Roads and Highways Department

Bangladesh

ENVIRONMENTAL IMPACT ASSESSMENT OF MYMENSINGH KEWATKHALI BRIDGE IMPROVEMENT PROJECT

Submitted By

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ABBREVIATION

AIIB. *Asian Infrastructure Investment Bank*
AOI). *Area of Influence*
BCCSAP. *Bangladesh Climate Change Strategy and Action Plan*
BDT. *Bangladesh Taka*
BIWTA. *Bangladesh Inland Water Transport Authority*
BNBC. *Bangladesh National Building Code*
BOQ. *Bill of Quantity*
BRTC. *Bureau of Research Testing and Consultancy*
BUET. *Bangladesh University of Engineering and Technology*
BWDB. *Bangladesh Water Development Board*
CEMP. *Contractors Environmental Management Plan*
CRO. *Chief Resettlement Officer*
CSC. *Construction Supervision Consultant*
DAE.. *Department of Agricultural Extension*
DOE. *Department of Environment*
ECA. *Environmental Conservation Act*
ECC. *Environmental Clearance Certificate*
ECP. *Encironmental Code of Practive*
ECR. *Environmental Conservation Rules*
EES. *Environmental Evaluation System*
EIA. *Environmental Impact Assessment*
EIV. *Environmental Impact Value*
EMP. *Environmental Management Plan*
EQS. *Environmental Quality Standard*
ESIA. *environmental and social impact assessment*
ESMP. *environmental and social Management Plan*
ESMPF. *environmental and social Management Plan Framework*
ESO. *Environmental Safety Officer*
ESP. *Environmental and Social Policy*, *Environmental and Social Policy*
ESS. *Environmental and Social Standard*
EU. *Environmental Unit*
FFWC. *Flood Forecasting and Warning Center*
FGD. *Focused Group Discussion*
GBV. *gender-based violence*
GOB. *Government of Bangladesh*
GRC. *Grievance Redress Commitee*
GRM. *Grievance Redress Mechanism*
HVAC. *Heating Ventilation and Cooling*
IEE. *Initial Environmental Examination*
INGO. *International Non Government Organization*
IUCN. *International Union for Conservation of Nature*
IWM. *Institute of Water Modeling*
JNCC. *Jaoint Nature Conservation Commitee*
LGED. *Local Government Engineering Department*
MKBIP. *Mymensingh Kewatkhali Bridge Improvement Project*
MoRTB. *Ministry of Road Transport and Bridges*
MSL. *Mean Sea Level*
NAEP. *National Agricultural Extension Policy*
NGO. *Non Government Organization*
NLUP. *The National Land Use Policy*
NOAA. *National Oceanic and Atmosphere Administration*
NWP). *National Water Policy*
OHS. *Occupational Health and Safety*, *Occupational Health and Safety*
PAP. *Project Affected People*

PD. *Project Director*
PIU. *Project Implementation Unit*
PPP. *Pollution Prevention Plan*
RCP. *Representative Concentration Pathway*
RHD. *Roads and Highways*
ROW. *Right of Way*
SEA. *sexual exploitation and abuse*
SIA. *Social Impact Assessment*
SMVT. *Slowing Moving Vehicle Traffic*
TOR. *Terms of Reference*
WASH. *Water Sanitation and Hygeine*
WHO. World Health Organization

EXECUTIVE SUMMARY

Introduction

The Government of Bangladesh through Roads and Highways (RHD) plans to construct a new bridge over the Old Brahmaputra River at Mymensingh with a Railway Overpass and 4-lane approach road and seeks financial assistance from the Asian Infrastructure Investment Bank (AIIB). The project is known as the "Mymensingh Kewatkhali Bridge Improvement Project" (MKBIP). This is an Environmental Impact Assessment (EIA) study Report for the proposed project in order to address the environmental and social impacts of this project and in compliance with the national regulatory as well as AIIB's Environmental and Social Policy (ESP) stipulated in AIIB's Environmental and Social Framework (2016).

The Project is a substantial solution to ease traffic congestion in Mymensingh City by diverting traffic away from the city's busy central area. The project will provide a connectivity link to a population of over 11 million in Mymensingh Division and some part of Dhaka Division. In the light of categorization made under Environmental Conservation Rules 1997 of Bangladesh (ECR'97), the proposed project falls under the 'Red' category. In accordance with AIIB ESP, this Project is categorized 'A' given the alignment of the road through built-up areas in the city at the southwest side of Old Brahmaputra River, which will require a considerable amount of resettlement and relocation of businesses..

Policy and legal consideration

The environmental aspects of transportation projects are governed by: The Environmental Conservation Act, 1995, the Environmental Conservation Rules, 1997 and the Forest Act, 1927 (if forestland has been converted). The MKBIP will conduct its operations in compliance with local, national and international legislation. In other words, the proposed projects will be executed and operated in accordance with Bangladesh legislations and international agreements to which Bangladesh is a party.

Project description

The proposed project consists of two components as described below.

> **Component 1:** Construction works and consulting services. The project will support the construction of Kewatkhali Bridge and approach road about six kilometers in length. Other ancillary works to make the project bridge fully functional are also included, e.g., installation for traffic management equipment and traffic surveillance, construction for O&M facilities, and tolling and communication systems. Construction supervision for the project is also included in the component. Moreover, feasibility studies, environmental and social safeguards identification, implementation and management and preliminary designs of other selected strategic locations will be sponsored under the component.

Component 2: Project management support and capacity building. This component is comprised of the project management costs of the project implementation unit. The project will also support the training, capacity building and institutional development of RHD for operating, managing and maintaining the RHD networks of the project division areas.

Project Cost: The project's preliminary cost is estimated at USD235.1 million, of which USD152.6 million is covered by the AIIB sovereign-backed loan. The government will cover the cost of land acquisition which is estimated to be about USD82.5 million.

The civil works of the proposed project is consisted of 4 major components: approach roads (3500m and 2162m), main bridge body(320m), interchange and intersections and culverts (nine curvets). The proposed main bridge is a steel arch bridge with a proposed 180m-long span and suitable pier's locations were selected considering comprehensively securing the required Navigation Clearance (Class II, 76.22x12.2) and ground construction for the piers under the dry condition. The approach roads will be installed with drainage facilities.

Construction method: Either large block or small black construction method will be used for erection of bridge superstructure. For construction of bridge piers, maximal two piers will be built on mud flat of the river, so cofferdam will be built during construction of both piers. The project will also include a large amount of earth works for 4-lane approach road construction and other civil works for bridge and culvert on the approach road. The materials for pavement will be produced in batching plant and asphalt plant. The contractor shall utilize existing batching plants/facilities as much as possible.

Construction camps and storage yard: Camp sites will be selected keeping in view the availability of an adequate area for establishing camps, including parking areas for machinery, stores and workshops, access to communication and local markets, and an appropriate distance from sensitive areas in the vicinity. Temporary storage areas will be required for certain activities, such as the storage of sand and gravels and construction equipment. These storage areas may range in size from anything between 50 m^2 to more than a hectare.

Analysis of project alternatives

According to the analysis of "No project scenario", without the proposed project to divert traffic and ease congestion and traffic jam, the already bad traffic condition in Mymensingh will be getting worse as the city is continually growing and the traffic passing through the existing Shomvuganj Bridge is increasing.

Alternatives of alignment of approach road, location of the new bridge and superstructure types were compared based on a comprehensive review of technical feasibility, construction cost, environmental affect, land acquisition and resettlement plan, and obstacles including utilities. Considering the project cost, the options that are technically feasible with least environmental and social impacts are finally selected.

Baseline environmental conditions

River network: The Old Brahmaputra River is one of the main distributaries of the Jamuna (Brahmaputra) that distributes part of Jamuna discharge over a large area of North Central region of Bangladesh. The estimated bank-full discharge is 2,800 m^3/s. The average sinuosity of the channel is 1.24. With average bed slope 8.4cm/km, the average grain size of the river varies between 0.005mm to 0.356mm. The proposed Kewatkhali bridge is connected with the approach road at both banks of the Old Brahmaputra River after crossing the river, one tributary is flow through drainage of approach road of right bank.

Low flow and dredging: According to the Bangladesh Inland Water Transport Authority (BIWTA), there is no flow in the river during dry season at the existing condition, whereas in the dredged condition, there remains flow in the dry season. However, challenge is to ensure sustained dry season flow through establishment of linkage and sediment management.

Historical flood: During the devastating floods of 1998 and 1988 in Bangladesh, the water level in Old Brahmaputra at Jamalpur (SW 225) was 17.47 m and 17.83m respectively exceeding the danger level. At Mymensingh (SW 228.5) the water levels were recorded as 13.04m and 13.69m during the devastating floods of 1998 and 1988 respectively both exceeding the danger level of the water level at Mymensingh.

Environmental quality: The baseline environmental quality has been assessed through instrumental measurement in March and December 2020. All the air quality parameters are within national standard of Bangladesh. According to WHO guideline most of the parameters of air quality are within the WHO standard except PM10 and PM2.5 because of dust particles from the main road and other commercial activities. Noise level exceeded the national standard and WB standard set for the commercial and residential area for the sampling locations for both day and nighttime due to excessive traffic volume and people/vehicular movement. Surface water quality test result shows that the concentration for almost all of the parameters are not yet standardized according to ECR,1997. In Groundwater quality test, the concentration for almost all of the parameters are within the national standard according to ECR, 1997. Parameters analyzed in baseline quality of sediment were observed to be well below the threshold limits for Intervention as per the Dutch Standards where almost some of the parameters are not yet standards according Dutch Standards. In case of Soil, it is seen that all the parameters are not yet standardized according to Dutch standards.

Flora and fauna: Primary ecological survey was carried out in the Area of Influence (AOI) in March 2020. Common benthos and plankton species were found in Old Brahmaputra River. The proposed bridge and approached road alignment are mainly harboring naturalized shrubs, herbs, grasses and weeds. Roadside plantation is common. The region is highly diversified in terms of vegetation. For terrestrial fauna, mammals, avifauna, reptiles and amphibians were surveyed. In addition to domesticated animals in the project area, wild animals were sighted in forest or bushy areas. Some species reported by locals fall into the category of Endangered or Vulnerable species in International Union for Conservation of Nature's (IUCN's) Red List of Threatened Species (local status). However, most of these species used to exist in the project

area but have not been sighted in recent years.

Ganges River Dolphin: The Ganges River dolphin inhabits in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh. This species is categorized as Endangered by the IUCN. The Ganges River dolphin favors deep pools. The project area does not fall inside any Dolphin Sanctuary. The Old Brahmaputra River has undergone severe sedimentation and siltation across its larger. This has led to almost unsuitable dolphin habitats in winter as the Old Brahmaputra River has only been considered a possible passage of dolphins. However, during the monsoon, dolphins are found to remain concentrated in the deeper section (Tin Ganger More) in the river according to locals. Thus, optimum water depth preferred by the Ganges River Dolphin throughout the year is mostly available in sections where scours in the river exist. Secondly, most river fishes occur in the scours of the river during the winter and summer months, as the local fishermen informed.

Fishing and fisheries: The Old Brahmaputra River is well-known for fishing activities since other channels are suffering from low water. Locals mentioned that the negative trend fish availability is due to overfishing, indiscriminate fishing of larvae and juveniles, siltation and pollution.

Impact assessment and mitigation measures

Positive impacts: The proposed bridge will provide a safer and more efficient connectivity link for passenger and freight traffic from Mymensingh-Sherpur road, Mymensingh-Phulpur-Haluaghat road, Mymensingh-Netrokana road and Mymensingh-Kishorgonj road to connect to the N3 highway to Dhaka. It will also bring economic benefits by reducing cost of vehicle operation, travel time, and transaction costs related to transportation. The project will ease traffic congestion in Mymensingh City by diverting traffic away from the city's busy central area. To release more valuable space and improve urban services, it is important to segregate the strategic through traffic flows out from the city's core areas. During the construction activities of the project jobs and income opportunities will be created while for operation, a number of long-term skilled and unskilled personnel will be required for operation and maintenance (O&M) work which will create employment opportunities for the local communities.

Climate change adaptation: The project area is notable among the flood affected districts of Bangladesh. The climate change would worsen the situation. Many bridges and culverts are designed in this project over depressions and low-lying ditches. The additional road embankment height has also been designed to incorporate climate change induced flooding, the differences in water level between base and future time slices are computed.

Potential adverse impacts: Potential negative impacts during the pre-construction, construction and O&M of the projects are summarized below.

During the pre-construction phase, invulnerable resettlement and land acquisition will occur due to the project siting, which are discussed in the Social Impact Assessment (SIA) for this

project. The provisions of compensation to address these impacts are also included in the same.

The adverse impact of this project will mainly occur during construction phase and most of them are temporary.

Water contamination: Construction of the main bridge and the bridge and culverts on the approach road may cause increase of water turbidity due to piling and excavation works. However, such works will be conducted in non-monsoon season, so the potential impact would not be significant. The river training works will also lead to water contamination temporarily. In addition, possible oil spills and runoff from construction sites, barges and construction camps may also pollute the nearby waterbodies. The appointed contractor will first prepare the Contractor's EMP (CEMP) which needed to be approved by the RHD appointed Environmental Specialist. The CEMP will include a Pollution Prevention Plan (PPP) to address the impact on water quality.

Noise and vibration: During construction, noise and vibration are likely to be generated from site clearing, excavation, concrete mixing, crushers, construction vehicles, barges and piling of bridge construction. The construction noise may affect sensitive receptors identified in the EIA. In particular, the high noise caused by pile driving on the mud flat of the Old Brahmaputra River may affect fish and dolphins. Various measures should be taken by the contractor, including reducing the noise at the source (construction equipment) and using temporary barriers around high-noise equipment/construction sites. Pile driving activities should avoid mon-soon season and nighttime, use cofferdams and pile tapping, and apply pile drivers that can meet the noise criteria presented in the EIA.

Air pollution, soil contamination: Air quality will be affected and dust will be generated during construction activities. Major sources of air pollution are drilling activities, excavations, emissions from construction related traffic and equipment, batching plant and asphalt plant. Accidental spill and leakage at construction sites and camps, effluents and dumping of solid waste may contaminate the soil. The construction activities may destroy the topsoil and cause soil erosion. To mitigate deterioration of air quality and soil, the contractor will prepare and implement the PPP.

Solid waste: The construction works generate large quantities of excess materials from construction sites (concrete, discarded material, vegetation), demolition wastes (dismantled asphalt and other facilities), and wastes from construction camps and construction yards, including garbage, recyclable waste, food waste, and other debris. In addition, dredged/excavated materials will be generated from limited dredging in the river and canals. The contractor will have to follow the EMP strictly to manage various solid wastes and the contractor will prepare and implement a Solid Management Plan.

Impact on wildlife: The proposed approach road on the north west side will cause some disruption and disturbance to the ecosystem including fragmentation of the habitat, but the designed culverts will provide crossing for the wildlife. There might be instance of accidental kill of mammalian animals and the reptilian animal during vehicle and equipment movements.

Efforts will have to be made to minimize the accidental kill. A more detailed wildlife survey will be carried out prior to the construction. Wildlife conservation plan and procedures for find of protected species will be developed by the contractor.

Impact on Dolphin: The constructions will take place during non-monsoon seasons when the water level in Old Brahmaputra River is low. The Ganges River Dolphin is not likely to be affected by the construction as they do not move in the river during non-monsoon seasons and as compared with similar bridge project in Bangladesh. However, similar precautionary measure taken in the construction of Padma bridge has been suggested, i.e. piling activities should be restricted in the whole river with a water column depth of 7m during March to July. Other mitigation measures include using cofferdams and controlling noise of piling.

Crop damage: The construction activities along the cultivation fields have a potential to damage crops caused by vehicle movement, material stockpiling, or releasing wastes inside cultivation fields. This will cause economic loss and livelihood impacts on the farmers. The significance of this impact has been assessed as High. A compensation program for creation of employment for victim families, initiatives to reduce negative impact on agricultural lands and increased crop production needs to be arranged by RHD through proper agencies, such as DAE.

Impact on fisheries: There will be in water construction in the low lying and wetland area on the north east side of the project where the roadway will be developed in green fields. Based on the fisheries survey the fishery activity is mainly in the river and fishery activity in the wetlands and canals are limited. No construction shall be undertaken during the spawning and breeding period between June and September at these activity aquatic sensitive locations.

Impacts of borrow pits/areas and construction camps: The borrow areas for the project may cause a number of adverse impacts, including loss of fertile soil, damage to cultivation fields, soil erosion, devaluation of land value, and safety hazards. The construction camps, if not managed well, will have impacts and risks on the environment and surrounding communities. The location of borrow areas and construction camps shall be approved by RHD. The topsoil shall be preserved. The borrow pits should be restored to the condition with the agreement of the land owners. Management plan for construction camps will be prepared and implemented by the contractor.

Occupational health and safety: Some of the Occupational Health and Safety (OHS) risks which are likely to arise during the construction phase of the Project, and are typical to many construction sites, include: exposure to physical hazards from working on heights, use of heavy equipment including cranes; trip and fall hazards; exposure to dust, noise and vibrations; falling objects; exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery. The contractor will prepare and implement an Occupational Health and Safety (OHS) Plan.

Community health and safety: These risks and impacts of the project on communities include, among others, dust, noise, and vibration from construction vehicle transit, and communicable diseases associated with the influx of temporary construction labor, and operation of heavy

construction machinery as well as movement of construction vehicles. The contractor will strengthen construction camps and sites management and prepare and implement a Code of Conduct for all site personnel, in consultation and coordination with the local community to avoid health and safety on communities. The World Bank Guidance Note will be used to address potential impacts caused by temporary project induced labor influx.

During the O&M phase, the impact on air quality will be positive because of better road condition and less traffic congestion. For traffic noise during O&M, RHD will carry out a separate noise assessment study through noise modeling to evaluate the impact of traffic noise. There will also be OHS risks to workers for O&M works. The major risk to local communities during operation of the road will be road accidents. OHS procedures and plan will be prepared for O&M phase. Road safety measures have been included in the design including lighting, signage's and crossings. Road safety management including emergency services will be planned for O&M phase.

Environmental Management Plan, Institutional Framework and Grievance Redress Mechanism

Environmental Management Plan (EMP): The above-mentioned mitigation measures are summarized in the Environmental and Social Mitigation Plan for construction and O&M phases of the project.

Institutional arrangements: The MKBIP's institutional arrangement consist of Project Implementation Unit (PIU), Construction Supervision Consultant (CSC) and the contractors. A PIU will be established in RHD, which will be fully responsible for management of environmental risks and impacts of the project. While contractor is responsible for implementation of EMP during construction works, CSC is primarily responsible for supervision and monitoring of the implementation of the EMP and also reporting the progress to RHD.

Environmental monitoring plan: Monitoring of implementation of the EMP and CEMPs will be carried out by CSC and RHD. In addition, instrumental monitoring of environmental quality is planned for construction and O&M phases. Summary of the monitoring requirements and tasks covering all sites and all project implementation phases are compiled in an environmental monitoring table. The detail monitoring plan with schedule and implementation method has been presented in Table 8-8.

Cost of implementation of the EMP: The total cost of implementation of the EMP is estimated USD XXX.

Grievance Redress Mechanism (GRM): A GRM for project-affected people (PAP) will be established for this project. A Grievance Redress Committee (GRC) will be formed, which will be comprised of one representative of RHD, the Area Manager of the PIU, the Chairman or his representative of the Union Parishad/Municipality where the complaint is registered, one representative of the PAPs, and women member of local Union Parishad/Municipality. The

grievance redress procedures and operational rules will be widely publicized during community meetings, and pamphlets in the local language will be distributed to ensure that stakeholders are aware of their rights and procedures to redress grievances. The GRM will be IT-based through which the complaints can be filed by the PAPs and the screening and follow-up can be improved.

A separate GRM mainly focused on workers will also be established, which seeks to resolve issues concerning wage rates and unpaid overtime work; irregular and partial payments; inadequacy of living accommodations; lack of clean drinking water and sanitation facilities; lack of medical care in emergencies; lack of protection against gender-based violence, sexual exploitation and abuse (GBV/SEA) of female workers by labor suppliers / sardars, supervisors, and others who also deal with workers.

Public participation and consultation with stakeholders

During the field survey, significant efforts were made to identify the possible categories of stakeholders and their stakes. Among the participants, most of them are farmers and businesspersons and a few are fisherman, local persons etc. Female participation in the consultation meetings is found in satisfaction level in the project area.

Total Four (04) Focus Group Discussion (FGD) meetings were arranged in different places of project area with a total of 58 (male 47 and female 11) people such as elected representatives, affected people, teachers, journalists, land owners, businessmen, local elites, day laborers, farmers, and housewives. The stakeholders were made aware about the impact of the project with project information being disclosed.

The major issues raised and taken notes for design consideration and EMP development are: people use the rail bridge to cross the river, sometimes it becomes risky for them to use the rail bridge, so they are happy to have a bridge for the people to cross over; participants believe that this bridge project will lower the amount of road accident and traffic congestion and will help in their better life style; Most of the land in this area is Khas land. So, the poor people living in this area are concerned about their resettlement; Most of the people in this area are fishers, farmers or day laborers, so they are hope-full that this project might benefit them in the future; There is a lack of educational institutions in the area so, people are hope-full that this project will benefit in the educational sector as it will improve transportation communication across the districts. Responses to stakeholders' concerns and questions were given during the meetings and documented in the EIA.

The draft EIA has been disclosed on the website of RHD and public consultation workshops will be carried out following the disclosure.

1 CHAPTER : INTRODUCTION

1.1 Introduction

The Government of Bangladesh through Roads and Highways(RHD) plans to construct a new bridge over the Old Brahmaputra River at Mymensingh with a Railway Overpass and 4-lane approach road and seeks financial assistance from the Asian Infrastructure Investment Bank (AIIB). The project is officially known as the "Mymensingh Kewatkhali Bridge Improvement Project"[1] and henceforth referred to as MKBIP.

The RHD is a Government Department under the Ministry of Road Transport and Bridges and it is responsible for operation and maintenance of the entire road and bridge network of the country. The proposed Mymensingh Kewathkhali Bridge over the old Brahmaputra river, to be implemented by RHD, will establish strategic linkage between landlocked north central and northeast Bangladesh and improve their connectivity with Dhaka, the capital city of Bangladesh. The existing Shambuganj bridge is currently connecting Mymensigh and other northeastern districts with Dhaka. The Shambuganj Bridge is 455m long and 11m wide two-lane bridge[2]. With the increase in vehicles, the expansion of towns toward the proposed bridge location and the resulting congestion around the crossing point, an improvement is required to move traffic away from town, expand the bridge capacity and reduce travel time. The proposed bridge will generate multidimensional benefits for the local population and promote inter-regional trade in the country. It will facilitate quick movement of goods and passenger traffic. The major reason for the construction of new bridge over the Old Brahmaputra River has become inevitable due to load restriction and speed restrictions and width facility on the existing bridge.

This is an Environmental Impact Assessment (EIA) report for the proposed project in order to address the adverse environmental impacts of this project and in compliance with the national regulatory as well as AIIB's Environmental and Social Policy (ESP) dated 2016. A separate Social Impact Assessment (SIA) to address social impacts has also been prepared by RHD. The RHD has engaged consultants to carry out the Feasibility Study and Detailed Engineering Design as well as the Environmental and Social (E&S) studies for the proposed project with the Special Fund grant provided by the AIIB.

The basic data of the project are furnished in Table 1-1

1 AIIB. URL: https://www.aiib.org/en/projects/details/2018/proposed/Bangladesh-Mymensingh-Kewatkhali-Bridge-Improvement-Project.html, date accessed: 3 Aug 2020.

2 AIIB (2019) Project Summary Information (PSI): Mymensingh Kewatkhali Bridge Project, Project Number: 000163. Asian Infrastructure Insvestment Bank (AIIB). URL: https://www.aiib.org/en/projects/proposed/2018/_download/Bangladesh/mymensingh-kewatkhali-bridge.pdf. Date accessed: 2 Aug 2020

Table 1-1 Basic data of Mymensingh Kewatkhali Bridge Improvement Project (MKBIP)

1. Name of the project	Mymensingh Kewatkhali Bridge Improvement Project (MKBIP)
2. Components	Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach Road (including Service Road) project
3. Project Proponent	Roads and Highways Department, Road Transport and Highways Division, Ministry of Road Transport and Bridges, Bangladesh (RHD)
4. Project Location	Mymensingh District, Bangladesh -Between N309, Mymensingh and R370, Shambhuganj
5. Type of Project	Bridge and Road construction project
6. Potential Financer	Asian Infrastructure Investment Bank (AIIB)
7. Project Cost	

1.2 Project Background

Kewatkhali Bridge is part of the Dhaka-Mymensingh-India border corridor, which is strategically important for both regional and local connectivity. The link between those regions will help facilitate cross-border trade with India. Currently, resident in the north central districts on the eastern side of the Bramhaputra River is connected with Dhaka through Mymensingh city by the existing Shambuganj Bridge. The Shambuganj Bridge is a two-lane bridge with 455 meter in length and 11 meters in width. With the increase of vehicles, the expansion of towns toward the proposed bridge location and the resulting congestion around the crossing point, an improvement is required to move traffic away from the town and to reduce travel time by expanding the bridge capacity.

The Project is a substantial solution to ease traffic congestion in Mymensingh City by diverting traffic away from the city's busy central area. The project will provide a connectivity link to a population of over 11 million in Mymensingh Division and some part of Dhaka Division composed of Mymensingh District (5.11 million population), Netrokona District (2.23 million population), Sherpur District (1.36 million population) and Kishoreganj District (2.91 million population). It will also provide a safer and more efficient connectivity link for passenger and freight traffic from Mymensingh-Sherpur road, Mymensingh-Phulpur-Haluaghat road, Mymensingh-Netrokana road and Mymensingh-Kishorgonj road to connect to the N3 highway to Dhaka. It is anticipated that these will result in greater integration of local markets with national markets and growth generation in the north-central region. The project is a substantial attempt to ease traffic congestion in Mymensingh City by diverting traffic away from the city's busy central area. The location of the project is shown in Figure 1-1

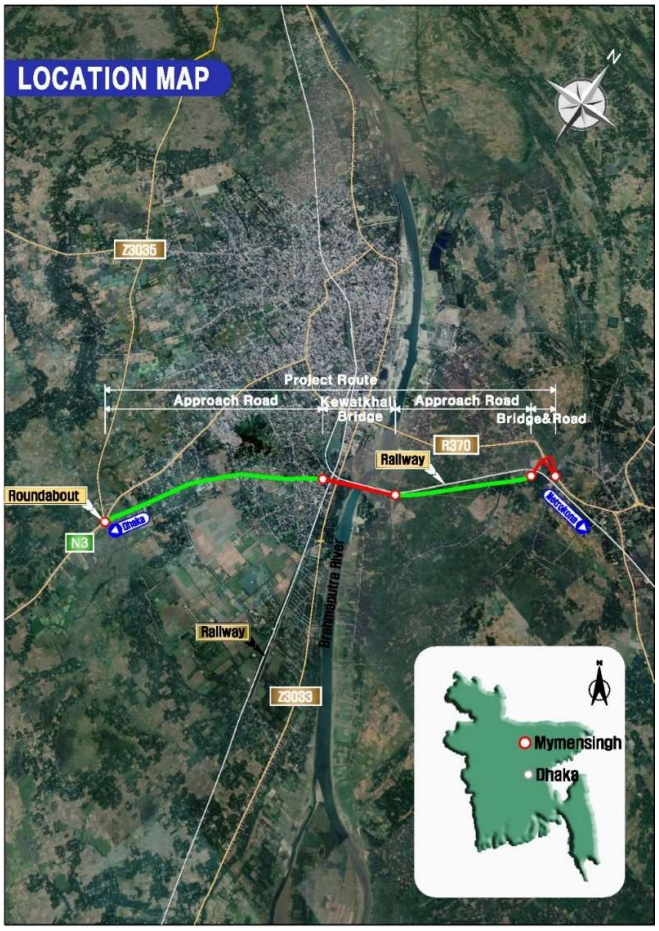

Figure 1-1 Project Location

1.3 Overview of the Project

The proposed project consists of two components as described below[3].

Component 1: Construction works and consulting services. The project will support the construction of Kewatkhali Bridge and approach road about six kilometers in length. Other ancillary works to make the project bridge fully functional are also included, e.g., installation for traffic management equipment and traffic surveillance, construction for O&M facilities, and tolling and communication systems. Construction supervision for the project is also included in the component. Moreover, feasibility studies, environmental and social safeguards identification, implementation and management

[3] AIIB (2019) Project Summary Information (PSI): Mymensingh Kewatkhali Bridge Project, Project Number: 000163. Asian Infrastructure Insvestment Bank (AIIB). URL: https://www.aiib.org/en/projects/proposed/2018/_download/Bangladesh/mymensingh-kewatkhali-bridge.pdf. Date accessed: 2 Aug 2020

and preliminary designs of other selected strategic locations will be sponsored under the component.

Component 2: Project management support and capacity building. This component is comprised of the project management costs of the project implementation unit. The project will also support the training, capacity building and institutional development of RHD for operating, managing and maintaining the RHD networks of the project division areas.

Project Cost: The project's preliminary cost is estimated at USD235.1 million, of which USD152.6 million is covered by the AIIB sovereign-backed loan. The government will cover the cost of land acquisition which is estimated to be about USD82.5 million.
The financing sources are as follows: in Table 1-2.

Table 1-2 Project Financing Sources

For Loans/Credits/Others	Amount (USD million)
AIIB Loan	152.6
Government of Bangladesh	82.5
Total	235.1

1.4 Scope and Objectives of the EIA Study

The objective of environmental Study is to identify significant environmental impacts for the construction of proposed Mymensingh Kewatkhali Bridge. In this process of the environmental parameters were collected from the existing data from all possible sources were carried out. The environmental reconnaissance was conducted to identify and delineate the significant impacts of the project and to eliminate the other impacts for further considerations. The mitigation measures were proposed for identified environmental impact items. It is noteworthy that the checklist including general environmental impact items was prepared in accordance with the AIIB guidelines. Major positive impacts were found in local economy, employment and landscape improvement.

The study has been based on the environmental and socio-economic perspectives of the project site and that of the surrounding area to the possible extent and the significant impacts of the proposed project anticipated upon the existing environmental and socio-economic system pertaining to the project command area. Broad objective of this study has been to provide a basis for detailed assessment of the identified environmental and socioeconomic impacts of the proposed bridge project and, thereafter, to undertake mitigation measures toward minimizing adverse impacts and measures to enhance beneficial impacts, formulate environmental

management and monitoring plans and plans for addressing health and safety issues. The specific objectives of this EIA are to:

- Present a general description of the project and the process;
- Analyze and compare E&S impacts among alternatives of the project;
- Present a description of the baseline environment;
- Identify and delineate the anticipated significant environmental issues found and believed to be involved;
- Identify the environmental impacts of the project and quantify them to the extent possible;
- Propose measures to avoid, reduce, minimize and mitigate the negative environmental impacts of the project;
- Develop an Environmental Management Plan (EMP) including a monitoring plan for the management of environmental risks and impacts of the project.

1.5 Legislative Requirements

1.5.1 Bangladesh DOE Requirements

Environment Conservation Act, 1995 (ECA'95) is currently one of the main legislative document relating to environmental protection in Bangladesh. Under this act, 'No industrial unit or project shall be established or adopted without obtaining environmental clearance, in the manner prescribed by the rules, from Director General'. Compliance with the provision of this Act is the responsibility of Department of Environment (DoE). A set of the relevant rules to implement the ECA' 95 had been promulgated in August 1997. The rules mainly consist of:

- ✓ Categorized list (green, orange and red) of the projects.
- ✓ Application format to take environmental clearance.

Ambient standards in relation to water pollution, air pollution and noise, as well as permitted discharge/emission levels of water and air pollutants and noise by industries. The legislations relevant for environmental assessment for Kewatkhali Bridge Project 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 location, size, severity of pollution loads construction of the bridge was considered to be significant impact on the important environmental components (IEC). Therefore, Mymensingh Kewatkhali Bridge Improvement Project (MKBIP) falls under the 'Red' category.

The procedures for "Red" Category include submission of:

- ❖ An Initial Environmental Examination (IEE); and
- ❖ An Environmental Impact Assessment
- ❖ An Environmental Management Plan (EMP)

1. Environment clearance has to be obtained by the respective implementing agency or project proponent (private sector) from the Department of Environment (DoE). The environmental clearance procedure for "Red" Category projects can be summarized as follows:
2. Application to DoE→Obtaining Site Clearance →Applying for Environmental Clearance →Obtaining Environmental Clearance→Clearance Subject to annual renewal.

In the light of categorization made under the above ECR, '97, the proposed **Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach Road (including Service Road)** at Mymensingh, Bangladesh falls under the 'Red' category. The rules also incorporate "inclusion lists" of projects requiring varying degrees of environmental investigation e.g. all the new projects under red category generally will require two-steps assessment procedure, firstly an Initial Environmental Examination (IEE) for site clearance, and secondly, if warranted, a full Environmental Impact Assessment (EIA) for technical clearance.

To fulfill these requirements of ECR, '97 an IEE was developed and submitted to DoE on February 2, 2020. The IEE was approved by DoE on March 3, 2020 (in the 456th meeting of DoE) with the Terms of References (ToR) being issues for preparing the EIA document. The ToR has been preliminary approved and revised ToR with comments provided by the DOE was forwarded to the proponent by a letter issued on March 19, 2020. A copy of the letter has been attached in the Appendix 1 Approval of TOR by DOE

. The timeline of the application process and approval dates are shown in Table 1-3.

Table 1-3 Timeline of the application and approval dates with DoE

Application/Document	Submission/Approval Date
Initial Environmental Examination	February 2, 2020
The Initial Environmental Examination and The Terms of Reference for the EIA	Approved on March 3, 2020

The Project will apply for the site clearance and environmental clearance after signing of finalized Project agreements with the regulatory authorities. The EIA Report (this report), which is being prepared for the potential lenders (here RHD), will be updated as and if necessary, in accordance comments given by the DOE and then submitted to the DoE for obtaining environmental clearance.

1.5.2 AIIB Requirements

AIIB's Environmental and Social Policy (ESP) including the Environment and Social Standards (ESS) and Environmental and Social Exclusion List has been applied in screening and categorizing and due diligence with respect to the specific context of the project. As per AIIB's ESP, the project is assigned Category A given the alignment of the road through built-up areas in the city at the southwest side of Old Brahmaputra River, which will require a considerable amount of resettlement and relocation of businesses. As part of project preparation, an EIA including an Environmental Management Plan (EMP) and a SIA have been prepared, in accordance with the requirements in the ESP. This document is the EIA to satisfy AIIB′s environmental due diligence requirement.

1.6 Scope of Study

The scope of work of this study is limited to the following:

- Primary environmental baseline survey
- Stakeholder assessment and consultation including public consultation
- Analysis of Impacts and management measures
- Analysis of Alternatives to the proposed project
- Environmental management plan
- Institutional Arrangement to manage environmental impacts effectively

1.7 EIA Study Methodology

This section presents the methodology used to conduct the EIA. The EIA methodology follows the overall approach illustrated in Figure 1-2. The EIA has been undertaken following a systematic process that evaluates the potential impacts the Project could have on aspects of the physical, biological, social/ socio-economic and cultural environment, and identifies preliminary measures that the Project will take to avoid, reduce, mitigate, offset or compensate for potential adverse impacts; and to enhance potential positive impacts where practicable.

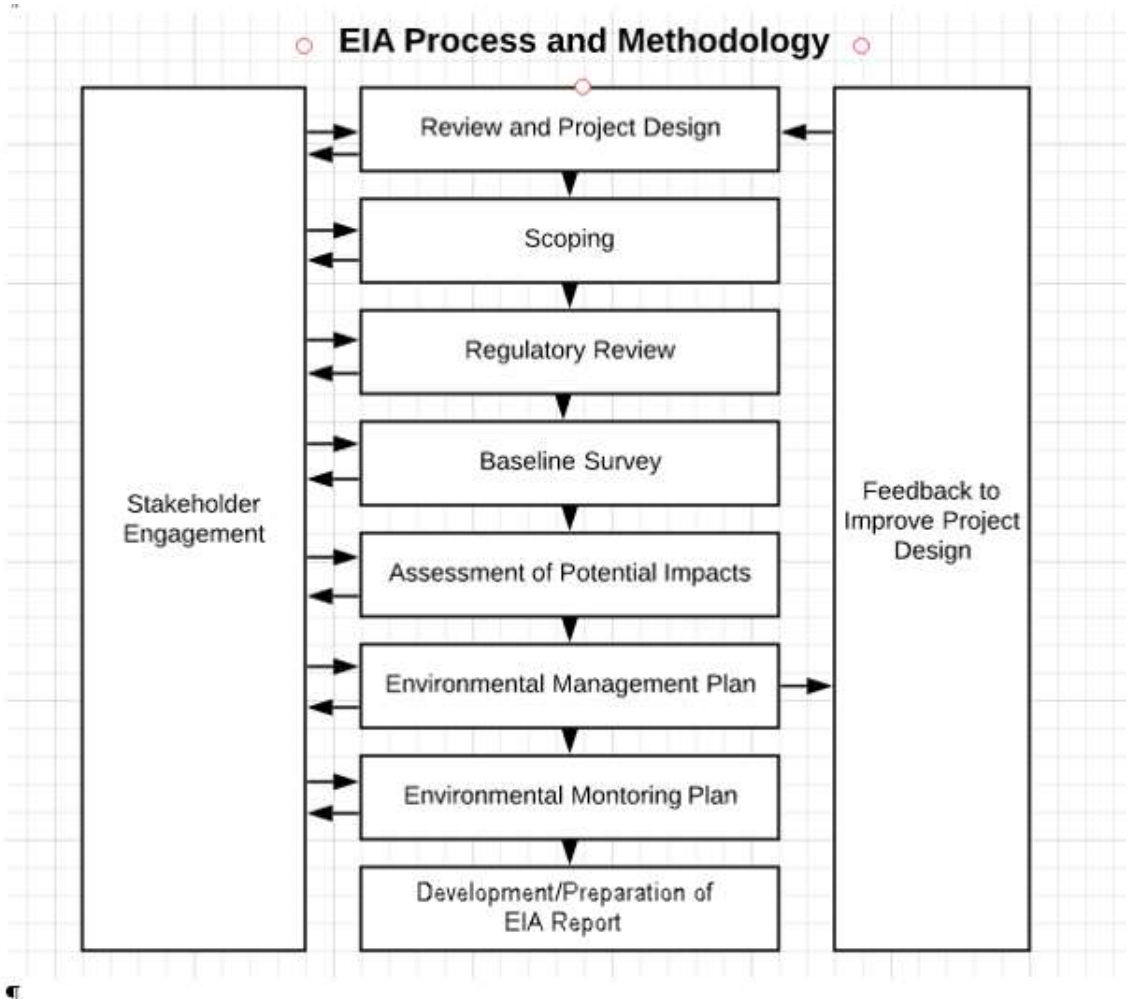

Figure 1-2 Process Followed for EIA Study

1.7.1 Area of Influence

The direct Area of Influence is considered to be about 500 m of both sides of the proposed alignment from southwest side to the northeast of the Old Bramaputra River. The area of influence (AOI) diagram for which the survey for the sensitive receptors was done is shown in Figure 1-3.

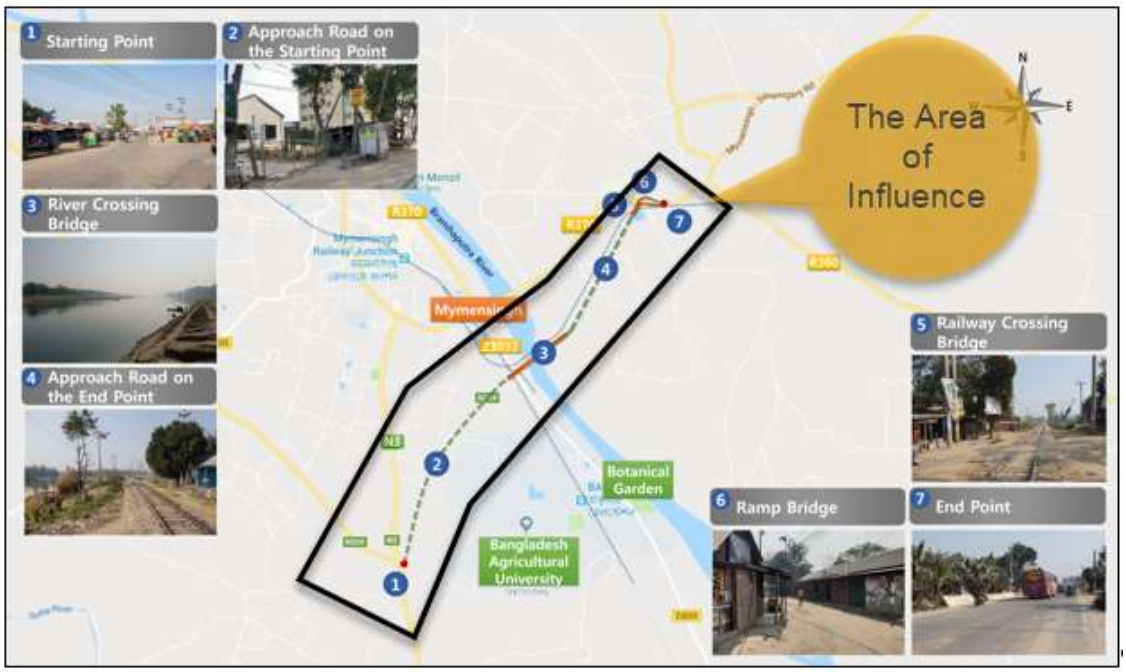

Figure 1-3 Area of Influence

1.7.2 EIA Process and Methodology

Step 1 Review of Project Design

Detailed information about project was collected from Project Feasibility Study of "Mymensingh Kewatkhali Bridge Improvement Project, by the environmental team members for gaining an understanding of the proposed interventions and their possible environmental impacts and possible

The design data was collected for preparation of the EIA document from the following documents:

1. Feasibility Study of Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach (including Service Road) Road;
2. Detail Design of Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach (including Service Road) Road.

Step 2 Scoping

Scoping has been undertaken to identify the potential Area of Influence for the Project (and thus the appropriate Study Area), to identify potential interactions between the Project and resources/receptors in the Area of Influence and the potential impacts that could result from these interactions. It also helps in developing and selecting alternatives to the proposed action and in identifying the issues to be considered in an EIA. During the process, the study team also took into consideration ideas and suggestions of the representatives of the primary and secondary stakeholders and local authorities.

Step 3 Regulatory Review

As part of this task, national regulatory framework relevant to environmental assessment was reviewed. The applicability of the Bangladesh Government's rules, regulations, policies and legislations relevant for environmental assessment for the Kewatkhali Bridge Improvement Project were assessed under the lens of the Environmental Conservation Act 1995 (ECA'95) and the Environmental Conservation Rules 1997 (ECR'97). In addition, the AIIB's ESP and ESS were reviewed and their relevance to the proposed project were identified. Finally, a comparison of the two sets of the requirements (ie, national and AIIB requirements) was carried out and gaps between them identified in Section 2.6.2

Step 4 Environmental Survey

The environmental and social baseline conditions of the proposed project area have been determined by collecting relevant data from primary and secondary sources. Under the EIA study, available data on climate, geology, seismicity, water resources, land resources, soil properties, agriculture, ecology and socio-economic components have been collected from secondary sources. Reconnaissance field visit and instrument monitoring of environmental quality were carried out from February 2019 to March 2020 to collect primary data in the key areas of terrestrial ecology, hydrology, industries and socioeconomics of the local community, physical and biological environment.

Socio-economic data have been collected from the project area and relevant committees, local residents of Dakkhin Charkalibari, Charkalibari, Kewatkhali Nodir Par Colony, Digharkanda Bypass More, through Focus Group Discussions (FGDs), workshops, and face-to-face interviews.

Step 5 Assessment of Potential Impacts and mitigation measures

Subsequent to the scoping, review of project details, and review of baseline environmental conditions, assessment of impacts on each of the environmental and social parameter was carried out. Once the potential impacts were identified, their significance was assessed. Subsequently, the mitigations and enhancement measures were suggested to avoid, minimize and /or compensate the potential impacts. For this purpose, mitigation strategies adopted during earlier projects of similar nature were reviewed in addition to relying upon experts' judgment. Subsequently, residual impacts - impacts that are likely to take place even after the implementation of mitigation measures - and their significance were assessed.

Step 6 Development of Environmental and Social Management Plan (EMP)

The Environmental Management Plan (EMP) was prepared once the impact assessment was completed and mitigation measures identified. During the EMP preparation, institutional arrangements for environmental and social management of the project were recommended, mitigation and monitoring plans were formulated, documentation and reporting protocols were defined, training needs were assessed, and cost of EMP implementation estimated.

Step 7 Stakeholder Engagement

Stakeholder engagement started from environmental baseline stage when data and information on baseline conditions was collected from the directly and indirectly project impacted people. Their perceptions were considered in the selection of important environmental through the scoping process.

Four consultations were carried out during the EIA study. The EIA team arranged a formal consultation meeting with project affected people at Mymensingh Sadar region Dakkhin Charkalibari, Charkalibari, Kewatkhali Nodir Par Colony, Digharkanda Bypass More communities. Along with this, the study team also communicated with local government authority to inform them and to learn their perception regarding this project. A participatory approach was followed during consultation meetings.

Step 8 EIA Report Preparation

Towards the end of present assignment, the EIA report was prepared compiling the process and outcome of the tasks described above. The EIA report follows the standard structure that has been described later in the Chapter.

1.8 The EIA Team

The team comprises a group of Engineers, Environmental Specialists, Biologists and Surveyors from DOWHA and DDC who have the overall responsibility for preparation and following the process for Regulatory and AIIB approval and concurrence. Additionally, a team of Engineers, Surveyors and Biologist from DSCL ltd. were responsible for environmental quality assessment survey and ecological survey. The Department of Lifesciences of Jahangir Nagar University was responsible for providing guidance on ecological survey methods. The EIA team is given in Table 1-3.

1.9 Limitations

This EIA report forms the second part(The first part was the Initial Environmental Examination, IEE) of the regulatory impact assessment process of the proposed bridge Project. This EIA is limited to investigating and managing potential impacts associated with during construction and operation stage. This EIA should not be in any way construed as providing impact assessment for any further work or developments on this or any other site. No assessment has been made for any future projects or activities that may arise as a result of this Project. If or when any such developments are proposed, additional environmental impact assessment should be carried out at that stage in accordance with the legal requirements of Bangladesh.

Services performed by the consultant are conducted in a manner consistent with that level of care and skill generally exercised by members of the engineering and consulting profession. The report may not exhaustively cover an investigation of all possible circumstances that may

exist. However, an effort is made to discover all meaningful areas under the stipulated time available.

In evaluating subject site, consultant relies in good faith on information provided by client's management or employees. The Consultant assume that the information provided is factual, accurate and accepts no responsibility for any deficiency, misstatement or inaccuracies contained in this report as a result of omission or misrepresentation of any person interviewed or contacted. However, the consultant notifies the contradictions and errors in the data, where it seems appropriate.

It should be recognized that the information given in the report is time specific and with the passage of time the relevancy of data and analysis may suffer. Specific circumstances and condition of site can change due to which conclusion and opinions may also change.

This EIA is confined to the study of the potential impacts of the Project on the physical, biological, and socio-economic environments of the study area. This study has been carried out by assessing data from a wide range of primary and secondary data. These include literature reviews, reports and other documents, which have been supplemented with primary field data collection. Assessment of the Project is limited by the quantity and quality of available data.

Certain provisions in this EIA report assume reliance on conceptual design and technical information. If the design of the Project changes from that assessed due to design development, inclusion of new information, changing motivations or any other reason, the results of any impact assessment or mitigate measures provided in this report may be inconsistent.

1.10 Report Structure

This EIA report contains 9 chapters:

- Chapter 1 discusses the background of the Bridge Project, purpose of the study and the methodology used in this study;
- Chapter 2 describe policy and legal framework;
- Chapter 3 describes the project giving details of the interventions of the bridge;
- Chapter 4 analyzes the alternatives of the project;
- Chapter 5 presents environmental baseline conditions are described;
- Chapter 6 identifies the potential impacts;
- Chapter 7 is the evaluation of impacts and mitigation measures;
- Chapter 8 provides the environmental management plan, institutional framework and grievance redress mechanism;
- Chapter 9 presents the public participation and consultation with stakeholders;
- Chapter 10 summarizes the conclusion and recommendations of the EIA study.

1.11 Acknowledgement

The EIA Report has been prepared basically with the support from **Roads & Highways Department** and also from various government agencies and NGOs including Bangladesh Meteorological Department (BMD), Soil Resource Development Institute (SRDI), Bangladesh Bureau of Statistics (BBS), Bangladesh Water Development Board (BWDB), Department of Environment (DOE) and Department of Agriculture Extension (DAE). Also, thanks go to Jahangir Nagar University Department of Life Sciences for valuable guidance. Kind gratitude to AIIB staff for proving valuable comments and suggestions. We would like to say thanks to each organization and its employees for their contribution in conducting the study.

2 CHAPTER: POLICY AND LEGAL CONSIDERATIONS

2.1 Introduction

Development projects are governed by some legal and institutional requirements. So, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before they actually execute a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. The following sections review the relevant national legislations and policies along with some international laws.

The Mymensingh Kewatkhali Bridge Improvement Project (MKBIP) will conduct its operations in compliance with local, national and international legislation. In other words, the proposed projects will be executed and operated in accordance with Bangladesh legislations and international agreements to which Bangladesh is a party.

2.2 Regulatory Bodies, Relevant Policies and Laws for Environmental Protection

Ministry of Environment, Forest and Climate Change (MoEFC)

The Ministry of Environment, Forest and Climate Change (MoEFC) is the nodal ministry that supervises the implementation of environmental and forestry programs in Bangladesh. The Department of Environment (DoE) carries out policy analysis, planning and evaluation, program coordination, and monitoring and evaluation of the environmental programs. The Forest Department in the ministry deals with the forestry programs.

The environmental aspects of transportation projects are governed by: the Environmental Conservation Act, 1995, the Environmental Conservation Rules, 1997 and the Forest Act, 1927 (if forestland has been converted).

Department of Environment (DoE)

The DoE is the technical arm under the MoEF and is the agency responsible for environmental planning, management and monitoring. Under the provision of the Environmental Conservation Act, 1995 (ECA 1995), the DoE is authorized to issue environmental clearance for all types of the projects and mandated to formulate environmental guidelines. The DoE is also too mandated to coordinate the activities of any authority or agency. The DoE is also responsible for the environmental quality standards air, water, and soil, usage of water and wastewater discharge. The department is also responsible for defining EIA procedures, issuing the environmental clearance certificate, and declaring and protecting degraded ecosystems. The following Policy, Acts and Rules facilitate the activities of the Department:

Roads and Highways Department

- Environmental Policy 1992
- Environmental Conservation Act, 1995 and subsequent amendments in 2000, 2002 and
- 2010
- Environmental Conservation Rules 1997 and subsequent amendments in 2002 and
- 2003
- Environmental Court Act 2000 and subsequent amendments

Environmental Assessment requirement

The requirement for undertaking environmental studies has been specified under the ECA 1995 and the ECR 1997. Section 12 of ECA 1995 stipulates that "No industrial unit or project shall be established or undertaken without obtaining environmental clearance from the Director General, Department of Environment (DG, DoE) in the manner prescribed by the rules". Further, Section 20 of the Act has bestowed rule-making powers on the government and Clause (2) (f) of this section requires that rules be made to "evaluate and review the environmental impact assessment (EIA) of various projects and activities, and procedures be established for approval". All these requirements have been promulgated in the ECR 1997.

In addition to the ECA, 1995 and the ECR, 1997, depending on applicability, the entrepreneur may have to adhere to and may require to take approvals of other existing policies, ordinances, acts and rules, a list of which are listed below in Table 2-1.

Table 2-1 List of Applicable environmental laws, guidelines, rules, ordinances and policies

Applicable Laws/Acts/Guidelines
Bangladesh Environmental Conservation Act (ECA), 1995
Bangladesh Environmental Conservation Act (ECA), (Amendments) 2010
Bangladesh Environmental Conservation Rules (ECR), 1997
The Environment Court Act, 2000
Relevant National Policies, Strategies and Plans
National Environment Policy, 1992
National Environmental Management Action Plan (NEMAP), 1995
National Water Policy, 1999
National Water Management Plan, 2001 (Approved in 2004)
National Land Use Policy (MoL, 2001)
National Agriculture Policy, 1999
National Fisheries Policy, 1996
National Policy for Safe Water Supply and Sanitation (1998)
National Adaptation Programme of Action (NAPA)
Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009
Other Environmental Relevant Acts, Laws and Rules
Bangladesh Wildlife (Preservation) Order (1973) and Act (1974)
Protection and Conservation of Fish Act (1950)

Embankment and Drainage Act, 1952
Bangladesh Water Act, 2013
Bangladesh Labor Act, 2006
Bangladesh National Building Code, 2006

2.3 National Environmental Acts , Rules Plan and Policy

2.3.1 National Environmental Acts

2.3.1.1 Bangladesh Environmental 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 Kewatkhali Bridge Project 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 Kewatkhali Bridge Projectinterventions.

2.3.1.2 Bangladesh Environmental Conservation Act (ECA), 1995 (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.

2.3.1.1 Bangladesh Environmental Court Act, 2010

Bangladesh Environment Court Act, 2010 has been enacted to resolve the disputes and establishing justice over environmental 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 Mymensingh Kewatkhali Bridge Improvement Project interventions

2.3.2 National Environmental Rules

2.3.2.1 Bangladesh Environmental Conservation Rules (ECR), 1997

The Environmental 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; and
- 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 ECA 95. 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 Orange B category proposed industrial unit or project, the application must be accompanied with feasibility report, Initial Environmental Examination (IEE), EMP. The Kewatkhali Bridge Project is an 'Orange B' category project which requires IEE, 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 (DG). 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.

2.3.3 National Environmental Plans

2.3.3.1 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.

2.3.3.2 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:

1. **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.

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

3. **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.

4. **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.

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

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

2.3.4 National Environmental Policies

2.3.4.1 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, 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 Kewatkhali Bridge Project 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 Kewatkhali Bridge Project are required to clearly address the potential impacts and propose mitigation measures.

2.3.4.2 National Water 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.

2.3.5 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.

2.3.5.1 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 Kewatkhali Bridge Project:

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

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

2.3.5.2 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.

2.3.5.3 National Agricultural Extension Policy 2013

A revised National Agricultural Extension Policy (NAEP) which sets extension policy directions for transferring technologies to crop, fisheries and livestock sector development. Here, key elements of lesson learnt from existing policy, macroeconomic scenario, agro ecology /bio-ecological zones and current issues in agriculture such as natural disaster, production stagnation, land ownership and tenancy, poor soil health status, decreasing agricultural land, irrigation water scarcity, lack of good agricultural practices, high demand of quality seeds/planting materials etc., livestock and fishery issues including emerging challenges and perspectives have been pointed out for strong consideration. In light of these elements, this policy document has been formulated.

2.3.5.4 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; and
- Laws will be formulated to ban the disposal of any untreated industrial effluents into the water bodies.

2.4 Other Environmental Relevant Acts, Laws and Rules

2.4.1 Bangladesh Wildlife (Preservation) Order (1973) and Act (1974)

The Bangladesh Wildlife Preservation (Amendment) Act 1974 regulates the hunting, killing, capture, trade and export of wildlife 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:

- The 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;
- The 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; and
- 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.

2.4.2 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.

2.4.3 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 Kewatkhali Bridge 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).

2.4.4 Bangladesh Water Act, 2013

The recently published Water Act, 2013 is based on the National Water Policy, and designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh. In general, if one takes a critical look at the Act, the new law has provided the right framework for better management of water resources in the country.

As per this Act, all forms of water (e.g., surface water, ground water, sea water, rain water and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. The private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act. A worthwhile initiative is the requirement for permits/licenses for large scale water withdrawal by individuals and organizations beyond domestic use. Without prior permission issued by the Executive Committee, no individuals or organizations will be allowed to extract, distribute, use, develop, protect, and conserve water resources, nor they will be allowed to build any structure that impede the natural flow of rivers and creeks. However, the maximum amount of surface water or groundwater that can be withdrawn by individuals or organizations is not mentioned in the Act. Setting up a priority order for water usage in an area where the water resources is in critical condition is also a significant step.

2.4.5 Bangladesh Water Rules 2018

Bangladesh Water Rule 2018' got approved through a Government Gazette Notification has been published on 18 August 2018 for the same.

Bangladesh Water Rules 2018, was prepared and finalised following Bangladesh Water Act, 2013. Water Resources Planning Organization (WARPO) of Ministry of Water Resources has taken the lead coordination role make it happened and organised a number of consultations with relevant sector actors.

Along with other sector actors, WaterAid Bangladesh, involving all the WASH Networks and CSOs under Watershed-Empowering Citizens programme, has taken a number of initiatives to influence the process and provided a number of recommendations on the draft.

Bangla Gazzate copy of 'Bangladesh Water Rule 2018' is available here for further reference:[4]

2.4.6 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.

2.4.7 Bangladesh National Building Code, 2015

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

[4] https://warpo.portal.gov.bd/sites/default/files/files/warpo.portal.gov.bd/page/8efa30e5_bb1b_47b5_b9b3_b8d03060df8d/Gazette_BWR2018.pdf

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.
Building Research Institute (HBRI) has been entrusted with BNBC 2015 FINAL DRAFT buildings. The updated BNBC contains chapters addressing the task of providing secretarial service to the Steering the issues of energy conservation, rainwater harvesting Committee and managing the implementation of the and distribution mechanisms in buildings.
project. According to an agreement between HBRI and In Part 3, "General Building Requirements, Control and Bureau of Research Testing and Consultancy (BRTC), Regulation" a new Chapter titled, "Energy Efficiency and Bangladesh University of Engineering and Technology Sustainability" has been included giving minimum code (BUET), for the purpose of reviewing and updating the requirements for achieving the efficiency. Bangladesh National Building Code 1993, BRTC, BUET To reduce energy consumption in building provisions for deputed leading experts in all relevant fields among use of variable refrigeration system in HVAC applications, academics and professionals.

2.5 Environmental categorization

Environmental categorization: GoB

Under the legal provisions, the industrial entrepreneurs must take mitigation measures for protecting the environment from pollution impacts and must get 'Environmental Clearance' from DOE before setting up and running their industries. These rules are equally applicable to both new and the existing industries. There are some other sectoral rules related to the industrial projects, which predate environmental legislations. These legislations have become effectively obsolete with the promulgation of the ECA, 1995 and the ECR, 1997 and their subsequent amended versions.

