds of many riverine fishes. A total of 56 ha culture ponds found in the study area. Upazila wise distribution of different fish habitats is given in **Table 5.26**. These estimates will be updated while conducting the EIAs of the later phases of the RBIP.

Table 5.25: Fish Habitat in Project Influence Area (in ha)

Fisheries Type	Fish Habitat	Area (ha)		
		Priority Zone (50km)	Remaining Zone (132km)	Project Area (182km)
Capture	River	12652.91	24655.81	37308.72
	Canal (both natural and manmade khals)	91.30	89.00	180.30
	Beel	1289.00	2239.20	3528.20
	Flood plain	3917.50	7454.80	11372.30
	Embayment (Kole)	719.40	1823.00	2542.40
	Sub-total	18670.11	36261.81	54931.92
Culture	Pond	20.90	34.60	55.50
	Sub-total	20.90	34.60	55.50
Total		**18691.01**	**36296.41**	**54987.42**

Source: Field investigation, September 2014, IUCN

Table 5.26: Distribution of Fish Habitats within Project Influence Area

Zone	Upazila/District	Habitat type	Area (country side) ha	Area (river side) ha	Total area (ha)
Priority zone	All	River	1832.92	10676.50	12509.42
Remaining zone			6626.64	17500.34	24126.98
	Sub-total		8459.55	28176.84	36636.40
Priority zone	Sirajganj Sadar	Canal	-	0.60	0.60
		Beel	19.00	-	19.00
		Flood plain	44.30	-	44.30
		Embayment (Kole)	-	342.70	342.70
		Pond	3.60	1.00	4.60
		Total	**66.90**	**344.30**	**411.20**
	Kazipur, Sirajganj	Canal	52.90	-	52.90
		Beel	890.00	-	890.00
		Flood plain	2500.00	-	2500.00
		Embayment	-	128.00	128.00
		Pond	3.70	1.20	4.90
		Total	**3446.60**	**129.20**	**3575.80**
	Dhunat, Bogra	Canal	20.00	-	20.00
		Beel	80.00	-	80.00
		Flood plain	312.50	10.00	322.50
		Embayment	56.50	-	56.50
		Pond	3.30	2.30	5.60
		Total	**472.30**	**12.30**	**484.60**
	Sariakandi, Bogra	Canal	3.50	14.30	17.80
		Beel	300.00	-	300.00
		Flood plain	1050.70	-	1050.70
		Embayment	-	192.20	192.20
		Pond	4.60	1.20	5.80
		Total	**1358.80**	**207.70**	**1566.50**
	Sub total (priority zone)		**7177.52**	**11370.00**	**18547.52**
Remaining zone	Sonatola, Bogra	Canal	8.00	-	8.00
		Beel	4.00	-	4.00
		Flood plain	13.40	-	13.40
		Embayment	-	12.00	12.00
		Pond	1.90	0.60	2.40
		Total	**27.30**	**12.60**	**39.80**
	Saghata, Gaibandha	Canal	-	-	0.00

Zone	Upazila/District	Habitat type	Area (country side) ha	Area (river side) ha	Total area (ha)
		Beel	10.20	-	10.20
		Flood plain	19.60	-	19.60
		Embayment	184.00	-	184.00
		Pond	2.30	0.60	2.90
		Total	**216.10**	**0.60**	**216.70**
	Fulchari, Gaibandha	Canal	-	-	0.00
		Beel	60.00	-	60.00
		Flood plain	237.00	-	237.00
		Embayment	-	40.10	40.10
		Pond	2.90	0.60	3.50
		Total	**299.90**	**40.70**	**340.60**
	Gaibandha Sadar	Canal	3.00	1.00	4.00
		Beel	600.00	-	600.00
		Flood plain	1933.20	-	1933.20
		Embayment	-	105.10	105.10
		Pond	11.90	0.90	12.70
		Total	**2548.10**	**107.00**	**2655.00**
	Chilmari, Kurigram	Canal	54.00	-	54.00
		Beel	500.00	-	500.00
		Flood plain	1437.60	-	1437.60
		Embayment	-	148.30	148.30
		Pond	3.20	1.20	4.40
		Total	**1994.80**	**149.50**	**2144.30**
	Ulipur, Kurigram	Canal	11.00	-	11.00
		Beel	950.00	-	950.00
		Flood plain	3602.10	-	3602.10
		Embayment	-	889.80	889.80
		Pond	3.40	0.70	4.20
		Total	**4566.50**	**890.50**	**5457.10**
	Kurigram Sadar	Canal	12.00	-	12.00
		Beel	115.00	-	115.00
		Flood plain	211.90	-	211.90
		Embayment	-	443.70	443.70
		Pond	3.60	0.80	4.50
		Total	**342.50**	**444.50**	**787.10**
	Sub total (remaining zone)		**16621.84**	**19145.74**	**35767.58**
	Grand total		**23799.35**	**30515.74**	**54315.10**

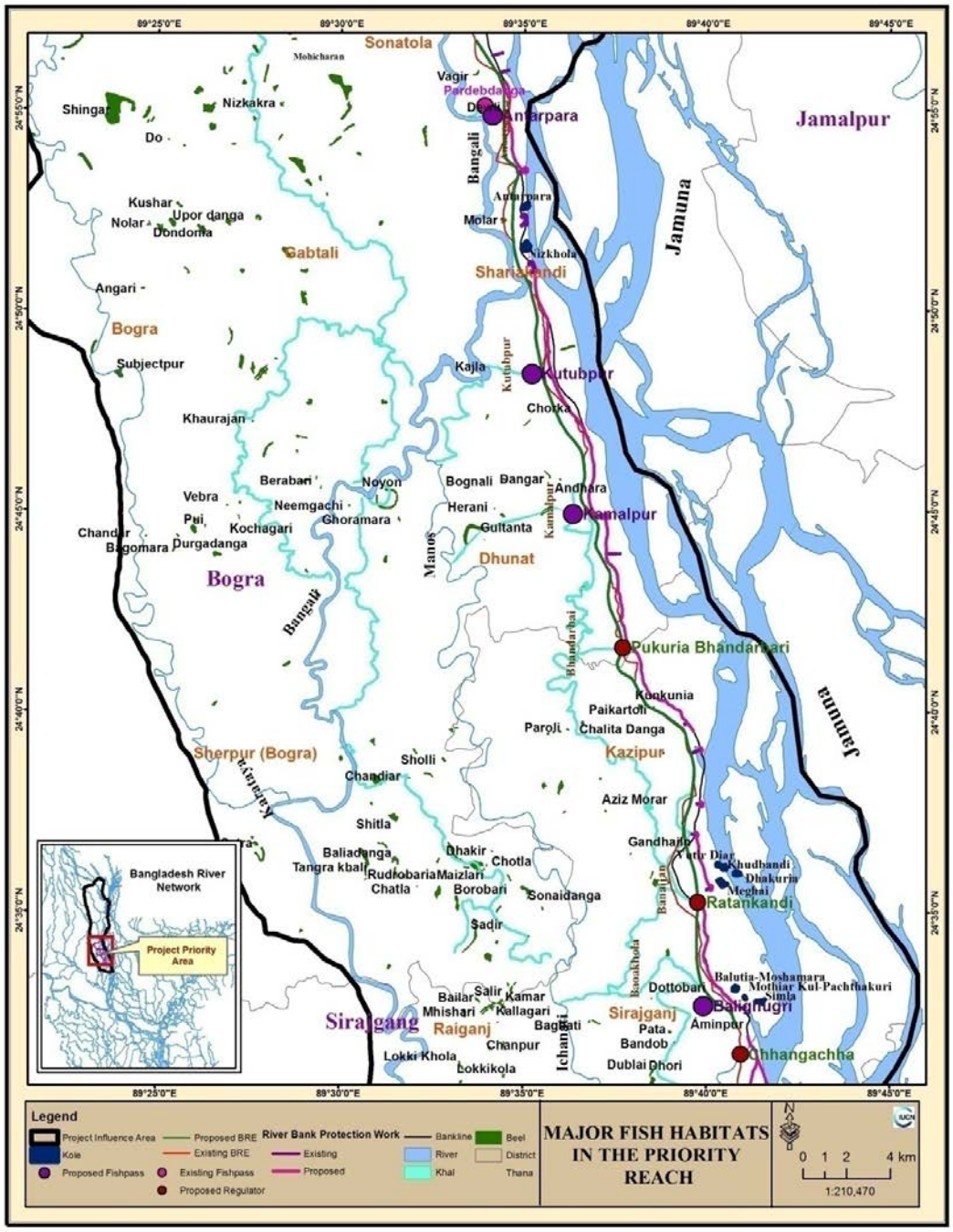


Figure 5.40: Location of the major fish habitats in the Study Area (source: IUCN, 2014)

Fish habitat characteristics of the Jamuna River

As shown earlier that different types of habitats exist in the Jamuna River most of which have been formed due to the complex hydro-morphological characteristics of the river. Each of those has an identical hydraulic profile for which fish community structure is different from one to another, those are: main channel, second level channel, third level

channel, embayment (*Kole*), charland channel, bankside and floodplain (in chars). A total of 149 chars were identified during the field investigation, of which 55 chars fall under priority area. Most of these chars and associated river channels form various kole (embayment) some of which are permanent in nature. **Figure 5.41** (IWFM, 2011) shows the sub-habitats of Jamuna river along the Sirajganj Sadar Upazila. One of the authors of this report was also a co-author of the IWFM, 2011 study on the fish habitat profiling of the Jamuna River.

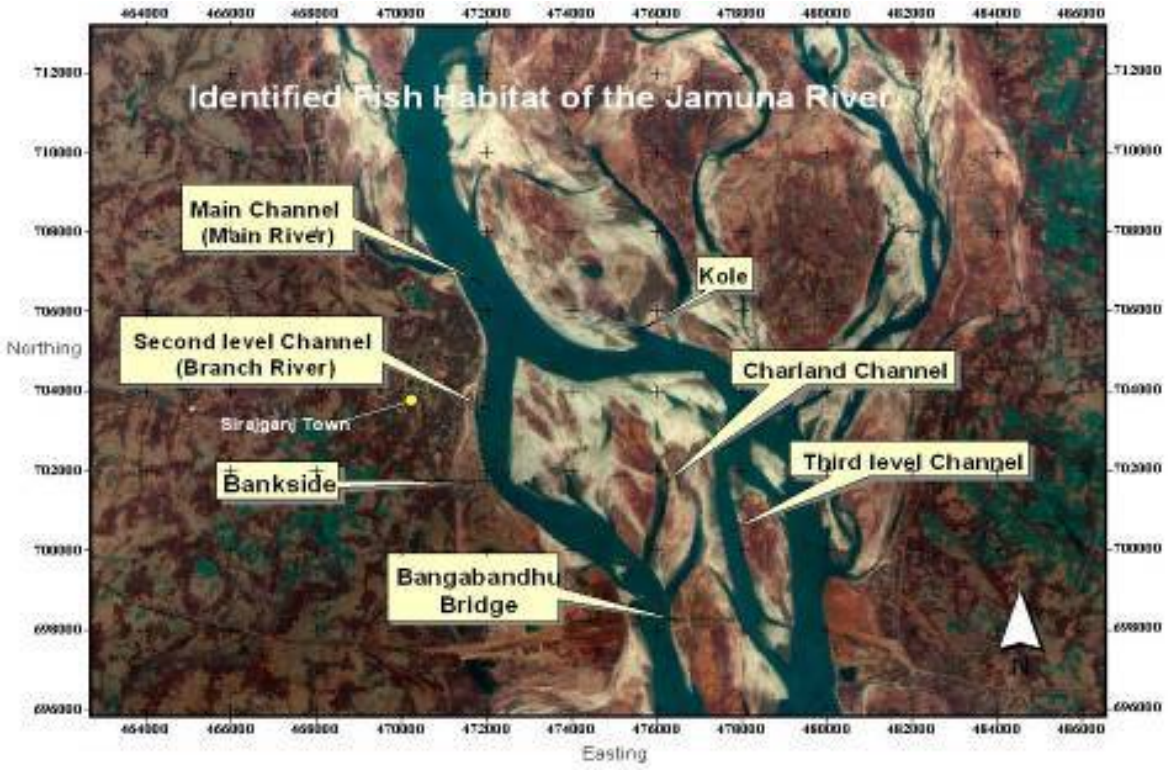


Figure 5.41: Different fish sub-habitats of the Jamuna River (Source: IWFM, 2011)

Hydraulic profile of these important fish sub-habitats of Jamuna river was also prepared during the same study and is furnished in the Baseline report under a separate cover. Fish habitats of the priority zone as well as remaining zone of the Jamuna river got same hydraulic profiling which favors by different fishes.

Characteristics of other fish habitats of the study area

The eddy counter-current system at the confluence of Jamuna with its tributaries is an ideal place for fish assemblages. Bangali river, Ichamati river, Hurasagar river, Ghagot river, Manosh river, Alai river, Dudhkumar river and Teesta river which are connected either directly or through different canals with the Jamuna river forming a fish movement network in the entire study area. Boruah and Biswas (2002) recorded 77 fish species from the confluences of these tributaries of the Upper Brahmaputra river. The confluences are also the passageways for upstream fish migration.

The study area also has numerous seasonal and perennial beels/wetlands, some of which are connected with these rivers through the internal stream networks. Beels of the Brahmaputra basin are weed infested shallow water bodies temporarily or permanently

connected with the main river. Beels act as feeding and breeding grounds for many riverine species. However, beels do have a residential fish population. Besides, a considerable amount of seasonal floodplain area found within the study area which remains inundated for 1-4 months/year with average depth 1-4 ft. Aquaculture practice found comparatively lower in the study area than other parts of the country, mostly because of recurrent flooding. Around 50 percent of the ponds found derelict in the project influence area. Location of different fish habitats and their profile generated during field investigation is furnished in **Table 5.27**.

Table 5.27: Upazila wise name and location of different fish habitats of the Project Influence Area

Upazila/District	Habitat type	Name/Number
Sirajganj Sadar	Canal (natural and manmade)	WAPDA Khal, Doi Vanger khal, Baliaghugri khal, Bahuka khal
	Beel/floodplain	Aminpur beel, Joynagar beel, Charkhada, Chatiantolir beel, Ghuria beel, CNB Beel
	Embayment (Kole)	Simla kole, Mothiar kul - Pachthakuri, Balutia-Moshamara
	Pond	62 no.
Kazipur, Sirajganj	Canal (natural and manmade)	Halot khal, Meghai khal
	Beel/floodplain	Paikartoli beel, Chalita danga beel, Vhut baria beel, Kachihara beel, Pagol kandi beel
	Embayment (Kole)	
	Pond	88 no.
Dhunat, Bogra	Canal (natural and manmade)/river	Manos river, Madhob Danga, Shimul bari khal
	Beel/floodplain	Jagiar beel, Bera danger beel, Houra khali beel
	Embayment (Kole)	Pukuria, Sariakandi, Shamol bari, Baniajan, Adhanagar, Boishakhi, Chunia para
	Pond	99 no.
Sariakandi, Bogra	Canal (natural and manmade)	Kata khal, Kuripara canal, Shalukar canal, Char bati canal
	Beel/floodplain	Dauli beel, Vakir beel, Bera beel, Dikdar beel, Dighol kandi beel, Satbilla beel, Kalaihata beel, Burungir beel, Gojariar beel
	Embayment (Kole)	Antarpara kole, Nich Kola, Khurda boloi, Maiz bari, Taltola, Kazlar kole, Gobindapur, Nolcia, Beragram, Holdia
	Pond	95 no.
Sonatola, Bogra	Beel/floodplain	Saluka beel
	Embayment (Kole)	
	Pond	18 no.

Upazila/District	Habitat type	Name/Number
Saghata, Gaibandha	Beel/floodplain	Kharkhara, Charagata, Ghoridaho, Kachur beel, Beel bosta, Vagir beel, Napiter beel
	Embayment (Kole)	Hatbari, Pansi para, Saghata, Kachuar kole, Bashhata, Shatilla
	Pond	46 no.
Fulchari, Gaibandha	Canal (natural and manmade)/River	Ghaghot river, Alai river, Gopaldoba
	Beel/floodplain	Singrai beel, Gauchulki beel, Khathuria beel, Kabilpur beel, Gun bhuri, Ratanpur beel
	Embayment (Kole)	Khazjani Kole, Coach khali kole
	Pond	67 no.
Gaibandha Sadar	Canal (natural and manmade)	Kamarjani khal, Dara/Canal
	Beel/floodplain	Vela goa beel, Pakhimara beel, Puiya gara beel, Purbo Baroboldia beel, Gidari beel
	Embayment (Kole)	Uttar gidari kole, Gorain kole, Kalaibari, Khazjani, Gidari, Khana bari, Kamarjani, Koraibari, Matikhola
	Pond	261 no.
Chilmari, Kurigram	Canal (natural and manmade)/River	Sorai river, Gidari canal, Antarpur canal
	Beel/floodplain	Chang mari beel, Nakhali beel, Baharer beel, Hasar dala beel, Mohisalar beel, Magurar beel, Shol dukri, Kodal daho beel, Kalir pati, Rajar ghat, Ranigonj (Domer hat), Khaye ghat, Hagritola beel, Koyar beel
	Embayment (Kole)	Agabor kole, Horipur-1, Horipur-2, Hasher beel kole, Bahattor kole, Haser vita kole, Kachkole, Kolapani, Badhdhara, Uttarowari, Bongram
Ulipur, Kurigram	Beel/floodplain	Anantapur beel, Paglir kuri, Nayantapur, Chirokhaoya dola, Malchar par, Kosulla, Singramari, Kossa, Darki mari beel, Chokchoka beel
	Embayment (Kole)	Jolanger kuthi, Anatapur kole, Kolakata, Gujimari
	Pond	51 no.
Kurigram Sadar	Canal (natural and manmade)	Girai nodi/Khal
	Beel/floodplain	Ponchasar beel, Jobber munsher beel, Amluddi hazir beel, Kazol daho, Dubba churi, Gagla beel, Sarisui beel, Dolarpar beel, Sonalir khuthi beel, Hodir beel, Koi ghuri, Duba churi, Kazol daho, Pachgaciar chora, Misti parar beel
	Embayment	Gobindopur, Perbotti pur, Vushakuthi, Sarkerpara

Upazila/District	Habitat type	Name/Number
	(Kole)	vanga, Prothom alo kole, Bangar dola kole, Kath giri kole, Pocha kata kole, Shantiar kole, Rolakata kole, Narayanpur kole, Astoasi kole, Jhumkar kole
	Pond	50 no.

5.4.7.4. Fish Production

Annual total fish production of the study area has been estimated at 8501.92 metric ton of which river contributes the largest share (34 percent) followed by floodplain (27 percent), beel (22 percent), kole (16 percent) and pond culture (01 percent) (**Table 5.28**). Fish production from canals/streams is insignificant as most of those are either dried up during peak dry season or remain closed by flood control structures. Unlike other areas of the country, bulk of the fish production is coming from open water or capture fisheries sources as opposed to fish cultures.

Table 5.28: Annual fish production of the Project Influence Area

Fisheries Type	Fish Habitat	Annual Production (tonnes)		
		Priority Zone (50km)	Remaining Zone (132km)	Project Area (182km)
Capture	River	1138.76	1725.91	2864.67
	Canal (both natural and manmade khals)	5.48	4.94	10.41
	Beel	792.74	1101.22	1893.96
	Flood plain	781.29	1538.67	2319.96
	Embayment (Kole)	463.84	857.52	1321.36
	Sub-total	3182.10	5228.25	8410.36
Culture	Pond	32.98	58.58	91.56
	Sub-total	32.98	58.58	91.56
Total		**3215.08**	**5286.83**	**8501.92**

Source: Field investigation, September 2014, IUCN

Fish production of the Jamuna river has been declining continuously until recently (trend analysis of the FRSS time series data 1984-2012). Annual total fish production decreased approximately 3,200 tonnes in 30 years. A sharp decline of fish production took place during the 80's, a trend that continued until the year 2004-05. After that in last few years fish production has been improving. More specifically, increasing trend of fish production found along the bank of Sirajganj, Gaibandha and Kurigram districts, whereas decreased in Bogra. On the other hand, fish production along the left bank is consistently declining since early 80s. Fish production was decreasing because of increased fishing pressure and a decrease in the extent of floodplain habitats because of the construction of flood control, drainage and irrigation systems, and the consequent obstruction of fry and fingerlings

from rivers. Further declines of fish production are anticipated when all the planned water control projects are completed. Increasing trend of fish production in recent times resulting from enforcing fisheries regulations by DOF, banning fishing during breeding season, improving resources management and establishing sanctuaries.

Among the upazilas at the right bank of the Jamuna river, Kazipur of Sirajganj, Sonatala and Sariakandi of Bogra are the most productive zone due to good connectivity between the main river and its floodplains. According to Lasne *et al.*, 2007; Leigh *et al.*, 2010 and Arthington & Balcombe, 2011 the single most important factor for the persistence of the fish assemblage in an isolated wetland is the flow connection between the wetland and a main stream. Upazila wise fish production by habitat types is furnished in **Table 5.29**.

Table 5.29: Annual Fish Production Status of Different Upazilas of Project Influence Area

Zone	Upazila/District	Habitat type	Production (tonnes)
Priority zone	All	River	1138.76
Remaining zone			1725.91
	Sub-total		2864.67
Priority zone	Sirajganj Sadar	Canal	0.04
		Beel	11.69
		Flood plain	6.65
		Embayment (Kole)	222.76
		Pond	6.90
		Total	**248.02**
	Kazipur, Sirajganj	Canal	3.17
		Beel	547.35
		Flood plain	500.00
		Embayment (Kole)	81.92
		Pond	7.84
		Total	**1140.28**
	Dhunat, Bogra	Canal	1.20
		Beel	49.20
		Flood plain	64.50
		Embayment (Kole)	36.16
		Pond	8.96
		Total	**160.02**
	Sariakandi, Bogra	Canal	1.07
		Beel	184.50

Zone	Upazila/District	Habitat type	Production (tonnes)
		Flood plain	210.14
		Embayment (Kole)	123.01
		Pond	9.28
		Total	**528.00**
	Sub total (priority zone)		**3215.08**
Remaining zone	Sonatola, Bogra	Canal	0.48
		Beel	2.46
		Flood plain	2.68
		Embayment (Kole)	7.68
		Pond	3.84
		Total	**17.14**
	Saghata, Gaibandha	Canal	0.00
		Beel	6.24
		Flood plain	4.02
		Embayment (Kole)	112.24
		Pond	4.93
		Total	**127.43**
	Fulchari, Gaibandha	Canal	0.00
		Beel	36.72
		Flood plain	48.59
		Embayment (Kole)	24.46
		Pond	5.95
		Total	**115.72**
	Gaibandha Sadar	Canal	0.22
		Beel	367.20
		Flood plain	396.31
		Embayment (Kole)	64.11
		Pond	21.59
		Total	**849.43**
	Chilmari, Kurigram	Canal	2.97
		Beel	220.00
		Flood plain	297.58

Zone	Upazila/District	Habitat type	Production (tonnes)
		Embayment (Kole)	64.96
		Pond	7.48
		Total	**592.99**
	Ulipur, Kurigram	Canal	0.61
		Beel	418.00
		Flood plain	745.63
		Embayment (Kole)	389.73
		Pond	7.14
		Total	**1561.11**
	Kurigram Sadar	Canal	0.66
		Beel	50.60
		Flood plain	43.86
		Embayment (Kole)	194.34
		Pond	7.65
		Total	**297.11**
	Sub total (remaining zone)		**5286.83**
	Grand total		**8501.92**

Source: Field investigation, September 2014, IUCN

5.4.7.5. Fishing Effort

Number of fishermen

More than 3500 fishermen were found during the catch assessment survey along the right bank. Fishing is one of the available livelihood options for most of the landless people of the study area. The more people become landless due to river bank erosion they loss their traditional income earning sources and turned into fishermen. Hence, overall catch per fisher is declining due partly to the growth in the number of fishing efforts.

Fishing pattern

The pattern of fishing along the right bank is found similar to the Padma river with a major peak in the pre-monsoon season (April-July) and a second peak in the post-monsoon season (October-December). This largely coincides with the migratory movements of many fish species, particularly amongst the hilsa, catfishes and cyprinids. Catfishes and major carps are much prominent in Jamuna. Major carps are also key indicators of the Jamuna river system. They were originally a dominant group in the river and floodplain eco-system. They are amongst the most highly regarded of the fish species with respect to commercial value and also for aquaculture.

Fishing gears and crafts

An attempt has been made to investigate the fishing gears available in the study area during catch assessment survey. Detail information on the gears specification was also collected in this respect. **Table 5.30** and **Figure 5.42** summarize target fishes and catch per unit effort (CPUE) of different types of fishing gears used in open water fishing. Gill net, long line and cast net got the highest CPUE (2-2.71 kg/hr/gear).

Table 5.30: Fishing gear efficiency

Fisheries Type	Fishing Gears	Target Fish Species	Fish catch per unit effort (CPUE) (Kg/hr/gear)
Capture	Gill net (Phasi jal)	Hilsa and Large Cat fishes (Boal, Rita, Aire, Bagaire)	2.71
	Seine Net/ Ber jal (Kazoli jal)	Kazoli and Mixed SIS*(Baila, Chingri, Poa, Bata, Pabda)	0.13
	Current jal (Mono filament net)	Mixed SIS (Tengra, Puti, Chela, Bashpata, Bele)	0.32
	Lift net (Vesal Jal)	Kazoli and Mixed SIS	0.13
	Push net	Mixed SIS	0.13
	Cast net	Mixed SIS	2.00
	Moi Jal	Mixed SIS	0.13
	Trap (Doair chai)	Mixed SIS	0.13
	Angling	Boal, Chital, Taki, Baim	0.81
	Long line	Boal, Chital, Aire, Guji	2.71

*SIS= Small Indigenous Species

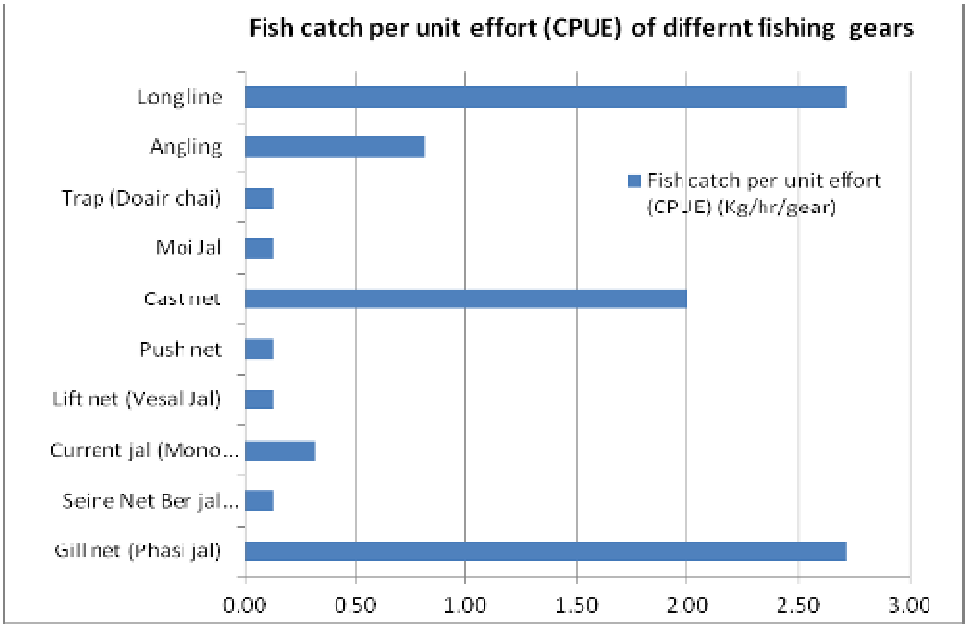


Figure 5.42: CPUE of the different fishing gears

A total of about 1800 fishing crafts were found during catch assessment survey. Some fishing gears like gill nets (for hilsa catch) and seine nets (for mixed fishes) need multiple fishermen for operation. Pictorial view of the fishing crafts and gears are given in the **Figure 5.43**. Operational specification of different fishing gears are furnished in the **Table 5.31.**

Figure 5.43: Different types of fishing gears and crafts of the study area

Table 5.31: Fishing gears and their operational specification

Fishing gears	Total no. of gear	Mesh size (inch)	Length (m)	Fishing depth (m)	Fishermen no. engaged per gear	Average duration/ haul (hr)	Average no. of haul/day
Gill net (Phasi jal)	30	12-14	365-950	14-22	8-12	2.5 – 3	3
Seine Net/	55	0.25	90-275	9-15	7-12	2-2.5	3-6

Fishing gears	Total no. of gear	Mesh size (inch)	Length (m)	Fishing depth (m)	Fishermen no. engaged per gear	Average duration/ haul (hr)	Average no. of haul/day
Ber jal (Kazoli jal)							
Current jal (Mono filament net)	76	1-2	55-140	0.70-1.83	1-2	3-12	1-2
Lift net (Vesal Jal)	14	0.25-1	4.60-7.31	-	1-2	0.083-0.25	36-144
Push net	8	0.25-0.5	-	-	1	0.033-0.07	15-40
Cast net	16	0.5-1	-	-	1	0.07-0.17	10-30
Moi Jal	6	0.25-1	15-24	5-10	2-4	1.5-3	2-5
Trap (Doair chai)	25	-	-	-	1	3-12	1-2

Fishing Season

Hilsa and carps are the dominant species of the Jamuna River. First hilsa fishing starts in June (15th) and continue up to August (15th). Second Hilsa fishing starts in September (15th) and continue up to October (15th). Rest of the time fishermen are mainly engaged in other fishing. Fishing using Ber jal (Kazli jal) continue for 7 months (November –May). Different fishing traps are generally used by the fishermen during dry season months. The seasonality of major fishing types in different habitats are furnished in **Table 5.32**. Fishing season as per gears operated for hilsa fishing is furnished in **Table 5.33**.

Table 5.32: Fishing seasonality of different habitats

Habitat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
River	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
Canal				✔	✔	✔	✔	✔	✔	✔	✔	
Floodplain				✔	✔	✔	✔	✔	✔	✔		
Embayment (Kole)	✔	✔	✔	✔						✔	✔	✔
Beel	✔	✔	✔	✔						✔	✔	✔

Table 5.33: Crafts and gears use for hilsa fishing

Type of Net	Local Name	Craft used	Nos. crew	Operation Season	Fishing type
Set gill net	Gara jal	Kosa	6-8	Nov-Feb	Gilling & Selective
	Dhara jal	Kosha	4-6	May-Oct	Gilling & Selective
	Daba jal	Kosha	4-6	May-Oct	Gilling & Selective
	Bundhi jal	Dingi	10-15	Jan-May	Gilling & Pocket Selective
Drift gill net	Current jal	Dingi/kosha	2-4	Year round	Gilling & Selective
	Gulti jal	Chandi	8-10	May-Oct	Pocketing
	Kona jal	Chandi	8-10	May-Oct	Gilling & Pocketing
Clap net	Shangla jal	Dingi/kosha	2	Aug-Oct	Trapping
	Kharki jal	Kharki	2	Aug-Oct	Trapping
Seine	Jagat ber	Chandi	40-50	Jan-May	Encircling
	Ber jal	Chandi	30-40	Jan-May	Encircling
Lift net	Khara/Bhesal	Dingi	1-2	Jan-May	Lifting

5.4.7.6. Fish Biodiversity

Huge number of stagnant water bodies in chars and river channels support a habitat of rich fish biodiversity. Rahman and Akhter (2007) identified 156 fish species of which, 89 are commercially important and 53 are rare in the river. Thousands of fishermen are also dependent on this river. FAP 17 (1995) carried out a catch assessment survey in Jamuna and Padma rivers during March 1993 - February 1994. The study classified the fish species according to their preference of habitat namely riverine, migratory and floodplain resident. The study identified 68 fish species for Jamuna, out of which 22 were riverine, 18 migratory, and 28 floodplain resident. Catches from Jamuna accounted 60 percent of riverine species, whereas migratory and floodplain resident fish species were equally abundant on the Jamuna comprising 13 percent. Hilsa was the dominant species occupied 31 percent of the catch. The study noted that the number of floodplain species found in the catch during winter highlights the importance of the extensive areas of these large rivers as shelter during a critical period in the hydrological cycle when the area of perennial water on the floodplain is at a minimum. Jamuna river is renowned for its high diversity of the small indigenous fish species (SIS). Some of the fishes like Piyali (Joya) are only now available in Jamuna and its adjacent floodplain (**Figure 5.44**). Large Hilsa is only available up to Sirajganj. A list of abundant species found during the catch assessment survey and determined through FGD in the study area is furnished in the Baseline report that is presented under a separate cover.

Figure 5.44: Small Indigenous Species (SIS) of the Jamuna River

5.4.7.7. Species of Conservation Significance

260 species of fishes were found in the northwestern region of the country of which 143 belonged to small fishes (Fresh Water Fishes of Bangladesh, 2005). More than 41 species of small fishes are on the verge of vulnerability now. These include: Shankha, Fansha, four varieties of Puti, Khayera, Pabda, Panikoi, Bancha, Milon, Yellow Tengra, Bele, Ganges Pangas fish, Bheda fish, Piyali, and Bou fish. IUCN has made a list of threatened species of different areas of Bangladesh. Based on the red list (2000), species of conservation significance in the Jamuna is given in **Table 5.34**. Out of 54 threatened fishes of the country 29 were found in the study area during field investigation.