According to ECR, 1997 there are 4 categories-

i. Green
ii. Orange A
iii. Orange B
iv. Red

This project has fallen under 'Red' category as per ECR 97, schedule 1 page 203 Construction/reconstruction/expansion of bridge (length 100 meter and above) [5]

Environmental and Social Categorization: AIIB

In accordance with AIIB ESP, this Project is categorized A given the alignment of the road through built-up areas in the city at the southwest side of Old Brahmaputra River, which will require a considerable amount of resettlement and relocation of businesses. The Bank requires

[5] https://www.elaw.org/system/files/Bangladesh+--+Environmental+Conservation+Rules,+1997.pdf

the Client to conduct an environmental and social impact assessment (ESIA) or equivalent environmental and social assessment, for each Category A Project and to prepare an ESMP or ESMPF, which is included in the ESIA report for the Project. The ESIA for a Category A Project examines the Project's potentially negative and positive environmental and social impacts, compares them with those of feasible alternatives (including the "without Project" situation), and recommends any measures needed to avoid, minimize, mitigate, or compensate for adverse impacts and improve environmental and social performance of the Project. In accordance with the requirements, an EIA and a SIA have been prepared for this project

2.6 AIIB's Environmental and Social Policy

The proposed project is being financed by AIIB and therefore its Environmental and Social Policy will be applicable to the project.

2.6.1 Key Elements of Environmental and Social Framework

Environmental and Social Policy

The objective of this overarching policy is to facilitate achievement of these development outcomes, through a system that integrates sound environmental and social management into Projects. The overarching policy comprises Environmental and Social Policy (ESP), and Environmental and Social Standards (ESSs) and Environmental and Social Exclusion List. The ESP sets out mandatory requirements for the Bank and its Clients relating to identification, assessment and management of environmental and social risks and impacts associated with Projects supported by the Bank.

Environmental and Social Standards

The environmental and social standards (ESSs) set out more detailed mandatory environmental and social requirements, as described below.

Environmental and Social Standard 1 (ESS 1). The ESS 1 aims to ensure the environmental and social soundness and sustainability of Projects and to support the integration of environmental and social considerations into the Project decision-making process and implementation. ESS 1 is applicable if the Project is likely to have adverse environmental risks and impacts or social risks and impacts (or both). The scope of the environmental and social assessment and management measures are proportional to the risks and impacts of the Project. ESS 1 provides for both quality environmental and social assessment and management of risks and impacts through effective mitigation and monitoring measures during the course of Project implementation. The ESS 1 defines the detailed requirements of the environmental and social assessment to be carried out for any project to be financed by the Bank.

Environmental and Social Standard 2 (ESS 2). The ESS 2 is applicable if the Project's screening process reveals that the Project would involve Involuntary Resettlement (including

Involuntary Resettlement of the recent past or foreseeable future that is directly linked to the Project). Involuntary Resettlement covers physical displacement (relocation, loss of residential land or loss of shelter) and economic displacement (loss of land or access to land and natural resources; loss of assets or access to assets, income sources or means of livelihood) as a result of: (a) involuntary acquisition of land; or (b) involuntary restrictions on land use or on access to legally designated parks and protected areas. It covers such displacement whether such losses and involuntary restrictions are full or partial, permanent or temporary. The ESS 2 defined detailed requirements of resettlement planning of the projects involving involuntary resettlement.

Environmental and Social Standard 3 (ESS 3). The ESS 3 is applicable if Indigenous Peoples are present in, or have a collective attachment to, the proposed area of the Project, and are likely to be affected by the Project. 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: (a) self-identification as members of a distinct indigenous cultural group and recognition of this identity by others; (b) collective attachment to geographically distinct habitats or ancestral territories in the Project area and to the natural resources in these habitats and territories; (c) customary cultural, economic, social or political institutions that are separate from those of the dominant society and culture; and (d) a distinct language, often different from the official language of the country or region. In considering these characteristics, national legislation, customary law and any international conventions to which the country is a party may be considered. A group that has lost collective attachment to geographically distinct habitats or ancestral territories in the Project area because of forced severance remains eligible for coverage, as an Indigenous People, under ESS 3. The ESS 3 defines the detailed requirements of People planning, in case such groups are present in the project area and are likely to be affected by the project.

2.6.2 Applicability of ESP for Proposed Project

The Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach (including Service Road) Road triggers the local environmental and social laws and regulations and also the ESP and ESS of AIIB. Under MKBIP, ESS 1: Environmental and Social Assessment and Management and ESS 2: Involuntary Resettlement are applicable. The EIA (this study) addresses ESS1 and SIA addresses ESS 2. Standards on Indigenous Peoples (ESS 3) is not be triggered by the proposed project.

The Bank requires its clients to manage the environmental and social risks and impacts associated with its project in a manner designed to meet the ESP and the applicable ESSs. The present EIA has been developed in compliance with the ESS 1. The applicability of ESP and ESSs for the proposed project is presented in Table 2-2

Table 2-2 Applicability of AIIB ESS

Environmental and Social Standards		Applicability	Triggering Status
ESS 1	Environmental and Social Assessment and Management	ESS 1 is applicable if the Project is likely to have adverse environmental risks and impacts or social risks and impacts (or both)	Yes, since the proposed project is likely to have negative environmental and social impacts. The present EIA has been conducted in compliance
ESS 2	Involuntary Resettlement	ESS 2 is applicable if the project is likely to cause involuntary resettlement impacts.	Yes. The project involves economic displacement due to the siting of the project. Given such impacts, though low intensity in nature, ESS 2
ESS 3	Indigenous Peoples	ESS 3 is applicable if Indigenous People are present in the project area	No, since no Indigenous people, as defined in the ESP.

2.7 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 is given in the following Table 2-3

Table 2-3: 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

Treaty	Year	Brief Description	Relevant Department
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 access to genetic resources	DoE
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

2.8 Environmental Clearance Procedure

The ECR'97 provides a basic framework for environmental evaluation of proposed projects in all sectors and establishes procedures. Accordingly, the project proponent should first obtain a

location clearance and conduct the appropriate study to obtain environmental clearance of the project. Any project constructed in Bangladesh must obtain an Environmental Clearance Certificate (ECC) before its operation.

Similar to Environmental Screening process of the projects, Rule 7 of ECR has classified the projects into following four categories based on the site conditions and the impacts on the environment. The projects are categorized under four categories they are: Green, Orange A, Orange B and Red. Various industries/projects falling under each category have been listed in schedule-1 of the ECR. According to the Rules of the ECC to all existing and proposed industrial units and projects, which are falling in the green category without undergoing EIA. However, for category Orange A and B and for Red projects require location clearance certificate and followed by issuing of ECC upon the satisfactory submission of the required documents.

For getting location and environmental clearances, the project proponent of concerned project should apply to the concerned Divisional Officer of DoE by filling Form-3 as per the rules given in the ECR. They should accompany with the following documents:

1. Application through prescribed form-3 under ECR 1997
2. Prescribed fee under the schedule of ECR 1997 (Amended in 2002)
3. Report on Feasibility of the industrial unit or project
4. Initial Environmental Examination (IEE) Report or EIA as per the Terms of Reference Provided by the DoE
5. EMP for the proposed project
6. No Objection Certificates (NOC) from the Local Authorities.
7. Emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution
8. Outline of Relocation and rehabilitation plan
9. Other necessary information (based on the type of the project)

The environmental clearance is One-year validity for the Projects which come under the Red Category. The environmental clearance process as per the DoE, Ministry of Environment and Forests, Government of Bangladesh is shown in Figure 2-1.

Figure 2-1 Environmental clearance procedure for red category projects

2.9 Harmonization of policies

In the country, there are more than 200 laws and by-laws exist to tackle these challenges related to environmental issues. Strategies and policies are in place. The Government of Bangladesh (GoB) realizes that good public policy needs to be matched by investments to ensure implementation. Some comparative analysis has been drawn between AIIB policy and GoB policies, then a harmonized framework has been provided in Table 2-4.

Table 2-4 Comparison of National legislation with AIIB policy on Environmental aspects

Aspect	AIIB Regulation	National Bangladesh Regulation	Harmonized Framework
Environmental Policy and Regulations	There are AIIB Environmental and Social Framework, Environmental and Social Policy and Environmental and Social Standards	Environment Conservation Act 1995 is currently the main act governing environmental protection in Bangladesh, which replaced the earlier environment pollution control ordinance of 1992 and provides the legal basis for Environment Conservation Rules, 1997 (ECR'97). The main objectives of ECA'95 are: conservation of the natural environment and improvement of environmental standards, and control and mitigation of environmental pollution. According to Article-12 of Environment Conservation Act 1995, "No industrial unit or project shall be established or undertaken without obtaining, in the manner prescribed by rules, an Environmental Clearance Certificate from the Director General. The Ecologically Critical Area (ECA) is an environmentally protected zone where the ecosystem is considered to be endangered to reach a critical condition by the changes brought through various human activities. Section 2(gg) of the Bangladesh Environment Conservation (Amendment) Act (2010) provides that "Ecologically critical Area" means such area which is rich in unique biodiversity or due to the importance	In most of the cases national requirements and standards for environment quality are matching with AIIB Policy and Standards (For example, Environmental Assessment is compulsory for both requirements). However, there are some parameters when national and AIIB requirements and standards are different (For example, National legislation does not require a preparation of separate EMP or any other environmental documents/plans/checklists for project). In such cases more stringent provisions will apply for the project.

Aspect	AIIB Regulation	National Bangladesh Regulation	Harmonized Framework
		of environmental perspective necessary to protect or conserve from destructive activities. ECA also falls within the category of natural and cultural heritage.	
Screening and Categorization	AIIB carries out project screening and categorization at the earliest stage of project preparation when sufficient information is available for this purpose. In the case where AIIB and national categorization requirements differ, the more stringent requirement will apply. This refers mostly in the case of deciding about Category C subprojects - the national EA legislation doesn't refer to small scale activities, including construction and rehabilitation of various buildings. In these cases	It is mandatory to obtain Environmental Clearance for each and every type of industry and project as per Bangladesh Environment Conservation Act, 1995 (Amended 2010). For the purpose of issuance of Environmental Clearance Certificate, the industrial units and projects shall, in consideration of their site and impact on the environment, be classified into the following four categories (see Annexure-I): • Green • Orange-A • Orange-B • Red	AIIB and Bangladesh project categorization could be harmonized by accepting the following principle: IIB Bangladesh (Red to Green) Category A; Category Red Category B Orange B(mostly) Category B Orange A Category C Green *The proposed project has been assessed as Category A in accordance with AIIB ESP.*
Environmental Impact Assessment Report	In accordance with Environmental and Social Policy, ESIA processes report for category A projects includes the following chapters: (a) description of the Project; (b) policy, legal and	The report has to include: (i) baseline data, (ii) project description, (iii) anticipated environmental impacts, (iv) waste management, (v) analysis of emergency situation, and (vi) and anticipated changes due to project	The present EIA has been prepared in fulfilling the national as well as AIIB requirements.

Aspect	AIIB Regulation	National Bangladesh Regulation	Harmonized Framework
	administrative framework, including the international and national legal framework applicable to the Project; (c) scoping, including stakeholder identification and consultation plan; (d) analysis of alternatives, including the "without Project" situation; (e) baseline environmental and social data; (f) evaluation of environmental and social risks and impacts; (g) public consultation and information	implementation. Information on applicable laws and regulation usually is presented in "Introduction" part. For the projects of category Orange B,, the EIA report is more simplified. For Green and Orange A an EIA report is not required	
Environmental Impact Assessment Report	In accordance with Environmental and Social Policy, ESIA processes report for category A projects includes the following chapters: (a) description of the Project; (b) policy, legal and administrative framework, including the international and national legal framework applicable to the Project; (c) scoping, including stakeholder identification and consultation plan; (d) analysis of alternatives, including the "without Project" situation; (e) baseline environmental and social data; (f) evaluation of environmental and social	The DOE TOR defines content of EIA report for project belonged to categories I-III. The report has to include: (i) baseline data, (ii) project description, (iii) anticipated environmental impacts, (iv) waste management, (v) analysis of emergency situation, and (vi) and anticipated changes due to project implementation. Information on applicable laws and regulation usually is presented in "Introduction" part. For the projects of category Orange A and Orange B the EIA report is more simplified.	The present EIA has been prepared in fulfilling the national as well as AIIB requirements.

Aspect	AIIB Regulation	National Bangladesh Regulation	Harmonized Framework
	risks and impacts; (g) public consultation and information disclosure; and (h) development of mitigation, monitoring and management measures and actions in the form of an ESMP or ESIA. For the category B project, the scope of EIA and report should be narrow than for category A projects.		
ESMP	ESMP should be prepared and should specify, along with the proposed mitigation activities, a monitoring plan and reporting requirements, institutional arrangements for ESMP implementation. For sub-projects category B with low impact ESMP checklist has to be filled.	National legislation on EIA requires to identify possible impacts, but it does not require a preparation of separate EMP or any other environmental documents/plans/checklists. There is no requirement on environmental monitoring with specification of monitoring parameters and location.	An EMP has been prepared and included in the present EIA.
Public Consultations and Disclosure	The Sub-borrower is responsible for conducting at least one meaningful consultation for all Categories A, B and C projects to discuss the issues to be addressed in the EMP or to discuss the draft EMP itself.	Conducting of public consultation is not mandatory. It may be conducted, if required at the time of the EIA (second stage of EIA). Notice to relevant agencies and no object clearance from the local Government authority must be obtained	Public consultations have been carried out with the stakeholders, and affected people as part of the present EIA, in line with the AIIB requirements. The feedback received from the Public.

Aspect	AIIB Regulation	National Bangladesh Regulation	Harmonized Framework
			Consultations has been used to finalize the present EIA.

3 CHAPTER : PROJECT DESCRIPTION

3.1 Location of the Project

The proposed project is located in Mymensingh district between N309, Mymensingh and R370, Shambhuganj (Figure 3-1and Figure 3-2). Netrokona district is to the north-west and Kishoreganj district is to the south-east of the project location.

Figure 3-1 Location of the Project area

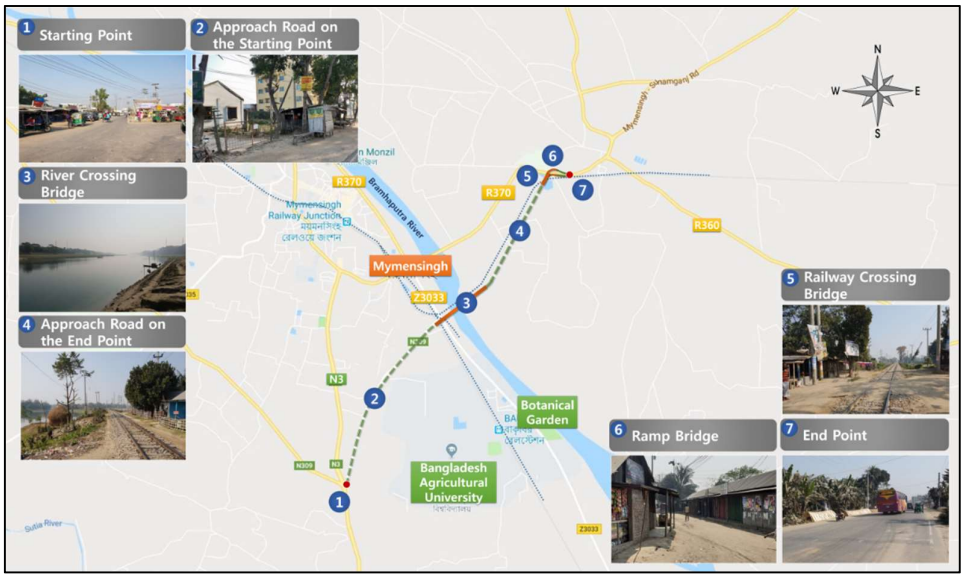

Figure 3-2 Location Map

3.2 Key Components of The Project

The proposed project is consisted of 4 major components: approach raods, main bridge body, interchange and intersections and culverts. The components are illustrated in Table 3-1

Table 3-1 Component Details of MKBIP

Component	Details
Approach Road	Approach Road 1: 3500m Approach Road 2: 162m
Bridge	320 m
Interchange and Intersection	Iinterchange#1 Entry & Exit intersection #1 Interchange #2 Entry & Exit intersection #2 Interchange #3
Culvert	Total 9 Culverts 6 culvert extension 3 new culverts

The detail design components of the project can be seen in Figure 3-3 and Figure 3-4.

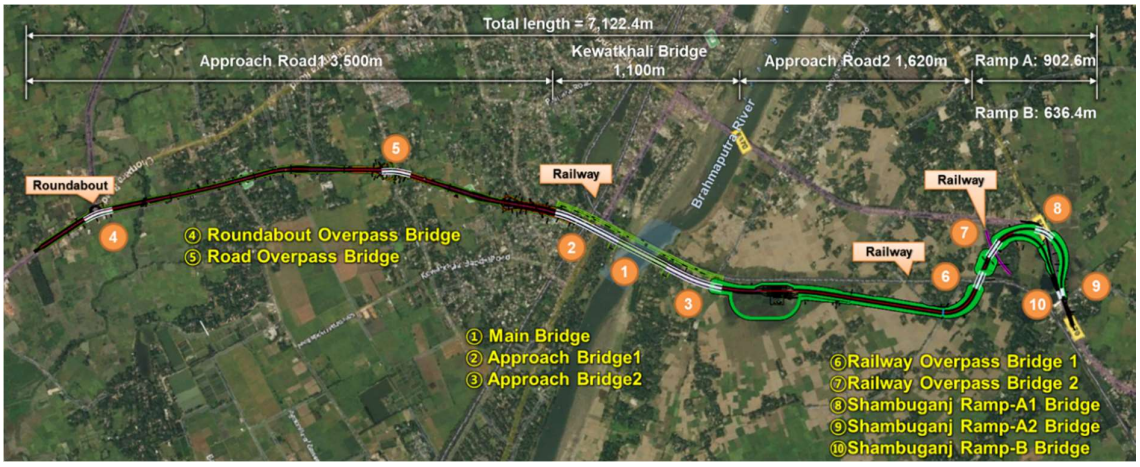

Figure 3-3 Components of the Project

Figure 3-4 Location of the Interchanges

The detailed design components of the proposed Kewatkhali bridge is given in Table 3-2.

Table 3-2 Bridge Details Table

Bridge		Bridge Type	Length (m)	Width(m)
Kewatkhali Bridge	①Main	Steel Arch	70.0+180.0+70.0 = 320	42.150
	②Approach 1 (to Dhaka)	PSC-I Girder	2@40+2@40+50+50 +3@40+40 = 420.0	34.750
	③Approach 2 (to Netrokona)	PSC-I Girder	40+3@40+3@40 +2@40=360.0	34.750
④Roundabout Overpass Bridge		PSC-I Girder	41.85+4@42.6+41.85=254.1	14.250
⑤Road Overpass Bridge		PSC-I Girder	41.85+5@42.6+41.85=296.7	21.550

Bridge	Bridge Type	Length (m)	Width(m)
⑥Railway Overpass Bridge1	PSC-I Girder	3@40 = 120	34.750
⑦Railway Overpass Bridge2	PSC-I Girder	3@40 = 120	34.750
⑧Shambuganj IC Ramp-A1 Bridge	PSC-I Girder	3@40 = 120	17.375
⑨Shambuganj IC Ramp-A2 Bridge	PSC-I Girder	41.1	17.375
⑩Shambuganj IC Ramp-B Bridge	PSC-I Girder	41.1	13.100
Total Bridge Length		2,095.690m	

3.3 Project environment

3.3.1 Starting Point (Digarkanda bypass moor)

The starting point of the project area is a part of the national highway N309 (Eastern Bypass). Dhaka Mymensingh highway(N3), Mymensingh city bypass(N309) and Eastern bypass(N309) are connected at station 4+000, forming the 4-way roundabout named on Digarkanda bypass moor. Some of the road pavement is good in condition. However, most of the pavement is poor in condition with the two-lane road. Road marking of the existing road has been faded and also the drainage system does not exist on both sides of the road. The existing conditions of the starting point are shown in Figure 3-5 below.

① Starting Point

Figure 3-5 Digarkanda bypass moor

3.1.2 Urban section (Sta.0+000~Sta.2+030)

The Road contains two lanes which have poor pavement condition with no lane mark as well as a drainage system does not exist on both sides of the road. The existing traffic is composed of small vehicles, motorbikes, trucks and buses. It is a highly urbanized area with residential buildings, shops, additional roads, Utility lines, mosque, and pond around existing road 'Eastern bypass(N309).

The pictures of this area are shown in Figure 3-6 below.

Figure 3-6 Urban section

3.3.2 Starting Point of the Kewatkhali Bridge (Railway & Pond)

The Kewatkhali bridge begins at the north end of the Road N309, and it overpasses the two-existing railway 'Dhaka-Mymensingh railway and kewathkhali loco connecting railway' and one junction connecting Road N309 and Road Z3033. Since the Kewatkhali road extending the east bypass(N309) overpass Kewatkhali Rd(Z3033), a connection plan should be provided to enable vehicles moving from Z3033 to access the Kewatkhali road.

The pictures of this area are shown in Figure 3-7 below.

Figure 3-7 Starting Point of the Kewatkhali Bridge

3.3.3 Brahmaputra River Crossing Section (Kewatkhali Bridge)

The Kewatkhali bridge is built next to the existing railway bridge which crosses the old Brahmaputra river. The river acts as the life force for the local people. Therefore, the design consultants focused on not only the best bridge design work but also river training work to improve the protection of floodplain and to minimize economic loss of human life area from the flood at the proposed bridge location. The pictures of this area are shown in Figure 3-8 below.

① Brahmaputra River Crossing Section

Figure 3-8 Brahmaputra River Crossing Section

3.3.4 Rural Section (Sta.4+325~Sta.5+600)

The Kewatkhali road is passing through 30m to 160 meters away from the railway on this section, and there is sand-fill area, small pendant, low land and earthen road around the Kewatkhali road. Geotechnical investigation shows that soft ground is located in some sections. As a result of the hydrological analysis, this section shall be designed to prevent roads from flooding more than 50yr High Water Level. The pictures of this area are shown in Figure 3-9 below.

① The starting point of the Bridge

Figure 3-9 Starting Point of the Kewatkhali Bridge

3.3.5 End Point of the Project (Railway Overpass & Route R370 Access)

The section mostly consists of buildings, houses, farmlands and the bridge on both sides along the road R370, ponds and water reservoirs are also found at several spots. The endpoint of the project site is connected with the national highway R370 and it overpasses the existing railway. The road pavement is in good condition with the two-lane road. The lane mark of the road has been faded and also the drainage system has not existed on both sides of the road. The buildings and house have been located along the road, and the existing traffic is composed of non-motorized small vehicles, motorbikes, trucks, and buses. The pictures of this area are shown in Figure 3-10 below.

Figure 3-10 End Point of the Project

3.4 Design details

The feasibility study for the Kewatkhali bridge had performed from 05 September 2019 to 04 December 2019. By the Recommendation of the feasibility study, the Detailed design for the road part is conducted after the topographical survey, geotechnical investigation and additional field are performed. The following key technical issues are reviewed and reflected in the detailed design.

3.4.1 Cross Section Design of Approach Road

Four (4) lane approach road including separate 'Slowing Moving Vehicle Traffic (SMVT+)' lane is required according to the TOR. The consultant has reviewed standards in Bangladesh and practical cross-section as well as road width including separate SMVT lane. Considering the latest design of SMVT, driving safety and traffic flow, 5.5m of width is selected for SMVT lane. Since the project road is located in an urban area, so the median is applied absolute minimum width in

those urban areas to be consistency to bridge cross-section 1.0m of new jersey barrier is planned in the project.

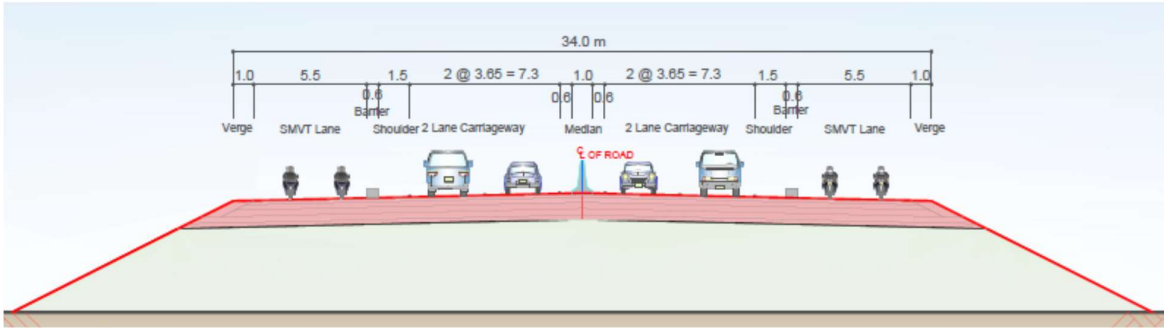

Figure 3-11 Road Cross-Section including SMVT lane

3.4.2 Bridge Overview

3.4.2.1 The navigation clearance

The navigation waterway limitations are classified by Bangladesh Inland Water Transport Authority (BIWTA) and vertical alignment is necessary to comply with this limitation. Classification of waterways passing under the Kewatkhali bridge is classified as Class-2 to consent standard by suggested by BIWTA and the design level is considered Standard high-water level (SHWL). The navigation waterway limitation by BIWTA is described in the following in Table 3-3

Table 3-3 Navigation Waterways Limitation

Classification of Waterways	Clearance		Remarks
	Minimum Vertical	Minimum Horizontal	
Class - 1	18.30 m	76.22 m	
Class - 2	12.20 m	76.22 m	The Kewatkhali bridge
Class – 3	7.65 m	30.48 m	
Class - 4	5.00 m	20.00 m	

3.4.2.2 Kewatkhali Main Bridge (Steel Arch Bridge)

A. Span Arrangement

The proposed span length is 180m and suitable pier's locations were selected considering comprehensively securing the required Navigation Clearance (Class II, 76.22x12.2), ground construction for the piers under the dry condition, minimizing the negative environmental impacts on the river, dredging work plan of main canal, and the direction of river erosion.

The balance arch bridge is combining the structural efficiency of the general arch bridges with the structural advantages of the continuous support system. The balance arch bridge type was adopted to secure the main span length 180m (Figure 3-12).

Also, the three-spans balance arch bridge is considered a good alternative in terms of the improvement of Bangladesh's bridge technology, aesthetics, uniqueness, and iconic value since the simple span steel arch bridge was applied in "KALNA Bridge" (Nilsen Arch type), which is currently under construction (Figure 3-13).

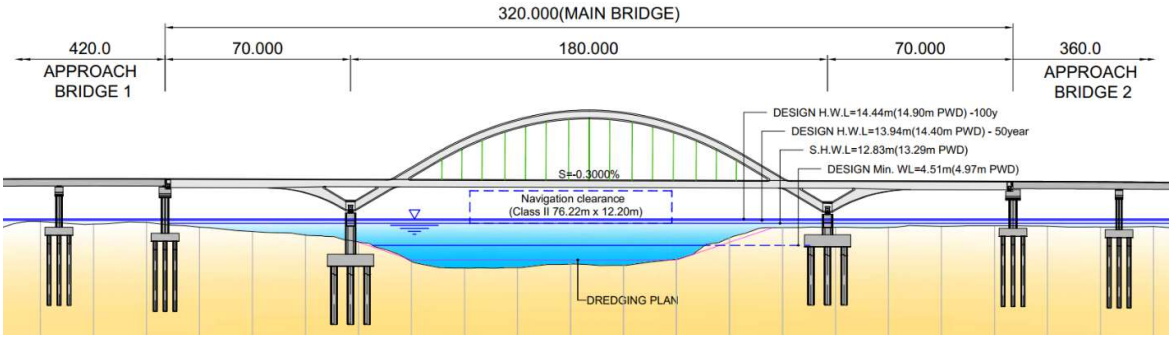

Figure 3-12 Steel Arch Bridge Profile

Figure 3-13 Graphic Representation of the Proposed Arch Bridge

3.4.3 Interchange and Intersection Design

(1) Interchange #1(Digarkanda bypass moor)

As the two lanes overpass the current Digarkanda bypass moor, the location of it is changed to install pier of the bridge. The specifications of the Digarkanda roundabout such as the diameter of inner-circle maintained specification of the current Digarkanda to minimize the impact of the surrounding houses and buildings.

Table 3-4 Dimension of Digarkanda Roundabout

Center island diameter	Inner circle diameter	Outer circle diameter	Lane width of roundabout
48m	49m	60m	2 lanes@5.5m=11m

Because the low-speed vehicles are separated into separate SMVT lanes, the maximum vertical slope is applied 3.5% to minimize the length of the bridge and retaining wall in consideration of economic feasibility.

Table 3-5 Applied Geometric Value for IC#1

IC type	Design speed	Applied horizontal radius	Applied vertical slope	Lane width
Overpass	80km/h	500m	3.5%	2 lanes@3.65m=7.5m

Figure 3-14 Plan of Interchange #1

(2) Interchange #2

IC#2 is applied to pass the U-turn and high-speed traffic volume without stopping, and Intersections in the form of DIAMOND are applied to minimize the acquisition of land. Vehicles using through IC#2 can be moved to the Kewatkhali district and the Maskanda district.

Table 3-6 Applied geometric value for IC#2

IC type	Design speed	Applied horizontal radius	Applied vertical slope	Lane width
Diamond	80km/h	500m	3.5%	2 lanes@3.65m=7.5m

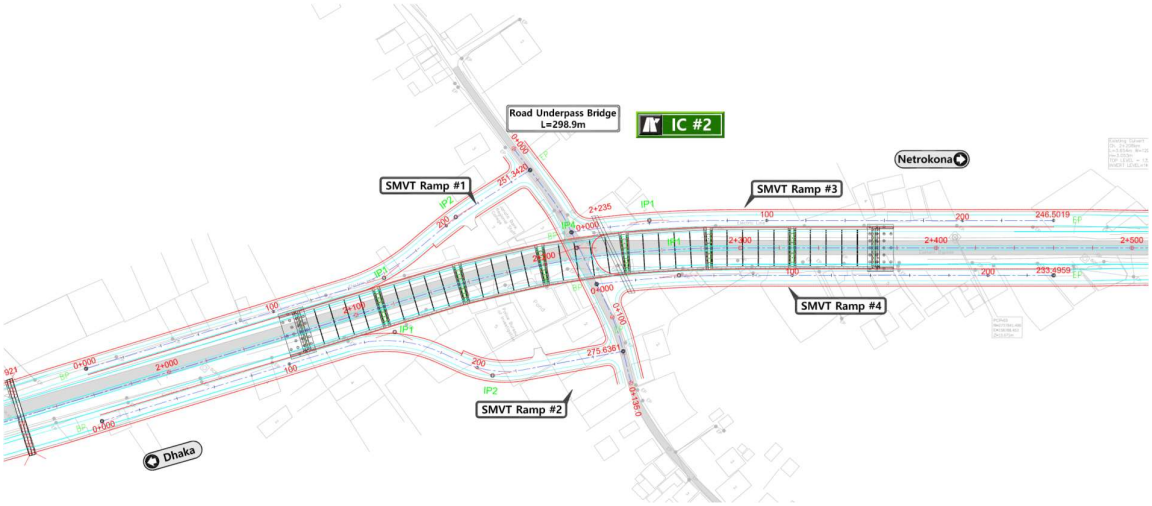

Figure 3-15 Plan of Interchange #2

(3) Interchange #3

In the Feasibility Study, the type of IC#3 between shamvugonj highway(R370) and the Kewatkhali road is determined as grade separation interchange with Ramp-A and Ramp-B. In accordance with the results of the feasibility study, the Ramp-A and Ramp-B alignment optimized to minimize bridge length and houses affected by the Kewatkhali road on the Detailed design.

Table 3-7 Applied geometric value for IC#3

IC type	Design speed	Applied minimum horizontal radius	Applied vertical slope	Lane width
Grade separation interchange	60km/h	160m	3.0%	2 lanes@3.65m=7.5m SMVT 5.5m

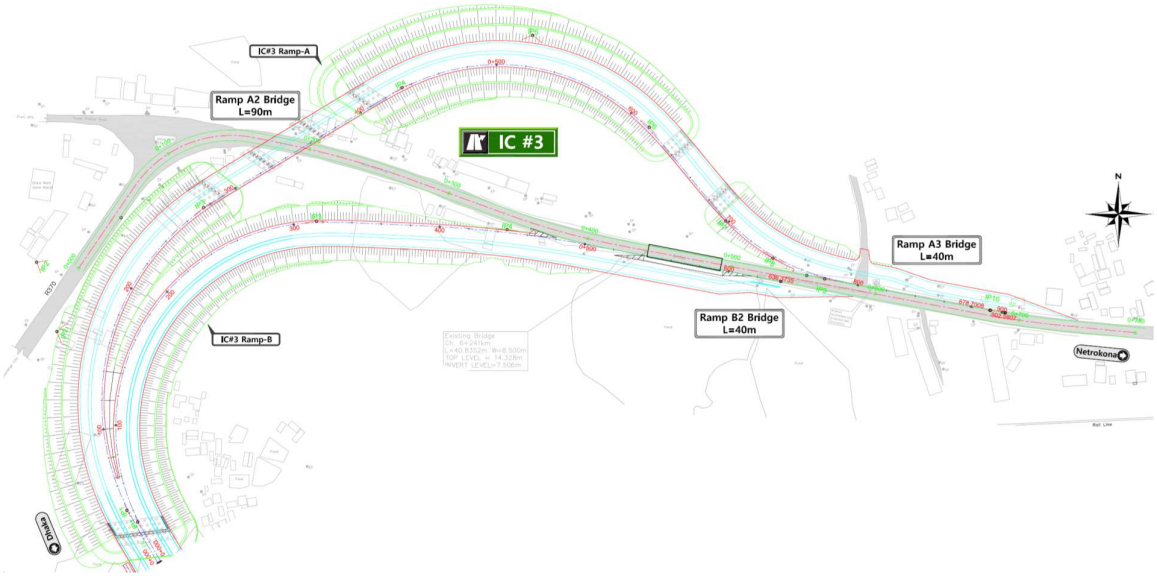

Figure 3-16 Plan of Interchange #3

(4) Entry & Exit intersection #1 and #2

The Kawatkhali road is a road where four high-speed lanes and SMVT lanes used by the low-speed vehicle separated by a divider. Entry & Exit intersection are installed on the left and right sides of the IC#3 to be moved from the high-speed lanes to low-speed lanes. Through the Entry & Exit interaction #1 and #2, high-speed vehicles can move to residential areas around the Kewatkhali road.

Figure 3-17 Plan of Entry & Exit intersection #1

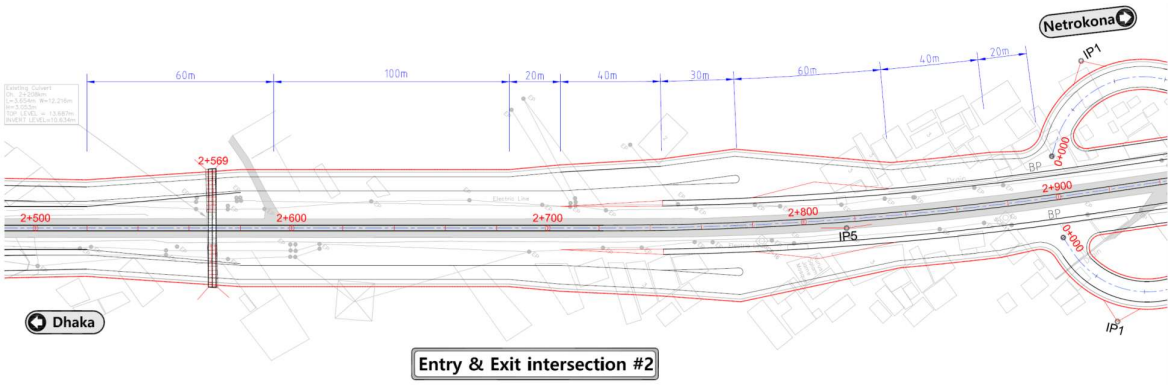

Figure 3-17: Plan of Entry & Exit intersection #2

Table 3-13 List of Interchange and Intersection

Division	Location	Description
IC #1	Sta. 0+15 ~ Sta.0+765	Overpass with 2 lanes
Entry & Exit intersection #1	Sta. 0+520 ~ Sta.0+890	Connect with 4 lanes and SMVT lane
IC #2	Sta. 1+837~ Sta. 2+593	Overpass with 4 lanes and 4 SMVT
Entry & Exit intersection #2	Sta. 2+520~ Sta. 2+895	Connect with 4 lanes and SMVT lane

IC #3	Ramp-A and Ramp-B on ending section	Connection Ramp of width 17.9m

3.4.4 Culverts and drainage

Drainage, both on the pavement and from the sides and subsurface, is an important design consideration. Inadequate drainage can lead to high maintenance costs and adverse operational conditions.

Drainage facilities on roads are important to ensure the preservation of road pavement and embankment, and the installation of suitable surface drainage facilities for the road, in particular, determines the stability of road pavement and embankment.

3.4.4.1 Culverts

There are 7 nos. of exiting box culvert under this project. 6 nos. of those box culverts are proposed to be extended on both side for providing 6-lane carriageway facility and 1 box culvert (at chainage 0+692km) is proposed to be newly constructed at the same place after demolishing existing structure for providing adequate clearance required as per hydrological consideration. In addition, two new skew type box culvert is proposed at chainage 2+235km and 3+108km as per hydrological requirement. A summary of culvert is shown on the following table:

Table 3-8 Proposed Culvert Details

No.	Chainage (km)	Existing / Newly Proposed	Skew/ Straight	Span Arrangement (Nos. of Vent × Clear Opening Width, S (m) × Clear Opening Height, H (m)	Recommendation
1	00+692	Existing	Skew (30˚)	3 × 6.00 × 6.00	New culvert to be constructed at the same position after demolishing existing culvert. Proposed barrel length = 55.0m
2	00+858	Existing	Straight	1 × 3.05 × 2.88	Extension on both Side is proposed. Left Side proposed extension length = 20.0m Right Side proposed extension length = 12.0m
3	01+357	Existing	Straight	1 × 3.05 × 2.88	Extension on both Side is proposed. Left Side proposed extension length = 15.0m Right Side proposed extension length = 15.0m

4	01+601	Existing	Straight	1 × 3.05 × 2.88	Extension on both Side is proposed. Left Side proposed extension length = 18.0m Right Side proposed extension length = 24.0m
5	01+921	Existing	Straight	1 × 3.06 × 2.788	Extension on both Side is proposed. Left Side proposed extension length = 12.0m Right Side proposed extension length = 20.0m
6	02+235	Newly proposed	Skew (20˚)	1 × 3.00 × 3.00	New skew bridge is proposed. Proposed barrel length= 48.0m
7	02+569	Existing	Straight	1 × 3.06 × 2.788	Extension on both Side is proposed. Left Side proposed extension length = 20.0m Right Side proposed extension length = 20.0m
8	03+108	Newly proposed	Skew (45˚)	1 × 3.00 × 3.00	New skew bridge is proposed. Proposed barrel length= 90.0m
9	03+253	Existing	Straight	1 × 3.06 × 2.788	Extension on both Side is proposed. Left Side proposed extension length = 25.0m Right Side proposed extension length = 28.0m

For the extension of the culvert 300 mm long φ16 mm dowel bar is proposed as deboner. In between joint of existing and proposed culvert 10mm thick mastic packing is proposed.

3.4.4.2 Drainage design of the Urban section

Urban section(sta.0+000~3+500) is an area that has already been urbanized, and In the near further it will be more urbanized than now after constructing the Kewatkhali road. Surface drainage facility is a drainage facility designed to ensure traffic safety by smoothly handling rainwater on the road in case of rain. Drainage facilities applied to the Kewatkhali road are saucer drain, road curb, rainwater drain and culvert. Rainwater fall on the road & that rainwater can be drained through a box culvert installed in the transverse direction.

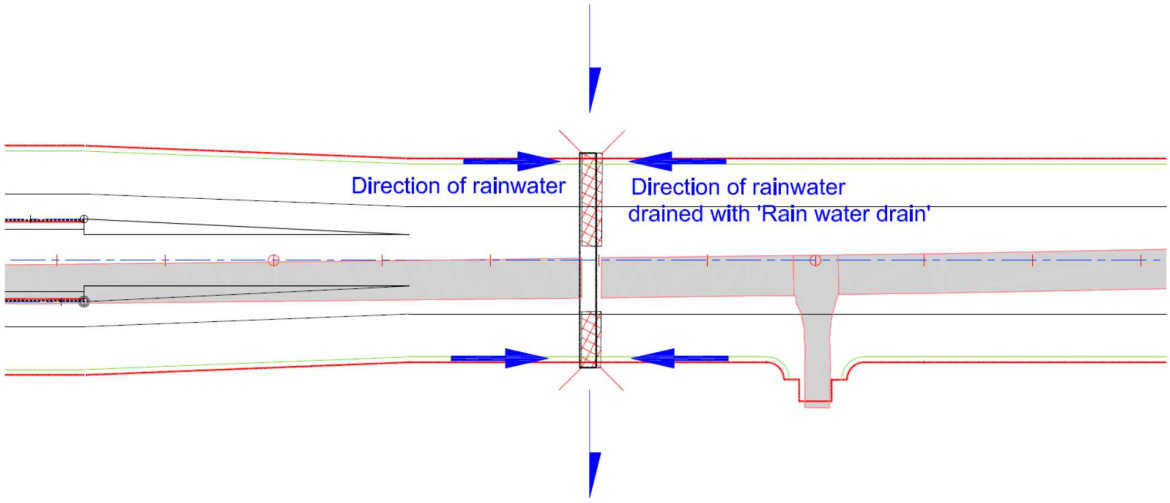

Figure 3-18 Concept of Drainage design of the Urban section

3.4.4.3 Drainage design of Rural section

Since the Rural section (Sta.3+500~Ending point) is a section which passing through a plain area. surface drainage facility of longitudinal direction is not considered separately. However, drainage structures of the lateral direction are installed to prevent the excavation of embankment in the section where the road surface water collected in the rainy season and the section where the super-elevation was applied. At the lowest point of concave, a T-shaped collecting ditch was installed and an L-type collecting ditch installed as 25m interval. The drainage concept on rural section is as follows.

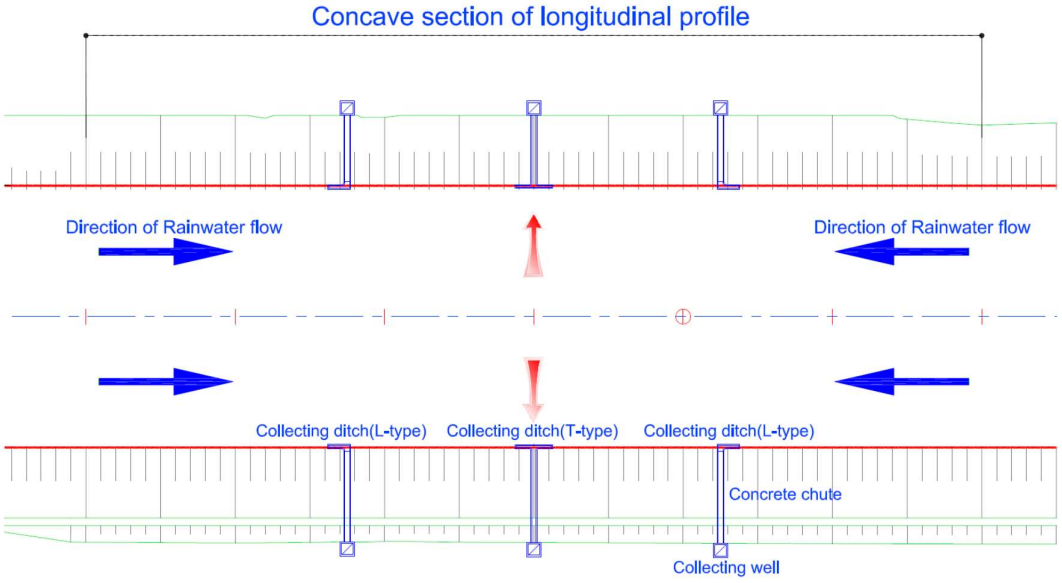

Figure 3-19 Concept of Drainage design of Rural section

3.4.5 Alternative Drainage Plans to Reduce Contamination of The Brahmaputra River

The purpose of the drainage system installed on the bridge is to maintain the safety of vehicle operators and the durability of the bridge deck by smoothly draining the bridge deck water caused by rainwater. Therefore, the bridge drainage facility applied to this Project has been designed to faithfully meet this purpose.

The bridge deck drainage system of the Kewatkhali Main Bridge crossing the Brahmaputra River is shown in Figure 3-20 below.

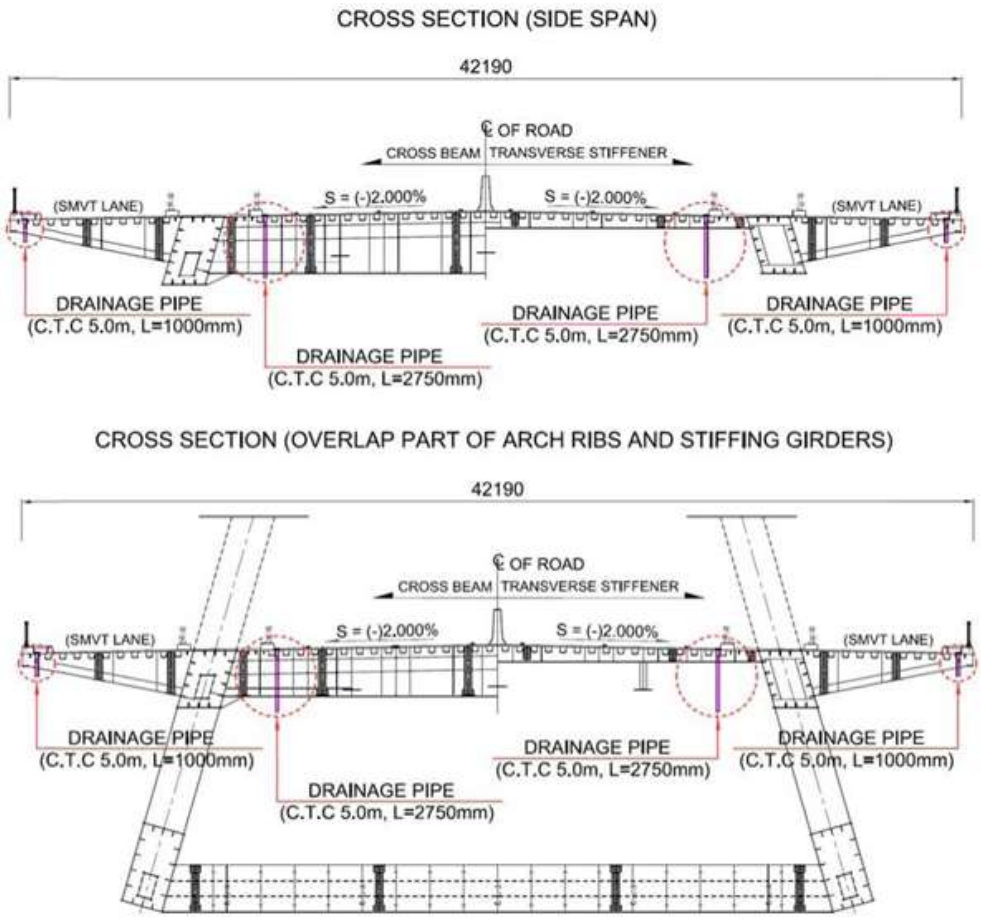

Figure 3-20 Current Drainage Plan of the Kewatkhali Main Bridge (1)

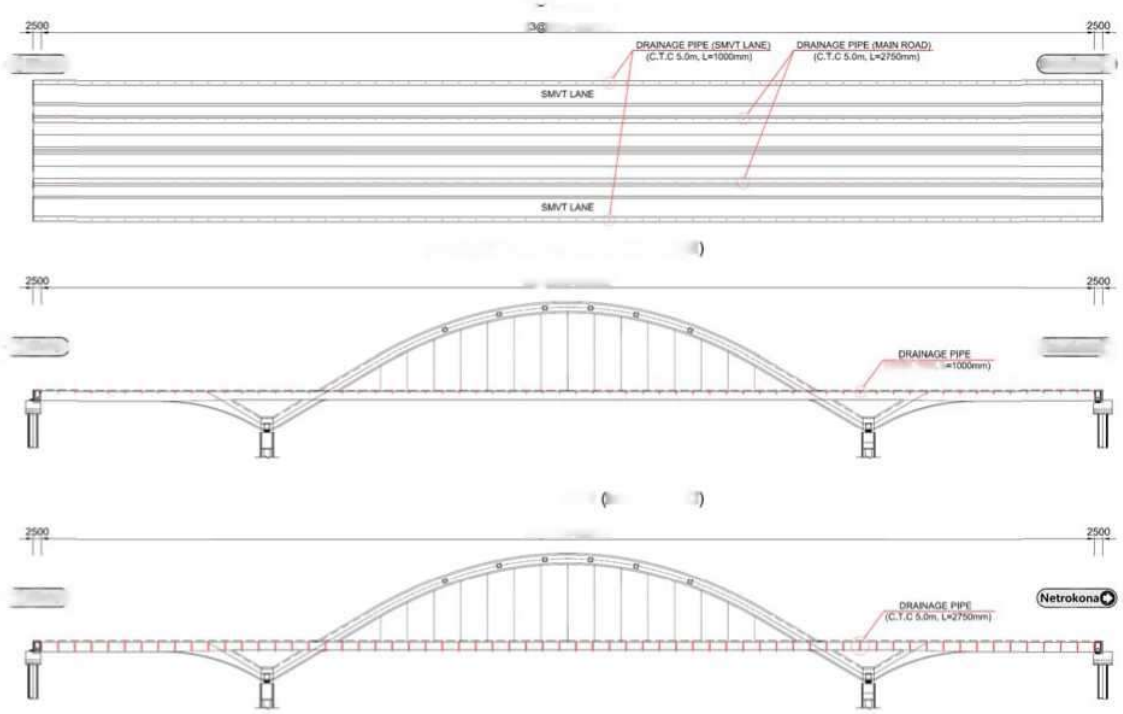

Figure 3-21 Current Drainage Plan of the Kewatkhali Main Bridge (2)

The reason for applying the method shown in Figure 3-20 and Figure 3-21 is that it was judged to be the best in terms of constructability, maintainability, and Economic efficiency, as well as draining rainwater most rapidly during rainfall.

3.4.5.1 Review on alternative drainage system

As environmental impact is also one of the primary concerns for the project, the scenario of the contamination of the Brahmaputra river due to leaking pollutants have been discussed during the technical meeting with the Client and AIIB. After that, the consultant has proceeded to review alternatives to the requirements. It was the introduction of Non-point source pollution reduction system that conducted the review first.

The above mentioned Non-point source (NPS) pollution is pollution resulting from many diffuse sources, in direct contrast to point source pollution which results from a single source. Non-point source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrological modification (rainfall and snowmelt) where tracing pollution back to a single source is difficult.

The Non-point Source Pollution Reduction System applied to the Bridge refers to the facility that treats the first flush occurring on the bridge deck's surface. The first flush refers to the high concentration of rainwater including pollutants and sediment on the ground that fall simultaneously with precipitation from the atmosphere at the beginning of the precipitation phenomenon.

The most easily accessible alternative is to introduce a Filter Medium Replacement type as shown in Figure Figure 3-22 one of the Non-point source pollution reduction system for bridges, in addition to the currently planned drainage system.

This method means a facility which is inserted into the bridge catchment and has the advantage of being very simple to install. However, in order to install the filter, the size of the catchment hole must be increased, which means that the hole in the deck to be drilled becomes larger. When the deck's hole is enlarged, interfering members may occur, and stress concentration may occur, which adversely affects the structure. In addition, if the filter becomes clogged over time, it loses its

function, so it has to be replaced periodically. As a result, it is very disadvantageous in terms of maintenance and thus its use is rapidly decreasing in recent years.

Figure 3-22 ALT1: Filter Medium Replacement Type

Therefore, the consultant then has proceeded to review the other alternatives. As a result of reviewing several alternatives, it was judged that the most realistic alternative is a combination of the induction drainage treatment method at the beginning and end of the bridge and Non-point source pollution reduction system. This alternative is to connect the currently planned vertical drainage pipe with a longitudinal drainage pipe to induce drainage to the pier locations of P10 and P13, which are the starting and endpoints of the Kewatkhali main bridge, and then to install a Non-point source pollution reduction system at the end of the longitudinal drainage pipe. The schematic diagram for this is shown in and Figure Figure 3-23

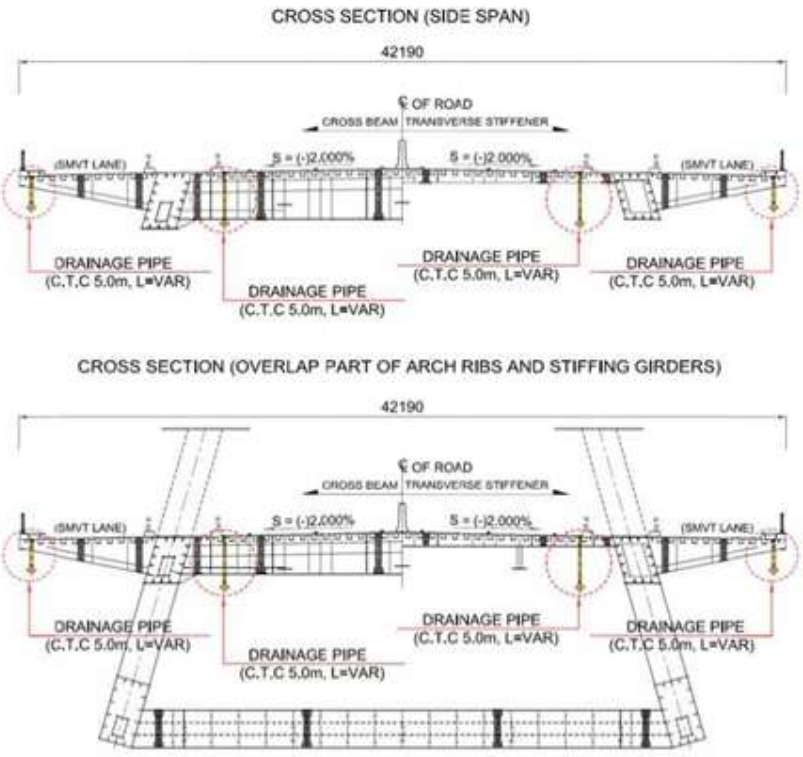

Figure 3-23 ALT2: Induction Drainage Treatment Method of the Bridge (1)

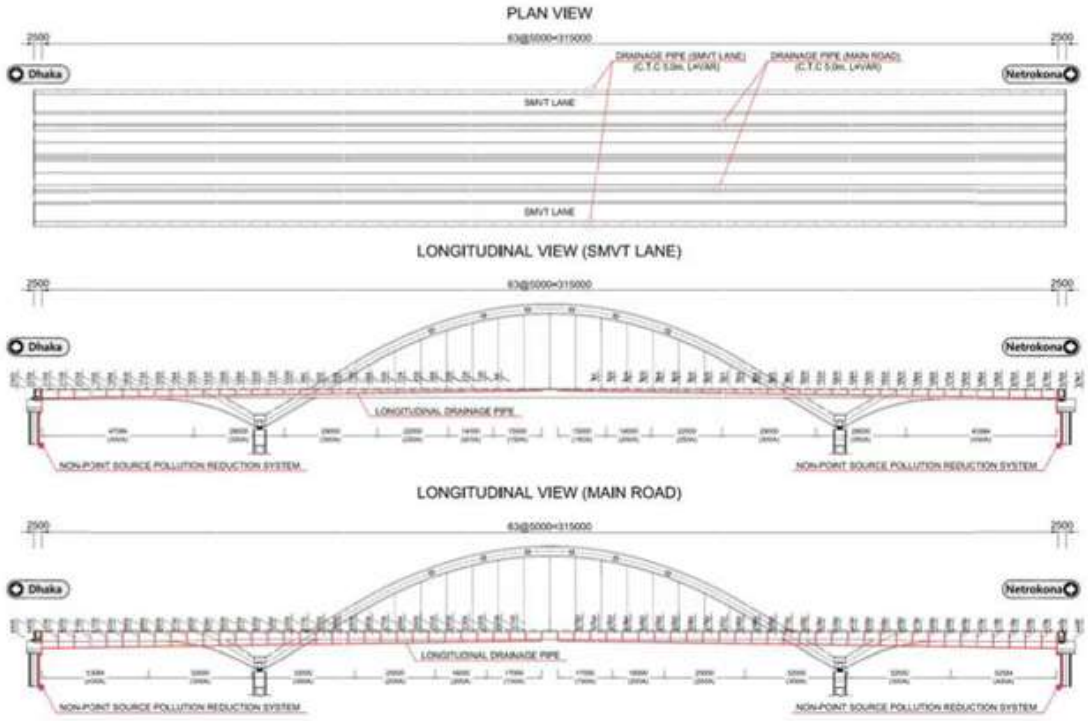

Figure 3-24 ALT2 : Induction Drainage Treatment Method of the Bridge(2)

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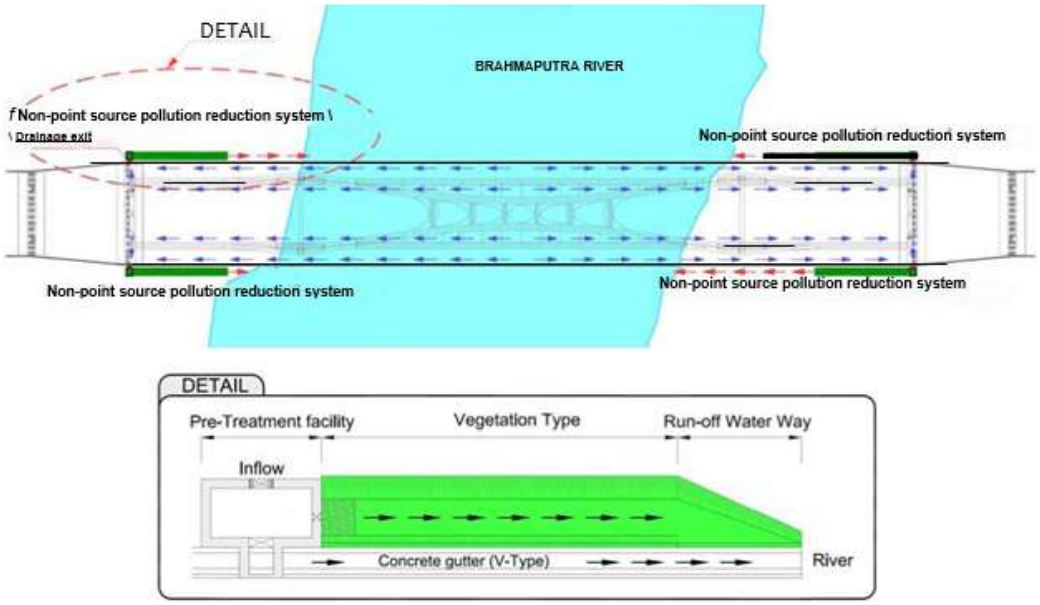


Figure 3-25 ALT2: Installation-location of Non-point source pollution reduction system and

Drainage Channel Plan

The induction drainage treatment method at the beginning and end of the bridge requires a lot of initial construction cost because the vertical drainage pipe must be connected with a longitudinal drainage pipe, and construction is very difficult because it must be installed on the bridge over the river. It is estimated that approximately 1.3 million USD (11 Crore Taka) will need to be added over compared to the current drainage plan, even if it excludes the Non-point, Pollution Source Pollution Reduction System and Drainage Channel. Another disadvantage of this method is that it not only hinders the aesthetics of the Bridge, as shown in Figure 5-89, but it is difficult to maintain its function as a drainage pipe if the vertical drainage pipe is blocked by foreign substance or sediment or the discharge area is reduced.