Table 5.34: List of species for conservation significance

Scientific name	Local name	Common name	CR	EN	VU
Labeo calbasu	Kalbasu	Black Rohu		√	
L. gonius	Gonia	Kuria Labeo		√	
L. boga	Bangon bata	Boga Labeo	√		
L. nandina	Nandil	Nandi Labeo	√		
Cirrhinus reba	Raik, Vagna	Reba			√
Chela laubuca	Lauboka	Indian grass barb		√	
Puntius ticto	Tit puti	Ticto barb			√
P. sarana	Sar puti	Olive barb	√		
Ompok bimaculatus	Kani pabda	Indian Butter Catfish		√	

Scientific name	Local name	Common name	CR	EN	VU
Ompok pabda	Modhu pabda	Pabdah Catfish		√	
Ompok pabo	Pabda	Pabo Catfish		√	
Clupisoma garua	Gharua	Garua Bacha	√		
Eutropiichthys vacha	Bacha	Batchwa bacha	√		
Bagarius bagarius	Bagghair	Gangetic Goonch	√		
Chaca chaca	Cheka	Indian Chaka		√	
Rita rita	Rita	Rita	√		
Mystus aor	Aor	Long whishkeper Cat fish			√
M. seenghala	Guizza Ayer	Gaint river catfish		√	
Monoptenus cuchia	Kuicha	Cuchia			√
Chanda nama	Nama Chanda	Elonget Glass-perchlet			√
Pseudambassis ranga	Ranga chanda	Indian Glassy fish			√
Nandas nandas	Meni	Mud perch			√
Botia dario	Rani	Necktie Loach		√	
Channa marulis	Gajar	Giant snakehead			√
C. gachua	Cheng	Asiatic snakehead			√
Macrognathus aculatus	Tara baim	Lesser –spiny eel			√
Mastacembalus armatus	Sal baim	Tire-track Spinyeel		√	
Notopterus notopterus	Foli	Grey-Featherback			√
Chitala chitala	Chital	Humped Featherback		√	

CR= Critical Endangered ,EN= Endangered, UV =Vulnerable

5.4.7.8. Area of Conservation Significance

FAP 2 (1991) identified six principal carp spawn collecting sites along the Brahmaputra-Jamuna mainly on its right bank (**Figure 5.45**). Important carp spawn/egg collection stations are Ratankandi, Madhupur, Anterpur, Udakhal, Kutubpur, and Gidari. River areas adjacent to these spawn/egg collection stations are considered as carp breeding grounds of the Jamuna river.

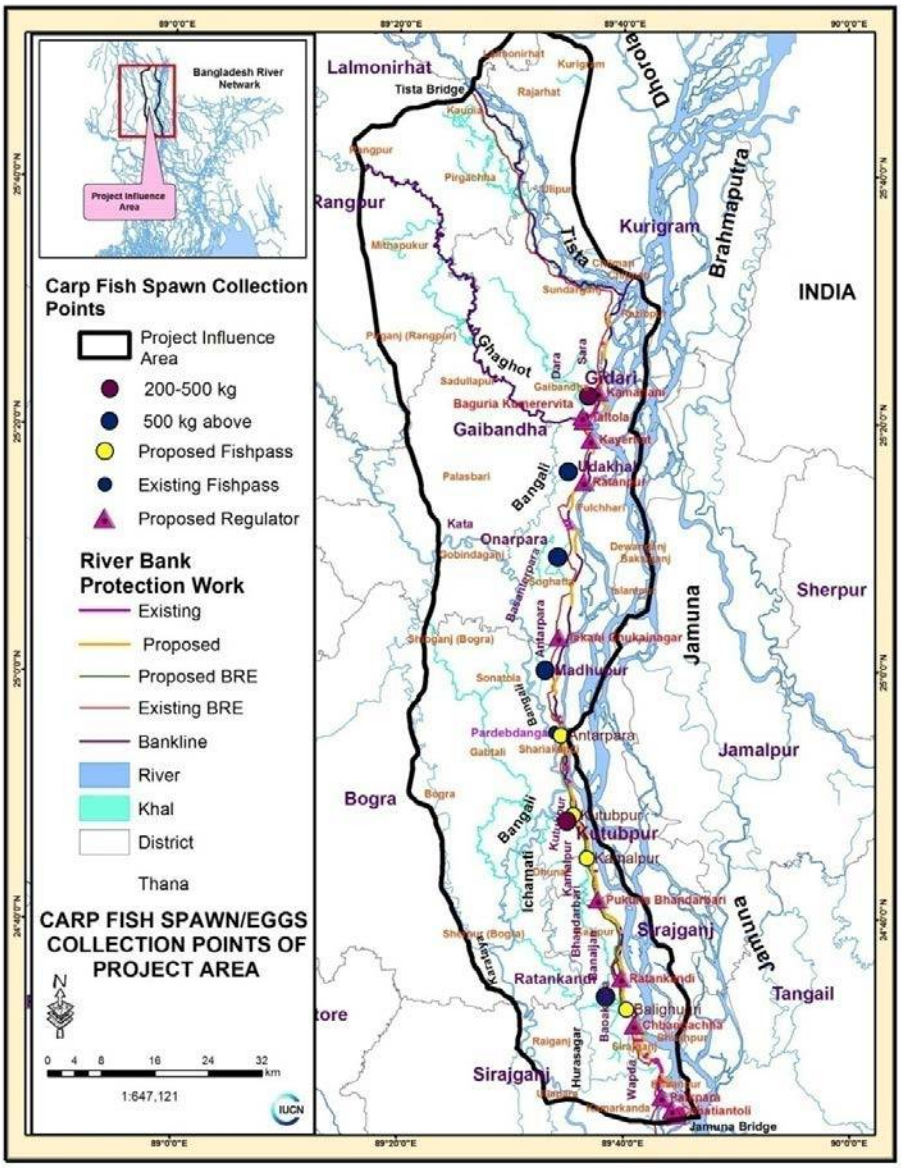


Figure 5.45: Carp Spawn Collection Points of the Jamuna River

Carp spawn collection has been decreasing remarkably over the last three decades (**Figure 5.46**). In the year 2012, total 1514 kg egg/spawn was collected from different breeding spots of the Jamuna river (FRSS, 2012). Spawn/egg collection status of the year 2012 is given in **Table 5.35**.

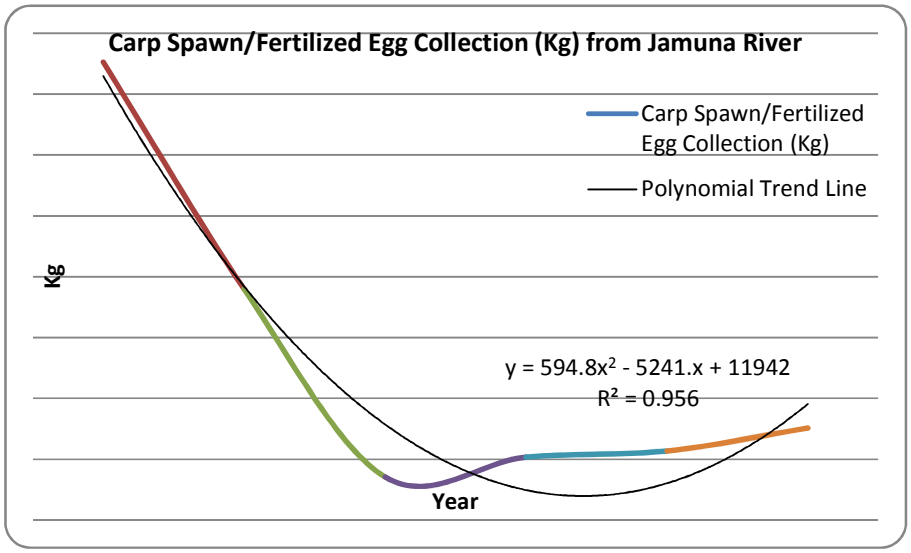


Figure 5.46: Carp spawn collection trend of the Jamuna river

Table 5.35: Carp spawn/fertilized egg collection from Jamuna river in 2012 (FRSS, 2012)

Location	Collection Center	River	Frequency of Spawning Time	Quantity of Spawn/Fertilized Egg Caught (kg)	Sale Rate BDT per kg
Kazipur (Sirajganj)	Singrabari, Khudbandi	Jamuna	1	80	1650
Sirajganj	Vatpiary, Puthiabari, Char Malsapara	Jamuna	2	175	1600
Shajadpur (Sirajganj)	Enayatpur, Sonatali, Hatpachil, Bharakola	Jamuna	1	24	4000
Chauhali (Sirajganj)	Khashpukuria	Jamuna	2	800	1200
Belkuchi (Sirajganj)	Khidramati, Delua, Thakurpara, Jangalia	Jamuna	3	120	2000
Sariakand (Bogra)	Devdango to Sbanbairdo	Jamuna	2	215	1200
Bera (Pabna)	Goghunathpur	Jamuna	3	215	3500
	Total		**1514**		

Note: All the above locations, except Bera, are located in PIA.

The study area has some embayments (kole) and perennial beels which serve as feeding grounds and provide shelter during over wintering period. Important water bodies mentioned by the fishermen during FGD and field investigation are given in **Table 5.36**.

Table 5.36: Areas of Conservation Significance of Priority Reach

Name of fish habitat	Area (in ha) and Location	Distance from project Embankment Alignment
Simlar kole	2.67 ha; Baliaghugri, Sirajganj;	4 km east from proposed Baliaghugri regulator
Mothiar kul/ Pachthakuri kole	3.34 ha; Baliaghugri, Sirajganj;	1.25 km north-east from proposed Baliaghugri regulator
Pukuria kole	6.68 ha; Pukuria, Dhunat, Bogra;	0.75 km east from proposed Pukuria – Vanderbari regulator
Sariakandi kole	0.67 ha; Bogra	0.5 km east from proposed embankment
Boishakhi kole	5.34 ha; Dhunat, Bogra;	1 km east from existing Shamolbaria spur
Chunia para kole	40.08 ha; Dhunat, Bogra;	0.5 km east from proposed Kamalpur regulator
Taltola kole	66.80 ha; Sariakandi, Bogra;	4km east from Sariakandi fish pass, Bogra
Kazlar kole	10.69 ha; Sariakandi, Bogra	2 km east from the proposed embankment

Department of Fisheries (DoF) has established some fish sanctuaries in the study area with the help of local fishing communities to promote sustainable harvesting. The objecttive of the sanctuaries is to avoid fishing in these sanctuaries during spawning periods. These sanctities have no legal status. **Table 5.37** shows a list of existing fish sanctuaries established by the DoF. **Figure 5.47** shows fish sanctuaries established by DoF in the project influence area. Most of these sanctuaries are not well managed.

Table 5.37: Existing Fish Sanctuaries of the Project Influence Area (Source: DoF)

Name of Sanctuary	Location			Distance from River Bank line (km)	Water body Name
	Union	Upazila	District		
Fakirpasha	Nazimkhan	Rajarhat	Kurigram	Tista -2.44	Fakirpasha beel
				Dhorala-12.43	
				Brahmaputra-17.07	
Koteshar	Gharialdanga	Rajarhat	Kurigram	Tista -0.99	Koteshar beel
				Dhorala-14.56	
				Brahmaputra-21.26	
Gharildanga	Rajarhat	Rajarhat	Kurigram	Tista -3.96	Gharildanga
				Dhorala-11.50	
				Brahmaputra-	

Name of Sanctuary	Location			Distance from River Bank line (km)	Water body Name
	Union	Upazila	District		
				18.87	
Mashankura	Annadanagar	Pirgachha	Rangpur	Tista -6.94	Mashankura Mora nodi
				Brahmaputra-26.02	
Harudanga	Chhaola	Pirgachha	Rangpur	Tista -1.40	Harudanga beel
				Brahmaputra-20.56	
Tulshidanga	Latifpur	Mithapukur	Rangpur	Ghaghot -8.96	Tulshidanga beel
				Tista-23.32	
				Brahmaputra-38.49	
Kafri khal	Bara Hazratpur	Mithapukur	Rangpur	Ghaghot -6.54	Kafri khal
				Tista-20.23	
				Brahmaputra-34.30	
Chokchoka	Bara Hazratpur	Mithapukur	Rangpur	Ghaghot -6.46	Chokchoka
				Tista-20.86	
				Brahmaputra-35.69	
Meshta	Sanerhat	Pirgang	Rangpur	Ghaghot -12.05	Meshta
				Tista-27.51	
				Jamuna-32.85	
Atrai beel	Bara Hazratpur	Pirgang	Rangpur	Ghaghot -9.29	Atrai beel
				Tista-22.37	
				Jamuna-31.02	
Serudanga	Mirzapur	Mithapukur	Rangpur	Ghaghot -7.63	Serudanga
				Tista-20.71	
				Jamuna-28.94	
Borobila	Pirgang	Pirgang	Rangpur	Ghaghot -11.42	Borobila
				Jamuna-30.47	
Ghagot river	Ballamjhar	Gaibandha	Gaibandha	Ghaghot -1.63	Ghagot river
				Jamuna-8.51	
Konai Brahmaputra kol	Fazlupur	Fulchhari	Gaibandha	Jamuna -2.27	Konai Brahmaputra kol
				Bangali-7.13	
Talaijan Kalapani	Bonarpara	Sughatta	Gaibandha	Jamuna -5.92	Talaijan Kalapani
				Bangali-4.24	
Nizkakra	Sekher Kola	Gabtali	Bogra	Jamuna -18.00	Nizkakra beel
				Bangali-15.59	
Mohicharan	Digdair	Sonartala	Bogra	Jamuna -8.91	Mohicharan beel
				Bangali-6.64	
Bangali	Fulbari	Sariakandi	Bogra	Jamuna -1.42	Bangali river
				Bangali-0.58	

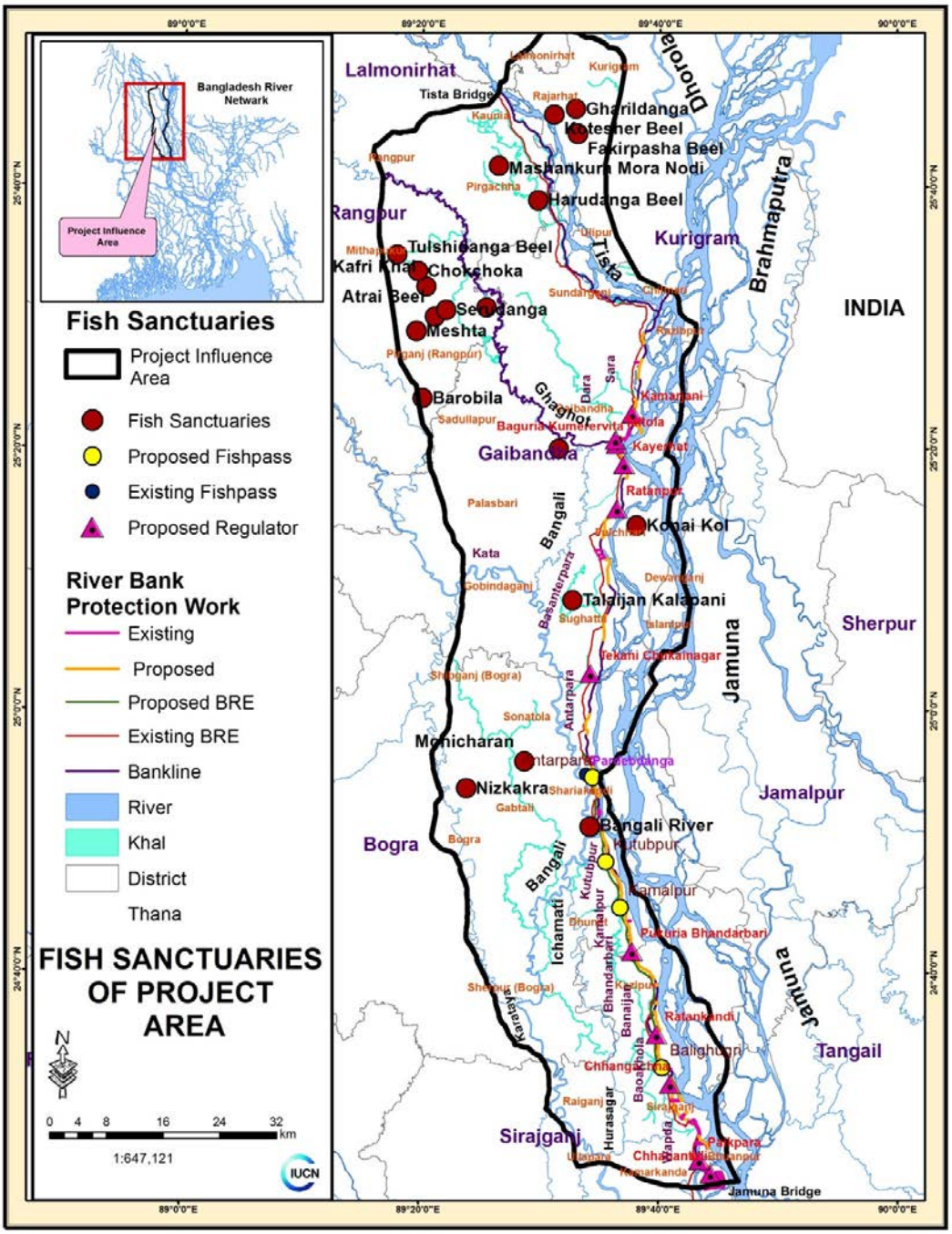


Figure 5.47: Location of the Fish Sanctuaries of Project Influence Area

5.4.7.9. Fish Migration

Some species of fish remain confined to the riverine water, some species migrate from flood plain to the river mostly for breeding, and again some species migrate to the upper reaches during monsoon season. On the basis of the fish behavior, mainly related to migration and reproduction, the fish species of the Jamuna river can be divided in two groups: "whitefish" and "blackfish" (Sao-Leang and Dom Saveun, 1955). "Blackfish"

species are able to tolerate the de-oxygenated water conditions of dry season floodplain water-bodies and may spend most of their lives in a single water-body. These include species such as snakeheads (Channidae), catfish (Heteropneustidae) and climbing perch (Anabas testudineus). "Whitefish" migrate upstream and laterally to the inundated floodplains adjacent to the river channel in the late dry season or early rainy season in order to spawn in the nutrient-rich waters. The eggs and larvae of these species are drifting downstream and are entering the floodplain with the floodwater, where they feed on the developed plankton. At the end of the rainy season, the adults and young of the year escape/migrate to the main river channel in order to avoid the harsh conditions of the floodplain during the dry season. Migration cycle of the floodplain dependent fishes is shown in **Figure 5.48**.

Migration and spawning of the major carp in Bangladesh was first studied by Tsai and Ali in 1983-85 (Tsai & Ali, 1986). They found that the major carp in Bangladesh were comprised of three stocks: the Brahmaputra stock, Padma stock and the Upper Meghna stock. The Brahmaputra stock is the largest stock in Bangladesh, and its spawning grounds are located in the Southern tributaries of the Brahmaputra river in the Assam Hills and Letha Range, Assam, India (Alikhuni, 1957 and Jhingran, 1991). Upstream migration of adult major carps in the Jamuna/Brahmaputra River starts in March, coinciding with the gradual rise of water level. Spawning starts in May, with the onset of the Southwest monsoon, and continues until the end of July (Azadi, 1985, Shaha and Haque, 1976 and Tsai and Ali, 1986).

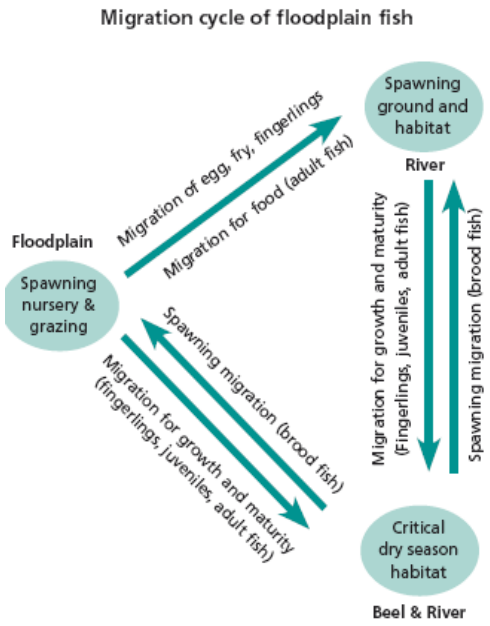


Figure 5.48: Migration pattern of the floodplain fishes of the study area

Connecting canals between main rivers and other water bodies are vital for maintaining successful fish migration at different seasons. Field survey has identified five migration routes (**Figure 5.49**) of the priority area are as follows:

- Jamuna to Icamoti river through Baliaghugri regulator

- Jamuna to Bangali river through Sariakandi fish pass
- Jamuna to Dauli beel to Bangali river through Antarpara regulator
- Jamuna to Manos river through proposed Kamalpur fish pass
- Jamuna to Bangali river via Kutubpur khal through proposed Kutubpur fish pass

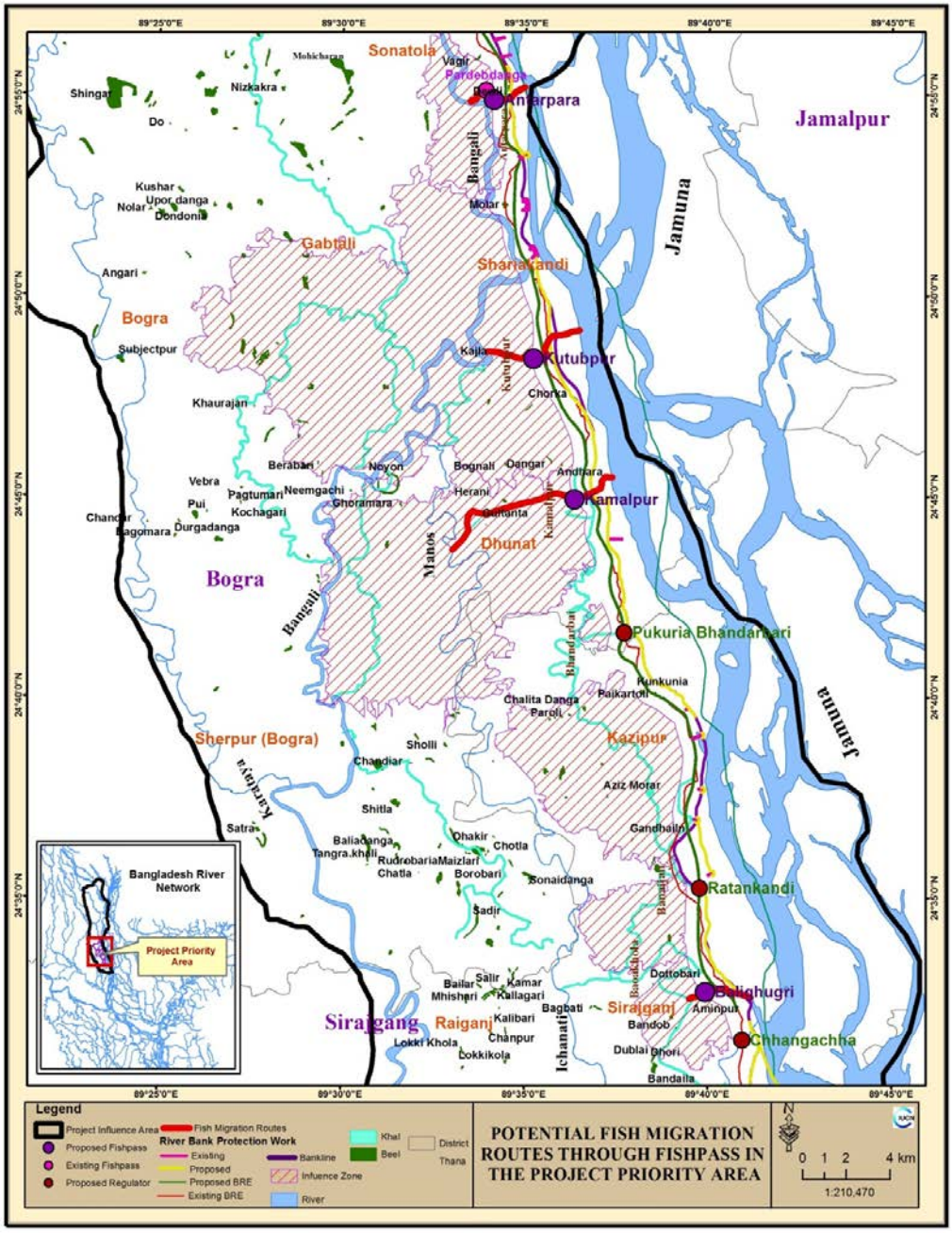


Figure 5.49: Potential fish migration routes through fish pass in the priority area

Among these five, Sariakandi fish pass was built in late 90's to facilitate fingerlings migration into the Bangali river and its adjacent floodplain, which is now almost silted

(**Figure 5.50**). Other four fish migration routes are partially obstructed due to the existing regulators/BRE. The regulator had built for only irrigation purpose and not suitable for fingerlings migration into the floodplain. Basically water velocity and depth are the two controlling factors for effective fish migration through water control structure. Most of the connected khals/streams in the study area are either silted or discontinued in different places which hinder fish migration. Present condition of the khals/canals of the study is furnished in the **Table 5.38**.

Figure 5.50: Sariakandi fish pass (September 3, 2014)

Table 5.38: Present condition of the khals/canals of the study area-potential fish migration routes

Upazila	Name of Khal	Problem	Location related to the existing/ proposed structures
Sirajganj Sadar	Doi Vanger khal	• No connectivity to the countryside. • No existence at the time of consultation as it merged into the Jamuna river	Proposed Baliaghuri regulator
	Balia ghugri khal (Jamuna – Ichamoti River)	Connectivity has been blocked in between Jamuna & Ichamoti River due to the BRE.	Proposed Baliaghuri regulator
	Banaijan Khal (Jamuna-Ichamoti River)	• Need excavation to reduce sedimented condition. • Connectivity with the Jamuna was destroyed by the BRE.	Proposed Ratankandi Box Culvert-1

Upazila	Name of Khal	Problem	Location related to the existing/ proposed structures
	Baoikhola Khal (Jamuna-Ichamoti River)	• Need excavation to reduce sedimented condition. • Connectivity with the Jamuna was destroyed by the BRE.	Proposed Ratankandi Box Culvert-2
	Bahuka khal (Jamuna-Ichamoti River)	Flow was interrupted due to the existing embankment and artificially sedimented by the local people.	A regulator should be Constructed (according to the public opinion)
Kazipur	Halot khal (Jamuna-Ichamoti River)	Flow was interrupted due to the existing ring dam	
Dhunat	Madhob Danga (Jamuna – Beradanga Beel)	Need connectivity to the Jaguria Beel	Proposed Pukuria Vandarbari Regulator
	Shimul bari khal (Jamuna- Jagiar Beel)	• Connectivity with Jamuna was destroyed due to spur • Several Areas were occupied by the local powerful people.	Shimulbari Spur
Sariakandi	Kata khal (Bangali River-Dewli beel)	Need re-excavation for connectivity in between Bangali River and Dewli Beel.	Proposed Anterpara Regulator
	Kutubpur Khal (Jamuna river-Manos River)	• Need Connectivity with Manos river • Need re-excavation	Proposed Kutubpur Regulator

Timing of fish migration

The timing of fish migration is described below.

- 15 March - Broodstock (berried fish) starts migration towards upstream
- 15 April to 30 May - Most of the matured broods complete either partial or full breeding i.e. eggs/spawn, so need connectivity with the adjacent floodplains to facilitate drifting downstream migration.
- 01 to 30 July - Most of the fingerlings enter into the floodplains. After that, only lately recruited spawn/eggs drifted down to the floodplain.
- 15 September to 30 October - Adults and young fishes migrate to the main river channel.

Criteria for fish migration studied by the IWFM, 2011 revealed that flow velocity and water depth play a major role. Depth and velocity preference are also different from

species to species. Charts for depth and velocity preference of different kind and age of fishes are furnished in **Figure 5.51**. Most the connected canals of the study area are either silted or encroached and sometime disconnected from its original water source. Hence, the required flow and depth for movement of fishes are not found in almost all the canals. It can be stated that the following threshold value should be maintained in identified migration routes to sustain fish biodiversity.

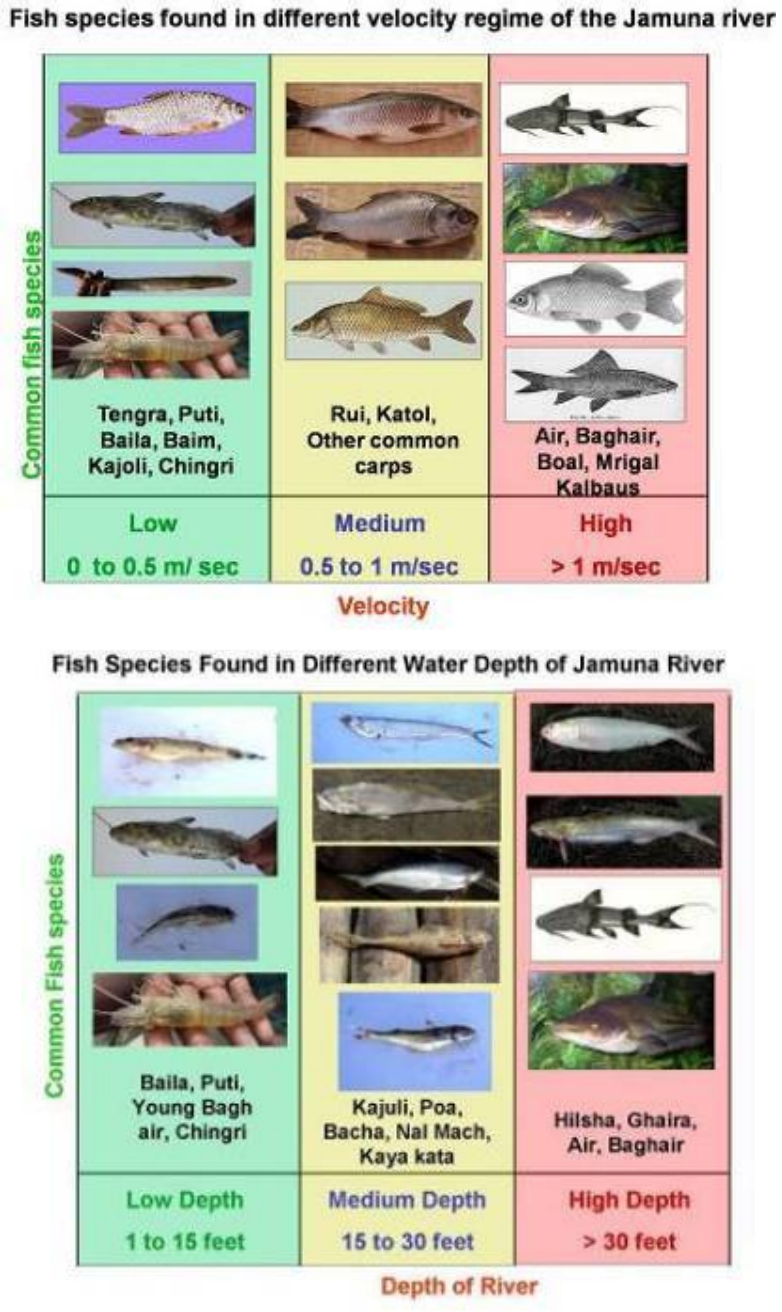


Figure 5.51: Depth and Velocity Preference for Fish (IWFM, 2011)

Other kind of fish migration in Jamuna is longitudinal migration of hilsa, an anadromous fish species. Hilsa migrates from Bay of Bengal to Meghna – Padma – Jamuna river

system for spawning and breeding. Besides the these rivers, hilsa were also abundant in other rivers such as Karnafuly, Feni, Surma, Kusiara, that directly drains to Bay of Bengal (Ahsanullah, 1964, Quereshi, 1968, Haldar et. al. 1992). Hilsa migrates into Jamuna during March-May from Bay of Bengal through the Meghna and the Padma. The range of migration of hilsa in the Brahmaputra River was up to Tezpur, Assam province of India. Migration pattern of the Hilsa fish at different season is furnished in the **Figure 5.52.** It is evident from different sources, that the condition that avails for Hilsa migration is fulfilled the biological requirement (including water depth, water flow, velocity, and water quality) of other riverine catfishes and carps. During the last decades, a major change in the abundance and distribution of hilsa in the inland waters of Bangladesh has occurred.

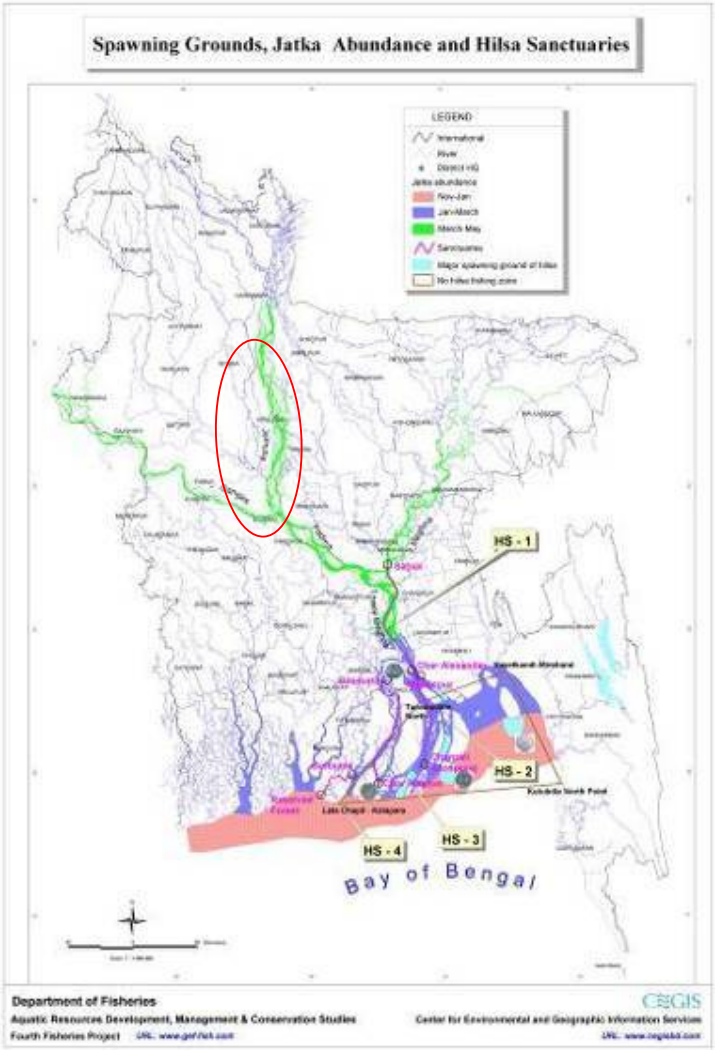


Figure 5.52: Movement of Jatka (Hilsa juvenile) into the Jamuna river (source: FFP, DoF/CEGIS)

5.4.7.10. Fish catch composition

Hilsa occupied only 27 percent of Jamuna catch. Whereas, miscellaneous fishes comprise the highest 67 percent, major carps 1 percent, cat fishes <1 percent, and shrimps-prawns 4 percent (**Figure 5.53**). Among the principal rivers, considerable amount of major carps

(Rui, Catla, and Mrigal) production is coming from Jamuna. Other carps (Ghania, Kalbasu, and Kalia) production is the lowest in this river. Catfish (Rita, Boal, Pangas, Silon, Aor, and Bacha) production is also the highest in Jamuna. Small shrimps are available in almost all rivers, whereas big shrimp production is found comparatively higher than other rivers.