Therefore, drainage pipes can maintain their function only when maintenance is performed such as removal of sediment and replacement of old drainage pipes. Also, because it is a structure that is vulnerable to wind load and earthquake, it should be checked frequently.

Figure 3-26 Example of Bridge Induction Drainage Treatment Method

Non-point source reduction facilities applied to the alternative are largely divided into Natural Type Figure 3-27 and Device Type Figure 3-28. The pros and cons of the two types are clear.

First, the natural type has the advantage of being able to keep it close to the natural state before road construction. However, it is required a large area at the time of installation, and if it is not managed continuously, it can become a habitat for pests such as mosquitoes and has a disadvantage that serious odors may occur, as shown in Figure 3-30. Also, it has a disadvantage of low confidence in removing pollutants.

The device type has the advantage that the required installation area is small and the pollution reduction effect is excellent, but it has disadvantages in terms of maintenance, such as a decrease in treatment efficiency due to clogging if the filter material is not replaced periodically as shown in Figure 3-30

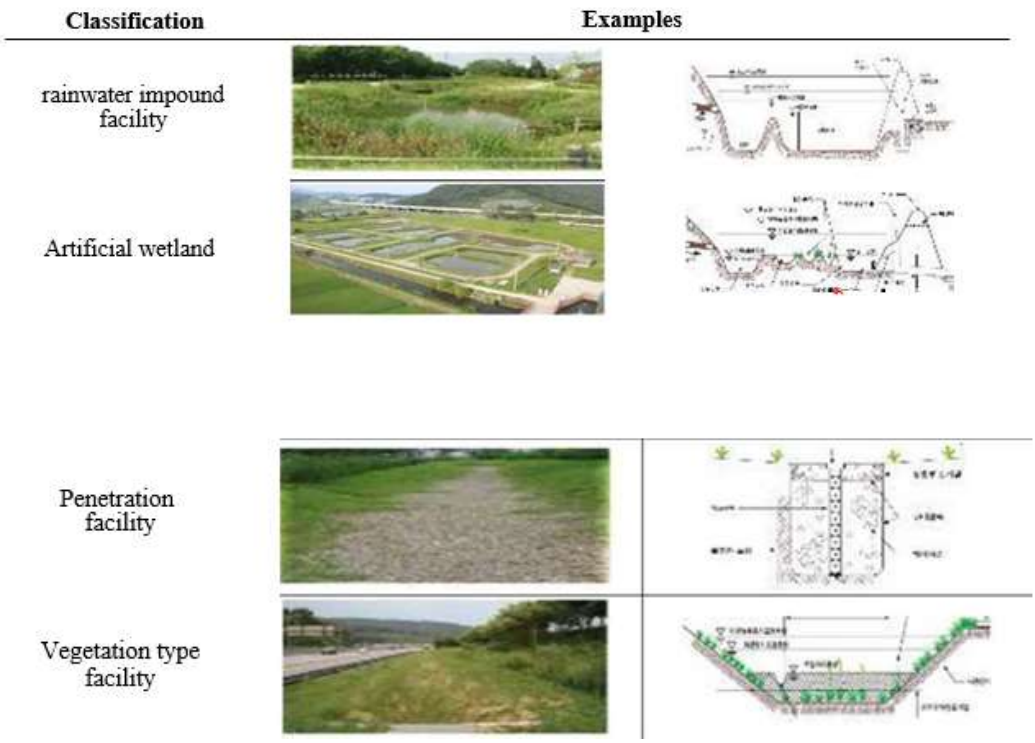


Figure 3-27 Non-point source pollution reduction system: Natural Types

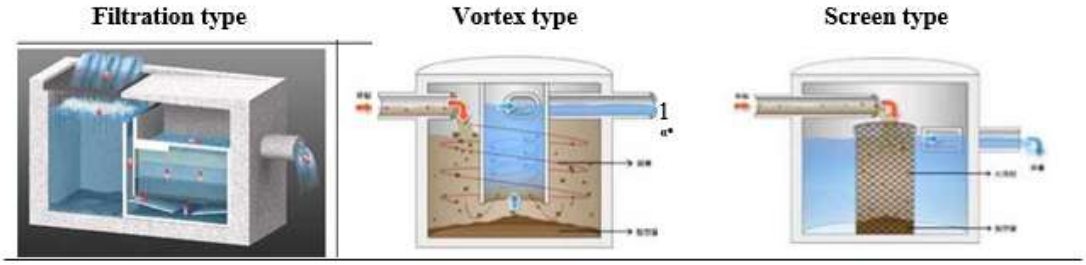


Figure 3-28 Non-point source pollution reduction system: Device Types

Figure 3-29 Examples of poor maintenance of Natural Types

Figure 3-30 Examples of poor maintenance of Device Types

Conclusion

As described above, it was reviewed whether there are alternatives to the currently planned bridge drainage plan to reduce contamination on the Brahmaputra River. As a result of reviewing two alternatives that are likely to be applicable, the applicability is questioned when considering the local conditions in Bangladesh.

It was concluded that it was very difficult in reality to satisfy both conditions of rapid drainage capacity and pollutant reduction effect. In the case of ALT1 and ALT2, if periodic and continuous maintenance is not performed, not only the basic function of the drainage system but also the function of reducing non-point pollutants may be lost, leading to the worst result.

It is also true that some experts are skeptical about the pollutant reduction effect of Non-point source reduction facilities. The two alternatives were considered to be more disadvantageous in terms of constructability, economic feasibility, functionality, aesthetics, and maintenance compared to the original plan.

On the other hand, even if an oil spill accident occurs due to a vehicle collision, which is the worst situation that can occur on the Bridge, it is reviewed that it is not an efficient method to treat it through a 'Non-point source reduction system' considering its treatment capacity. In this case, it is judged that removing contaminants from the bridge immediately after an accident can be the most realistic way to reduce the occurrence of secondary river pollution.

Therefore, as a result of the comprehensive consideration of various conditions, the consultant recommends the currently planned river drainage method as the most efficient' method.

3.5 Construction Methods

3.5.1 Main bridge

Since the side spans of Kewakhali Main Bridge can be ground-based construction at the low water level season, the relatively easy installation is expected by adjusting the timing of the construction. However, since the main span area is located on the water at all times, they should review and select not only environmental factors but also many aspects such as ship passage and environmental pollution. Also, dredging of the Old Brahmaputra River will be conducted as part of Bangladesh Inland Water Transport Authority's (BIWTA) overall plan, but it will not be part of the project. Considering these conditions, the applicable construction methods of arch bridges are as follows.

3.5.1.1 Construction Methods for Superstructure

There are two methods, i.e. small block construction method and large block construction method for erection of bridge arch.

(1) Small Block Construction Method using Temporary Bent

It is a construction method to transport and to install small block members assembled near the site using barge or crane after erecting the bents at the construction site.

Figure 3-31 Small block construction method used in arch bridge

This method is suitable when the depth of water is shallow, and the flow is weak, or if the temporary bent can be installed under the bridge. The proper bearing capacity of the temporary bents shall be ensured when this method is applied. If the arch ribs are of the type Basket Handle, the working radius for the arch ribs construction shall be increased, so the capacity of the crane shall be carefully considered. As the arch ribs of the proposed bridge are inclined, so that horizontal forces are applied to the temporary bent, safety review of the temporary bent is essential considering this load. In addition, temporary bridges for the crane work shall be installed on both sides of the bridge. This method is limited in the lateral clearance of the temporary bent during the construction, so there is a restriction on the passage of vessels.

(2) Large Block Construction Method

This construction method is widely used when the bridge is built in the ocean or river. The entire bridge structure is lifted by the jack-up system and transported by barge to the final installation site.

In this construction case, proper water depth is must be ensured to carry barge. This method can be classified into two systems according to the lifting method which is Barge-Lifting System and The Lifting System on the bridge deck. The Barge-Lifting system is a method of installing the jacking tower on a barge, placing the superstructure of the bridge on top of the jacking tower, and moving it to the installation position to jack up the superstructure. The barge must support both the weight of the superstructure and the jacking tower, so there is no need for much reinforcement on the superstructure. However, because this lifting equipment are installed on it, it is required as a large size. A barge can be made onsite and can be adjusted to its draft by calculating the load.

In addition, if there is a shortage of its draft, it is possible to dredge only some of the required area for the movement of it at the site to secure the required depth of water. This method does not require a bent or a temporary bridge at the bottom of the bridge, and the built superstructure of the arch center is installed in batches, thus minimizing the installation time and not restricting the passage of vessels. However, it is the most expensive construction method.

The Lifting System on the bridge deck is a method for installing and lifting jacking devices on the bridge deck at the installing location. The effect of the flow or wave of water is low when the block lifting. The stability is excellent when transporting large blocks by barge. However, a lot of stiffeners are required for the installation of lifting devices on the bridge deck. It is also possible to build a barge on-site, as with the barge lifting system. It doesn't require a particular temporary bent or temporary bridge under the bridge, and the fabricated arch structure is installed in batches, thus minimizing the installation time and not restricting the passage of vessels. The construction cost is somewhat lower than that of the barge lifting system.

Both method, Small Block Method & Large Block Method are widely used for the erection of the Arch Bridge. In the Small Block Method case, the restriction on the passage of vessels is inevitable. On the other hand, the Large Block Method has a water depth restrictions of operating the floating barge system. Thus, after a monsoon season, having enough water depth for operating the floating barge system, is recommended the most right time for the erection of the steel arch bridge.

3.5.1.2 Construction for bridge piers

According to the detailed design of the bridge, there will be two piers constructed on the mud flat of the Old Brahmaputra River. Cofferdams will be adopted for the construction of these two piers.

A cofferdam is a temporary structure designed to keep water and/or soil out of the excavation in which a bridge pier or other structure is built.

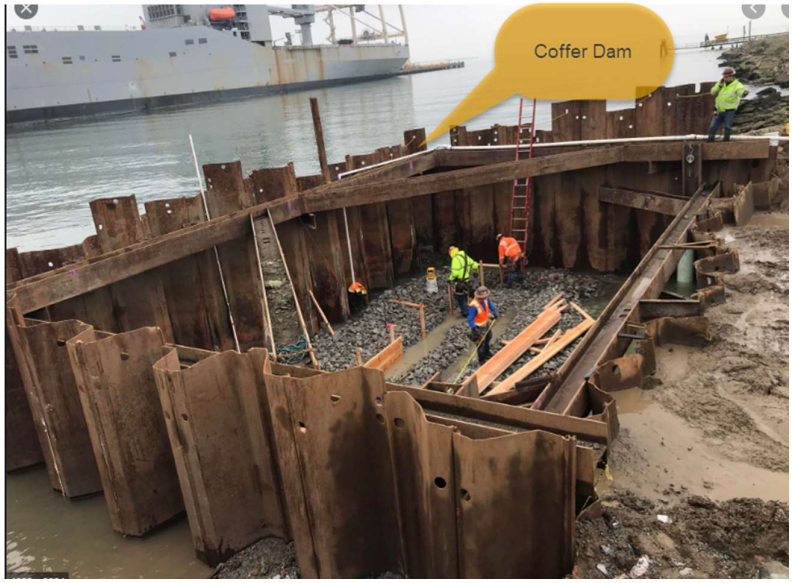


Figure 3-32 Cofferdam in which bridge pier is constructed

3.5.2 Excavation method

Excavation methods for installation of footing can be generally classified into three methods: Open Cut, H-pile and Sheet Pile. Excavation method for each section is decided by considerations of excavation depths, ground water levels, subsurface conditions and site spaces. The most efficient methods were determined in consideration of the variable site conditions. The excavation methods by conditions are as follows.

Category	Open Cut	Temporary Retaining Wall	
		H-Pile	Sheet Pile
Design Concept			
	• Forming stable state slope without support	• Forming retaining wall by inserting H-piles simultaneously with excavation	• Forming retaining and cut-off wall by inserting sheet simultaneously with excavation
Advantage & Dis advantage	• More easy and fast construction with low cost • Can be required a wide space when it is applied to soft ground or deep excavation	• Can be less expensive than sheet pile method • Can be effectively used in case of low groundwater level • Cause noise and vibration	• Can be quite efficient in cutoff seepage water • The highest cost • Cause noise and vibrationt
Application	• Stable soil • Wide space	• Soft soil • Narrow space • Low groundwater level	• Soft soil • Narrow space • High groundwater level

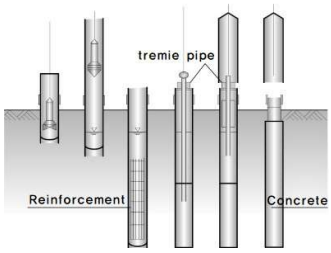
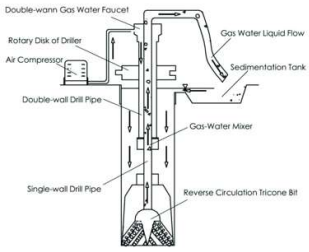
Figure 3-33 Excavation methods that can be applied in the project

3.5.3 Construction Method of Cast-in-Place Pile

The result of the geotechnical investigation shows that soft clays or loose sandy soils are distributed in the upper part of the ground. "All casing" method is recommended to prevent the collapse of the walls in the ground and to minimize the penetration of groundwater during pile construction.

The comparison of excavation method for the construction of cast-in-place piles is as follows.

Table 3-9 Comparison of Cast-In-Place Pile Construction Method

Category	BENOTO	ALL CASING	RCD
Design Concept			

Equipment	•Oscillator All Casing Excavator •Crawler Crane • Hammer Grab • Casing Crown with Bit • Casing Tube	• Large-scale All Casing Excavator • Crawler Crane • Hammer Grab • Casing Crown with Bit • Casing Tube	• RCD Excavator • Crawler Crane • Hammer Grab • Casing Crown with Bit • Casing Tube, Stand Pipe • RCD Bit, Vibro Hammer
Method	•Press the casing to which shoes are attached by turning it from 15 ° to 25 ° from side to side with the Oscillator Excavator and excavate the inside soil with hammer grab •Rocking 15°- 25°	•Rotate the casing 360 degrees to which casing crown bits are attached by Large-scale All Casing Excavator while pressing the casing and excavate the soil inside the casing with hammer grab	•Stabilize excavation wall by inserting stand pipe into ground with Vibro Hammer •Excavation with RCD Excavator •The underground walls are stabilized with high pressure circulation water
Ground Applicability	•General soil and weathered rock	•All layers such as soft ground, boulder, all rocks	•General soil and rock
Construction Depth	30~40m	50~130m	60~70m
Advantage & Dis advantage	•Applicable up to weathered rock •The rock type excavation method enables excavation of the sand laver, boulder and all stone layers. •Since the hammer grab is preceded, there may be a case where the surrounding ground is settled due to heaving or boiling in the borehole. .	•High applicability to the ground (all stones and rocks are also available) •Good verticality and fast construction speed •Large equipment and expensive construction cost •Favorable for heaving and boiling as casing precedes	•Excellent rock excavation ability by using Percussion RCD excavator with special bit for rock excavation •Water pollution when using Bentonite solution •Difficulty in quality control of concrete due to Bentonite solution
Applicability	•Cast-in-Place Pile tips shall be placed on the dense sand layer with an N value of more than 50 by penetrating through the upper soft clay or loose sand layer. •"All Casing" method is recommended to prevent the collapse of the walls in soft clay layers or loose sandy soil layers and it can minimize the effect of groundwater during pile construction.		

3.5.4 Construction Procedures of Cast-in-Place Pile

This method is used in soils or rocks in which caving or excessive deformation is likely to occur when the borehole is excavated. The sequence of construction is shown in . and may be explained as follows:

Step 1. The excavation procedure is initiated as in the case of the dry method of construction. See Figure 3-34**(a)**.

Step 2. When the caving soil is encountered, bentonite slurry is introduced into the borehole. See Figure 3-34 **(b)**. Drilling is continued until the excavation goes past the caving soil and a layer of impermeable soil or rock is encountered.

Step 3. A casing is then introduced into the hole. See Figure 3-34 **(c)**.

Step 4. The slurry is bailed out of the casing with a submersible pump. See Figure 3-34 **(d)**.

Step 5. A smaller drill that can pass through the casing is introduced into the hole, and excavation continues. See Figure 3-34 **(e)**.

Step 6. If needed, the base of the excavated hole can then be enlarged, using an under reamer. See Figure 3-34 **(f)**.

Step 7. If reinforcing steel is needed, the rebar cage needs to extend the full length of the excavation. Concrete is then poured into the excavation and the casing is gradually pulled out. See Figure 3-34 **(g)**.

Step 8. Figure 3-34 **(h)** shows the completed drilled shaft.

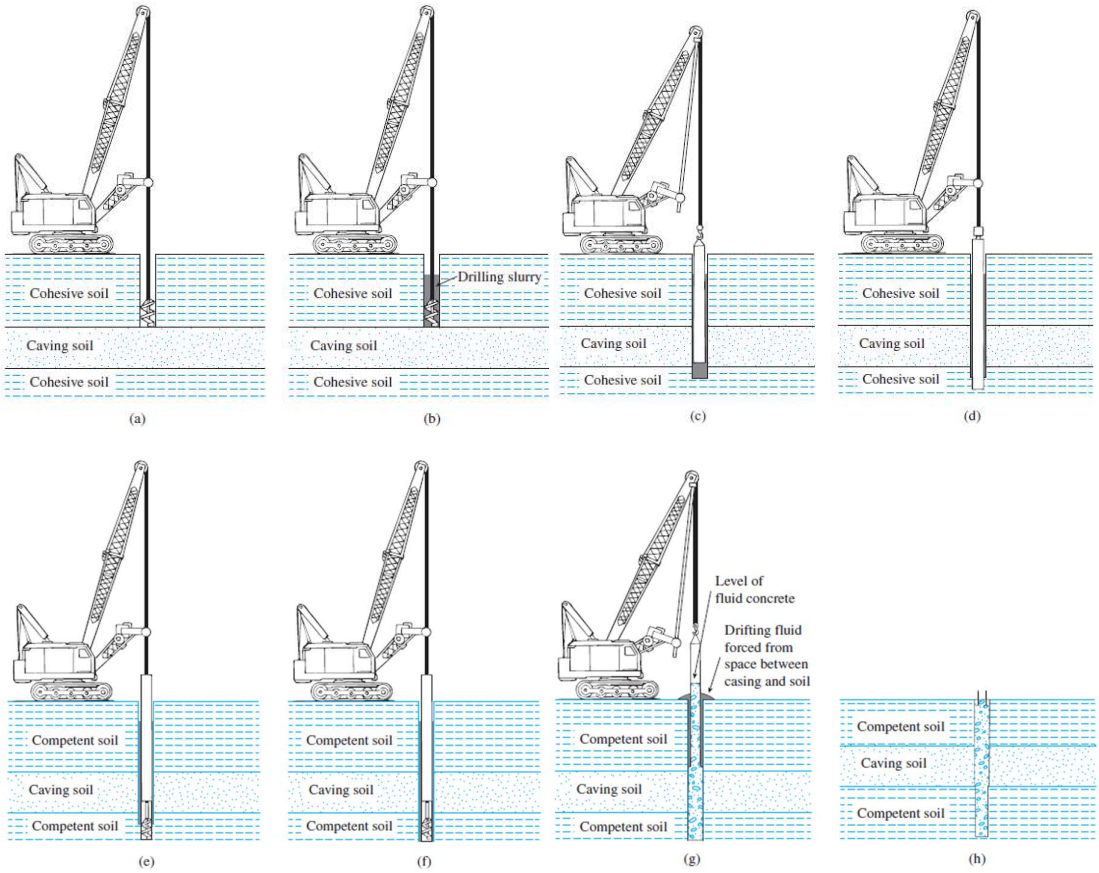


Figure 3-34 Casing Method of Construction

3.6 Construction Activities

3.6.1 General

During the construction phase the following activities will be undertaken:

- Implementation of the Resettlement Plan. A Resettlement Plan is included in the SIA. The PIU will implement the plan and acquire the land before the commencement of the construction works at any part of the site.
- Site Clearing Works - The Works include the following site clearing works within or adjacent to the Road Project, in accordance with the drawings or instructions of the Engineer:
  - Clearing and grubbing.
  - Removal and disposal of traffic signs, sign posts and their foundations.
  - Demolition, removal and disposal of existing structures if any including foundations, riverbank and waterway protection works.
  - Demolition, removal and disposal of existing culverts, inlet and outlet structures, headwalls, concrete drains, channel lining, and erosion protection works.
  - Removal of and any other natural or artificial objects within the MKBIP.
  - Removal and disposal of all vegetation and debris within the designated limits.
- Relocation of Existing Services - The Works include the relocation of all services affecting the construction of the MKBIP Road. The services include the following:
  - water mains
  - overhead electric supply lines
  - gas pipelines - underground telephone cables
- Construction Activities- The main construction phase aspects are described in detail below.

3.6.2 Bridges and Interchanges

The construction of the new bridges and interchanges includes but is not limited to the following parts of the structures and associated works:

- Foundations and bridge piers.
- Substructure including bridge bearings.
- Superstructure, including erection of bridge arch, construction of expansion and deformation joints and footpaths.
- Small temporary jetty to bring construction materials.
- Movement of barges in the river for transporting materials and structures.
- Deck pavement including hydro isolation, drainage, hand railing, and conduits for services.
- Approach slabs.
- Slope treatments in front and around the abutments.
- Construction and maintenance of traffic detours.
- Scour and erosion protection of the waterway areas and river bank protection upstream and downstream of the bridge crossing, and removal of old foundations and substructure from the waterways.
- All necessary and incidental items required for a complete bridge.
- All new and widened bridges will be designed for the life expectancy of 100 years.
- Oil and grease interceptor tanks.

3.6.3 Culverts

Project works include the construction of culverts, including inlet and outlet structures and associated works in accordance with the Specification. The scope of the cross drainage works includes:

- Complete replacement of existing culverts which are old, structurally deficient or undersized;

- Extension of existing culverts which are of adequate design and in good condition;
- Construction of new culverts at locations where no cross-drainage structure existed before;
- Cleaning of existing culverts which are partially or completely silted;
- Miscellaneous repair of the existing culvert joints, headwalls, wing walls, and scour and erosion protection works;
- Construction of new scour protection and channel lining works.

3.6.4 Other Drainage Structures

Surface runoff from the carriageway and all other pavements, and any cut and embankment slopes must be discharged through longitudinal drains designed for adequate cross section, bed slopes, invert levels and the outfalls. The works include construction of the drainage system components in urban and rural areas according to the types, dimensions, classes and material requirements for this work

3.6.5 Earthworks

The Works include the following types of earthworks necessary for the construction of the Project Road and all associated works:

- Removal of topsoil.
- Construction of subgrade.
- Excavation and removal of the existing pavement materials and the existing road embankment.
- Removal and replacement of unsuitable materials.
- Structural excavation.
- Excavation for the construction of side drainage and cross-drainage works.
- Excavation for the removal and relocation of the existing utilities.
- All backfilling necessary for the construction of bridges, retaining walls or other earth retaining structures, cross drainage structures and associated works, side drains and erosion protection work.
- Preparation of beddings and filters for all structural, cross drainage, side drains or pavement works.
- Excavation, filling or backfilling necessary for the execution of any other incidental works.

3.6.6 Removal of Asphalt

The Contractor shall remove the existing bituminous pavement layers and stockpile this material at locations that will be specified by the PIU and instructed by the Engineer. The asphalt will be re-used, where practical, for access roads and temporary roads, after which it will be re-used for shoulder material.

3.6.7 Batching and Asphalt Plants

The materials for pavement will be produced in batching plant and asphalt plant. The contractor shall utilize existing batching plants/facilities as much as possible. If there are no available facilities in the project area that meet the need of this project, the contractor will select proper location and build new batching and asphalt plants.

3.6.8 Camps and Storage Areas

3.6.8.1 Construction Camps

Camp sites will be selected keeping in view the availability of an adequate area for establishing camps, including parking areas for machinery, stores and workshops, access to communication

and local markets, and an appropriate distance from sensitive areas in the vicinity. The final locations of the camps will be selected by the Contractor after the approval from the Engineer.

The area requirement for construction camps will depend upon the workforce deployed and the type and quantity of machinery mobilized. For example, the camps may include rock crushing plant and concrete batching facilities. In view of the area required, it will not be possible to locate campsites within the MKBIP area and the contractors will have to acquire land on lease from private landowners. The construction camp will also have facilities for site offices, workshop and storage yard, and other related facilities including fuel storage.

The Contractor will provide the following basic facilities in the construction camps:

- Safe and reliable water supply.
- Hygienic sanitary facilities and sewerage system.
- Treatment facilities for sewerage of toilet and domestic wastes
- Sickbay and first aid facilities.

3.6.8.2 Storage Areas

Temporary storage areas will be required for certain activities, such as the storage of sand and gravels and construction equipment. These storage areas may range in size from anything between 50 m^2 to more than a hectare. The precise locations of these temporary facilities are not known at this stage. The final locations of the storage areas will be selected by the Contractor after the approval from Engineer.

4 CHAPTER: ANALYSIS OF PROJECT ALTERNATIVES AND ASSOCIATED FACILITIES

4.1 Introduction

The project has been considered and investigated for several alternatives to reduce the environment and social impacts. The alternatives assessed were not limited to environment and social aspects, but assessment also included the technical and financial impacts of different options. This section presents an assessment of "no project" scenario, types of pavement and design of interchanges. The conclusions have been incorporated into the project design and implementation arrangements

4.2 Alternative 0: "No-project" Scenario

Mymensingh Kewatkhali Bridge is part of the Dhaka-Mymensingh-India border corridor, which is strategically important for both regional and local connectivity. Three land ports have been developed along the Indian border in Mymensingh Division, namely Nakugaon Land port in Sherpur district, Gobrakura Land Port and Haluaghat Land Port in Mymensingh District. Traffic from the three land ports must cross Old Brahmaputra River at Mymensingh City in order to reach Dhaka and other parts of Bangladesh. As with other land ports on the northern border with India, the main import items are coal, limestone, boulder, stone, glass sand, fruits and raw hides. Export items are food and beverage items, plastic goods and bricks. Given the proximity to the Indian border (around 60-80 km from Mymensingh to the three land ports), the road passing through Mymensingh serves international trade by carrying the major import/export items from/to India.

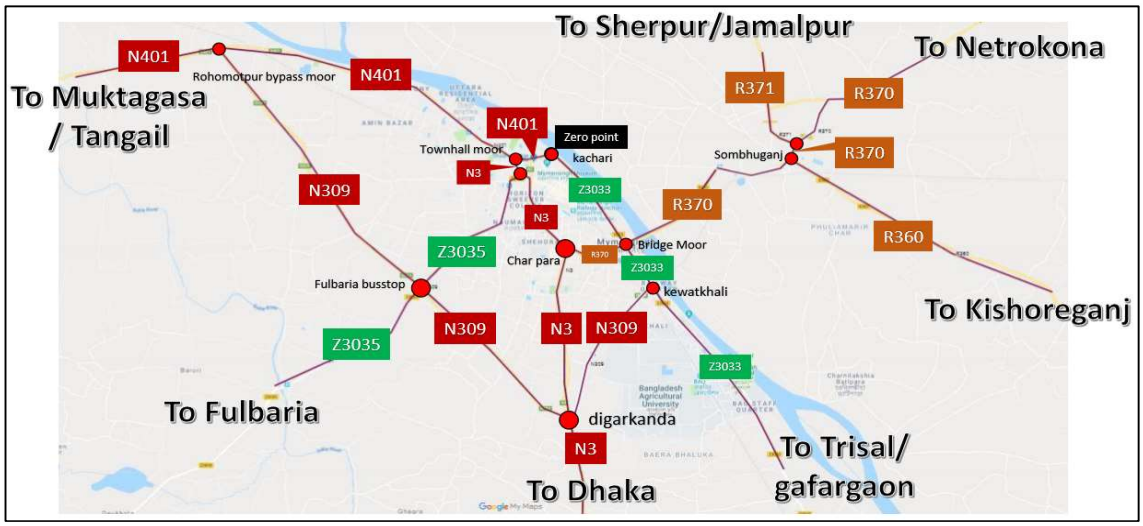


Figure 4-1 Proposed Project Transportation Network Diagram

The population of the city is more than four lakhs (0.4million). The Old Brahmaputra river flows along the north side of Mymensingh city. Shambhuganj is situated on the other side of the Old Brahmaputra, connected by the Shambhuganj Bridge with the city center area. The

Shambuganj Bridge is a two-lane bridge 455 meters in length by 11 meters wide. With the increase in vehicular traffic demand, the expansion of towns toward the Shambuganj Bridge resulting congestion around the crossing point. This traffic and regional conditions continue to cause bottlenecks in the Dhaka-Mymensingh-India border area Unplanned development in Patgudam intersection near the China-Bangladesh Friendship Bridge is causing perennial traffic congestion in the district town, as the local administration stays oblivious to the problem.

Figure 4-2 Traffic Jam at the Shambhuganj Bridge

Every day, up to 2,500 buses use the terminal on the southern side of the bridge, locally known as Shambhuganj bridge. People traveling to and from the northern districts, Netrakona and Kishoreganj through Mymensingh suffer for hours due to tailbacks in the terminal area. Locals say such jams are a regular phenomenon and sometimes last an entire day Passengers, drivers, transport workers and traffic personnel say the problem would worsen unless the terminal is relocated outside the town. Without the proposed project to divert traffic and ease congestion and traffic jam the situation will continually get worse as the City is continually growing and the traffic passing through the existing Shomvuganj Bridge is increasing

4.3 Alternative analysis: Road Alignment

4.3.1 Selection criteria

Horizontal and vertical alignment of the bridge and its approaches will be designed to conform design speed, geometric criteria, and cross-section, which were reviewed in a previous chapter. The proposed approaching section for the bridge to be constructed newly shall be linked with the existing roads properly. During the feasibility study stage, the Consultant considers the

local conditions, and make a number of candidate route, using data available. The final route will be determined after reviewing and comparing all alternatives. In order to meet the technical requirement of the standard, the Consultant will suggest the optimized horizontal and vertical alignment at site locations based on the following principles.

- Determination for optimum connection point with Mymensingh~Netrakona Highway and the most appropriate configuration for ramp design
- In the case of utilizing the existing road, the horizontal alignment will be emphasized to minimize land acquisition quantities and compensation costs
- Optimize access location of ending section and intersection type

Based on the principle above mentioned, the alignment design is implemented, and alignment were studied in terms of costs, environmental, and connectivity with existing roads, respectively. The concept of the options is illustrated in the following figure.

4.3.2 Comparison of Route Options (approach road)

The consultant proposed three options of alignment and additional option, suggested by the client. The brief description is the following. The route of beginning section runs from roundabout branching N309 and N3 and is planned along the existing N309. After the residential area the route overpass two railway and road Z3033, and then it runs parallel to the railway to ensure navigational clearance. All options are an equal route with beginning section and main bridge section. The ending section is provided the difference, and each option is described herein.

- **Option 1** is crossing the railway and access to intersection. The intersection is improved as a type of roundabout and the length of road and bridge is the lowest.
- **Option 2** is crossing the railway, and then the route is separated into up/down carriageway and access to road R370. The option is good for the level of service.
- **Option 3** is also crossing the railway and access to road R370. Roundabout is planned at R370, and the length of road is the longest.
- **Option 4** is crossing the railway and road R370 at one swoop with long bridge. Intersection at ending point accesses to bypass.

Road alignment was planned based on a review of construction cost, environmental affect, land acquisition and resettlement plan, and obstacles including utilities. The consultant has reviewed three (3) alignment options and one (1) additional option which is suggested by the client after draft feasibility study submission, and the comparison of the options is described in the following Table 4-1. The description and explanation of environmental and social impact ratings are provided in Section 4.4. All the options considered are shown in Figure 4-3 and Figure 4-4.

Figure 4-3 Project Route

Table 4-1 Comparative analysis of road alignment options

Description		Option 1		Option 2		Option 3		Option 4	
Summary of Alternative		• Alignment on the beginning section is along exiting road • Design speed for main route is applied 80km/hr and design speed for ending section is 60km/hr				•		• Alignment on the beginning section is along exiting road • Design speed for main route is applied 80km/hr and design speed for ending section is 60km/hr	
		• Most economical alternative due to installation of minimum structures • Ending point is set roundabout intersection		• Traffic flow is optimized • Ending point is set ramp to road R370		• Avoid obstacles along the alignment • Ending point is set roundabout intersection		• Secure main traffic flow due not to access R370 but the bypass road • Ending point is set roundabout at bypass	
Length		L=6.2km		L=6.6km		L=7.0km		L=6.7km	
BRIDGE	Main	320m		320m		320m			
	Approach	885m		885m		885m			
	Other	1EA/455m		1EA/680m		1EA/600m			
Construction Cost (million TK)		• Road :	**3,484**	• Road :	• **3,946**	• Road :	• **3,690**	• Road :	**3,480**
		• Bridge :	**11,820**	• Bridge :	• **13,089**	• Bridge :	• **12,638**	• Bridge :	**13,366**
		• Total :	**15,304**	• Total :	• **17,019**	• Total :	• **16,328**	• Total :	**16,846**

Description	Option 1	Option 2	Option 3	Option 4
Features	• Length of road is minimum • Number of bridge is decreased because of not cross of R370 • Separate distance from railway is about 70m • Construction cost is low • Level of service for ending intersection is poor • Intersection longitudinal grade is poor • Minimum curve radius is 500m	• Length of road is middle level • Bridge length is the longest • Separate distance from railway is about 70m • Construction cost is a little high • Level of service for ending section is better • Secure road safety and reduce traffic accidents • Minimum curve radius is 135m	• Length of road is longer • Bridge length is increased • Separate distance from railway is about 70m • Construction cost is high • Level of service for ending section is good • Water reservoir is affected • Avoid sensitive obstacles • Minimum curve radius is 500m	• Length of road is middle level • Bridge length is increased • Separate distance from railway is about 70m • Construction cost is a little low • Ending point is planned roundabout at bypass road so traffic impact is minimized on R370 • Crossing local road • Minimum curve radius is 500m
Social Impact*	Resettlement impact is low	Resettlement impact is medium	• Resettlement impact is high	Resettlement impact is medium
Environmental Impact*	• Environmental impact is low	Environmental impact is medium	• Environmental impact is high	Environmental impact is medium

* Detailed analysis are shown in following sections.

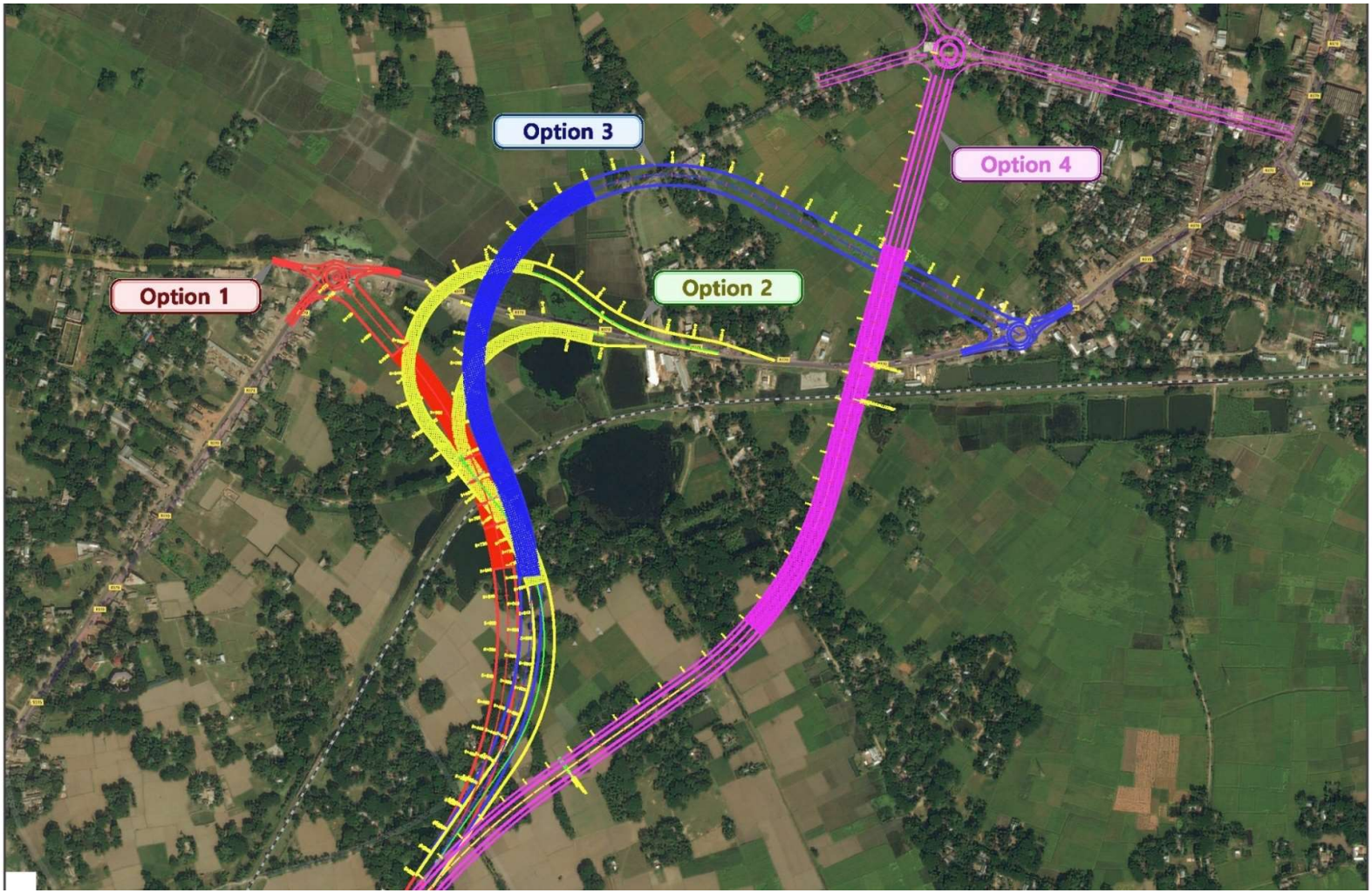


Figure 4-4 Alternative drawing

4.4 The Method of Assessment

4.4.1 Evaluation of Option Based on Environmental and Social Parameters

A simple methodology has been developed for Environmental Evaluation System (EES developed by Battelle Columbus Laboratories in the United States. In Bangladesh, in absence of a database it is only possible to estimate the potential environmental changes from the existing situation. In this method, the existing environmental conditions will be the reference level and the positive and negative changes in environmental conditions resulting from the proposed project will be evaluated. The environmental impact will be assessed by Environmental Impact Values (EIVs), which may be defined mathematically as follows:

Where Vi is the relative change in the value of environmental quality of parameter i with respect to existing situation, Wi is the relative importance or weight of parameter i, and n is the total number of environmental parameters related to the project.

The computation of Environmental Impact Value (EIV) of a project needs determination of Vi, the value representing the magnitude of alteration of the environmental parameters, and Wi is the value representing relative weight or importance of the respective parameters.

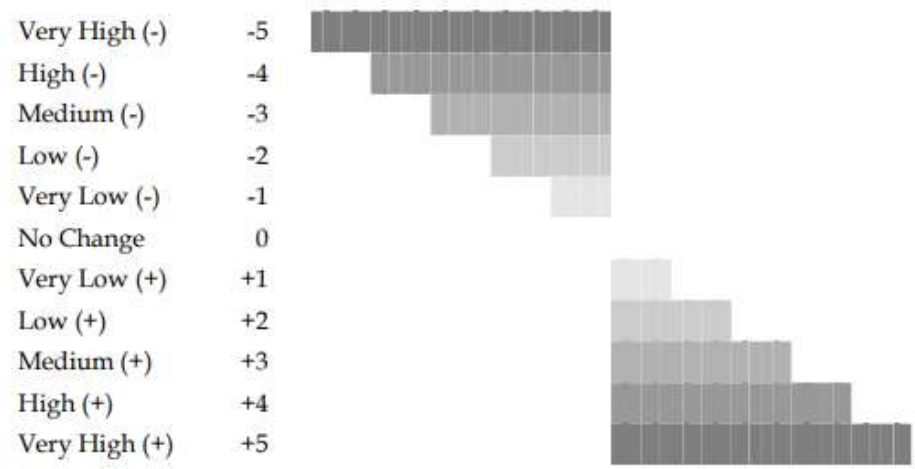


Figure 4-5 Magnitude of Environmental Impact Value

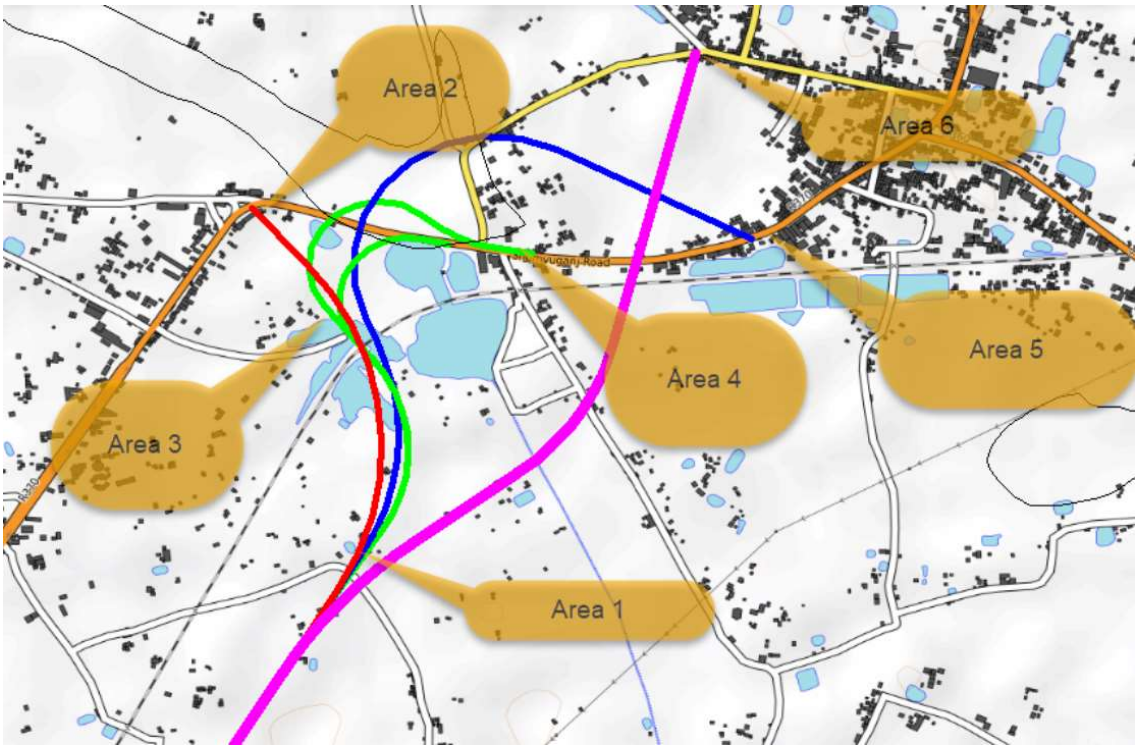


Figure 4-6 Location of settlements and water bodies

Change of environmental parameters should not be measured with respect to existing condition. The standard practice is to compare the future-with-project condition against the future-without-project condition, difference between these two are taken as the change in environmental parameters. The future-without-project condition should be generated through trend analysis using historical data collected during the establishment of baseline condition. The beneficial and adverse changes in environmental parameters resulting from a project, usually expressed in qualitative terms have been plotted in a scale to quantify the environmental alterations.

Since the changes of environmental parameters are measured with respect to existing condition,

no change has 0 values. Benefits or positive impacts are here graded from +1 to +5, and negative impacts scored from -1 to - 5. Impacts are assessed quantitatively wherever possible. A value from the scale representing effect of the project on each parameter has been taken to compute the EIV of the project.

For the purpose of estimation, positive and negative impacts are divided into three different groups, as Low, Medium and High. A low numerical value ranges from 1 to 2, Medium 3 and High with a numerical value ranging from 4 to 5.

Relative Importance of Environmental Parameters

All environmental parameters influenced by the project are not of equal importance or weight. The importance of a parameter varies from country to country depending on the environmental concerns of the country. Generally, in Bangladesh flood, employment, agriculture, fisheries etc. carry more importance than many others. The importance may also vary in different regions within the country. So the same parameter may have different values for subprojects located in different regions

Table 4-2 Environmental and Social Impact Parameters of Different Option

PHYSICAL PARAMETERS	Value	No Project	Option 1	Option 2	Option 3	Option 4
Regional Hydrology)'/ Flooding	4	0	-1	-2	-4	-3
Drainage Congestion/ Water Logging	4	0	-1	-1	-4	-3
Erosion and Siltation	2	0	-1	-1	-2	-2
Dust and Noise Pollution	2	0	-1	-1	-1	-2
Water Pollution	2	0	-1	-1	-2	-1
Soil Characteristics/ Soil Fertility'	4	0	-2	-2	-3	-3
Ground Water Table	2	0	0	0	0	0
ECOLOGICAL PARAMETERS						
Fisheries	8	0	0	-3	-5	-2
Forest	2	0	-1	-1	-2	-2
Wildlife and Biodiversity	4	0	-2	-1	-2	-3
Solid Wastes	2	0	-1	-1	-1	-1
Slaughtering Wastes	2	0	0	0	0	0
Nuisance Plant/ Eutrophication	1	0	-1	-1	-1	-1
Wetland and Wetland Habitat	4	0	-1	-2	-4	-2
Terrestrial Habitat	2	0	-1	-1	2	2
Tree Plantation/ Urban Vegetation	2	0	2	2	2	2
Wastewater	1	0	-1	-1	-1	-1
HUMAN INTEREST RELATED PARAMETERS						
Loss of Agricultural Lands	6	0	-2	-3	-4	-5
Loss of Top Soil of Agricultural Lands	2	0	-0.66667	-1	-1.33333	-1.66667
Land Acquisition and Resettlement	6	0	-4	-5	-6	-6
Employment Opportunity	6	-4	3	6	4	4

Industrial Activities	3	-3	2	3	2	2
Irrigation Facilities	2	-2	1	2	1	1
Navigation/ Boat Communication	2	0	0	0	0	0
Road Communication/ Transportation	7	-6	3	7	5	5
Agricultural Development	6	-6	3	6	4	4
Landscape	2	-2	2	2	1	1
QUALITY OF LIFE VALUES						
Sanitation & Pure Water Supply	1	0	1	1	1	1
Education/ Literacy	3	-3	2	2	2	2
Road Safety	6	-3	2	6	3	3
	100	-29	-0.66667	9	-16.3333	-11.6667

4.4.2 Recommended Option

Based on the evaluation shown on the above table based on environmental and social parameters, it can be seen that Option 2 scored the highest on scoring. This is partly due to the fact that this option is the most technically feasible in terms of transportation, also provides the most economic value. Further, the environmental impact is moderate and scores second in terms of environmental impact. Option 1 scores the best option in terms of environmental impact however scores low on transportation/ communication viability perspective.

4.5 Alternative analysis: Bridge Location and Design

4.5.1 Alternatives of Suitable Bridge Location

Three (03) locations were preliminarily proposed as seen in Figure 4-7 from the local perspectives. An additional site was proposed later. All the sites were investigated using multicriteria analysis to choose the best option.

For site suitability analysis the following criteria were considered:

- Close to existing road network to connect the bridge with minimum length; of approach road;
- Straight reach of river for avoiding bends close to the bridge location
- Minimum width of river;
- River cross-section having uniform velocity distribution at the mid-reach: Little or no riverbank erosion;
- Perpendicular position between bridge alignment and river reach avoiding skewness;
- Minimum impact of bridge on river morphology.

The proposed sites were investigated for hydro-morphological characteristics to see how they meet the above-mentioned criteria. Results of the hydro-morphological analysis are shown in Figure 4-7 and the results of multicriteria has been presented in Table 4-3.

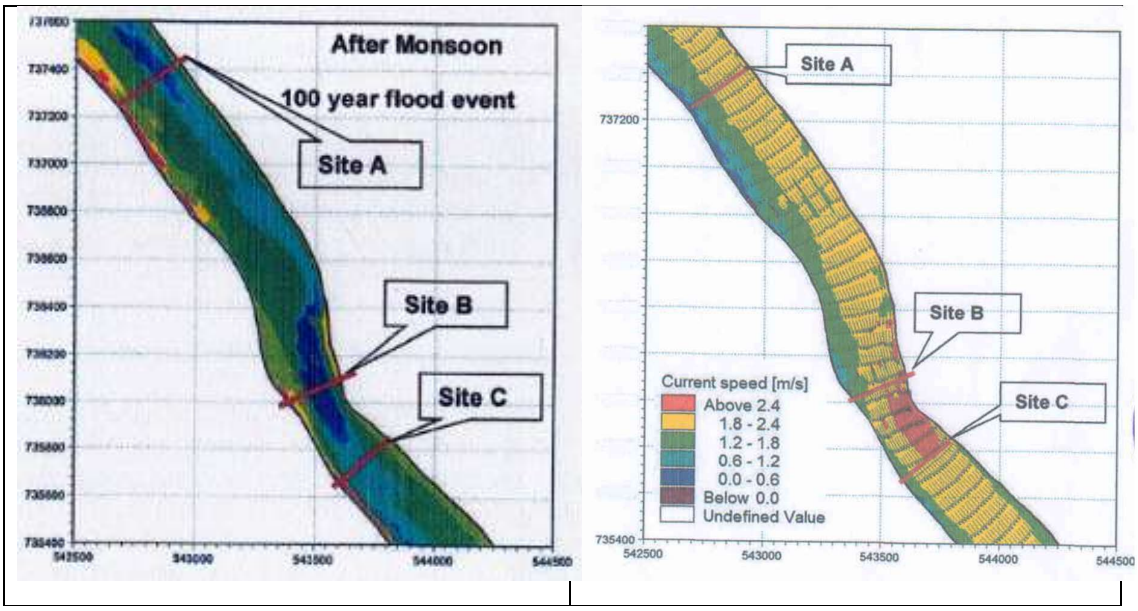


Figure 4-7 Probable bed level contour and Velocity of the old Brahmahputra River for 100 years flood event

Table 4-3 Comparison of Probable Bridge Site at Old Brahmuputra River

Bridge	Items	Alternatives				Remarks
		Site A	Site B	Site C	New proposed	
Kewatkhali	Distance from Railway bridge	Upstream 550m	Downstream 90m	Downstream 500m	Downstream 50m	Minimizing E&S Impact
	River Width(m)	299	291	352	240	Cross section
	Max. Velocity	2.24	2.68	2.51	2.51	100 year
	Top width of Lowest W.L(m)	180	160	160	160	After Dredging
	Compensation Expenses	Medium	High	Medium	Low	Electric power line and Houses
	Connection condition with N309 Road	Bad	Good	Bad	Good	Approach road

From the above figure, Site-B looks preferable for bridge construction. Moreover, the river section at site B is more defined compared to site A and C and the top width of the river at site B is less than that of the two other sites. So, considering all aspects, Site-B has been preferred for the proposed bridge construction. However due to the proposed railway overpass and settlement on the east side of the River the alignment has been shifted and the bridge is proposed 40 meter upstream of site B as shown in figure

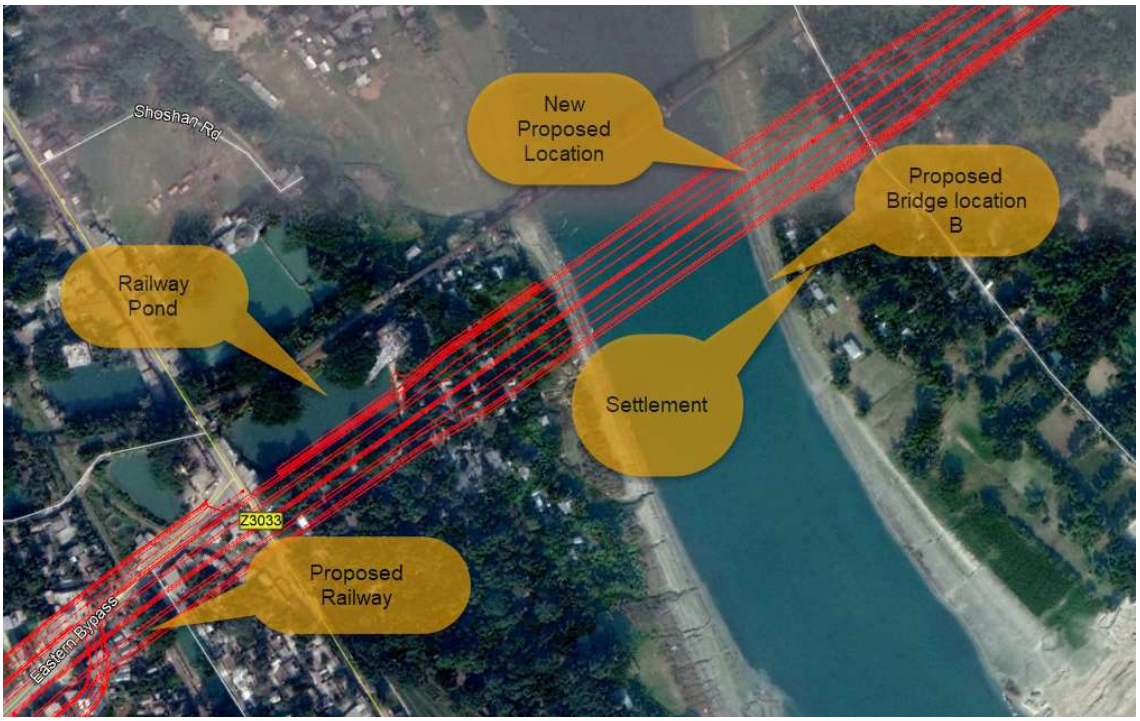


Figure 4-8 New proposed bridge location

4.5.2 Selection of the Main Bridge Type

The selection of the proper type of bridge is determined based on the results of topographic survey, geological survey, traffic survey, geotechnical survey, hydro-technical survey, etc., as well as construction cost, environmental impact, maintenance, and esthetics. The diagram of the selection of the main bridge is presented below.

However, the maximum span length is generally an important factor that should be considered for designing the bridge superstructure due to the fact that each bridge type has its own scope of application. The various types of possible the superstructure are discussed in the following section.

Selection of the Main Bridge

Preliminary Design

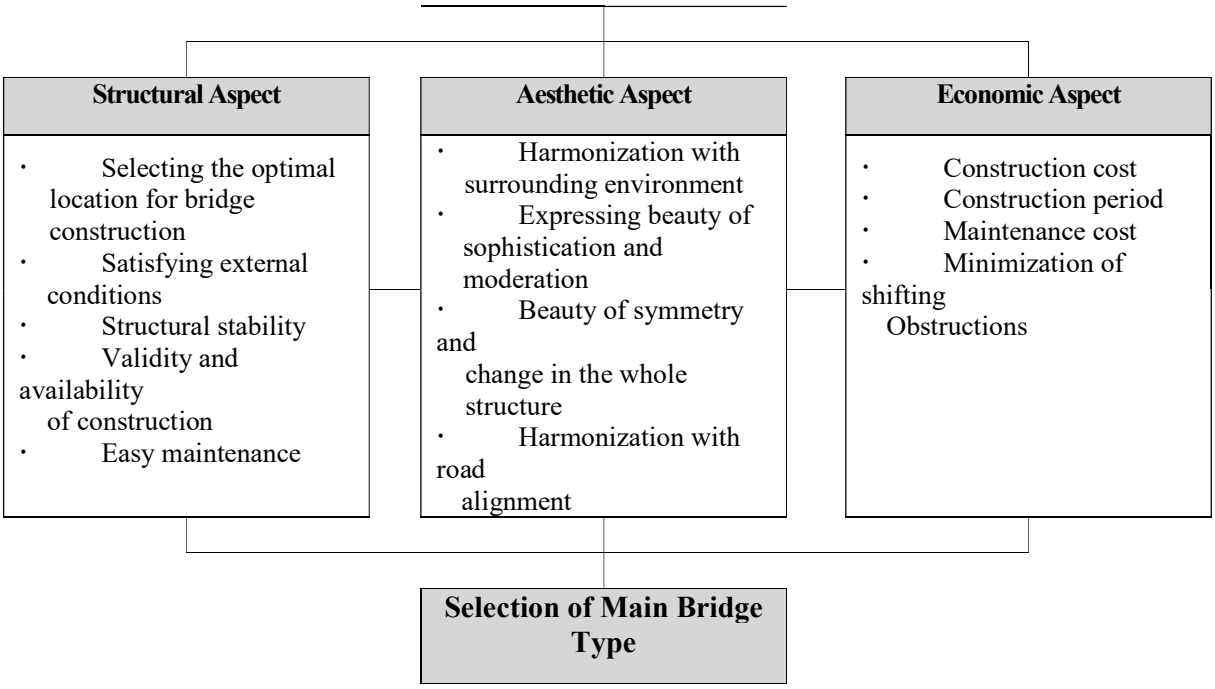
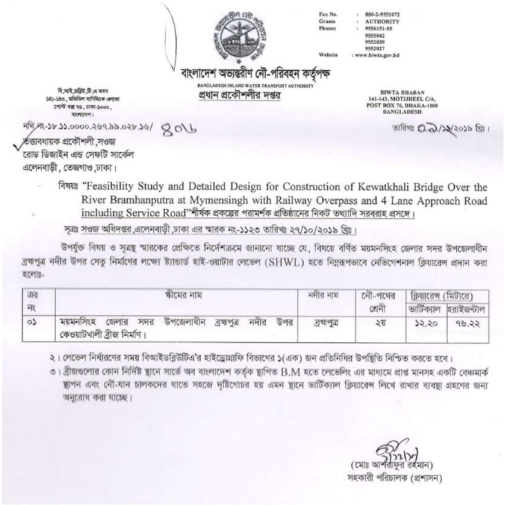


Figure 4-9 Selection of the main bridge type

4.5.3 Bridge span length and Navigation clearance

- **Study of the Navigation Clearance and Minimum span length**



বাংলাদেশ অভ্যন্তরীণ নৌ-পরিবহন কর্তৃপক্ষ
BANGLADESH INLAND WATER TRANSPORT AUTHORITY
প্রধান প্রকৌশলীর দপ্তর

BIWTA BHABAN
141-143, MOTIJHEEL C/A,
POST BOX 76, DHAKA-1000
BANGLADESH

বিষয়: "Feasibility Study and Detailed Design for Construction of Kewatkhali Bridge Over the River Bramhanputra at Mymensingh with Railway Overpass and 4 Lane Approach Road including Service Road" শীর্ষক প্রকল্পের পরামর্শক প্রতিষ্ঠানের নিকট তথ্যাদি সরবরাহ প্রসঙ্গে।

ক্রম নং	স্কীমের নাম	নদীর নাম	নৌ-পথের শ্রেণী	ক্লিয়ারেন্স (মিটারে) ভার্টিক্যাল	ক্লিয়ারেন্স (মিটারে) হরাইজন্টাল
০১	ময়মনসিংহ জেলার সদর উপজেলাধীন ব্রহ্মপুত্র নদীর উপর কেওয়াটখালী ব্রীজ নির্মাণ।	ব্রহ্মপুত্র	২খ	১২.২০	৭৬.২২

(মোঃ আশরাফুল ইসলাম)
সহকারী পরিচালক (প্রশাসন)

Figure 4-10 Official Letter from BIWTA

The Consultant received an official letter from Bangladesh Inland Water Transport Authority (BIWTA) about the Navigation Clearance which is presented in Figure 4-10. Their letter Reference Memo No. 18.11.0000.267.99.028.16/406 has given the Navigational Clearance for the bridge and is enclosed herewith.

According to the response from Bangladesh Inland Water Transport Authority (BIWTA), the Navigation Clearance is class II with Minimum Vertical Clearance(H) and Minimum Horizontal Clearance(B) of 12.20m and 76.22m respectively. The vertical clearance applies from the Standard High Water Level. The Standard High Water Level is 13.29mPWD (12.83m MSL) for the Kewatkhali bridge. For waterways which have not been classified by BIWTA, consideration shall be given to the local requirement for passage of fishing vessels, boats, trawlers, barges, etc. At least one span must be kept wide enough to accommodate intended river traffic. Related on the navigational classification of River of Kewatkhali bridge location, the previous document (IWM, 2015) referred to as Class III. However, the Client mentioned it was a request from the Ministry of shipping and asked for Class I for the passage of future transportation. The minimum span length of bridge is shown in Figure 4-11.

Therefore, in order to ensure the navigation limit of the Old Brahmaputra River, the main span length has to be longer than 180 meters. The limitation of bridge length is presented in Table 4-4

Table 4-4 The Limitations of Bridge Length

Classification	Limitations	Remark
Old Brahmaputra River	Total width = 291m Total width = 125m (normal day)	Need to minimize the impact on river flow and the environment.
Navigation Clearance	Class II (Confirmation from BIWTA) ・ Minimum Horizontal = 76.22m ・ Minimum Vertical = 12.2m	Official letter from Bangladesh Inland Water Transport Authority (BIWTA) Need a span length satisfied Class II
Minimum Span Length	Minimum Span Length Required : 180m	Main waterway width after Dredging work of BIWTA: 160m

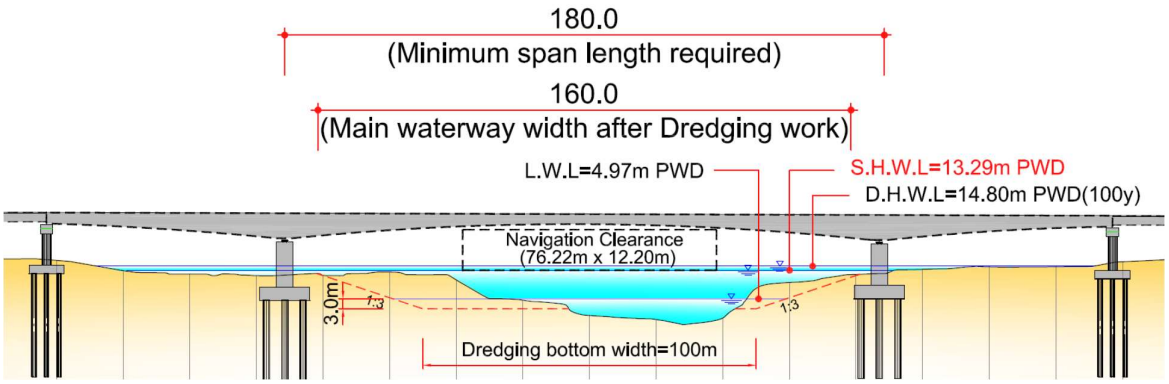


Figure 4-11 Minimum Span Length of Bridge

4.6 Review of Superstructure Types

According to the current river condition, dredging work plan of BIWTA and official letter from BIWTA, The Main bridge is required to be a longer span. In order to ensure the Navigation limit of the Brahmaputra River, the span length is required to be longer than 180 meters. The possible bridge types are PSC Box Bridge, Steel Deck Plate Box Girder Bridge, Steel Arch Bridge, Extradosed Bridge, and Cable-stayed bridge. Span lengths of each bridge type with a long span are shown in the following Table 4-5.

Table 4-5 Span Length for Each Long Span Bridge Type

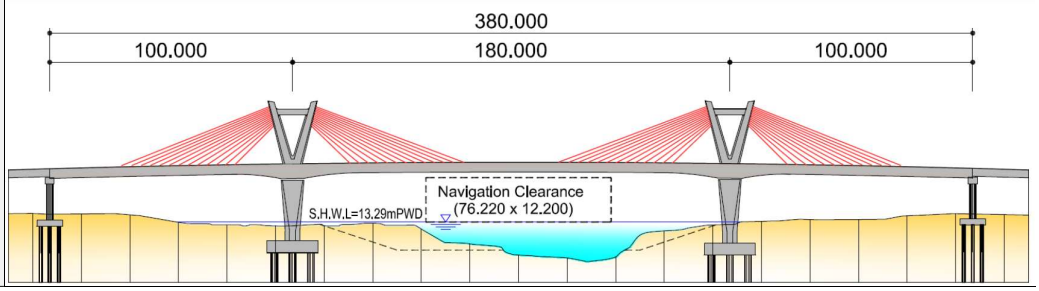
Classification	100m	120m	140m	160m	180m	200m	Over	Remark
PSC Box Bridge (FCM)	■	■	■	■	■ ■ ■			
Steel Deck Plate Box Girder Bridge	■	■	■	■	■			
Steel Arch Bridge	■	■	■	■	■			
Extradosed Bridge	■	■	■	■	■	■		
Cable-stayed bridge	■	■	■	■	■	■	■	

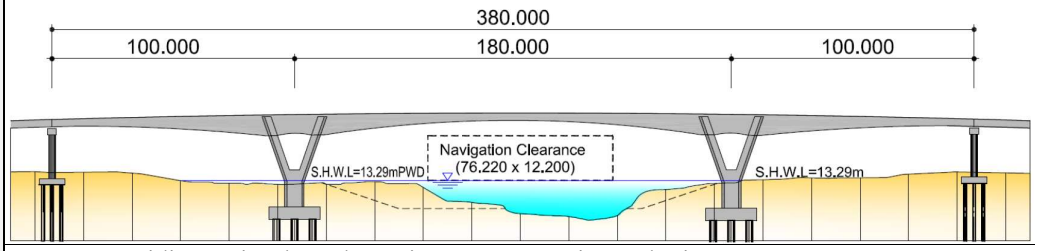
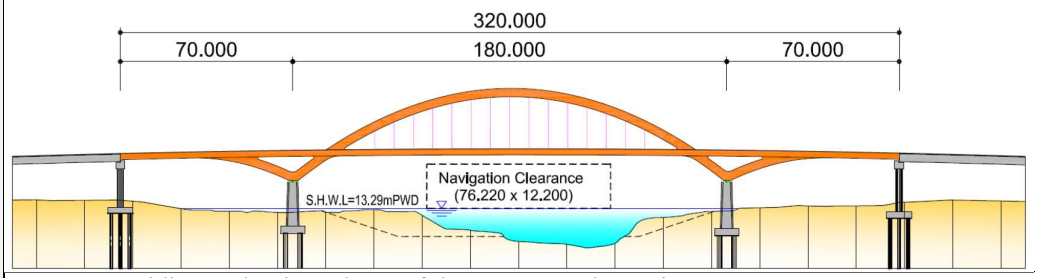
Among the classification above, three (3) types of bridge have been selected for the alternative study of main span bridge. These are Extradosed bridge, PSC box girder bridge and Arch bridge and it is presented in Figure 4-12below. The main bridge is compared considering aesthetics, iconic value, maintenance, construction cost and structural stability

Type of Bridge	Aerial View
Extradosed Bridge	
PSC Box Girder(FCM)	
Arch Bridge	

Figure 4-12 Applicable Bridge types in the main Bridge

Table 4-6 Review on Comparison of Main Span Bridge Types

Type	Profile and Characteristics
Extra dosed	

	· Providing a modern look, feel, and excellent symbolic aspect as well. · Providing a uniqueness due to its less track record of the construction in Bangladesh. · Providing large eccentricity that pre-stressing works effectively on the main girder. · Performing the construction using balanced-cantilever erection. · Providing low height of towers which can be easily maintained pylon and cables. · **Approximate construction costs: $ 96.0 million (including Approach bridge)**
PSC Box Girder (FCM)	 · Providing a simple and concise appearance in aesthetics. · The most frequent usage bridge type in Bangladesh. (Uncompetitive in the uniqueness aspect) · Providing a high torsional rigidity and low material content compare to I-girder type. · Performing the construction applying a free cantilever method using form traveler. · Providing the most efficient and cost effective maintenance & operations. · **Approximate construction costs: $ 89.4 million (including Approach bridge)**
Steel Arch	 · Providing a classic and graceful appearance due to its curvaceous structure. · Providing the most unique bridge type, since it has never been constructed in Bangladesh. · The curved structure that supports the loads parallel to its axis of symmetry. · Requiring a frequent maintenance as the structure ages to ensure structural stability. · **Approximate construction costs: $ 109.3 million (including Approach bridge)**

4.6.1 Evaluation of Bridge Type Alternatives

Three (3) types of bridge were examined for the preliminary design. The brief summary of each feasible bridge type is presented in Table 4-6

The adopted bridge types were highly influenced by evaluation criteria which are the possible span, aesthetics, uniqueness, structural effectiveness, constructability, maintenance & operation as well as costs & economic aspect. The detailed descriptions of the adopted bridge are as follows.

Table 4-7 Evaluation of Alternate Bridge Options

Aspect	PSC box girder bridge type	Steel Arch bridge type	Extradosed bridge type case
Aesthetics	type provides a simple appearance in aesthetics. It is true that the preference for aesthetics depends on personal preference. However, generally, this type is not competitive with the other types in the symbolic aspect.	the Arch bridge is one of the most popular types of bridge, which came into use over 3000 years ago and remained in height of popularity until now. This type provides classic and graceful appearance due to its curvaceous structure.	one of the most elegant designs for a bridge. It has a modern look and feel, and provides superior symbolic aspect as well. Through the shape of pylon and cable arrangement
Uniqueness	the most frequent usage bridge type in Bangladesh; thus, this type is not competitive with the other types in uniqueness aspect.	it has never been constructed in Bangladesh while the Concrete Arch bridge has been constructed frequently, thus it could be the most unique type in Bangladesh	this type is unique, as very few structures of this type have been constructed in Bangladesh. There are only two Extradosed bridges are existed in Bangladesh; One is already under operation and the other one is under construction. Thus, this type is also one of the possible bridge types to be adopted in the uniqueness aspect.
Structural Effectiveness	proves significantly high torsional rigidity and low material content when compared with the I-girder type. This type of bridge cross-sections may take the form of	a curved structure that supports the loads parallel to its axis of symmetry. This bridge type generally has abutments at each end and works by transferring the	the stay cable forces for the Extradosed bridges under dead load, which can be controlled by shortening the cables to a predetermined length to achieve

Aspect	**PSC box girder bridge type**	**Steel Arch bridge type**	**Extradosed bridge type case**
	single- cell, multiple-spine, or multi-cell with common bottom flange	self-weight other external loads in vertical directions partially into a horizontal thrust restrained by the abutments (or piers) at both sides.	specific desired bending moment distribution. This is a new type of PSC bridge that combines the characteristics of girder bridges and cable-stayed bridges
Constructability	can be applicable to spans approximately up to 160 meters, applying a free cantilever method using form traveler. A cast-in-place method which is using form traveler with equipment for making segments. This method provides the economic efficiency and does not require a manufacturing plant and operation of the barge in the river.	a large block erection method is generally used for launching the superstructure of the arch bridge. However, this construction method has a limitation of accessibility of construction equipment such as the floating barge and crane. In this project case, the bridge will be constructed near the existing railway bridge which will be the major obstacle of using and shipping the construction equipment.	it is possible to perform the construction using balanced-cantilever erection. In this scenario, few if any temporary supports would be required in the Brahmaputra River
Maintenance and Operation	it is the most excellent type for the maintenance and operations. The maintenance of PSC box girder is easier; interior space is directly accessible without the use of scaffolding.	must receive ongoing maintenance to ensure the supports are distributing weight to the abutments as they should. That means there must be frequent inspections of the span as the structure ages to ensure it is not	the cable and tower are the most important component in the maintenance & operation. Unlike the cable stayed bridge system which the cable employs all of the load, however, the Extradosed bridge employs a structure that

Aspect	**PSC box girder bridge type**	**Steel Arch bridge type**	**Extradosed bridge type case**
		weakening over time. In addition, the painting treatment is also required periodically due to its material characteristics	combines the main elements of both girders and stay cables
Costs & economic aspect	it provides the most competitive construction cost for the project. However, this type provides the shortest main span which can cause the additional installation of the piers. This could increase the construction costs more.	it has a disadvantage of construction cost due to characteristics of steel industry in Bangladesh. Even though steel offers a lot of flexibility in span length and curvature, its use is often restricted by the location of the nearest certified fabrication shops and long-term maintenance considerations such as painting. In Bangladesh's case, the fabrications shops have not existed, so all of the fabricated steel structures must be imported from the other countries, and it will lead to an increase of construction costs.	this type provides the reasonable costs for the construction. Since the pylon of Extradosed bridges are nearly one-third lower than those of traditional Cable-stayed bridges, the crossbeams are not necessary in the structure

4.6.2 Recommended Option for the Bridge

Based on a comprehensive review of the three feasible (3) options, the Consultant recommended the Extradosed bridge type as the most suitable bridge type for the project.

In contrast, the Client expressed a different perspective for the main bridge type. The client is of the opinion that though the cost of Arch Bridge is a little higher than the extradosed type, considering the uniqueness and iconic value, Arch Bridge should be finalized. As the Steel Arch bridge has never built in Bangladesh, the Client emphasized the uniqueness of the structure the most. Even though the Steel Arch bridge type has disadvantages of maintenance and constructability, the Client mentioned that they are ready for a challenge of the new type of structure to improve the technology of the bridge industry. The Consultant fully understands the Client's opinions and adopted the Steel Arch Bridge as the main bridge type for the project. The adopted bridge type is presented in the figure below.

Adopted Bridge Type (Steel Arch Bridge)

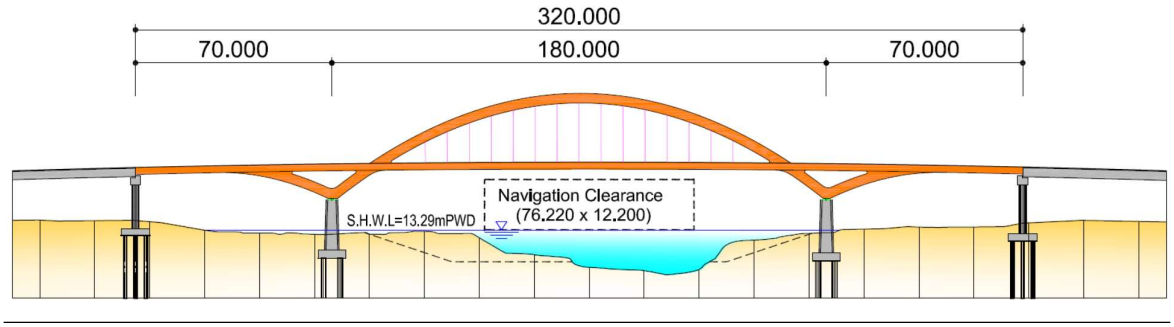


Figure 4-13 Adopted Bridge Type (Steel Arch Bridge)

5 CHAPTER BASELINE ENVIRONMENTAL CONDITIONS

Baseline data on environment is important to understand existing physical, biological, cultural, economic and social environmental characteristics. This information serves as the basis for identification, prediction and evaluation of impacts of the project activities. Mainly there are two principal objectives in examining and defining the existing environment:

- To provide a baseline against which environmental conditions in which the project will be measured and to document conditions which were either existing or developing before the introduction of the project and not due to the project.
- To identify existing environmental issues without the project.

The baseline environmental quality is assessed through secondary data and primary data via field studies within the impact zone for various components of the environment, including air quality, noise, water quality, and land and socio-economic. For this EIA study, the baseline survey covered the study area defined in Section 1.7 and emphasis was given on the AOI, i.e. the environmental features that are of particular significance to the present project. Considerations are given to both the environment and ancillary area that seems to be affected

5.1 The River System

5.1.1 Network

The Old Brahmaputra is one of the main distributaries of the Jamuna (Brahmaputra) that distributes part of Jamuna discharge over a large area of North Central region of Bangladesh. The old course of the Branmaputra River, presently known as the Old Brahmaputra, takes off at Kholabarichar, approximately 10km upstream from Bahadurabad, and follows a south-easterly course via Mymensingh and take up to Bhairab Bazar - at the confluence with the Upper Meghna River.

The total length of Old Brahmaputra river between the off-take and outfall is approximately 227 km. The Old Brahmaputra River is at present reduced to a left bank spill channel of the Brahmaputra River and only active during the high stage of the Brahmaputra River. The discharge and sediment transport through the river is dependent on opening of the off-take with the Brahmaputra River. The 227km long Old Brahmaputra River is meandering in nature and has limited capacity for passing flood discharges. In the lower areas of the basin, flooding situation aggravates due to the tendency of channels to overflow towards the floodplains during the flood period. The slope gradually decreases in the downstream direction, from 8.4 cm/km to 5.8 cm/km at the offtake of the Lakhya River. The Jhenai, Banar, Sutia, Iman- Akhila and Sita-Lakhya originate from the Old Brahmaputra. Banar offtake is completely closed and a regulator controls the Sutia offtake over Sutia River. The Lakhya also originates from the Old Brahmaputra near Toke and ultimately discharges into the Dhaleswari. The tributary Jinjirum, coming across the Indo-Bangladesh border joins the Old Brahmaputra River very close to its off-take and act as the main source of dry season flow of the Old Brahmaputra.

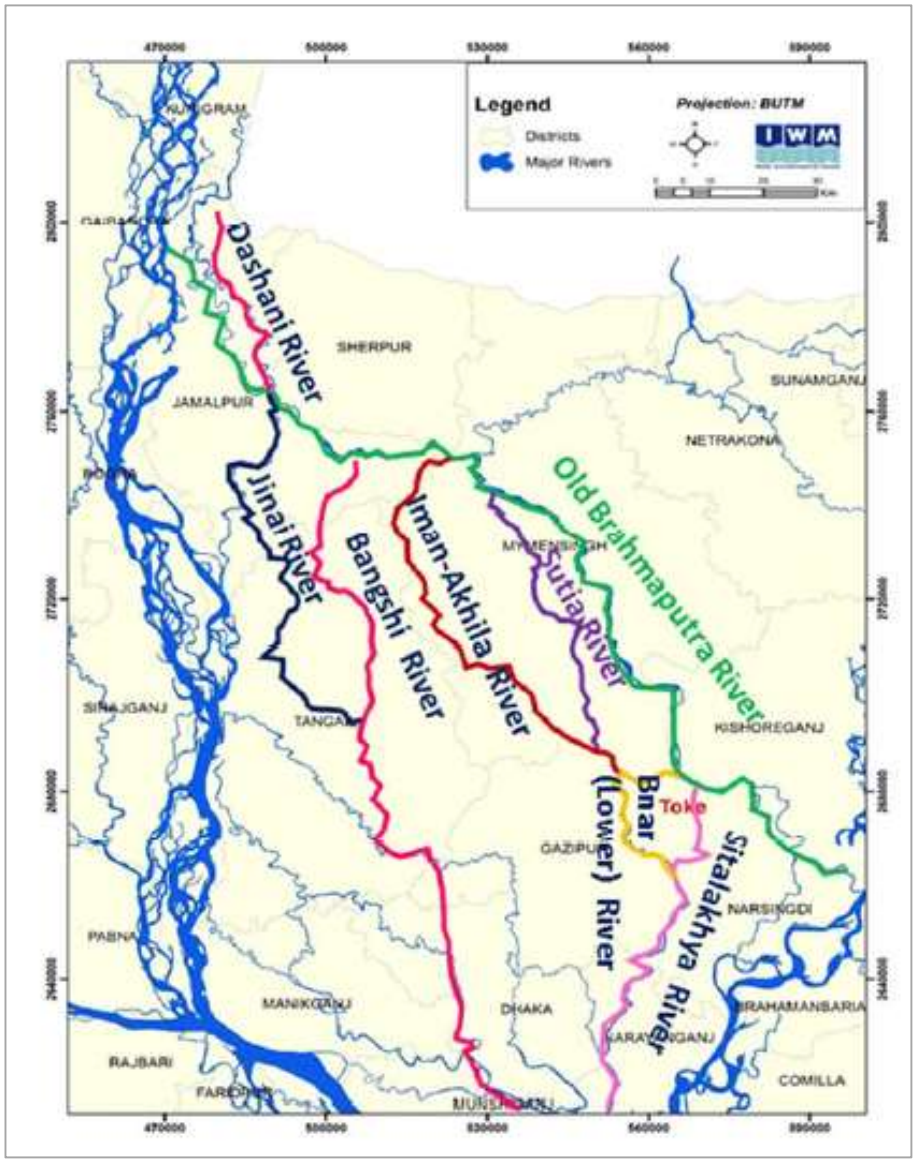


Figure 5-1 old Brahmaputra river network

5.1.2 Morphology

From the available observed water level data of Mymensingh station from 1970 to 2015, maximum and minimum water levels have found 13.71mPWD[6] (meter, Power and Works Department) and 4.97mPWD, respectively. The highest recorded discharge of the river at Mymensingh is 3,775 m3/s during monsoon (September 1, 1988), the lowest recoded discharge at the same station was near to

[6] BWDB and other government departments refer water levels to the Public Works Datum (PWD). PWD is a horizontal datum believed originally to have zero at a determined Mean Sea Level (MSL) at Calcutta. PWD is located approx. 1.5 ft below the MSL established in India under the British Rule and brought to Bangladesh during the Great Trigonometric Survey.

zero during the dry period (April 5,1966), Rivers that experience such large fluctuation of discharge tend to be unstable and the river may change its morphology in medium to long-term perspective. The estimated bank-full discharge is 2,800 m3/s. The average sinuosity of the channel is 1.24. With average bed slope 8.4cm/km, the average grain size of the river varies between 0.005mm to 0.356mm. The proposed Kewatkhali bridge is connected with the approach road at both banks of the Old Brahmaputra River after crossing the river, one tributary is flow through drainage of approach road of right bank.

5.1.3 Water level and discharge

Yearly maximum and minimum water level data in the past 50 years at Mymensingh Station on the Old Brahmaputra River suggests that both peak (monsoon period) and low (lean period) water level is decreasing. This may have impact in reducing the flow of the river. From the available observed water level data of Mymensingh station from 1970 to 2015, maximum, minimum and average water levels have been found 13.71mPWD and 4.97mPWD, respectively as below (Figure 5-2):

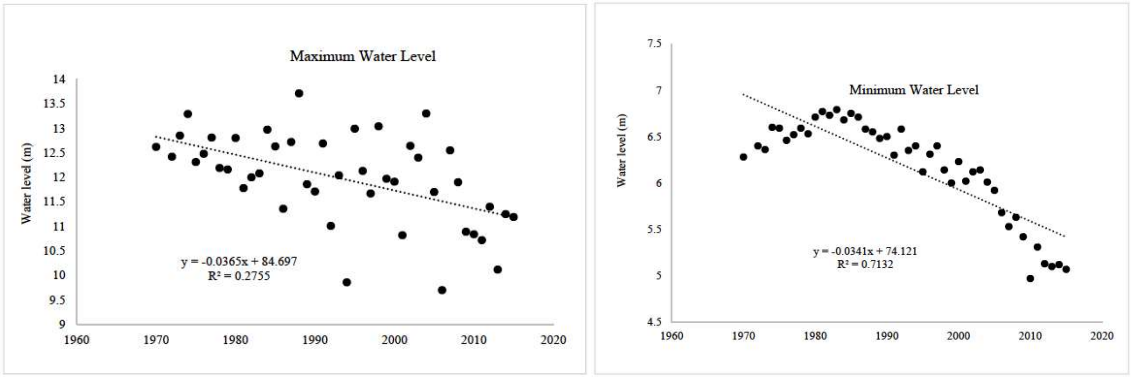


Figure 5-2 Time series water level at Old Brahmaputra, Mymensing station (data source: BWDB)

Annual variation of discharge data from 1970 to 2015 shows the decreasing trend both for maximum and minimum flow. Maximum flow has reduced to around 1,560 m3/s in 2015 which was close to 3,760 m³/s in 1988 (high flood). The average maximum flow is about 1,610 m³/s in 2015. Average minimum annual flow is also reducing yearly, lately close to 1 m³/s.

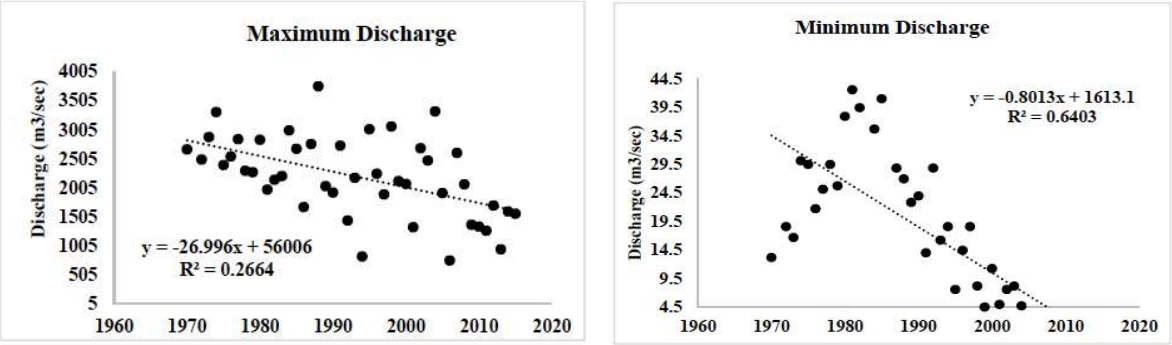


Figure 5-3 Time series discharge at old Brahmaputra river, Mymensingh station (data source: BWDB)

5.2 Land Use of Study Area

The land use in the AOI has been analyzed as shown in Figure 5-4 and Figure 5-5 The description of the key features at both sides of the alignment is presented in Table 5-1 Key Features along the Project Road in Table 5-2 Area of Key Features Table 5-2

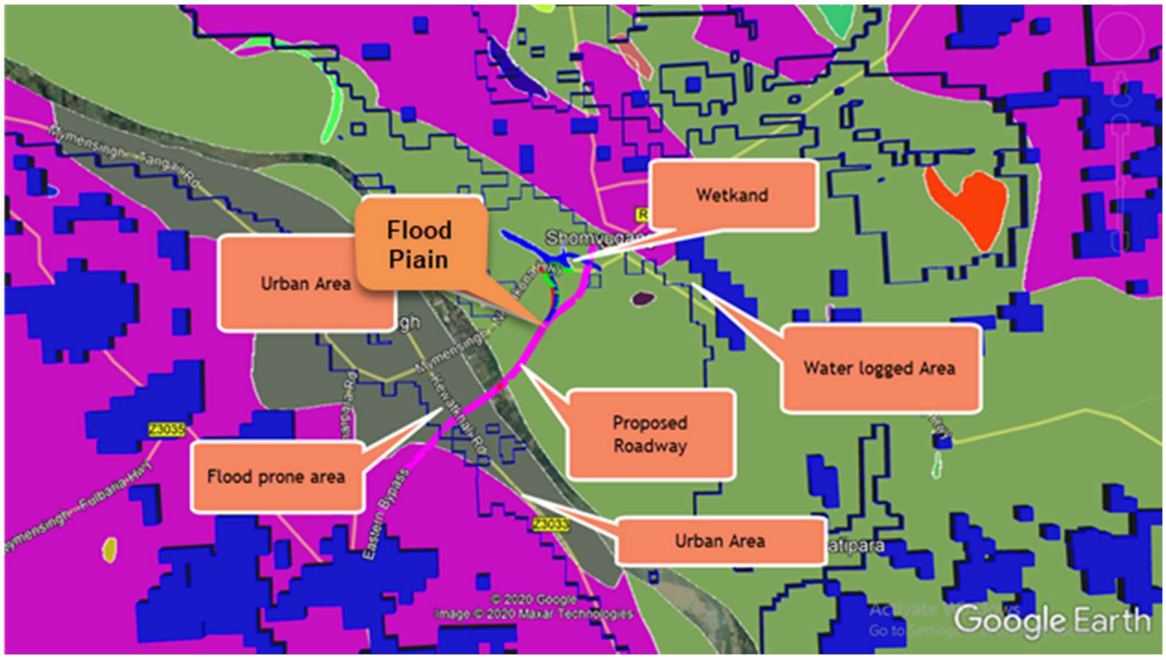


Figure 5-4 Land Type Surrounding the Project Corridor

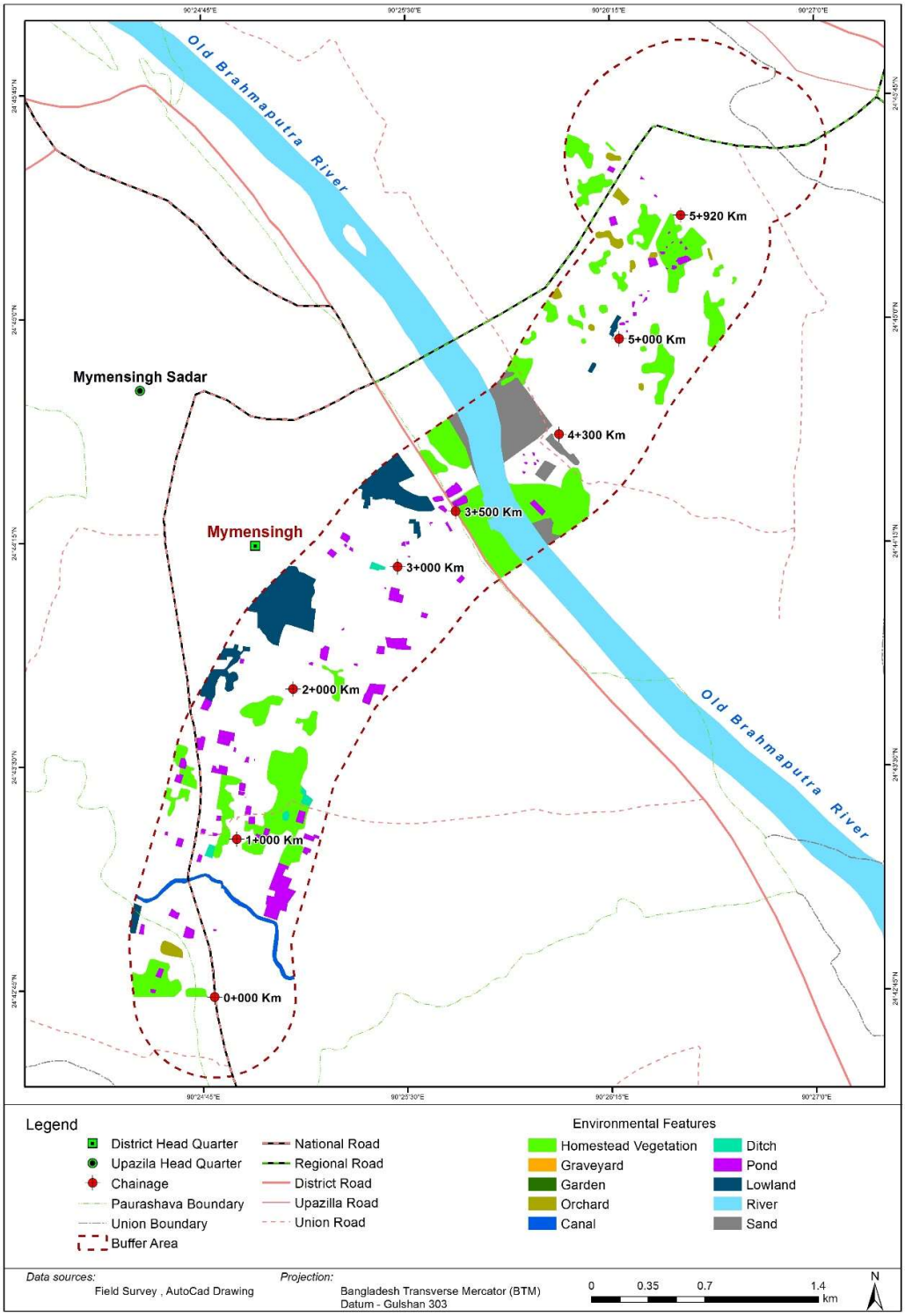


Figure 5-5 Environmental Features in the Project Influence Area

Table 5-1 Key Features along the Project Road

Approach Road # 1		
Environmental Features (Right Side)	**Chainage (km)**	**Environmental Features (Left Side)**
Pond, Homestead Vegetation, Garden, Canal	0+000 to 1+000	Canal, Ditch, Homestead vegetation, Lowland, Orchard, Pond
Pond, Homestead Vegetation, Ditch	1+000 to 2+000	Homestead Vegetation, Lowland, Pond
Pond, Homestead Vegetation	2+000 to 3+000	Ditch, Lowland, Pond
Pond, Homestead Vegetation	3+000 to 3+500	Lowland, Homestead Vegetation, Pond
Bridge		
Environmental Features (Upstream)	**Chainage (km)**	**Environmental Features (Downstream)**
Homestead Vegetation, Sand, Pond, River	3+500 to 4+300	Homestead Vegetation, Sand, Pond, River
Approach Road # 2		
Environmental Features (Right Side)	**Chainage (km)**	**Environmental Features (Left Side)**
Orchard, Homestead Vegetation	4+300 to 5+000	Orchard, Lowland, Sand, Homestead Vegetation
Pond, Orchard, Homestead Vegetation, Graveyard	5+000 to 5+920	Pond, Orchard, Homestead Vegetation, Graveyard, Lowland

Table 5-2 Area of Key Features

Approach Road # 1				
Environmental Features (Right Side)	**Area (acre)**	**Chainage (km)**	**Environmental Features (Left Side)**	**Area (acre)**
Canal	4.95	0+000 to 3+500	Canal	3.39
Ditch	1.69		Ditch	1.61
Garden	0.01		Homestead Vegetation	34.09
Homestead Vegetation	39.48		Lowland	61.41
Pond	21.49		Orchard	2.43
	-		Pond	13.50

Total	**67.61**			**116.41**
Main Bridge				
Environmental Features (Upstream)	**Area (acre)**	**Chainage (km)**	**Environmental Features (Downstream)**	**Area (acre)**
Homestead Vegetation	17.42	3+500 to 4+300	Homestead Vegetation	49.64
Intertidal Area	39.81		Pond	1.12
Pond	2.52		River	22.65
River	17.93		Sand	8.03
Sand	0.47			0.00
Total	**78.15**			**81.44**
Approach Road # 2				
Environmental Features (Right Side)	**Area (acre)**	**Chainage (km)**	**Environmental Features (Left Side)**	**Area (acre)**
Graveyard	0.002	4+300 to 5+920	Graveyard	0.007
Homestead Vegetation	24.98		Homestead Vegetation	39.87
Orchard	0.62		Lowland	4.55
Pond	0.84		Orchard	6.41
	0.00		Pond	3.13
Total	**26.44**			**53.97**

5.3 Soil Classification and Landform

Soils: According to Bangladesh Agricultural research council's Agro-Ecological Zoning map of Bangladesh, the proposed project area falls in the Old Brahmaputra Floodplain (Figure 5-6). The Old Brahmaputra Floodplain (7,230 sq km) region occupies a large area of Brahmaputra sediments before the river shifted to its present Jamuna channel about 200 years ago. The region has broad ridges and basins. Relief is irregular, especially near the old and present river channels. Soils of the area are predominantly silt loams to silty clay loams on the ridges and clay in the basins. Organic matter content is low on the ridges and moderate in the basins, topsoil moderately acidic but subsoils neutral in reaction. General fertility level is low[7].

[7] FAO/UNDP, Land Resources Appraisal of Bangladesh for Agricultural Development Report 2: Agroecological Regions of Bangladesh, FAO/UNDP, 1988; Bangladesh Bureau of Statistics, 1998 Yearbook of Agricultural Statistics, BBS, Dhaka, 1999.

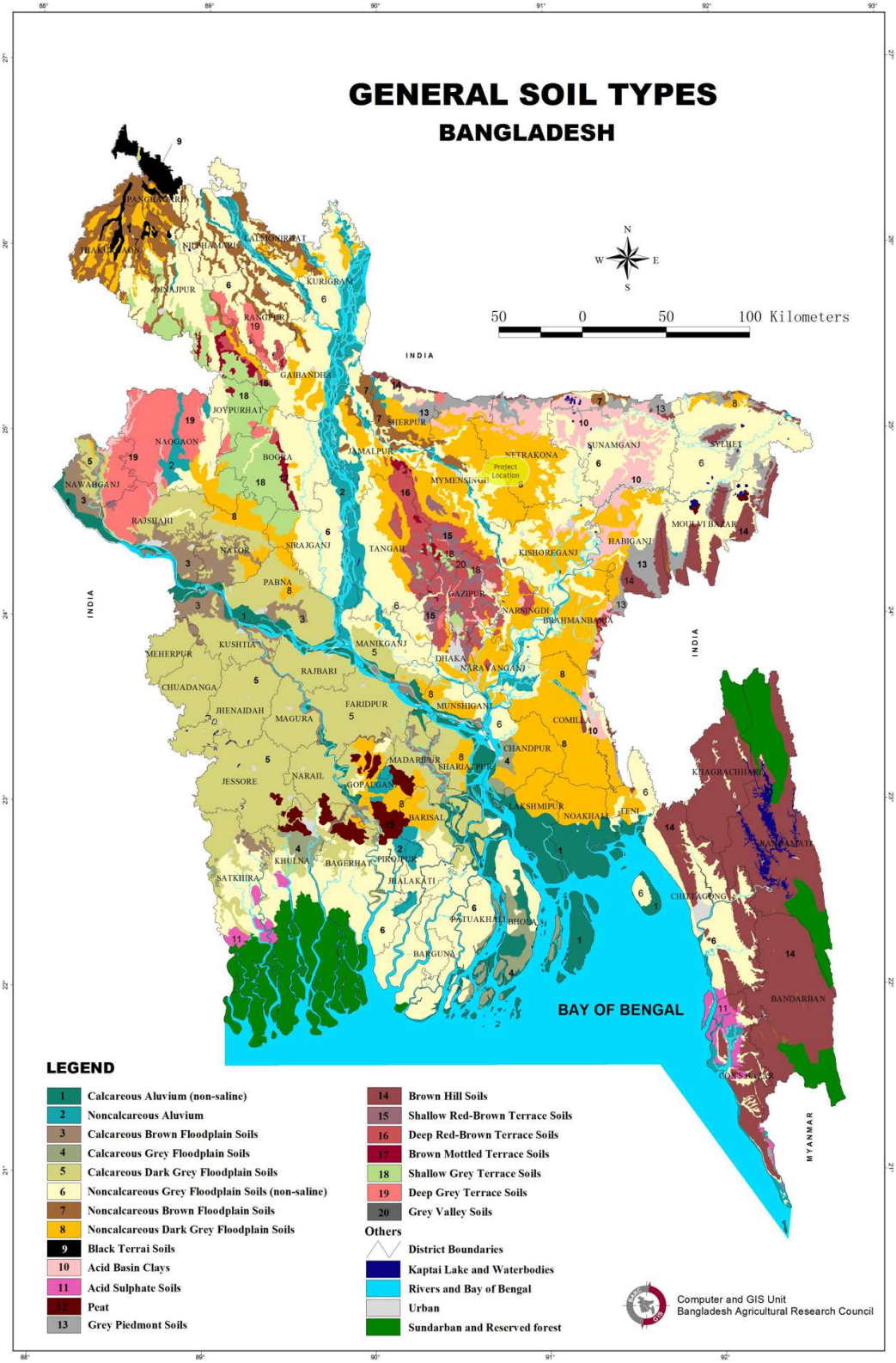


Figure 5-6 General soil types of Bangladesh

Figure 5-7 Soil Type of the Project Area

More specific soil type distribution can be seen in the above figure (Figure 5-7), From the project road alignment beginning at the south west end for 2 km the soil is mostly silty clay as shown in dark green. Then for a small stretch for approximately 0.5 km the topsoil is mixed silt loam. Then the roadway goes through an urban area as shown in orange. After crossing the Old Brahmaputra River the proposed roadway alignment on the north east side, the topsoil is mostly silt loam as shown in blue.

Landform: A remarkable change in the course of the Brahmaputra took place in 1787. In that year, the river shifted from a course around the eastern edge to the western side of the Madhupur tract. This new portion of the Brahmaputra is named the Jamuna. The old course (old Brahmaputra) between Bahadurabad and Bhairab shrank through silting into a small seasonal channel only two kilometers broad. The old river had already built up fair high levees on either side over which the present river rarely spills. The Old Brahmaputra floodplain stretching from the southwestern corner of the Garo Hills along the eastern rim of the Madhupur Tract down to the Meghna river exhibits a gentle morphology composed of broad ridges and depressions. The latter are usually flooded to a depth of more than one meter, whereas the ridges are subject to shallow flooding only in the monsoon.

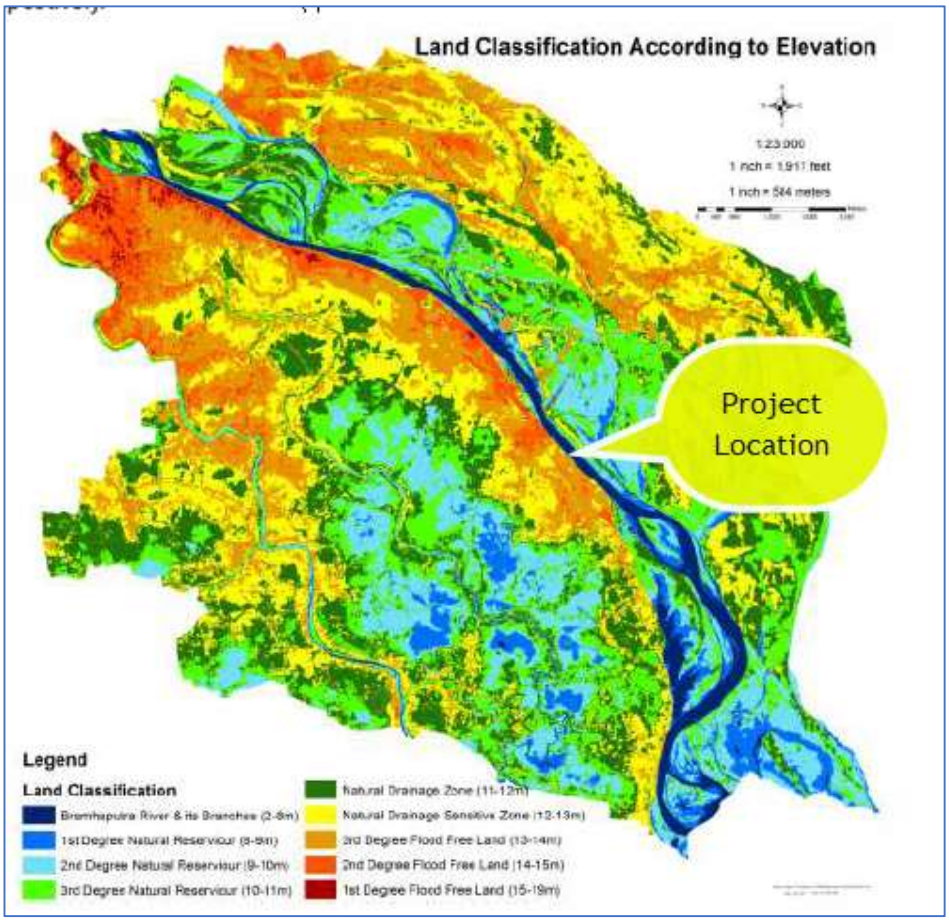


Figure 5-8 Land classification according to elevation

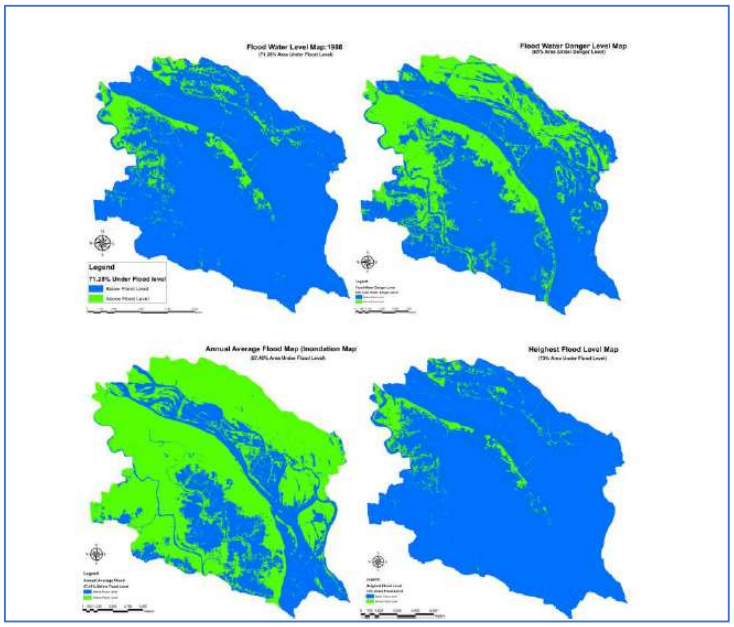


Figure 5-9 Different Flooding Scenario

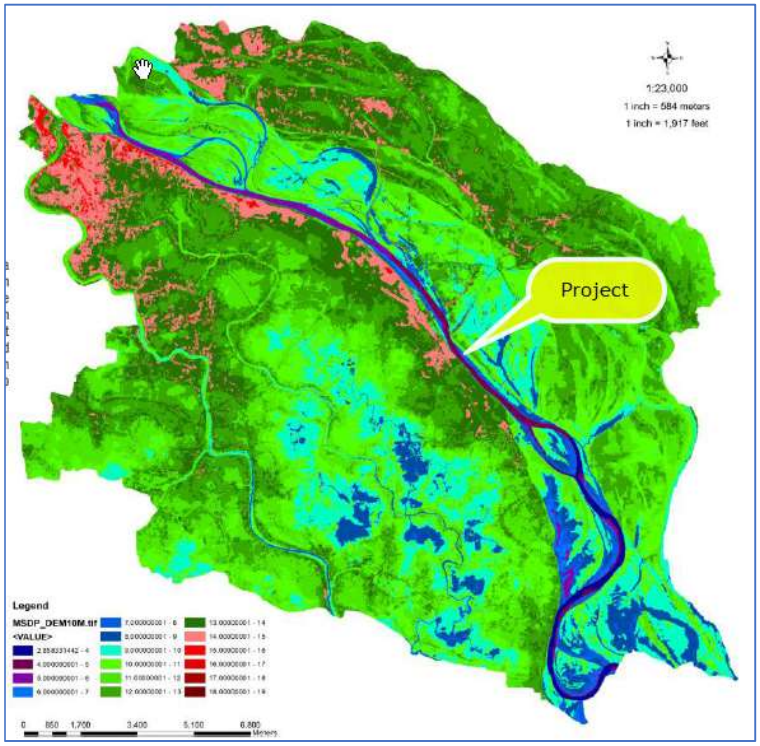


Figure 5-10 Digital elevation model of the project area

5.4 Hydrological Study, Drainage and River Training Works

5.4.1 Hydrology and drainage

For the assessment planform development in the study reach, dry season satellite images analyzed to assess the development and change of planform of the Old Brahmaputra River, which is presented in Figure 5-11 (Institute of Water Modeling , IWM 2015[8]) It has been observed that the river was bifurcated with a medial bar at the upstream of the proposed bridge location along with sand bars both upstream & downstream proposed bridge location as well as the river was wider in 1989. Later in 1997, the presence of vegetation was observed in the medial bar which bifurcated into two channels (left & right) and the presence of sand bars was observed. However, the river become narrower compared to 1989.

In 2005, more vegetation coverage was found along the left channel, which makes it inactive during dry season, and right channel was active. The presence of sandbars was less and river becomes narrower. Since then trend of declining the river corridor is clearly visible until now. This could be easily linked with the hydrological data that reduction of flow volume over time made the river more inactive. This would trigger in lessening the width of the river and the flow area.

The proposed bridge is connected with the approach road at both banks of the Old Brahmaputra River after crossing the river. The location of proposed Kewatkhali Bridge has been decided suitable location considering construction of safe, economical and easily maintainable crossing, having regards to approach requirements and to the nature of the waterway and its environment.

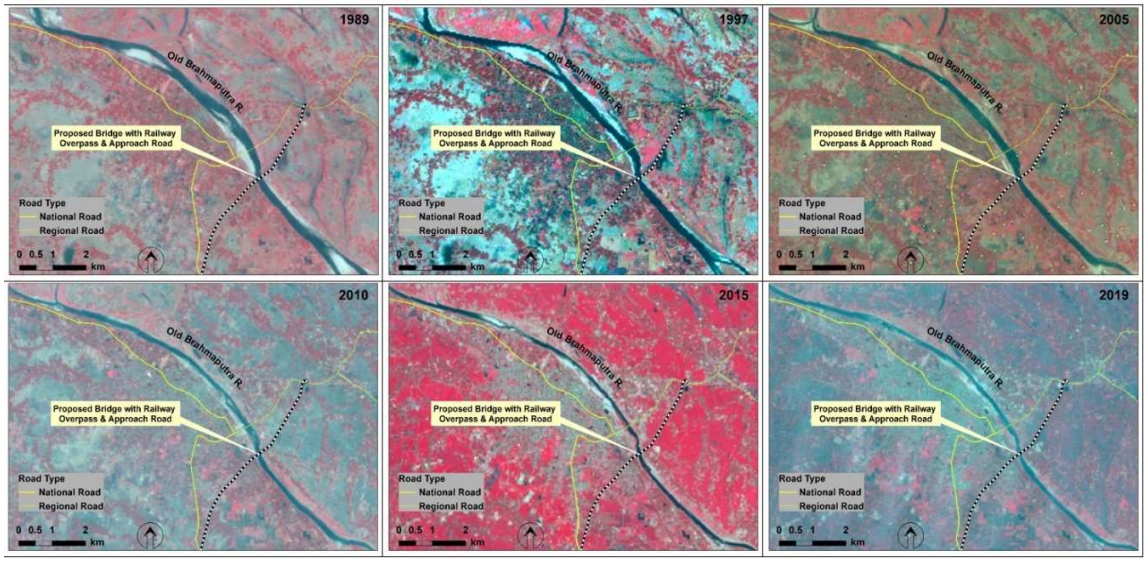


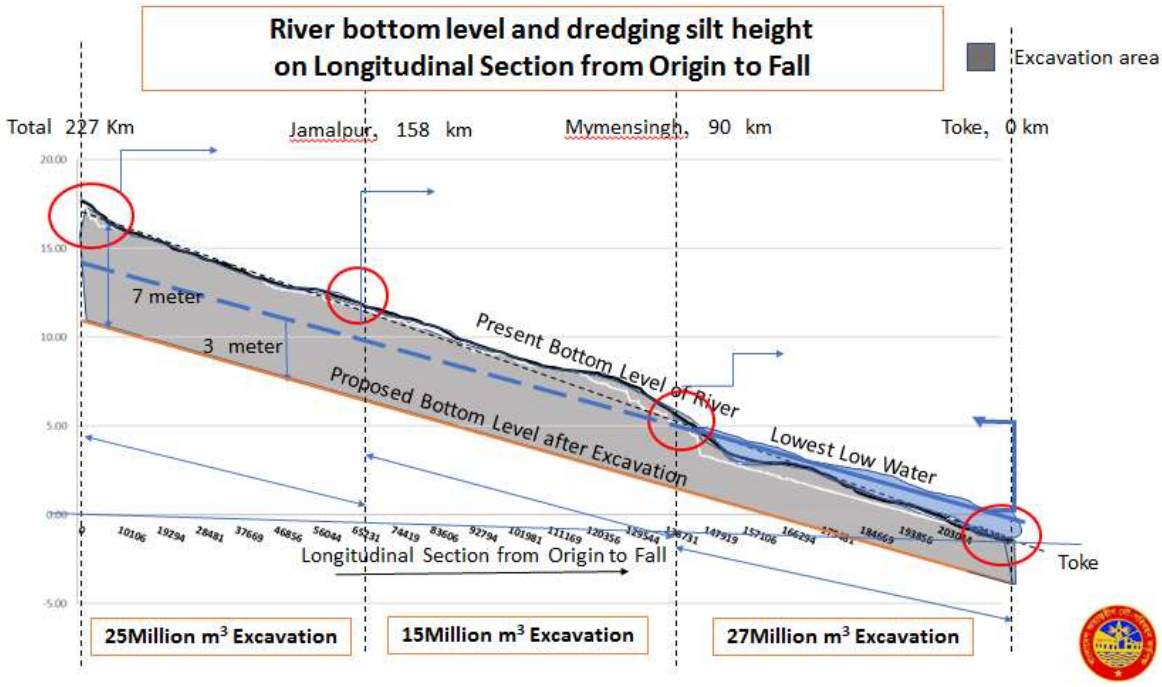
Figure 5-11 Development of Planform in the last 30 years in the study area

[8] Institute of Water Modelling (IWM) 2015. Hydro-morphological study of the Brahmaputra river and adjoining area of the river for construction of a Bridge at 3rd km of Mymensingh-Raghurampur-Netrokona-Monohonganj-Jamalganj-Sunamganj road under Mymensingh road division, December 2015

5.4.2 low flow and dredging

The original Brahmaputra which flows through Jamalpur district and South-East of Mymensingh and falls in the upper part of Meghna River. Only in the rainy season, big cargoes and trollers ply when water level rises in this portion of river. In the dry season, the river gets separated from Jamuna river and almost dried up due to changing pathway of Jamuna river and a lot of siltation in origin face. As a result, agriculture and fisheries breeding system are decreased and creates a great impact on local economy.

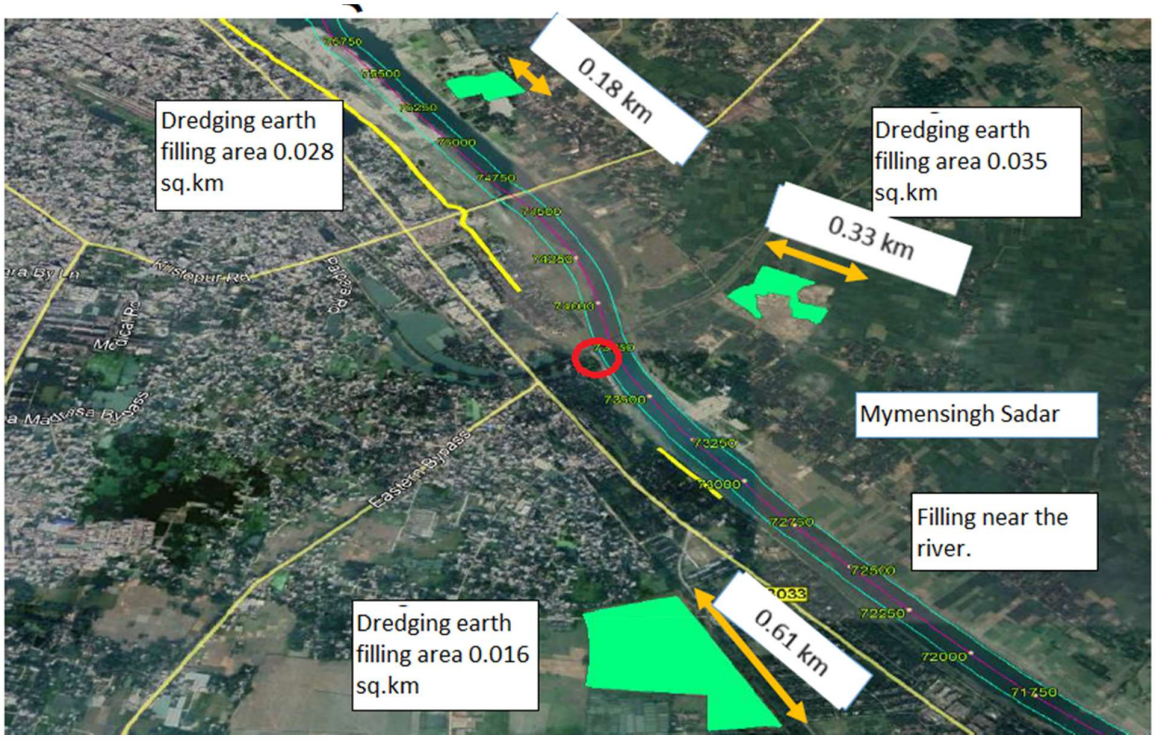
According to the Bangladesh Inland Water Transport Authority (BIWTA), there is no flow in the river during dry season at the existing condition, whereas in the dredged condition, there remains flow in the dry season. However, challenge is to ensure sustained dry season flow through establishment of linkage and sediment management. Due to BIWTA's ongoing dredging activity, the minimum river inflow from Jamuna river will be remained around 50m3/s from January to April. The length of the present river will be developed from the source to Toke via Bhairab as shown in Figure 5-12 under this project, about 227 km length and average bottom width of 100m will be dredged.



Source) BIWTA data (2019)

Figure 5-12 Dredging Longitudinal section plan of Old Brahmaputra

The proposed Kewatkhali Bridge will be located within from No.73.500 to No.73.750 of dredging section at Figure 5-13. Dredged soil from river should be used for the development of local people and social organization.



Source) BIWTA data (2019)

Figure 5-13 Dredging Locations at the Project Site

5.4.3 Water level

Yearly maximum water level data in the past 50 years (from 1970 to 2019) at Mymensingh Station (228.5) on the Old Brahmaputra River suggests that peak (monsoon period) water level is decreasing.

5.5 Climate

The weather and climatic condition of the project is similar to that of Dhaka and nearby areas. The project area is under the typical monsoon climate prevailing in the country. It has three main seasons as shown in Table 5-3

Table 5-3 Seasons in Project Area

Season	Months
Summer/pre-monsoon	March to Ma y
Rainy season/monsoon	June to October
Winter	November to February

The summer is hot and dry interrupted by occasional heavy rainfall. The rainy season is also hot and humid having about 88 percent of the annual rainfall. The winter is predominantly cool and dry. The average low temperature occurs in November to January while the average high temperature high temperature may be occurring in May.