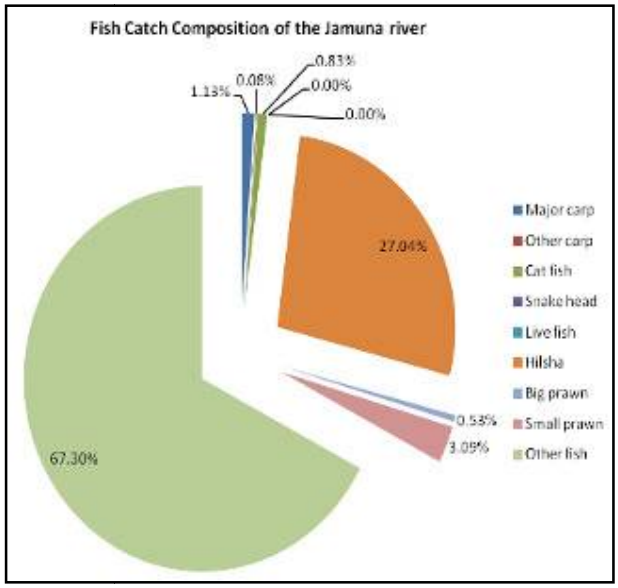


Figure 5.53: Fish catch composition (percent) of the Jamuna River (FRSS, 2012)

5.4.8. Aquatic Invertebrates

In freshwater biology, benthos are referred to the organisms at the bottom of freshwater bodies of water, such as lakes, rivers, and streams. These are the organisms which live on, in, or near the benthic zone. Most organisms in the benthic zone are scavengers or detritivores. Different types of zoo-benthos and phyto-benthos exist in the aquatic part of the study area. Insect larvae constitute the most numerous and diverse zoo-benthos group. Daphnia, Cypris, Cyclops and several copepods are important zooplankters in freshwater and are food of many fish and other crustaceans.

According to a survey of the Department of Zoology, Rajshahi University, the rivers in Bangladesh once thrived with thousands of species of zooplankton and zoobenthos. The number of species has dwindled to 19 species of Rotifer, 12 species of Cladocera and 11 species of Copepoda. Many other indigenous species of plankton, beneficial insects and water worms have become extinct or on the way to extinction (Bhuiyan et. al. 2008). During an earlier study, 11 species of Crustacea (Arthropoda) and Gastropoda (Mollusca) were recorded in the Padma river. Crustaceans included four species: Macrobrachium rosenbergii, M. malcolmsonei and Cancer sp. which are present throughout the year and breed during December-February; and, M. lamarrei which also is present throughout the year and breeds during April-June. Two species of mollusks were collected (Pila globosa and Unio sp.); these species are present throughout the year and breed during April-June. Among non-fin fishes 36 percent were arthropods, 18 percent, mollusks and 45 percent chordates.

Crustaceans are predominantly aquatic; the class Crustacea includes the crabs, shrimps, lobsters, barnacles, water fleas, fish lice, and hermit crabs. The study area supports many important freshwater crabs. Of them Paratelphusa lamelliforns is commonly used as food.

During a benthos study of the Fourth Fisheries Project (Willoughby et. al., 2004) a checklist of common benthos indicator was prepared for the fresh water rivers in Bangladesh; indicator species are shown in **Figure 5.54**.

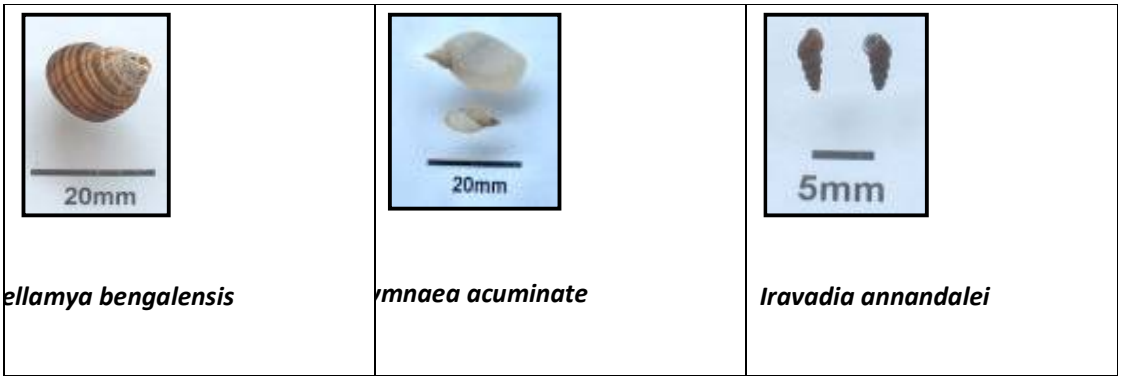


Figure 5.54: Benthos indicator species for fresh water bodies in Bangladesh

These freshwater invertebrates play several important roles in freshwater ecosystem. They are instrumental in cleaning excess living and non-living organic material from freshwater systems, a service that contributes to the overall quality of the freshwater resource. Detritivores that feed on decaying organic matter speed up the decomposition process, maintaining the nutrient load in the freshwater resource. Freshwater mussels filter the water on a microscopic level, removing algae, bacteria, and other microorganisms. Water quality degradation adversely impacts the health of aquatic communities including fish and invertebrates. As a result, benthic freshwater invertebrate communities are valuable indicators of water quality.

5.5. Socioeconomic Aspects

This section describes the existing socio-economic conditions of the project area. This description has been prepared with the help of secondary literature review and field data collection carried out during the EIA study of the Phase I of RBIP. This description will be updated, expanded, and verified as appropriate while conducting the EIAs of the subsequent phases.

5.5.1. Administrative Structure

Each district is headed by a Deputy Commissioner. District administration is a part of the central administration controlled from the capital Dhaka. The Deputy Commissioner at the district administration is supported by three Additional Deputy Commissioners assigned to general administration, revenue and education, besides an additional district magistrate. Police administration is headed by a Superintendent of Police directly controlled from the capital Dhaka. The Deputy Commissioner holds a very wide range of responsibilities. They include revenue management, land administration, district and executive magistracy, public order and safety, law and order, government treasury, licensing, and others.

Each district has a tier of sub-district or upazila. Each sub-district has also full-fledged police administration. Below the sub-district there is union which in turn consists of mauza and revenue village. Bogra has the highest number of sub-districts (12) while Gaibandha has the lowest number of sub-districts (7). The number of unions is also highest in Bogra district (108) and it is lowest in Kurigram district. Mauza or revenue village is a unit comprising the agricultural holdings which provide the basis for revenue collection. **Table 5.39** presents the break-down of the administrative units in the project area.

Table 5.39: Administrative Units in Project Influence Area

District	Upazila or sub-district	Union	Mauza or revenue villages	Villages
Kurigram	9	72	639	1907
Gaibandha	7	83	1093	1244
Bogra	12	108	1672	2706
Sirajganj	9	82	1300	2006

At the district and sub-district levels different governmental offices related to different ministries, directorate and department are located. To ensure law and order there is police department along with para-military force. Related to agriculture and food a number of departments are present – agricultural extension, fishery, livestock and others. The responsibility of communication and engineering lies with roads and highways, telecommunication departments. For health and education there are specific departments; schools and hospitals fall within the purview of these departments. Besides, the departments of forestry, human resource development also exist. Each department at the district level is headed by a district officer, while a coordination body exist that is headed by the Deputy Commissioner to integrate the activities. Similarly the Upazila Nirbahi Officer or the Sub-district Executive Officer coordinates the activities of different offices while each office headed by its respective officer. There are several NGOs functioning in the four districts engaged in health, education, environment, women's empowerment and livelihood sectors. Micro-credit institutions are important segment of this part[15].

At the district level the district council is the representative body, whereas municipality is headed by a chairman. The local body at the sub-district level is called ***upazila parishad,*** headed by a chairman. Below this level there is union ***parishad*** at the village level which is the lowest tier of local body structure[16].

5.5.2. Economy and Occupation Pattern

The districts in the project area are predominantly agricultural although Bogra is slightly different. In Kurigram district about 59 percent households are engaged in farming activities producing varieties' of crops. According to governmental accounts non-agricultural activities in Kurigram district is in a developing stage. The non-farm

[15]BBS (2014), *Statistical Pocketbook Bangladesh 2013*, Ministry of Planning, GOB.and the governmental portal.

[16]BBS (2014), *Statistical Pocketbook Bangladesh 2013*, Ministry of Planning, GOB. and the governmental portal

activities in Gaibandha district are also not significant. In Bogra agriculture and livestock sectors play a vital role in economy although it is considered as the industrial city of North Bengal. About 27 percent of all establishments are located in urban areas of Bogra. Sirajganj is also predominantly agricultural and more than 52 percent households are engaged in agriculture.

Table 5.40 shows the traditional economic activities in non-agricultural sector, because in all four districts the majority of entrepreneurs are engaged in wholesale and retail trade. In Gaibandha 60 percent of non-agricultural enterprises are engaged in wholesale and retail trade. Less than one percent of enterprises represent the modern type, namely bank, insurance and financial establishments[17].

Table 5.40: Business Establishments in Project Influence Area

Districts	Traditional (wholesale & retail trade) as % of total establishments	Modern (bank, insurance and financial) institutions as % of total establishments
Kurigram	58	0.67
Gaibandha	60	0.69
Bogra	53	0.65
Sirajganj	51	0.37

In terms of occupation of the four districts agricultural labor is found to be the most common one which represents 20 percent of the occupation. Construction workers comprise more than 12 percent while transport sector absorbs 8 percent of the households. About 7 percent households are engaged in industrial work, about 6 percent are engaged trade and business while salaried jobs absorbed about 5 percent[18]. At the macro level Bangladesh is slowly changing, its garment sector now absorbs 3 million workers of whom 80 percent are women. Similarly construction and service sector is also gradually expanding, the scenario of four districts share these features to a certain extent.

5.5.3. Education

Educational campaign is a major development initiative in Bangladesh. Introducing universal primary education is a major effort in this regard. Enrolment rate has increased although dropout rate is also high. Child labor is a major reason for high dropout rate at the primary and secondary level. Besides, parents cannot afford educational cost for a long period. About 37 percent of the people that are 5 years or older are still illiterate. About 8 percent of the population has passed school final or the college final

[17] Information of this section are derived from : BBS (2011), *District Statistics 2011, Sirajganj*, Ministry of Planning, GOB, BBS (2011), *District Statistics 2011, Bogra*, Ministry of Planning, GOB, BBS (2007), *Economic Census 2001 & 2003, Zila Series, Zila: Gaibandha*, Ministry of Planning, GOB, BBS (2007), *Economic Census 2001 & 2003, Zila Series, Zila: Kurigram*, Ministry of Planning, GOB, BBS (2011), *Census of Agriculture 2008, Zila Series Gaibandha*, Ministry of Planning, GOB, BBS (2011), *Census of Agriculture 2008, Zila Series Kurigram*, Ministry of Planning, GOB.

[18] Derived from the data of Social Assessment of RBIP, 2014.

examination. Less than 1 percent has been found who have the certificate of tertiary level completion such as Bachelor or Master degree[19].

5.5.4. Urbanization

Among the four districts the scale of urbanization is higher in Bogra district. It has 12 municipalities with urban population of0.59 million. Sirajganj has 6 municipalities with0.32 million urban population. Gaibandha has threemunicipalitieswith0.19 million people. Kurigram has three municipalities with0.27 million urban population. These municipalities provide facilities to the dweller such as access to electricity or sewer system, but their coverage is still limited. However, among the four towns the Bogra town is most bustling compared to other three with the presence of offices, banks and insurance. Hotel establishments are also better in Bogra town. There are colleges and hospitals in these places. In all four districts the office of Deputy Commissioner and other line ministries are located. However, recreational facilities are not too many; fast food shops are more noticeable in Bogra town than other places. Compared to Dhaka or Chittagong the level of urbanization is still much lower even in Bogra let alone the other three districts. Urbanization is not evenly taking place in Bangladesh, thus significant difference can be noticed between the metropolitan areas like Dhaka, Chittagong or Khulna and the district headquarters like Bogra, Sirajganj or Gaibandha.

5.5.5. Norms, Values and Local Institution

Being an agriculturally predominant area the traditional institutions still predominate the northern districts. Nuclear, joint and extended families furnish the basic units of the society. In the villages nuclear families surpass the other types in terms of proportion because of the splitting of land. Joint land ownership is a precondition for the existence of joint families where the budget is commonly shared. More than 80 percent families are of nuclear type[20] . However, the presence of extended families where intense social interactions among the kin take place is still prevailing in the rural and urban areas. In both Muslim and Hindu tradition relatives are placed at a high esteem. Showing respect to the elder is a part of social tradition, however market economy norms sometimes clash with the function of long cherished social tradition. Impoverishment of economic condition is also encouraging the nuclearization of families. The relevance of lineage or *gushti* is on decline and social cohesion is functioning under pressure to some extent. However, the effect of lineage is manifested in political conflict or in other tension ridden situations. Political factionalism is on rise in rural areas, particularly in the distribution of favor among the poor households. In the distribution of Social Safety Net benefits the effect of political factionalism can be noticed. *Salish* or traditional village arbitration bodies are still functioning but its scope is becoming reduced. The role of the local body such as Union *Parishad* is increasing in the dispute resolution in the countryside. Formal political linkage of the local bodies is also on increase in the recent time. Festivals are important part of the life of the society. Among the Muslims two major festivals are *Idl Fitr* and *Idl Azha*. Since the society is predominantly Muslim these festivals are observed pompously. Among the Hindus *Durga puja* is a major religious festival and plenty of *mandap* are installed. There is a Bengali festival called *naba barsha* or welcoming Bengali calendar participated by Hindu Muslim alike.

[19]Derived from the data of Social Assessment of RBIP, 2014.

[20]Derived from the data of Social Assessment of RBIP, 2014. ; Also see Aziz KMA, *Kinship in Bangladesh*, ICDDRB, and Key Informant Interviews.

5.5.6. Historical Places

The history of the districts in project area is quite old and several entities and aspects have acquired significances in the mind of the people and society with a fair amount of imprint on their memories. The Mahasthangarh of Bogra boasts its ancientness being the capital of Pundranagara during the 4th to 8th century BC. There are Islamic relics that attract the attention of tourists. The Kherua mosques, tomb of Shah Sultan Balkhi, and Parshuram's palace are a few historical sites in Bogra. Sirajganj district has also a few important archeological sites that are historically prominent. These are also related to the names of saints, sacred places like temple or the building used by some renowned poet. Rabindranath Tagore used to use Kuthi Bari at Shahjadpur as his office cum residence, there is a homestead of mythical figure Behula, Shiva temple and the tomb and mosque of Khawja Pir Saheb of Enayetpur. Gaibandha district includes the house of Naldanga Zamindar along with its Shiva Linga made of black basalt, Vrisa Mandir of white stone and a large pond, Mosque of Shah Sultan Gazi at Mirer Bagan. Temples, zamindar's or lord's house or mosque drew attention of the tourists at Kurigram which include three domed mosque at the village Majider Par of Bhurangamari, image of Kali at Dasherhat, images of Mangal Chandi, Kamakkha Devi, Laksmi and Sattanarayan in front of the Bhetarbandh Zamindar Bari[21]. However none of these places are in the immediate vicinity of the project interventions.

5.5.7. Agriculture

Jotedari holdings characterized the agrarian structure of the northern districts of the Country. This category of land holders represented large landholders who used to give their land to the small peasants on share-crop basis. In local language it was called ***barga chash*** meaning share cropping. The *jotedar* or the owners of the lands used to take half of the yields by virtue of ownership. It created deep resentment among the cultivators and in mid–twentieth century famous ***tebhaga*** movement was waged by the small peasants who demanded the distribution of the yield into three parts, one would be for the owner of the land, second part for the cultivator and the remaining part who bears the cost of cultivation. The struggle was bloody which led to death of small peasants. Gradually *jotedari* system came to an end and there emerged the rich landowning class who engaged wage labor for cultivation under their own supervision. With the introduction of Green Revolution it gained momentum since it was lucrative. However, at present agriculture has become less lucrative since the input cost has risen very high. However northern districts are famous for vegetable, paddy, jute and other crops. Once jute was a very popular crop and fetched many foreign merchants here. With increasing population the size of the agricultural holding is becoming smaller and the proportion of the owner cultivator is also increasing[22].

Bangladesh is situated in the north of the Bay of Bengal and is predominantly low lying. The alluvial plains of the delta are formed by the Ganges, the Brahmaputra and the Meghna rivers. The economy of the country is primarily dependent on agriculture. About 71 percent[23] of the total population lived in rural areas and are directly or indirectly

[21] The account of this section is drawn from the following: BBS (2011), *District Statistics 2011, Sirajganj*, Ministry of Planning, GOB, BBS (2011), *District Statistics 2011, Bogra*, Ministry of Planning, GOB, *amardesh.com/zila_**kurigram**.php, amardesh.com/zila_**gaibandha**.php.*

[22] Please also see Bose S. (1986), *Agrarian Bengal: Economy, Social Structure and Politics*, Cambridge University Press.

[23] http://www.tradingeconomics.com/bangladesh/rural-population-percent-of-total-population-wb-data.html

engaged in a wide range of agricultural activities. The contribution of agriculture to GDP growth was 33 percent in 1980-81, 25 percent in 2000-2001 and 21 percent in 2005-2006.[24] The latest Household Income and Expenditure Survey (HIES), 2010 reported 17.6 percent of the country's population currently lives in extreme poverty -- defined as those people whose total expenditure is equal to the food poverty line (the cost of a basket of goods amounting to the consumption of 2,100 Kcal per person day). More food production is needed to improve the livelihoods of people who are still lying below poverty level (25 million or more), which directly related with flood control measure in west bank of Brahmaputra/Jamuna river. No major townships except Sirajganj have been established in the project influence area due to its vulnerably to river erosion and as such the areas/populations are mostly rural, so around 70 percent population dependent upon agriculture farming. The share of agriculture in annual family income of rural households lived in west bank of Jamuna is 82 percent and small business only 8 percent[25]. So their livelihoods are practically agriculture based which is under threat of breaching of embankment almost in every year (flood damage of crops), river erosion, sand deposit and opening of new watershed that washed-away fertile crop lands.

The construction of river embankments to protect agricultural land from seasonal flooding/inundation is a common and continuous phenomenon of the country. Usually the silty alluvium deposit caused by flooding is brought under cultivation within 2-3 years. The floodplain areas are traditionally fertile land with alluvium deposit but generally less productive due to depth of flood water level during the monsoon. Before construction of embankment in 1960 the traditional crops grown in the area are broadcast aman rice[26] (low yield potentials 1.0 – 10.5 t/ha during productive year), Aus rice also with low yield and local aman rice that was mostly vulnerable to flood damage. Some other crops like grass pea, corn, gram pulse, chili, and sugarcane were the crops in the dry season. The farmers were very poor and under threat of migration from their locality due to lack of livelihood support. After construction of embankment the scenario of crops and cropping and the livelihoods of people started to change. The flood plain areas became productive by started to produce good local aman rice reducing the areas of broadcasted deep-water aman rice. The dry land crops like vegetables and oilseeds started to occupy the areas of corn/gram pulse and sugarcane. In 80's major crops were early aus rice, jute, deep-water aman rice, gram pulse, corn, mustard, rabi pulses, rabi groundnut and sugarcane. Transplanted aman rice is sometimes planted on silty alluvium or silty soils as the floodwater recedes, and boro paddy is grown locally in depressions, usually using traditional irrigation devices or hand pumps. There were ample surface water and groundwater resources, but they are difficult to exploit for irrigation except by small-scale traditional devices or hand pumps because of shifting river channels and changing land qualities. At present the farmers are mostly cultivating High Yielding Varieties (HYV) of Transplanted Aman and HYV Boro rice instead of local low yield potential varieties, Aus[27] almost wiped out from the area. Among the popular crops now farmers have

[24] Updating Poverty Maps of Bangladesh, The World Bank, Bangladesh Bureau of Statistics, World Food Program, 2009

[25] Annual Report 2013-14, Second Crop Diversification Project, DAE, Khamarbari, Dhaka

[26] Deepwater paddy cultivated in low land with more than 180 cm water depth during monsoon, Transplanted aman rice cultivated in medium land during monsoon and aus rice either broadcast or transplant cultivated during pre-monsoon season (Mar-June)

[27] Three types of rice is grown in the country: Aus rice either transplanted or broadcast cultivated in pre-monsoon period (Mar to June); Aman rice either transplanted or broadcast in monsoon period (July to Oct); and Boro rice cultivated in dry/winter season (Nov to Feb).

adopted boro rice, Aman rice, Maize, potato, mustard, chili, wheat, jute, and vegetables. The yield of rice has increased from 1.5 – 2.0 t/ha to 3.5 – 6.0 t/ha. Similarly the production per unit area of other popular crops potentially increased.

The area is still under threat of river breach the embankment during the monsoon that damages transplanted aman crop fully or partially. The breaching not only floods the crops, but also damages the fertility of the agriculture lands by depositing river sand. The proposed embankment would certainly restrict the occasional floods and sand cover of crop land and farmers would have good yield of transplanted man (T. Aman) rice regularly which is presently irregular and governed by flood. It is expected that the proposed construction of embankment would not only increase the area of T. Aman cultivation but also increase the yield levels of T. Aman by 10-15 percent as the farmers would invest more when they ensure about no flood damage.

6. Impact Assessment

This Chapter discusses potential and mostly typical impacts of the RBIP on the key environmental parameters. The discussion has benefitted from the detailed impact assessment carried out for the Phase I (Priority Reach) of the RBIP.

6.1. Overview of Potential Impacts

After its completion, the project is expected to have a multiple of very positive and beneficial effects on the people and economy of the area. First of all, the river bank protection will discontinue the recurring bank erosion and the associated loss of homesteads and cultivated land. Then, the improved embankment will also significantly reduce the flooding events and associated economic losses. Finally, the road constructed on the embankment will facilitate local mobility as well as long-distance transportation. All of these factors are likely to have very profound positive impacts on the local people and their economic condition. In addition, increased safety against river bank erosion and flooding as well as improved mobility and connectivity will bring in further development and investment in the area that is currently not possible because of the area vulnerability.

Most of the proposed interventions pertain to rehabilitation and improvement of the existing embankment and hence the potentially negative environmental impacts will primarily be limited to the construction activities.

The key potentially negative impacts and issues associated with the construction phase of the proposed program include changes in aquatic habitat because of riverbank protection works as well as from sand extraction from the river bank; changes in land form and land use because of rehabilitation of existing and construction of new embankment; land acquisition for construction of new embankment and resulting displacement of people; use of natural resources particularly river sand; health and safety risks associated with handling of hazardous materials and operation of construction machinery; air quality deterioration because of operation of construction vehicles and machinery as well as excavation activities; noise generation caused by the operation of construction machinery and vehicles; contamination of land and water caused by wastes generated from construction activities and camp operation; loss of trees that need to be removed for construction of embankment; risk of accidents associated with movement of construction vehicles and machinery; blockage of local routes caused by construction activities; and impacts on sensitive receptors such as schools along the embankment.

The potentially negative impacts associated with the O&M phase of the project include changes in river morphology caused by riverbank protection; changes in aquatic habitat caused by riverbank revetment; blockage of local routes caused by the embankment and road, effects on water bodies and associated habitats caused by disruption of hydrological and ecological connectivity between main river and internal rivers, beels and khals; noise generation and air quality deterioration caused by the vehicular traffic on the embankment road; risks of accidents associated with vehicular traffic on the embankment road; and increased usage of agro-chemicals caused by agricultural intensification due to enhanced protection against riverbank erosion and flooding.

6.2. Assessment Methodology

The assessment of effects and identification of residual impacts takes account of any incorporated mitigation measures adopted due to any potential impact of Project activities, and will be largely dependent on the extent and duration of change, the number

of people or size of the resource affected and their sensitivity to the change. Potential impacts can be both negative and positive (beneficial), and the methodology defined below will be applied to define both beneficial and adverse potential impacts.

The criteria for determining significance are generally specific for each environmental and social aspect but generally the magnitude of each potential impact is defined along with the sensitivity of the receptor. Generic criteria for defining magnitude and sensitivity used for the Project are summarized below.

6.2.1. Magnitude

The assessment of magnitude shall be undertaken in two steps. Firstly the key issues associated with the Project are categorized as beneficial or adverse. Secondly, potential impacts shall be categorized as major, medium, minor or negligible based on consideration of the parameters such as:

- Duration of the potential impact;
- Spatial extent of the potential impact;
- Reversibility;
- Likelihood; and
- Legal standards and established professional criteria.

The magnitude of potential impacts of the Project shall be identified according to the categories outlined in **Table 6.1**.

Table 6.1: Parameters for Determining Magnitude

Parameter	Major	Medium	Minor	Negligible/Nil
Duration of potential impact	Long term (more than 35 years)	Medium Term Lifespan of the project (5 to 15 years)	Less than project lifespan	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains constant
Legal standards and established professional criteria	Breaches national standards and or	Complies with limits given in national standards but breaches	Meets minimum national standard	Not applicable

Parameter	Major	Medium	Minor	Negligible/Nil
	international guidelines/obligations	international lender guidelines in one or more parameters	limits or international guidelines	
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

6.2.2. Sensitivity

The sensitivity of a receptor shall be determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding area. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table 6.2**.

Table 6.2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very Severe	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
Severe	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Mild	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low / Negligible	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation

6.2.3. Assigning Significance

Following the assessment of magnitude, the quality and sensitivity of the receiving environment receptor shall be determined and the significance of each potential impact established using the potential impact significance matrix shown in **Table 6.3**.

Table 6.3: Assessment of Potential Impact Significance

Magnitude of Potential impact	Sensitivity of Receptors			
	Very Severe	Severe	Mild	Low / Negligible
Major	Critical	High	Moderate	Negligible
Medium	High	High	Moderate	Negligible

Magnitude of Potential impact	Sensitivity of Receptors			
	Very Severe	Severe	Mild	Low / Negligible
Minor	Moderate	Moderate	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

6.3. Selection of Important Environmental and Social Components (IESCs)

Environmental and social parameters likely to be impacted by the project interventions are termed as Important Environmental and social Components (IESCs). IESCs have been selected based on the rationale of impact for each component during pre-construction, construction and post-construction stages. A scoping process was followed for selecting IESCs which are likely to be impacted by the proposed interventions of RBIP. Scoping was done in two stages. Individual professionals of EA study team made a preliminary list of the components pertaining to their disciplines, which could be impacted by the project. The second stage included scoping sessions where stakeholder perceptions have been obtained about those environmental and social components. Professional judgment of the EA team members as well as the stakeholder opinions obtained in the scoping sessions was considered in selecting the IESCs. Area likely to be impacted by the proposed interventions of the RBIP was delineated in consultation with the feasibility study team members in addition to feedback received from the local people during baseline consultation and stakeholder consultation meeting. The entire area influenced by proposed sub-projects under RBIP was considered as the potential area to be impacted.

6.4. Summary of key project impacts on Important Environmental Components (Key Environmental Parameters)

The potential impacts of the project on the IESCs (key environmental parameters) that have been identified as part of the EIA of the Phase I (priority reach) but broadly valid for the remaining phases are listed in **Table 6.4**. Also given in the table is the significance of each impact based upon the criteria defined in **Section 6.2** and **Tables 6.1** to **6.3**. In the subsequent sections, these impacts are discussed and guidelines included for the EIAs of the later phases of the RBIP.

Subsequent EIAs for additional project phases should modify and further detail out this high level analysis as applicable to each phase, starting with a review of what the relevant IESCs are for that phase, based on professional judgment and public consultations.

The additional phase EIAs should also incorporate into their impact assessment a review of monitoring results from the priority reach phase, and adjust this preliminary impact identification as appropriate based on the findings.

Table 6.4: Summary of Potential Impacts and their Significance

Potential Impacts on IESCs	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance after Mitigation
Control of Riverbank Erosion	Long term	Local	Yes	Certain	Major	-	High positive	High positive
Improved flood protection	Long term	Local	Yes	Certain	Major	-	High positive	High positive
Impacts related to Project siting								
Land cover and land use changes	Long term	Local	No	Certain	Major	Mild	Moderate negative	Low negative
Loss of natural vegetation and trees	Long term	Local	Yes	Certain	Major	Mild	Moderate negative	Low negative
Loss of riverbank/aquatic habitat	Long term	Local	No	Likely	Medium	Mild	Moderate negative	Low negative
Loss of flood plain habitat	Long term	Local but beyond project foot print	No	Certain	Major	Severe	High negative	Low negative
Drainage congestion and water logging	Long term	Local but beyond project foot print	No	Likely	Medium	Mild	Moderate negative	Low negative
Land acquisition and resettlement	Long term	Local	No	Certain	Major	Severe	High negative	Low to moderate negative
Loss of agriculture	Long term	Local	No	Certain	Major	Severe	High negative	Low to moderate negative
Impacts on Community Facilities and Places of Religious Significance	Long term	Local	No	Certain	Major	Severe	High negative	Low to moderate negative
Blocked access because of road and embankment	Long term	Local but beyond	No	Certain	Major	Mild	Moderate negative	Low negative

Potential Impacts on IESCs	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance after Mitigation
		project foot print						
Improved road connectivity	Long term	Local	No	Certain	Major	-	High positive	High positive
Environment impacts during construction phase								
Impacts of borrowing of material	Short term	Local	Yes	Certain	Major	Severe	High negative	Low negative
Air pollution	Short term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Noise	Short term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Water pollution	Short term	Local	Yes	Certain	Major	Severe	High negative	Low negative
Soil contamination	Short term	Local	Yes	Certain	Major	Severe	High negative	Low negative
Solid wastes and hazardous wastes	Short term	Local	Yes	Certain	Major	Severe	High negative	Low negative
Impacts on aquatic habitat	Short term	Local	Yes	Certain	Major	Severe	High negative	Low to moderate negative
Impacts on floodplain habitat	Short term	Local	Yes	Certain	Major	Severe	High negative	Low negative
Impacts on *charland* habitat	Short term	Local	Yes	Unlikely	Minor	Low	Minimal	Minimal
Site clearance and restoration	Short term	Local	Yes	Likely	Medium	Severe	Moderate negative	Low negative
Social impacts during construction phase								
Impacts on cultural heritage	Short term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Impacts on community facilities	Short term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Occupational health and safety	Short term	Local	Yes	Certain	Major	Severe	High negative	Low to moderate negative

Potential Impacts on IESCs	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance after Mitigation
Community health and safety	Short term	Local	Yes	Certain	Major	Severe	High negative	Low to moderate negative
Environmental impacts during O&M								
Changes in river morphology	Long term	Local	No	Likely	Nominal	Severe	Minimal Negative	Minimal negative
Loss of ecological connectivity	Long term	Local	No	Certain	Major	Severe	High negative	Low negative
Drainage congestion and water logging	Long term	Local	No	Likely	Medium	Mild	Moderate negative	Low negative
Generation of solid waste	Long term	Local	Yes	Certain	Major	Severe	High negative	Low negative
Air pollution	Long term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Noise generation	Long term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Water pollution	Long term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Risk of embankment breaches	Long term	Local but beyond project foot print	Yes	Likely	Major	Very Severe	Critical	Low to moderate negative
Social impacts during O&M								
Changes in agricultural pattern	Long term	Local	Yes	Likely	Medium	Mild	Moderate negative	Low negative
Community health and safety	Long term	Local	Yes	Certain	Major	Severe	High negative	Low to moderate

6.5. Significant Environmental Impacts from Project Siting

6.5.1. Control of River Bank Erosion

During the last four to five decades, Jamuna river has been undergoing strong metamorphosis in width, bank erosion, braiding intensities. Recent researches suggest that sediment slugs generated by 1950 Assam earthquake was the main driver for those rapid changes. In particular, the riverbank erosion has been resulting in loss of valuable land along both of the river banks.

The riverbank erosion not only causes loss of land, but also attacks the already dilapidated BRE, causing frequent beaches that in turn result in flooding of the BRE-protected floodplain causing substantial losses to private and public assets as well as crops and cultivation fields.

As detailed in the Phase I EIA, the revetment works envisaged under the proposed RBIP (Phase I) will help avoid the above-mentioned losses and will result in saving of about US $ 17.33 million per year – the annual losses that are likely to take place caused by the riverbank erosion if no protective measures are undertaken under the Priority Reach works.

The EIAs of the later phases of RBIP will include detailed analysis of the riverbank erosion along the remaining reaches and the associated monetary loss - the amount that would be saved once the riverbank protection works under the later phases of RBIP are implemented.

6.5.2. Improved Flood Protection

As already described in **Section 1.1**, prior to the BRE construction, overbank spills regularly caused flooding to a 240,000 ha area along the right bank of Jamuna. Originally, the BRE had a setback distance of about 1.5 km from the Jamuna river bankline. Over the years the embankment has been increasingly under attack from bank erosion causing the embankment to breach at several locations. After such breaches of the embankment, it needs to be retired back away from its original alignment and reconstructed.

As detailed in the EIA of the RBIP Phase I, the embankment rehabilitation and reconstruction works envisaged under the proposed RBIP will help avoid the losses caused by the repeated floods and will result in saving of about US $ 164 million per year – the annual losses that are likely to take place caused by the flooding if no protective measures are undertaken. *The EIAs of the later phases of RBIP will include details of the projected losses associated with the flooding of the area and the amount that would be saved once the new embankment is constructed.*

6.5.3. Land Cover and Landuse Changes

Potential impacts. As already discussed in **the baseline chapter**, the project influence area is dominated by cultivation and associated activities covering 53 percent of the area, followed by settlements that cover about 29 percent of the area.

The cropping intensity is already quite high in the project influence area (211 percent against the national average of 190 percent). Therefore there is a limited opportunity for any increased cropping intensity once the RBIP is complete providing enhanced security against floods caused by the Jamuna river. However, cropping pattern could be changed with increasing trend of high value crops.

Based upon the changed cropping pattern and increased yield as mentioned above, there will be an increase in the agricultural income from the project influence area. While the increased agricultural income will positively impact the livelihood of the local farmers, the increased cropping intensity and changed cropping pattern discussed above will potentially cause an increased use of agro-chemicals.

The EIAs for the later phases of RBIP, the above mentioned economic benefit and increased usage of agro-chemicals will be quantified.

The increased use of agro-chemical can potentially cause an enhanced level of soil and water contamination and pose health hazards for the farm workers and also for the communities in the project influence area. Significance of these impacts has been determined as **Moderate** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The integrated pest management programs (IPM) are already under implementation in Bangladesh. Linkage with these programs will be facilitated to address any increase usage of agro-chemicals in the area.

In addition to the above, an integrated pest management plan (IPMP) will be prepared by the RBIP during the project implementation but before its completion. The key objectives of the IPMP will include: i) to increase the productivity of agricultural crops through IPM and Integrated Plant and Soil Nutrient Management (IPSNM) practices, that includes the rational use of chemical pesticides and nutrients; ii) to raise awareness of all stakeholders about the IPM approach to crop management, and train extension agents and farmers to become practitioners of IPM; and iii) to determine the level of pesticide residue on agricultural crops in normally-treated and IPM-treated areas and disseminate information to stakeholders on the usefulness of undertaking IPM practices. The key elements of the IPMP will include: i) awareness/ dissemination of Information; ii) training of facilitators (ToF) and establishing of Farmer Field Schools (FFS); iii) implementing Integrated Plant and Soil Nutrient Management (IPSNM) techniques (including organic fertilizers, composting and worm culture); iv) determining pesticide residue on crops; and v) strengthening institutional capacity on IPSNM.

Furthermore, the Information, Education, and Communication (IEC) component of the Social Development Plan (SDP) of RBIP will include capacity building of farmers and awareness raising of communities. For this purpose, linkage will be developed with the Agriculture Extension Department and local farmers will be provided IPM trainings; in addition, potential candidates will be identified among the local farmers to be trained as IPM trainers. This will ensure sustainability of capacity building initiative even after the completion of five-year SDP under RBIP.

In the EIAs of later phases of RBIP, the above-described mitigation measures will be reviewed and revised if needed in light of the experience of their implementation during the Phase I.

Residual impacts. With the implementation the above measures, the impacts associated with intensification of cultivation will be adequately addressed and the significance of the residual impacts is likely to be **Low**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.5.4. Loss of natural vegetation and trees

Potential impacts. Project area harbors different sorts of floral species though along the proposed embankment the number of species richness and individual quantity is not so much high relative to the other part of country. The floral composition of the project site comprises tree, shrubs and herbs. The survey during the baseline data collection has indicated that there are 114 mature trees per ha and 21 mature shrubs in per ha while the number of bamboo species in project site is 34 per ha. Most of the tree species comprises timber (e.g. eucalyptus and acacia) and horticultural species (e.g. mango, jackfruit). Ecologically, these species are not very important; moreover they have negative impact on human health also. Except for the economic value of eucalyptus and acacia, these species have no significant benefit for the ecosystem. On the other hand, the horticultural species like mango and jackfruit support the poor people of this area by providing various products such as fuel wood, food and timber. Some horticultural species such as jackfruit is used as fodder as well. These species are used by birds for their habitat and food. Due to the proposed interventions during the Phase I, the project influence area in the priority will lose about 170,000 trees, as detailed in the EIA of Phase I (priority reach). *The EIAs of subsequent phases will provide details of the trees that would need to be felled in the remaining reaches.*

The revetment proposed under the RBIP can potentially affect the aquatic vegetation along the riverbank. Some parts of the riverbank are covered with dense reeds that provide nursing ground of birds and small fishes. However, the revetment is being proposed for the riverbank stretches that undergo severe erosion during every high-flow season resulting in loss of any vegetation that exists there. Hence the revetment works are unlikely to cause any significant loss of the aquatic vegetation; in fact these protection works will discontinue the loss of vegetation caused by the riverbank erosion. Furthermore, the aquatic vegetation naturally grows along slow moving streams at different places of Jamuna river hence it is expected that it will gradually re-grow along the protected riverbank as well. *While conducting the EIA of the later phases of the RBIP, the above aspect will be reconfirmed and actual state of the riverbank along which revetment will be constructed will be described.*

The significance of the above impacts is likely to be **Moderate**, based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. For the trees to be removed for the proposed interventions, compensatory tree plantation will be carried out along the embankment. About 140 ha of land is available for this purpose. A plantation plan has been prepared for the priority reach. In addition to providing ecological service, embankment stabilization, and enhanced aesthetic value, this plantation will also prevent any encroachment over the embankment. A monitoring program will be initiated for the re-growth of the aquatic vegetation along the riverbank revetment.

For the later phases of the RBIP, a similar plantation plan will be prepared and implemented; details will be included in the EIAs of those phases. The experience of plantation carried out in the priority reach and results of the earlier described monitoring program (if available) will also be included in the respective EIAs.

Residual impacts. With the help of the above-mentioned mitigation measures, the potential impacts associated with clearing of riparian as well as terrestrial vegetation/trees will be adequately addressed and hence the significance of the residual impacts in likely

to be **Low**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.5.5. Loss of riverbank/aquatic habitat

Potential impacts. Total length of the revetment to be constructed during the Phase I of RBIP will be about 17 km divided into four major sites at Balighuri, Ratankandi, Baniajan and Chandanbaissa. Average width of the revetment will be 100 meter of which the under-water portion will be 60 meter. Hence the estimated total potentially impacted aquatic area will be about 102 ha. However, this part of the aquatic habitat is regularly eroded because of the frequent riverbank erosion. Hence the revetment will not result in any additional loss of aquatic habitat. *Similar estimates will be included in the later EIAs for the revetment to be constructed during the later phases of the RBIP.*

The river bottom material like clay, silt, sand, cobbles, and boulders has different physical and chemical gesture and may support aquatic life differently. Geo-bags are helpful to stun sediment which will help to improve water transparency. On the other hand, geo-bag will cover part of the riverbed that may potentially have negative impacts on benthos. The benthic fauna at the substrates and phytoplankton at the water column will potentially be affected negatively at the revetment sites, which will in turn have effect on the food chain and may result in food shortage for faunal species such as fish, crab, and turtle. The covering of river bed with geo-bags in limnetic zone may potentially affect some fishes, such as Ayre (Aorichthys aor), boal (Wallago attu), Pangas (Pangasius pangasius), different types of baim, gutum (Lepidocephalus guntea), bala (Glossogobius giuris) and some small fish species by limiting their feeding opportunity. The associated fish production loss has been estimated at about 9 tonnes annually during the construction phase (considering that the annual fish production rate of the Jamuna river is 90kg/ha/year); however this loss will be more than compensated through increased fish production in the flood plains (discussed later in the Chapter). *Similar estimates will be included in the later EIAs for the revetment to be constructed during the later phases of the RBIP.*

Furthermore, it is now established that the geo-bags revetment creates fish habitat, as phytoplankton grow on their surface. Previous studies[28] [29] on impacts of geo-bags on the aquatic species have shown positive results. In general, there were more number of species and more population of fish and non fish aquatic organisms in areas protected with geo-bags. The overall accumulation of species in number was better in geo-bag protected area than in the areas protected by cement concrete blocks. The quantity of fish availability was also better with geo-bags in many locations. In addition, the CC blocks used in the upper portion of the revetment are likely to provide habitat for certain fish species such as eels. The revetment is not likely to affect the dolphin or wintering bird habitats since the river protection works will not be carried out at or in the vicinity of those areas.

The above assessment will be revisited with the help of results (if available) of the habitat monitoring that will be carried out during the implementation of Phase I works (monitoring is described under the mitigation measures given below).

[28] Geotextile Bags for River Erosion Control in Bangladesh, Under water behavior and environmental aspects. Hannes Zellweger; 2007.

[29] Bank Protection and Fisheries at JMREMP; Jamuna-Meghna River Erosion Mitigation Project, Special Report; 2007.

The aquatic habitat can also be potentially affected if sediments and pollutants from the construction sites and camp sites are released in the water bodies.

Based upon the above discussion, the potential impacts of the project on aquatic habitat have been characterized as **Moderate**, using the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. Since most of the potentially negative impacts of riverbank revetment on the aquatic habitat are expected to be temporary in nature, and since the revetment is likely to provide habitat for some aquatic species, as stated earlier, no mitigation measures are needed for this activity. Habitat monitoring will however be carried out during the construction phase and will be continued thereafter to fully understand the impact of revetment on the aquatic habitat. Appropriate mitigation measures may need to be designed and implemented on the basis of monitoring results. Similarly, long-term monitoring of river morphology will also be initiated to fully understand the changes in river morphology.

The monitoring program will be based on the assumption that different riverine fish species prefer different bankline conditions. The program will include year-round data collection on fish and non-fish organisms in control sites (i.e., areas without geo-bag revetment) as well as revetment sites. For each location, depth series data will be collected on fish habitat, availability of food, and abundance of key species. The monitoring will primarily focus on adult or sub adult fish that will be available along bankline, however additional information will also be collected on breeding, nursing, and migration of the key species. The monitoring program will also cover potential impacts on other key aquatic species such as dolphins and turtles.

To protect the aquatic habitat from the sediments and pollutants from the construction sites and cam sites, contractors will be required to prepare and implement pollution prevention plan and waste management plan. Through these plans, it will be ensured that no untreated effluents or solid waste is released in the water bodies.

Residual impacts. With the help of the above-mentioned mitigation measures, the potential impacts associated with aquatic habitat will be adequately addressed and hence the significance of the residual impacts in likely to be **Low**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.5.6. Loss of floodplain habitat

Potential impacts. The embankment works will affect about 340 ha of terrestrial habitat in the priority reach however most parts of this area is completely modified and is currently either under cultivation or included in built-up area (homesteads, other physical infrastructure). Hence the project interventions are unlikely to cause any significant negative impacts on the natural habitat under its immediate footprint (loss of natural vegetation is already covered earlier in the Chapter). This potential impact is assessed as **Low**, based upon the criteria described in **Section 6.2** and hence no mitigation is required for this. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

In addition to the above impacts, the embankment construction can potentially disrupt the hydrological and ecological connectivity between the Jamuna River and smaller inland rivers, *khals* and *beels* – negatively affecting the floodplain habitat and potentially reducing the fish production in the area. This potential impact is characterized as **High**, based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

It is estimated that total annual fish production will decline by about two tonnes in *khals* (water channels) and internal rivers, about 261 tonnes in *beels* (water ponds), and about 311 tonnes in floodplains of the priority reach as detailed in the EIA of the Phase I. The associated annual economic loss has been estimated to be BDT 616,275 from *khals* and internal rivers, BDT 78,306,750 from *beels* and BDT 93,355,500 from floodplain – a total of about BDT 255 million on a yearly basis. *Similar estimates will be included in the EIAs of the later phases of the RBIP.*

Mitigation and Enhancement. To restore the ecological and hydrological connectivity, appropriate number of regulators and fish passes will be constructed at appropriate locations as part of the RBIP. During the EIA of the priority reach (Phase I) four potential areas within the priority reach have been identified where re-establishing of ecological connectivity will greatly help in restoring the biodiversity of the area particularly facilitating the fish migration, which in turn will enhance the fish production in the beels, khals, and other water bodies of the floodplain. *During the EIAs of the later phases of RBIP as well, regulators and fish passes will be proposed at appropriate location.*

Operation and maintenance committees will be established for each regulator to appropriately operate and maintain these structures. These committees will be responsible for scheduled opening and closing of regulator gates, and removal of silt deposits in the khals. These committees will be provided with adequate training in O&M of the regulators. Furthermore, to achieve maximum benefit and also to ensure functionality of the fish passes, it is also necessary to undertake enhancement measures in the connecting *khals*, *beels* and other water bodies.

Construction of fish passes will facilitate fish migration that will ultimately enhance fish production of the area. It is estimated that the restoration of ecological connectivity achieved through fish pass structures and regulators will enhance the fish production from the floodplain of the priority reach by about 1,880 tonnes per year, resulting in a net economic benefit of about BDT 564 million annually in the priority reach, as detailed in the EIA of Phase I of RBIP. *Similar estimates will be included in the EIAs of the later phases of the RBIP.* Since the productivity enhancement is a gradual process, it is estimated that the above enhancements will be achieved after five years of project completion.

Residual impacts. With the help of the above-described mitigation measures, the potential impacts on the floodplain habitat are likely to be adequately addressed and hence the residual impacts will be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.* On the other hand, the project will result in net economic benefit of BDT 564 million on an annual basis in the priority reach, as described above.

6.5.7. Drainage Congestion and Water Logging

Potential impacts. As stated in above section, construction and or rehabilitation of the embankment may potentially block some water channels (*khals*), which provide ecological connectivity in addition to facilitating irrigation/drainage. Some regulators were constructed across the original embankment constructed as part of the BRE however many of them have either been blocked or not functioning properly. As a result some cultivated lands particularly near Baliaghuri in Sirajganj are facing drainage congestion and water logging problems. Significance of these impacts has been determined as

Moderate based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. Water regulators have been included in the project design of Phase I; *similarly, regulator will be included in the later phases of RBIP at appropriate locations*, as stated earlier. Appropriate operating procedures will be implemented to operate these structures to address the drainage congestion and water logging problems in the area.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with water logging and drainage congestion are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.6. Significant Social Impacts from Project Siting

6.6.1. Land acquisition and Resettlement

Potential impacts. Rehabilitation of existing and construction of new embankment will cause changes in land form and land use. For the priority reach, the total land requirement is about 370 ha. According to the full census of the priority reach carried out by the social safeguard team, a total of 5,751 households will be affected by the construction / rehabilitation of the embankment, in which 3,639 households need to be relocated. *Similar estimates will be included in the EIAs of the later phases of RBIP.* In addition, there will be some temporary land take during construction phase for establishing contractors' facilities such as camps and offices.

Significance of the above-described impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. To address the land take and resettlement impacts, detailed resettlement planning is underway following the national as well as World Bank policies and guidelines. A Resettlement Acton Plan (RAP) has been prepared for the Priority Reach; *similar plans will be prepared for the later phases of the Program and summarized in the EIAs of those phases*. The RAP includes entitlement matrix for each kind of resettlement impact, compensation payment procedure, monitoring requirements, and a comprehensive grievance redress mechanism (GRM).

Residual impacts. With the implementation RAP, the displacement-related impacts will be greatly addressed and the significance of the residual impacts is likely to be **Low to Moderate**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.6.2. Loss of Agriculture and Other Sources of Income

Potential impacts. The project interventions particularly the embankment works can potentially affect agricultural and other income generating activities under the project footprint and its immediate vicinity. The embankment works in the priority reach are likely to affect 276 ha of agricultural land and a total of 232 business structures. *Similar estimates will be included in the EIAs of the later phases of RBIP.*

Significance of the above impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The RAP will address all losses to agriculture and other income-generating activities caused by the project.

Residual impacts. With the implementation RAP, impacts associated with loss of agriculture and other incomes will be greatly addressed and the significance of the residual impacts is likely to be **Low to Moderate**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.6.3. Impacts on Community Facilities and Places of Religious Significance

The project interventions particularly the embankment can potentially affect community facilities, common property resources, and religious places such as mosques, temples, and graveyards. The embankment in the priority reach is likely to affect a total of 74 such places. *Similar estimates will be included in the EIAs of the later phases of RBIP.* Most of these facilities are likely to be displaced because of the land acquisition for the project. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The relocation of the above listed community facilities and places will be covered under the RAP that is being prepared for the RBIP priority reach as mentioned in **Section 6.6.1** earlier; *similar RAPs will be prepared for the later phases of the RBIP as well.* The RAP describes the procedure to be adopted to relocate these facilities and will also include cost estimates for the relocation. The entire process of relocation will be carried out in complete coordination and participation of the relevant community and in a culturally- and socially-acceptable manner.

Residual impacts. With the implementation RAP, the displacement-related impacts will be greatly addressed and the significance of the residual impacts is likely to be **Low to Moderate**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.6.4. Barrier/Severance Effect

Potential impacts. Riverbank revetment may potentially block access of the people to the river since slope of the concrete blocks can potentially make it difficult for the people and livestock to cross it. Similarly linear nature of embankment may block communities' access to and from the river. The embankment slope will also pose a hurdle for the people and livestock to cross it. Finally, when the road is constructed and becomes operational, it may potentially act like a barrier between the settlements and river. However, the road once operational will greatly facilitate local and long-distance transportation. The EIA of the Phase I lists the key bazaars and jetties that could potentially be affected by the project works; *a similar list will be included in each of the EIAs of the later phases as well.*

Significance of the above impacts has been determined as **Moderate** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. Stairs and ramps will be built at appropriate places of the river bank protected by revetment, in consultations with the local community. Similarly, stairs and or ramps will be built across the embankment at appropriate places in consultation with the local community. For vehicular traffic, road crossings will be

included in the road design; for pedestrian crossing appropriate arrangements such as zebra crossings and foot bridges will be included in the road design.

The EIA of the Phase I lists locations of the possible intersections along the road; *a similar list will be included in each of the EIAs of the later phases of the RBIP*.

During detailed design of road component, the location of the intersections and crossings along the road will be finalized using the following criteria:

- Selection of four arm junction:
  - Bank erosion line is more than 400m away
  - Earthen shank is directly connected to proposed embankment.
  - Big bazaar or growth center is on the river side.
  - Regular all weather crossing route exists
  - Big char area on the river side with habitation.
  - Road crossing the embankment.
  - Proposed alignment is straight and side road from river is perpendicular.
- Selection of T junction:
  - A connection to local road in country side
  - Big bazaar or growth center exists.
  - Regular all weather crossing route exists.
  - Road exists close to alignment
  - To connect nearby upazilas
  - To facilitate traffic for connecting other rural roads.

Residual impacts. With the help of above-specified mitigation measures, potential impacts associated with blocked access will be adequately addressed and hence the residual impacts will be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7. Significant Environmental Impacts during Construction

6.7.1. Impacts from Borrow Areas

Potential impacts. During the construction phase, RBIP will need sand for construction of embankment and filling of geo-bags for riverbank protection. A limited quantity of earth will also be needed for embankment cladding. Sand will be extracted from the river banks with the help of small pumps. For the entire works under the Phase I, about 23 million m^3 of sand would be needed (see **Table 3.7**). *Similar estimates will be included in the EIAs of the later phases of RBIP.* Sand extraction can potentially cause negative impacts on the aquatic fauna although because of the high silt load in the river water, the sand extraction areas will rapidly be covered with fresh sediments hence minimizing any long lasting impacts. Earth if obtained from the cultivation fields can lead to significant impact on the already scarce cultivable land in the area.

Although, the sand extraction locations are not known at this stage, but it can be assumed that the contractors will prefer to collect sand from the nearest shallow semi-permanent sand bars. It is estimated that for the priority reach works, about 500 ha of riverbed

would be affected by the sand extraction during each dry season (basis: about 23 million m^3 sand needed; about 10 million m^3 sand to be extracted each year along about 50 km river stretch with depth of about 2 m). *Similar estimates will be included in the EIAs of the later phases of RBIP.* Sand extraction may potentially decrease the quality of river habitat by increasing the water turbidity which may potentially affect the aquatic fauna including fish and dolphin. If this activity takes place during the breeding season (July to August) of fish and dolphin then it may negatively affect their population dynamics as well. The sand extraction if carried out during nighttime may potentially affect the wintering birds that are mostly found on chars.

Several carp spawn collection area, some *koles* (embayment), and important *charlands* having waterfowl habitats were identified during the baseline survey. The sand extraction may potentially temporarily impact these areas by reducing feeding ground, creating noise, illumination, and increasing water turbidity. In addition, benthic fauna, phytoplankton and zooplankton may potentially be affected at the sand extraction sites ultimately disrupting the food chain, and as a result, tertiary level animals such as fish, birds, and dolphins that feed on these primary and secondary level fauna are likely to temporarily leave the area. The loss of fish production from the affected river area due to sand extraction for the RBIP Phase I (ie, priority reach) is estimated to be about 45 tonnes during each year of sand extraction (considering that the annual fish production rate of the Jamuna river is 90kg/ha/year). *Similar estimates will be included in the EIAs of the later phases of RBIP.* The disturbed river productivity will be restored by next flooding season due to natural sedimentation process of the river. Furthermore, this temporary loss will be more than compensated with the expected increase in the fish production on a permanent basis

Significance of the above impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The contractor will be required to prepare the Borrow Area Management Plan and obtain approval from the construction supervision consultants (CSC). Sand extraction from river bank will be carried out in an environmentally and ecologically safe manner. Only small quantities of sand will be collected from any single location and stretches of riverbank will be left undisturbed between the locations from where the sand is extracted – in order not to disturb long, unbroken stretches of river bank thus allowing the aquatic fauna to rejuvenate at the sand extraction locations. Sand extraction will not be carried out at or in the vicinity of sensitive habitats.

The contractor will obtain clearance from the CSC before sand extraction can be carried out at any particular location. The CSC will issue this clearance after surveying the area and ensuring that no critical habitat exists at such location.

Monitoring will be initiated during the construction phase of the Phase I and continued thereafter to determine any long lasting impacts of sand extraction and to identify any mitigation measures if so needed (ToR of this monitoring is included in the EIA of Phase I). *The EIAs of the later phases will include the results of this monitoring if available by that time.*

No earth will be obtained from any cultivation fields; the existing embankments will be excavated to obtain the earth required for the embankment cladding.

Water will be obtained from the existing sources after reaching agreements with the relevant community and after paying the appropriate cost. Otherwise new tube-wells will be installed but maintaining safe distances from the existing ones thus ensuring no draw down of water in them. The GRM will also be put in place to address community complaints.

Residual impacts. With the help of the mitigation measures described above, the potential impacts associated with and extraction and water procurement will be adequately addressed and hence the significance of the residual impacts is likely to be **Low**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.2. Air Pollution and Greenhouse Gases Emissions from Construction Works

Potential impacts. Construction of bank revetment, embankment and road works will generate emissions from excavation equipment, other machinery and construction traffic. The emissions will also include greenhouse gases (GHGs) from engine fuel combustion (exhaust emissions) and evaporation and leaks from vehicles (fugitive emissions) and emissions from asphalt works. The EIA of the Phase I of RBIP includes estimates for the total emissions of Reactive Organic Gases (ROG), carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) generated by construction of embankment and revetment (from 2015 to 2019) and road works (from 2019 to 2020). *Similar estimates will be included in the EIAs of the later phases of RBIP.* Total GHG emissions in terms of CO_2 equivalent are provided in the EIA of the Phase I. It is estimated that about 0.019 million tonnes of CO_2 will be emitted during the six years of construction period from all the construction activities during the RBIP Phase I. *Similar estimates will be included in the EIAs of the later phases of RBIP.* The emissions from construction activities will deteriorate the ambient air quality and affect the public health. The dense populated areas and crowded market places (bazaars) are particularly vulnerable to these impacts. In addition, dust generated from the above activities will also have impacts on crops and livestock. These impacts have been assessed as Moderate Adverse. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and management. To mitigate deterioration of air quality and generation of dust, following measures will be taken:

- The equipment and vehicles used during the construction process will comply with the national standards on emission exhausts.
- Concrete batching and asphalt plants will be located minimum 500 m away from residential areas and will have appropriate dust/emission suppression mechanisms such as wet scrubbers.
- Contractor will implement dust prevention measures such as watering of roads near the residential areas and spraying of water on loose material where required and appropriate.
- Continuous air monitoring will be carried out near the sensitive receptors (already identified for the priority reach and listed in the EIA of the Phase I; *similar receptors will be identified in the EIAs of later phases of the RBIP*) to ensure ambient air quality remains within the EQS limits.

- Construction materials will be stored away from the residential areas and will be properly covered.
- Measures will be taken to protect the workers from excessive dust.
- A grievance redress mechanism (GRM) (discussed later in the document) will be put in place to receive complaints from public on various aspects of environmental issues, including air pollution. These grievances will be addressed by the contractor by adopting necessary pollution control measures. Continued consultations with the affected communities will be carried out during construction phase.
- To reduce the greenhouse gases emissions, a series of vehicle exhaust emission controls will be implemented. These include regular maintenance of vehicles, plant and machinery in accordance with manufacturer's specifications; monthly visual inspections on vehicle and plant exhausts to identify excessive emissions of smoke, and maintenance undertaken where required; switch off / throttle down all site vehicles and machinery when not in use; and avoid unnecessary idling of equipment.
- In addition, the measures in Environmental Codes of Practice (ECoP) on air quality management will be implemented (ECoPs are discussed later in the document).

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with air quality deterioration are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.3. Noise Pollution from Construction Works

Potential impacts. Noise will be produced by vehicular movement, excavation machinery, concrete mixing, and other construction activities. The schools, religious places and crowded market areas are particularly vulnerable to the increased noise levels. Noise levels resulting from construction works during the Phase I have been estimated using US Federal Highway Administration's (FHWA) Roadway Construction Noise Model (RCNM) and presented in the associated EIA; *similar estimates will be included in each of EIAs for the later phases of the RBIP*. These impacts have been assessed as Moderate Adverse. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and management. To mitigate impacts associated with noise generation, following measures will be taken:

- The equipment and vehicles used during the construction process will comply with the national standards on noise.
- Continuous monitoring of noise levels will be carried out to ensure they do not exceed national standards.
- Contractors will adopt appropriate noise attenuation measures to reduce the noise generation from construction activities. The noise attenuation measures will include, (i) fitting of high efficiency mufflers to the noise generating equipment; and (ii) keeping acoustic enclosures around drilling equipment.
- The construction activities near the settlements will be stopped during night times if high noise values are observed

- A grievance redress mechanism (GRM) will be put in place to receive complaints from public on various aspects of environmental issues, including noise pollution. These grievances will be addressed by the contractor by adopting necessary pollution control measures. Continued consultations with the affected communities will be carried out during construction phase.
- In addition, the measures in ECoP on noise quality management will be implemented

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with noise generation are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.4. Water Pollution

Potential impacts. During the construction phase, sand extraction and launching of geo-bags along the river bank can potentially cause some localized increase in water turbidity. However this increase in turbidity is not likely to have any significant impact on overall water quality and the aquatic fauna primarily because of its temporary and localized nature. The construction camps and other site facilities such as offices and warehouses will also generate substantial quantities of waste effluents. It is estimated that about 75,000 liters per day of waste effluents will be generated during the construction works of Phase I of the RBIP as detailed in the associated EIA; *similar estimates will be provided in each of the EIAs of later phases of the RBIP*.

Other possible causes of land or water contamination include accidental leakage or spillage of fuels, oils, and other chemicals, and waste effluents released from workshops and washing bays for vehicles.

These effluents can potentially contaminate the drinking water sources of the area and can also be harmful for the natural vegetation, cultivation fields, water bodies, and aquatic flora and fauna. The EIA of Phase I identifies the location of the water bodies (*khals* and *beels*) in the priority reach and their distance from the proposed embankment alignment; some of these water bodies are quite close to the alignment (eg, Kothir Pinjira khal, WAPDA khal, and Balia Ghugri khal); *similar estimates will be included in the EIAs of the later phases of RBIP.*.

Significance of the above-described impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. A methodology will be prepared for the river bank protection works in which the geo-bag launching will not be carried out in long stretches of the bank simultaneously. In this manner any increased water turbidity will remain limited and localized in nature hence avoiding any significant impact on overall water quality and aquatic fauna.

Similarly, sand extraction will not be carried out in long, contiguous stretches hence minimizing the extent of water pollution caused by this activity.

The contractors will be responsible to prepare and implement a waste and pollution management plan. The Plan will need to be cleared by the Construction Supervision Consultants (CSC) before it can be implemented. The Plan will include categorization and quantities, treatment mechanism (such as retention ponds and septic tanks), and final

disposal of various waste streams; monitoring protocols; roles and responsibilities for the personnel assigned to implement the Plan; and documentation requirements.

For avoiding and managing any accidental leakages and spillages, standard operating procedures will be included in the HSE Plan described earlier. Monitoring of drinking water sources and other key water bodies in the area will also be carried out to ensure that these water resources are not affected by the project activities.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with water pollution are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.5. Soil Contamination

Potential impacts. Much like water pollution discussed above, soils in the construction area and nearby lands that are used for agriculture will be prone to pollution from the construction activities, construction yards, workers camps and other construction areas. Fuel and hazardous material storage sites and their handling are also the potential sources for soil and water pollution. Improper siting, storage and handling of fuels, lubricants, chemicals and hazardous materials, and potential spills from these will severely impact the soil and water quality and also cause safety and health hazards. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. For avoiding and managing any accidental leakages and spillages, standard operating procedures will be included in the HSE Plan. The contractors will also be responsible to prepare and implement a waste and pollution management plan. For the effluents to be released from workshops, camps, and offices, appropriate treatment arrangements such as retention ponds and septic tanks will be incorporated in the facility design.

The contractor will employ the general criteria for oil and leakage at construction sites, in accordance with the standards set forth by "Guidelines for Oil Spill Waste Minimization and Management" issued by International Petroleum Industry Environmental Conservation Associate which are as follows[30]:

- **Minor Skill / Leakage:** Soil contaminated by minor spills / leakages (defined as leaks from vehicles, machinery, equipment or storage containers such that the area and depth of soil contaminated is less than 1 sq meter and 75 mm respectively) is to be scraped and burnt in a burn pit, away from population.
- **Moderate Spills** are defined as spills of volume less than or equal to 200 liters is to be contained and controlled using shovels, sands and native soil. These equipment and materials are to be made available at camp sites during the operation. The contaminated soil is to be excavated and stored in a burn area lined with an impermeable base. Depending on the volume, the contaminated soil is either disposed of by burning in the burn pit or by specialized treatment such as bioremediation.

[30] Source: IPIECA/Energy Institute/Cedre 2004. IPIECA Report Series, Volume-12, "Guidelines for Oil Spill Waste Minimization and Management"

- **Major Spills** (defined as spills of volume much greater than 200 liters) requires initiation of Emergency Response Plan. These spills are to be handled and controlled according to the Plan and require special treatment such as bioremediation.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with soil pollution are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.6. Generation of Solid Waste and Hazardous Waste

Potential impacts. Solid waste generated during the construction phase will include excess construction material such as sand and soil, faulty/damaged parts, metal scraps, cardboard boxes and containers, and cotton swaths from workshops, and domestic solid waste from construction offices and camps. It is estimated that about 150 kg of domestic solid wastes will be generated daily from the construction camps and offices during the construction works of the RBIP Phase I. *Similar estimates will be included in the EIAs of the later phases of RBIP.*

In addition to the above, small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (liquid fuels; lubricants, hydraulic oils; chemicals, such as anti-freeze; contaminated soil; spillage control materials used to absorb oil and chemical spillages; machine/engine filter cartridges; oily rags, spent filters, contaminated soil, and others). It is imperative that such waste is responsibly disposed to avoid adverse environmental, human health and aesthetic impacts.

Inappropriate disposal of these wastes can lead to soil and water contamination as well as health hazards for the local communities, livestock, and aquatic as well as terrestrial fauna. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and management. Contractors will be required to prepare and implement a Waste and Pollution Management Plan in accordance with the WB EHS Guidelines and ECoP. The Plan will be prepared on the 3R principle (reduce, reuse, and recycle), and will specify appropriate disposal mechanism and place for each type of waste. Particular attention will be focused on hazardous waste and it will not be released to the environment in any circumstance. Appropriate procedure such as MSDS will be used to dispose hazardous wastes. Complete record will be maintained for waste disposal. The GRM will also capture any complaints related to inappropriate solid waste disposal.

As an environmental enhancement measure, the project will prepare a waste management plan for the communities along the embankment. The Plan will be prepared under the Social Development Plan of RBIP, during the construction phase of the project.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with solid waste generation are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.7. Impact on Aquatic and Floodplain Habitats

Potential impacts. Sand extraction from the riverbank, launching of geo-bags, and placement of concrete blocks for the river revetment may potentially disturb the aquatic habitat by increasing the water turbidity (siting impacts of these activities have already

been discussed earlier in the Chapter). Significance of these impacts has been determined as **Moderate** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Some sensitive and important habitats exist in the river chars (shoals) for wintering birds and some of the river channels for fish and dolphins. Similarly some of the beels (wetlands) in the floodplain provide important habitat for aquatic fauna. However embankment construction activities are not likely to have any direct impact on terrestrial or aquatic wildlife or their habitat since no sensitive ecological hot spots have been identified along the existing and proposed alignment in the priority reach (RBIP Phase I). A similar assessment will be carried out during the EIAs of the later phases of the RBIP. However any accidental leakage, spillage of contaminants, or dumping of solid waste/debris on land or in water bodies can potentially affect these habitats. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

During the project-related boat traffic, there is a potential risk of collisions with fish and dolphins. This can cause injuries and even fatalities to these species.

Mitigation and Management. The potential impacts on the aquatic fauna can be at least partially addressed by not carrying out sand extraction and revetments along long, contiguous sections of the river bank at a time, as already described earlier. This measure is likely to keep the increased water turbidity and any other impacts on aquatic habitat localized and minimized, in addition to help rejuvenate the benthic fauna. In addition, the geo-bags and concrete blocks are likely to provide habitat for aquatic fauna such as eels. However to further understand the impact of revetment on aquatic fauna and characteristics of the new habitat provided by geo-bags and concrete blocks a long term monitoring and data collection is needed. This will be initiated during the project construction phase and continued thereafter; attempts will be made to involve national and international research and educational organization for this purpose. The ToR of this monitoring program has been included in the EIA of the Phase I.

Boat movement will be restricted to within 500 m of river bank. Motor boat speed will be limited to 15 km/h in accordance with best international practices. Pingers will be used to chase away dolphins form the construction areas thus minimizing the chances of any collision.

Any negative impacts on terrestrial or aquatic flora and fauna through land and water contamination can be adequately addressed by adopting pollution control measured implementation of which will be a binding on the contractors (see **Sections 6.7.4** to **6.7.6**).

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with aquatic habitat are likely to be somewhat addressed and hence the residual impact is likely to remain **Low to Moderate** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.8. Impact on *Charland* Habitat

Potential impacts. The construction activities are not likely to affect the wintering birds that are mainly found in the chars (shoals) since these chars are across the river channels and quite away from the construction sites. If any sand extraction activities are located near chars, noise generated from these activities has a potential to affect the migratory

birds. However, due to the vast habitat range of these birds along the chars in Jamuna, the project is not expected to have any impacts on the migratory birds. If any construction activities disturb their roosting, hunting and feeding grounds, they would move to another lesser or undisturbed areas without any difficulty. Significance of these impacts has been determined as **Minimal** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The contractors will be required to reduce the noise levels generated from the construction activities by providing mufflers or acoustic enclosures for high noise generating equipment. The Contractor will also raise awareness about the protection of birds among the work force to reduce impacts such as disturbance and poaching.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with charland habitat are likely to be somewhat addressed and hence the residual impact is likely to remain **Minimal** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.7.9. Site clearance and Restoration

Potential impacts. After the completion of the construction activities, the left over construction material, debris, spoils, scraps and other wastes from workshops, and camp sites can potentially create hindrance and encumbrance for the local communities in addition to blocking natural drainage and or irrigation channels. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The contractors will be required to remove all left over construction material, debris, spoils, and other wastes from the construction sites. The camps sites will be completely cleaned and restored in original condition to the extent possible. No waste disposal will be carried out in water channels (*khals*) or natural depressions and ponds (*beels*).