5.5.1 Precipitation

According to Wikipedia Approximately 87% of the annual average rainfall of 1,739 millimetres occurs between May and October. Monthly rainfall distribution has been shown in .

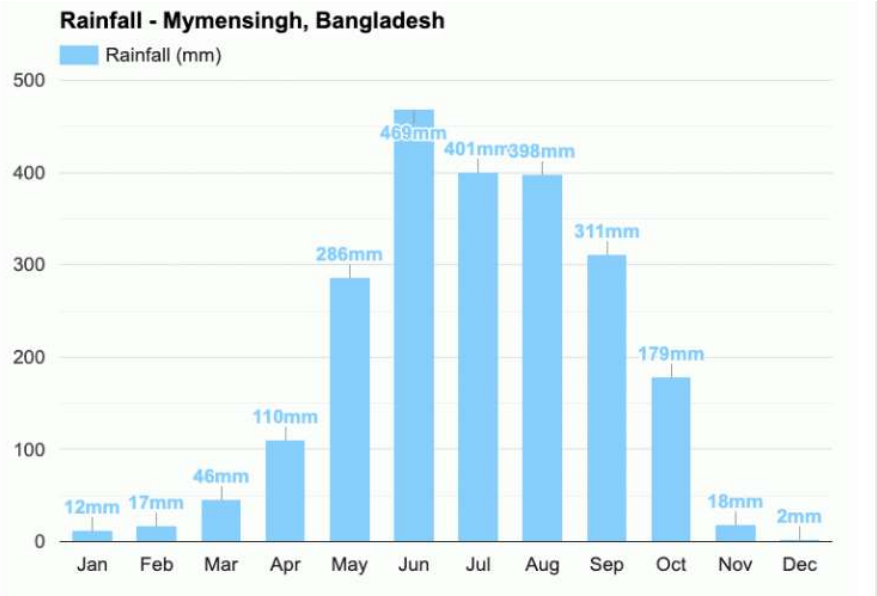


Figure 5-14 Average Rainfall in Mymensigh

5.5.2 Temperature a

The climate of Mymensingh is moderate, much cooler than Dhaka, as it is closer to the Himalayas. The monsoon starts in May or June and continues till August. It rains heavily and sometimes for days and weeks. During the monsoon, the temperature varies between 15 and 20 degrees. The temperature falls below 15 °C (59 °F) in winter which is spread over December and January and may well include November and February. The highest temperature is felt during April–May period, when the temperature may be as high as 40 °C (104 °F). High humidity causes heavy sweating during this period. For western travellers, the best time to visit is between November and February.

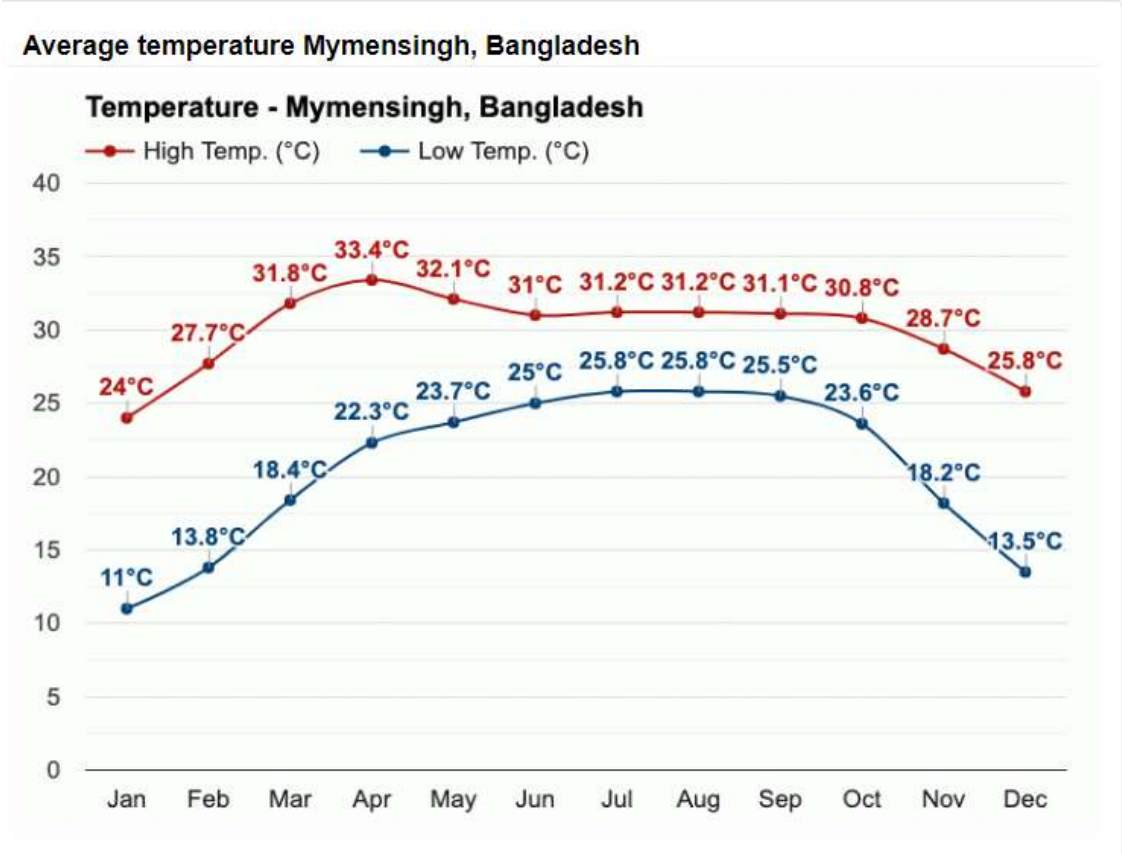


Figure Maximum and minimum temperature

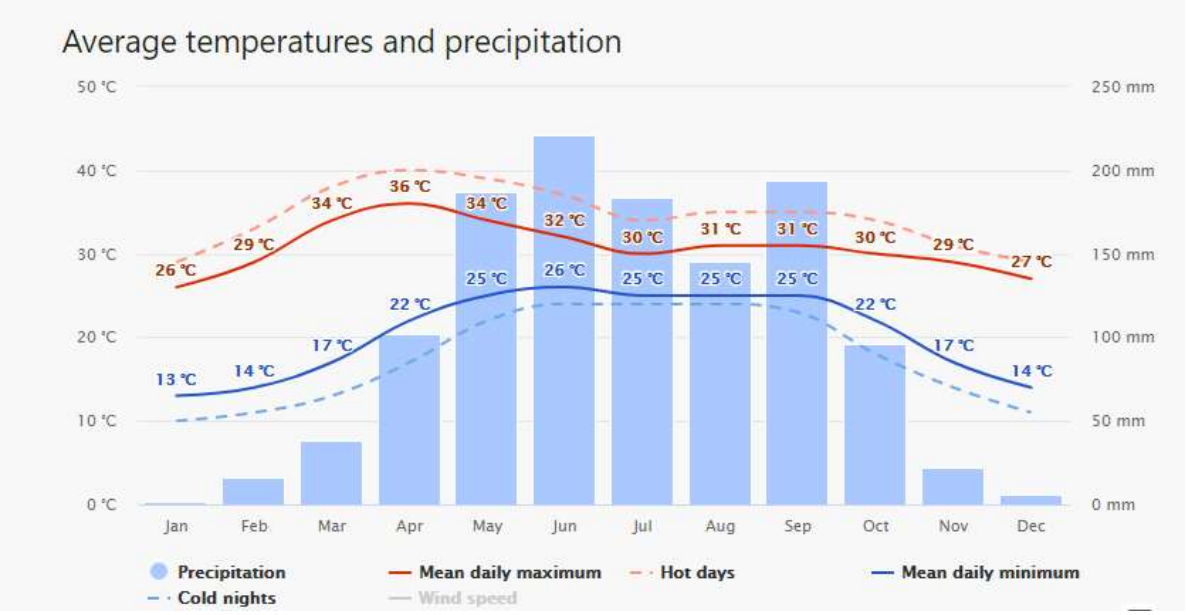


Figure 5-15 Average temperature and precipitation

5.5.3 Humidity

Mymensingh experiences extreme seasonal variation in the perceived humidity. The muggier period of the year lasts for 8.2 months, from March 19 to November 25, during which time the comfort level is muggy, oppressive, or miserable at least 25% of the time. The muggiest day of the year is August 5, with muggy conditions 100% of the time.

The least muggy day of the year is January 11, with muggy conditions 1% of the time.

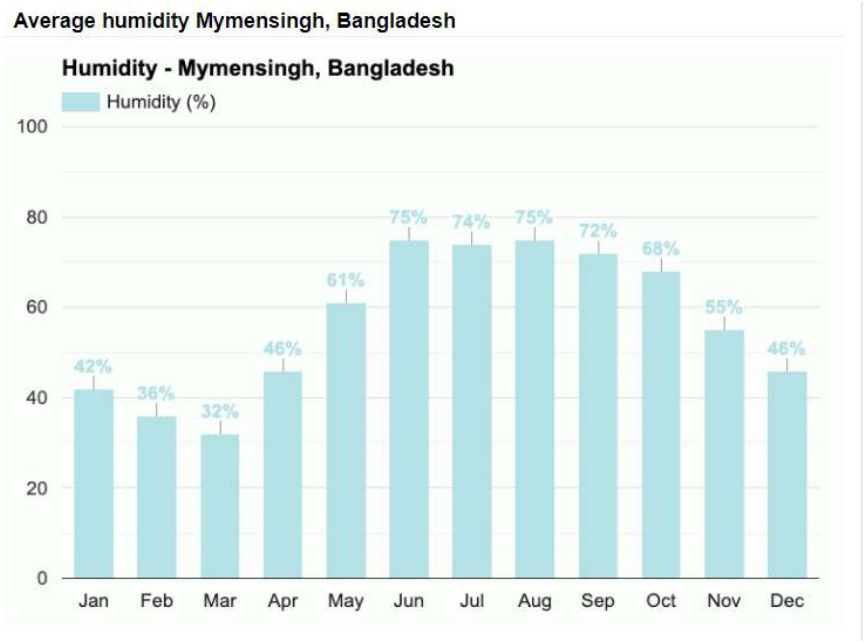


Figure 5-16 Average humidity in Mymensingh

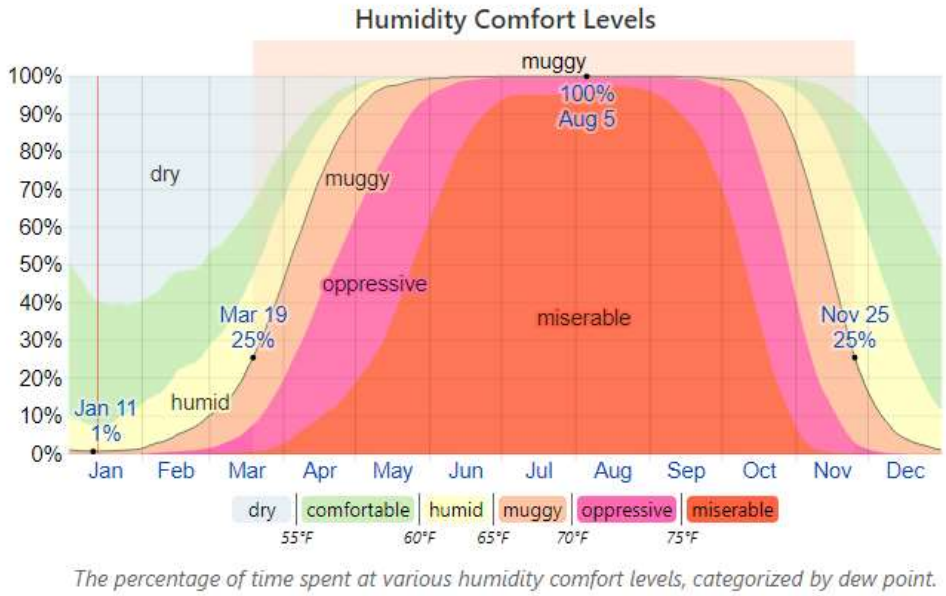


Figure 5-17 Humidity comfort levels

5.5.4 Wind

This section discusses the wide-area hourly average wind vector (speed and direction) at 10 meters above the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages.

The average hourly wind speed in Mymensingh experiences significant seasonal variation over the course of the year.

The windier part of the year lasts for 5.3 months, from March 28 to September 5, with average wind speeds of more than 6.3 miles per hour. The windiest day of the year is July 7, with an average hourly wind speed of 8.7 miles per hour.

The calmer time of year lasts for 6.7 months, from September 5 to March 28. The calmest day of the year is November 28, with an average hourly wind speed of 3.9 miles per hour.

The predominant average hourly wind direction in Mymensingh varies throughout the year.

The wind is most often from the west for 1.9 months, from January 26 to March 24, with a peak percentage of 46% on March 2. The wind is most often from the south for 6.5 months, from March 24 to October 8, with a peak percentage of 77% on July 11. The wind is most often from the north for 3.3 months, from October 18 to January 26, with a peak percentage of 42% on January 1.

The key parameters of wind are shown in the following figures.

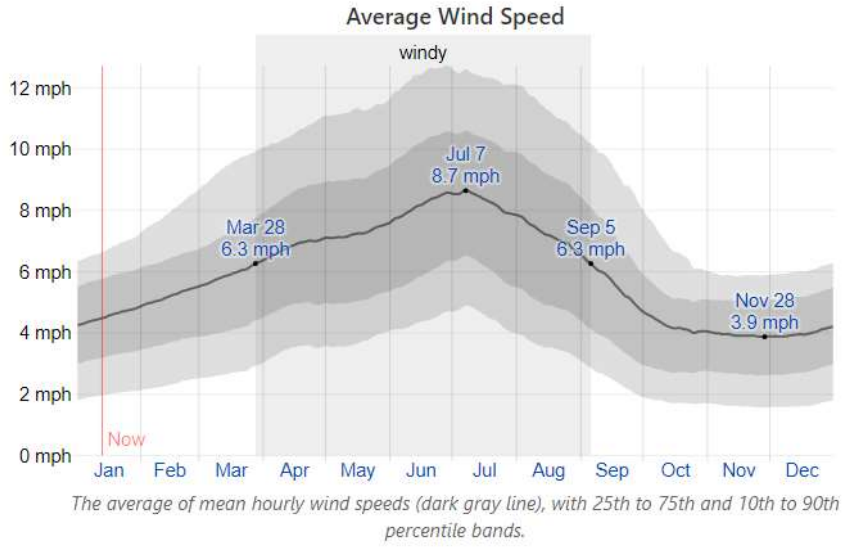


Figure -5-18 Wind Speed for Mymensingh

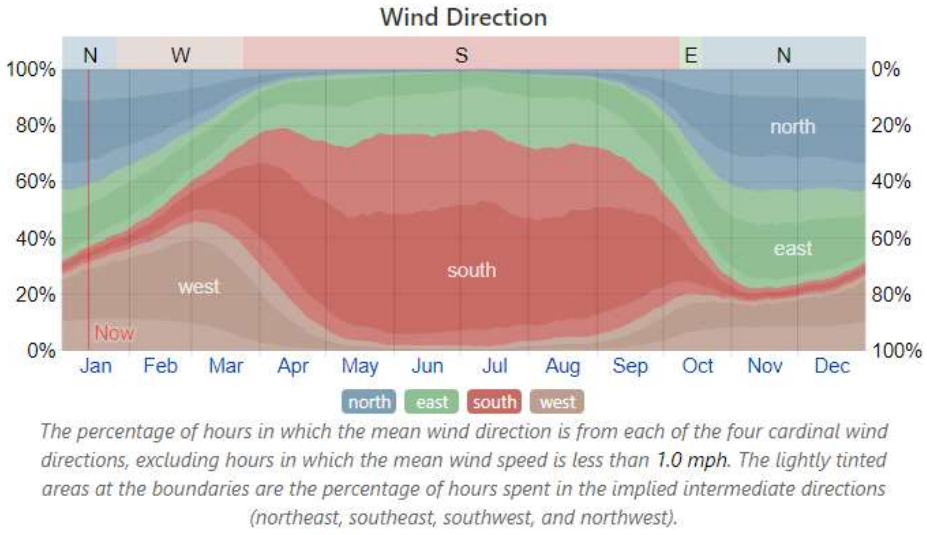


Figure 5-19 Wind direction

Monthly average wind rose for Mymensingh meteorological stations have been collected from BMD .Wind rose shows the frequency of winds blowing from particular directions. Wind roses typically use in 16 cardinal directions, such as north (N), South(S), South East (SE) etc. The length of each "spoke" around the circle is related to the frequency that the wind blows from a particular direction per unit time.

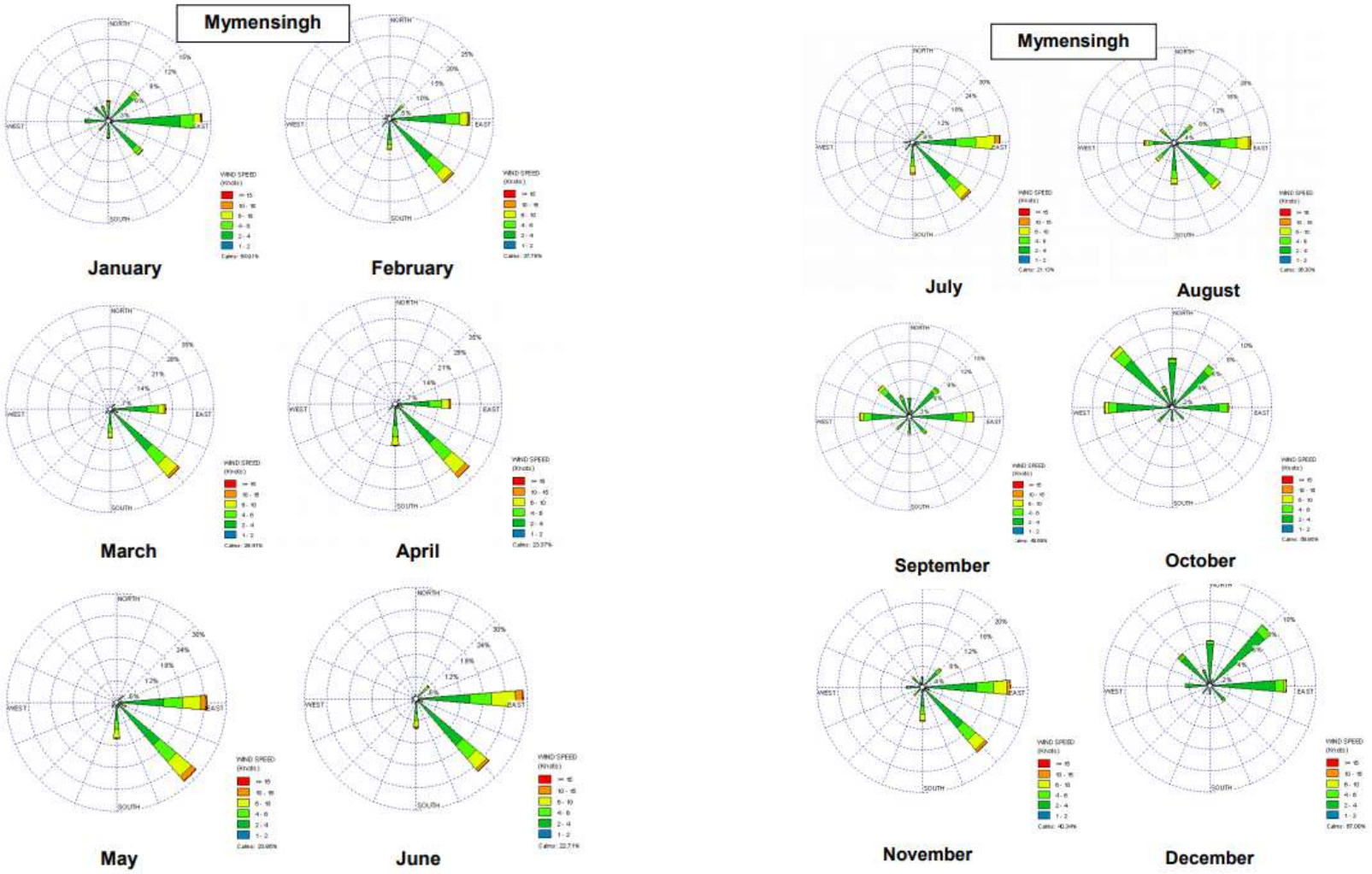


Figure 5-20Wind Rose Diagram Mymensingh

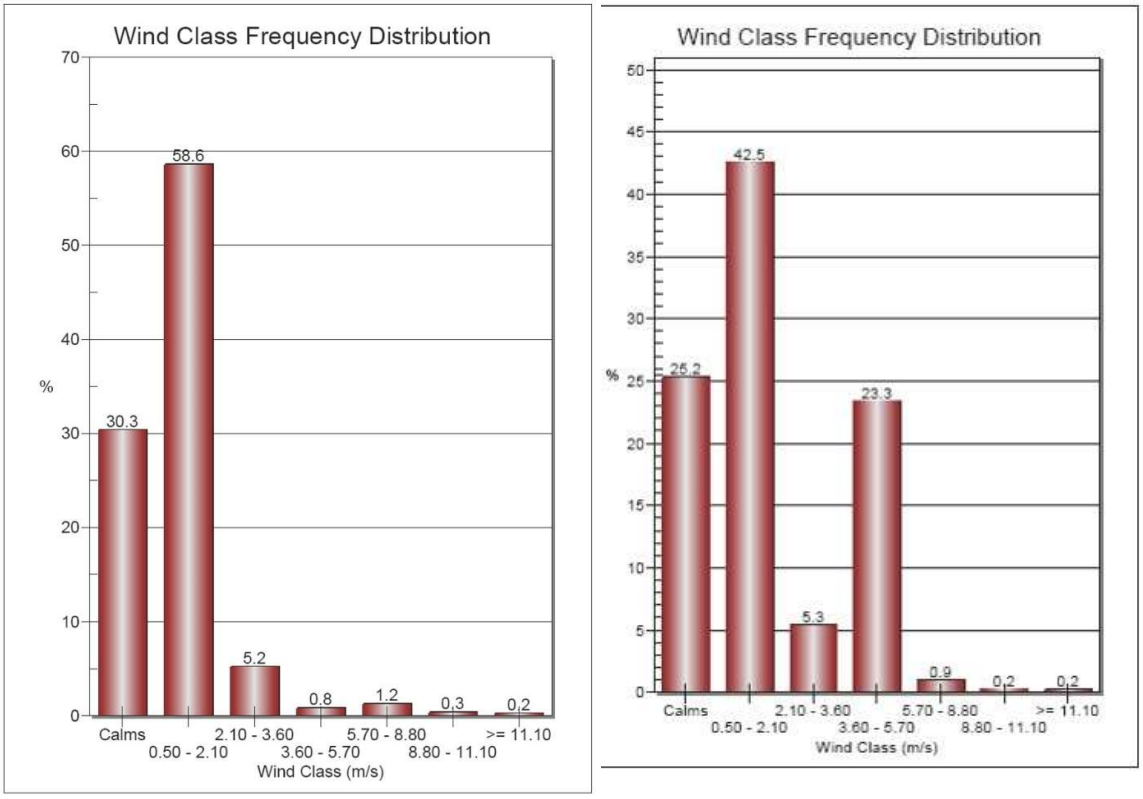


Figure 5-21 Wind class Frequency Distribution

5.6 Natural Hazard

5.6.1 Seismicity

Mymensingh municipality lies in one of the most earthquake prone areas of Bangladesh. The town was completely destroyed during the Great Indian Earthquake of 12 June 1897 having a surface-wave magnitude of 8.1. In this study, 1897 Great Indian Earthquake was used as a scenario event by Bangladesh University of Engineering and Technology (BUET) for developing seismic microzonation maps for Mymensingh as shown in Figure 5-23

Figure 5-22 shows the seismic zoning map of Bangladesh. Mymensingh falls in zone 4 with a seismic coefficient of 0.25g. Recent earthquakes in and adjoining areas of Bangladesh is a wake up call for the Bangladeshi people to take adequate measures against earthquake.

Figure 5-22 Bangladesh Seismic Zone

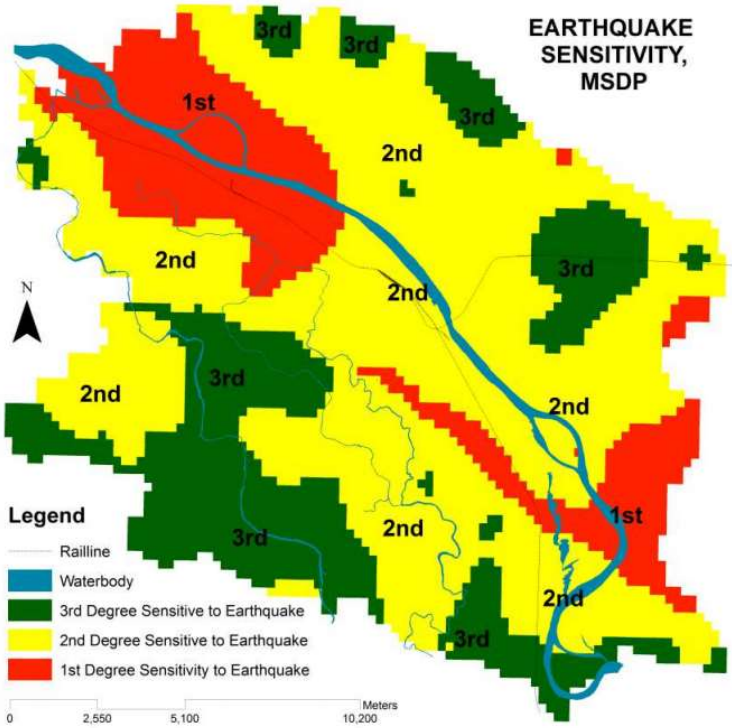


Figure 5-23 Earthquake Sensitivity Map

Based on Figure 5-23 the propose MKBIP will fall within mostly the 2nd and 3rd degree sensitivity to earthquake.

5.6.2 Flooding Hazard

5.6.2.1 Overview

Old Brahmaputra River is one of the major distributary of the Brahmaputra-Jamuna river of Bangladesh carrying a small but significant amount of the Brahmaputra-Jamuna flow to the Upper Meghna River (Ahmed, 2018). Flood along the Old Brahmaputra frequently occurs during the rainy season (BWDB, 2010). Mymensingh, Kishoreganj and surrounding districts are notable among the flood affected districts of Bangladesh. The danger level at Jamalpur (SW 225) and Mymensingh (SW 228.5) of Old Brahmaputra River is 17 m and 12.5m respectively. Locations of the water level measuring stations in Jamalpur and Mymensingh Sadar are shown in Figure 5-24

Figure 5-24 Locations of the water level measuring stations in Old Brahmaputra River

The peak water levels of the Old Brahmaputra River during monsoon are documented in different Annual Flood Reports of FFWC. In 2011, the water level of Old Brahmaputra River at Jamalpur showed rise and fall during the monsoon, one peak of 15.30 m, one of 15.25 at the 2nd week of August and the last and the highest one at 3rd week of August was recorded 15.41m. At Mymensingh the water level of the river followed the similar trend; the recorded peak was 10.72m on 19th August. Hydrograph of Mymensingh water level measuring station of BWDB is presented in Figure 5-25.

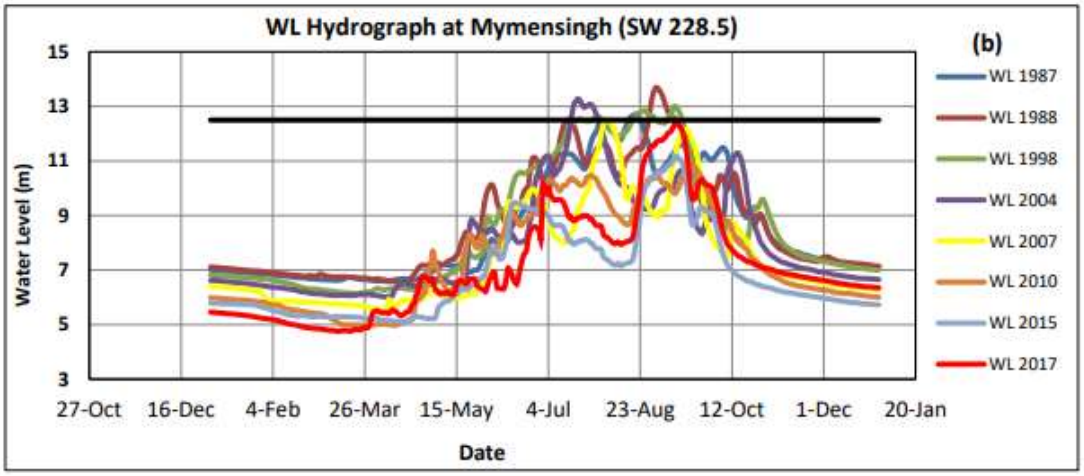


Figure 5-25 Hydrograph at Mymensingh (BWDB Station: SW 228.5)

5.6.2.2 Analysis of Historical Flood Events of Old Brahmaputra River

It has been recorded that during the historical flood event in Bangladesh, the water level in Old Brahmaputra River was above the danger level and caused flooding on the nearby floodplain. During the devastating floods of 1998 and 1988 in Bangladesh, the water level in Old Brahmaputra at Jamalpur (SW 225) was 17.47 m and 17.83m respectively exceeding the danger level. At Mymensingh (SW 228.5) the water levels were recorded as 13.04m and 13.69m during the devastating floods of 1998 and 1988 respectively both exceeding the danger level of the water level at Mymensingh.

5.6.2.3 Analysis on Future Flood Events

Analysis on Future Flood Inundation Depth under Climate Change Scenario of RCP (Representative Concentration Pathway) 8.5

Old Brahmaputra River has been simulated for the flood events of few years including 1988, 1998, 2004, 2007, 2010, 2013, 2016 and 2017. Later, exported RASTER file of inundation depth of the study area for the historical flood years have been post- processed to prepare maps showing flood depths categorizing the depths into five classes. The classes were denoted as (F0), (F1), (F2), (F3) and (F4) with range of the flood depth of 0m-0.30m, 0.3m-0.9m , 0.9m-1.8m 1.8 m-3.6 m and more than 3.6 m respectively as prescribed by the National Water Management Plan (NWMP). Figure 5-26 shows the inundation depth maps of Old Brahmaputra river floodplain for the maximum inundation condition of the year 1988, 1998, 2004, 2007, 2010, 2013, 2016 and 2017 respectively.

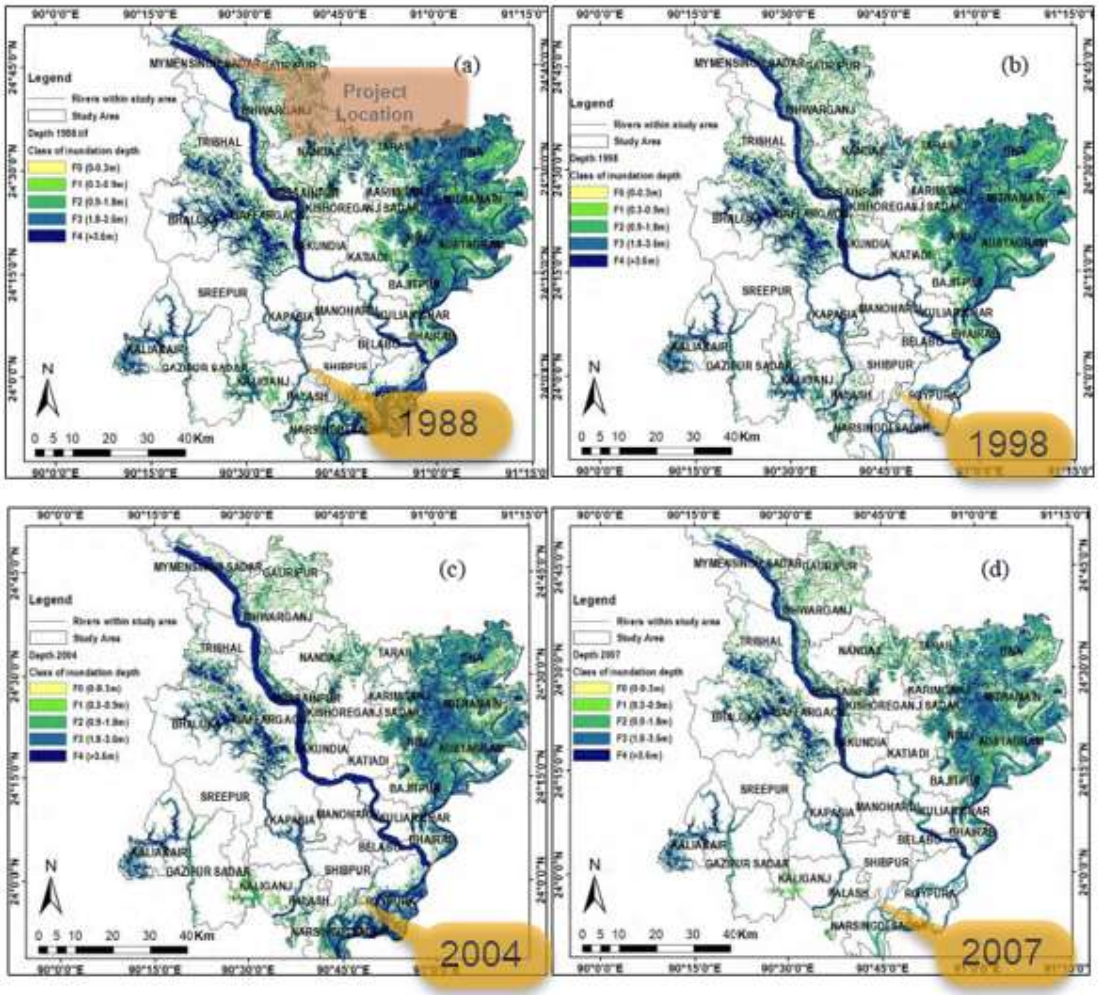


Figure 5-26 Flood Inundation Based on Historical Event

The flood inundation maps of base period, 2020s, 2050s and 2080s for RCP 8.5 scenario are shown in Figure 5-25. In these inundation maps, flood depths are classified in 5 classes: F0 (0-0.3m), F1 (0.3m- 0.9m), F3 (0.9m-1.8m), F4 (1.8m-3.6m) and F4 (>3.6m) as adapted for the historical flood depth mapping. Comparison on the classified flood maps of different time regime shows that, there is an increasing trend of flood depth from baseline to 2080s as the flood depth mapping turns more bluish as we move to future.

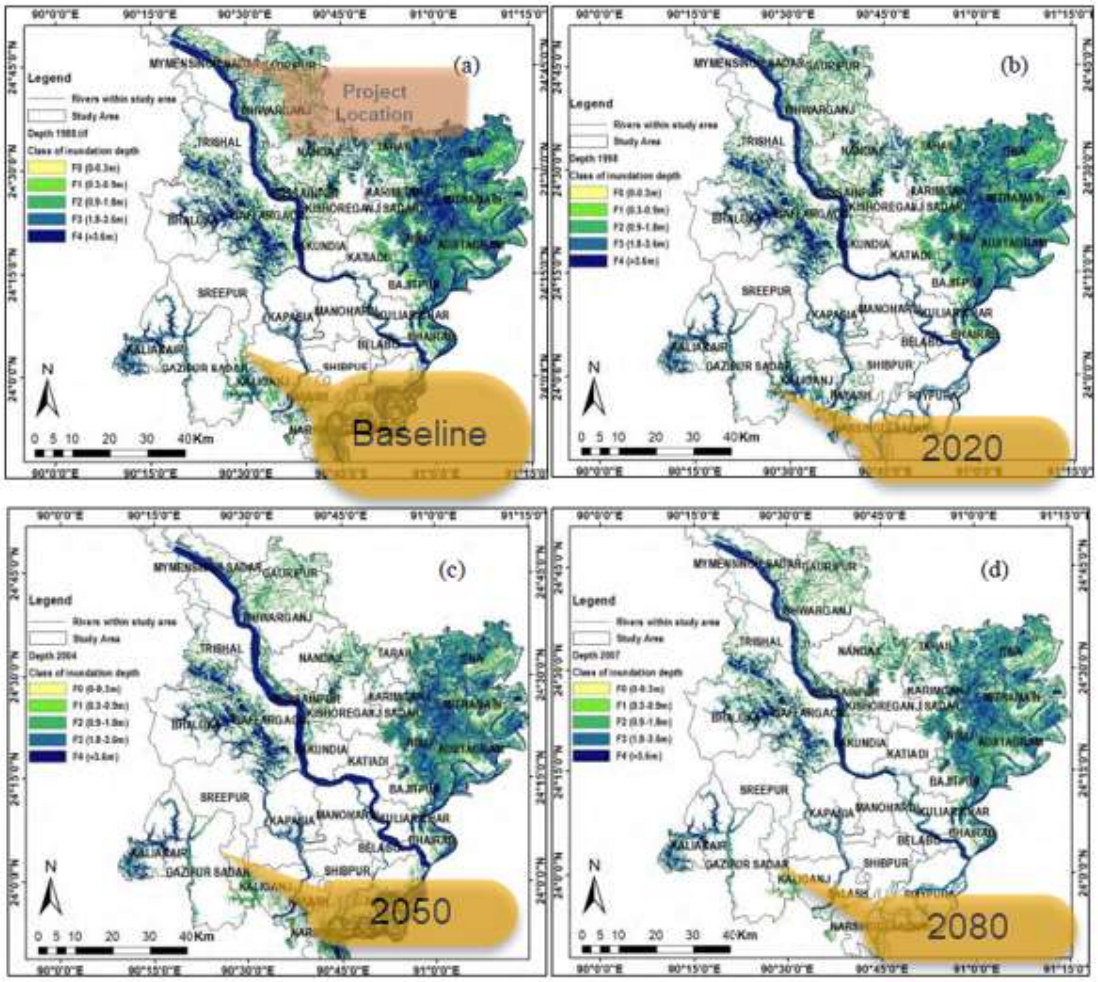


Figure 5-27 Flood inundation maps for RCP 8.5 scenario (a) baseline period (b) 2020s (c) 2050s and (d) 2080s

5.7 Environmental Quality Assessment

5.7.1 Introduction

The existing environmental quality in the project influence area serves as the basis for identification, prediction and evaluation of potential environmental impacts of the proposed project interventions. The baseline environmental quality has been assessed through field studies from 14-19 March 2020 and 20-23 December 2020 within the impact zone and analysis the information for various components of the environment, viz. air, noise, water, soil, riverbed sediment, benthos and plankton etc.

5.7.2 Materials and methods

The methods used for environmental quality are described in the following paragraphs:

1. **Air quality:** The scope of work includes air quality monitoring in Five (05) locations for eight hours duration. The parameters monitored were: Suspended Particulate Matter

(SPM), PM2.5 and PM10, SO2, Carbon Monoxide (CO), Nitrogen Oxides (NOx) and Pb.

2. **Noise:** The objective of the survey is to measure the baseline noise level of the project area and the project surrounding areas. Noise level is monitored were measured for 30 minutes during day and night time at Six (06) locations encompassing both sites of the proposed bridge and approach road.
3. **Vibration:** Vibration level were measured at Five (05) locations at day time encompassing both sites of the proposed bridge and approach road for 15 minutes. Within these 15 minutes, 5 minutes for velocity, 5 minutes for acceleration and 5 minutes displacement data were taken.
4. **Surface water quality:** Baseline parameters selected for the study are: pH, Temperature, Turbidity, Electric conductivity (EC), Chemical Oxygen Demand (COD), Biochemical Oxygen demand (BOD), Total Dissolved Solids (TDS), Total suspended Solids (TSS), Dissolved Oxygen (DO), Nitrate and Phosphate. Four (04) surface water samples were collected from the both sites (downstream and upstream of the proposed project site) of the Old Brahmaputra River and adjacent ponds of the approach road.
5. **Ground water quality:** The following parameters are studied for assessing the groundwater quality area pH, Turbidity, Salinity, Total Dissolved Solids (TDS), Chloride, Electric conductivity (EC), Salinity, Total suspended Solids (TSS), Arsenic (As), Iron (Fe) and Manganese (Mn). A total Three (03) groundwater samples are collected from both sides of the Kewatkhali Bridge and approached road locations.
6. **Soil quality:** Soil samples were collected and analyzed for physical, chemical and biological parameters. Two (02) soil samples were collected at the nearby roadside and agricultural lands along the project corridor. The soil was tested for Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb) and Zinc (Zn).
7. **Riverbed sediment:** Riverbed sediments were collected along the proposed bridge locations and analyzed for the heavy metals. Riverbed sediment of the rivers were collected from Two (02) locations (upstream and downstream) of the Old Brahmaputra River where the proposed bridge will be constructed. The Baseline parameters for the riverbed sediment quality area were analyzed for: Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb) & Zinc (Zn).

The details of the methodology for collection and analysis of sample are provided in Appendix

5.7.3 Results and Discussions

5.7.3.1 Air Quality

Ambient air quality data at the project site were measured to verify the current quality of air. The aim was to collect the baseline air quality data and to compare the data with the air quality data during project activities to check if there is any high air pollution level due to the construction activities and to design adequate mitigation measures, as applicable. The main air pollutants in the project location are SPM, $PM_{2.5}$ and PM_{10}, SO_X, Carbon Monoxide (CO), Nitrogen Oxides and Lead. Motor vehicles are the major source

of PM pollution. Most of the PM pollutants (greater than 80%) come from diesel-run vehicles. Around the project influenced area, huge amount of brick kilns is existing that contribute to high levels of particulate matter operate during the dry months November– April. Dispersal of pollutants depends upon factors like prevailing wind direction and other weather conditions, atmospheric stability, height of the source. The air quality monitoring was performed at selected locations (see). All the locations of air quality sampling are showed in . Results of the air quality monitoring are given in . Analysis of each measured parameters are given the next paragraphs. The Details analysis are given in Appendix 4 of the report.

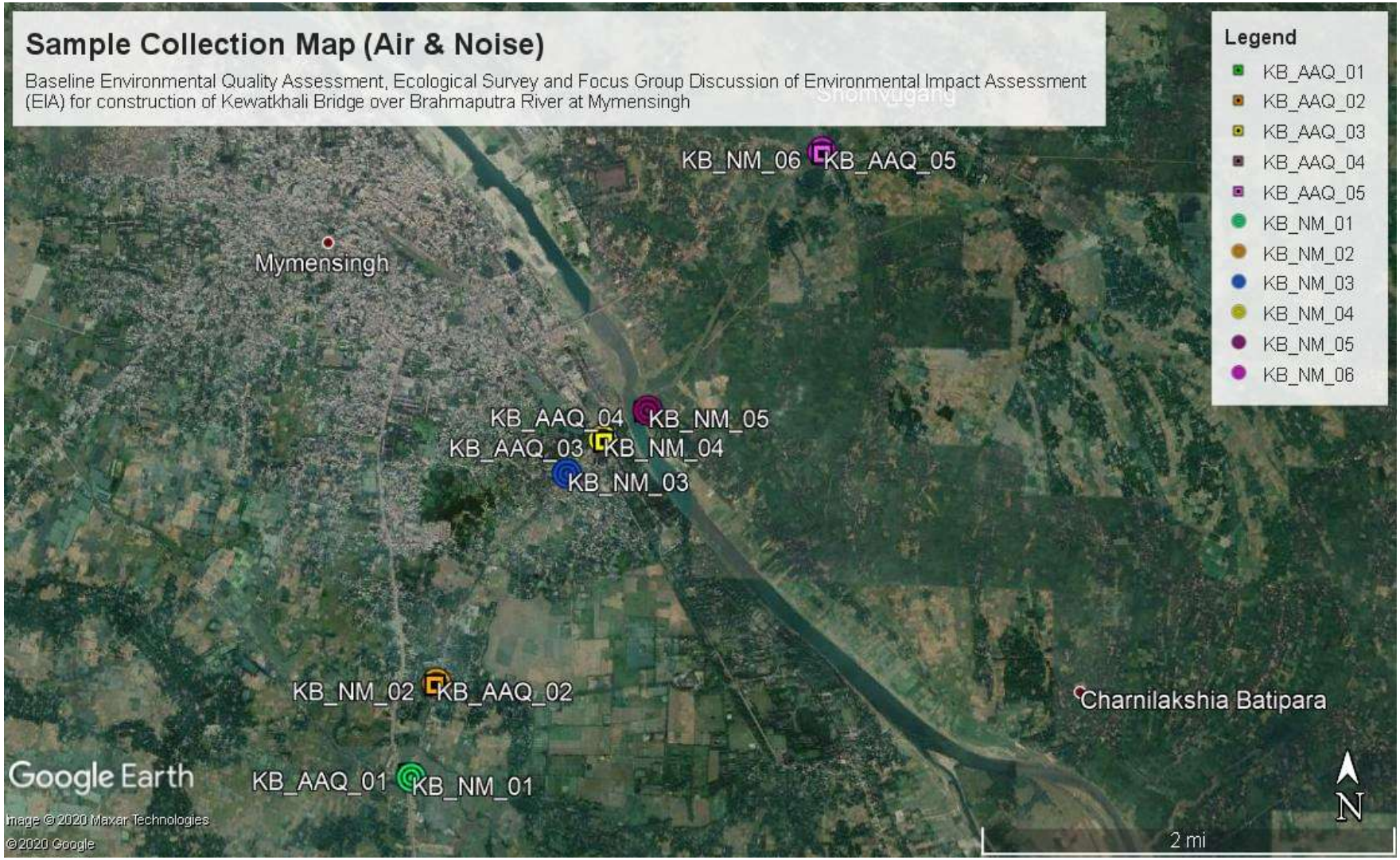


Figure 5-28: Air Quality and Noise Monitoring Sample Collection Map

Table 5-4 Test Results of Ambient Air Quality Monitoring

Sample ID	Location	GPS Location	SPM (µg/m³)	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	SO_x (µg/m³)	NO_x (µg/m³)	Pb (µg/m³)	CO (mg/m³)
KB_AAQ_01	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh	24.71695°N 90.41014°E	120.45	58.23	78.21	16.32	35.67	0.04	1.15
KB_AAQ_02	Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh	24.72303°N 90.41205°E	90.13	36.31	56.12	09.39	26.43	0.02	1.15
KB_AAQ_03	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh	24.73991°N 90.42509°E	112.32	50.98	73.34	18.23	38.21	0.03	2.29
KB_AAQ_04	Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh	24.74203°N 90.42829°E	68.13	29.90	45.67	10.34	22.11	0.002	0.95
KB_AAQ_05	Char Jhaugora, Mymensingh Sadar, Mymensingh	24.76036°N 90.44234°E	99.54	41.87	61.17	11.87	29.56	0.02	1.15
Duration (Hours)			**24**	**24**	**24**	**24**	**Annual**	**Annual**	**08**
Weather Condition			**Sunny**						
Bangladesh Standard for Ambient Air Quality			**200**	**65**	**150**	**365**	**100**	**0.5**	**10**
WHO standards for Air Quality* **			**NYS**	**25**	**50**	**20**	**40**	**0.5**	**10**

DSCL Environmental Laboratory, April 2020

*Note: * CO concentrations and standards are 8-hourly only., NYS-Not Yet Standardized*

*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005; ***WHO Standards for Air Quality, 2005*

Table 5-5: Description of the Surrounding Environment

Sample Location and ID	Sample Site Description
Digharkanda Bypass More, Mymensingh Sadar, Mymensingh **KB_AAQ_01**	➢ The weather was mostly sunny ➢ People movement was High ➢ Traffic volume was high. ➢ Huge amount of dust particle present due to traffic movement. ➢ Temporary CNG Stand Area. ➢ Huge smoke coming from vehicles.
Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh **KB_AAQ_02**	➢ The weather was mostly sunny ➢ Moderate amount of dust particles is present. ➢ Low people movement ➢ Beside main road. ➢ Traffic volume was moderate.

Sample Location and ID	Sample Site Description
Kewatkhali Bypass, Mymensingh Sadar, Mymensingh **KB_AAQ_03**	➢ The weather was mostly sunny ➢ Huge amount of dust particle present due to traffic movement. ➢ People movement was high because of crowded Area. ➢ Traffic Volume was high and huge smoke coming from vehicles.
Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh **KB_AAQ_04**	➢ Adjacent to Kewatkhali rail bridge ➢ Lower amount of dust particles is present ➢ Weather was sunny ➢ Beside Brahmaputra river bank ➢ Moderate People Movement ➢ Low traffic volume ➢ The place is in residential area
Char Jhaugora, Mymensingh Sadar, Mymensingh **KB_AAQ_05**	➢ Beside Mymensingh-Netrokona Highway. ➢ Moderate amount of dust particles is present. ➢ People movement was high. ➢ Traffic volume was high.

SPM: The test results show that, for all the locations, SPM values did not exceed the national standard. The Value of SPM according to World Health Organization (WHO) is not yet Standardized at all. The result revealed that KB_AAQ_01 (Digharkanda Bypass More) has the highest concentration of SPM (120.45 µg/m^3) since it was observed that higher amount of dust particles is present in the sampling site due to excessive traffic movement. KB_AAQ_04 (Dakshin Char Kalibari) has the lowest concentration of SPM (68.13 µg/m^3) because of lower amount of dust particles is present in this area and the movement was traffic was frequent less.

$PM_{2.5}$: The test results show that for all of the locations the values did not exceed the national standard. According to WHO standards, the concentration of PM $_{2.5}$ is 25 µg/m3. So, from the test result $PM_{2.5}$ value is exceeding the WHO standard due to some dust particles for the nearby main road and other commercial activities. The result also reveals that KB_AAQ_01 (Digharkanda Bypass) has the highest concentration of $PM_{2.5}$ (58.23 µg/m^3) since it was observed that higher amount of dust particles is present in the sampling site due to other project construction works. KB_AAQ_04 (Dakshin Char Kalibari) has the lowest concentration of $PM_{2.5}$ (29.90 µg/m^3) because of the sampling site is in residential area and the amount of dust particles are comparatively low.

PM_{10}: From the above table of test results, it is seen that, the PM10 value did not exceeded the national Standard for all of the sampling locations. According to WHO standards, the concentration of $PM_{2.5}$ is 50 µg/m^3. So, from the test result it can reveal that the $PM_{2.5}$ value has been exceeding the WHO standard due to some dust particles from frequent vehicular movement in the main road and other anthropogenic sources. KB_AAQ_01 (Digharkanda Bypass) has the highest concentration of PM_{10} (78.21 µg/m^3) since it was observed that higher amount of dust particles is present in the sampling site due to huge amount of people and traffic movement. KB_AAQ_04 (Dakshin Char Kalibari) has the lowest concentration of PM_{10} (45.67 µg/m^3) because of the lower amount of dust particles and people movement.

NOx: The test results above show that, for all the locations the values are within the national standard. According to WHO standards, the concentration of NO_x is 40 µg/m^3. So, from the test result it can be revealed that the NO_x value was within the project standard. The above result explains that KB_AAQ_03 (Kewatkhali Bypass) has the highest concentration of NOx (38.21 µg/m^3) since it was observed that residential dwellings are very close to the sampling sites where

fossil fuel burned and some diesel-based vehicles are moved frequently. KB_AAQ_04 (Dakshin Char Kalibari) has the lowest concentration of NOx (22.1 µg/m^3) because there is minor existence of diesel-based vehicle movement around the sampling area.

SOx: From the test results it can be said that, for all the locations, the value was within the national standard. According to WHO standards, the concentration of SOx is 20 µg/m3. So, from the test result reveal that the SOx value was within the project standard. KB_AAQ_03 (Kewatkhali Bypass) has the highest concentration of SO_x (18.23 µg/m3) since it was observed that one brick filed are 100m away from the sampling site which emits the Sulphur gases and huge smoke coming from vehicles. KB_AAQ_02 (Hridoyer More) has the lowest concentration of NOx (09.39 µg/m3) because there is no existence of immediate residential dwellings and diesel-based vehicle movement around the sampling area is frequent.

CO: The above table shows that, for all the locations, CO was within the national standard. According to WHO standards, the concentration of CO is 10 mg/m^3. So, from the test result, it can be revealed that the CO value was within the WHO standard. CO Values were range from less than 1 to 2 ppm for all of the locations.

Lead (Pb): The above table shows that, for all the locations, Pb value was within the national standard. According to WHO standards, the concentration of Pb is 0.5 mg/m^3. So, from the test result, it can be revealed that the Pb value was within the WHO standard.

5.7.3.2 Noise Level Measurement

Excessive noise is a potential issue for both human and biological receivers and can cause a range of negative issues, from mild annoyance and moderately elevated levels of aggression to significant disturbance of behavioral patterns and in severe cases temporary or permanent hearing loss. Noise level measurement was analyzed at six project influenced locations from 15 March to 19 March 2020 (). All the locations of sample collection are shows in a Map (). Results of the noise level monitored at the project locations have been showed in . The details analysis of noise level measurement result is given in of this report.

Table 5-6: Test Result Noise Level Measurement

Sample ID	Location	GPS Location	Land Use Category	Measurement Time				Noise Level dB(A) (LA_{eq})		Bangladesh Standard*		WB EHS Standards**	
				Day		Night							
				Start	End	Start	End	Day	Night	Day	Night	Day	Night
KB_NM_01	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh	24.71659°N 90.41022°E	Commercial	09:21 am	09:51 am	09:11 pm	09:41 pm	69.98	63.70	65	55	70	70
KB_NM_02	Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh	24.72303°N 90.41205°E	Commercial	10:39 am	11:09 am	08:56 pm	09:06 pm	67.11	61.29	65	55	70	70

Sample ID	Location	GPS Location	Land Use Category	Measurement Time				Noise Level dB(A) (LA_{eq})		Bangladesh Standard*		WB EHS Standards**	
				Day		Night		Day	Night	Day	Night	Day	Night
				Start	End	Start	End						
KB_NM_03	Hakkani More, Balaspur Bypass Mymensingh	24.73751°N 90.42212°E	Commercial	12:24 pm	12:59 pm	08:00 pm	08:30 pm	66.31	62.89	65	55	70	70
KB_NM_04	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh	24.73992°N 90.42491°E	Commercial	01:04 pm	01:39 pm	09:22 pm	09:52 pm	71.97	66.40	65	55	70	70
KB_NM_05	Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh	24.74196°N 90.42845°E	Residential	09:12 am	09:42 am	08:38 pm	09:08 pm	57.78	47.28	55	45	55	45
KB_NM_06	Char Jhaugora, Mymensingh Sadar, Mymensingh	24.76037°N 90.44227°E	Commercial	11:06 am	11:39 am	08:48 pm	09:18 pm	68.17	62.56	65	55	70	70

Notes:
- *Land use category is based on the classification provided in the Noise Pollution Control Rules (2006).*
- *The sound level standard for residential area at day time is 55 dBA and night time is 45 dBA.*
- *The sound level standard for commercial at day time is 65 dBA and night time is 55 dBA.*
- *Noise Level is the average noise recorded over the duration of the monitoring period.*

**Bangladesh National Standard for Noise Level According to Noise Pollution Control Rules (2006)*

***World Bank Noise Standard according to WB Environmental, Health and Safety (EHS) Guidelines*

Table 5-7: Description of the Surrounding Environment

Sample Location and ID	Sample Site Description
Digharkanda Bypass More, Mymensingh Sadar, Mymensingh **KB_NM-01**	➢ People movement was high ➢ Traffic volume was high ➢ Commercial area ➢ Some grocery shop is present. ➢ Temporary CNG stand
Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh **KB_NM_02**	➢ People movement was moderate ➢ Traffic volume was high. ➢ Commercial area ➢ Beside Eastern Bypass Road
Hakkani More, Balaspur Bypass Mymensingh **KB_NM_03**	➢ Commercial area ➢ Beside bazar ➢ People movement was High. ➢ Traffic volume was high
Kewatkhali Bypass, Mymensingh Sadar, Mymensingh **KB_NM_04**	➢ People movement was high. ➢ Traffic volume was high. ➢ Commercial area. ➢ Crowded Area.
Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh **KB_NM_05**	➢ People movement was low. ➢ Traffic volume was low. ➢ Residential area. ➢ Beside Brahmaputra River.

Sample Location and ID	Sample Site Description
	➢ Adjacent to existing Kewatkhali Railway Bridge
Char Jhaugora, Mymensingh Sadar, Mymensingh **KB_NM_06**	➢ People movement was high ➢ Beside Main Road ➢ Traffic volume was high. ➢ Beside Char Jhaugora Primary school.

The result shows that time weighted average value of the sound monitored inside the project influenced area exceeded the national standard set for the sampling locations for residential and commercial area both at day and nighttime. This might be because of the sampling locations is beside the main road and railway bridge where traffic volume and vehicle movement create large level of noise. Residential dwellings are responsible for noise generator due to their household and anthropogenic activities. Different types of interruption during the monitoring period are given in of the report.

5.7.3.3 Vibration Measurement

The vibration level of the surroundings project area is significant. However, there is moderate vibration level from the traffic movement on the nearby road. Vibration level has been monitored at five locations along the project corridor (Figure 5-29). All the locations of sample collection are showed in a map below. Results of the vibration level monitored along with details of the sampling locations have been showed in . The graphical representation of result is given in of the report.