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with site clearance are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.8. Significant Social Impacts during Construction

6.8.1. Impact on Cultural Heritage

Potential impacts. A number of sites and buildings of religious and cultural importance such as mosques, temples and graveyards in the priority reach will have to be relocated because of the reconstruction and rehabilitation of the embankment, as detailed in the EIA of Phase I. *The EIAs of the later phases will also identify any such sites that would potentially be affected by the construction activities.* Significance of these impacts has been determined as **Moderate to High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The contractors will be required to prepare code of conduct to be followed by all site personnel - to respect religious beliefs and sites, and to conduct in a culturally appropriate manner. In addition, 'chance find' procedures will be followed in case of accidental discovery of any sites or artifacts of religious, historical, or cultural importance.

Relocation of places such as mosques and temples will be covered under the RAP and the project will cover the entire cost of such relocation or reconstruction.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with cultural resources are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.8.2. Impact on Community Facilities

Potential impacts. A few schools and other community facilities exist along the embankment in the priority reach; a list of such facilities is included in the EIA of the RBIP Phase I. *The EIAs of the later phases will also identify any such community facilities that would potentially be affected by the construction activities.* The potential impacts of the project on these schools could include relocation, air quality deterioration, noise, and safety hazards.

The construction activities can potentially damage the existing public and private infrastructures such as local roads, foot paths, and boat jetties. This can further aggravate the sufferings of the local communities because of river bank erosion and floods.

Significance of the above impacts has been determined as **Moderate** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. Any relocation needs of the schools and other community facilities will be adequately covered under the RAP that has been prepared for the Priority Reach. For noise, air quality, and safety hazard, the contractors will be required to ensure that activities in the vicinity of the sensitive receptors such as schools are carried out in a manner so as to minimize these risks (e.g., carrying out the construction activities after the school time). The construction site will be fenced near such places to minimize safety hazards. Safety signage will be placed and coordination will be maintained with the facility management as well as with the community to minimize the risks. Finally, any complaints of related to project impacts on the sensitive receptors will be addressed through the GRM described earlier.

The RAP covers the replacement and or relocation of the infrastructure that is affected by the direct land take for the project. Other damaged infrastructure affected by the construction activities will be repaired and or restored by the contractor.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with community facilities are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.8.3. Blockage of Local Roads/Routes/Jetties and Traffic Congestion

Potential impacts. Construction activities for riverbank protection may potentially block/hinder access to boat jetties. Similarly, construction works on the embankment may block local roads and routes and may prevent the local people to cross the construction area. Furthermore, the construction works and associated vehicular traffic may cause traffic congestion on local roads, particularly near local markets and boat jetties (list of the key boat jetties and local bazaars in the priority reach has been included in the EIA of Phase I; the EIAs of later phases will also include similar lists). Significance of these impacts has been determined as **Moderate** based upon the criteria described in

Section 6.2. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The contractor will prepare and implement a traffic management plan. Consultations with the local communities will be carried out on an on-going basis and the construction schedule will be discussed with them to ensure that blockage of the local routes is minimized. The construction works particularly at/near the boat jetties and local bazaars will be carefully planned to minimize hindrance to the local communities. The GRM described earlier will address any community grievances related to blocked routes as well. The contractors will be required to prepare and implement a traffic management plan that will be prepared in consultation with the local community and relevant officials.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with blockage of local routes and roads are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.8.4. Occupational Health and Safety

Potential impacts. Generally the construction activities will involve large scale excavation, operations of heavy construction machinery and vehicular traffic. These activities may pose health and safety hazards to the workers at site during use of hazardous substances, lifting and handling of heavy equipment, operating machinery and electrical equipment, working near water or at height and more.

The project will need fuels, oils, and asphalt during the construction phase. Inappropriate handling or accidental spillage/leakage of these substances can potentially lead to safety and health hazards for the construction workers as well as the local community.

Significance of the above impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. Standard operating procedures will be used to handle, transport, and store hazardous materials during the construction phase. Contractors will be required to prepare and implement Health, Safety, and Environment (HSE) plan at the construction sites and in construction camps. The Plan will need to comply with the WB Environment, Health, and Safety (EHS) Guidelines and Environmental Code of Practice (ECoP). The Plan will include standard operating procedures for handling with emergencies, accidents, and incidents; roles and responsibilities, training and capacity building requirements; and documentation and reporting protocols. The contractors will have qualified people at the site to implement the HSE Plan. The construction workers will use PPEs. Contractors will also prepare an Emergency Response Plan (ERP) to define procedures and actions in the event of any accidents such as fires. Contractors will also be responsible to provide HSE trainings to their staff and workers and awareness raising of nearby communities.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with health and safety issues are likely to be addressed to a considerable extent and hence the residual impact is likely to be **Low to Moderate** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.8.5. Community Health and Safety

Potential impacts. During the construction phase, the population living in close proximity of the construction area and construction camps, people living in and around the potential resettlement sites, the construction workforce and individuals drawn to the area in search of income opportunities will be exposed to a number of temporary risks such as safety hazards associated with the construction activities and vehicular movement, exposure to dust, noise, pollution, infectious disease, and various hazards, including potential conflict with "outsiders" to the project influence area about employment and income. The influx and accommodation of a large work force will result in increased concerns for the health and safety of local population, including the spreading of sexually transmitted diseases such as HIV/AIDS. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. To address the safety risks for the construction workers, the contractors' HSE plan will include detailed occupational health and safety (OHS) procedures and protocols. Similarly, the HSE plan will also include measures and protocols to protect the nearby community against the risk of accidents and mishaps. In addition, the ERP will also include procedures to be followed in case any accident does take place. Community awareness, warning signboards, and area fencing where possible will be some of the key elements of the safety protocols.

To address the health hazards caused by the project, the Public Health Action Plan (PHAP) has been prepared as part of the social safeguard documents. The key interventions proposed under PHAP include the following:

- **Safe drinking water**: Testing of tube well water for households along old embankment and upgrading them if required, as well as safe tube wells in resettlement sites.
- **Hygienic latrines**: water-sealed slab latrines for each household along old embankment and in new resettlement sites.
- **Clean cooking stoves**: provision of clean cooking stoves for each household along the old embankment and in new resettlements
- **Information, Education, and Communication (IEC)**: Construction-related risks (for households along embankments), HIV/AIDS, TB, hand washing, maternal health, nutrition for households along the old embankment and in new resettlement.
- **Capacity Building**: Training of upazila and zila (district) public health staff on infectious diseases, emergency care, traumatology and referral; and Training of Skilled Birth Attendant and Community Health Workers.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with the community health and safety issues are likely to be addressed to a considerable extent and hence the residual impact is likely to be **Low to Moderate** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.9. Environmental Impacts during Operation and Maintenance

6.9.1. Potential Changes in River Morphology and Erosion

Potential impacts. The potential changes of the revetment on river morphology may include stabilization and deepening of the river channel. These changes are mostly positive in nature, likely to take place over a long period of time and need to be regularly monitored for better understanding of the phenomenon. Geomorphic studies (Attachment 1 of Feasibility Report) have shown that river bank protection revetments are likely to induce only minor, localized effects on the river morphology. Morpho-dynamic modeling was also carried out to assess the effects of river bank protection structures on water levels, near-bank velocity, bank erosion, and riverbed level. These model investigations confirmed the geomorphic assessment that the planned river bank protection works will only induce localized bed changes. Furthermore, the morphological changes that may be caused by the proposed revetment will not extend beyond the Jamuna bridge since at that location river morphology changes significantly and Jamuna flows mainly as a single channel river. This potential impact has also been assessed as **Moderate**, based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. To better understand the cause and effect relationship of river bank revetment and morphological changes in the river, a long term monitoring program will be designed and initiated during the project implementation. The monitoring program will continue after the project completion and arrangements will be made for funds allocation for this program on a sustainable basis. Possibility of engaging national and international educational and research organizations will also be explored. This will in turn help provide resources and manpower for on-going efforts for data collection, monitoring, analyses, as well as planning for future interventions in and around the river.

6.9.2. Generation of Solid Waste

Potential impacts. Solid waste will be generated from future toll plaza and also during regular operation and maintenance activities. Hazardous waste will also be generated from road maintenance from removal of asphalt. This waste if not appropriately disposed has a potential to contaminate soil and water resources, thus negatively affecting communities as well as natural habitat. Significance of these impacts has been determined as **High** based upon the criteria described in **Section 6.2.** *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and management. The BWDB will prepare an HSE Plan that will cover the appropriate disposal mechanism for various types of solid wastes.

In addition, a waste management plan will be prepared for the communities along the embankment, as stated earlier as well in **Section 6.7.6**.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with waste generation are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.9.3. Air Pollution from Traffic

Potential impacts. Emissions from road traffic may affect the ambient air quality along the road embankment. Air quality modeling will be taken up during detailed design of

road component to predict the air quality during O&M Phase. Annual GHG emissions from road traffic along 50 km of priority reach are estimated using the EBRD guidance note on 'Methodology for Assessment of Greenhouse Gases'. Annual GHG emissions from future traffic will vary from 0.02 to 0.16 million tonnes. These impacts have been assessed as **Moderate** based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The following measures will be implemented to address the air quality issues:

- During design of road component, various options to reduce the traffic congestion will be considered to reduce traffic emission. These measures could include: (i) minimizing grade changes, at-grade crossings, and sharp curves which can promote congestion and (ii) design of roadway to shed water to minimize rolling resistance, as well as to enhance safety
- The road surface will be maintained regularly for smooth traffic flow and reduction of vehicular emissions
- Tree plantation will be carried out along the road embankments to reduce the impacts on air quality.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with air quality are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance.

6.9.4. Noise Pollution from Traffic

Potential impacts. During operation, noise levels along the Project roads will be increased due to the higher traffic volume. Traffic noise will be a significant nuisance to the sensitive receptors such as schools and religious places located vary close to the road. The traffic noise levels will depend on road way profile, horizontal alignment, road and receptors elevation, number of lanes, average daily traffic with type of vehicles, speeds, receiver location, nature of intervening ground, and the presence of noise shielding elements. Since most of this information will be available only after design of the road, a detailed traffic noise modeling will be carried out during detailed design phase of the road component (2016-2018). Based on the outcome of the noise modeling, noise barriers will be constructed near the sensitive receptors. However, a preliminary assessment has been carried out to predict the traffic noise levels using US Federal Highway Administrators Traffic Noise Model (FHWA TNM 2.5). Without construction of barriers or development of plantation along the road, the noise levels within 50 m of road will exceed the national standards. These impacts have been assessed as **Moderate**, based upon the criteria described in **Section 6.2**. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation Measures. The following measures will be implemented to address the noise quality issues:

- During design of road component, a detailed traffic noise modeling will be carried to out to design noise barriers (e.g. walls, vegetation) along the embankments to reduce the noise levels near sensitive receptors such as schools.
- GRM will be established to address complaints particularly from the communities along the road.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with noise generation are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.9.5. Water Pollution

Potential impacts. Generally paved road increases the amount of impermeable surface area, which increases the rate of surface water runoff. Increased storm water flow rates can lead to stream erosion and flooding downstream; cause soil erosion, channel modification and siltation of streams.

During the O&M phase, some localized increase in turbidity may take place during any maintenance works on the bank revetment. Similarly, the maintenance works can also generate a limited quantity of waste effluents.

Significance of the above impacts has been determined as **Moderate** based upon the criteria described in **Section 6.2.** *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. Appropriate storm water drainage arrangements will be included in the road design. The runoff will be released in a manner that it does not cause soil erosion. To address the potential issues associated with waste effluents generated by O&M activities, the HSE Plan prepared by the BWDB also mentioned earlier will include disposal mechanism for waste effluents as well.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with storm water are likely to be adequately addressed and hence the residual impact is likely to be **Low** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.10. Significant Social Impacts during Operation and Maintenance

6.10.1. Community Health and Safety

Similar to construction activities, significant community health and safety issues associated with the maintenance activities will include pedestrian safety, traffic safety and emergency preparedness. Pedestrians will be at greatest risk of serious injury from collisions with moving vehicles. Collisions and accidents can involve a single or multiple vehicles, pedestrians or bicyclists, and animals.

Emergency situations most commonly associated during O&M phase will include accidents involving single or multiple vehicles, pedestrians, and/or the release of oil or hazardous materials.

Toll Plaza and maintenance personnel at work will be subjected to physical and chemical hazards and noise. Maintenance personnel and landscaping workers working on right of way vegetation will be exposed to variety of physical hazards, particularly from operating machinery and moving vehicles and also working at elevations on bridges and overpasses.

Chemical hazards in operations and maintenance activities may be principally associated with exposures to dust during construction and paving activities; exhaust emissions from heavy equipment and motor vehicles during all maintenance activities; potentially hazardous dust generated during bridge paint removal; herbicide use during vegetation management; and diesel fuel used as a release and cleaning agent for paving equipment.

Significance of the above impacts has been determined as **High** based upon the criteria described in **Section 6.2.** *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. During the O&M phase, the BWDB will be required to implement HSE procedures and prepare its own ERP. For the safety hazards associated with vehicular traffic on the embankment road, standard road signage and other safety measures such as Zebra Crossings and pedestrian walk-overs (bridges) are being included in the road design. Community awareness raising about these risks will be carried out during the construction phase and will also be included in the IEC component of the social development program.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with safety hazards are likely to be addressed to a considerable extent and hence the residual impact is likely to be **Low to Moderate** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

6.10.2. Risk of Embankment Breaches and Emergency Response Mechanism

Potential impacts. Though the RBIP aims to strengthen the embankment, breaches can still take place because of a variety of reasons such as earthquakes and riverbank erosion. Such breaches in the post RBIP completion phase can potentially cause considerably higher losses than currently being incurred because of the intensified cultivation and increased area development that is likely to take place because of the enhanced protection against riverbank erosion and floods, as described earlier as well. Significance of the these impacts has been determined as **High** based upon the criteria described in **Section 6.2.** *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

Mitigation and Management. The BWDB's O&M procedures include regular monitoring of the embankment and its structural integrity, ensuring that the breaches can be prevented (see **Section 3.5**). The BWDB will also prepare an ERP that will address among others embankment breaches.

Residual impacts. With the help of the above mitigation measures, the potential impacts associated with embankment breaches are likely to be addressed to a considerable extent and hence the residual impact is likely to be **Low to Moderate** in significance. *This assessment will be revisited during the EIAs of the later phases of the RBIP.*

7. Environmental Management Plan

This Chapter presents the outline environmental management plan (EMP) of the RBIP project. A more detailed version has been included in the EIA of the RBIP Phase I; the EIAs of subsequent phases will also include a similarly detailed version of EMP.

7.1. EMP Objectives

The basic objective of the EMP is to manage adverse impacts of project interventions in a way that minimizes the adverse impact on the environment and people of the Project influence area. The specific objectives of the EMP are to:

- Facilitate the implementation of the mitigation measures identified during the present EIA and discussed earlier in the document.
- Maximize potential project benefits and control negative impacts;
- Draw responsibilities for project proponent, contractors, consultants, and other members of the Project team for the environmental and social management of the Project;
- Define a monitoring mechanism and identify monitoring parameters in order to:
- Ensure the complete implementation of all mitigation measures,
- Ensure the effectiveness of the mitigation measures;
- Maintain essential ecological process, preserving biodiversity and where possible restoring degraded natural resources; and
- Assess environmental training requirements for different stakeholders at various levels.

The EMP will be managed through a number of tasks and activities and site specific management plans. One purpose of the EMP is to record the procedure and methodology for management of mitigation identified for each negative impacts of the Project. The management will clearly delineate the responsibility of various participants and stakeholders involved in planning, implementation and operation of the Project.

7.2. Inclusion of Relevant Components of EMP in Contract Documents

In order to make contractors fully aware and responsible of the implications of the EMP and to ensure compliance, it is essential that environmental and social management measures are included in the tender documentation. The various contractors must be made accountable to implement the plans and mitigation measures which pertain to them through contract documents and/or other agreements of the obligations and importance of the environmental and social components of the Project.

7.2.1. Payment Milestones

Payments to contractors would be linked to environmental performance, measured by completion of the prescribed environmental and social mitigation measures. Contractors would be required to join forces with the executing agency, project management unit, supervising consultants and local population for the mitigation of adverse impacts of the project. For effective implementation of the proposed mitigation and monitoring measures they would attract trained and experienced environmental management staff.

7.2.2. Guideline to Incorporate Environmental Management in Bid Document

The design consultants will be responsible to incorporate environmental management requirements in the bidding documents, with the assistance of the environmental consultants. The generic guidelines to incorporate environmental aspects in the bidding documents are listed below.

- Prepare cost estimates, to be incorporated in Bid Documents.
- Contractor version of the Environmental Management Plan along with the ECoPs to be incorporated in the bid document's work requirements.
- Penalty clauses for not complying with EMP requirements to be incorporated. Indicative penalty clauses are presented below (Addendum to Clause 17.2 Contractor's Care of the Works of FIDIC).
- The contractor has to follow all traffic safety measures as defined in the technical specification. Damage shall be levied at the rate Tk. 3000/- per day per location for non – conformity of traffic safety measures as per the decision of the engineer.
- The contractor has to follow all environmental mitigation measures as defined in the technical specification read along with the Environmental Management Plan for the specific RBIP activities. Damage shall be levied at the rate Tk. 3000/- per day per location for nonconformity of Environmental Management Plan measures as per the decision of the BWDB Engineer.
- The contractor has to ensure that prior to every monsoon season, during the construction period; all the temporary and permanent cross drainage structures are free from debris as defined in the Technical Specifications read along with the Environmental Management Plan. Damage shall be levied at the rate of Tk.3000/- per day per location for non-conformity as per the decision of the Engineer.
- The contractor has to ensure that sufficient numbers and good quality Personnel Protective Equipment (PPE), should be provide to staff and labor all time as defined in the labor codes read along with the EMP. Damage shall be levied at the rate of Tk. 1000/- per day for non-conformity as per the decision of the Engineer. In addition, for any non-compliance causing damages or material harm to the natural environment, public or private property or resources, the contractor will be required to either remediate / rectify any such damages in a timeframe specified by and agreed with the engineer, or pay BWDB for the cost (as assessed by BWDB) of contracting a third party to carry out the remediation work.
- Since many contractors do not have clear understanding the need of environmental management, some quote very low price for implementation of EMP and eventually cannot implement EMP as per design. To avoid this problem, fixed budget may be assigned for EMP implementation. The contractors may need orientation on the requirement of the EMP in the pre-bidding meeting.

7.3. Institutional Arrangements

The following institutional arrangements have been included the EIA of the RBIP Phase I. *For the later phases, these arrangements will be revisited and modified as appropriate.*

7.3.1. Construction Phase

The RBIP implementation will be led by the River Management Office (RMO) that will be established within BWDB. The RMO will be headed by the Chief Engineer River Management (CERM) acting as Project Management Unit (PMU) and Project Director (PD). The post CERM was approved in November 2014 as part of the planning wing under the Additional Director General Planning. Further details of the institutional arrangement for the overall RBIP management are available in Feasibility report under the Institutional Arrangement volume.

The overall responsibility of environmental performance including EMP implementation of the RBIP will rest with the PMU (i.e., RMO). The PMU will engage construction supervision consultants (CSC) (described as the Project Management Consultants in the feasibility report) to supervise the contractors that will carry out the construction activities. The CSC will ensure adherence to the design parameters including quality requirements.

Within the PMU, the environmental and social development unit (EDSU) will be established tasked with implementing the EMP during the project construction phase. The ESDU will have adequate numbers of environmental and social scientists/specialists and maintain coordination and liaison with CSC for effective EMP implementation. Similarly, the CSC will also have environmental and social monitors who will supervise and monitor the contractors for effective EMP implementation. The contractors in turn will also have HSE supervisors who will ensure EMP implementation during construction activities and will be tasked to implement HSE Plan. The PMU will also engage an independent organization to carry out environmental monitoring during project implementation. The roles and responsibilities of ESDU, CSC, and contractors are presented in **Table 7.1** below.

Table 7.1: Roles and Responsibilities for EMP Implementation

Organizations	Responsibilities
PMU (RMO)	• Ensure that all project activities are well-managed and coordinated. • Procurement of works and goods. • Payment of compensation to the project affectees • Recruitment and supervision of Construction Supervision Consultants (CSC) • Recruitment and supervision of external monitor and independent Panel of Experts
ESDU	• Ensuring inclusion of EMP in bidding documents • Supervising CSC for the implementation of EMP • Ensure that all the project activities are carried out in environmentally sound manner. • Closely coordinate with other concerned agencies, local governments and communities to support implementation of EMP • Preparation of progress reports on implementation of EMP. • Ensure effective implementation of EMP components not directly tasked to the contractor including components dealing with indirect, induced and cumulative effects, as well as operations and

Organizations	Responsibilities
	maintenance stage plans and measures. • Commissioning and review of consultant reports for EIAs/EMPs to be developed for subsequent phases of RBIP.
CSC (PMC)	• Supervise civil works, ensuring compliance with all design parameters including quality requirements • Supervising contractors for EMP implementation • Prepare monthly reports and submit to PMU • CSC will have dedicated environmental and social staff
Contractor	• Responsible for implementation of mitigation and monitoring measures proposed in the EMP • Each contractor will recruit an Environmental, Health, and Safety Manager (EHSM), who will be responsible for implementing the contractors' environmental responsibilities, and liaising with government agencies. S/he will have adequate number of staff to support him/her for these tasks.
External Monitor	• Independent monitoring of implementation of EMP • External Monitoring and evaluation

7.3.2. O&M Phase

For the environmental management of the project during the O&M phase, BWDB will establish the Environmental and Social Cell (ESC). ESC will have adequate numbers of the environmental and social specialists.

7.3.3. Environment and Social Development Unit

The ESDU to be established to implement and manage the EMP will be structured to provide co-ordination, technical support and services during the environmental screening and preparation of EA, and implementation of the environmental mitigation measures. Functions and the staffing responsibilities of ESDU are listed in **Table 7.2** below. In order to effectively manage the EA process and EMP implementation, the ESDU will be established and made operational before awarding the contract to contractor. One Senior Environment Specialist will be appointed at the head quarter. One environment specialist and one social development specialist will be posted at the field level.

Table 7.2: Functions and Responsibilities of the ESDU

Designation	Function/Responsibility
ESDU (Sr. Environment Specialist)	• Assist the PD in conducting environmental screening and categorization of each phase; • Assist the PD in implementation of the EIA and EMP during the project implementation period; • Preparation of EA and finalization of the same in close co-ordination with the design consultants and the World Bank; • Ensure integration of the EA and resulting EMP into the project redesign

Designation	Function/Responsibility
	and implementation plans (contract documents); • Ensure compliance of the mitigation measures by the Contractors; • Ensure incorporation of appropriate environmental specifications into the respective bidding and contract documents; • Assist the BWDB Engineers at site by providing appropriate environmental advice, and developing appropriate environmental mitigation measures; • Documenting the experience in the implementation of the environmental process; • Assist consultant's and BWDB community organizer to carryout participatory consultation during planning, design and implementation; • Assist the PD in obtaining Environmental Clearances from the DOE; • Assist in development of training program for the key stakeholders (BWDB, contractors, public representatives and local government institutions/ NGOs, in collaboration with the field level junior Environmental Specialist; • Review and approve the Contractor's Implementation Plan for the environmental measures, as per the EMP; • Liaison with the Contracts, CSC for the Implementation of the EMP; • Liaison with the DOE on environmental and other regulatory matters; • Interact with the NGOs and Community based organizations to be involved in the project for EMP implementation; • Dialogue with the project affected persons (PAPs) and ensure that the environmental concerns and suggestions are incorporated and implemented in the project; • Undertaking environmental monitoring and reporting to the Project Director and follow-up activities; • Assist field level junior environment specialist to resolve any environment related issue in the project • Document the standard construction practices in the project on incorporation and integration of environmental issues into engineering design and on implementing measures reconstruction/rehabilitation and maintenance programs; • Assist the PD to arrange for the Environmental Auditing and follow up action on the Audit recommendation. • Report to the PD on the environmental aspects pertaining to the project. • To guide and assist the PD and the BWDB to strengthen the environmental management practices in embankment rehabilitation, revetment and road construction. • Ensuring Update of Database for project specific environmental information • Prepare periodic progress reports on the implementation of the EMF/EMP for transmission to the World Bank throughout the project

Designation	Function/Responsibility
	implementation period. • Update of Environmental Management Plan and Environmental Impact Assessment after receiving information from the contractors and design consultants. • Capacity Building of the responsible assistant and deputy chief responsible for environmental sustainability assurance of BWDB project • Maintaining project-specific Database for Environmental Management
Field Level Environment and Social Development Specialists	• Assist the Design Consultants in Environmental screening process • Assist the PMU in Environmental and Social Assessments for the projects; • Assist PMU in obtaining of requisite Environmental Clearances for the project; • Assist the Senior Environment Specialist and the Environmental Specialist of the Design Consultants and CSC in preparation of the training materials and in conducting training; • Review the contractor's Implementation Plan for the environmental and social mitigation measures, as per the EMP with assistance from the Environmental Specialist of the consultant; • Liaison with the contractors and CSC on the implementation of the EMP; • Carry out consultations with the NGOs and Community groups to be involved in the project; • Establish dialogue with the affected communities and ensure that the environmental concerns and suggestions are incorporated and implemented in the project; • Carry out site inspections, check and undertake periodic environmental monitoring and initiate necessary follow-up actions; • Document the good practices in the project on incorporation and integration of environmental issues into engineering design; • Report to the Executive Engineer (Environment) / PD on the environmental aspects pertaining to the project; • Assist in the preparation of periodic reports for dissemination to the PMU, and World Bank.

Under RBIP, the ESDU will provide trainings to the BWDB personnel responsible for monitoring of environmental compliance during the O&M phase of the project. Thus smooth transition to BWDB will happen to ensure environmental compliance during the O&M phase.

7.3.4. Construction Supervision Consultants (CSC)

The CSC will be responsible for supervising the contractors for the implementation of EMP. For this purpose, the CSC will appoint dedicated environment and social staff to ensure EMP implementation during the project. They will supervise the contractor for the

EMP implementation, particularly the mitigation measures. They will also be responsible for implementing the monitoring of effects of these measures.

CSC will have the following environmental staff appointed at the site:

- Team Leader (international environmental specialist)
- Environmental Specialists (two national specialists)
- Ecologist (one national specialist)
- Ichthyologist (one national specialist)
- Occupational Health and Safety Specialist (one national specialist))
- Environmental Surveyors (four national)

The environment staff of CSC will closely supervise the construction team to ensure that all environmental commitments are incorporated into the construction activities and work processes. Specific responsibilities include:

- Supervising and supporting contractors in fulfilling their responsibilities as outlined in the EMP;
- Issuing non-compliance notices to the contractors;
- Providing input, advice, and approval on activity specific work plans relating to EMP;
- Supervising the implementation of activity specific work plans;
- Regularly reviewing and assessing environmental risks throughout the construction phase;
- Identifying and preparing environmental induction and training materials;
- conducting environmental trainings;
- Assist ESDU in addressing and resolving environment-related complaints and grievances
- Responding to environmental incidents as required;
- Managing compliance reporting as it relates to the Project, and preparing quarterly EMP compliance reports;
- Liaise with ESDU for effective environmental management at site;
- Reviewing EMP and revising it if required on six-monthly basis.

7.3.5. Contractors

Each contractor will be required to appoint adequate number of dedicated Environment/Social Officers at the site for the implementation of EMP in the field, particularly the mitigation measures. The contractor will also be responsible for communicating with and training of its staff in the environmental/social aspects. The contractor will develop the various plans directed towards health, safety, the environment and social issues (discussed later in the Chapter), and get them approved by the CSC before the commencement of the physical works on site. Appropriate numbers of the following personnel are required in the contractor's environmental team:

- Environmental Specialists

- Occupational Health and Safety Specialists
- Environmental Technicians (both for lab and field investigations)

The construction contracts will have appropriate clauses to bind the contractors for the above obligations.

7.4. Environmental and Social Management

Various environmental and social management plans that have been/will be prepared for each phase of the RBIP are listed in **Table 7.3** and described in subsequent sections.

Table 7.3: Management Plans

	Plan	Responsibility			Timing
		Plan Preparation	Plan Approval	Implementation	
1.	Environmental Codes of Practice (ECPs)	Consultants	BWDB /WB	BWDB through contractors	Already prepared (**Annex B**)
2.	Mitigation and Compliance Monitoring Plans	Consultants	BWDB /WB	BWDB through contractors	Already prepared for the Phase I and included in the associated EIA; similar plans will be included in the EIAs of later phases.
3.	Material borrowing plan (river sand)	Contractor	BWDB /WB	BWDB through contractors	Within one month of mobilization of each phase.
4.	Plantation Plan	Consultants	BWDB	Contractors	Already prepared for the Phase I and included in the associated EIA; similar plan will be included in the EIAs of later phases
5.	OHS Plan	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor
6.	Pollution Prevention Plans (related to air, noise, soil, water resources)	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor

	Plan	Responsibility			Timing
		Plan Preparation	Plan Approval	Implementation	
7.	Waste Disposal and Effluent Management Plan	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor
8.	Drinking Water Supply and Sanitation Plan	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor
9.	Traffic Management Plan	Contractors	CSC and PMU	Respective contractors	Before mobilization of each contractor
10.	Construction Camp Management Plan	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor
11.	Fuels and hazardous substances management plan	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor
12.	Emergency Preparedness Plan (for construction phase)	All contractors	CSC and PMU	All contractors	Before mobilization of each contractor
13.	Emergency Preparedness Plan (for O&M Phase)	BWDB	-	BWDB	During O&M
14.	Resettlement Action Plan	Consultants	BWDB / WB	BWDB	Already prepared for the Phase I; similar plans will be prepared for later phases as well.
15.	Gender Action Plan	Consultants	BWDB / WB	BWDB	Already prepared for the Phase I; will be revisited for later phases
16.	Public Health Action Plan	Consultants	BWDB / WB	BWDB	Already prepared for the Phase I; will be revisited for later phases

7.4.1. Environmental Codes of Practice

The environmental codes of practice (ECoPs) are generic, non site-specific guidelines. The ECoPs consist of environmental management guidelines and practices to be followed by the contractors for sustainable management of all environmental issues. The contractor will be required to follow them and also use them to prepare site-specific management plans (discussed later in the Section). The ECoPs are listed below and attached in **Annex B**.

- ECoP 1: Waste Management
- ECoP 2: Fuels and Hazardous Substances Management
- ECoP 3: Water Resources Management
- ECoP 4: Drainage Management
- ECoP 5: Soil Quality Management
- ECoP 6: Erosion and Sediment Control
- ECoP 7: Top Soil Management
- ECoP 8: Topography and Landscaping
- ECoP 9: Borrow Areas Management
- ECoP 10: Air Quality Management
- ECoP 11: Noise and Vibration Management
- ECoP 12: Protection of Flora
- ECoP 13: Protection of Fauna
- ECoP 14: Protection of Fisheries
- ECoP 15: Road Transport and Road Traffic Management
- ECoP 16: River Transport management
- ECoP 17: Construction Camp Management
- ECoP 18: Cultural and Religious Issues
- ECoP 19: Workers Health and Safety.

7.4.2. Mitigations and Compliance Monitoring Plans

The mitigation and compliance monitoring plans are the key element of EMP to be prepared on the basis of impact assessment described in **Chapter 6**. The Plans describe the potentially negative impacts of each project activity, lists mitigation and control measures to address the negative impacts, and assigns responsibilities for implementation and monitoring of these measures. The Plans for the Phase I have been prepared and included in the EIA of that phase; similar plans will be prepared for the later phases and included in the associated EIAs. **Table 7.4** presents the format of these plans.

Table 7.4: Format of Mitigation and Compliance Monitoring Plan – Construction Phase

Environmental Impact/Issue	Actions	Responsibility		Key Performance Indicator	Timing	Cost Allocation
		Execution	Monitoring			
1. Activity: Design / pre-construction considerations						
1.1 Changes in land use, loss of properties, cultivated land and grazing land, relocation of settlements and amenities	– The RAP will be implemented for permanent land acquisition and loss of assets/livelihood and other similar impacts	BWDB PMU	ESDU	– Documentary evidence of RAP implementation – Establishment of resettlement sites – Payment of compensation amounts – People resettling in new villages – Income levels of displaced households – Number of public grievances re resettlement and compensation	Before construction	Included in overall Project cost
	– Contractors will lease the land for construction facilities on temporary basis. Proper documentation will be carried out for this leasing. Site selection will be carried out in consultation with the community and local officials; approval from CSC will also be required for the selected sites.	Contractor	CSC/ESDU	– Documentary evidence of land leasing for temporary facilities – CSC approval for the selected site(s) – Absence of grievances regarding temporary facilities	Before contractor mobilization	Included in contractors ' costs
1.2 borrowing construction material	– A material (particularly river sand) borrowing plan will be prepared	Contractor	CSC/ESDU	– Approved plan – Plan itself will outline appropriate KPIs for its implementation.	Before construction	Included in contractors ' costs

7.4.3. Site Specific Management Plans

Sand borrowing plan will be prepared and implemented by the contractors on the basis of the ECoPs and the mitigation measures given in **Chapter 6** and **Table 7.4**. The Plan will describe among others the methodology to be adopted, restrictions to be followed, prior survey to be conducted, and documentation to be maintained for the sand extraction. The Plan will be submitted to the CSC for their review and approval before initiating the sand extraction activity.

Pollution Prevention Plan will be prepared and implemented by the contractors on the basis of the ECoPs and WBG EHS Guidelines (1997) that will be part of the bidding documents. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Waste Disposal and Effluent Management Plan will be prepared and implemented by the Contractor on the basis of the EMP, ECoP, and WBG EHS Guidelines (1997), which will be part of the bidding documents. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Drinking Water Supply and Sanitation Plan: Separate water supply and sanitation provisions will be needed for the temporary facilities including offices, labor camps and workshops in order not to cause shortages and/or contamination of existing drinking water sources. A Plan will be prepared by the contractors on basis of the EMP and ECoPs, which are part of the bidding documents. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Occupational Health and Safety (OHS) Plan will be prepared and implemented by each contractor on the basis of the WBG EHS Guidelines (1997), ECoPs, mitigation plan (**Table 7.4**), and other relevant standards. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

Traffic Management Plan will be prepared by each contractor after discussion with BWDB and authorities responsible for roads and traffic. The Plan will be submitted to the CSC for their review and approval before contractor mobilization. The Plan will identify the routes to be used by the contractors, procedures for the safety of the local community particularly pedestrians, and monitoring mechanism to avoid traffic congestion.

Construction Camp Management Plan will be prepared by each contractor. The Plan will include the camp layout, details of various facilities including supplies, storage, and disposal. The Plan will be submitted to the CSC for their review and approval before camp establishment.