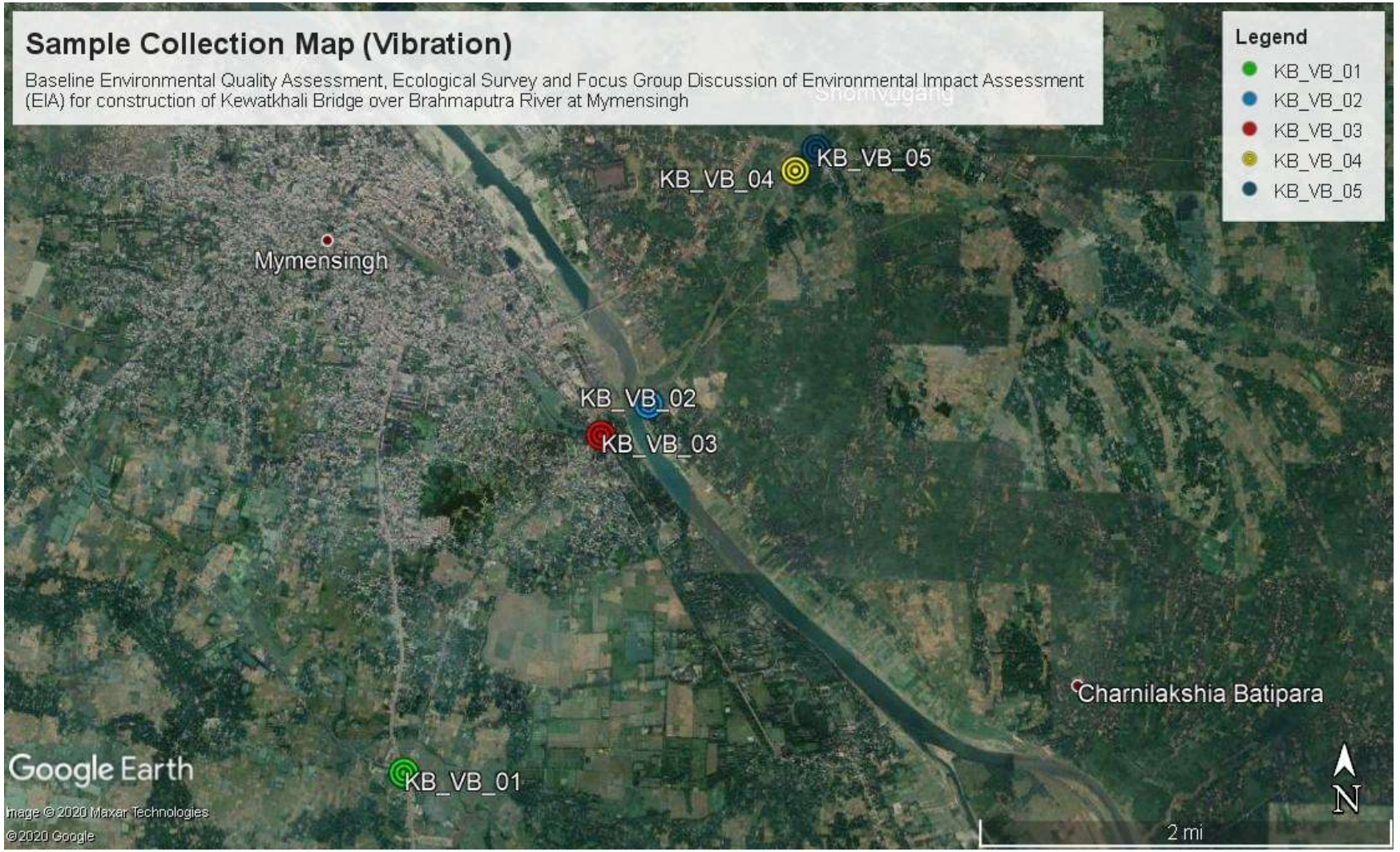


Figure 5-29: Vibration Level Measurement Sample Collection Map

Table 5-8: Results of Vibration Level Monitoring

Sample ID	Location	Velocity (mm/s)				Acceleration (m/s²)				Displacement (mm)			
		Max.	Min.	Standard Deviation	Mean Value	Max.	Min.	Standard Deviation	Mean Value	Max.	Min.	Standard Deviation	Mean Value
KB_VB_01	Kewatkhali Bypass, Sadar, Mymensingh	12.83	0.05	2.173	2.813	43.4	0	5.945	4.241	3.246	0	0.224	0.034
KB_VB_02	Dakshin Chor kalibari, Sadar, Mymensingh	0.35	0.35	0.000	0.350	0	0	0.000	0.000	0.207	0	0.052	0.020
KB_VB_03	Digharkanda Bypass, Sadar, Mymensingh	0.21	0.05	0.071	0.150	15	0	6.001	4.900	0.021	0	0.002	0.002
KB_VB_04	Chor kalibari, Sadar, Mymensingh	0.43	0.43	0.000	0.430	14.7	0	3.460	4.321	0.015	0	0.003	0.003
KB_VB_05	Charjahugara, Sadar, Mymensingh	25.19	0.09	10.240	7.170	4.2	0	1.356	2.100	0.019	0	0.005	0.005

DSCL Environmental Laboratory, April 2020

Velocity: The result shows that the maximum velocity was 25.19 m/s in KB_VB_05 (Charjahugara) and minimum velocity 0.05 in the KB_VB_03 (Digharkanda) location. The standard deviation of velocity maxed in KB_VB_05 (Charjahugara) which is 10.240 m/s and was minimum in KB_VB_04 (Charkalibari) and the value was 0.000 m/s.

Acceleration: Maximum acceleration occurred in KB_VB_01 (Kewatkhali Bypass) Location which was 43.4 m/s^2. Minimum acceleration was 0 for all of the locations. The standard deviation of acceleration maxed in KB_VB_03 (Digharkanda Bypass) Location which is 6.001 m/s^2 and was minimum in was 0.000 for KB_VB_03 (Dakshin Charkalibari) location.

Displacement: Maximum displacement occurred in KB_VB_01 (Kewatkhali Bypass) Location and the value was 3.246 mm. Minimum displacement was 0 for all of the locations. Standard Deviation for Displacement maxed in KB_VB_01 (Kewatkhali Bypass) which is 0.0224 mm and was minimum in KB_VB_03 (Dakshin Charkalibari) location with a value of 0.002 mm.

5.7.3.4 Surface Water Quality

Surface Water samples were collected from Four (04) project influenced locations (Figure 5-30). Test Result of surface water sampling analysis of project influenced area is given in Table 5-9. The laboratory test result is given in appendix of the report.

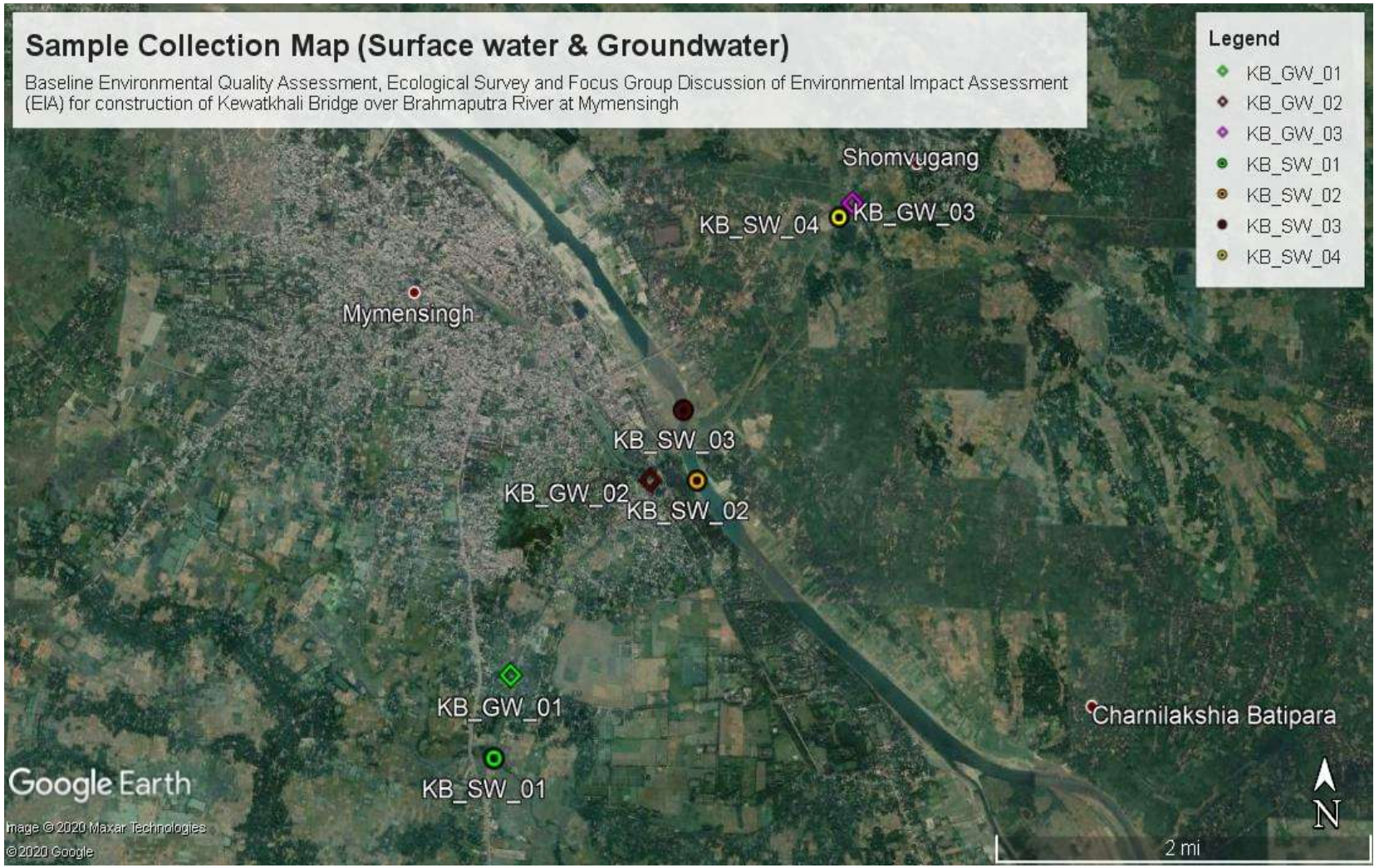


Figure 5-30: Surface Water and Groundwater Sample Collection Map

Table 5-9: Test Result of Surface Water Sampling Analysis

Parameters	Unit	KB_SW_01	KB_SW_02	KB_SW_03	KB_SW_04	Standards for Inland Surface Water** (best practice for fishing)	Analysis Method
		24.718798°N 90.410887°E	24.73925°N 90.42802°E	24.74477°N 90.42699°E	24.75986°N 90.44095°E		
		Inland surface water	Old Brahmaputra River Downstream	Old Brahmaputra River Upstream	Inland surface water		
		Khal Water	River Water	River Water	Pond Water		
pH*	-	9.85	8.34	8.35	8.28	6.5-8.5	Multi Meter
Temperature*	^{0}C	24.7	31.4	25.7	28.7	NYS	Multi Meter
Total Dissolved Solids (TDS)*	mg/L	1289	1532	1322	1369	NYS	Multi Meter
Electric Conductivity*	µS/cm	266	387	347	402	NYS	Multi Meter
Dissolved Oxygen (DO)*	mg/L	4.4	5.1	5.3	5.4	5 or more	DO Meter
Chemical Oxygen Demand (COD)	mg/L	52	12	80	4	NYS	CRM
Biochemical Oxygen Demand (BOD)	mg/L	12	2	20	1	6 or less	5 days Incubation
Total Suspended Solids (TSS)	mg/L	13	18	8	6	NYS	Gravimetric Method
Nitrate	mg/l	2.0	5.3	1.5	3.8	NYS	UV-VIS
Phosphate	mg/l	0.43	0.31	0.38	0.26	NYS	UV-VIS

*Note: *Standards for Inland Surface Water is followed Environmental Conservation Rule (ECR)'97*
**On-site Test Result; *NYS- Not Yet Standardized; **
Source: DPHE Laboratory Test, June 2020 and January 2021

Table 5-10: Description of the Surrounding Environment

Sample Location and ID	Sample Site Description
Digharkanda, Mymensingh Sadar, Mymensingh **(KB_SW_01)**	➢ The sample is collected form inland water source ➢ It is more like waste water in a khals. ➢ The depth from where sample were collected is approximately 6 inches/ 2.54 centimeters ➢ Water is so much polluted due to different anthropogenic issues.
Brahmaputra River Downstream, Mymensingh **(KB_SW_02)**	➢ Sample collected from the downstream of Brahmaputra River ➢ The depth from where sample was collected is approximately 6 inches ➢ Water remains all around the year ➢ Water sample is collected from low tide.
Brahmaputra River Upstream, Mymensingh **(KB_SW_03)**	➢ The water sample is collected from Upstream of Brahmaputra River ➢ The depth from where sample was collected is approximately 6 inches ➢ Water remains all around the year
Char Kalibari, Mymensingh Sadar, Mymensingh **(KB_SW_04)**	➢ The sample is collected from a Pond ➢ The depth from where sample was collected is approximately 6 inches ➢ Water remains all-round the year. ➢ Rain water washes into the Pond. ➢ Fish cultivated in this pond.

The surface water quality standard is yet not developed in the ECR 1997 except for few parameters.

Temperature: The test result shows that the highest temperature was found to be 31.4°C in KB_SW_02 (Brahmaputra River Downstream) and lowest temperature was found to be 24.7°C in KB_SW_01 (Khal water near Digharkanda, Mymensingh Sadar).

pH: The test result shows that most of the sampling locations is meet the national standard set for inland surface water according to ECR,97 except KB_SW_01 (Khal water near Digharkanda, Mymensingh Sadar) because the water is so much polluted due to anthropogenic disturbance.

Total Dissolved Solids (TDS): The test results show that, TDS value was higher in KB_SW_02 (Old Brahmaputra River Downstream) and it was 1532 mg/L and lowest in KB_SW_01 (Khal water near Digharkanda, Mymensingh Sadar) and it was 1289 mg/L.

Electrical Conductivity (EC): The test result shows that the highest concentration of EC was found to be 402 µs/cm in KB_SW_04 (Pond water in Charkalibari, Mymensingh) and lowest concentration was found in KB_SW_01 (Khal water near Digharkanda, Mymensingh Sadar) and it was 266 µs/cm.

Total Suspended Solids (TSS): The test results show that, TSS value was higher in KB_SW_02 (Old Brahmaputra River Downstream) location which was 18 mg/l and lower in KB_SW_04 (Old Brahmaputra River Downstream) location which was 6 mg/l.

Dissolved Oxygen (DO): The DO values meet the national standards for all of the sampling locations except KB_SW_01 (Khal water near Digharkanda, Mymensingh Sadar) because the water is so much polluted and huge amount of waste materials are present in the water body.

Turbidity: Turbidity is considered as a good measure of the quality of water. The test result shows that the highest concentration of Turbidity was found to be 310 NTU in KB_SW_02 (Old Brahmaputra River Downstream) location and lowest concentration was found in KB_SW_04 location (Pond water in Charkalibari, Mymensingh).

Chemical Oxygen Demand (COD): COD or Chemical Oxygen Demand is the total measurement of all chemicals in the water that can be oxidized. The test result shows the highest concentration of COD was 80 mg/l in KB_SW_03 (Old Brahmaputra River Upstream) location and lowest concentration of COD in KB_SW_04 (Pond water in Charkalibari, Mymensingh) location and it was 4 mg/l.

Biochemical Oxygen Demand (BOD_5): Biochemical Oxygen Demand is supposed to measure the amount of food (or organic carbons) that bacteria can oxidize. The standard for inland surface water for BOD_5 is 6 or less mg/L. The test result shows the level of BOD is below the national standard for the sampling locations. Because of the sample is collected from the river and pond water and the water is being polluted by different anthropogenic and commercial activities. The highest concentration of BOD was 20 mg/l in KB_SW_03 location (Old Brahmaputra River Upstream) and lowest concentration of BOD in KB_SW_04 (Pond water in Charkalibari, Mymensingh) location and it was 1 mg/l.

Phosphate (PO_4): The test result shows the highest concentration of Phosphate was 0.38 mg/l in KB_SW_03 (Old Brahmaputra River Upstream) location and lowest concentration of phosphate in KB_SW_04 (Pond water in Charkalibari, Mymensingh) location and it was 0.26 mg/l.

Nitrate (NO_3-): The test result shows that the highest nitrate was found to be 5.3 mg/l in KB_SW_02 (Brahmaputra River Downstream) location and lowest nitrate was found to be 1.3 mg/l in KB_SW_03 (Brahmaputra River Upstream) location.

5.7.3.5 Groundwater Quality

Three (03) groundwater samples were collected form the both sides of the Kewatkhali Bridge and approach road locations (Figure 5-30). All the locations of sample collection are showed in a map above. Results of ground water sampling analysis of project influenced area are given at Table 5-11. The laboratory test result is given in appendix of the report.

Table 5-11: Test Result of Groundwater Quality

Parameters	Unit	KB_GW_01	KB_GW_02	KB_GW_03	Standards for Potable Water**	Analysis Method
		24.724706°N 90.412088°E	24.739312°N 90.424061°E	24.76089°N 90.44208°E		
		Deep Tubewell Water	Deep Tubewell Water	Deep Tubewell Water		
pH*	-	7.82	7.98	7.26	6.5-8.5	Multi Meter
Electric Conductivity (EC)*	µS/cm	323	343	284	NYS	Multi Meter
Turbidity	NTU	0.36	0.37	2.2	10	Turbidity Meter
Salinity*	ppt	<1	<1	<1	>1ppt	Multi Meter
Total Suspended Solids (TSS)	mg/L	1	1	2	10	Gravimetric Method
Total Dissolved Solids (TDS)*	mg/L	269	287	190	1000	Multi Meter
Chloride (Cl^-)	mg/L	15	16	40	150-600	Titrimetric
Arsenic (As)	mg/L	0.003	0.001	0.001	0.05	AAS
Iron (Fe)	mg/L	0.18	0.20	0.22	0.3-1	AAS
Total Coliform (TC)	N/100ml	-	-	0	0	MFM
Fecal Coliform (FC)	N/100ml	-	-	0	0	MFM
Manganese (Mn)	mg/L	0.04	0.03	1.65	0.1	AAS

Source: DPHE Laboratory Test, June 2020 and January 2021
*Note: *Bangladesh Standard for Drinking Water (ECR)'97*
** On-site Test Result*

Table 5-12: Description of the Surrounding Environment

Sample Location and ID	Sample Site Description
Bypass More-Darul alam Madrasa Masjid, sadar, Mymensingh **(KB_GW_01)**	➢ The sample is collected form deep tubewell water. ➢ The water is used for drinking and bathing purposes. ➢ Septic tank is far 100 distance from the water source ➢ The owner of the source is mosque authority ➢ Depth is approximately 350 m
Baytur Rahman Jame Masjid, Balashpur, sadar, Mymensingh **(KB_GW _02)**	➢ The sample is collected form deep tubewell water. ➢ The water is used for drinking and bathing purposes. ➢ Septic tank is far adjacent to the water source ➢ The owner of the source is mosque authority ➢ Depth is approximately 380-400 m

Sample Location and ID	Sample Site Description
Char-jhaugasa, Mymensingh sadar, Mymensingh **(KB_GW_03)**	➢ The sample is collected from Tube well ➢ Nearest latrine is about 4 meters away ➢ Water used for drinking and domestic purpose ➢ Depth is approximately 400m.

pH: From the test result, the value of pH was within the national standard for all of the sampling locations.

Turbidity: Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. Turbidity is considered as a good measure of the quality of water. Turbidity of all the locations is below the national standard.

Electrical Conductivity (EC): EC stands for electrical conductivity, which measures the potential for a material to conduct electricity. The concentration of EC is not yet standardized according to ECR,1997. The test results show that the value of EC is highest from KB_GW_02 (Baytur Rahman Jame Masjid, Balashpur, sadar, Mymensingh) location.

Salinity: Salinity is the saltiness or dissolved inorganic salt content of a body of water. Substances that are dissolved in water are usually called solutes. The value of salinity was within the national standard according to ECR,1997 for all the sampling locations.

Total Dissolved Solids (TDS): The test results show that, the TDS values were within the national standard for all the sampling locations.

Total Suspended Solids (TSS): Total suspended solids (TSS) are the dry-weight of particles trapped by a filter. The standard for inland surface water for TSS is 10mg/L. The test results show that, for all the locations TSS values are within the national standard.

Chloride: Chlorides are important in detecting the contamination of groundwater by sewage. Chlorides are leached from various rocks into soil and water by weathering. The standard level for chloride is within 150-600 mg/L. The test result shows that for all of the locations Chloride value was within the national standards.

Iron (Fe): Natural waters contain variable amounts of iron depending on the geological area and other chemical components of the waterway. Iron in groundwater is normally present in the ferrous or bivalent form [Fe^{++}] which is soluble. The test result shows that for all of the locations Iron value was within the national standards.

Arsenic: Arsenic is a natural component of the earth's crust and is widely distributed throughout the environment in the air, water and land. It is highly toxic in its inorganic form. The test result revealed that for all of the locations Arsenic value was within the national standards.

Manganese (Mn): Manganese is a mineral that is found naturally in the environment and is one of the most abundant metals on the earth's surface, in air, water, and soil. The test result revealed that for KB_GW_03 location Manganese value was exceed within the national standards. This might be because of the depth of the deep tube well or the over exploration of pollutants.

Total Coliform (TC): Total coliforms are a group of bacteria that are widespread in nature. All members of the total coliform group can occur in human feces, but some can also be present in

animal manure, soil, and submerged wood and in other places outside the human body. The value of Total coliform was within the standard for the sampling location (KB_GW_03).

Fecal Coliform (FC): The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. Fecal Coliform bacteria indicate the presence of sewage contamination of a waterway and the possible presence of other pathogenic organisms. The value of Fecal coliform was within the standard for the sampling location (KB_GW_03).

5.7.3.6 Soil Quality Test Results

Soil samples were collected from two (02) project influenced location encompassing both sides of the project corridor (Figure 2.1). All the locations of sample collection are showed in a Map (Figure 5-31). Test result of soil analysis of project influenced area is given in . Laboratory test results are given in of the report.

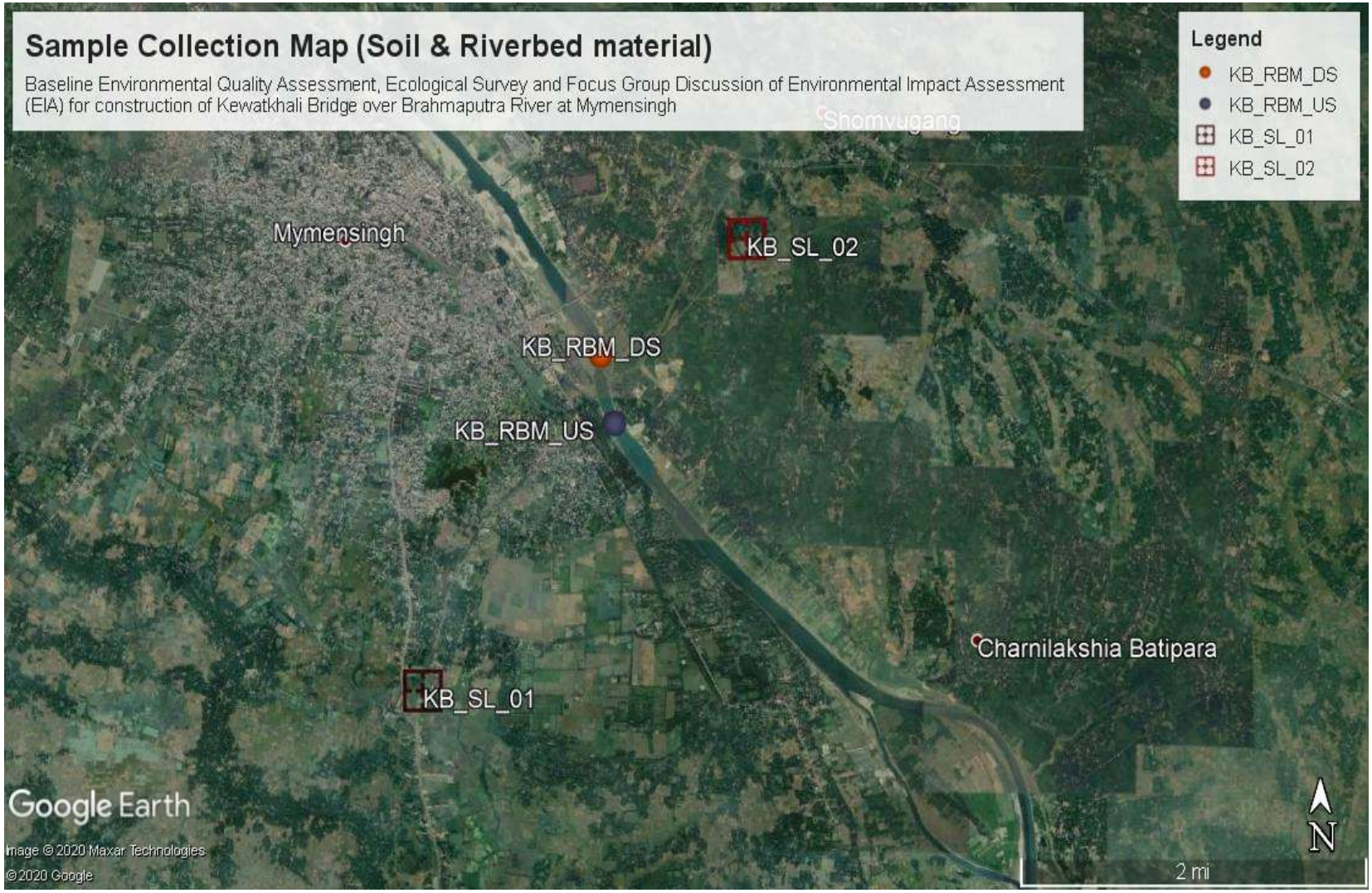


Figure 5-31: Soil and Riverbed Sediment Sample Collection Map

Table 5-13: Test Result of Soil Quality Analysis

Parameters	Unit	KB_SL_01	KB_SL_02	Dutch Standard for Soil*
		24.71848°N 90.41064°E	24.75390°N 90.44070°E	
		Beside SEP filling station-Digharkanda Bypass More, sadar, Mymensingh	Char kalibari, Mymensingh sadar, Mymensingh	
Iron (Fe)	%	2.30	0.74	NYS
Manganese (Mn)	%	0.017	0.013	NYS
Copper (Cu)	ppm	13.84	6.66	NYS
Zinc (Zn)	ppm	45.21	15.76	140
Lead (Pb)	ppm	14.46	11.08	NYS
Cadmium (Cd)	ppm	2.43	1.61	NYS
Chromium (Cr)	ppm	16.56	5.76	NYS

* *Source: DU Laboratory Test, December 2020*
**Dutch Standards for Soil*

There is no Bangladesh regulation/standard for soil. In the absence of local country standards, it is the environment consultant's practice to use globally recognized 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines - Soil and Groundwater Standards' to assess soil quality and to determine the need, if any, for remedial action. Parameters analyzed in baseline quality of soil were observed to be well below the threshold limits for Intervention as per the Dutch Standards where almost most of the parameters are not yet standards according to Dutch Standards.

Iron (Fe): From the test results, the Iron (Fe) concentration in the project influenced areas ranged from 2.30% to 0.74%. The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

Manganese (Mn): From the test results, the Mn concentration in the project influenced areas ranged from 0.017 % to 0.013 %. The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

Zinc (Zn): From the test results, the Zinc (Zn) concentration in the project influenced areas ranged from 15.76 ppm to 45.21ppm. The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

Copper (Cu): From the test results, Copper (Cu) concentration was found to be 13.84 ppm to 6.66 ppm. The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

Lead (Pb): From the test results, Lead concentration ranges from 14.46 ppm to 11.08 ppm The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

Cadmium (Cd): From the test results, Cadmium concentration ranges from 1.61 ppm to 2.43 ppm. The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

Chromium (Cr): From the test results, Chromium concentration ranges from 5.76 ppm to 16.56 ppm. The minimum value was in KB_SL_02 (Char Kalibari, Mymensingh Sadar, Mymensingh) and maximum value was in KB_SL_01 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh).

5.7.3.7 Riverbed Sediment Quality

Riverbed Sediment sample were collected from Two project influenced location (upstream and downstream) from Brahmaputra River and analyzed for the heavy metals (Figure 5-31). Any construction or alteration of watercourse severely affects the bottom living benthos and planktons. All the locations of sample collection are showed in a Map above. Test result of sediment analysis of project influenced area is given in Table 5-14. Laboratory test result are given in appendix of the report.

Table 5-14: Test Result of Riverbed Sediment Quality

Parameters	Unit	KB_RBM_US 24.74483°N 90.42708°E Upstream of Brahmaputra River	KB_RBM_DS 24.73922°N 90.92801°E Downstream of Brahmaputra River	MPCA Standard for Riverbed Dredged Materials 2014*
Iron (Fe)	%	1.17	0.79	NYS
Manganese (Mn)	%	0.012	0.010	8100
Copper (Cu)	ppm	6.20	5.42	9000
Zinc (Zn)	ppm	15.89	15.52	75000
Lead (Pb)	ppm	10.95	11.37	700
Cadmium (Cd)	ppm	1.18	1.27	200
Chromium (Cr)	ppm	6.88	4.50	100,000

** Minnesota Pollution Control Agency (MPCA) Standard for Riverbed Dredged Materials 2014*
*** Level 2 Soil Reference Value (SRV) (Dredged Material is suitable for use or reuse on properties with an industrial use category)*
Source: DU Laboratory Test, December 2020

There is no Bangladesh regulation/standard for sediment. In the absence of local country standards, it is the environment consultant's practice to use globally recognized 'Minnesota Pollution Control Agency- Managing Dredged Materials, April 2014 to assess sediment quality and to determine the need, if any, for remedial action. Parameters analysed in baseline quality of sediment were observed to be well below the threshold limits for Intervention as per the

MPCA Standards where almost one of the parameters are not yet standards according MPCA Standards.

Iron (Fe): From the test results, the Iron (Fe) concentration in the project influenced areas ranged from 0.79% to 1.17 %. The minimum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River) and maximum value was in KB_ RBM_US (Upstream, Old Brahmaputra River).

Manganese (Mn): From the test results, the Manganese (Mn) concentration in the project influenced areas ranged from 0.010 ppm to 0.012 ppm. The minimum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River) and maximum value was in KB_ RBM_US (Upstream, Old Brahmaputra River). The concentration of Manganese (Mn) was well below the standard according to MPCA for Riverbed Materials 2014.

Copper (Cu): From the test results, the Cu concentration in the project influenced areas ranged from 5.42 ppm to 06.20 ppm. The minimum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River) and maximum value was in KB_ RBM_US (Upstream, Old Brahmaputra River). The concentration of Copper (Cu) was well below the standard according to MPCA for Riverbed Materials 2014.

Zinc (Zn): From the test results, Zinc (Zn) concentration ranged from 15.52 ppm to 15.89 ppm. The minimum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River) and maximum value was in KB_ RBM_US (Upstream, Old Brahmaputra River). The concentration of Zinc (Zn) was well below the standard according to MPCA for Riverbed Materials 2014.

Lead (Pb): From the test results, Lead concentration ranges from 10.95 ppm to 11.37 ppm. The minimum value was in KB_ RBM_US (Upstream, Old Brahmaputra River) and maximum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River). The concentration of Lead (Pb) was well below the standard according to MPCA for Riverbed Materials 2014.

Cadmium (Cd): From the test results, Cadmium concentration ranges from 1.18 ppm to 1.27 ppm. The minimum value was in KB_ RBM_US (Upstream, Old Brahmaputra River) and maximum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River). The concentration of Cadmium (Cd) was well below the standard according to MPCA for Riverbed Materials 2014.

Chromium (Cr): From the test results, Chromium concentration ranges from 4.50 ppm to 6.88 ppm. The minimum value was in KB_ RBM_US (Upstream, Old Brahmaputra River) and maximum value was in KB_ RBM_DS (Downstream, Old Brahmaputra River). The concentration of Chromium (Cr) was well below the standard according to MPCA for Riverbed Materials 2014.

5.7.4 Summary of Environmental Quality Assessment

The main aims of this work are to control and reduce the adverse impact during construction phase. Construction workers may be affected adversely due to hazardous working environments such as air quality which is declined due to construction vehicle and machineries; noise generated from construction vehicle, water pollution by disposal of construction waste. The management and monitoring team were verified as the environmental impacts were regularly identified or this project in order to reduce adverse impacts and enhance positive impacts from specific project activities during construction phase. From the environmental assessment it is found that all the air quality parameters are within national standard of Bangladesh. According to WHO guideline most of the parameters of air quality are within the standard except PM_{10} and

$PM_{2.5}$ because of dust particles from the main road and other commercial activities. Noise level exceeded the national standard and WB standard set for the commercial and residential area for the sampling locations for both day and night time due to excessive traffic volume and people/vehicular movement. Surface water quality test result shows that the concentration for almost all of the parameters are not yet standardized according to ECR,1997. In Groundwater quality test, the concentration for almost all of the parameters are within the national standard according to ECR,1997. Parameters analyzed in baseline quality of sediment were observed to be well below the threshold limits for Intervention as per the MPCA Standard for Riverbed Dredged Materials 2014 where some of the parameters are not yet standards. In case of soil, it is seen that all the parameters are not yet standardized according to Dutch standards.

5.8 Ecological Survey

5.8.1 Introduction

Survey was undertaken to assess habitat type and quality, species, diversity, rarity, fragmentation, ecological linkage, age and abundance. A rapid survey was conducted for the following parameters:

- Identify any legally protected areas or internationally recognized areas
- Identify any critical area
- Identify vegetation cover and current status of mutual habitats or species, including mangrove and other ecologically important habitats; and
- Identify and assess ecological resources

During the ecological survey any critical habitat and its significance needs were identified, and protection status recorded. In practice, a checklist of each individual species was followed in order to be able to determine its protection status:

- International Union for Conservation of Nature (IUCN's) Rad List of Threatened Species status (both National and global threatened category);
- Species protected under Bangladesh Wildlife Preservation Act (1974);
- Species included in CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora.
- Species protected under any protocol, conventions and any other agreement;
- Species considered as flagship species, keystone species or other significant species; and Endemicity of the species

5.8.2 Objectives

The study was undertaken with following broad objectives:

5.8.2.1 Benthos and Plankton Analysis

- Benthos is the community of organisms that live on, in, or near the seabed, river, lake, or stream bottom, also known as the benthic zone. Benthos sample are collected from Two (02) locations the Brahmaputra river (Upstream and downstream) where the proposed bridge will be constructed.
- Plankton are the diverse collection of organisms that live in large bodies of water and are unable to swim against a current. Plankton samples are collected from Two (02) locations

the Brahmaputra river (Upstream and downstream) where the proposed bridge will be constructed.

5.8.2.2 Terrestrial Flora and Wildlife Survey

- Assess the status of major floral and faunal components of all the terrestrial habitats (Forest, grassland, fallow land, riverine land, agroecosystem and homestead plantation) present in the Project AOI (including the project site) adopting different standard techniques;
- Collection and compilation of secondary information on the status of floral and faunal components and habitats from the concerned department – Forest department and others;
- Provide quantitative information on different floral and faunal components: using statistical analysis and derive diversity indices;
- Identification and listing of floral and faunal species of conservation significant (rare, endangered and threatened – RET species and endemic species in accordance with IUCN RED List/ MoEFCC) in the Project AoI;
- Identification of areas of conservation significance (Protect Areas: Sanctuary, National Parks, Biosphere Reserve, landscape and Sacred grows- pertaining to Floral diversity) areas in the vicinity of the Project AOI;
- Assess the status of floral components (macro and micro flora) of perennial aquatic habitats (lake, reservoirs/dams and rivers) present in the Project AOI (Including the project site) adopting standard techniques; and

5.8.2.3 Habitat Survey

- Identification of different habitat types (forest/vegetation types) of the Project AOI and provide information on forest types, species composition, terrain and topographical features. This will then allow for the identification of natural and modified habitat for a critical habitat assessment.

5.8.2.4 Fauna

- Aquatic survey, including fish and stream macro invertebrates;
- Identify and evaluate the likely impacts on faunal components (Amphibians reptiles, terrestrial and aquatic birds and mammals, e.g dolphins) due to proposed projects and associated activities.

5.8.2.5 Fisheries Survey

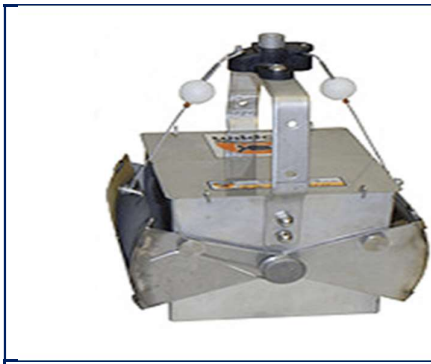
- Identification of various fish species found in the Project AOI based on survey and market survey (= landing surveys);
- Consultation with local people and in local fish markets;
- Identification of threatened/ endemic and protected fish species in the Project AOI;

5.8.3 Materials and Methods

5.8.3.1 Benthos and Plankton Analysis

5.8.3.2 Benthos Species

Benthos is the community of organisms that live on, in, or near the seabed, river, lake, or stream bottom, also known as the benthic zone. Benthos samples were collected from 02 locations (upstream and downstream) of the Brahmaputra river on 20 December 2020 where the proposed bridge will be constructed (). To collect the benthos samples Ekman Dredger was using for grabbing the sediments (). The sediment was placed on a stack of five different mesh sizes sieves. The benthos species was differentiated through the sieves. The samples were placed in small plastic bottle by mixing with 1 ml formalin. The collected benthos samples were tested from Department of Zoology, Dhaka University (DU) Laboratory for further analysis of samples.



Ekman Dredger

Sieves

Figure 5-32: Equipment to collect Benthos Sample

Table 5-15:Sampling Locations of Benthos Species

Parameters	Locations	Samples Collected (No.)
Benthos Species	Brahmaputra River Downstream, Mymensingh	1
	Brahmaputra River Upstream, Mymensingh	1

5.8.3.3 Plankton Species

Plankton are the diverse collection of organisms that live in large bodies of water and are unable to swim against a current. The individual organisms constituting plankton are called plankters. They provide a crucial source of food to many small and large aquatic organisms, such as bivalves, fish etc. Plankton samples were collected from 02 locations (upstream and downstream) of the Brahmaputra river on 20 December 2020 where the proposed bridge will be constructed (Table 3.2). Plankton samples was collected by a Plankton net. For sample collection 40 liters of water will be poured by a bucket through Plankton net. The samples were placed in small plastic bottle by mixing with 1 ml formalin. The collected plankton samples were tested from Department of Zoology, Dhaka University (DU) Laboratory for further analysis of samples.

	
Plankton Net	**Bucket**

Figure 5-33: Equipment to collect plankton species

Table 5-16:Sampling Locations of Plankton Species

Parameters	Locations	Samples Collected (No.)
Plankton Species	Brahmaputra River Downstream, Mymensingh	1
	Brahmaputra River Upstream, Mymensingh	1

5.8.3.4 Terrestrial Flora Survey

A combination of methods was used in this inventory. The survey was conducted for 5 days, from 15 to 19 March 2020 and 20-23 December 2020. The first day was used for exploration and transect walks to find suitable locations for sampling.

Transect Lines

In this method flora were observed and recorded on each side of the transact line (size: 500 m) using measurement tape. Transect lines were performed along the alignment. A total of 04 transect lines were made across the study site. See and .

Figure 5-34: Surveyors are conducting transect lines

Quadrates

A total of 4 grids (size: 100 m × 100 m) were selected to study floral composition (See). A total of 5 days was spent in the field. Observation was started early in the morning and ended at late

afternoon in each day (0600 hr – 1800 hr). Unidentified vegetation species were collected (either seed, flower or leaf) for later identification.

Micro level approach involved mainly the field based primary data collection on different components of the project objectives/scope of work using well established and accepted ecological methods in different habitats identified within the Project AOI. The field data collection mainly included biodiversity status assessment of different life forms of floral elements such as trees, shrubs, climbers, herbs and grass (see).

Figure 5-35: Surveyors are conducting quadrates sampling method

Transect Walk

Alongside Transect line and gridding/quadrated methods, surveyors preformed transect walking to randomly identify floral species. These random transect walks were done in-between the quadrate exercises. See for details.

Figure 5-36: Surveyors are conducting transect walks

Interviews

Beside all the methods mentioned earlier, a few Interviews were also conducted to understand localized events: species declination, causes of declination, habitat change etc. Moreover, not all the species were found or recorded since the survey period was only 06 days. In such cases, interviews provided very useful information ().

Figure 5-37: Surveyors are conducting interviews

Table 5-17: Sampling Points and distribution of floral survey

Land use class	Methods	Number	Location*
Roadside Plantation	Transect line	1	China Town, Mymensingh Sadar, Mymensingh
	Quadrate	1	
	Transect walk	1	
Homestead plantation	Transect line	2	China Town, Mymensingh Sadar, Mymensingh
	Quadrate	2	Char Kalibari, Mymensingh Sadar, Mymensingh Railway Colony, Kewatkhali, Mymensingh
	Transect walk	2	Char Kalibari, Mymensingh Sadar, Mymensingh Railway Colony, Kewatkhali, Mymensingh
Commercial Plantation	Transect line	1	Moynar More, Mymensingh Sadar, Mymensingh
	Quadrate	1	
	Transect walk	1	

Source: Survey Team, 2020

5.8.3.5 Wildlife Survey

Faunal diversity was assessed by inventorying the major taxa like herpetofauna (amphibian and reptiles), avifauna (both aquatic and terrestrial) and mammals. A faunal Survey was conducted based on the opportunistic search method in different habitats. Survey included the fauna such as herpetofauna, avifauna and mammals. Focused group consultations were also undertaken in order to confirm the range of fauna occasionally visiting the Project AOI. Since only 06 days were spent in field, neither all the faunas were observed, nor is it possible to observe them all. Therefore, public consultation and literature reviews were done to prepare a list of the faunas.

However, during observation, movement of observer was kept at a uniform speed and while walking along a route, attempts were made to note the animals when they were whiting, singing or flying over the study area or foraging and feeding either on the ground or on the trees. During observation and data collection field notes, two pairs of binoculars, digital camera (Cannon auto focus 35 mm and 16 mm equivalent), Video Camera, GPS, distance measuring plastic tape, surgical gloves, google map, paper box and rubber tapes, etc. were used.

We also used field guide on birds (Ali and Ripley 1983), amphibians and reptiles (Daniel 1983, Smith 1931, 1943) and mammals (Prater 1993) in order to identify species during observation. Data collected in each trip inputted in the computer to make the systematic data base for each species and categorized according to the taxonomic position. Habitat types, food habits, etc. were also recorded.

Figure 5-38: Surveyors were Conducting interviews for collect information regarding wildlife

5.8.3.6 Fisheries Survey

The survey team used the FAO (2002) proposed sample-based fisheries survey techniques and reporting guidelines for the fisheries survey. The methodology used in this survey is modified from the FAO (2002) guidelines to fit with the sampling frame (i.e., Project site and buffer zone). The general methodology is described in while the detailed step by step methods employed are discussed in the later sections.

General Approaches

The survey was conducted for a period of 04 consecutive days in Brahmaputra River. The study area, as per requirement of the ToR, was a 5 km buffer zone with considering the alignment on river/watercourse as center. This means, 5km upstream and 5km downstream from the existing alignment was considered as study site. One survey team surveyed the upstream region and one survey teams surveyed the downstream areas for 3 hours each during morning and evening (= total 6 hours a day). During boat survey, 08 fishing unit (i.e. fishing boat, gear effort, land-based efforts) samples were collected while during landing surveys some samples were collected to reach 90% total accuracy were surveyed every 2 hours for twice each during morning and evening. During survey, every morning and evening shift an hour-long scan around the whole study site every 1 hour was preformed to count the number of fishing units present at a time.

A specially designed fishing unit and gear survey form was filled-up by counting the fishing units and gear types. Sampling of catches and their assessment were done every day. The fishermen were selected on the basis of types of gear they operated to reach the most diversity. The total catches were weighed by a balance and the representative samples were taken with the help of hand without repetition of the same gear in each sampling day. The collected fish were sorted species-wise and the number of individuals for each species were counted and then their percent composition was determined.

Fishermen interviews were also conducted during surveys to understand their perceptions and thoughts of fishing techniques, availability of fish and correlation of fish catch with environment. Interviews also covered environmental considerations, e.g. changes in the environment over last 30 years and its correlation with fish catch or migratory route.

Survey Approaches

Survey team combined the 'Boat activity surveys' and 'Landing survey' to attain highest possible accuracy and reliable estimates. The details are provided afterwards.

Boat Activity Survey

The primary objective of our Boat Activity Survey is to formulate the Boat Activity Coefficients (BAC), which represent the probability that a fishing unit of a given boat/gear type will be active on any day during a certain reference time. Boat Activity Surveys also assist in assessing the general accuracy of previous Frame Surveys through sampling, as well as for recognizing significant changes in the fisheries.

Landing Survey

Landings Surveys are conducted at landing sites with the purpose of collecting sample data on total catch and species composition, associated effort, and other secondary data such as prices and fish size (in weight units). Surveyors were conducted the landing surveys to ensure that the following information is estimated correctly or more accurately: a. catch of all species; b. associated fishing effort; c. overall CPUE; d. catch by species; e. first-sale prices; and f. number of fishes in catch by species, A list of fishes available in the locality were identified by interviewing local fishermen and Market landing basis. Local fisheries markets and river branches with wetlands were surveyed to prepare a list of available fish in the locality and their present status. (see).

Figure 5-39: Landing Surveys to collect information regarding fishes

5.8.4 Result and Discussions

5.8.4.1 Benthos and Plankton Analysis Result

Benthos Species

Benthos is the community of organisms that live on, in, or near the seabed, river, lake, or stream bottom, also known as the benthic zone. The quality of the local benthos quality was identified to characterize the baseline status. During the survey period, two (02) benthos samples were collected from the upstream and downstream of the Brahmaputra river (). The test result of benthos species is shown in . The laboratory test result is given in of the report.

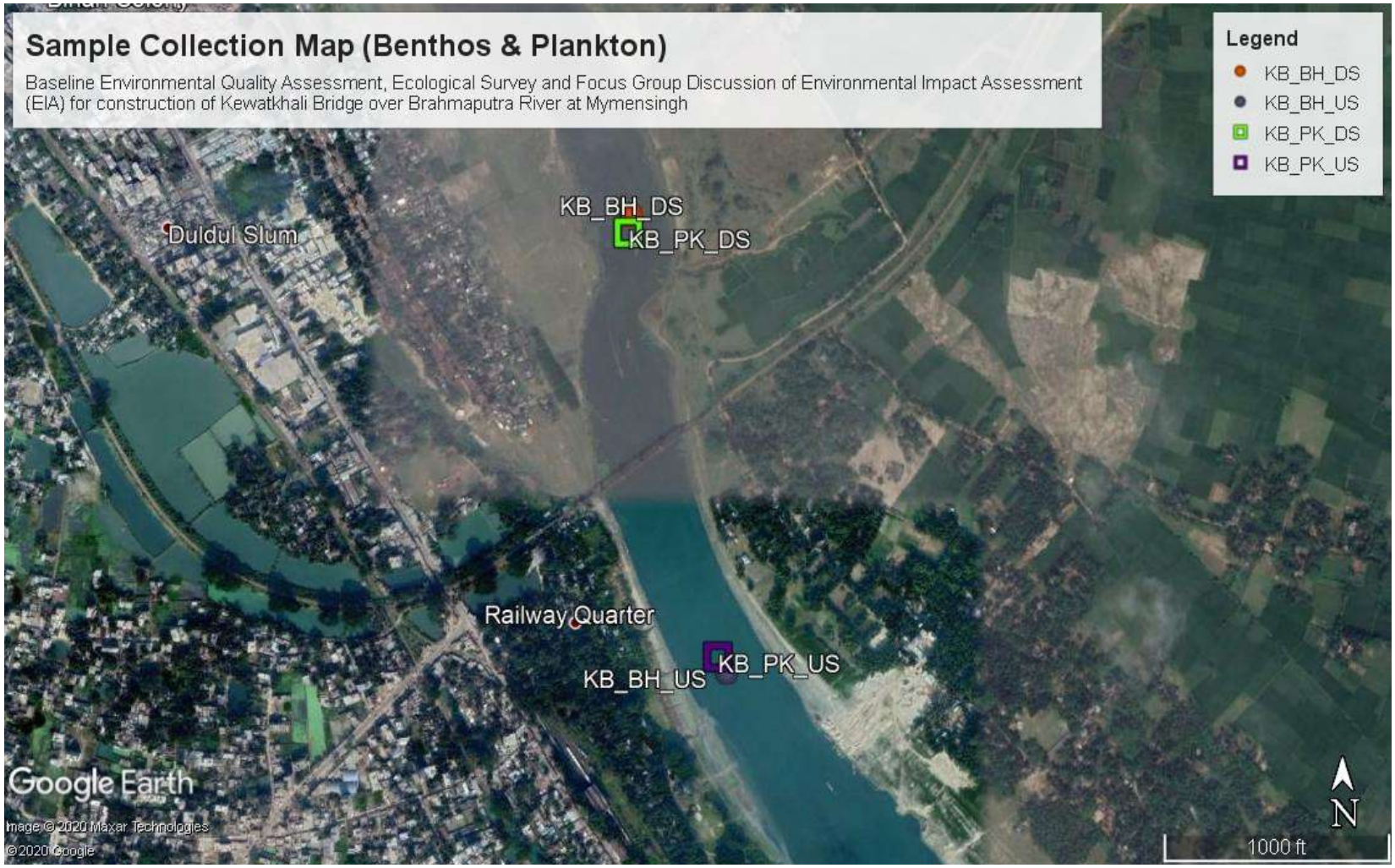


Figure 5-40: Benthos and Plankton Species Sample collection map

Table 5-18: Test Result of Benthos Analysis

Sample No.	Sample ID	Location	Results	Ecosystem
01	KB_BH_US	Brahmaputra River Upstream	*Bellamya sp. (Gastropoda)-19* *Melania sp. (Gastropoda)- 3* *Planorbis sp. (Gastropoda)-3* *Micromollusc bivalves (Bivalvia) -6*	Freshwater
02	KB_BH_DS	Brahmaputra River Downstream	*Bellamya sp. (Gastropoda)-7* *Micromollusc bivalves (Bivalvia) -8*	Freshwater

Source: DU Laboratory, December 2020

The total four (04) species of benthos are found at the sampling site of the Brahmaputra river which are *Bellamya sp.* (Gastropoda), *Melania sp.* (Gastropoda), *Planorbis sp.* (Gastropoda) and *Micromollusc bivalves* (Bivalvia). From the test results, it can be said that most of the benthic species were found from KB_BH_US (Upstream sampling site of the Brahmaputra river) and that number was thirty-two (32). However, no plant species were identified in the benthic samples.

Plankton Species

Plankton are the diverse collection of organisms that live in large bodies of water and are unable to swim against a current. The quality of the plankton quality was identified to characterize the baseline status. During the survey period, two (02) benthos samples were collected from the upstream and downstream of the Brahmaputra river where the proposed bridge will be constructed (). All of the locations of sample collection are showed in a Map. The results of the test are shown in . The laboratory test result is given in Appendix 9 of the report.

Table 5-19: Test Result of Plankton Analysis

Sample No.	Sample ID	Location	Results	
			In 1ml SR Cell	Total SR Cell Count (unit/m^3)
01	KB_PK_US	Brahmaputra River Upstream	Zooplankton: Cyclops (Copepoda)- 4	1800
02	KB_PK_DS	Brahmaputra River Downstream	Zooplankton: Cyclops (Copepoda)- 2	1200

Source: DU Laboratory, December 2020

Only one species of Zooplankton was found from the both locations of the Brahmaputra River. Zooplankton which are found in the water of the Brahmaputra river is *Cyclops (Copepoda).* The test result shows that highest number of Zooplankton was found in KB_PK_US (Upstream side of Brahmaputra River) and the lowest number of Zooplankton was found in KB_PK_DS (Downstream side of Brahmaputra River).

5.8.4.2 Terrestrial Ecology (Quadrate report)

Phytosociology

Quantitative Plant surveys were conducted in two habitats to enumerate the vegetation occurring within the Project AOI. These are discussed below. The proposed bridge and approached road alignment mainly harboring naturalized shrubs, herbs, grasses and weeds. Roadside plantation was common. The region is highly diversified in terms of vegetation. Total 52 species were identified. There is no IUCN Red list of plants for Bangladesh.

Since there is no single satisfactory book of red list in Bangladesh, for threatened species listing, we used the categories identified by various papers with references. presents the detail information of the quadrate survey conducted in field.

Table 5-20: Details Quadrate information of floral survey

S/N	Location	Latitude/Longitude	Types of Habitat
1	China Town, Mymensingh Sadar, Mymensingh	24.76118°N 90.43610°E	Roadside
2	Char Kalibari, Mymensingh Sadar, Mymensingh	24.74502°N 90.43195°E	Home Stead
3	Railway Colony, Kewatkhali, Mymensingh	24.74063°N 90.42587°E	
4	Moynar More, Mymensingh Sadar, Mymensingh	24.731688°N 90.416458°E	Artificial (Commercial)

Source: Survey Team, 2020

Threated Species

The names of threatened species were found from interviews with local people. The base of this analysis was, identifying the species that are disappearing fast in last 20 years. A list of the species from quadrate surveys are given in . As unveiled in Mahagoni and Bamboo has been found as the most dominant tree species in the entire project location ().

Table 5-21: Location wise dominant and threatened species

S/N	Location	Types of Habitat	Dominant (1 or 2 species)/Local name	Locally threatened species
1	China Town, Mymensingh Sadar, Mymensingh	Roadside	Mehegoni, Akasmoni, Eucalyptus	Shil, Horitoki, Kat Badam
2	Char Kalibari, Mymensingh Sadar, Mymensingh	Home Stead	Amm, Supari	Krisnocura, Babla
3	Railway Colony, Kewatkhali, Mymensingh	Home Stead	Amm, Dumur, Bamboo, Mehegoni	Dewa, Kamranga, Chalta
4	Moynar More, Mymensingh Sadar, Mymensingh	Artificial (Commercial)	Akash Moni, Mehuguni	Segun, Sajina

Source: Survey Team, 2020

Figure 5-41: Mehegoni and Bamboo were the most dominant tree species

Homestead Plantation

A total of 27 homestead plants were found in the project area. The most common species were Acacia auriculiformis (Akash Moni), Mangifera indica (Amm), Annona squamosa (Ata),

Bambusa balcooa (Bash), Aegle marmelos (Bel), Acacia nilotica (Babla), Ficus benghalensis (Bot), Averrhoa bilimbi (Bilombo), Ziziphus mauritiana (Boroi), Albizia recardiana (Chamble), Dillenia indica (Chalta), Artocarpus lacucha (Dewa), Ficus sycomorus (Dumur), Eucalyptus globulus (Eucaliptus), Diospyros discolor (Gab), Melia azedarach (Ghora Neem) etc (). Many backyards plantations were also found, which were categorized as homestead plantation. A list of plant found at homesteads of the project area is given in

Table 5-22: List of Homestead plantation found in the project area

SL. No.	Local name	Scientific name	Family	Uses/importance
1	Aam	*Mangifera indica*	Mangifera indica	Fruits, timber, fuel, furniture
2	Bel	*Aegle marmelos*	Rutaceae	Fruits, herbal medicine
3	Dalim	*Punica granatum*	Punicaceae	Fruits, medicinal use
4	Kathal	*Artocarpus heterophyllus*	Moraceae	Fruits, furniture, fuel, fodder
5	Khejur	*Phoenix sylvestris*	Palmae	Juice, fruits, fuel, fence, Basket
6	Narikel	*Cocos nucifera*	Palmae	Fruits, drinks, fuel, fence, handicrafts
7	Peyara	*Psidium guajava*	Myrtaceae	Fruits, jelly, fuel, tools
8	Supari	*Areca catechu*	Palmae	Fruits, fuel, pole, window rod
9	Tetul	*Tamarindus indica*	Leguminosae	Fruits, medicine, timber, fuel
10	Tal	*Borassus flabellifer*	Palmae	Fruits, fuel, juice, timber, hand, fan
11	Deshi Jam	*Syzygium cumini*	Myrtaceae	Fruits, timber
12	Deuwa	*Artocarpus lacucha*	Moraceae	Fruits, fuel
13	Loqut	*Eriobotrya japonica*	Rosaceae	Fruits, fuel
14	Jambura	*Citrus grandis*	Rutaceae	Fruits, herbal medicine
15	Amloki	*Phyllanthus embelica*	Euphorbiaceae	Fruits, timber, dye, medicine
16	Ataphal	*Annona reticulata*	Annonaceae	Fruits, timber
17	Baroi/Kul	*Zizyphus mauritiana*	Rhamnaceae	Fruit, agriculture tools, fuel
18	Safeda	*Manilkara sapota*	Sapotaceae	Fruits
19	Kadbel	*Feronia limonia*	Rutaceae	Fruits, herbal medicine
20	Lichu	*Litchi chinenss*	Sapindaceae	Fruits, fuel
21	Lebu	*Citrus spp.*	Rutaceae	Citrus fruits, medicine
22	Sarifa	*Annona squamosa*	Annonaceae	Fruits
23	Kamranga	*Averrhoa carambola*	Averrhoaceae	Fruits, herbal medicine
24	Amra	*Spondias pinnata*	Anacardiaceae	Fruits, fuel
25	Jalpai	*Elaeocarpus robustus*	Elaeocarpaceae	Fruits, oil
26	Jamrul	*Syzygium samarangense*	Myrtaceae	Fruits, timber
27	Kamla	*Citrus reticulata*	Rutaceae	Fruits

Source: Survey Team, 2020

Figure 5-42: Commonly found homestead plants in project area

Roadside Plantation

Betel Nut (Supari), Terminalia arjuna (Arjun), Swietenia macrophylla (Mehegoni), Streblus asper (Shaora) etc. were found as most common roadside plantation (). A list of roadside plats is presented in

Figure 5-43: Roadside plants in project area

Table 5-23: List of Roadside plantation found in the project area

Sl. No.	Scientific Name	Local Name	English	Types	Use	Indigenous/ Exotic
1	*Acacia auriculiformis*	Akash Moni	Ear-pod Wattle	Fuelwood tree	Fodder	Exotic
2	*Terminalia arjuna*	Arjun	Arjun tree	medicinal	Medicinal	Exotic
3	*Annona squamosa*	Ata	Custard	fruit bearing tree	Food	Indigenous
4	*Averrhoa bilimbi*	Bilombo	Cucumber tree	fruit bearing tree	Food	Exotic
5	*Eucalyptus globulus*	Eucaliptus	blue gum	Timber	Timber	Exotic
6	*Lannea coromandelica*	Jiol	Indian ash tree	Woody Tree	Timber	Indigenous
8	*Delonix regia*	Krsnacura	Royal poinciana	Flower and Timber	Timber	Indigenous
9	*Vachellia nilotica*	Khoi Babla	Egyptian acacia	fruit bearing tree	Food	Indigenous
10	*Khaya anthotheca*	Lombu	White mahogany	woody tree	Timber	Exotic
11	*Swietenia macrophylla*	Mahagoni	Spanish Mahagoni	woody tree	Timber	Exotic
12	*Acacia mangium*	Mengium	Wattle	Fuelwood	Fuelwood	Exotic
13	*cassia siamea*	Minjiri	Cassia tree	Fuelwood	Fuelwood	Exotic
14	*Samanea saman*	Rain Tree	Rain Tree	Fuelwood	Fuelwood	Exotic
15	*Tectona Grandis*	Segun	Teak	Woody tree	Timber	Exotic
16	*Streblus asper*	Shaora	Tooth brush tree	Shrub	papermaking	Exotic
17	*Albizia procera*	Shil Koroi	White Siris	Fuelwood	Fuelwood	Indigenous
18	*Bombax ceiba*	Shimul	cotton tree	Cotton Tree	Cotton	Indigenous
19	*Dalbergia sissoo*	Sishoo	North Indian rosewood	Fuelwood	Fuelwood	Exotic
20	*Betel Nut*	Supari	Areca Nut	Fruit and Woody Tree	Food	Exotic

Source: Survey Team, 2020

Commercial Plantation

Commercial plantation was found a few, while only one quadrate was recorded. Among commercial plantation mahogany and bash were found as common (see).