Fuel and Hazardous Substances Management Plan will be prepared by each contractor in accordance with the standard operating procedures, relevant guidelines, and where applicable, material safety data sheets (MSDS). The Plan will include the procedures for handling the oils and chemical spills. The Plan will be submitted to the CSC for their review and approval before contractor mobilization.

An **Emergency Preparedness Plan** will be prepared by each contractor after assessing potential risks and hazards that could be encountered during construction. The Plan will be submitted to the CSC/BWDB for their review and approval before contractor mobilization.

Plantation Plan: A plantation plan has been prepared (discussed in **Chapter 6**) for the trees to be planted on the embankment of the priority reach. The Plan includes the species

to be planted, the plantation methodology, and plantation layout. *Similar plans will be prepared for the later phases of the RBIP as well.*

Resettlement Action Plan (RAP): The Project will require about 340 ha of land and affect a total of 15,558 persons for the construction of embankment in the priority reach (ie, Phase I of the RBIP). The social impacts largely include loss of residential and agricultural land, residential, commercial and communal structures, as well as loss of income and livelihoods. To address and mitigate these relocation and resettlement impacts, the Resettlement Action Plan (RAP) has been prepared. The RAP is based on the findings of the inventory and census surveys as well as meetings and consultations with various project-affected persons. The RAP presents (a) type and extent of loss of assets including land, structures and trees; (b) principles and legal framework applicable for mitigation of these losses; (c) the entitlement matrix, (d) relocation strategies and plans, including provision for livelihoods; (e) resettlement and rehabilitation budget; and (f) institutional framework for the implementation of the plan, including monitoring and evaluation. It has been designed as a "development" plan, therefore the overall objective of the RAP is to restore and/or improve the living standards of the affected persons from pre-project level. *Similar RAPs will be prepared for the later phases of the RBIP as well.*

7.5. Monitoring Program

As one of the key elements of the EMP, a three-tier monitoring program has been proposed comprising compliance monitoring, effects monitoring, and external monitoring. The main purpose of this monitoring program is to ensure that the various tasks detailed in the EMP particularly the mitigation measures are implemented in an effective manner, and also to evaluate project's impacts on the key environment and social parameters. Various types of EMP monitoring are discussed below.

7.5.1. Compliance Monitoring

The purpose of the compliance monitoring is to ensure that the contractor implements the mitigation measures given in the EMP are effectively and timely implemented. This monitoring will generally be carried out by the CSC with the help of checklists prepared on the basis of the Mitigation Plan (**Table 7.4**).

7.5.2. Effects Monitoring during Construction

Effects monitoring is a very important aspect of environmental management to safeguard the protection of environment. The effects monitoring plan proposed for the RBIP Phase I is presented in **Table 7.5**; for the later phases, this program will be revisited and revised. The monitoring will comprise surveillance to check whether the contractor is meeting the provisions of the contract during construction and operation of the Project including the responsible agencies for implementation and supervision.

Table 7.5: Effects Monitoring Plan

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Sand extraction	River bank	Visual inspection to ensure the depth of excavation from the river bed is limited to 3m.	Weekly	Contractor	CSC
	River bank	Visual inspection to	Weekly	Contractor	CSC

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
		ensure the extraction location is more than 20 m from the river bank (boats and measuring instruments would be needed)			
	River bank	Visual inspection to ensure that sand extraction is not carried out in single, contiguous stretches	Weekly	Contractor	CSC
Pb, Cd, Cr, Cu, Zn, Mn, As, Se Hg, and oil/grease	Riverbed within the project boundary	Laboratory analysis of material for screening for metals and oil/grease	Before sand extraction	Contractor through a nationally recognized laboratory	CSC
Soil Pollution	Embankment	Visual inspection that filling is through several compartments	Beginning of earth filling works	Contractor	CSC
	Embankment	Ensure no contaminated effluent is leaving from the filling area to the nearby agricultural lands	Weekly	Contractor	CSC
	Material storage sites	Visual inspection.	Monthly	Contractor	CSC
Erosion	Side slopes	Visual inspection of erosion prevention measures and occurrence of erosion	At the end of filling activity	Contractor	CSC
Hydrocarbon and chemical storage	Construction camps	Visual Inspection of storage facilities	Monthly	Contractor	CSC
Damage to local roads	Approach Roads to the construction sites	Visual inspection to ensure local roads are not damaged	Monthly	Contractor	CSC
Traffic Safety	Haul Roads	Visual inspection to see whether proper traffic signs are placed and flag-men for traffic management are engaged	Monthly	Contractor	CSC
Air Quality (dust, smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (eg, spraying of waters) are in place.	Daily	Contractor	CSC
	Asphalt Plant	Visual inspection to ensure asphalt plant is	Monthly	Contractor	CSC

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
		located >500 m from residential areas			
	Material storage sites	Visual inspection to ensure dust suppression work plan is being implemented	Monthly	Contractor	CSC
	Sensitive receptors along construction corridor	Continuous monitoring with the help of appropriate instruments and analyzers	Quarterly during the constructio n phase	Contractor	CSC
Noise	Construction sites	Physical inspection to ensure good standard equipment are in use; Noise measurement using noise meter	Weekly	Contractor	CSC
	Construction sites	Visual inspection to ensure ear plugs are in use by the construction workers	Weekly	Contractor	CSC
		Ensure work restriction between 21:00-06:00 close to the sensitive locations	Weekly	Contractor	CSC
Water quality (As, Mn, Fe, and coliforms)	Locations of tube-well installation	Depth of tube well should be more than 300m. Test water for arsenic, iron and manganese before installing of casing. If the quality is found not suitable further deepening will be done.	During drilling of wells	Contractor trough a nationally recognized laboratory	CSC External Monitor
	Near camp sites and other sensitive locations along the construction corridor	Laboratory analysis	Monthly during constructio n phase	Contractor trough a nationally recognized laboratory	CSC
Plantation	Embankment/ road	Visual inspection to ensure plantations in green areas and other designated sites.	Monthly	Contractor	CSC
Waste Management	Construction camps	Visual inspection that solid waste is disposed at designated site	Monthly	Contractor	CSC
Drinking water and sanitation	Camps, offices	Ensure the construction workers are provided	Weekly	Contractor	CSC

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
		with safe water and sanitation facilities in the site			
Flora and Fauna	Sensitive habitats in Project influence area (Tables 6.7, 6.16, and 6.17)	Survey and comparison with baseline environment	Six-monthly	Contractor through nationally recognized institute	CSC, M&E Consultant, BWDB
Fish migration	Khals, beels and river (Tables 6.7, 6.16, and 6.17; Annex F of EIA)	Survey and comparison with baseline environment	Six-monthly	Contractor through nationally recognized institute	CSC, M&E Consultant, BWDB
Cultural and archeological Sites	At all work sties	Visual observation for chance finds	Daily	Contractor	CSC, M&E Consultant, BWDB
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	Contractor	CSC, M&E Consultant, BWDB
Safety of workers Monitoring and reporting accidents	At work sites	Usage of Personal Protective equipment	Monthly	Contractor	CSC, M&E Consultant, BWDB
During Operation and Maintenance					
Surface Water Quality (TDS, Turbidity, pH, DO, BOD, COD etc)	At the baseline monitoring sites	Sampling and analysis of surface water quality	Six-monthly	BWDB through a nationally recognized laboratory	BWDB
Pesticide residue in soil and water	Cultivation fields, khals and beels	Laboratory analysis	Six-monthly	BWDB through a nationally recognized laboratory	BWDB
Air Quality (Dust PM_{10}, $PM_{2.5}$)	At the baseline monitoring sites	24 hours Air quality monitoring	Yearly	BWDB through a nationally recognized laboratory	BWDB
Flora and Fauna	Sensitive habitats in	Detail species assessment and compare	Yearly	BWDB through a	BWDB

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
specially fisheries	Project influence area (Tables 6.7, 6.16, and 6.17 and Annex F of EIA)	with baseline		nationally recognized institution	
Agriculture	In the project influence area	Compare the production with the baseline	Yearly	BWDB through a nationally recognized institution	BWDB
Operation of regulators and fish passes	In the project influence area	Visual inspection and public feedback	Yearly	BWDB	BWDB

7.5.3. External Monitoring

The BWDB will engage an independent consulting firm to conduct external and independent monitoring of the EMP implementation. The main purpose of the external monitoring will be to ensure that all the key entities including EDSU, CSC, and contractors are effectively and adequately fulfilling their designated role for EMP implementation, and that all the EMP requirements are being implemented in a timely and effective manner. The ToR of the external monitoring is presented in the EIA of Phase I of the RBIP.

7.6. Performance Indicators

For evaluating the performance of the environmental management and monitoring plan, performance indicators are identified to for efficient and timely implementation of measures/actions proposed in EMP. The indicators are defined both for implementation phase and for operation phase. CSC will be responsible for compiling the information on these indicators and report to BWDB.

Separate performance indicators for each environmental issue have been specified in the mitigation plans for the Phase I and included in the associated EIA; *similar performance indicators will also be included in the mitigation plans that would be prepared and included in the EIAs of the later phases of the RBIP*. To measure the overall environmental performance of the project, an additional list of performance indicators is given below.

- Number of inspections carried out by CSC per month
- Number of non-compliances observed by CSC or ESDU.
- Availability of environmental specialists in ESDU.
- Availability of environmental specialists in CSC.
- Availability of environmental specialists with contractors.
- Timely reporting of documents (as defined in EMP and monitoring plan)

- Number of trainings imparted to stakeholders/other capacity building initiatives
- Timely disbursement of compensation/ timely resettlement of project affectees
- Timely implementation of resettlement schedule.
- Number of grievances received.
- Number of grievances resolved.
- Number of construction related accidents.

7.7. Grievance Redress Mechanism [31]

The project will establish a grievance redress mechanism (GRM) for addressing grievances and complaints received from the project-affected persons. The fundamental objective of GRM will be to resolve any project-related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of the social and environmental action plans. Another important objective is to democratize the development process at the local level and to establish accountability to the affected people. The procedures will however not pre-empt a person's right to go to the courts of law.

Under the GRM, two grievance redress committees (GRCs) will be formed: local grievance redress committee (LGRC); and project grievance redress committee (PGRC). Most of the grievances would be resolved at LGRC while a few might be forwarded to PGRC. These GRCs are described below.

7.7.1. Local Grievance Redress Committee

The following LGRC composition has been proposed for the project:

- Executive Engineer – RBIP, BWDB: Convener
- Representative of an international non-governmental organization: Member, Secretary
- Chairman – concerned Union *Parishad (UP)*: Member
- Female member of concerned ward of the UP: Member
- Representative of Women affected persons (APs): Member

LGRC meetings will be held in the convener's office in the project influence area or other location(s) as agreed by the Committee members. If needed, LGRC members may undertake field visits to verify and review the issues, including titles/shares, reason for any delay in payments, or any concern regarding social or environmental impacts of the project.

7.7.2. Project Grievance Redress Committee

The grievances that are not resolved at the LGRC will be forwarded to the PGRC. The PGRC will be empowered to take a decision, which would be binding on BWDB but it would require approval of the Project Director for implementation of the decision. The Project Director will head the PGRC. The composition of the PGRC will be as follows:

- Project Director: Chair Person

[31] Further details on GRM are available in RAP.

- Head of ESDU: Member, Secretary (Team Leader of INGO will assist the Secretary in grievance redress mechanism).
- Representative of Civil Society: Member (nominated by Project Director with the help of INGO).

The Secretary of PGRC with the help of INGO Team Leader will provide necessary knowledge and information regarding relevant project policies and agreements with development partner. The provision of PGRC will further establish fairness and transparency in the resolution of grievances of the project-affected persons. In case of technical nature of environmental issues, or any legal matters, Team Leader of INGO or environmental and social development specialists of CSC will advise the PGRC. In specific cases, external legal and or technical advice may also be sought, if required.

7.8. Capacity Building

Capacity building for effective implementation of the environmental and social safeguard requirements is a key element of the EMP. Capacity building for environmental and social safeguard management will need to be carried out at all tiers of the project, including BWDB, ESDU, CSC, and contractors. At the construction site, CSC will take the lead in implementing the capacity building plan, though the contractors will also be responsible to conduct trainings for their own staff and workers. The various aspects that are covered under the capacity building will include general environmental and social awareness, key environmental and social sensitivities of the area, key environmental and social impacts of the project, EMP requirements, OHS aspects, and waste disposal. **Table 7.6** provides a summary of various aspects of the environmental and social trainings to be conducted at the construction site. ESDU may revise the plan during the Project implementation as required.

During the O&M phase of the Project, these trainings will continue to be conducted by BWDB staff for all relevant O&M personnel and community.

Table 7.6: Environmental and Social Trainings

Contents	Participants	Responsibility	Schedule
General environmental and socioeconomic awareness; Environmental and social sensitivity of the project influence area; Key findings of the EIA; Mitigation measures; EMP; Social and cultural values of the area.	Selected staff of BWDB, CSC, and contractors	CSC	Prior to the start of the Project activities. (To be repeated as needed.)
General environmental and socioeconomic awareness; Environmental and social sensitivity of the project influence area; Mitigation measures; Community issues;	PMU; CSC; selected contractors' crew	CSC	Prior to the start of the field activities. (To be repeated as needed.)

Contents	Participants	Responsibility	Schedule
Awareness of transmissible diseases Social and cultural values.			
EMP; Waste disposal; OHS	Construction crew	Contractors	Prior to the start of the construction activities. (To be repeated as needed.)
Road/waterway safety; Defensive driving/sailing; Waste disposal; Cultural values and social sensitivity.	Drivers; boat/launch crew	Contractors	Before and during the field operations. (To be repeated as needed.)
Camp operation; Waste disposal; OHS Natural resource conservation; Housekeeping.	Camp staff	Contractors	Before and during the field operations. (To be repeated as needed.)
Restoration requirements; Waste disposal.	Restoration teams	Contractors	Before the start of the restoration activities.

7.9. Documentation

The ESDU with assistance from CSC and contractors will produce the following environmental reporting documentation:

- *Environmental Monitoring Reports:* The environmental monitoring reports will include environmental mitigation measures undertaken, environmental monitoring activities undertaken, details of monitoring data collected, analysis of monitoring results particularly the non-compliances, recommended mitigation and corrective measures, environmental training conducted, and environmental regulatory violations observed. The environmental monitoring reports will be submitted quarterly during the construction period and annually for three years after completion of construction.
- *Project Completion Environmental Monitoring Report:* One year after completion of construction, the ESDU will submit a Project Completion Environmental Monitoring Report which will summarize the overall environmental impacts from the Project to all the co-financiers.

BWDB will engage External Monitors during construction period to measure the effectiveness and outcome/impact of EMP, as stated earlier. The External monitors will submit the quarterly reports throughout the contract time, impact evaluation report at the end of each year and finally a completion Report at the end of contract period.

7.10. EMP Implementation Cost

The estimated costs for the environmental management and monitoring activities for the Phase I of the RBIP are set out in **Table 7.7** below. Similar estimates will be included in the each of the EIAs of the later phases.

Table 7.7: Cost Estimates for Environmental Management and Monitoring

Project Component		Description	Amount, USD
A. Rehabilitation/Civil Works	1	Contractors Budget (for development of management plans, staff, training, etc.)	1.00
	2	Air, noise and water quality monitoring during construction (quarterly for 5 years)	0.50
	3	Tree plantation development and maintenance along embankments	1.00
B. Implementation of EMP	4	Baseline Ecological Studies, development of conservation plans and biodiversity monitoring during construction and operation (5 years), training to workers, monitoring of sand extraction sites	2.00
	5	Implementation of conservation plans (e.g. fish sanctuaries in koles, bird sanctuaries in chars, dolphin sanctuary in river); eco tourism development	3.00
	6	O&M of fish passes (an agency to form and train the management communities, operation and maintenance, and monitoring equipment such as under water) cameras	1.00
	7	Fisheries development in the floodplains (improving connectivity of khals, artificial stocking of fingerlings, capacity building in sustainable harvesting, awareness raising, development of market facilities)	2.00
	8	Community Plantation development and maintenance (in resettlement sites, beels, riparian, etc.)	1.00
	9	Integrated pest management	1.00
	10	Resettlement sites management (O&M costs for sanitation and waste management, staff, etc.)	0.50
	11	Additional studies and Support	1.00
	12	Contingencies	0.50
C. CSC and M&E Consultants	13	CSC Environmental Staff	1.50
	14	Independent Environment Consultants/M&E	0.50
D. PMU and Capacity Building	15	PMU Environmental staff	1.00
	16	Capacity building and institutional strengthening	0.50
		TOTAL	**18.00**

8. Environmental Assessment and Management Process for RBIP

This Chapter describes the general principles for environmental management of RBIP and also specifies the environmental assessment procedure to be employed for conducting EIAs of various RBIP phases.

8.1. Key Principles of Environmental Management in RBIP

The key tasks to be undertaken for the environmental assessment and management of RBIP, for each of its phases, are listed below.

- The environment consultants, engaged by BWDB, will perform the environmental screening and detailed assessment of each RBIP phase, and prepare EIA reports, in accordance with the GoB and WB requirements, ToR of the environmental study included in **Annex A**, and the present EMF. The key steps of the environmental assessment are summarized later in the Chapter.
- The environment consultants, while conducting the EIAs of the later phases of RBIP, will review the EIA already conducted for the RBIP Phase I and the results (if available) of environmental monitoring carried out during the Phase I implementation.
- BWDB through its ESDU will conduct verification of screening and assessment as well as review of the EIA reports.
- The BWDB will ensure that environmental assessment addresses all potential environmental impacts, both direct and indirect, of the RBIP throughout its entire lifecycle: pre-construction, construction and operation stages.
- Design consultants will ensure that environmental considerations are given sufficient attention, weight and influence over design decisions of various project components.
- Bid documents will be prepared by the design consultants and appropriate clauses will be included in them regarding EMP implementation and the related obligations of the contractors
- EMP implementation will be done by Contractors (whenever measures relate directly to construction impacts management) and by BWDB (for all other measures)
- RBIP works and EMP implementation will be supervised by CSC and BWDB.
- All the activities of RBIP will follow EMP and Environmental Code of Practices (ECoP) prepared under EIA of RBIP.

8.2. Environmental Assessment Process

The environmental assessment will be conducted using major stages as shown in the diagram given in **Figure 8.1** below and discussed in the subsequent subsections.

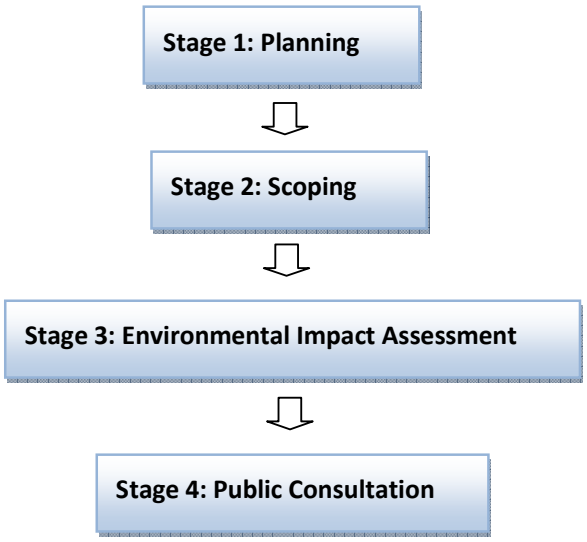


Figure 8.1: Diagram: Environmental Assessment Process

8.2.1. Stage 1: Planning

Soon after the commencement of planning and design process, based on desk study, reconnaissance survey and experience of earlier projects, detailed methodology and schedule should be prepared for the effective and timely execution of the Environmental Assessment.

Desk Study: To collect the secondary information and checking out the methodology for carrying out the EA study and fixing of responsibilities of the EA team members for preparing a complete, addressing all issues, Environmental Management Plan.

Reconnaissance survey: To collect the first hand information about the project area and develop a perspective of the entire team and revise the methodology and work program.

Experience from earlier project:

- **Focus on the main issues:** It is important that the EA does not try to cover too many topics in too much detail. Effective scoping can save both time and money by focusing the EA studies on the key issues.
- **EA requires the formation of a multidisciplinary team and the leadership of a strong EA coordinator.** The range of effects considered in the EA requires the skills mix of technical experts to be employed on an assessment team, led by a Team Leader. It is important to involve the right people (e.g., scientists, engineers, policymakers, government representatives, representatives of public interest groups and the local community) and agencies (e.g., the developer, the aid agency, regulatory authorities and politicians) in the EA process. Selection will be made through consultation at different stages.
- **Make maximum use of existing information before engaging expensive field studies.**
- **Cumulative impacts of the project.** Based on reconnaissance survey and desk study and modeling, project influence area will be finalized.

- **Present clear and appropriate options for mitigation of impacts and for sound environmental management.** Mitigation is an integral part of impacts assessment. Application of appropriate mitigation can eliminate or reduce negative impacts, and improve the net overall environmental performance of a project. Hence public consent, practical viability will be considered in proposing the mitigation measures.
- **Post-EIA audits and monitoring programs are essential to ensuring that EA commitments are carried out and that future EA improve.** An effective monitoring plan will be proposed in consultation with the client and the World Bank. Proper budgeting will be ensured for smooth functioning of monitoring plan proposed.

8.2.2. Stage 2: Scoping

Scoping will identifies which of the activities has a potential to interact with the environment. Scoping will be conducted early in the EA process so that a focus on the priority issues (i.e. those that have the greatest potential to affect the natural and/or environment) can be established for the rest of the EA process. Necessary consultation with stakeholders will be made after scoping to incorporate any unattended issues. Key elements/inputs to the scoping exercise will be as follows:

- Gathering and reviewing existing environmental data like climate, topography, land use pattern, hydrology and drainage pattern, major rivers and waterways, religious, cultural and archaeological sites and sensitive areas.
- Identifying project stakeholders; including project affectees, Government and non-government agencies (utilities), Bangladesh Water Development Board, Forest Department, Agricultural Department, and Department of Environment (DOE).
- Assemble and review relevant legislative requirements, environmental standards and guidelines (national and international) associated with the proposed development as well as the World Bank‘s operational policies and standards.
- Gathering existing information sources and local knowledge;
- Informing stakeholders of the project and its objectives and get input on the EA;
- Identifying the key environmental concerns (community and scientific) related to a project and the relative importance of issues;
- Defining/preparing the EA work program, including a plan for public and stakeholder involvement;
- Carrying out monitoring of natural environment including air, water, soil, noise etc.
- Defining the range of project alternatives to be considered.
- Obtaining agreement/consensus on the methods and techniques to be used in EA studies and document preparation;
- Determining/freezing the spatial and temporal boundaries for the EA studies.

Focus of scoping will be on the collection and analysis of pertinent data and the assessment of significant environmental attributes. The end result will be a work program

which is well focused and cost-effective. The following issues will be addressed through scoping, but will not be limited to:

- To improve the quality of EA information by focusing scientific efforts and EA analysis on truly significant issues;
- To ensure environmental concerns identified and incorporated early in the project planning process, at the same time as cost and design factors are considered;
- To ensure research efforts are not wasted on insignificant issues, rather focused on core issues.
- Reducing the likelihood of overlooking important issues;
- reducing the chance of prolonged delays and conflicts later in the EA process by engaging stakeholders in a constructive participatory process early in the EA process.

8.2.3. Stage 3: Impact Assessment

The EIA of the RBIP phases should be conducted following the Guideline for Environmental Assessment of Water Management Projects (WARPO, 2005) and the Environmental Assessment requirements of World Bank. After conducting IEE, the EIA should be conducted, as per TOR for EIA suggested in IEE study and approved by DOE. The process of EIA study is briefly described below.

Analysis of the Project Design and Components: All the components of the RBIP and design specifications will be analyzed to get insight of the project interventions. This will guide detail environmental baseline survey and particular investigations.

Data collection on environmental and social baseline: Environmental and social baseline condition of the proposed sub-projects should be collected through several field visits, surveys and intensive consultation with local people. Detailed data on land resources, water resources, agriculture, fisheries, ecosystems and socio-economic condition should be collected. Intensive consultation with the stakeholders should be carried out to obtain their perceptions on the proposed interventions and the possible impacts.

- **Primary data collection:** to define characteristics of the existing environmental condition including soil, water, air, noise, land use, cultural properties and flora and fauna.
  - Monitoring to be carried at critical locations;
  - Identification of residential, commercial, industrial and forest areas for monitoring;
  - Air and noise monitoring at significant location, major settlements, mosque, school and hospitals
  - Water monitoring at river/canal/pond and ground water sources near major settlements;
  - Soil monitoring at major settlements, near surface water bodies;
  - Tree inventory to be carried out, in consultation with the Forest Department; and
  - Inventory of cultural, religious and archeological sites will be done along with measurements, details and photographs, consultation will be done for gathering public opinion.

- **Secondary data** to define meteorological, geology, seismicity, quarries, borrow areas, disposal sites etc.
- Details of quarry and borrow areas to be used will be collected (photographs, measurements and public opinion) and a comprehensive plan for extracting material will be prepared.
- Meteorological data from Bangladesh Meteorological Department (BMD), topographic sheets and maps from Survey of Bangladesh (SOB), geological and soil data from Bangladesh Soil Resources Institute, Seismic data from Space Research and Remote Sensing Organization (SPARSO).
- **Social data** including ownership pattern, identification of tribals, vulnerable social groups, and land estimates.

Project Area of Influence: At the outset of the study, the Project area of influence (or Project area for short) will be broadly demarcated. This included the area inside the flood embankments where most of the Project interventions would take place, area immediately outside the flood embankments (this area could be used for staging of construction works, material stockpiling, and/or earth borrowing), access routes for the embankments, borrow as well as spoil disposal areas, and labor camps/contractor facilities. The project area of influence will be inconsistent with the area of influence defined in Section 5.1.

Scoping: Important Environmental and Social Components (IESCs), likely to be impacted directly and indirectly by the project interventions, selected at the IEE stage will be revisited for finalizing their selection based on detailed information on the proposed interventions.

Major Field investigations: At this stage, detailed field survey (social and environmental) will be carried out to obtain information on the possible impact of the interventions on the IESCs.

Assessment of Environmental and social Impacts: The impacts of the proposed RBIP on the environmental and social components will be identified through consultation with experts and local community. The impacts will be analyzed and graded qualitatively (e.g. high, medium, low) based on the potential magnitude of the impact and sensitivity of the receptor(s), in order to identify the major impacts. The future-without-project (FWOP) condition will be generated through trend analysis using information collected. The future-with-project (FWIP) condition will be predicted using professional judgment of the multi-disciplinary team members based on information collected. Difference between the two (FWIP-FWOP) conditions will be taken as impact of the proposed interventions. Moreover, cumulative impacts of the project inside or outside the project area will be analyzed. Possible mitigation measures for alternatives of the project will be identified in this stage. For true impacts prediction following questionnaire will be attempted to answer:

- How will a particular project activity give rise to an impact?
- How likely is it that an impact will occur?
- What will be the consequence of each impact?
- What will be the spatial and temporal extent of each impact?

Analysis of Alternatives: Since the existing embankments will be improved under RBIP, alternative options for designing the project interventions will be analyzed. The potential impacts of alternative design of structure will be evaluated.

- With or without the project.
- Analysis criteria to include environmental, social, technical/design and economic options.
- Alignment options within existing positions
- Suitable locations of hydraulic structures
- Other engineering alternatives

Preparation of environmental management plan: The EMP will be prepared suggesting mitigation measures for minimizing the effect of the negative impacts, compensation measures for the negative impacts which cannot be mitigated, enhancement measures for increasing the benefits of the positive impacts, contingency plan for taking care of natural hazards and accidental events. An environmental monitoring plan will also be suggested in the EMP. Each component of the EMP will be divided into pre-construction, during construction, post construction and operation and maintenance phases. Responsibilities of the institutions in the implementation of the EMP will be suggested to ensure efficient utilization of all the parties involved. The EMP should also include institutional capacity assessment and capacity building plan.

EIA Report Preparation: All the findings would be presented in the EIA reports as per outline given in **Annex A**.

8.2.4. Stage 4: Stakeholder Consultations

Stakeholder consultations refer to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account all the material concerns in the project or activity design as appropriate. All projects or activities shall undertake public consultation. The key points of public consultation are given below.

- Identification of primary and secondary stakeholders.
  - Primary stakeholders include people having direct impact.
  - Secondary stakeholders include village representatives, women‘s group, voluntary organizations NGOs, field level officers and staff, other government officials.
- Structured Consultation
  - Consultation at Village Level
  - Consultation at Upazila and District Level
  - Consultation at Divisional level
- Along with preliminary inventory and survey information dissemination will be done along embankments canvassing about the project. Date and venue for detailed consultation will be fixed.
- Pictorial method (Pamphlet) will be adopted to explain proposed improvements and possible environmental impact in the concerned villages.
- Public consensus would try to be arrived for and mitigation proposed.

- Public suggestion and graveness will be addressed at appropriate level.

Consultation at Upazila and District Level

- Consultation with officers of Agricultural Department, Forest Department, Soil Department, Fisheries Department, Department of Public Health Engineering (DPHE), and others.
- - Consultation with the elected representatives and other stakeholders.

Consultation at Divisional level

- Consultation with senior department officers, like DOE office, District Commissioner Offices, Settlement offices etc. and mechanism of regulatory clearance, utility shifting, and land acquisition.

After completion of the public consultation, the design consultant shall address all the material environmental concerns expressed during this process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by the client to the concerned regulatory authority for appraisal.

8.3. Guideline for Compensation and Contingency Plan during Project Construction Phase

Compensation becomes necessary when project impacts cannot be satisfactorily mitigated. This can be paid in cash or kind and the emphasis should be on ensuring fairness and causing minimum inconvenience to the affected party. The most common cause of compensation payment is displacement of people and loss of productive land due to land acquisition, tree cutting, or property damage. Such impacts can rarely be fully compensated. The compensation should be given as per provision of the Resettlement Action Plan. Any disputes over the compensation should be handled by the Grievance Redress Committee.

In addition to the compensation, project should also have a contingency plan to deal with emergencies and accidents. Such incidences encompass a whole range of situations from personal injury during operation of a machine to breaching of an embankment. Therefore, BWDB and its contractors would prepare for the following emergency situations:

- Embankment failure during a flood – keep sufficient number of sand bags in reserve.
- Bank caving/erosion – keep sufficient number of concrete blocks and sand bags in reserve.
- Have an emergency evacuation plan for the people in the line of danger, disclose the plan to the potentially affected workers and population, and educate them (including through drills, workshops, etc.) about how to minimize their own risk levels in case of an embankment breach or other emergency, how they will be informed / warned of imminent danger (for example through sirens, loudspeakers, visits from BWDB field staff, etc.) and what may be required of them (for example evacuations).
- Accidental spill of pesticide or similar harmful chemicals – train some members of the contractor's workforce and BWDB personnel on how to confine such a spill and minimize potential danger to humans and other animals.

- Fire – keep fire extinguisher or emergency water pump ready at local project office.
- Personal injury – keep a first aid box at the project office. Have a plan for quickly transporting a seriously injured person to the nearest hospital.

8.4. Methods for estimating costs and benefits of the impacts and mitigation/enhancement measures

It is very crucial to estimate the benefits of the proposed interventions, damages/loss due to the impacts as well as cost and benefits of mitigation / enhancement measures for proper evaluation of the proposed program. Quantitative and qualitative approach can be followed depending on the indicators to be measured or estimated. Some of the methods are described below. These methods need to be applied while conducting detail EIA study. This assessment should be integrated into the alternatives analysis to be completed as part of each EIA for subsequent project phases, and cost estimate measures should also be built into the monitoring program of the priority reach, to generate quantitative data on actual environmental costs which can help inform the analyses for subsequent phases of RBIP.

8.4.1. Methods for estimating costs of environmental damages

Valuation of environmental damages due to proposed program can be estimated using direct and indirect valuation methods with specific indicators of damages. For instance, reduction of fish capture can be estimated from the differences of fish catch between before project and after project situation, whereas loss of migratory fish can be estimated through counting number of fish species in before project and after project situation. Similar example of damage estimation methods are given in **Table 8.1**. Some of the damages can be expressed in monetary terms, some are not. In such case, multi criteria based combined index can be calculated to estimate value of overall negative impacts of the proposed program.

Table 8.1: Example of methods for Estimating Costs of Environmental Damages

Possible Negative Environmental Impacts	Method for estimating damages
Fish habitat could decrease due to loss of ecological connectivity	Estimating market value of the amount of fish catch decreased (Taka/ year)
Some migratory fish species may be reduced due to closure of local rivers	Counting number of migratory fish species decreased
Aquatic habitat area will be reduced due to decreased water inflow.	Estimating area of aquatic habitat reduced (ha)

8.4.2. Methods for estimating benefits of the direct positive impacts of the project

Similar methods will be used for estimating benefits of the project as the methods for estimating damages. Examples of methods for estimating benefits of the positive environmental impacts are shown in **Table 8.2**.

Table 8.2: Example of methods for estimating benefits of positive environmental impacts

Possible Positive Environmental Impacts	Method for estimating benefits
Cropped area will increase due to increase of flood protection	Estimating value of additional crop produced in the increased cropped area due to project (Taka/year)
fish production will increase due to increased flood protection and new regulators	Estimating value of fish catch increased due to channel re-excavation (Taka/ year)
Fish migration will improve as well as species diversity will improve due to new regulators	Counting number of migratory fish species increased
Employment opportunity will increase	% of employment
Employment opportunity of the local labor will increase during construction of embankment	% of employment
Household income and food consumption will be improved due to flood free environment	Estimating the amount of household income increased after project interventions
Population migration will decrease due to increase of flooding free area	% of day labor migrating to other areas
Quality of life indicators such as housing, drinking water, health and sanitation will be improved	% of households having access to safe drinking water supply and sanitation
Women status in the society may improve gradually	% of woman employment

8.5. Guidelines for Selecting and Managing Resettlement Sites

8.5.1. Site Selection Guidelines

The guidelines for selecting the resettlement sites as part of the RBIP are presented below.

- Sites having minimum displacement requirements will be selected
- Sites with minimum impacts on agriculture activities and cultivated land will be selected
- Sites with minimum impacts on natural vegetation particularly trees will be selected
- Sites will be located at a safe distance from sensitive habitats (see **Figures 5.45** and **5.47**; and **Tables 5.35**, **5.36**, and **5.37**)
- Sites will not be located at or in immediate vicinity of any *beels* and *khals*
- Areas prone to flooding will be avoided
- Areas requiring minimum cutting and or filling will be selected
- It will be ensured that the site does not block any existing route
- Community consultation will be carried out to finalize the sites.

8.5.2. Guidelines for Designing the Resettlement Sites

The guidelines for designing the resettlement sites as part of the RBIP are presented below.

- Adequate arrangements will be made to protect the sites from floods
- Appropriate arrangements (ie, access road) will be made for connecting the sites with the existing road network
- Arrangements for storm water drainage, sewage collection, treatment, and disposal, and solid waste management will be included in the design – ensuring that existing water resources of the areas are not contaminated and nearby cultivation fields are not flooded because of the effluents or solid waste disposal from the sites
- Provision of safe drinking water will be ensured
- Use of renewable energy technologies such as photovoltaic cells will be encouraged
- The design will include tree plantation using indigenous species.

8.6. Cost of implementing EMP and source of funds

Tentative cost of implementing proposed mitigation plan, enhancement plan, compensation and contingency plan, and monitoring plan needs to be estimated. The financial costs and benefits of mitigation/enhancement measures can be estimated based on the material and human resources requirements for the particular mitigation/ enhancement measures. Some example of methods for estimating cost and benefits of mitigation/ enhancement measures are shown in **Table 8.3**.

Table 8.3: Example of methods for estimating cost and benefits of mitigation/ enhancement measures

Mitigation/ Enhancement Measures	Objective	Items to be included for estimating cost	Items to be included for estimating benefits
Enhancement measures			
Support of DAE should be extended to promote sustainable agriculture practices (with low agro-chemical inputs, efficient irrigation system)	To reduce overuse of agro-chemicals and promote efficient irrigation system in the flood-protected areas	- Organizing training and public awareness program cost - Demonstration project for sustainable agriculture cost	- Increase of net benefit from agriculture production
Afforestation	To increase fuel wood and timber production	- Cost of seedlings, and labor - Maintenance cost - Awareness program	- Market value of potential timber and fuel wood production
Mitigation measures			

Mitigation/ Enhancement Measures	Objective	Items to be included for estimating cost	Items to be included for estimating benefits
Adopting erosion control and soil stabilization measures is necessary to maintain embankment	To reduce river bank erosion	- Erosion protection works cost	- Protected land area - Protected population - Protected agriculture crop production
Construction of fish friendly structures like fish-pass instead of traditional structures. In other cases openings of structures should be made as wide as possible for relatively free movement of fishes during migration.	To reduce loss of migratory fish species and increase fish production	- Construction cost of fish friendly structures - Maintenance cost of structures	- Fish production - Number of migratory fish species

Cost for implementing monitoring plan should include the following items:

- Cost for Laboratory Data Testing
- Remuneration of professionals of monitoring team
- Cost for field visits and data collection (including surveyor, travel, etc.)
- Cost for laboratory test of required environmental parameters
- Cost for report production, etc.
- Cost of activity specific mitigation measures

All the costs for implementing EMP should be included in the project budget. The funds for implementing EMP can be generated from the following sources, depending on the measures mentioned in EMP. Specific suggestions should be made in the EIA report.

- Budget of the RBIP
- Funds for implementing EMP
- Projects of other departments (e.g. enhancement measures for agriculture can come through DAE; fisheries management projects of DoF, Forestry project)
- O & M budget for RBIP from government revenue budget
- Livelihood development program through NGOs and donor agencies
- Special fund created by local beneficiaries/ stakeholders.

9. Consultations and Disclosure

This Chapter summarizes the stakeholder consultations carried out for the RBIP and also specifies the disclosure requirements. More detailed account of all consultations carried out during the safeguard studies have been presented in the EIA report of the Phase I of the RBIP. Similar consultations will be carried out while conducting the EIAs of the later phases.

9.1. Objectives of Consultations

The GoB as well as international donors (e.g. the World Bank) place great importance on involving primary and secondary stakeholders for determining the environmental and social impacts associated with project implementation. In order to gather local knowledge for baseline conditions, understand perceptions of the community regarding impact significance, and propose meaningful mitigation measures, participation of stakeholders is an integral part of the environmental assessment process. During the preparation of the present EMF, initial consultations with the key stakeholders have been carried out to obtain their views on Project interventions. Additional consultations have been held on this draft EMF as well as the full draft EIA for the priority reach in January 2015. This process will be continued during the subsequent EIAs of the project for later phases.

The consultation process has been conceived, planned, and initiated with the following key objectives:

- To provide key Project information and create awareness among various stakeholders about project intervention;
- To share the terms of reference of the current EMF and proposed EIA for the priority reach;
- To have interaction for primary and secondary data collection with project beneficiaries, affectees, and other stakeholders;
- To identify environmental and social issues such as displacement, safety hazards, employment, and vulnerable persons;
- To begin establishing communication and an evolving mechanism for the resolution of social and environmental problems at local and Project level;
- To involve Project stakeholders in an inclusive manner; and
- To receive feedback from primary stakeholders on mitigation and enhancement measures to address the environmental and social impacts of the Project.

9.2. Methodology and Tools for Consultation

The consultation and participation process undertaken so far has adopted a highly participatory approach fully involving all the stakeholders, both primary and secondary. The various tools used for consultations included household level interviews, participatory rural appraisal, focus group discussions (FGD), stakeholders consultation meetings, issue specific consultation meetings, open meetings, and workshops. Consultation meetings and FGDs were carried out alternatively after every kilometer of the project area along the embankment. This ensured a comprehensive coverage of the entire project area.

9.3. Consultation Meetings and FGDs

A total of 139 consultation meetings and 227 FGDs were held in the project area. On an average a consultation meeting was conducted every two kilometers, covering the households living on the embankment. Both male and female stakeholders were consulted through these meetings. Additionally, teachers, businessmen, village leaders, and local government members, farmers, and fishermen were consulted individually. Female heads of the households were also interviewed. List of consultation meetings and FGDs carried out in different districts is given in **Table 9.1**; venue and participant details are presented in **Table 9.2**. **Figures 9.1** to **9.6** present some photographs of the consultation meetings and FGDs.

Table 9.1: List of Consultation Meetings and FGDs in Different Districts

District	Chainage	Upazila	Number of Consultation Meetings	Number of FGD's
Sirajganj	00+400 To 37+4000	Kazipur	30	50
		Sirajganj Sadar	16	30
Bogra	37+400 To 80+000	Sonatola	4	21
		Dhunut	4	18
		Sariakandi	39	42
Gaibandha	80+000 To 146+400	Fulchari	6	11
		Gaghata	10	5
		Sundorganj	3	8
		Gaibandha Sadar	4	9
Kurigram	146+400 To 181+400	Kurigram Sadar	6	8
		Chilmari	8	9
		Nagesshari	4	10
		Ulipur	5	6
	Total =		**139**	**227**

Table 9.2: Venue and Participant Details

Meeting Venues	No of Consultations or FGDs	No of Participants		
		Male	Female	Total
Kazirpur, Sariakandi and Hasnapara	Consultations: 4	129	37	166
Sirajganj, Bogra, Kurigram, Gaibandha	Consultations: 94	2,399	1,580	3,979

Meeting Venues	No of Consultations or FGDs	No of Participants		
		Male	Female	Total
Sirajganj, Bogra, Kurigram, Gaibandha	FGDs: 92	956	758	1,714
Sirajganj and Bogra	Consultations: 6	721	72	793
Sirajganj and Bogra	FGDs: 15	142	72	214
Sirajganj and Bogra	Consultations: 25	336	189	525
Sirajganj and Bogra	FGDs: 120	520	320	840
Within 50 km of priority package	Consultations: 13	810	410	1,220
Total		**6,013**	**3,438**	**9,451**

Figure 9.1: Consultation Meeting in Project Area

Figure 9.2: Consultation Meeting with Women

Figure 9.3: Informal Meeting on Embankment

Figure 9.4: Informal Meeting in the Field

Figure 9.5: FGD in the Field

Figure 9.6: FGD in the Field

9.4. Key Findings of the Consultations

Irrespective of their age, sex, occupation or economic condition, all of the consulted stakeholders strongly welcomed the project. Some of the senior respondents stated that they would willingly leave their homestead if the project guarantees to end river bank erosion. Although some were hesitating about leaving an environment that they are accustomed to and adjusting to a new location, but considering future benefits to the larger community, they are ready to be imparted from their habitation.

Although most of the respondents are very optimistic about the project, but as most of them are living on the embankment for around 15-20 years on an average, their present residence gives them a sense of comfort in the presence of their social bonding and kin members. Therefore, they are a bit hesitant to move out of their community. In addition to that, the community members help each other in day to day activities as well as during emergencies. Moving away from the neighborhood also involves losing local connections, which has a bearing on their livelihood. They are also concerned that the project activities will affect community buildings such as schools, mosques, temples, and Eid Gah. As most of the people are related to agriculture for their livelihood, they are also concerned about losing cropped land due to the project and future industrialization of the area.

Some of the expectations and needs of the people identified during the consultations include river bank protection measures, dredging of Ichamoti River, re-excavation of Ichamoti khal (water channel), and Banaijan khal for protection from flood and erosion, regulators at different locations of the proposed alignment (e.g. Bahuka) for ecological connectivity, removing drainage congestion from Pukuria Vandarbari, connectivity between Manos and Jamuna River for proper fish migration, more vents at Kutubpur

Regulator, connectivity of water flow for irrigation and fish migration through existing and proposed Antarpara Regulator, restoration of Sariakandi fish pass by de-sedimentation, khal re-excavation to maintain flow from *beels* to rivers during rainy season to remove drainage congestion and also water logging in dry season, rehabilitation of existing regulators for proper connectivity of water flow from the *beels* to river for reducing inundation, fish migration and irrigation purposes, solid waste management needed for the Gaibandha region for conservation of biodiversity, and bridge on Gaghot river.

9.5. Framework for Future Consultations

Consultations with the key stakeholders will need to be carried out throughout the project life. These will include consultations and liaison with communities and other stakeholders during the construction phase and also extensive consultations with the grass-root as well as institutional stakeholders during the EIA studies of the various RBIP phases. The framework for the future consultations is presented in **Table 9.3** below.

Table 9.3: Consultation Framework

Description	Objective/Purpose	Responsibility	Timing
Consultations with communities and other stakeholders during construction phase	Information dissemination; public relationing; confidence building; awareness about risks and impacts; minimizing conflicts and frictions.	ESU, BWDB; Contractors; CSC	Construction phase
Consultations with communities and other stakeholders during EIA studies of various RBIP phases	Sharing EIA TOR	BWDB and EIA team	During scoping stage of EIA
	Dissemination of information on project and its key impacts and proposed mitigation measures; soliciting views, comments, concerns, and recommendations of stakeholders	BWDB and EIA team	During EIA study (once draft analysis is available for discussion and feedback)
Consultations with communities	Liaison with communities and project beneficiaries	BWDB	O&M phase

9.6. Public Disclosure Requirement

The results of draft environmental assessment study for RBIP will be disclosed to the local and national level stakeholders through different methods as described below.

- ***Workshop:*** Workshops would be organized at the local and national level to disclose the findings of the environmental assessment study of the RBIP (e.g.

proposed program's objectives, description, potential impacts and summary of EA). Representative of implementing authority, the study team, and the government officials from different departments, representatives from NGOs, local communities of different occupation, journalist, and local elite/civil society may attend the workshops. In the workshops, the participants will share their observations, views, and remarks with the study team. Appropriate suggestions and recommendations on different issues from the stakeholders of the meeting would be incorporated in the environmental assessment study especially the EIA. The workshops will also help to resolve conflicting issues among stakeholders.

- ***Publication in electronic and print media:*** The information on project interventions and the findings of environmental assessment would also be disclosed through newspapers and electronic media (e.g. internet, TV, radio, etc.). The report would be disclosed in Bengali language.
- ***Availability of the Document:*** The Environmental Assessment, documenting the mitigation measures and consultation process, will be made available for public review in both English and Bengali. The summary EIA will be published on the BWDB and WB websites, and the full environmental report will be available upon request from the BWDB and WB office and will be accessible in BWDB and WB website. Hard copy of the EIA and EMF will be available at BWDB Divisional office.

Annex A. Terms of Reference of EIA Study

1. Background

Bangladesh is mainly comprised of the fertile alluvial floodplains and the delta of the Ganges-Brahmaputra-Meghna river system (Brahmaputra south through Bangladesh, named as the Jamuna). These three rivers combine within the country to form the world's third largest river, the Lower Meghna, which drains into the Bay of Bengal via a constantly changing network of estuaries and tidal creeks. Bangladesh is one of the most vulnerable countries to natural disasters, mainly by upstream river floods during monsoon season and coastal cyclones from the Bay of Bengal. Floods are of recurring phenomena in Bangladesh, and in each year about 22 percent of the country is inundated. Major floods occur when upland flood flows of the three rivers converging to Bangladesh coincide and combine with the heavy monsoon rainfall. It is also difficult to regulate these flood flows as over 90 percent of their river catchments areas are outside the Bangladesh.

Brahmaputra is the largest of the three rivers with highest erosion and bank movements. Prior to the construction of Brahmaputra Right Embankment (BRE), over bank spills along the 220 km stretch of the right bank of the Brahmaputra River used to cause flooding on an area of about 240,000 ha. In early 1960s, the BRE was built to protect from this flooding problem and to foster agricultural growth in the protected area. The original BRE had a setback of about 1.5 km from the Brahmaputra's right bank and it was allowed to have bank erosion life of 25-30 year span. In the 1970s the embankment started to fall under sporadic erosion attacks. During 1980s, the frequency of the BRE breaches by erosion increased rapidly as longer sections came within the range of rapidly eroding river bends which could cause bank-line erosion rates of several hundred meters per year in early stages of bend formation. To prevent flooding, these breaches were typically closed by local BRE retirements at about 200 meter set-backs. As a result of this minimal set-back distance the BRE has been retired several times in many places and at present perhaps only 50 KM of the original BRE has remained in place. Currently, many long stretches of the BRE are very close to the river-bank line. Hence when embankment is breached at many places it is often left open as closing of such breaching is becoming impossible. Consequently, security of area protected by the BRE has been seriously threatened and large areas of land and cities with large population like Sirajganj are exposed to flooding.

Under Flood Action Program a Master Plan was prepared in 1993 (River Training Studies of the Brahmaputra River, 1993) for improving the performance of BRE that preparing a revamping program to be implemented over a period of 30 years with identified priority investments in phasing. Based on these studies several hard points were identified and river bank protection revetments were constructed at Sirajganj, Sariakandi, Mathurapar and Kalitola and the embankment sections were improved. These protection works have performed very well in keeping the BRE anchored without much ongoing maintenance. The proposed consulting services are for the Environmental Assessment for the revamping plan for BRE (220 KM) starting from Nagarbari to the upstream point of BRE via Sirajganj Kazipur.

The main focus of the BRE rehabilitation work is on its length alongside the Brahmaputra/ Jamuna River from Bangabandhu (Jamuna) Bridge to the Teesta River (Appendix A). The task needs to consider inclusion of the flood protection embankment of the Kurigram Irrigation Project alongside the Brahmaputra River. The priority works will cover the approximately 50-kilometre long priority reach from Sailabari to Hasnapara. This reach has the highest historic erosion rates. The project may also include the option of a toll road (highway) associated with the flood embankment. The project's physical works will include:

- River bank protection on portions of the western(right) bank;

- Embankment upgrading, reconstruction and realignment , including adding drainage/control
- structures (regulators);
- A new road on the embankment, along with a new bridge crossing of the Teesta.

The project may also provide livelihood and resettlement support to the displaced people. Based on the field reconnaissance and the preliminary morphological assessment, the project works has been divided into two phases:

Reach	Length (km)	Phase
Jamuna Bridge to Sailabari	19	Remaining
Sailabari to Hasnapara	50	Priority
Hasnapara to Belka	77	Remaining
Upstream of Teesta River	36	Remaining
Total	182	

The proposed project will be financed by IDA with GoB contribution and the project has to comply with the policies and legislative requirement of the World Bank and the GoB. Proper environmental management will require ensuring that the project would be environmentally sound and sustainable, and thus decision making will take place. It is envisaged that the detail Environment Impact Assessment (EIA) along with Environmental Management Plan (EMP) needs to be developed for priority phase. The borrower is responsible for carrying out these activities. The project is expected to be classified as Category 'A' project in accordance Bank's policy. BWDB intends to hire a consulting firm (the Consultant) to carry out these environment activities of the proposed project at the preparation stage to ensure that the proposed infrastructure takes environmental concerns into account.

2. Objective

The objective of the assignment is to carry out the tasks related to environmental aspects in light of the TOR. These include preparation of the **Environmental Impact Assessment** (including EMP) of the priority phase (Sailabari to Hasnapara).

3. Scope of Services

Carry out an overall Environmental Assessment (EA) and prepare Environmental Management Plan (EMP) for the project area covered under the feasibility study. For the area covered under the detailed designs conduct detail Environmental Impact Assessment and prepare full Environmental Management Plan (EMP). EIA, and EMP would be prepared according to the World Bank Guidelines and Operational Policies and the GOB procedures. The Consultant shall familiarize themselves with the project details and components as well as the Consultant shall interact with other preparation consultants (i.e, design consultant, social consultant etc) to determine best way of conduction environment activities and fits into overall project preparation/project cycle. Consultant shall appropriately plan the timing of the deliverables.

The major activities to be carried out will include, but not limited to the following.

3.1 Environmental Impact Assessment of Priority Phase (Document owned by the Implementing Agency and Requirement of GoB and World Bank)

3.1.1 Study Area and Likely Major Impacts.

i. Specify the boundaries of the study area for the assessment (project influence area): river basin/catchments, upstream land use, the drainage area and patterns, irrigation and other development scheme(s) – current and proposed, watersheds, access to sensitive/remote areas such as parks/ reserves/forests/agriculture land, elements of transport development program in the area.

3.1.2 Describe the proposed project.

ii. Provide information on the following: location of all project-related development sites and general layout and extent of facilities at project-related development sites; flow diagrams of facilities/operations; design basis, size, capacity; pre-construction activities; construction activities (land clearing, land grading, worker camps, if any), schedule, staffing and support, facilities and services; operation and maintenance activities (water management, monitoring of flows and groundwater, etc), staffing and support, facilities and services; management of risks, including health and safety; life expectancy for major components. Components may include any or all of the following: embankment, structural control measures; river channel modifications, dikes and levees; overflow basins; floodways and drainage and nonstructural measures (eg, zoning, floodplain regulations, building and sanitary ordinances and regulation of land use in basin/watershed areas), road route(s), types, ROWs, adjustments to alignments, including earthworks; repair/replacement of bridges; widening and stabilization of embankments; improvements to drainage and service ducts; sources of materials used during proposed road works; generation of wastes and their disposal expected volume of use and traffic impacts; necessary rehabilitation activities resettlement, land acquisition and temporary re-routing of traffic, safety features; staffing and accommodation of employees, including site clearance, scheduling of project activities; road paving and road signs and markings; operation and maintenance activities (eg, clearing of ditches, prevention of erosion, especially at culverts).

iii. Provide maps at appropriate scales to illustrate the general setting of project-related development sites, as well as surrounding areas likely to be environmentally affected. These maps shall include topographic contours, as available, as well as locations of major surface waters, roads, villages/towns, parks and reserves, and political boundaries. Also provide, as available, maps to illustrate existing land uses.

3.1.3 Description of the Environment

iv. Assemble and evaluate and baseline data on the environmental characteristics of the study area, including river basin/watershed, site of embankment, inundation, floodplain and biological features (habitats and rare species, fisheries), floodplain (recession) agriculture. Include information on any changes anticipated before the project commences.

(a). Physical environment: geology, topography, soils, climate, surface and ground water hydrology, annual peak discharge, ambient air quality; recurrence intervals of various peak discharges and peak stages of various discharges), erosion and sediment loading, existing/projected pollution discharges and receiving water quality; instances of flooding, siltation/erosion;

(b) Biological environment: ecology: flora and fauna, including rare or endangered species; sensitive natural habitats, including parks and reserves; potential vectors for disease; exotics and aquatic weeds; application of pesticides and fertilizers (current and projected as agriculture production is expected to be increased);

(c) Socio-cultural environment: land use (including current crops and cropping patterns - terracing or contour planting, population in the floodplain, etc.);

fisheries and farm/industrial outputs and inputs; transportation; land tenure and land titling; present water supply and water uses (including current distribution of water resources); control over allocation of resource use rights; water-related human health problems; cultural sites, present and projected population; present land use/ownership; planned development activities; community structure; present and projected employment by industrial category; distribution of income, goods and services; recreation; public health; cultural properties; indigenous peoples, customs and aspirations; significant natural, cultural or historic sites, etc. Presence of HIV/AIDS and other sexually transmitted diseases;

(d) If resettlement sites and livelihood options are considered to support, find the physical, biological and socio economic conditions of the area;

v. Provide chainage wise information along the two sides of the project intervention and identify any critical aspect which needs special consideration during design, construction and operation.

3.1.4 Determination of the Potential Impacts of and Impacts on the Proposed Project.

vi. This analysis will require in depth interpretation. In this analysis, distinguish between significant positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts. Identify impacts that are unavoidable or irreversible. Wherever possible, describe impacts quantitatively, in terms of environmental costs and benefits. Assign economic values when feasible. Characterize the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with predictions of impact. Compare the impact with the baseline. Provide TORs for studies to obtain the missing information. Special attention should be given to:

(a). Effects of the flood control embankment: direct environmental impacts of the embankment construction; effects on fisheries resources (creation of a reservoir fisheries, loss of downstream fisheries); effects on water quantity and quality; effects on floodplain ecology and estuarine, river hydrology, if applicable;

(b). Effects of flood control structures, intervention of river training structure and measures (e.g., channelization measures, floodways (high flow diversions or spillways), overflow basins, disposal of dredging spoils) on: aquatic ecology, particularly fish resources; hydrology, including groundwater recharge and exclusion of water from certain areas that may impact the hydrology and associated wildlife and agriculture; water quality; plant and animal ecology of the floodplain (habitat and species); and,

(c). Socio-economic impacts on populations in inundation area and downstream (floodplain dwellers, urban population, etc.) through: land use changes; impacts on water-related economic activities (e.g., fisheries, flood plain agriculture, transportation, etc.); health effects (e.g., increased incidence of water-borne and water related diseases). Additionally for road construction, consider loss of agricultural and residual lands; destruction of properties; loss of livelihood or other social disruption; relocation of infrastructures; unplanned settlements; noise; threat to cultural and historical sites or artifacts; demographic changes; potential for HIV/AIDS and other sexually-transmitted diseases. Also identify the impact due to resettlement and new livelihood options.

(d) Impact from road construction: Impact on air quality: air pollution from asphalt plants; dust; noise from construction, equipment and blasting; impact on land resources: crossing of rivers, streams, canals and ravines, loss of habitat; foreclosure

of other land uses; landslides; erosion; roadside litter; impact on hydrology: crossing of rivers, streams, canals and ravines; foreclosure of other land uses; landslides; erosion; modifications to natural drainage patterns and groundwater elevation; flash flooding; road side litter; impact on water quality: river/stream and lake sedimentation; use of pesticides; fuel and oil spills; water pollution from spills or accumulated contaminants on road surfaces; impact on biological environment: land clearance and loss of habitat; impacts on biodiversity caused by facilitation of access to and spontaneous settlements in natural areas; impacts on wetland management; control of hunting and poaching/wood-cutting

vii. Conduct model study on the water flow, geomorphology and water quality due to project intervention and predict the impact on ecology and socio economic activities after ten years.

viii. Identify the impact of the project intervention during lean period (seasonal variation) (impact on navigability, water variability).

ix. Determine the cumulative impact of the road construction and river bank improvement for the entire project area. Identify any steps to be taken to reduce the impact of the construction of remaining tasks on the current project.

3.1.5 Analysis of Alternatives to the Proposed Project.

x. Describe alternatives that were examined in the course of developing the proposed project and identify other alternatives that would achieve the same objectives. The concept of alternatives extends to siting and design of new alignments, rehabilitation techniques, choice of hydrological structures, and phasing, and operating and maintenance procedures, resettlement sites and livelihood support. Compare alternatives in terms of potential environmental impacts, capital and operating costs (including mitigation measures and their monitoring), and institutional, training, and monitoring requirements. To the extent possible, quantify the costs and benefits of each alternative, incorporating the estimated costs of any associated mitigating measures.

xi. Based on the above analysis identify and propose the best engineering design parameters to ensure minimal environment impacts due to the project.

xii. Closely work with the design consultants that those parameters are incorporated in the design.

3.1.6 Development of an Environmental Management Plan (EMP)

xiii. Identify key mitigation and enhancement approaches and prepare the impact specific mitigation measures. Estimate the impacts and costs of the mitigation measures and of the institutional and training requirements to implement them. If appropriate, assess compensation to affected parties for impacts that cannot be mitigated. Prepare an EMP, including proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigating measures, monitoring, etc. Include measures for emergency response to accidental events (e.g. entry of raw sewage or toxic wastes into rivers, streams, etc).

xiv. Prepare a detailed plan to monitor the implementation of mitigating measures and the impacts of the project during rehabilitation and operation (eg, emission and ambient levels of pollutants where these may be detrimental to human health, soil erosion, changes in the floodplain). Include in the plan an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to implement the plan.

Include a regular schedule of monitoring the quality of surface and ground waters to ensure that mitigation measures are effective. Provide guidance for reporting and enforcement and conducting environmental audits.

xv. Estimate the costing of EMP, ECoP and provide necessary clauses for incorporating in the bid document.

xvi. Review the responsibilities and capability of institutions at local, provincial/regional, and national levels and recommend steps to strengthen or expand them so that the EMP may be effectively implemented. The recommendations may extend to new laws and regulations, new agencies or agency functions, intersectoral arrangements, management procedures and training, staffing, operation and maintenance training, budgeting and financial support.

xvii. An outline of the contents of the EMP to be included in the project's Operational Manual should be provided along with environmental/social protection clauses for contracts and specifications**.**

3.1.7 Assist in Inter-Agency Coordination and Public/NGO Participation.

xviii. The Consultant will assist the government in coordinating the EIA with relevant agencies and the government will consult with affected groups likely to be affected by the proposed project and with local NGOs on the environmental and social aspects of the proposed project. These groups should be consulted when a draft EIA is available (a summary of the EIA will be available prior to the meeting). The draft EIA should also be available in a public place accessible to affected groups and local NGOs being consulted. The consultation workshops will be held locally, regionally and nationally.

Relevant materials will be provided to affected groups in a timely manner prior to consultation and in a form and language that is understandable and accessible to the groups being consulted. The Consultant should maintain a record of the public consultation (written and video and pictorial proof) and the records should indicate: means other than consultations) eg, surveys) used to seek the views of affected stakeholders; the date and location of the consultation meetings, a list of the attendees and their affiliation and contact address; and, summary minutes.

3.1.8 Institutional responsibility

xix. Define the roles and responsibilities of officials, staff, consultants and contractors of BWDB on environmental management;

xx. Describe in details who will (a) implement the environmental mitigation activities (b) carrying out environmental monitoring; (c) supervise environmental mitigation and monitoring; (d) design, implement and apply the environmental management information system (EMIS); and (e) prepare quarterly progress report on environmental management;

xxi. Finalize the draft EIA incorporating the comment from the consultation;

xxii. Translate and finalize the EIA in Bengali.

4. Consulting Team composition and qualifications

i. The studies outlined require interdisciplinary analysis with specialized sector knowledge (i.e., water resource and hydrology/embankment). The general skills required of the Environmental Safeguard team are: environmental management planning, civil/river /embankment engineer(s), with particular experience in dredging projects, river training and embankment construction and water-based transport; aquatic biologist depending upon the predicted impacts, land use planner, sociologist, archaeologist and communications / stakeholder engagement. The consulting team must be able to demonstrate appropriate skill mix and depth of experience to cover all areas of the proposed analysis, including incorporation of other specialized skill sets where required. The consulting team shall be led by a Team Leader with at least 10 years of experience leading EIA studies, including prior international experience on similar types of water resource projects, and prior experience as either team leader or deputy team leader on at least 3 previous major infrastructure EIAs for World Bank funded projects.

5. Schedule/Duration of the study

The study period shall be of **6 (six)** months from the date of commencement of the study.

6. Reports

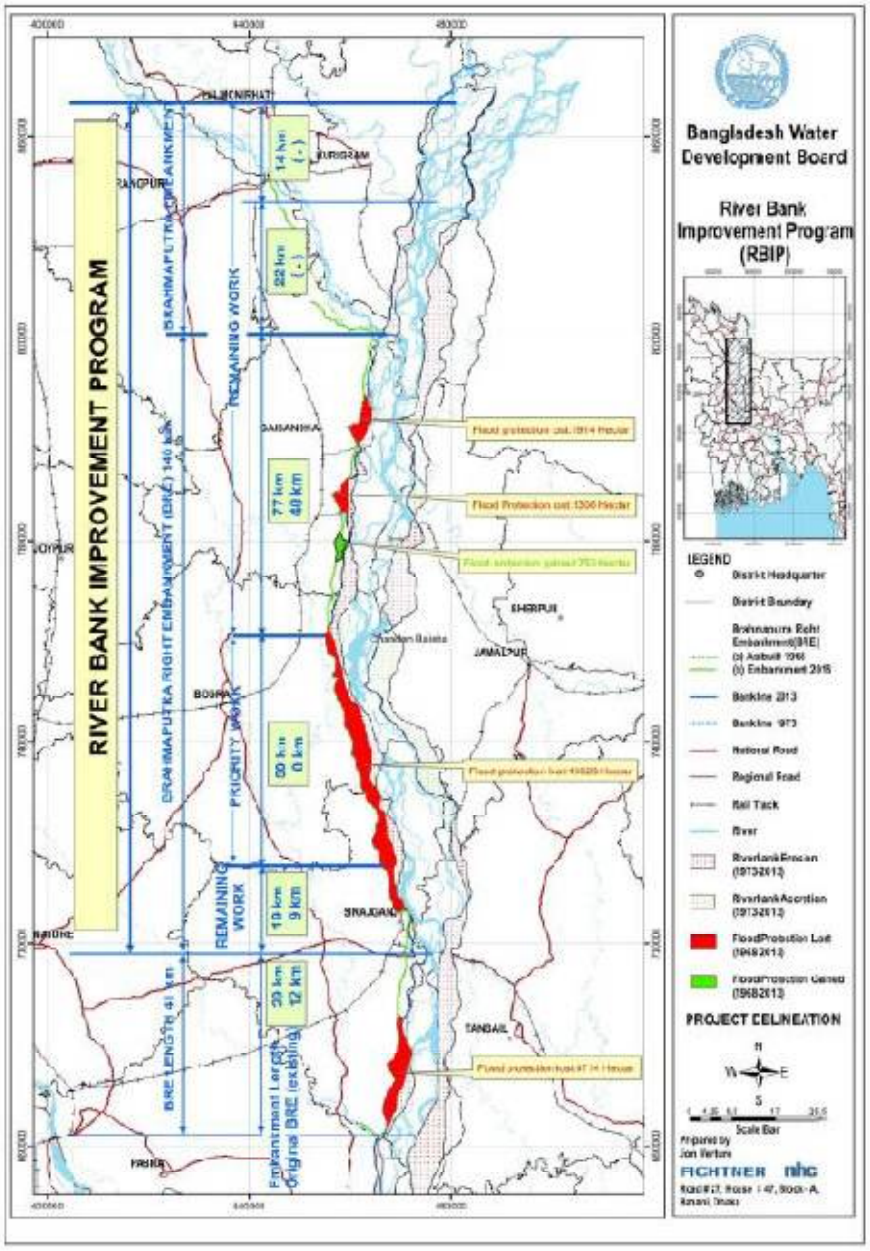
After commencement of the study the submission of the reports shall be both in **hard (3 copies) and soft copy** as follows:

- Draft Environmental Impact Assessment---submitted at the end of 4th month of signing the contract
- Final Environmental Management Framework--submitted at the end of 3rd month of signing the contract.
- Final Environmental Impact Assessment---submitted at the end of 5th month of signing the contract
- Bengali Translation of the Environmental Management Framework--submitted at the end of 5.5th month of signing the contract.
- Bengali Translation of the Environmental Impact Assessment--submitted at the end of 6th month of signing the contract.

8. Reporting

The consultant will report to the Project Director, River Bank Improvement Project, Bangladesh Water Development Board (BWDB).

Appendix A: Location of Priority (Phase I) and Remaining (Phase II) Project Location



Appendix B: Structure of EIA Report

The Consultant is required to prepare an EIA report that is concise and limited to significant environmental issues. The main text should focus on findings, conclusions and recommended actions, supported by summaries of the data collected and citations for any references used in interpreting those data. Detailed or uninterrupted data are not appropriate in the main text and should be presented in appendices or a separate volume. Unpublished documents used in the assessment may not be readily available and should also be assembled in an appendix. Organize the environmental assessment report according to the outline below.

The report should be prepared as per the following key contents:

1. Executive Summary (ES): The Executive Summary should mirror the report both in form and content and should be about 10 percent in length of the report. The significant findings and recommended actions should be clearly discussed in the ES.
2. Introduction: This section will include (i) purpose of the report and (ii) extent of the environmental study.
3. Policy, Legal and Administrative Framework: This section will describe relevant environmental policies, rules and administrative procedures that need to be followed for the proposed project. The relevant international environmental agreements to which Bangladesh is a party should also be discussed.
4. Project design and Description: This section will provide a brief but clear picture about (i) type of project; (ii) category of project; (iii) need for project; (iv) location (use maps showing general location, specific location, and project site); (v) size or magnitude of operation;(vi)Project influence area (vii) proposed schedule for implementation. The proposed project should be described with reasonable details so that the EIA report can be read as a standalone document without reference to other project documents.
5. Analysis of Alternatives: Systematic comparison for feasible alternatives to the proposed project site, technology, design, and operation--including the "without project" situation--in terms of their potential environmental impacts should be done. The feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements have to be provided. For each of the alternatives, the quantification of the environmental impacts to the extent possible, and economic values where feasible should be given. The basis for selecting the particular project design proposed and justification for recommended emission levels and approaches to pollution prevention and abatement have to be provided.
6. Environmental Baseline: *This section will provide sufficient information on the existing environmental baseline resources in the area affected by the project, including the following:*

   (i) Physical Resources:((e.g. atmosphere (e.g. air quality and climate), topography and soils, surface water & groundwater, geology/seismology)

   (ii) Water Resources: (e.g. hydrology, surface water and groundwater system, sedimentation, tidal influence, etc.)

   (iii) Land and Agriculture resources: (e.g. land type, land use, cropping pattern, crop production, etc.)

   (iv) Fisheries resources: (e.g. fisheries diversity, fish production, etc.)

   (v) Ecology:(e.g. ecosystems, wildlife, forests, rare or endangered species, protected areas, coastal resources, etc.)