Figure 5-44: Commercial plants in project area

Agricultural Land

Most of the land in the project locations belong to agricultural land, in general. A variety of naturalized weeds also grows along with the crops. Agricultural lands are dominated with herbs like Lippa alba, Xanthium indicum, Alternanthera sesilis, Grangea sp., Dentalla repens, Eclipta alba, Lens esculenta etc. Sedges like Cyperus rotundus are commonly occurring in the agricultural lands. Grasses like Cynodon dactylon and Paspalum conjugatum can be found in the natural state. Climbers like Vicia hirsuta and Ipomea indica also occur in the Project AOI. Cropping pattern in the area is given in . Farmers practice agriculture in this region for 3 seasons, i.e. Rabi, Kharif I and Kharif II. Source of irrigation in this region are storm water are rain water harvesting ponds, ground water, khals/canal etc. Major crops of the region are paddy, betel leaf, betel nut, potato, corn, turmeric, tea, tomato, peanut, mustard, patol (heap), brinjal, ginger, cucumber and other vegetables ().

Table 5-24: Cropping Pattern of the Project Area

Sl No.	Cropping season	Major Crop	Month
1	Kharif - I	B. Aus, Jute and vegetables	March to May
2	Kharif – II	T. Aman (HYV & L) and fallow land	June to October
3	Robi	Boro (HYV), vegetables, fruits and pulses	November to February

Source: Survey Team, 2020

Figure 5-45: Agricultural Plants in project area

Aquatic Plants

In Bangladesh Agricultural University (BAU) campus (approximately 2.28 Km away from proposed Kewatkhali Bridge site) there was found some floating aquatic weeds liketopapana (*Pistia stratiotes*), Khudipana (*Lemna minor*), Kutipana (*Azolla pinnata*), Sonapana (*Spirodela polyrrhiza*) (figure 3.24). Common aquatic plants included Malancha (*Alternanthera philoxerodies*), Kolmi (*Ipomoea aquatica*), Bishkatali (*Polygonum hydropiper*), Panikochu (*Sagittaria spp.*), Amroolshak (*Oxalis corniculata*), Sushnishak (*Marsilea quadrifolia*), Kanaibashi (*Commelina bengalensis*), Kanaidoga (*Commelina appendiculata*), Dholkolmi (*Ipomoea carnea*), Lalshapla (*Nymphaea rubra*), Sadashapla (*Nymphaea nauchali*), Arail (Leersia hexandra), Chechra (*Scirpus mucronatus*), Keshordham (Ludwigia adscendens), Helencha (*Enhydra fluctuans*), Paniphal (*Trapa natans*), Kochu (*Colocasia esculenta*), Dol

(*Hygroryza aristata),* Kolmishak (*Ipomoea spp*.), Kara (*Nymphoides aquatica*), Hugla (*Typha spp.)* and Ghechu (*Aponogeton spp*.).

Figure 5-46: Aquatic Plants in project area

Table 5-25: List of Aquatic Plants in Project Area

Sl. No.	Local name	*Scientific name*	Type	Status
1	Topapana	*Pistia stratiotes*	Aquatic weed	Unknown*
2	Khudipana	*Lemna minor*	Aquatic weed	Unknown*
3	Kutipana	*Azolla pinnata*	Aquatic weed	Unknown*
4	Malancha	*Alternanthera philoxerodies*	Aquatic plant that lives on buffer zone	Unknown*
5	Kolmi	*Ipomoea aquatica*	Aquatic plant that lives on buffer zone	Unknown*
6	Bishkatali	*Polygonum hydropiper*	Aquatic plant that lives on buffer zone	Unknown*
7	Panikochu	*Sagittaria sp.*	Aquatic plant that lives on buffer zone	Unknown*
8	Amroolshak	*Oxalis corniculata*	Aquatic plant that lives on buffer zone	Unknown*
9	Sushnishak	*Marsilea quadrifolia*	Aquatic plant that lives on buffer zone	Unknown*
10	Kanaibashi	*Commelina bengalensis*	Aquatic plant that lives on buffer zone	Unknown*
11	Helencha	*Enhydra fluctuans*	Aquatic plant that lives on buffer zone	Unknown*
12	Ghechu	*Aponogeton sp.*	Aquatic plant that lives on buffer zone	Unknown*

Source: Survey Team, 2020

Photo Plate of Flora available in the project AOI

Figure 5-47: Common Plants in Project AOI

Figure 5-48: Wild Plants in Project AOI

Figure 5-49: Agricultural Plants in Project AOI

Figure 5-50: Aquatic Plants in Project AOI

Plant Statistics and Listing

Grid wise appearance of the plants are listed in

Table 5-26: Grid Distribution of Plants in Project Area

Sl. No.	Local name	*Scientific name*	English name	Appearance in quadrates			
				SP-1	SP-2	SP-3	SP-4
1	Akash Moni	*Acacia auriculiformis*	Ear-pod Wattle	2	0	0	3
2	Amloki	*Phyllanthus emblica*	Gooseberry	0	1	1	1
3	Amm	*Mangifera indica*	Mango	6	10	3	8
4	Amra	*Spondias mombin*	Hog plum	1	3	2	2
5	Arjun	*Terminalia arjuna*	Arjun tree	2	1	0	0
6	Ata	*Annona squamosa*	Custard	0	10	1	0
7	Bash	*Bambusa balcooa*	Bamboo	15	22	34	12
8	Bel	*Aegle marmelos*	Wood Apple	2	5	2	1
9	Bon Jam	*Ardisia solanacea*	Shoebutton ardisia	0	1	0	0
10	Boroi	*Ziziphus mauritiana*	Jujube	1	1	5	2
11	Bot	*Ficus benghalensis*	Banyan Tree	0	1	0	0
12	Chalta	*Dillenia indica*	elephant apple	0	1	0	0
13	Chamble	*Albizia recardiana*	Gogonsirir	5	2	3	1
14	Debdaru	*Polyalthia longifolia*	Ashoka tree	0	1	1	1

Sl. No.	Local name	*Scientific name*	English name	Appearance in quadrates			
				SP-1	SP-2	SP-3	SP-4
15	Dewa	*Artocarpus lacucha*	Monkey Jack	0	1	1	1
16	Dumur	*Ficus sycomorus*	Ficus	3	7	4	1
17	Eucalyptus	*Eucalyptus globulus*	blue gum	1	3	7	2
18	Gab	*Diospyros discolor*	velvet apple	0	1	0	0
19	Jibon	*Trema Orentalis*	Charcoal tree	1	0	0	0
20	Jam	*Syzygium cumini*	Black berry	2	2	1	1
21	Jambura	*Citrus maxima*	Pomelo	1	2	1	3
22	Jamrul	*Syzygium samarangense*	Wax Apple	0	2	2	1
23	Jarul	*Lagerstroemia speciosa*	Queen Flower	0	4	2	1
24	Jhau	*Casuarina equisetifolia*	Australian Oak	1	0	0	0
25	Jog Dumur	*Ficus racemosa*	Cluster fig tree	0	3	1	2
26	Jolpai	*Olea europaea*	Olive tree	1	2	1	1
27	Kadam	*Neolamarckia cadamba*	Burflower tree	3	1	3	1
28	Kalo Koroi	*Albizia lebbeck*	Fry Wood	1	1	2	0
29	Kamranga	*Averrhoa carambola*	Chinese Gosseberry	1	0	0	0
30	Kat Badam	*Terminalia catappa*	Tropical-almond	1	0	1	0
31	Kathal	*Artocarpus heterophyllus*	Jackfruit	3	4	6	5
32	Khejur	*Phoenix sylvestris*	Date palm	2	4	2	1
33	Khoi Babla	*Vachellia nilotica*	Egyptian acacia	1	4	2	1
34	Kola	*Musa acuminata*	Banana	11	4	3	13
35	Koromcha	*Carissa carandas*	Bengal currant	0	0	1	0
36	Lebu	*Citrus auranticola*	Lemon	2	1	4	1
37	Lichu	*Litchi chinensis*	Litchi	0	1	1	1
38	Mahagoni	*Swietenia macrophylla*	Spanish Mahagoni	10	14	11	8
39	Mandar	*Erythrina ovalifolia*	Indian Coral Tree	2	1	2	0
40	Narikel	*Cocos nucifera*	Coconut	2	4	3	2
41	Neem	*Azadirachta indica*	Neem	1	2	1	1
42	Pepe	*Carica papaya*	papaya	1	1	3	1
43	Peyara	*Psidium guajava*	Guava	1	0	1	1
44	Pitoli	*Mallotus nudiflora*	Latim Tree	3	0	0	0
45	Sada Shimul	*Ceiba pentandra*	Java cotton	0	1	0	0
46	Sajina	*Moringa oleifera*	Drumstick tree	0	1	2	0
47	Shaora	*Streblus asper*	Tooth brush tree	0	1	1	0
48	Shil Koroi	*Albizia procera*	White Siris	0	1	3	0
49	Shimul	*Bombax ceiba*	cotton tree	1	0	1	1
50	Sishoo	*Dalbergia sissoo*	North Indian rosewood	1	1	1	2
51	Supari	*Areca catechu*	Areca palm	8	5	1	24
52	Tal	*Borassus flabellifer*	Palm trees	0	1	1	1
53	Tetul	*Tamarindus indica*	Tamarind	3	1	1	1

Source: Survey Team, 2020

Table 5-27: Complete List of Plants in the project area with their name, origin and type

Sl. No	*Scientific Name*	Local Name	English name	Sighting Status*	Type	Use
1	*Acacia auriculiformis*	Akash Moni	Ear-pod Wattle	Very common	Fuelwood tree	Fodder Fuel paper pulp Tannin or dyestuff
2	*Phyllanthus emblica*	Amloki	Gooseberry	Few	fruit bearing tree	Food Medicinal Fuel
3	*Mangifera indica*	Amm	mango	Common	fruit bearing tree	Food
4	*Spondias mombin*	Amra	Hog plum	Few	fruit bearing tree	Food
5	*Terminalia arjuna*	Arjun	Arjun tree	Few	medicinal	Medicinal
6	*Annona squamosa*	Ata	Custard		fruit bearing tree	Food Fodder
7	*Bambusa balcooa*	Bash	Bamboo	Very Common	Clumping grass	Fodder Furniture Construction pulp
8	*Aegle marmelos*	Bel	Wood Apple	Few	fruit bearing tree	Food Medicinal
9	*Ardisia solanacea*	Bon Jam	Shoebutton ardisia	Vulnerable	fruit bearing tree	Food
10	*Ziziphus mauritiana*	Boroi	Jujube	Common	fruit bearing tree	Food
11	*Ficus benghalensis*	Bot	Banyan Tree	Few	woody tree	Fodder Medicinal
12	*Dillenia indica*	Chalta	elephant apple	Common	fruit bearing tree	Food Fodder
13	*Albizia recardiana*	Chamble	Gogonsirir	Common	fuelwood tree	Fodder Fuel
14	*Polyalthia longifolia*	Debdaru	Ashoka tree	Few	Ornamental tree	Ornamental tree
15	*Artocarpus lacucha*	Dewa	Monkey Jack	Few	fruit bearing tree	Food
16	*Ficus sycomorus*	Dumur	Ficus	Common	shrub	Fodder
17	*Eucalyptus globulus*	Eucalyptus	blue gum	Occasional	fuelwood tree	Timber Pulpwood Essential oil
18	*Diospyros discolor*	Gab	velvet apple	Common	fuelwood tree	Timber Tannin or dyestuff
19	*Syzygium cumini*	Jam	Black berry	Common	fruit bearing tree	Food Railway Slipper
20	*Citrus maxima*	Jambura	Pomelo	Common	fruit bearing tree	Food
21	*Syzygium samarangense*	Jamrul	Wax Apple	Common	fruit bearing tree	Food Medicinal
22	*Lagerstroemia speciosa*	Jarul	Queen Flower	Few	Medicinal	Medicinal

Sl. No	*Scientific Name*	Local Name	English name	Sighting Status*	Type	Use
23	*Casuarina equisetifolia*	Jhau	Australian Oak	Common	Ornamental	Tannin or dyestuff
24	*Olea europaea*	Jolpai	Olive tree	Common	fruit bearing tree	Food
25	*Neolamarckia cadamba*	Kadam	Burflower tree	Few	Ornamental	Food Fodder Fuel
26	*Albizia lebbeck*	Kalo Koroi	Fry Wood	Common	Fuelwood	Fodder Fuel
27	*Averrhoa carambola*	Kamranga	Chinese Gosseberry	Few	fruit bearing tree	Food
28	*Terminalia catappa*	Kat Badam	Tropical-almond	Common	fruit bearing tree	Food Medicinal
29	*Artocarpus heterophyllus*	Kathal	Jackfruit	Common	fruit bearing tree	Food Timber
30	*Phoenix sylvestris*	Khejur	Date palm	Common	fruit bearing tree	Food
31	*Vachellia nilotica*	Khoi Babla	Egyptian acacia	Few	fruit bearing tree	Food Fuelwood Fodder
32	*Musa acuminata*	Kola	Banana	Very Common	fruit bearing tree	Food Fodder
33	*Carissa carandas*	Koromcha	Bengal currant	Critically Endangered	flowering shrub	Food Medicinal
34	*Citrus auranticola*	Lebu	Lemon	Common	shrub	Food
35	*Litchi chinensis*	Lichu	Litchi	Few	fruit bearing tree	Food
36	*Swietenia macrophylla*	Mahagoni	Spanish Mahagoni	Very Common	woody tree	Timber
37	*Erythrina ovalifolia*	Mandar	Indian Coral Tree	Few	Ornamental	Fuelwood
38	*Acacia mangium*	Mengium	Wattle	Few	Fuelwood	Fuelwood
39	*Cocos nucifera*	Narikel	Coconut	Very Common	fruit bearing tree	Food
40	*Azadirachta indica*	Neem	Neem	Common	Medicinal	Medicinal
41	*Carica papaya*	Pepe	papaya	Very Common	fruit bearing tree	Food
42	*Psidium guajava*	Peyara	Guava	Very Common	fruit bearing tree	Food
43	*Mallotus nudiflora*	Pitoli	Latim Tree	Common	Fuelwood	Fuelwood
44	*Ceiba pentandra*	Sada Shimul	Java cotton	Few	Medicinal /Cotton Tree	Medicinal Cotton
45	*Moringa oleifera*	Sajina	Drumstick tree	Few	fruit bearing tree	Food Fodder
46	*Streblus asper*	Shaora	Tooth brush tree	Common	Shrub	Papermaking Medicinal
47	*Albizia procera*	Shil Koroi	White Siris	Few	Fuelwood	Fuelwood
48	*Bombax ceiba*	Shimul	cotton tree	Few	Cotton Tree	Cotton
49	*Dalbergia sissoo*	Sishoo	North Indian rosewood	Few	Fuelwood	Fuelwood Timber
50	*Areca catechu*	Supari	Areca palm	Common	fruit bearing tree	Food

Sl. No	*Scientific Name*	Local Name	English name	Sighting Status*	Type	Use
51	*Borassus flabellifer*	Tal	Palm trees	Few	fruit bearing tree	Food
52	*Tamarindus indica*	Tetul	Tamarind	Few	fruit bearing tree	Food Seed Oil
53	*Trema Orentalis*	Jibon	Charcoal tree	Common	Medicinal	Medicinal fodder

Source: Field Survey Team 2020

*Appearance Status: Calculated based on local appearance and Expert's opinion.

5.8.4.3 Wildlife Survey

Faunal Studies were undertaken in the Project AOI by opportunistic search methods where habitats of the different faunal species were repeatedly visited twice to confirm their presence and usage of the habitats. Focus was given on the larger animals which are under threat of frequent urbanization and industrialization in the area. The target faunal species studied are Mammals, Avifauna, Reptiles and Amphibians.

Mammals

Cows, goats, dogs, cats, rats were commonly found in the project corridor during the field visit. One wild fauna was found during survey period. As per discussion with local people it was also reported that, in the forested or bushy area wild animals like Fox (*Canis aureus Linnaeus*), Wild Cats (*Felis chaus Schreber*), Otter/Udbiral (*Lontra Canadensis*), Rabbits (*Lepus nigricollis F. Cuvier*), Baro Badur (*Pteropus giganteus*), Ram Kutta (*Cuon alpinus*), etc. can be found. Among them only Fox were spotted during field visit. Ram Kutta (*Cuon alpinus*) were seen before, yet they are not allegedly to be located of late. See for a detailed list.

Table 5-28: List of mammals in the project AOI and their local IUCN status

Serial No.	*Scientific Name*	Local Name	IUCN Redbook Status*	Source of Information	Habitat*
01	*Suncus murinus*	Chika	LC	Visual Observation	H
02	*Pteropus giganteus*	Baro Badur	LC	Local Information	Tt
03	*Cynopterus sphinx*	Kola Badur	LC	Local Information	Hh
04	*Scotophilus kuhlii Leach*	Choto Holdey Chamchika	LC	Local Information	Tt
05	*Canis aureus Linnaeus*	Pati Shial	LC	Visual Observation	Op
06	*Cuon alpinus*	Ram Kutta	EN	Local Information	Hh,Op
07	*Vulpes bengalensis*	Kheki	VU	Local Information	Hh,Op
08	*Felis chausSchreber*	Bon Bilai	NT	Local Information	Bh
09	*Prionailurus bengalensis*	Chita Biral	NT	Local Information	Bh
10	*Herpestes edwardsi*	Boro Beji	LC	Visual Observation	Bh
11	*Herpestes urva*	Moucha Bejji	NT	Local Information	Bh
12	*Lutra*	Vodor	CR	Local Information	We,C,R
13	*Callosciurus pygerythrus*	Badami Kathbirali	LC	Local Information	H
14	*Bandicota bengalensis*	Metho-indur	LC	Local Information	H
15	*Rattus*	Indur	LC	Visual Observation	H
16	*Hystrix indica Kerr*	Shojaru	LC	Local Information	Bh,H

Serial No.	*Scientific Name*	Local Name	IUCN Redbook Status*	Source of Information	Habitat*
17	*Lepus nigricollis F. Cuvier*	Khorgosh	LC	Local Information	H,Bh

Source: Field Survey 2020

* ***Abbreviation:*** C = Common, CR = Critically Endangered, EN = Endangered, Vu = Vulnerable, LC=Least Concern, NT=Near Threatened, R = Resident, Bh = Bush, Op = Open place, Hh = Human habitation, Tt = Tall tree, H = Hole, R = River, P = Pond, C = Canal, We = Water edge.

Figure 5-51: Commonly Found Mammals in the project AOI

Avifauna

Avifauna like Gugu/Dove (*streptopelia chinensis*), Paira/Pigeon, Doyal (*Magpie Ribbon*), House sparrow/Choroi, Parrot/Tiya, Crow (*Corvus splendens*), Myna/Shalik, Babui/Baya Weaver (*Ploceus philippinus*), Dhooli Bawk, Sarosh/Eastern Great Egret (*Ardea modesta*), Kaali Bawk, Machranga/Kingfisher (*Halcyn smyrensis*), Koyal/Kokil (*Eudynamys scolopaceus*), Baali, Dhanesh/ Indian grey hornbill(*Ocyceros birostris*), Baijja hash, blue throated barbet (*Megalaima asiatica*), Duck (*Anatidae anatinae*), Giria Hash (*Spatula querquedula*), Piang Hash (*Mareca strepera*), Dhar Bawk/Egret, Konch Bawk/Pond Heron (*Ardeola grayii*) are found in the study area . A detailed list is provided in .

Table 5-29: List of Avifauna found in the project AOI and their local IUCN status

Serial No.	*Scientific Name*	Local Name	IUCN Red list Status*	Source of Information	Habitat
1	*Tadorna tadorna*	Pati Chokachoki	LC	Visual Observation	Estuary, large rivers, larger wetlands
2	*Tadorna ferruginea*	Khoira Chokachoki	LC	Local Information	Wetland
3	*Netta rufina*	Laljhuti Bhutihash	LC	Local Information	Wetland
4	*Aythya ferina*	Pati Bhutihash	LC	Local Information	Freshwater wetland
5	*Aythya fuligula*	Tiki Hash	LC	Local Information	Freshwater wetland
6	*Spatula querquedula*	Giria Hash	LC	Visual Observation	River and Wetland
7	*Spatula clypeata*	Khunte Hans	LC	Local Information	Wetland
8	*Mareca strepera*	Piang Hash	LC	Visual Observation	Freshwater and wetland
9	*Anas poecilorhyncha*	Meteyhash	LC	Local Information	Wetlands
10	*Sarkidiornis melanotos*	Nakta Hansh	NT	Local Information	Wetlands
11	*Tachybaptus ruficollis*	Choto Dubur	LC	Local Information	Wetland
12	*Podiceps cristatus*	Boro Khopaduburi	LC	Local Information	Wetland
13	*Streptopelia decaocto*	Konthighughu	LC	Local Information	Wetland
14	*Hemiprocne coronata*	Jhutial Gachbatashi	LC	Local Information	Hill forest
15	*Ardeola grayii*	Kani Bok	LC	Local Information	Wetlands

Source: Field survey and local consultation 2020

** **Abbreviation:** LC=Least Concern, NT=Near Threatened.*

Figure 5-52: Commonly Birds Found in the project AOI

Reptiles

A total of 11 species of reptiles were identified within the project AOI. Of the reptilian species, 8 were lizards and 3 species of snakes. Out of these House Gecko (*Hemidactylus brookii*), Common Garden Lizard (*Calotis versicolor*) and Rat Snake (*Coluber mucosus*) were observed during field survey. Rest of the reptilian fauna (08 species) were reported by the local people while consultations have been conducted. Among the 11 species recorded, Grey Indian Monitor (*Varanus benghalensis*) and Ganges Soft Shell Turtle (*Nilssonia gangetica*) are reported in Bangladesh Wildlife Prevention Order, 1973 as Sch-III which protects them from hunting, killing and capturing. Two turtles and one terrapin, the Ganges Soft Shell Turtle (*Nilssonia gangetica*) are listed as Vulnerable, River Terrapin (*Batagur baska*) as Critically Endangered and Striped Roof Turtle (*Kachuga dhongoka*) as Endangered as per IUCN (2015, v.2) category. The Grey Indian Monitor, River Terrapin (*Batagur baska*) and Striped Roof Turtle were observed in the past, but they are not reportedly to be sighted lately. A detail list of the reptiles in the area is presented in .

Table 5-30: List of Reptiles found in the project AOI and their local IUCN status

Sl. No.	Scientific Name	English Name	Local Name	Sighting	IUCN Local status*	Source of Information	Habitat
1	*Hemidactylus flaviviridis*	House Gecko	Tiktiki	C	LC	Visual Observation	Bh, Op, Hh, Tt
2	*H. brookii*	Spotted House Lizard	Tiktiki	C	LC	Local Information	Bh, Op
3	*H. bowringii*	Bowring's House Lizard	Tiktiki	C	LC	Local Information	Bh
4	*Gekko gecko*	Wall Gecko	Takkhak	C	LC	Local Information	Bh, Op
5	*Calotes versicolor*	Common Garden Lizard	Rokto-chosa	VC	LC	Visual Observation	Bh, Op
6	*Mabuya carinata*	Common Skink	Anjon	VC	LC	Local Information	Bh, Op
7	*Eutropis dissimilis*	Striped Skink	Anjon	C	LC	Local Information	Bh, Op
8	*Varanus bengalensis*	Bengal Monitor/Grey Indian monitor	Gui Shap	FC	NT	Visual Observation	Bh, P,Ri
9	*Varanus flavescens*	Yellow Monitor	Holdy-gui	F	NT	Local Information	Bh, Cl

Sl. No.	Scientific Name	English Name	Local Name	Sighting	IUCN Local status*	Source of Information	Habitat
10	*Coluber mucosus*	Rat Snake	Darash shap	C	LC	Visual Observation	Bh, Op
11	*Nilssonia gangetica*	Ganges Soft Shell Turtle	Kocchop	O	EN	Local Information	Ri

Source: Field survey and local consultation 2020

** **Abbreviation:** VC = Very Common, C = Common, F = Few, O = Occasional, EN = Endangered, Vu = Vulnerable, M = Migratory, Bh = Bush, Op = Open place, Hh = Human habitation, Tt = Tall tree, H = Hole, Ri = River, P = Pond, C = Canal, Dt = Ditch, We = Water edge, Ri = River*

Figure 5-53: Commonly Reptiles Found in the project AOI

Amphibians

Only 2 amphibians were found during field study. No authentic data on local amphibians were found from anywhere. Therefore, the list of amphibians only sighted during field visit is provided below .

Table 5-31: List of amphibians found in the project AOI and their IUCN local status, distribution and habitat

Sc. name	English name	Local name	Sighting status	Sighted during Fieldwork	IUCN BD status*	Habitat*
Hoplobatrachus tigerinus	Bull Frog	Kolabang	VC	Y	LR	OP, P, Dt
Duttaphrynus melanostictus	Asian Common Toad	Kuno Bang	VC	Y	LR	OP, P, Dt

Source: Field Survey and Local consultation 2020

** **Abbreviation:** VC = Very Common, Y=Yes, N=No, LC = Least Concern, Op = Open place, P = Pond, Dt = Ditch*

Figure 5-54: Commonly Amphibians Found in the project AOI

Photo Plate of Fauna available in the project AOI

Figure 5-55: Wildlife Found in the project AOI

5.8.4.4 Fisheries Survey

Fisheries resources of the study area are rich and diversified. Study area consists of Brahmaputra river and some temporary wetlands. Water in these bodies varies from fresh to brackish. Both natural and cultured fisheries exist in the study area. In the study area, both capture fisheries and culture fisheries are available.

Study area consists of rivers, aquaculture ponds, canals and Khals. Fish habitats of the area are mainly rivers and some aquacultures ponds. Various nets were found in use for capture of fisheries.

General Findings

It was found that, in the project alignment on Brahmaputra River is well-known for fishing activities since other channels are suffering from low water. However, during the survey, some fishermen were seen fishing using drag net (current jal). So, the information collected on fisheries are based on both the landing surveys and fishermen interviews.

According to the local people and fishermen's opinion, very rare species as Along (Megarasbora elanga), Kalibaus (Labeo calbasu), Shorpunti (Puntius sarana), Gozar (Channa marulius), Pangas (Pangasius pangasius), Muribacha (Clupisoma garua), Baghair (Bagarius bagarius), Gang tengra (Gagata cenia) and Baim (Mastacembelus armatus) were available for at least 15-20 years ago. Now these species are facing an extremely high risk of extinction day by day. They also mentioned that this negative trend is due to overfishing, indiscriminate fishing of larvae and

juveniles, siltation and pollution. The findings clearly represent the declining trends of fish diversity in the study area which warning the gradual declination of fish diversity of Bangladesh.

During the study period man made activities were found as dominant decline causes of fish species in the Brahmaputra River. Indiscriminate fishing by using different nonselective fishing gears mainly badha jal and behundi jal was observed as major threat for the diversity of fishes. It was also observed that a number of drains have fallen into the river from both the banks. As a result, various chemical wastages from agro-industrial sources fall through the drainage and polluted the water quality consequently destroying the fish habitat. The construction of diversion canals and sluice gates cause heavy siltation in the riverbed.

Capture fisheries were studied using both boat-based survey and landing survey as illustrated in Methods section. For fisheries survey, boat survey and landing surveys was conducted

Figure 5-56: Surveyors Conducting Boat, Fisherman Survey and Landing Market Survey

Common Capture Fishes and Seasonality

According to the fishremen and local people, Mola (Amblypharyngodon mola), Jat punti (Puntius sophore), Golsa tengra (Mystus bleekeri), Tengra (Mystus vittatus), Kajuli (Ailia punctata), Chanda (Chanda nama), Bele (Glossogobius giuris) chingri (Macrobrachium tenuipes) were the most abundant species in monsoon period. On the other hand, Chapila (Gudusia chapra), Chandana ilish (Tenualosa toli), Taposi (Polynemus paradiseus), Cheua (Pseudapocryptes elongatus) and Dogri (Trypauchen vagina) are the abundant species in winter

(November - February) and Phasa (Setipinna phasa), Dhela (Osteobrama cotio) and Poa (Otolithoides pama) were the abundant species in summer (March - June).

Figure 5-57: Captured Fish Found at the Project Site

Gear Use and estimation of catch

Most of the catch of this river is landed by small-scale local fishermen and it is estimated that about one fourth of it is harvested by set bagnet. The large number of species caught by set bagnet has many negative impacts on biodiversity and fisheries, when compared with other fisheries. Set bagnet is a traditional fishing gear in the coastal area, still being operated by small-scale fisher folk in Bangladesh. Set bagnet makes an efficient gear for capturing a wide range of finfish and shellfish species including juveniles. The net is operated with some regional variations in design and mode of operation. This gear is widely used in the Brahmaputra river for collecting small fish mostly juvenile of commercially valuable species.

Set bagnet was the most common fishing gear in the region. Set bagnet with a mesh size greater than 90 mm was not harmful to stocked fish. However, most of the fishermen used mesh size less than 50 mm. In the Brahmaputra river, mouth opening mesh size of set bagnet ranged from 10 to 20 mm and in the codend, this ranged from 5 to 10 mm and even as small as 2 mm.

Types of Gear

During fisheries survey, various types of fishing gears were found to operate in the study area. Various types of fishing techniques have also been identified that can broadly categorized into netting, angling, trapping, spearing etc. We classified fishing gears rather than fishing technique for generalization and easier understanding. The fishing gears found in the study area can classified into 3 broad groups:

a. Nets
b. Traps, and
c. Wounding gears

It is important to note that, same fishermen were found use different types of gears to catch different size of fish over different seasons. Therefore, the statistics presented in this study actually refers to pre-monsoon season (April-May and first week of June) and suited gear types. Respondents said in pre-monsoon, relatively smaller fish are available for catch while monsoon comes with deep water and bigger fish size. According to the desired size of fish to be caught,

fishermen usually change their gears. gives an overview of the Gear-wise catch attachment in Brahmaputra River.

Table 5-32: Gear Wise catch assessment in the project AOI

Sl no	Gear (specific)	Total efforts per day (nos.)	Average catch per day (kg)	Type of fish
01	Current net (entangling net)	1	2	Tengra, Koi, Puti, Taki, Koilsha, Chanda
02	Atta net	2-3	8-9	Boal, Pabda, Chingri, Tengra, Bataya, Koi, Meni, Kanna, Puti, Sorputi, Shol, Taki, Gojar, Minar Carp, Grass Carp, kali Baush, Koilsha, Rui, Katla, Chanda, Shing, Magur, Chitol, Baen, Gutum, Bailla, Aair
03	Koni net	3-4	6-7	Tengra, Koi, Puti, Taki, Koilsha, Chanda, Sorputi, Chingri
04	Moi net	3	4.5	Chingri, Shing, Taki, Tengra
05	Ber net	2-3	20-25	Boal, Pabda, Chingri, Tengra, Bataya, Koi, Meni, Kanna, Puti, Sorputi, Shol, Taki, Gojar, Minar Carp, Grass Carp, kali Baush, Koilsha, Rui, Katla, Chanda, Shing, Magur, Chitol, Baen, Gutum, Bailla, Aair
06	Khora net	2-3	7-8	Boal, Pabda, Chingri, Tengra, Bataya, Koi, Meni, Kanna, Puti, Sorputi, Shol, Taki, Gojar, Minar Carp, Grass Carp, kali Baush, Koilsha, Rui, Katla, Chanda, Shing, Magur, Chitol, Baen, Gutum, Bailla, Aair
07	Tuna net	4-5	8-9	Kali Baush, Bailla, Puti, Boal
08	Borshi	100-150	1	Bailla, Puti, Boal, Tengra, Koi

Source: Field Survey and Local consultation 2020

A trend analysis was conducted to see if there are changes in catch rate of fisheries (Capture fisheries) over last 30 years or so. It has found that Aair, Grass Carp and Minar Carp (Local name) are now rare catch compared to 30 years back. The trend analysis is given in .

Table 5-33: Trend analysis of capture fisheries in the project AOI

Period	High catch	Medium catch	Low catch
Current (2020)	Tengra, Chanda, Puti,	Boal, Pabda, Koi, Meni, Kanna, Shol, Taki, kali Baush, Koilsha, Shing, Magur, Chitol, Baen, Gutum, Bailla,	Chingri, Bataya, Sorputi, Gojar, Grass Carp, Minar Carp, Rui, Katla
30 years back (rare catch now)	Aair, Grass Carp, Minar Carp		

Complete List of Fisheries

A comprehensive list of fisheries found in the region where the project alignment crosses are given in The table is prepared with observation, consultation with fishermen, local people, experts and literature. Couple of photographs of capture fisheries is presented is

Table 5-34: List of fisheries species in the project AOI with their IUCN red list status

Family	*Scientific Name*	English Name	Local Name	IUCN Red Book Status*
Ambassidae	*Parambassis ranga*	Indian glassy fish	Chanda	
Amblycipitidae	*Amblyceps mangois*	Indian Torrent catfish	Shing	
Anguillidae	*Anguilla bengalensis*	Indian longfin eel	Baen	
Anabantidae	*Anabas testudineus*	Climbing perch	Koi	
Balitoridae	*Lepidocephalichthys annandalei*	Annandale loach	Gutum	
Bagridae	*Mystus tengara*	Indian catfish	Tengra	
	Sperata aor	long-whiskered catfish	Aair	VU
Channidae	*Channa marulius*	Great snakehead	Gojar	
	Channa striata	Snakehead murrel	Shol	LC
	Channa punctata	Spotted snakehead	Taki	LC
Cyprinidae	*Labeo bata*	bata Labeo	Bata	
	Ctenopharyngodon idella	Grass carp	Grass carp	
	Labeo calbasu	Orange-fin labeo	kali Baush	DD
	Labeo catla	Indian carp	Katla	
	Cyprinus carpio carpio	Common carp	Minar Carp	DD
	Puntius chola	Swamp barb	Puti	LC
	Labeo rohita	Ruhi	Rui	
	Puntius sarana	Olive barb	Sorputi	
Clariidae	*Clarias gariepinus*	African catfish	Magur	
Malacostraca	*Penaeus monodon*	giant tiger prawn	Chingri	
Notopteridae	*Chitala chitala*	Indian featherback	Chitol	
Oxudercidae	*Awaous guamensis*		Bailla	LC
Osphronemidae	*Colisa fasciata*	Banded gourami	Koilsha	
Siluridae	*Wallago attu*	Cyprinidae	Boal	VU
Siluridae	*Ompok pabo*	Pabo catfish	Pabda	

Source: Field survey and local consultations,2020

** **Abbreviation:** VC = Very Common, C = Common, F = Few, O = Occasional, CR = Critically Endangered, EN = Endangered, Vu = Vulnerable, LR = Lower Risk, DD = Data Deficient, M = Migratory, R = Resident, Bh = Bush, Op = Open place, Hh = Human habitation, Cl = Cultivated land, Tt = Tall tree, H = Hole, R = River, P = Pond, C = Canal, Dt = Ditch, We = Water edge, Ri = River*

Fishing season

Fishermen identifies peak season as August – February when water stays deep and river current is present. April – June was identified as off-season. However, fishermen commented that there are variation of fish availability and fish catch over the year. In post monsoon, deep-water fish are more available while in dry season smaller fish are common. presents the picture seasonal variation of fish caught. On average the number of fish caught in peak season was at least 4 times higher than that of off season. For example, with current jal the average fish catch per day is around 5-7 kg during peak season, while during off season the catch comes down to 0.5 – 1.5 kg

per day. With barshi the stats are 10-12 kg day-1 and 2-2.5 kg day-1 for peak season and off season, respectively.

Table 5-35: Seasonal availability of few fish species in the project AOI

Species	Availability (Bengali month)											
	Baishak	Jaisthya	Ashar	Shraban	Bhadra	Ashwin	Karthik	Agrahayan	Poush	Magh	Falgun	Chaitra
Kajli												
Air												
Rui												
Katol												
Ghaura												
Bhola												
Baus												
Baim												
Ritha												
Baila												
Chital												
Bagair												
Bacha												
Kalbaus												
Sol												
Taposi												

Source: Survey Team 2020

Photo Plate of Fishes available in the project AOI

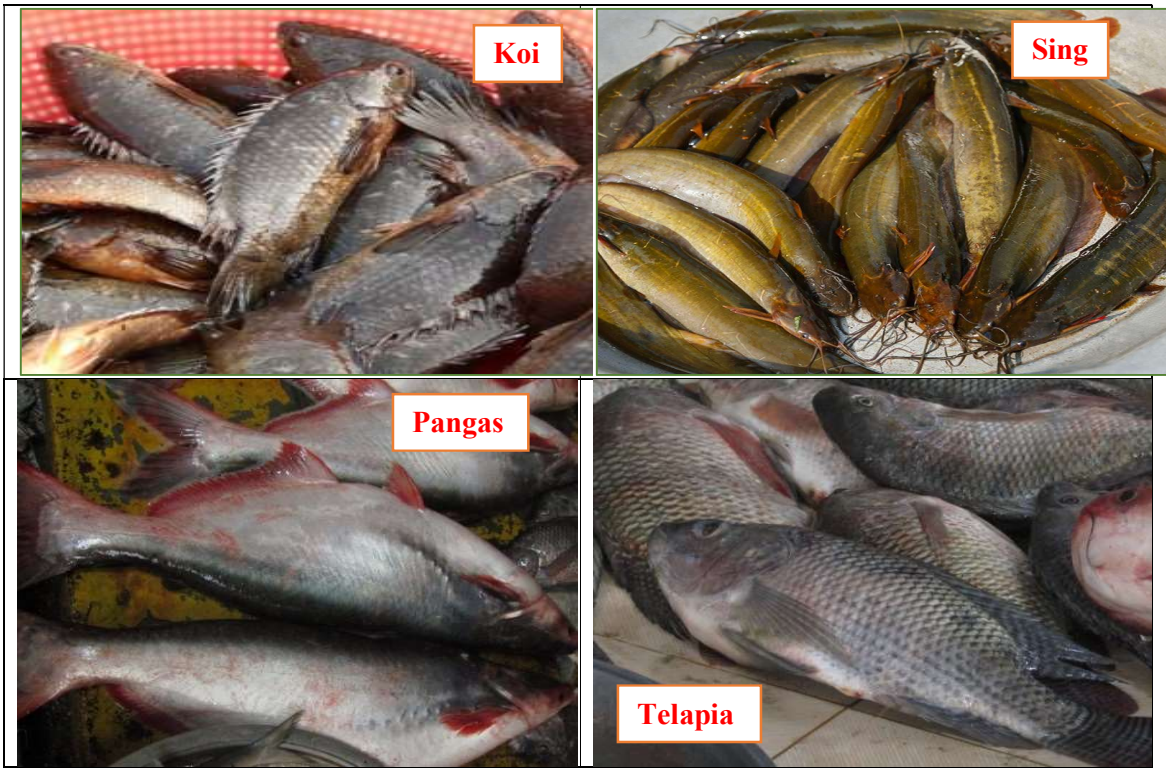


Figure 5-58: Commonly fishes in the project area

5.9 Ganges River Dolphin in Bangladesh

The Ganges River dolphin, or Susu, inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of Nepal, India, and Bangladesh. This species is categorized as Endangered by the IUCN. The Gang es River dolphin lives in one of the world's most densely populated areas and is threatened by removal of river water and siltation arising from deforestation, pollution and entanglement in fisheries nets. In addition, alterations to the river due to barrages are also separating populations. The species is found exclusively in freshwater habitat. In Bangladesh and India, individuals live in rivers that flow slowly through the plains. The Ganges River dolphin favors deep pools, eddy countercurrents located downstream of the convergence of rivers and of sharp meanders, and upstream and downstream of mid-Channel Islands.

The rivers Padma, Jamuna, Meghna, Brahmaputra and Karnaphuli including their tributaries are the principal habitats of this species in Bangladesh. The Ganges river dolphin is endangered globally as well as in Bangladesh (IUCN Bangladesh, 2015). This species is included in the First Schedule of Bangladesh Wildlife (Protection & Security) Act, 2012 to ensure higher level of protection for their in-situ conservation.

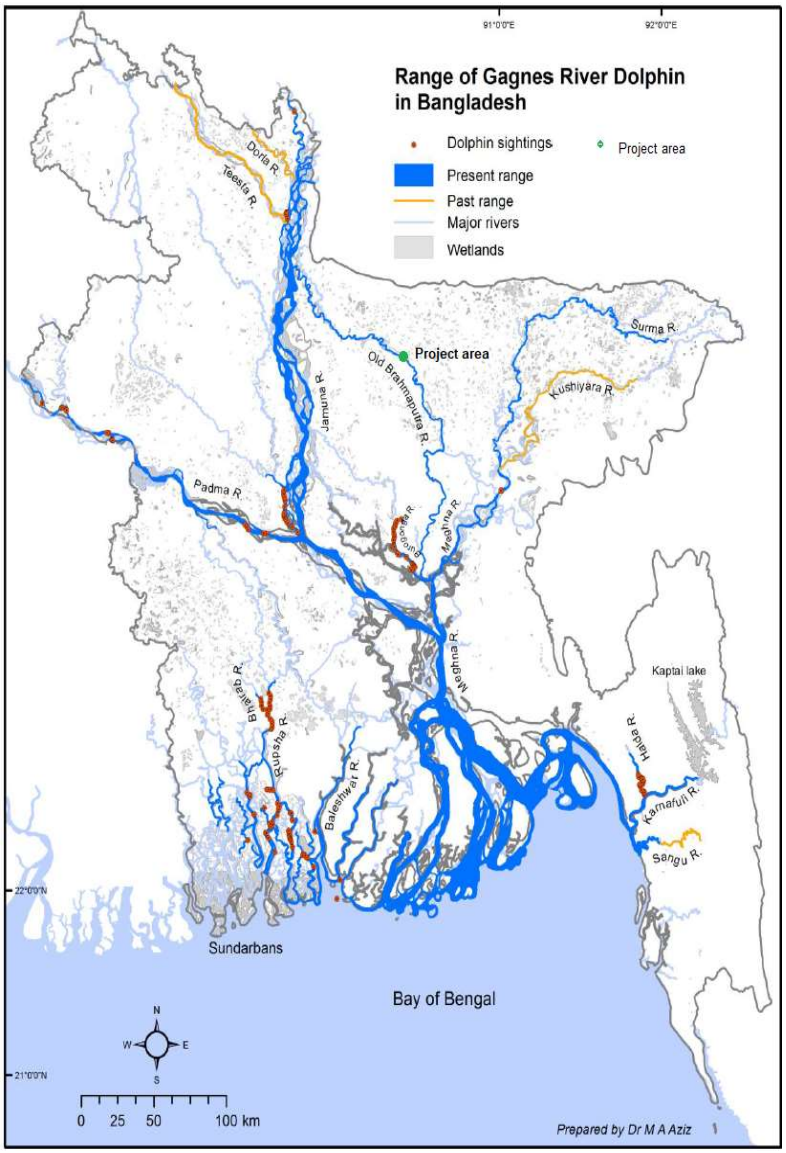


Figure 5-59 Distribution of Ganges river dolphin in Bangladesh (Adopted frrom Aziz ,2019)

5.9.1 Appearance of the Ganges River Dolphin in the project area

The Forest Department (FD) under the Ministry of Forest, Environment and Climate Change (MoEFCC) has taken a project called "Expanding the Protected Area System to Incorporate Important Aquatic Ecosystems Project". Under this project an "Atlas on Ganges River Dolphin and Irrawaddy Dolphin of Bangladesh" has been prepared[9]. According to the report, Irrawaddy dolphins live in brackish water and usually found in the coastal areas of Bangladesh. Historically, the Ganges river dolphin occurred across the entire Ganga and Brahmaputra rivers, and all their

[9] Aziz, MA (2019) Final Report: Atlas on Ganges river dolphin and Irrawaddy dolphin of Bangladesh. Expanding the Protected Area System to Incorporate Important Aquatic Ecosystems Project. Bangladesh Forest Department Ministry of Environment, Forests and Climate Change.

tributaries from the delta at the Bay of Bengal till the Himalayan foothills.

The Government of Bangladesh has established six wildlife sanctuaries specifically for the protection of the Ganges river dolphin and their habitats. Alongside the Swatch of No-ground located about 100 km from the coast of Sundarbans has been established for protecting a diversity of cetaceans and other aquatic resources.

Three wildlife sanctuaries (WS) within the Sundarbans (Chandpai, 560 ha; Dudhmukhi, 170 ha; Dhangmari, 340 ha) established in 2012 for the protection of freshwater dolphins are particularly effective at encompassing priority habitat for Ganges River Dolphins but only marginally effective in encompassing high priority habitat of Irrawaddy dolphins (Smith et al., 2010). The WS established outside of the Sundarbans include the Silonda-Nagderma WS at Boral River (24.17 ha), Nagarbari-Mohonganj WS at Jamuna River (408.11 ha) and Nazirgonj WS at Padma River (146 ha) (BFD, 2017). These sanctuaries were established for protecting the Ganges river dolphins in the Padma-Jamuna river systems. **The project area does not fall inside the Dolphin Sanctuary.** A map of the locations of Dolphin sighting and their habitats are given in Figure 5-59

5.9.2 Discussions of dolphin habitat around the project site

Dolphins are usually sighted around deep-water pools with rivers or lakes. A number of deep-water pools (kum) was identified based on the high level of dolphin sightings in winter months, most of which within the six wildlife sanctuaries for dolphins (Rashid et al., 2015). As stated earlier the project location does not fall within the wildlife sanctuaries (WS), the nearest WS being the Silonda-Nagderma WS at Boral River, and Nagarbari-Mohonganj WS at Jamuna River, approximately 80km and 120km away from the proposed bridge location, respectively. However, dolphins have been sighted in the Meghna river, immediate upstream of Bhairab bridge. Aziz (2019) in the Dolphin atlas mentioned this area as an important habitat for dolphins. The location is 30km downstream of the proposed bridge location in Kewathkhali. Although the Old Brahmaputra River has been shown as a possible range for dolphin passage in the Atlas (Figure 5-68), it does not mention the river as a potential dolphin habitat. The absence of dolphin may be attributed to the river losing its deep wager pools. The Old Brahmaputra has undergone severe sedimentation and siltation across its larger courses probably due to massive extraction of upstream water. This has led to almost unsuitable dolphin habitats in winter months . Decrease of water flow and siltation at old Bramaputra River in Mymensingh make it unsuitable for dolphins, mostly in the winter. Despite the physical condition being unsuitable for dolphin population, a dolphin survey in the project location was done to confirm the presence of the dolphins in the river. Methodology and results of the dolphin survey has been given in the later sections of the report.

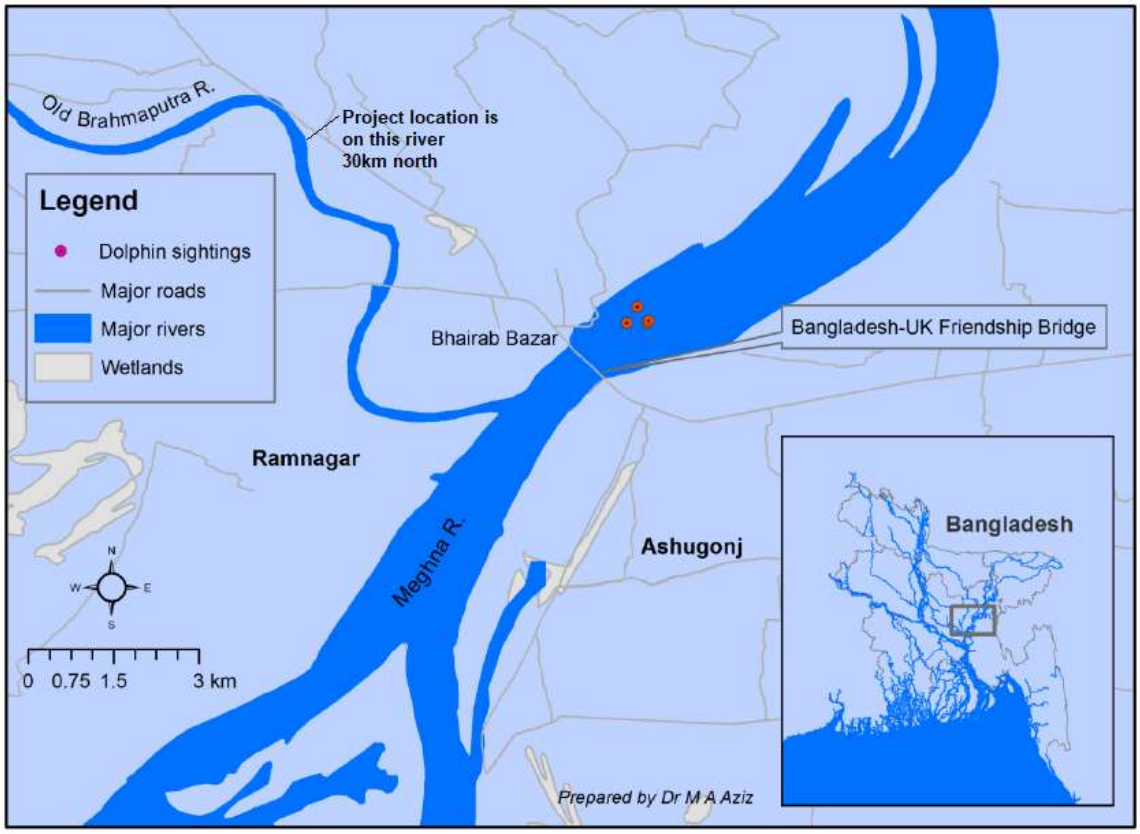


Figure 5-60 Map showing dolphin sightings at Bhairab of Meghna River (Adopted from Aziz, 2019)

Figure 5-61 Decrease of water flow and siltation at Old Brahmaputra River in Mymensingh

5.9.3 Threats to dolphins

The Ganges river dolphin has experienced both population and range decline across its historical habitats. Although several estimates are available, a reasonable global estimate may be 1200-1800 dolphins. The Ganges river dolphin has lost its ranges progressively since the nineteenth century comparing historical distribution (Anderson, 1879). Alarmingly, no dolphins have been reported in recent years in many historical locations in the Ganges of India (Sinha, 2000).

The decrease river depths and appearance of sand bars during the winter season cause danger to the dolphins as river is divided into small segments, causing segregation of populations in deeper pools. Narrowing of gene pool, increased intensity of fishing, river traffic, pollution due to untreated effluents from industries, incidental or intentional capturing for oil extraction for use as fish attractant, liniment and aphrodisiac etc. have become major threat for its survival.

The survival of the Ganges River dolphin is threatened by unintentional killing through entanglement in fishing gear; directed harvest for dolphin oil, which is used as a fish attractant and for medicinal purposes; water development projects (e.g. water extraction and the construction of barrages, high dams, and embankments); industrial waste and pesticides; municipal sewage discharge and noise from vessel traffic; and overexploitation of prey, mainly due to the widespread use of non-selective fishing gear. Irrigation-related projects have had an adverse impact on the habitat of this species. These projects result in major changes in the flow, sediment load, and water quality of rivers, which affects the quality of waters downstream. Pollution levels are a problem and are expected to increase with the development of intensive modern industrial practices in the region. Compounds such as organochlorine and butyltin found in the tissues of Ganges River dolphins are a cause for concern about their potential effects on the subspecies.

5.9.4 Dolphin Survey in Project Area

5.9.4.1 Introduction

The overall aim of the intended survey is to identify their presence, availability and habitat around the project location. To monitor the presence of this species the survey will be conducted by binocular and consultation with local peoples for better understanding.

The study was conducted to monitor the presence of this species in March 2020 for better understanding. Dolphins were surveyed within 5km radius of the project area.

5.9.4.2 Objective

The proposed bridge is a dedicated Bridge across the River Brahmaputra is conceptualized to improve the capacity and safe transportation across the River. The proposed bridge runs parallel to the existing Railway Bridge, thereby contributing to efficient transportation network within the country and with the neighboring countries in South Asia. It is assumed that, since the river is habitat to the Ganges river dolphins, the construction of the proposed bridge might impact the habitat and population of the dolphins. Therefore, objective of this survey report is to identify their presence, availability and habitat around the project location. To monitor the presence of this species the survey will be conducted for better understanding.

5.9.4.3 Study Approaches

Initially, the study team conducted some rapid reconnaissance in the study site to familiarize with the area/river to be studied for dolphin survey using existing maps. The field survey started from March 16 to March 19, 2020 covering 4 consecutive days. However, the surveyors tried to stay true to the length of the survey period as per methods as far as possible.

Two methods for field surveys were used:

- Boat based survey and Transect counting of dolphins through boat-cruising (Smith et al., 2006), and
- Counting of dolphins from land at randomly selected sections (blocks) of the rivers (adapted after Leatherwood, 1996).

Total length of the river included in the study of dolphins was 5 km to cover the buffer zone. However, for ease of accessibility and accurate observation, the rivers were divided into 4 transects: two in the upstream side of the exiting railway bridge and rest two in the downstream side of the existing railway bridge ().

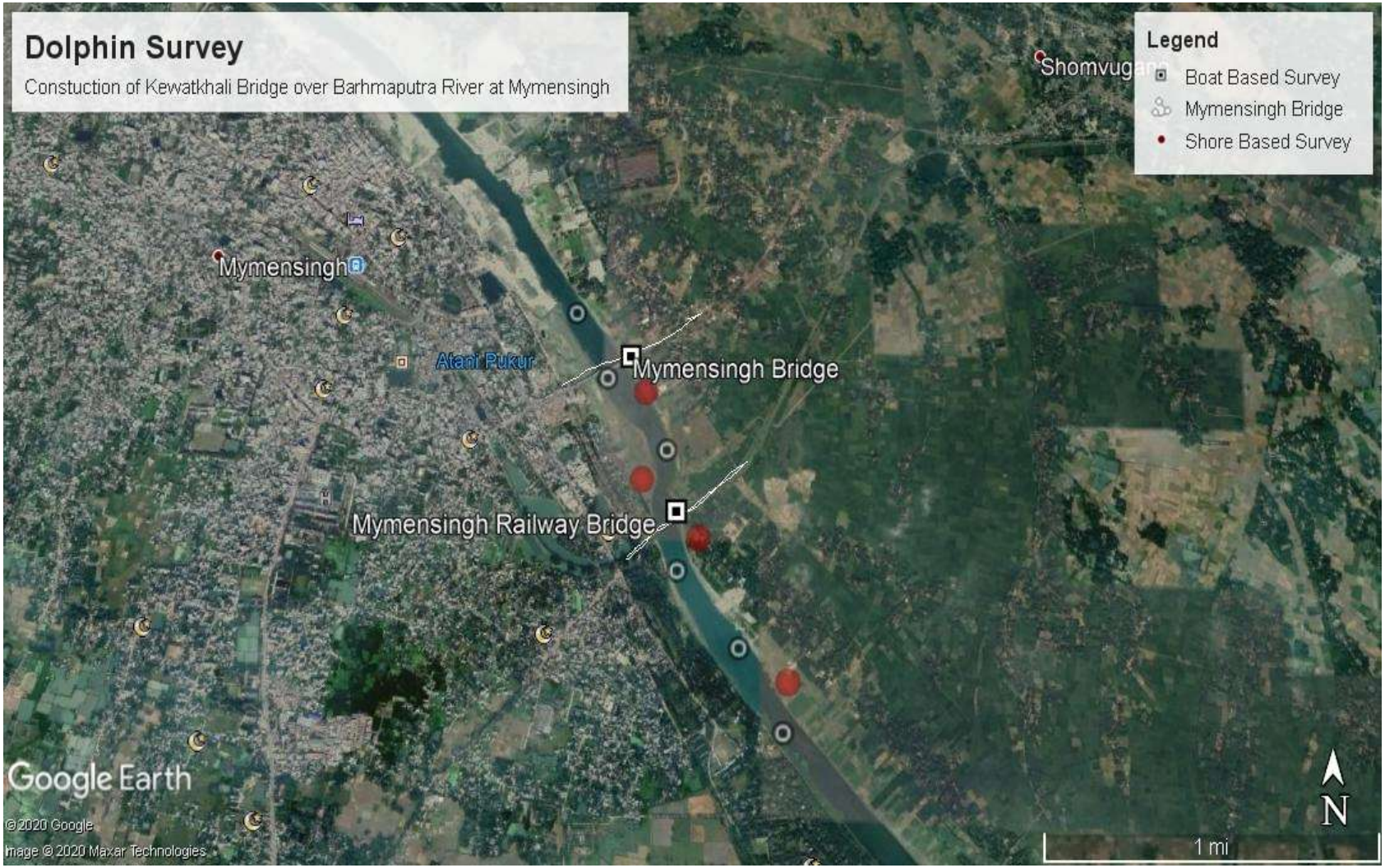


Figure 5-62: Sampling locations of Dolphin Survey

5.9.4.4 Boat Based Survey

Surveying and photographing cetaceans from small boats has proved a successful technique employed by many studies, further details can be found in the scientific literature (Wursig and Jefferson, 1990). In order to survey the whole area (i.e., 5km buffer zone), standardized boat-based surveys were regularly undertaken throughout this study.

Methodology

Two boat-based survey methods were used: a. transect counting; and b. still counting. *Transect surveys* were made within a predefined survey area and the route was designed to cover the area of the confluences and deeper parts visited by dolphin watching boats. The 10km survey route was planned to cover the 5km buffer zone of the existing bridge area.

The surveys were conducted at a steady speed of about 10kmph and lookout was maintained by each crew-member throughout. Each crew concentrated their observation over different sectors of the boat's path in order to maximize the search effort. The track of the boat was continually logged using an on-board Garmin GPS e-Trex 20.

The survey route was followed until dolphins were sighted. The dolphins were approached slowly whilst counts and behavioral information were recorded. A slow approach minimized disturbance to the dolphin group. The dolphins were approached from behind or from a perpendicular direction and efforts were made not to cross their path. The boat was brought parallel to the path 'up-sun' of the dolphins allowing the speed to be adjusted to match the progress of the group.

GPS was used to mark start and end points of each transect as well as the dolphin sightings each time each transect was navigated to count dolphins. The GPS data were downloaded to the computer using the GARMIN software to plot the route of the survey and dolphin sighting records. Daily records were maintained accordingly in MS Excel format, further analyse were done using statistical software MINITAB Ver. 17. The maximum numbers of dolphin sightings corresponded with the '*kola*' mentioned by the fishermen and our observation and were plotted in the map. Only the minimum numbers of dolphins sighted/counted during upstream transect were used to estimate dolphin abundance.

The count method was modified following Smith et al. (2006) where regular surveys once a month was recommended. Information on human activities like fishing, growth centres/bazaars, passenger boats, and another river traffic were also collected. Information on threats of dolphin was collected in dolphin survey data sheet through direct observation, discussion and interviews with the local people.

Still counting was another method applied for dolphin drive counts. Major dolphin drive locations were identified through transect surveys. Then surveyors approached to those locations and stayed still for one hour to count dolphin drives. In both cases (i.e. Transect and still survey) bad weather interrupted our survey activities. We tried to be true to the method as far as possible.

Figure 5-63: Boat Based Dolphin Survey

5.9.4.5 Shore Based Survey

Land based observations of dolphins provide the opportunity to collect data over a wide area without the risk of observer/subject interference. Shore watches (Figure 3.13) were used in this study to record behavior, habitat use, and movements of dolphins, where the presence of a research boat may have affected the natural behavior of dolphins.