   (vi) Socio-economic condition:(e.g. population and communities (e.g. numbers, locations, composition, employment), health facilities, education facilities, socio-economic conditions (e.g. community structure, family structure, social wellbeing), physical or cultural heritage, current use of lands and resources for traditional purposes by indigenous peoples, structures or sites that are of historical, archaeological, paleontological, or architectural significance, economic development (e.g. industries, infrastructure facilities, transportation, power sources and transmission, mineral development, and tourism facilities, etc.).

To assess the dimensions of the study area, the relevant physical, biological, and socioeconomic conditions before the project commencement should be discussed. The relevant data related to the issues have to be collected and reported.

7. Climate Change issues: *Climate change aspects in global, regional and local perspectives and the likely impacts on the Project area and its surroundings should be briefly discussed in this section.*

8. Significant Environmental Impacts: This chapter will need careful interpretation. Significant environmental and social impacts due to project location, and related to project design, construction, and operations phase should be discussed in detail in this section. The prediction and assessment of the project's likely positive and negative impacts, in quantitative terms to the extent possible should be made. The mitigation measures and any residual negative impacts that cannot be mitigated should be identified. The opportunities for environmental enhancement should also be explored. Estimates should be done on the extent and quality of available data, key data gaps, and uncertainties associated with predictions; and the topics that do not require further attention should be specified. Considering the impact the project has to be classified into Categories of A, B or C as per OP 4.01.

9. Cumulative and Induced Impacts: Cumulative impacts of the proposed Project and other projects as well as induced impacts should be provided in this section.

10. Design Parameters: This section should present the parameters which should be considered in the design for minimizing the environmental impact.

11. Environmental Management Plan: The environmental management plan (EMP) will include mitigation and enhancement plan, compensation and contingency plan as well as monitoring plan including institutional arrangement for implementation of the EMP. The EMP should also include tentative cost of implementation of the plan. Guideline for preparation of EMP is included below.

12. Stakeholder Consultation and Disclosure: The proceeding of the consultations done as per OP4.01 has to be included in this section of the EIA report. It is to be noted that during the EIA process for all WB Category A and B projects, the proponents have to consults project-affected groups and local nongovernmental organizations (NGOs) about the project's environmental aspects and take their views into account. The proponents' initiates such consultations as early as possible. For Category A projects, the proponents consult these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EIA is finalized; and (b) once a draft EIA report is prepared. In addition, the proponent must consult with such groups throughout project implementation as necessary to address EIA-related issues that affect them.

13. Disclosure: For meaningful consultations between the borrower and project-affected groups and local NGOs on all Category A and B projects proposed for WB financing, the proponents must provide relevant material in a timely manner prior to consultation and in a form and language (i.e. Bangla) that are understandable and accessible to the groups being consulted. The disclosure details done as per OP 4.01 should be provided in this section.

14. Grievance Mechanism**:** A mechanism should be outlined to ensure that the project sponsor maintains appropriate external channels for communicating with and receiving feedback, questions, and complaints from local stakeholders, as well as internal

procedures for following up and resolving any complaints or grievances in a timely manner. The mechanism should include more than one channel for receiving communications and grievances (for example, a hotline, a public information office, boxes to receive written complaints or queries, etc. – depending on local preferences, literacy levels, etc.), as well as indicating requirements, responsibilities and budget for documenting, processing, and resolving issues that arise, including providing feedback to complainant(s) regarding the resolution. The existence of the grievance mechanism must be fully and proactively disclosed to the public.

15. Discussions and Conclusions**:** The essential issues in the EIA report should be summarily discussed and the conclusions are to be included in this section.
16. **References:** References should be provided to written materials both published and unpublished, used in study preparation.

- Annexes:
  - ✓ List of Environmental Assessment Preparers
  - ✓ Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations (NGOs). The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs
  - ✓ Data and Unpublished Reference Documents

Guideline for Preparing Environment Management Plan

Environmental Management Plan (EMP)

The Consultant is required to develop an Environmental Management Plan (EMP) consisting of a set of feasible and cost-effective mitigation measures and monitoring and institutional plan to prevent or reduce significant negative impacts to acceptable levels. This will include measures for emergency response to accidental events (e.g., fires, explosions), as appropriate. The Consultant will provide an estimation of the impacts and costs of the mitigation measures, and of the institutional and training requirements to implement them. In particular this would include:

Environmental Mitigation & Enhancement Measures: Recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels. Apart from mitigation of the potential adverse impacts on the environmental components, the EMP shall identify opportunities that exist for the enhancement of the environmental quality along the surrounding area. Residual impacts from the environmental measures shall also be clearly identified. The EMP shall include detailed specification, bill of quantities, execution drawings and contracting procedures for execution of the environmental mitigation and enhancement measures suggested, separate for pre-construction, construction and operation periods. In addition, the EMP shall include good practice guides related to construction and upkeep of plant and machinery. Responsibilities for execution and supervision of each of the mitigation and enhancement measures shall be specified in the EMP. A plan for continued consultation to be conducted during implementation stage of the project shall also be appended.

Capacity Building & Training: The EMPs shall describe the implementation arrangement needed for the project, especially the capacity building proposals including the staffing of the environment unit (as and when recommended) adequate to implement the environmental mitigation and enhancement measures. For each staff position recommended to be created, detailed job responsibilities shall be defined. Equipment and resources required for the environment unit shall be specified, and bill of quantities prepared. A training plan and schedule shall be prepared specifying the target groups for individual training programs, the content and

mode of training. Training plans shall normally be made for the client agency (including the environmental unit), the supervision consultants and the contractors.

Supervision & Monitoring: Environmental monitoring plan will be an integral part of an EMP, which outlines the specific information to be collected for ensuring the environmental quality at different stages of project implementation. The parameters and their frequency of monitoring should be provided along with cost of the monitoring plan and institutional arrangements for conducting monitoring. Reporting formats should be provided along with a clear arrangement for reporting and talk corrective action. The EMP shall list all mandatory government clearance conditions, and the status of procuring clearances. Additionally, the EMPs shall include as separate attachments, if applicable, Natural Habitat Plan and/or Cultural Properties Plan to satisfy the requirements of the World Bank safeguard policies.

Annex B. Environmental Code of Practice

ECoP 1: Waste Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
General Waste	Soil and water pollution from the improper management of wastes and excess materials from the construction sites.	The Contractor shall • Develop waste management plan for various specific waste streams (e.g., reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to CSC for approval. • Organize disposal of all wastes generated during construction in an environmentally acceptable manner. This will include consideration of the nature and location of disposal site, so as to cause less environmental impact. • Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate and reuse or recycle all the wastes, wherever practical. • Prohibit burning of solid waste • Collect and transport non-hazardous wastes to all the approved disposal sites. Vehicles transporting solid waste shall be covered with tarps or nets to prevent spilling waste along the route • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process. • Provide refuse containers at each worksite. • Request suppliers to minimize packaging where practicable. • Place a high emphasis on good housekeeping practices. • Maintain all construction sites in a cleaner, tidy and safe condition and provide and maintain appropriate facilities as temporary storage of all wastes before transportation and final disposal.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices	The Contractor shall • Collect chemical wastes in 200 liter drums (or similar sealed container), appropriately labeled for safe transport to an approved chemical waste depot.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes appropriately in bunded areas away from water courses. • Make available Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. • Collect hydrocarbon wastes, including lube oils, for safe transport off-site for reuse, recycling, treatment or disposal at approved locations. • Construct concrete or other impermeable flooring to prevent seepage in case of spills

ECoP 2: Fuels and Hazardous Goods Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuels and hazardous goods.	Materials used in construction have a potential to be a source of contamination. Improper storage and handling of fuels, lubricants, chemicals and hazardous goods/materials on-site, and potential spills from these goods may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and submit the plan for CSC approval. • Train the relevant construction personnel in handling of fuels and spill control procedures. • Store dangerous goods in bunded areas on a top of a sealed plastic sheet away from watercourses. • Refueling shall occur only within bunded areas. • Make available MSDS for chemicals and dangerous goods on-site. • Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site approved by DoE. • Provide absorbent and containment material (e.g., absorbent matting) where hazardous material are used and stored and personnel trained in the correct use. • Provide protective clothing, safety boots, helmets, masks, gloves, goggles, to the construction personnel, appropriate to materials in use. • Make sure all containers, drums, and tanks that

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Store hazardous materials above flood plain level. • Put containers and drums in temporary storages in clearly marked areas, where they will not be run over by vehicles or heavy machinery. The area shall preferably slope or drain to a safe collection area in the event of a spill. • Put containers and drums in permanent storage areas on an impermeable floor that slopes to a safe collection area in the event of a spill or leak. • Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution. • Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials. • Return the gas cylinders to the supplier. However, if they are not empty prior to their return, they must be labeled with the name of the material they contained or contain, information on the supplier, cylinder serial number, pressure, their last hydrostatic test date, and any additional identification marking that may be considered necessary.

ECoP 3: Water Resources Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Hazardous Material and Waste	Water pollution from the storage, handling and disposal of hazardous materials and general construction waste,	The Contractor shall • Follow the management guidelines proposed in ECPs 1 and 2. • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	and accidental spillage	petroleum and chemical wastes). These substances must not enter waterways, storm water systems or underground water tables
Discharge from construction sites	During construction both surface and groundwater quality may be deteriorated due to construction activities in the river, sewerages from construction sites and work camps. The construction works will modify groundcover and topography changing the surface water drainage patterns of the area including infiltration and storage of storm water. These changes in hydrological regime lead to increased rate of runoff, increase in sediment and contaminant loading, increased flooding, groundwater contamination, and effect habitat of fish and other aquatic biology.	The Contractor shall • Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials • Install temporary sediment basins, where appropriate, to capture sediment-laden run-off from site • Divert runoff from undisturbed areas around the construction site • Stockpile materials away from drainage lines • Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot • Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bunded areas on site. Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This shall be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil Erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion • Ensure that roads used by construction vehicles are swept regularly to remove sediment. • Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		periods of high risk (e.g. high winds)
Construction activities in water bodies	Construction works in the water bodies will increase sediment and contaminant loading, and effect habitat of fish and other aquatic biology.	The Contractor Shall • Dewater sites by pumping water to a sediment basin prior to release off site – do not pump directly off site • Monitor the water quality in the runoff from the site or areas affected by dredge plumes, and improve work practices as necessary • Protect water bodies from sediment loads by silt screen or bubble curtains or other barriers • Minimize the generation of sediment, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways, storm water systems or underground water tables. • Use environment friendly and nontoxic slurry during construction of piles to discharge into the river. • Reduce infiltration of contaminated drainage through storm water management design • Do not discharge cement and water curing used for cement concrete directly into water courses and drainage inlets.
Drinking water	Groundwater at shallow depths is contaminated with arsenic and hence not suitable for drinking purposes.	The Contractor Shall • Pumping of groundwater shall be from deep aquifers of more than 300 m to supply arsenic free water. Safe and sustainable discharges are to be ascertained prior to selection of pumps. • Tube wells will be installed with due regard for the surface environment, protection of groundwater from surface contaminants, and protection of aquifer cross contamination • All tube wells, test holes, monitoring wells that are no longer in use or needed shall be properly decommissioned
	Depletion and pollution of groundwater resources	• Install monitoring wells both upstream and downstream areas near construction yards and construction camps to regularly monitor the water quality and water levels. • Protect groundwater supplies of adjacent lands

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines

ECoP 4: Drainage Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities harms environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare a program for prevent/avoid standing waters, which CSC will verify in advance and confirm during implementation • Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there • Rehabilitate road drainage structures immediately if damaged by contractors' road transports. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensure wastewater quality conforms to the relevant standards provided by DoE, before it being discharged into the recipient water bodies. • Ensure the internal roads/hard surfaces in the construction yards/construction camps that generate has storm water drainage to accommodate high runoff during downpour and that there is no stagnant water in the area at the end of the downpour. • Construct wide drains instead of deep drains to avoid sand deposition in the drains that require frequent cleaning. • Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion • Protect natural slopes of drainage channels to ensure adequate storm water drains.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem. • Reduce infiltration of contaminated drainage through storm water management design
Ponding of water	Health hazards due to mosquito breeding	• Do not allow ponding of water especially near the waste storage areas and construction camps • Discard all the storage containers that are capable of storing of water, after use or store them in inverted position

ECoP 5: Soil Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Filling of Sites with dredge spoils	Soil contamination will occur from drainage of dredged spoils	The Contractor shall • Ensure that dredged sand used for land filling shall be free of pollutants. Prior to filling, sand quality shall be tested to confirm whether soil is pollution free. Sediments shall be properly compacted. Top layer shall be the 0.5 m thick clay on the surface and boundary slopes along with grass. Side Slope of Filled Land of 1:2 shall be constructed by suitable soils with proper compaction as per design. Slope surface shall be covered by top soils/ cladding materials (0.5m thick) and grass turfing with suitable grass. • Leaching from the sediments shall be contained to seep into the subsoil or shall be discharged into settling lagoons before final disposal. • No sediment laden water in the adjacent lands near the construction sites, and/or wastewater of suspended materials excessive of 200mg/l from dredge spoil storage/use area in the adjacent agricultural lands.
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals will contaminate the soils	The Contractor shall • Strictly manage the wastes management plans proposed in ECP1 and storage of materials in ECP2 • Construct appropriate spill contaminant facilities for all fuel storage areas

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Establish and maintain a hazardous materials register detailing the location and quantities of hazardous substances including the storage, use of disposals • Train personnel and implement safe work practices for minimizing the risk of spillage • Identify the cause of contamination, if it is reported, and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site • Remediate the contaminated land using the most appropriate available method to achieve required commercial/industrial guideline validation results
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds

ECoP 6: Erosion and Sediment Control

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Clearing of construction sites	Cleared areas and slopes are susceptible for erosion of top soils, that affects the growth of vegetation which causes ecological imbalance.	• Reinstate and protect cleared areas as soon as possible. • Mulch to protect batter slopes before planting • Cover unused area of disturbed or exposed surfaces immediately with mulch/grass turfings/tree plantations
Construction activities and material stockpiles	The impact of soil erosion are (i) Increased run off and sedimentation causing a greater flood hazard to the downstream, (ii) destruction of aquatic environment in nearby lakes, streams, and reservoirs caused by	The Contractor shall • Locate stockpiles away from drainage lines • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds • Remove debris from drainage paths and sediment control structures • Cover the loose sediments and water them if required

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	erosion and/or deposition of sediment damaging the spawning grounds of fish, and (iii) destruction of vegetation by burying or gullying.	• Divert natural runoff around construction areas prior to any site disturbance • Install protective measures on site prior to construction, for example, sediment traps • Control drainage through a site in protected channels or slope drains • Install 'cut off drains' on large cut/fill batter slopes to control water runoff speed and hence erosion • Observe the performance of drainage structures and erosion controls during rain and modify as required.

ECoP 7: Top Soil Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Earthworks will impact the fertile top soils that are enriched with nutrients required for plant growth or agricultural development.	The Contractor shall • Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2m. • Remove unwanted materials from top soil like grass, roots of trees and similar others. • The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles in areas outside drainage lines and protect from erosion. • Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites • Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bunding of the soil layers, water penetration and revegetation
Transport	Vehicular movement	• Limit equipment and vehicular movements to

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	outside ROW or temporary access roads will affect the soil fertility of the agricultural lands	within the approved construction zone • Construct temporary access tracks to cross concentrated water flow lines at right angles • Plan construction access to make use, if possible, of the final road alignment • Use vehicle-cleaning devices, for example, ramps or wash down areas

ECoP 8: Topography and Landscaping

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Flood plains of the existing Project area will be affected by the construction of various project activities. Construction activities especially earthworks will change topography and disturb the natural rainwater/flood water drainage as well as will change the local landscape.	The Contractor shall • Ensure the topography of the final surface of all raised lands (construction yards, approach roads, access roads, bridge end facilities, etc.) are conducive to enhance natural draining of rainwater/flood water; • Keep the final or finished surface of all the raised lands free from any kind of depression that insists water logging • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change the shape of topography. • Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and bring improved landscaping

ECoP 9: Sand Extraction

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Sand extraction	Sand extraction can potentially impact the aquatic habitat, water	The Contractor shall: • not extract sand from the river bed in long

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	quality, and key aquatic species and their food availability.	continuous stretches; alternate patches of river bed will be left undisturbed to minimize the potentially negative impacts on the aquatic habitat. • not collect large quantities of sand from any single location • not excavate deeper than 3 m at any single location. • not carry out sand extraction near chars that have sensitive habitats • not carry out sand extraction during the night particularly near the chars • obtain approval from CSC before starting sand extraction from any location. • carry out sand extraction from sand bars to the extent possible. • maintain record of all sand extraction (quantities, location shown on map, timing, any sighting of key species) • provide silt fences, sediment barriers or other devices around the extraction areas to prevent migration of sediment rich water in to the river channels. • refuel of barges and boats with a proper care to avoid any spills. • make available spill kits and other absorbent material at refueling points on the barges. • properly collect, treat and dispose the bilge water from of barges, and boats. • regularly service all waterborne plant as per the manufacturer's guidelines and be inspected daily prior to operation. CSC will: • carry out survey of the area prior to sand extraction • identify any sensitive receptors/habitats (eg, turtle nesting area, birds colony) at or near the proposed sand extraction locations. • determine 'no-go' areas for sand extraction, based upon the above survey, • monitor the activity to ensure that the contractor complies with the conditions described earlier. • survey the area after sand extraction to identify any left over impacts.

ECoP 10: Air Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. • Operate the vehicles in a fuel efficient manner • Cover haul vehicles carrying dusty materials moving outside the construction site • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions • Control the movement of construction traffic • Water construction materials prior to loading and transport • Service all vehicles regularly to minimize emissions • Limit the idling time of vehicles not more than 2 minutes
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall • Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and minimize the contaminant emissions. Proof or maintenance register shall be required by the equipment suppliers and contractors/subcontractors • Focus special attention on containing the emissions from generators • Machinery causing excess pollution (e.g. visible smoke) will be banned from construction sites • Service all equipment regularly to minimize emissions • Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all its stages, including unloading, collection, aggregate handling, cement dumping, circulation of trucks and machinery inside the installations

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities	Dust generation from construction sites, material stockpiles and access roads is a nuisance in the environment and can be a health hazard.	• Water the material stockpiles, access roads and bare soils on an as required basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted • Minimize the extent and period of exposure of the bare surfaces • Reschedule earthwork activities or vegetation clearing activities, where practical, if necessary to avoid during periods of high wind and if visible dust is blowing off-site • Restore disturbed areas as soon as practicable by vegetation/grass-turfing • Store the cement in silos and minimize the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust dispersion is prevented because of such operations • Crushing of rocky and aggregate materials shall be wet-crushed, or performed with particle emission control systems

ECoP 11: Noise and Vibration Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic	The Contractor shall • Maintain all vehicles in order to keep it in good working order in accordance with manufactures maintenance procedures • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. • Organize the loading and unloading of trucks, and handling operations for the purpose of

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		minimizing construction noise on the work site
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately site all noise generating activities to avoid noise pollution to local residents • Use the quietest available plant and equipment • Modify equipment to reduce noise (for example, noise control kits, lining of truck trays or pipelines) • Maintain all equipment in order to keep it in good working order in accordance with manufactures maintenance procedures. Equipment suppliers and contractors shall present proof of maintenance register of their equipment. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment • Avoid the unnecessary use of alarms, horns and sirens
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify adjacent landholders prior any typical noise events outside of daylight hours • Educate the operators of construction equipment on potential noise problems and the techniques to minimize noise emissions • Employ best available work practices on-site to minimize occupational noise levels • Install temporary noise control barriers where appropriate • Notify affected people if major noisy activities will be undertaken, e.g. pile driving • Plan activities on site and deliveries to and from site to minimize impact • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas

ECoP 12: Protection of Flora

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance	Local flora are important to provide shelters for the birds, offer fruits and/or timber/fire wood, protect soil erosion and overall keep the environment very friendly to human-living. As such damage to flora has wide range of adverse environmental impacts.	The Contractor shall • Reduce disturbance to surrounding vegetation • Use appropriate type and minimum size of machine to avoid disturbance to adjacent vegetations. • Get approval from supervision consultant for clearance of vegetation. • Make selective and careful pruning of trees where possible to reduce need of tree removal. • Control noxious weeds by disposing of at designated dump site or burn on site. • Clear only the vegetation that needs to be cleared in accordance with the plans. These measures are applicable to both the construction areas as well as to any associated activities such as sites for stockpiles, disposal of fill and construction of diversion roads, etc. • Do not burn off cleared vegetation – where feasible, chip or mulch and reuse it for the rehabilitation of affected areas, temporary access tracks or landscaping. Mulch provides a seed source, can limit embankment erosion, retains soil moisture and nutrients, and encourages re-growth and protection from weeds. • Return topsoil and mulched vegetation (in areas of native vegetation) to approximately the same area of the roadside it came from. • Avoid work within the drip-line of trees to prevent damage to the tree roots and compacting the soil. • Minimize the length of time the ground is exposed or excavation left open by clearing and re-vegetate the area at the earliest practically possible. • Ensure excavation works occur progressively and re-vegetation done at the earliest • Provide adequate knowledge to the workers regarding nature protection and the need of avoid felling trees during construction • Supply appropriate fuel in the work caps to prevent fuel wood collection

ECoP 13: Protection of Fauna

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities	The location of construction activities can result in the loss of wild life habitat and habitat quality,.	The Contractor shall • Limit the construction works within the designated sites allocated to the contractors • check the site for animals trapped in, or in danger from site works and use a qualified person to relocate the animal
	Impact on migratory birds, its habitat and its active nests	The Contractor shall • Not be permitted to destruct active nests or eggs of migratory birds • Minimize the tree removal during the bird breeding season. If works must be continued during the bird breeding season, a nest survey will be conducted by a qualified biologist prior to commence of works to identify and located active nests • Minimize the release of oil, oil wastes or any other substances harmful to migratory birds to any waters or any areas frequented by migratory birds.
Vegetation clearance	Clearance of vegetation may impact shelter, feeding and/or breeding and/or physical destruction and severing of habitat areas	The Contractor shall • Restrict the tree removal to the minimum required. • Retain tree hollows on site, or relocate hollows, where appropriate • Leave dead trees where possible as habitat for fauna • Fell the hollow bearing trees in a manner which reduces the potential for fauna mortality. Felled trees will be inspected after felling for fauna and if identified and readily accessible will be removed and relocated or rendered assistance if injured. After felling, hollow bearing trees will remain unmoved overnight to allow animals to move of their own volition.
Construction camps	Illegal poaching	• Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching.

ECoP 14: Protection of Fisheries

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities in River	The main potential impacts to fisheries are hydrocarbon spills and leaks from riverine transport and disposal of wastes into the river	The Contractor shall • Ensure the riverine transports, vessels and ships are well maintained and do not have oil leakage to contaminate river water. • Contain oil immediately on river in case of accidental spillage from vessels and ships and in this regard, make an emergency oil spill containment plan to be supported with enough equipments, materials and human resources • Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river
Construction activities on the land	The main potential impacts to aquatic flora and fauna River are increased suspended solids from earthworks erosion, sanitary discharge from work camps, and hydrocarbon spills	The Contractor shall • follow mitigation measures proposed in ECoP 3 : Water Resources Management and EC4: Drainage Management
	Filling of ponds for site preparation will impact the fishes.	The Contractor shall • Inspect any area of a water body containing fish that is temporarily isolated for the presence of fish, and all fish shall be captured and released unharmed in adjacent fish habitat • Install and maintain fish screens etc. on any water intake with drawing water from any water body that contain fish

ECoP 15: Road Transport and Road Traffic Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Increased traffic use of road by construction vehicles will affect the movement of normal road traffics and the safety of the road-users.	The Contractor shall • Prepare and submit a traffic management plan to the CSC for his approval at least 30 days before commencing work on any project component involved in traffic diversion and management. • Include in the traffic management plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines

		arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs / lights, and road signs.
		• Provide signs at strategic locations of the roads complying with the schedules of signs contained in the Bangladesh Traffic Regulations.
		• Install and maintain a display board at each important road intersection on the roads to be used during construction, which shall clearly show the following information in Bangla:
		  • Location: chainage and village name
		  • Duration of construction period
		  • Period of proposed detour / alternative route
		  • Suggested detour route map
		  • Name and contact address/telephone number of the concerned personnel
		  • Name and contact address / telephone number of the Contractor
		  • Inconvenience is sincerely regretted.

	Accidents and spillage of fuels and chemicals	• Restrict truck deliveries, where practicable, to day time working hours. • Restrict the transport of oversize loads. • Operate road traffics/transport vehicles, if possible, to non-peak periods to minimize traffic disruptions. • Enforce on-site speed limit

ECoP 16: River Transport management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities in River	The presence of construction and dredging barges, pipe lines and other construction activities in the river can cause hindrance and risks to the river traffic.	The Contractor shall • Not obstruct other normal riverine transport while doing riverine transport and works • Identify the channel to be followed clearly using navigation aids such as buoys, beacons, and lighting • Provide proper buoyage, navigation lights and

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		markings for bridge and dredging works to guide the other normal riverine transport • Keep regular and close contacts with Bangladesh Inland Water Transport Authority (BIWTA) regarding their needs during construction of the project • Plan the river transport and transportation of large loads in coordination with BIWTA to avoid traffic congestions. • Provide signage for river traffic conforming to the BIWTA requirements • Position the dredge and pipeline in such a way that no disruption to the channel traffic will occur
	Accidents	The Contractor shall • Prepare an emergency plan for dealing with accidents causing accidental sinking of the vessels and ships • Ensure sufficient equipment and staffs available to execute the emergency plans • Provide appropriate lighting to barges and construction vessels.

ECoP 17: Construction Camp Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Siting and Location of construction camps	Campsites for construction workers are the important locations that have significant impacts such as health and safety hazards on local resources and infrastructure of nearby communities.	The Contractor shall • Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view. • Consider the location of construction camps away from communities in order to avoid social conflict in using the natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities. • Submit to the CSC for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities that are to be constructed together

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		with the location of site roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities, prior to the development of the construction camps. • Local authorities responsible for health, religious and security shall be duly informed on the set up of camp facilities so as to maintain effective surveillance over public health, social and security matters
Construction Camp Facilities	Lack of proper infrastructure facilities , such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	Contractor shall provide the following facilities in the campsites • Adequate housing for all workers • Safe and reliable water supply. Water supply from deep tube wells of 300 m depth that meets the national standards • Hygienic sanitary facilities and sewerage system. The toilets and domestic waste water will be collected through a common sewerage. Provide separate latrines and bathing places for males and females with total isolation by wall or by location. The minimum number of toilet facilities required is one toilet for every ten persons. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. Both sides of roads are to be provided with shallow v drains to drain off storm water to a silt retention pond which shall be sized to provide a minimum of 20 minutes retention of storm water flow from the whole site. Channel all discharge from the silt retention pond to natural drainage via a grassed swale at least 20 meters in length with suitable longitudinal gradient. • Paved internal roads. Ensure with grass/vegetation coverage to be made of the use of top soil that there is no dust generation from the loose/exposed sandy surface. Pave the internal roads of at least haring-bond bricks to suppress dusts and to work against possible muddy surface during monsoon. • Provide child crèches for women working construction site. The crèche shall have facilities for dormitory, kitchen, indoor and

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		outdoor play area. Schools shall be attached to these crèches so that children are not deprived of education whose mothers are construction workers • Provide in-house community/common entertainment facilities. dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible.
Disposal of waste	Management of wastes is crucial to minimize impacts on the environment	The Contractor shall • Ensure proper collection and disposal of solid wastes within the construction camps • Insist waste separation by source; organic wastes in one pot and inorganic wastes in another pot at household level. • Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. Establish waste collection, transportation and disposal systems with the manpower and equipments/vehicles needed. • Dispose organic wastes in a designated safe place on daily basis. At the end of the day cover the organic wastes with a thin layer of sand so that flies, mosquitoes, dogs, cats, rats, are not attracted. One may dig a large hole to put organic wastes in it; take care to protect groundwater from contamination by leachate formed due to decomposition of wastes. Cover the bed of the pit with impervious layer of materials (clayey or thin concrete) to protect groundwater from contamination. • Locate the garbage pit/waste disposal site min 500 m away from the residence so that peoples are not disturbed with the odor likely to be produced from anaerobic decomposition of wastes at the waste dumping places. Encompass the waste dumping place by fencing and tree plantation to prevent children to enter and play with. • Do not establish site specific landfill sites. All solid waste will be collected and removed from the work camps and disposed in approval waste disposal sites.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuel supplies for cooking purposes	Illegal sourcing of fuel wood by construction workers will impact the natural flora and fauna	The Contractor shall • Provide fuel to the construction camps for their domestic purpose, in order to discourage them to use fuel wood or other biomass. • Made available alternative fuels like natural gas or kerosene on ration to the workforce to prevent them using biomass for cooking. • Conduct awareness campaigns to educate workers on preserving the protecting the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	There will be a potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted infections and HIV/AIDS.	The Contractor shall • Provide adequate health care facilities within construction sites. • Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse. • Provide ambulance facility for the laborers during emergency to be transported to nearest hospitals. • Initial health screening of the laborers coming from outside areas • Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work • Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis • Complement educational interventions with easy access to condoms at campsites as well as voluntary counseling and testing • Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellant sprays during monsoon. • Carryout short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Safety	In adequate safety facilities to the construction camps may create security problems and fire hazards	The Contractor shall • Provide appropriate security personnel (police / home guard or private security guards) and enclosures to prevent unauthorized entry in to the camp area. • Maintain register to keep a track on a head count of persons present in the camp at any given time. • Encourage use of flameproof material for the construction of labor housing / site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. • Provide appropriate type of firefighting equipments suitable for the construction camps • Display emergency contact numbers clearly and prominently at strategic places in camps. • Communicate the roles and responsibilities of laborers in case of emergency in the monthly meetings with contractors.
Site Restoration	Restoration of the construction camps to original condition requires demolition of construction camps.	The Contractor shall • Dismantle and remove from the site all facilities established within the construction camp including the perimeter fence and lockable gates at the completion of the construction work. • Dismantle camps in phases and as the work gets decreased and not wait for the entire work to be completed • Give prior notice to the laborers before demolishing their camps/units • Maintain the noise levels within the national standards during demolition activities • Different contractors shall be hired to demolish different structures to promote recycling or reuse of demolished material. • Reuse the demolition debris to a maximum extent. Dispose remaining debris at the designated waste disposal site. • Handover the construction camps with all built facilities as it is if agreement between both parties (contactor and land-owner) has been made so. • Restore the site to its condition prior to

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		commencement of the works or to an agreed condition with the landowner. • Not make false promises to the laborers for future employment in O&M of the project.

ECoP 18: Cultural and Religious Issues

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites, and contractors lack of knowledge on cultural issues cause social disturbances.	The Contractor shall • Communicate to the public through community consultation and newspaper announcements regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction. • Do not block access to cultural and religious sites, wherever possible • Restrict all construction activities within the foot prints of the construction sites. • Stop construction works that produce noise (particularly during prayer time) shall there be any mosque/religious/educational institutions close to the construction sites and users make objections. • Take special care and use appropriate equipment when working next to a cultural/religious institution. • Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. It is an offence to recommence work in the vicinity of the site until approval to continue is given by the CSC/PMU. • Provide separate prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people • Allow the workers to participate in praying

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		during construction time • Resolve cultural issues in consultation with local leaders and supervision consultants • Establish a mechanism that allows local people to raise grievances arising from the construction process. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters

ECoP 19: Worker Health and Safety

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Best practices	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g. noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases etc), (ii) risk factors resulting from human behavior (e.g. STD, HIV etc) and (iii) road accidents from construction traffic.	The Contractor shall • Implement suitable safety standards for all workers and site visitors which shall not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations, in addition to complying with the national standards of the Government of Bangladesh (e.g. `The Bangladesh Labor Code, 2006') • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas, • Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones. • Safety procedures include provision of information, training and protective clothing to

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		workers involved in hazardous operations and proper performance of their job • Appoint an environment, health and safety manager to look after the health and safety of the workers • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters
	Child and pregnant labor	The Contractor shall • not hire children of less than 14 years of age and pregnant women or women who delivered a child within 8 preceding weeks, in accordance with the Bangladesh Labor Code, 2006
Accidents	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims	• Provide health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations shall be easily accessible throughout the place of work • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards. In a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules • Provide adequate lighting in the construction area and along the roads
Construction Camps	Lack of proper infrastructure facilities, such as housing, water supply and sanitation facilities will increase pressure on the local services and generate	The Contractor shall provide the following facilities in the campsites to improve health and hygienic conditions as mentioned in ECoP 17 Construction Camp Management • Adequate ventilation facilities • Safe and reliable water supply. Water supply from deep tube wells that meets the national

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	substandard living standards and health hazards.	standards • Hygienic sanitary facilities and sewerage system. The toilets and domestic waste water will be collected through a common sewerage. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • Recreational and social facilities • Safe storage facilities for petroleum and other chemicals in accordance with ECoP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for trainings • Paved internal roads. • Security fence at least 2 m height. • Sick bay and first aid facilities
Water and sanitation facilities at the construction sites	Lack of Water sanitation facilities at construction sites cause inconvenience to the construction workers and affect their personal hygiene.	• The contractor shall provide portable toilets at the construction sites, if about 25 people are working the whole day for a month. Location of portable facilities shall be at least 6 m away from storm drain system and surface waters. These portable toilets shall be cleaned once a day and all the sewerage shall be pumped from the collection tank once a day and shall be brought to the common septic tank for further treatment. • Contractor shall provide bottled drinking water facilities to the construction workers at all the construction sites.
Other ECPs	Potential risks on health and hygiene of construction workers and general public	The Contractor shall follow the following ECPs to reduce health risks to the construction workers and nearby community • ECoP 2: Fuels and Hazardous Goods Management • ECoP 4: Drainage Management • ECoP 10: Air Quality Management • ECoP 11: Noise and Vibration Management • ECoP 15: Road Transport and Road Traffic Management • ECoP 16: River Transport management
Trainings	Lack of awareness and basic knowledge in	The Contractor shall

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	health care among the construction workforce, make them susceptible to potential diseases.	• Train all construction workers in basic sanitation and health care issues (e.g., how to avoid malaria and transmission of sexually transmitted infections (STI) HIV/AIDS. • Train all construction workers in general health and safety matters, and on the specific hazards of their work Training shall consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Commence the malaria, HIV/AIDS and STI education campaign before the start of the construction phase and complement it with by a strong condom marketing, increased access to condoms in the area as well as to voluntary counseling and testing. • Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled occupations, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This shall be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.