Shore watch site locations were chosen on the following criteria:

- Good field of view (to allow large area of water to be surveyed from a single place)
- Accessibility and suitability for public access

Methodology

Typically, shore watches lasted for six hours and were made at fixed times (08:00 – 14:00) for stable and continuous data. However, due to bad weather and rough river conditions, it was not possible to get stable data and we were forced to change the time of data collection frequent basis. However, we tried to get six-hour data each day from 4 transects to achieve some sort of stability. Dolphin numbers, positions, behavior and direction of movement were recorded onto data sheets during ten-minute scan samples (Altmann, 1973). Scans were made on the hour and half hour throughout every watch. Scans were made using Bushnell POWERVIEW binoculars. Dolphin positions were derived using a GPS e-Trex 20.

Figure 5-64: Shore Based Dolphin Survey

5.9.4.6 Fisherman Interviews

The dolphin survey study also conducted five (05) interviews with locals and fishermen to understand dolphin behavior, habitats, feeding time, threats, preferable environmental conditions etc. (). The information collected were interpreted with the help of the surveys conducted and discussed.

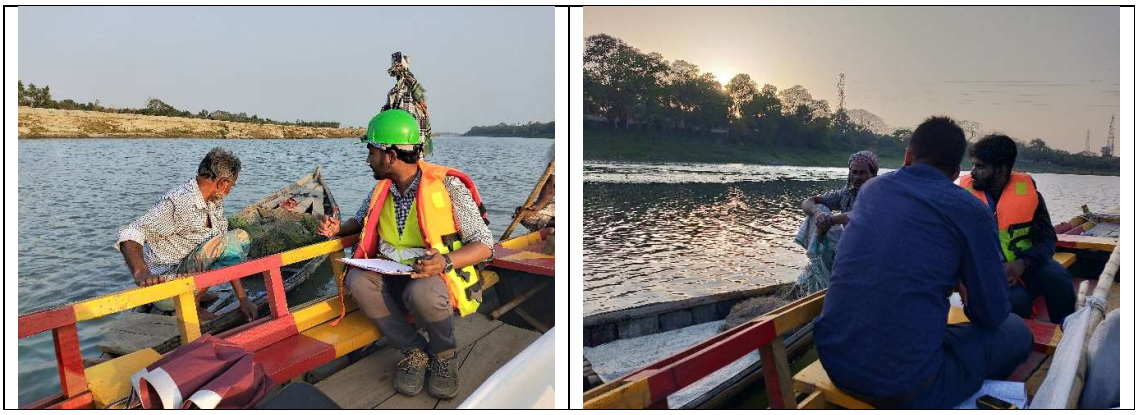


Figure 5-65: Fisherman Interviews about Dolphin Species

5.9.4.7 Field Interviews

Focused Group Discussion and Individual Interviews has been conducted one to one to gather an understanding of the Dolphin sighting, current and historical populations and threat (). The result was presented quantitatively to further understand the impact the project might have on the Dolphin population. In such cases, interviews provided very useful information.

Figure 5-66: Individual Interviews about existence of Dolphin species

5.9.4.8 Field Equipment

Boat

The survey study used mechanized boats of 7-10 meters length with maximum speed of 20 kmph. For cruising along the river for dolphin sighting, on average 15 kmph speed was kept.

GPS and Camera

Each survey team was equipped with Garmin GPS e-trex 20 and 20x. Two teams worked at a time in the river simultaneously. Continuous movement data was logged to confirm that all possible routes were covered.

5.9.4.9 Minimum Population Estimate

In order to arrive at an estimate of the number of dolphins in the river, one minimum population estimates were undertaken during the project. As described previously, each estimate involved placing observers at up to 4 vantage points along both shores of the river, from upstream to downstream, distributed evenly. Each observer made a 10-minute scan, using binoculars, every 30 minutes, on the hour and on the half hour, over a period of 6 hours and 10 minutes. During each scan observers recorded the location and number of dolphins seen in their watch area, as well as other details such as behavior, direction of movement etc. The individual counts from each observer were combined to give a total number of dolphins seen throughout the project area (5km buffer zone) for each scan. The highest combined total of the day was taken to be the minimum population estimate (adapted from Hammond and Thompson, 1991).

5.9.4.10 Status of Dolphin in Brahmaputra River

Shushuk occurs in all major rivers of Bangladesh. Although no credible assessments of dolphin abundance are available, at a recent meeting of the Asian River Dolphin Committee, members expressed concern at the serious decline in dolphin populations reported by the Bangladeshi members of the committee (Reeves and Leatherwood 1994). *Shushuk* is threatened from incidental catch in fishing gear and, at least in some parts of Bangladesh, directed hunting (Pelletier and Pelletier 1980, Reeves et al. 2000), as well as damming and the withdrawal of surface water (Reeves and Leatherwood 1994).

Within the project AOI, the two (02) locations were reported for Dolphin existence during the consultations with fishermen. These two locations are.

- ❖ Tin Ganger More Area (Approximately 3517m upstream from the proposed bridge location).
- ❖ Shambhuganj Bridge Area (Approximately 1000m downstream from the proposed bridge location)

Survey team conducted visual surveys for river dolphins during March 2020 for 4 consecutive days in the sections of the Brahmaputra River around the existing Kewatkhali Railway Bridge Area. The survey area was confined to a 5 km buffer zone. According to the fisherman, the mostly dolphin existence are in Tin Ganger More Area and occasionally few of the dolphins are seen at Shambhuganj Bridge Area during monsoon season.

Spatial Counts (Both Still counts and transects)

Out of 6 boat-based survey, the team did not find any dolphin drive count at four (04) survey locations which are given in table 5.37. No seasonal variation can be established since the survey was only 7 consecutive days. The results of the survey are given below-

Table 5-36: Drive count of dolphins (still count) in different sections of the study site

Location	Average Drive Count (nos./hour)			
	Day 1	Day 2	Day 3	Average
Downstream SW	0	0	0	0
Downstream SE	0	0	0	0
Upstream NW	0	0	0	0
Upstream NE	0	0	0	0

(Source: Field survey 2020)

In both cases of transect survey and still count survey, no drives of dolphins were observed in the upstream and downstream of the river.

Shore Based Observation

contains detailed count data of dolphins observed from land. During one hour each simultaneously at all 4 locations for six hours the numbers of dolphins counted was Nill. During shore-based observation no drives was observed in upstream and downstream locations.

Table 5-37: Shore Based dolphins count in different sections of the study site

Location	Total drive count (nos.)						
	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Total
Downstream SW	0	0	0	0	0	0	0
Downstream SE	0	0	0	0	0	0	0
Upstream NW	0	0	0	0	0	0	0
Upstream NE	0	0	0	0	0	0	0

In shore-based survey, no drives of dolphins were observed in the upstream and downstream of the river.

Minimum population estimation

As adapted from Hammond and Thompson (1991) we used the method described in order to estimate minimum population estimation for dolphins. Since no dolphin was found during

study period. However, the location of these dolphins may not be restricted/affected to the buffer zone, as designated for our study area.

5.9.4.11 Discussions

Habitat Use

According to the local consultation and individual interviews, seasonality, food availability and environmental conditions of the water are the main factors of the river dolphin for its habitat use/preference. Depth of water and also water turbidity in Brahmaputra River varies greatly due to changes of seasons, physical characteristics and other anthropogenic reasons. Water depth increases during the monsoon months and decreases during the winter and summer months in the river where dolphin survey was conducted. During the monsoon, dolphins were found to remain concentrated in the deeper sections of Tin Ganger More in the river and near the Shambhuganj Bridge area. So, the optimum water depth preferred by the Ganges River dolphin throughout the year is mostly available in sections where scours in the river exist. Secondly, most river fishes occur or should have occurred in the scours of the river during the winter and summer months, as the local fishermen said.

Threats to Dolphins

The Ganges river dolphin has experienced both population and range decline across its historical habitats. Although several estimates are available, a reasonable global estimate may be 1200-1800 dolphins. The Ganges river dolphin has lost its ranges progressively since the nineteenth century comparing historical distribution (Anderson, 1879). Alarmingly, no dolphins have been reported in recent years in many historical locations in the Ganges of India (Sinha, 2000).

Accidental killing of dolphin in the form of by-catch in net fishing was found to be the main threat for dolphins in the river of the project area. It was reported that accidental killing of dolphins in the project and surrounding areas through getting trapped or entangled in fishing nets were higher in the past but reported less during the survey period. Other threats for dolphins in the river included oil spill from boats and ships, river erosion, low water depth during winter, use of harmful fishing gears (especially current net) and making cross dam of bamboos across rivers for fishing.

As reported by local people (Figure 3.37), the practice of intentionally trapping and/or killing of dolphins in the rivers for commercial reasons is gradually gaining momentum for oil extraction. Remains of the dolphin body, particularly the head, are used in the brush pile fishery-certain sections of the river close to the banks is fenced using bamboos and piles of tree branches are used to provide a temporary refuge for the fish during the dry season when water level gets low. During dry season the fenced area is netted and fishes are caught. By putting the remains of the dolphin body and head together with the tree branches fishes are attracted by the smell as they decompose.

Figure 5-67: Surveyors interviewing Fisherman and Local People about dolphin Habitat

5.9.4.12 Conclusions and Recommendations

The continuous morphological change in the rivers may have an impact on the abundance, availability of food and breeding of the dolphins and other aquatic fauna about which we know very little. Moreover, the biological needs of the aquatic animals like dolphins have also never been addressed or assessed in Bangladesh. This demands due consideration of the water requirements for aquatic animals when major river intervention activities like dams, bridges, barrages, etc., are planned. Changes in the hydrological regime also affect the linear density of dolphins since the dolphins spread out during monsoon compared to the dry season when many dolphins stay close to the 'Tin Ganger More' and near Shambhuganj Bridge area. These places helped identifying the dolphin hotspots in Brahmaputra River and are usually located at the confluence, convergence or river bend.

In Bangladesh, occurrence of Ganges River dolphins was reported in the downstream of shallow areas or tributary junctions (Kasuya and Haque, 1972). Fish is the main food for dolphins (Sinha et al., 1993). Thus, dolphins are indicators of fish availability and fishermen follow them to get a good catch. Protecting and managing the identified Tin Ganger More and Shambhuganj bridge area as dolphin hotspots may bring in many positive results for fisheries and other aquatic biodiversity.

Agricultural activities along the river banks and chars were observed to rise. Solid wastes, particularly the plastics, discarded fishing nets do pose a problem for the dolphins. The Government of Bangladesh (GoB) has prepared the National Water Management Plan (NWMP

2001), which lays out strategies and priority programs at the national and regional levels that will maintain the water requirement so as to maintain the minimum water flow to support the various aquatic animals, vis biological requirement of large aquatic animals (dolphins, gharials). The study recommends that, during and after construction of the Kewatkhali Bridge, the NWMP (2001) should be followed for the area.

5.10 Sensitive Receptors

The sensitive receptors include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, cremation yards, market places, industrial structure, water bodies, etc., a few of which would be affected directly and indirectly by approach roads. Such sites are sensitive receptors to project activities and, hence, need to be dealt carefully during the construction phase. The survey has been conducted along the project alignment for sensitive receptors where details name, GPS & photographs are collected from 2km ROW of the alignment. The details of the sensitive receptors have been provided in Appendix List of Sensitive Receptors. A map of the sensitive receptors is shown in Figure 5-70.

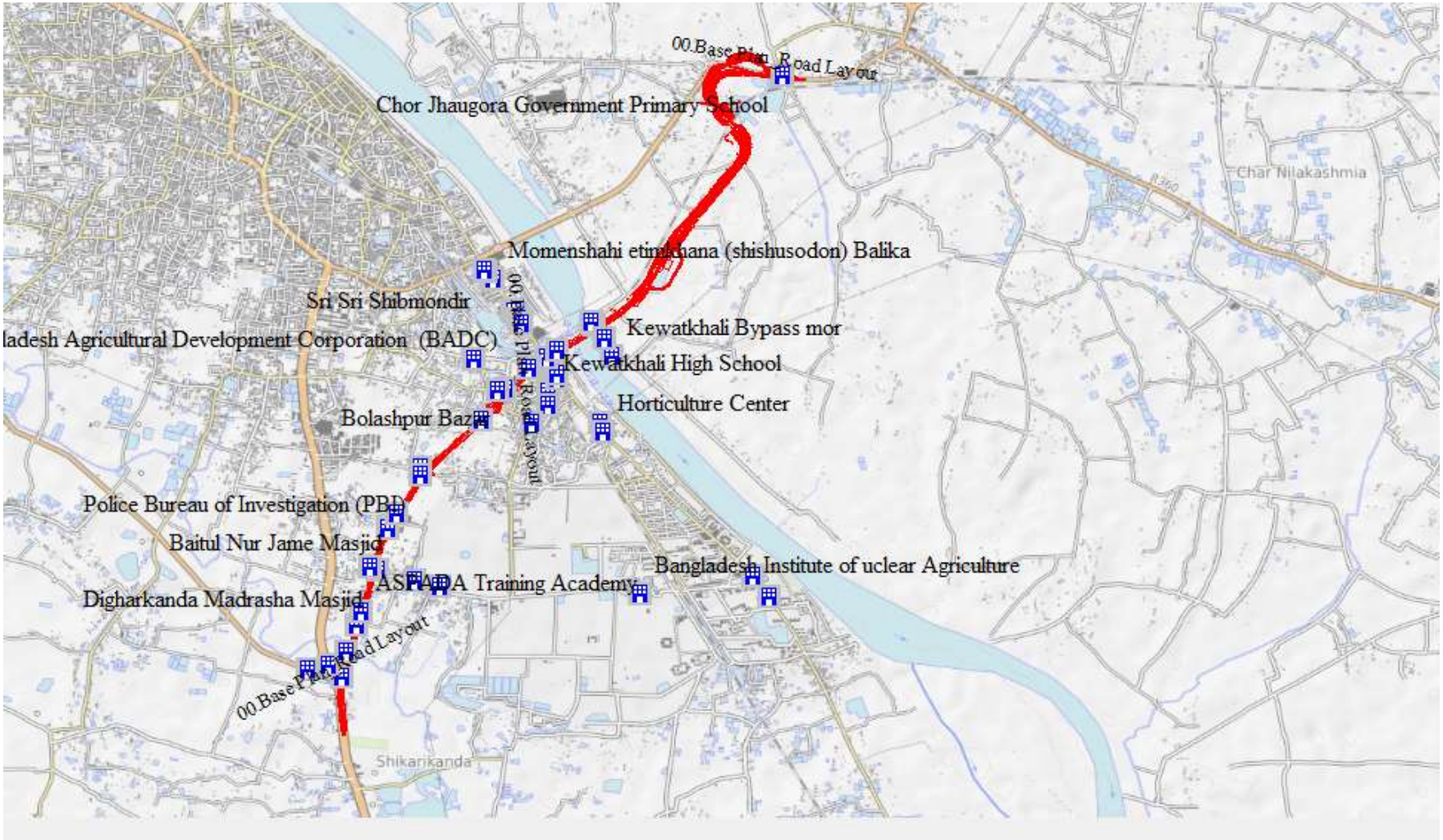


Figure 5-70 Sensitive Receptors in the Project

6 CHAPTER: IDENTIFICATION OF POTENTIAL IMPACTS

6.1 General Consideration

6.1 Impact Identification

An environmental impact is defined as any change to an existing condition of the environment. Findings of the assessment are presented according to site preparation, construction and operation phases.

The EIA study, based on the review of similar environmental assessment reports, baseline monitoring and stakeholder consultations, has identified some major environmental and social concerns that are expected from the project.

The impacts are broadly classified into following four categories during construction and operation stages:

- Impact on Physical Environment;
- Ecological Impact;
- Impact on People;
- Quality of Life Values.

This chapter describes the result of scoping including the environmental impacts caused by the project and the rating during pre-construction, construction and operation phases.

6.2 Scoping of Impacts

Identification of potential impacts due to the project location, construction and operation of the project has been done using Checklist. Checklists are comprehensive lists of environmental effects and impacts indicator designed to stimulate the analysis to think broadly about possible consequences of contemplated actions (Munn, 1979).

In this checklist major activities which create the Significant Environmental Impacts (SEIs) are shown. The terms none, minor, moderate and major are used in checklists to classify the magnitude of SEIs. As can be observed from the checklists, the major activities which have the potential of creating major negative SEIs are dust and gaseous emission from the project construction, transport of raw materials and operational activities and noise hazard from traffic. However, the project would have positive impacts in terms of employment for numbers of skilled, semiskilled and unskilled people in construction stage of the project. It should be noted that

identification indicated in the Checklists relates to the significance of impact that can arise from such a project. The detailed evaluation of the impacts is presented in Chapter 7, together with mitigation measures.

The potential impacts are qualitatively assessed based on their characteristics to determine the magnitude. The significance of potential impacts was assessed using the risk assessment methodology that considers impact magnitude and sensitivity of receptors, described below.

6.2.1 Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as i) duration of the effect; ii) spatial extent of the impact; iii) reversibility; and iv) legal standards and established professional criteria. The magnitude of each potential impact of the Project has been identified according to the categories outlined in Table 6-1

Table 6-1 Parameters for determining magnitude

Parameter	Major	Medium	Minor	Nominal
Duration of potential impact	Long term (beyond the project life)	Medium Term Lifespan of the project (within the project life span)	Limited to construction period	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 international guideline s/obligat ions	Complies with limits given in national standards but breaches international lender	Meets minimum national standard limits or international guidelines	Not applicable

6.2.2 Likelihoods

Likelihoods of the impacts are defined in this report as described in Table 6-2

Table 6-2 Parameters for determining likelihoods

Paramete	Major	Medium	Minor	Nominal
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Happens under worst case (negative impact) or best case (positive impact) operating conditions	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to happen

6.2.3 Sensitivity of Receptor

The sensitivity of a receptor has been determined based on a review of the population (including proximity/numbers/vulnerability) and the presence of features on the site or the surrounding area. For each potential impact of the project, sensitivity of the related receptor was determined using the criteria outlined in Table 6-3

Table 6-3 Sensitivity of Receptor

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	Vulnerable receptor with good capacity to absorb proposed changes or/and good opportunities for mitigation

6.3 Process of assigning significance

Following the assessment of impact magnitude and determining the quality and sensitivity of the receiving environment or potential receptor, the significance of each potential impact

was established using the impact significance matrix shown in Table 6-4

Table 6-4 Sensitivity of Receptors

Magnitude of Impact	Sensitivity of Receptors			
	Very Severe	**Severe**	**Mild**	**Low**
Major	Critical	High	Moderate	Minimal
Medium	High	High	Moderate	Minimal
Minor	Moderate	Moderate	Low	Minimal
Nominal	Minimal	Minimal	Minimal	Minimal

6.4 Summary of Potential Impacts

Based on the scopes in section 6.2 and 6.3 a summary of impacts has been presented in Table 6-5

Table 6-5 Impact Identification Checklist for MKBIP

Potential Impacts	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Mitigation Measures	Significance After Mitigation
Improved transport system	Long term	Local	Yes	Certain	Major	-	High positive	No mitigation is needed.	N/A
Impacts due to project siting									
Land acquisition and resettlement (related to five interchanges)	Long term	Local	No	Certain	Major	Mild	Moderate	Compensation to be paid to the affected people/entities.	Minimal
Loss of farms income and livelihood sources of affected households including vulnerable households	Long term	Local	No	Likely	Major	Severe	Moderate	Compensation to be paid to the affected people/entities.	Minimal
Impact on ecosystem	Long term	Local	No	Certain	Medium	Low	Minimal	No additional measures required	Minimal
Hydrology	Long term	Local	No	Certain	Medium	Low	Minimal	No additional measures required	Minimal
Impacts related to Construction Phase									
Employment opportunities for local	Short term	Within project boundary	Yes	Certain	Medium		High positive	Preference to the local communities in the construction works;	

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
communities								Employment Policy to be announced by contractors. Code of conduct for workers.	
Risk of soil contamination and soil erosion	Medium term	Local	Yes	Certain	Medium	Severe	High	Pollution prevention plan will be prepared and implemented. Excavated top soil in the cultivated areas will be stored separately, to be used as the top most layer during backfilling. Backfilled soil will be compacted to avoid soil erosion. Measures will be taken to avoid/minimize erosion of excavated soil. Top layer of soil will be stored separately and will be restored as the topmost layer after restoration	Minimal
Risk of water contamination	Short term	Wide spread	Yes	Certain	Medium	Severe	High	Pollution prevention plan will be prepared and implemented. No untreated effluents will	Minimal

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
								be released to ground or water bodies. Hazardous substances will be handled and stored according to the standards.	
Blockage of or damage to canals and drainage collectors	Short term	Local	No	Certain	Medium	Severe	High	Damage to canals and collectors will be avoided; Construction planning will be carried out to avoid any blockage of canals and collectors; If damaged, the canals and collectors will be repaired and restored. No spoils or debris will be released / thrown in to canals and collectors	Minimal
Dust and air pollution from construction activities	Short term	Local	Yes	Certain	Medium	Severe	High	Pollution prevention plan will be prepared and implemented. Water sprinkling will be carried out.	Minimal
Impacts on borrow areas and sourcing of construction	Short term	Wide spread	No	Certain	Medium	Severe	High	Borrow areas will be selected outside cultivated area; Areas will be restored after	Moderate

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
materials								borrowing the soil; Depth of borrow areas will be kept up to 1 meter. Sand and stones will be obtained from licensed quarries.	
Generation of spoils, debris, asphalt scrapings	Short term	Local	Yes	Certain	Medium	Mild	Moderate	Excavated spoil will be re-used to the extent possible; Left-over spoil and debris will be disposed in designated areas	Minimal
Generation of solid waste and hazardous waste	Short term	Local	Yes	Certain	Medium	Severe	High	Waste management plan will be prepared and implemented. Reduce, recycle and reuse (3R) practices will be encouraged	Minimal
Noise and vibration from construction activities	Short term	Local	Yes	Certain	Medium	Severe	High	Noise reduction measures such as noise barriers will be implemented particularly near sensitive receptors; Working times near sensitive receptors will be adjusted to minimize	Minimal to Moderate

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
								impact.	
Site clearance and restoration	Short term	Local	Yes	Certain	Medium	Mild	Moderate	Cleaning of the construction sites will be carried out	Minimal
Impact on Ecosystem	Short term	Local	Yes	Certain	Medium	Mild	Moderate	• Coordinate with the DOE authorities for any additional mitigation measures such as installing fence along the water bodies, low lying areas	Moderate
Disturbance to the wildlife	Short term	Local	Yes	Likely	Medium	Mild	High	• Prohibit poaching; • Conducting training of wildlife protection to workers; • Noise mitigation measures for construction	
Greenhouse gas emissions from site clearing, construction activities	Short term	Local	Yes	Certain	Medium	Mild	Moderate	• Emissions will be minimized through using efficient and well-maintained machinery	Minimal to Moderate
Potential Impacts	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	• Mitigation Measures	Significance after Mitigation

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
Crop damage	Short term	Local	Yes	Certain	Medium	Severe	High	• Crop damage will be minimized through astute construction and site management and scheduling of construction works; Compensation will be paid to the growers/landowners	Minimal to Moderate
Blockage of access roads and damages to local infrastructure, traffic congestion	Short term	Local	Yes	Certain	Medium	Severe	High	• Traffic management plan will be implemented Alternate routes will be identified; • Damaged infrastructure will be restored b	Minimal
Community health and safety from construction traffic and activities	Short term	Local	Yes	Certain	Major	Severe	High	Community health and safety management plan will be prepared and implemented; Hazardous substances will be handled and stored according to the standards; Community liaison will be maintained.	Moderate
Occupational	Short	Local	Yes	Certain	Major	Severe	High	Occupational health and	Moderate

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
health and safety	term							safety plan will be implemented	
Additional load on local resources	Short term	Local	Yes	Certain	Medium	Mild	Moderate	Local resources such as water and fuel will be obtained after obtaining necessary approval and community consultation	Minimal
Potential Impacts	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Mitigation Measures	Significance after Mitigation
Impacts on cultural resources	Short term	Local	Yes	Likely	Medium	Severe	High	Chance find procedures will be implemented	Minimal
Social conflict and privacy of women, influx of workers, gender issues	Short term	Local	Yes	Likely	Medium	Mild	Moderate	Community liaison will be maintained; Construction camps will be established at least 500 m from communities, with the approval of PMU and local authorities; Guidelines for Influx of Workers and Gender-based violence (GBV) will be implemented; Code of conduct for	Minimal to Moderate

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
								workers will be enforced.	
Impacts from O&M Activities									
Waste management on Road	Long term	Local	Yes	Certain	Major	Severe	High	Waste management plan will be implemented Road signage will be installed to educate road users	Minimal
Air pollution	Long term	Local	Yes	Certain	Major	Mild	Moderate to High	Tree plantation will be carried out along the road	Moderate
Noise and vibration	Long term	Local	Yes	Certain	Major	Severe	High	Noise reduction measures such as noise barriers will be considered at the sensitive receptors	Moderate
Potential Impacts	Duration of Impact	Spatial Extent	Reversible or not	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Mitigation Measures	Significance after Mitigation
Occupational health and safety during maintenance	Long term	Local	Yes	Likely	Major	Severe	High	OHS management plan will be implemented	Medium
Community health and safety	Long term	Local	Yes	Likely	Major	Severe	High	Community health and safety management plan will be implemented; Road signage will be	Moderate

Potential Impacts	**Duration of Impact**	**Spatial Extent**	**Reversible or not**	**Likelihood**	**Magnitude**	**Sensitivity**	**Significance Prior to Mitigation**	**Mitigation Measures**	**Significance After Mitigation**
								installed; Community liaison will be maintained. Emergency services (ambulance, rescue vehicles) will be arranged.	
Impact on (road hits, disturbance to wild species in the MKBIP	Long term	Local	Yes	Likely	Medium	Severe	High	Road signage will be installed; Liaison with the authorities to be maintained.	Minimal to Moderate
GHG Emissions	Long term	Global	No	Certain	Medium	Mild	Moderate	N/A	Moderate

7 CHAPTER : EVALUATION OF IMPACTS & MITIGATION MEASURES

7.1 Introduction

Based on the scoping presented in Chapter 7, this chapter evaluates each impact of the project on the physical, biological and socioeconomic environment in the project area. Potential environmental impacts associated with the proposed project activities are classified as:

a. impacts during pre-construction/design phase;
b. impacts during construction phase; and
c. impacts during operation phase.

7.2 General discussions

Major environmental impacts of this project will be associated with land acquisition, land stability (soil erosion), soil compaction and contamination, water availability, water quality of river/stream/canal, ground water contamination, waste and wastewater disposal, ambient air quality, ambient noise levels, vegetation, tree cutting (including commercial forestry tree), fauna (terrestrial and aquatic), drainage pattern, hydrology, climate change, socio economic, places of social/cultural importance (religious structures, community structure), construction material sourcing and occupational health and safety. Adequate mitigation measures are devised to mitigate/minimize all likely environmental impacts and the same have been presented along with the impacts.

7.3 Anticipated Positive Impacts of the Proposed Project

The proposed project will bring significant benefit or positive impacts. The anticipated benefits that the proposed project will bring are discussed in the following sections.

7.3.1 Greater connectivity

The proposed bridge will provide a safer and more efficient connectivity link for passenger and freight traffic from Mymensingh-Sherpur road, Mymensingh-Phulpur-Haluaghat road, Mymensingh-Netrokana road and Mymensingh-Kishorgonj road to connect to the N3 highway to Dhaka. It is anticipated that this will result in a greater integration of local markets with national markets and growth generation in the north central region. Inadequate infrastructure and low connectivity is considered to one of the major reasons for regional disparity and uneven economic opportunities. The project will contribute to cover the increasing demand of transportation in the Mymensingh area which needs an alternate route for crossing the river Brahmaputra. The Shambhuganj Bridge is currently the only bridge which is giving connectivity with 2 sides of the river and is very old. Thus, the new bridge and approach road will provide broader social connectivity within this area.

7.3.2 Improvement in economy

Road network is a key element of the economy development of the Mymensingh Region. The effective functioning of the transport system will lead to sustainable development of the economic growth, integrity and national security, as well as improvement of living standards and livelihoods of local population. The primary economic benefits of the investment program are cost savings from vehicle operation, reduction in travel time, and lower transaction costs related to transportation. Other benefits are: i) the establishment of international transport corridors; ii) improvements in road transport efficiency; iii) increase in freight and passenger transport due to improvements in the quality of roads; iv) increase axle load capacity; v) less road accidents due to improvements in road safety; (vi) improve sanitation facilities for local residents and tourists along project corridor open new livelihood generating opportunities for young people and women of the project area.

7.3.3 Employment benefits

During the construction activities of the project jobs and income opportunities will be created and as such per capita income will be enhanced in this area. For operation, a number of long-term skilled and unskilled personnel will be required for operation and maintenance (O&M) work which will create employment opportunities for the local inhabitants also.

Migration will be increased due to creating new job opportunities in the project area. People in the neighborhood are expected to get benefit from the employment that would be generated and from the increased business activities during construction period.

7.3.4 Improved traffic

The project is a substantial attempt to ease traffic congestion in Mymensingh City by diverting traffic away from the city's busy central area. Mymensingh city is located at the side of Old Brahmaputra River and is the capital of Mymensingh Division of Bangladesh. The city has a population of approximately 400,000 and is the second most densely populated city and fourth most populous urban agglomeration in Bangladesh. Mymensingh is a transportation and educational center in the region. A new Mymensingh town is planned for construction on the other side of the Old Brahmaputra river which would require an improved river crossing to maintain a seamless transport linkage with N3 to Dhaka. Through traffic mixed with inner-city traffic now causes prolonged delays in crossing the Old Brahmaputra River, so the location is becoming a bottleneck on the Dhaka-Mymensingh-India Border corridor. To release more valuable space and improve urban services, it is important to segregate the strategic through traffic flows out from the city's core areas.

7.3.5 Visual and Landscape

The proposed arch bridge will definitely add to the local aesthetics by introducing a unique design. The landscape may also attract local tourists and in in turn contribute to the micro economy.

7.4 Greenhouse Gas Emissions and Climate Change Adaptation

7.4.1 Greenhouse gas emissions

It is estimated that significant amount of greenhouse gas (GHG) can be reduced due to this project. The GHG emissions cost savings due to the MKBIP are shown in Table 7-2

Table 7-1 Emission in tons/year

Parameter	Without project baseline	Without Project 2041	With Project Baseline	With Project 2041
Nox	170.56	1,232.54	150.19	811.10
C02	1,633.40	15,159.05	8954.39	43,062.55

Table 7-2 Environmental Pollution Cost Calculation (costs are in BDT)

Parameter	Without Project Baseline	Without Project 2041	With Project Baseline	With Project 2041
NOx Cost	4,532,071.45	32,751,110.65	2,840,569.78	21,552,458.85
CO_2 Cost	32,667.92	652,947.00	127,471.18	927,418.33
Net Cost	4,564,739.38	33,404,057.65	2,968,040.96	22,479,877.18

The cost of CO_2 has increased with project as a greater number of vehicles are foreseen in 2041 with the project as compared to without project scenario. The cost of NOx has reduced as there will be a smaller number of stagnant vehicles with project in 2041.

The significance of the impact of GHG emissions is considered Low, as shown in Table 6-5

7.4.2 Climate adaptation

As mentioned in the baseline chapter, flood along the Old Brahmaputra frequently occurs during the rainy season (BWDB, 2010) and the project area are notable among the flood affected districts of Bangladesh. The climate change would worsen the situation. The flood prone areas are show in Figure 7-1

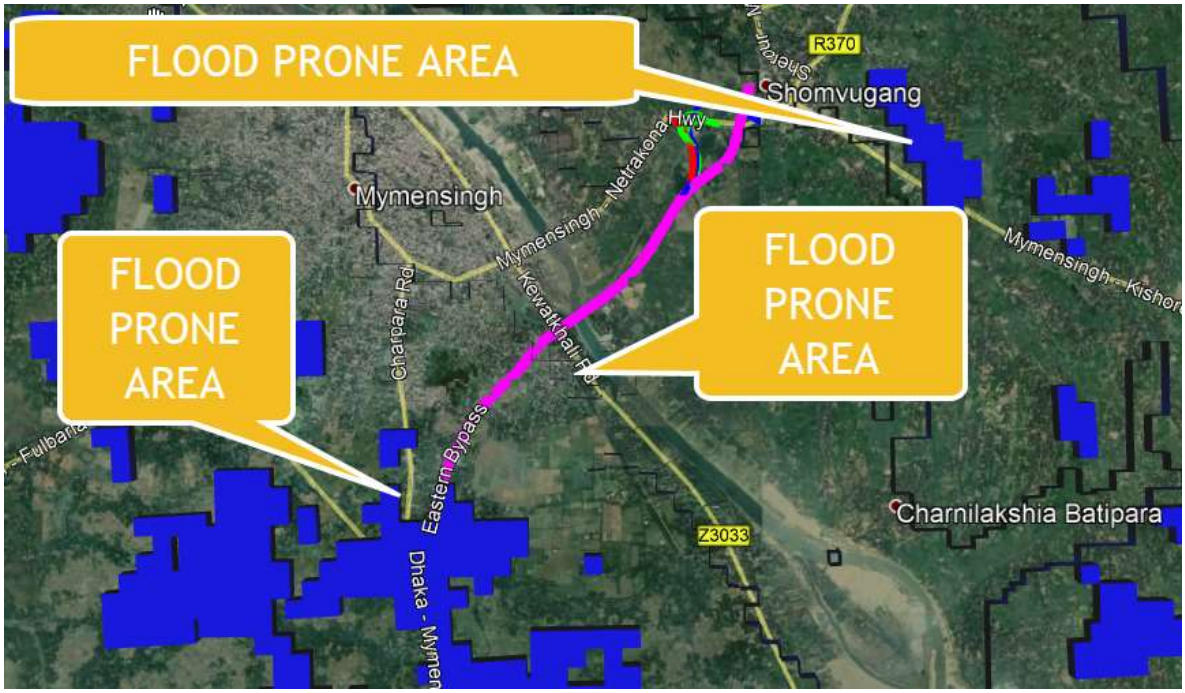


Figure 7-1 Project Flood Prone Areas

The predicted sea level rise is assessed as 6cm by 2020. This will result in changes in flooding pattern and increased discharges. Therefore, the drainage structures throughout the roads have to drain 20% additional water under climate change scenario, especially due to higher rainfall during extreme events. This requires more climate resilience designs for this project.

The impact of climate change on this project is estimated as High as shown in Table 6-5.

Adaptation measures: Approximately 2100m-long bridge and nine (09) culverts have been designed and included in the MKBIP. The major steel arch bridge is proposed on the Old Brahmaputra River. The rest of the structures are mostly across undefined channels that carry only seasonal flow. Many bridges are located over depressions and low-lying ditches. Culverts are located in depressions and at low lying agricultural land and operate merely as balancing structures, equalizing water levels at either side of the road embankment.
Moreover, the additional road embankment height to incorporate climate change induced flooding, the differences in water level between base and future time slices are computed. Among these values from different models, the maximum values were selected to ensure protection for worst case scenario. Besides that, as there is uncertainty in the Global Circulation Models (GCM) results, an additional safety factor of 1.5 might be applied on the suggested height requirements to cover this uncertainty. As the roads are designed mainly based on 20-year return period, Roads and Highways Department

suggested additional heights should be applied over the design road heights for 20-year return period (not the existing road levels) including freeboard and other additional components.

With the climate resilience designs of the project, this impact on the project is considered Low as shown in Table 6-5.

7.5 Adverse Impacts during planning phase

This section assesses the impacts caused by project-siting prior to construction during the planning and designs phase.

7.5.1 Involuntary Resettlement

The involuntary resettlement impacts of the project are primarily associated with land acquisition, which is required for the 3 new interchanges and 5.6 km of road construction.

The following is a summary of the resettlement impact. The impact is assessed as High as shown in Table 6-5.

Table 7-3 Summary of Resettlement Impact

Project Impacts	**Total**
Total number of households requiring relocation	**650**
Number of titled HHs losing res/com and other structures requiring relocation	260
Number of squatters losing res/com and structures requiring relocation	185
Number of renters (from squatters) losing res/com structures requiring relocation	205
Number of CPRs requiring relocation	8
Total number of persons affected	**3991**
Number of trees affected	156 + 335 (Government Trees)

Mitigation: The overall objective of resettlement policy is to ensure that all persons affected by the Project are able to maintain and, preferably, improve their pre-project living standards and income earning capacity by providing compensation for the loss of physical and non-physical assets and, as required, other assistance and rehabilitation measures to reestablish affected livelihood. The average compensation is shown in Table 7-4

Table 7-4 Average cost per structure type

Types of structure	Total number to be affected	Total Area to be affected (sq.ft)	Average Affected Area (sft/structure)	Cost per sft. (Taka)	Total Estimated cost (Taka)	Average cost (TK/per structure)
Pucca	60(42.86%)	257414	1514.2 sft	2825	587600000	3457800
Semi-pacca	50(35.71%)	72929	1458.58sft	1317	96047493	1920950
Katcha	30(21.43%)	13855.8	461.86sft	415	5750157	191672
Thatched	00	00	00	00	00	
All types	140(56.00%)	344198.8	1144.88sft	2003	689397650	2757590

A Resettlement Plan (RP) has been prepared and included in the SIA to address the involuntary resettlement impacts described above. Compensation and assistance will be paid to the affected people in accordance with criteria defined in the following document.

Residual Impacts

After implementing the RP, the involuntary resettlement impacts of the project will be mostly mitigated. Therefore, the significance of the residual impacts is likely to be Minimal, as shown in Table 6-5

7.5.2 Land Acquisition- Change of land use

The project activity involves widening of road. The required Right of Way (ROW) of 40m is available with RHD almost along the entire road length and proposed bridges and interchange locations. The total land to be acquired is 42 hectares (Table 7-5).

Table 7-5 Land Acquisition by Type of Land

Type of Land	Miter squire	Decimale	Acre
Open Area/Vita	30000	7413.13	74.1313
Agriculture	345000	8525.1	85.251
Homestead	27000	667.2	6.672
Commercial	18000	444.8	4.448

Total	420000	17050.23	170.5023

The construction for road, widening of road and Bridge/interchange construction will permanently change the land use while the construction site, access road, and construction camp will temporarily change the land use. Due to these interventions, agricultural, seasonal wet land area and social forestry tree around these areas may get affected adversely.

The impact of land use change will be moderate to high due to land acquisition, as shown in Table 6-5.

Mitigation: Compensation for land acquisition will be paid to alleviate the socio-economic impact to land owners (Table 7-6). The provisions of compensation is defined in the RP/SIA.

In addition, site clearance and restoration measures will be implemented to restore the land that will be occupied temporarily, which is explained in detail in Section 0

Table 7-6 Value by Type of Lands

Type of Land	FGD/KII		Registered Value		Ave.
	Maxm	Minm	Maxm	Minm	
Agriculture	Tk-700000	500000	304790	152344	414283.50
Homestead	Tk-1200000	1000000	866570	479400	886492.50
Open Area/	Tk-1000000	800000	545202	448402	698401.00
Commercial	Tk-1500000	1000000	545887	340738	846656.25
All category Avrrage	Tk-1100000	825000	565612.25	355221	711458.25

Residual impact: Through appropriate resettlement and land acquisition compensation and environmental mitigations, the impacts will be minimized in the long terms to Low level, as shown in Table 6-5

7.5.3 Topography

Impact: With the proposed planning for the project, the topography of the project area is not expected to be affected significantly other than from excavations for borrow pits, filling of low-lying areas and part of wetland. Some drainage patterns will also change and there could be ditches formed along the road due to excavation for the new roadway. Part of the wetland will also be filled around the north east side of the MKBIP. If not selected carefully, the borrow pits can lead to spoilage of agricultural land. The impact is estimated Moderate as shown in Table 6-5

Mitigation: The design has considered such impact which has been minimized. It is recommended that all requisite borrow pits shall be located outside the ROW or in uncultivated areas or private land with concurrence and agreed borrow bit rehabilitation plan with landowners. Other mitigation measures elaborated in below section for construction phase should be followed to mitigate the impact on topography.

Residual impact: Through the optimized design and mitigation measures proposed above, the residual impact is estimated as Minimal, as shown in Table 6-5

Natural Hazards

Flood and earthquake are the only two natural hazards possible in all the sub project area. Flood related impact is discussed in Section 7.4.2. Regarding the seismic hazards, the project is located in Zone II (Moderate) of seismicity. The seismic considerations have been integrated in the technical design of the bridge. Thus, no significant impact is anticipated. The significance of the impact is Low.

Mitigation: Relevant National and International codes have been referred and adopted while designing the civil structures to sustain the earthquake of higher magnitude.

Residual impact: the residual impact of seismicity on the project is considered Minimal given it is already addressed in the design.

7.6 Adverse Impacts during Construction Phase

The major environmental and social impacts which are anticipated would occur during the construction phase. For this project, the major activities which can be envisaged are construction of bridge, material transportation, construction camps, construction yards, activities related to construction of roads etc. The construction activities have been identified in Chapter 3. This section discusses the impacts caused by those construction activities and proposes the mitigation measures.

7.6.1 Water Contamination

Impact:

Impacts of main bridge construction: The main bridge of this project will cross the Old Brahmaputra River. Two piers of the bridge will be built on mud flat of the river. Piling and excavation activities will be conducted for pier construction. Such activities may cause increase the water turbidity and water contamination by discharging wastewater from construction site and oil spills. For erection of superstructure of the bridge, if Small Block Construction method is applied, the construction of bent may cause water increase water turbidity and other water

contamination like oil spills but the impact is limited and temporary as such construction will take place when water is shallow and river flow is weak.

If Large Block Construction methods is used, barges will be used to erect the bridge arch. In addition, this project may use barges as the main way for transporting construction materials. There is a risk of additional oil spill generated by barges for construction. Some amount of dredging might be needed for barges to have enough draft for operation. However, the dredging will not be substantial and the amount will be limited. The intervene of sediment due to dredging will cause water contamination. Since the natural turbidity of the river is generally high, the increased turbidity due to dredging activities will be insignificant. The increase of concentration of heavy metals and other pollutants will be temporary and not significant.

Impacts of river training works: The preferred river training areas are selected. The guide bund at the bridge will give stronger protection at the bridge landing point and will ensure high level of bridge safety from bank erosion. The rest being of revetment type, will ensure safety for the approach roads, bridge end facilities, resettlement sites, etc. The estimated amount of dredging is not available yet. A part of the dredge material will be used for geobag filling, construction works/earth-filling in the approach roads, bridge end facilities and backfilling behind the proposed guide bunds, while the rest needs to be disposed of.

Dredging works will be carried out during consecutive dry seasons along river banks. Due to the high turbidity of the material, direct disposal in the river during the dry season will create negative impacts on the aquatic life. Disposal of the materials on the land, for reclamation purposes or filling of project sites for 100-year flood level, generates a huge outflow of wet materials that contain very high turbidity and impact the soil fertility of nearby agricultural lands. In addition, the dredging activities will generate local turbidity around the cutter heads of the dredges, but this turbidity will not significantly spread beyond the dredging tranches and channels because the bulk of the dredging takes place below the surrounding riverbed.

The settling rate is primarily dependent on the density of the suspension and the grain size distribution of the suspended material, assuming a two-layer fluid system around the dredger or fill area outflow: an upper layer of water and a lower layer of suspension (water plus sediment). Sand size particles may settle within the hour, but clay-size particles (<2 micron) may take many hours (sometimes even days), if the density of the suspension is high. The influence of strong currents is indirect: they cause high turbulence that disturbs the boundary between the two layers and thereby causes mixing/dilution, leading to quick removal of part of the suspended sediment from the area with the water current.

Impacts of construction of approach road: There are large number of ponds and borrow pits currently being used for fishing, are likely to be affected since the proposed alignment of approach road pass though those pond and small perennial wetlands. Most of these ponds are seasonal in nature and go dry during dry season. The proposed approach road will cross several drainage canals. Project design has made provisions of bridges and culverts over these ponds and seasonal wetlands so that they are not affected. Piling activities are envisaged on the

drainage canals during construction of the culverts. Some excavation and dredging activities will also follow while piling. Such activities are likely to increase water contamination by discharging wastewater, oil spills and use of bentonite clay. This will increase water contamination during the construction activities. Since this will be a temporary phenomenon, no significant adverse impact is anticipated during this phase.

Impacts of construction sites and camps: Run-off from excavation, crushed and ground rock material from drilling, run off from earthmoving and spoil handling, open excavations, concrete batching for old road pavement, washing of vehicles and other machinery, and uncontrolled dumping of wastes, sewage, dredge materials, and accidental spillage of fuels and chemicals into the water bodies from construction sites and or camps may greatly deteriorate the water quality. The project construction is likely to last for a period of 2-3 years. There will be increase of water use and wastewater and sewage during the construction, which requires immediate and proper treatment.

The significance of impact on water environment has been assessed as High, as given in Table 6-5.

Mitigation: The following mitigation measures will be implemented to address the water contamination caused by the project. The appointed contractor will first prepare the contractor's EMP (CEMP) which needs to be approved by the RHD appointed Environmental Specialist and Construction Supervision Consultant (CSC). Contractor will in parallel, develop and implement a Pollution Prevention Plan (PPP) prior to the start of the work. Proper baseline data will be collected to prepare the PPP. In addition, the contractor will follow the following mitigation measures:

- Contractor will prepare Bridge Construction Management Plan to address environmental impacts of bridge construction;
- Cofferdams will be used for construction of bridge piers.
- Contractor will be required to comply with the national legislation for wastewater discharges into the water bodies;
- Contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the water;
- Monitor water quality parameters such as temperature and suspended sediment concentrations in the vicinity of the pile driving.
- All areas intended for storage of hazardous materials to be quarantined and provided with adequate facilities to combat emergency situations complying all the applicable statutory stipulation;

- For the treatment of effluent to be discharged, sedimentation ponds will be provided to allow sediment to settle for periodic removal for disposal in designated site spoil areas. Water being discharged from these ponds will be regulated to ensure they are within turbidity limits;
- Construction camps will be located minimum 500 m away from water bodies;
- Sewage from the toilets will go into lined septic tanks. Sewage disposal trucks will be used to periodically remove the sludge/sewage from the site and camps;
- Oil and water separators and settling ponds will be installed where appropriate to minimize the risk of contaminated construction water entering the canal, collector or groundwater and degrading water quality;
- Construction works near canals and collectors will be carried out ensuring that no debris or excavated soil are released in water.

Residual Impacts: After implementation of the above mitigation measures, the impacts of the project on the water resources will be adequately mitigated. Hence the significance of residual impacts will be Minimal, as shown in Table 6-5.

7.6.2 Noise and vibration

Impact: Various construction activities will cause noise and vibration. Noise from vehicles and construction equipment will also affect receptors near the construction sites and along the transportation routes. In particular, the sensitive receptors listed in Table 5-70 will be severely affected by this noise. The vibration may affect the stability of nearby structures. Noise will be generated during construction from construction activities and operation of heavy equipment and machinery and during operation mainly from the plying of traffic on the road.

Construction activity can result in varying degrees of ground vibration, depending on the equipment and methods employed. Operation of construction equipment causes ground vibrations which spread through the ground and diminish in strength with the distance. Buildings founded on the soil in the vicinity of the construction site respond to these vibrations, with varying results ranging from no perceptible effects at the lowest levels, low rumbling sounds and fellable vibrations at moderate levels and slight damage at the highest levels. Ground vibrations from construction activities very rarely reach the levels that can damage structures, but can achieve the audible and fillable ranges in buildings very close to the site. A possible exception is the case of old, fragile buildings of historical significance where special care must be taken to avoid damage. The construction vibration criteria include special consideration for fragile buildings. The construction activities that typically generate the most severe vibrations are pile driving.

During construction, noise is likely to be generated from site clearing, excavation, concrete mixing, crushers, piling in bridge construction.

Pile Driving: Pile driving may produce noise levels in excess of acceptable limits, even when feasible noise reduction methods are used. Various dampening and shielding methods discussed later can attain some reduction. However, such methods rarely reduce the noise level to an acceptable level for the sensitive receptors close to the site. As an alternative to driving piles, it is possible to use vibration or hydraulic insertion techniques. Drilled or augured holes for cast-in-place piles are another alternative that may produce noise levels significantly lower than the traditional driving method.

Pile driving activities generate very high under water noise levels. Several studies have been carried out throughout the world to assess the impact of sound associated with pile driving. Popper et all (2006)[11] presented a review of all these documents and presented a scientific assessment of pile driving exposures which are injurious to fish, and recommended a criteria for pile driving (SEL 187 dB[12] and Peak 208 dB at 10 m from source). The noise criteria of pile driving on the impact of fish as given by NOAA (National Oceanic and Atmosphere Administration, USA) are given in Table 7-7

Table 7-7 NOAA Criteria for Pile Driving and its Impact on Fish

Effect	Parameter	Fish Mass	Threshold
Onset of physical injury	Peak Pressure	N/A	206 dB (re: 1 µPa)
	Accumulated Sound Exposure Level (SEL)	> 2 g	187 dB (re: 1µPa2*sec)
		< 2 g	183 dB (re: 1µPa2•sec)
Adverse behavioral effects	Root Mean Square Pressure (RMS)	N/A	150 dB (re: 1 µPa)

Compressors: While most compressors are powered by diesel or gasoline engines, many are contained or have baffles to help abate noise levels. Electric compressors are significantly quieter than diesel or gasoline engine powered compressors.

The noise level from various construction equipment /machinery is (all levels are in dB(A)): Dozers (95-100), front Loaders (72-84), Backhoes (72-93), Tractors (76-96), Toppers/Trucks (82-94), Concrete mixers (75-83), Concrete pumps (75-83), Concrete pumps (81-83), Cranes (movable) (75-86), Vehicular Traffic (construction material & plant & Machinery) (85-98), Dg Set (90-95), Pumps (69-71), Compressors (74-86), Pneumatic Wrenches (83-88), Jack Hammer and rock drills (81-98), Pile Drivers (peak) (95-105).

Under the worst-case scenario, it is assumed that all these equipment generate noise from a common point. The increase in noise levels due to operation of various construction equipment is expected to increase the noise level from 100 dB (A) at a distance of 1 m to 52.1 dB (A) at a distance of 250 m from the sources. The vehicular increase during construction is likely to

[11] AN Popper, TJ Carlson, AD Hawkins, BL Southall and RL Gentry (2006) Interim Criteria for Injury of Fish Exposed to Pile Driving Operations: A White Paper - http://www.wsdot.wa.gov/NR/rdonlyres/84A6313A-9297- 42C9-BFA6-750A691E1DB3/0/BA_PileDrivingInterimCriteria.pdf

[12] Accumulated Sound exposure Level (SEL)

be limited and may not have any significant contributions to increase in ambient noise level.

The additional movement barges carrying construction materials will also generate additional noise.

Significance of noise and vibration has been assessed as High, as shown in Table 6-5.

Mitigation: The contractor will prepare and implement the PPP prior to the start of work. The mitigation measures are discussed below:

Less noisy equipment: One of the most effective methods of diminishing the noise impacts caused by individual equipment is to use less noisy machinery. By specifying and/or using less noisy equipment, the impacts produced can be reduced or, in some cases, eliminated. Source control requirements may have the added benefits of promoting technological advances in the development of quieter equipment.

Mufflers: Most construction noise originates from internal combustion engines. A large part of the noise emitted is due to the air intake and exhaust cycle. Specifying the use of adequate muffler systems can control much of this engine noise.

Shields: Employing shields that are physically attached to the particular piece of equipment is effective, particularly for stationary equipment and where considerable noise reduction is required.

Dampeners: Equipment modifications, such as dampening of metal surfaces, are effective in reducing noise due to vibration. Another possibility is the redesign of a particular piece of equipment to achieve quieter noise levels.

Aprons: Sound aprons generally take the form of sound absorptive mats hung from the equipment or on frames attached to the equipment. The aprons can be constructed of rubber, lead-filled fabric, or PVC layers with possibly sound absorptive material covering the side facing the machine. Sound aprons are useful when the shielding must be frequently removed or if only partial covering is possible.

Enclosures: Enclosures for stationary work may be constructed of wood or any other suitable material and typically surround the specific operation area and equipment. The walls could be lined with sound absorptive material to prevent an increase of sound levels within the structure. They should be designed for ease of erection and dismantling. Selection of Equipment: Newer equipment is generally quieter than old equipment for many reasons, including technological advancements and the lack of worn, loose, or damaged components. Some equipment manufacturers have made their equipment quieter in recent years and have achieved significant reductions over older equipment. In some cases, the use of over- or under-powered equipment may be an unexpected source of excessive noise. The types of engines and power transfer methods also play a significant role in achieving lowered equipment noise. The use of electric powered equipment is typically quieter than diesel, and hydraulic powered equipment is quieter than pneumatic power.

Stationary source: positioning stationary noise sources such as generators and compressors as far away as possible from noise sensitive areas should be considered. Temporary barriers can be employed and/or enclosures can be built around noisy equipment. These techniques can significantly reduce noise levels and, in many cases, are relatively inexpensive. These barriers can typically be constructed on the work site from common construction building material (plywood, block, stacks, or spoils). Enclosures are often constructed from commercial panels lined with sound absorbing material to achieve the maximum possible shielding effect.

To be effective, the length of a barrier should be greater than its height, the noise source should not be visible, and any barrier should be located as close as possible to either the noise source or the receiver. In addition, providing increased distance between a noise source and a noise receiver can also be considered a form of abatement.

- Electric powered equipment, rather than diesel powered mechanical equipment would be utilized;
- Use of impact devices such as jackhammer, pavement breakers and pneumatic tools should be limited and shrouds would be utilized to limit noise exposure;
- Construction staging areas would have appropriate noise attenuation installed around the areas and would be configured to minimize backup alarm and other noises; Contractors and subcontractors would be required to properly maintain and service their equipment and install quality mufflers so they meet noise specifications;
- Sound attenuating curtains or shrouds would be used on the pile driving hammers to reduce noise when operating in close ecologically sensitive area
- Movable noise attenuation measures would be erected around pumps, trucks, and other noisy equipment when operating in close proximity to residential areas.
- Using vehicles and equipment in good conditions.
- Forbidding horns in populated areas.
- Optimizing the construction schedule (e.g. piling works not at night) to minimize the impacts on nearby communities.

Mitigation Measures for Pile Driving Activity

- Using cofferdams and silt curtains, where feasible, to minimize discharge of sediment into the river. In this case, coffer dams will be used on both banks as seen in Figure.
- Using a vibratory pile driver to the extent feasible particularly for the initial pile segment.
- Using the pile driver and methods that can meet the criteria listed in Table 7-7

- Limiting the periods of pile driving to no more than 10-12 hours/day. (in rare circumference it is possible that piling may extend further than 12 hours depending on the practicality of driving)

- Monitoring locations to characterize the hydro-acoustic field surrounding pile driving operations, which also includes a nearfield component to evaluate the performance of underwater noise attenuation systems that are integral to the project.

- Pile tapping (i.e. a series of minimal energy strikes) for an initial period to frighten fish so that they move from the immediate vicinity of pile driving activity.

Mitigation measures for vibration

- Route heavily loaded trucks away from the residential streets, if possible, select streets with fewest homes, if no alternatives are available.

- Operate earth moving equipment on the construction lot as far away from vibration sensitive sites as possible

- Avoid nighttime activities. People are more aware of vibration in their homes during the nighttime hours.

Meanwhile, monitoring shall be carried out to inform the mitigation measures, especially monitoring of noise near sensitive receptors and vibration near the cultural heritage or historic buildings. In addition, the GRM will be established as described earlier to capture noise and vibration- related complaints and grievances.

Residual Impacts: After implementing the mitigation measures, the residual impacts have been assessed as Moderate, as shown in Table 6-5.

7.6.3 Soil Contamination and Erosion

Impact: During construction phase, there is a risk of accidental spills and leakages that may occur from fuel and oil tanks, vehicles and machinery, asphalt and batching plants, and storage of chemicals used in construction areas, yards, batching plants, worker camps, and residential areas and from storage sites. These spills can pollute soils and contaminate surface water and groundwater in the area. Waste effluents from temporary facilities such as camps and offices and dumping of wastes and debris can also contaminate soil.
Dumping of construction debris on fields adjoining the acquired areas, may lead to impairment of soil for agriculture, especially when the nearby areas to the alignment is largely agriculture. Parking of vehicles by the side of roads also leads to soil compaction and may spoil the soil characteristics necessary for cultivation.

Disturbance of soils during construction including (and particularly) from movement of man, machine and vehicles may lead to destruction of the integrity of upper soil layers. Damaged soil is more readily eroded and washed into water courses during rainfall events and can also form dust during dry periods. Excavation for reconstruction of Kewatkhali road can cause soil

erosion. High rainfall events can also potentially cause accelerated erosion particularly in excavated areas. due to movement of vehicle and construction equipment, setting up construction camps, resulting in reduction in agriculture yield.

Excavation and construction activities in the cultivation fields can potentially cause the loss of upper layer of soil, causing reduction in soil fertility and hence reduced crop productivity. The significance of impact on soil has been assessed as High, as given in Table 6-5.

Mitigation: The following mitigation measures will be implemented:

- Contractor will prepare and implement the PPP prior to the start of the work.
- Contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the soil;
- Contractor will confine the contaminants immediately after such accidental spillage;
- Contractor will collect contaminated soils, treat and dispose them in environment friendly manner;
- All areas intended for storage of hazardous materials to be quarantined and provided with adequate facilities to combat emergency situations complying all the applicable statutory stipulation;
- Top soil to be stripped and stockpiled where practical, particularly in cultivation fields.
- Vehicles and equipment will not be repaired in the field. If unavoidable, impervious sheathing will be used to avoid soil and water contamination.
- Temporary stockpile of soil to be protected from wind and water erosion.
- For sewage waste, appropriate treatment arrangement such as septic tanks and soakage pits will be installed on site. Water will percolate into the ground so there will be no discharge. Alternatively, sewage from construction camps and other facilities will be collected and transported to nearby sewage treatments plants.
- The movement of construction vehicles, machinery and equipment will be restricted to the corridor or identified route.
- Follow the Waste Management Plan and dispose various wastes properly to avoid contamination of soil.
- The compacted land is restored for agricultural use.

Residual Impacts: After implementation of the above mitigation measures, the impacts of the project on the soil contamination and soil erosion will be adequately mitigated. Hence the

significance of residual impacts is expected to be Minimal.

7.6.4 Air Pollution

Impact: Air quality will be affected and dust will be generated during construction activities. Major sources of air pollution are drilling activities, excavations, emissions from construction related traffic and equipment, batching plant and asphalt plant. The construction activities will also generate airborne dust and particulate matter. Dust raised from the above activities will have impacts on crops, animals and public health. These impacts will be most severe for the sensitive receptors in the area; see Table 7-8 for a list of such areas along the project road.

During construction phase, there are two main sources of air emissions i.e. mobile sources and fixed sources. Mobile sources are mostly vehicles involved in construction activities while emissions are from fixed sources that include diesel generator sets, construction equipment (e.g. compressors) and excavation/ grading activities.

Certain amount of dust and gaseous emissions will be generated during the construction phase from rock crushing, and road construction machineries. Pollutants of primary concern include Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM). However, suspended dust particles are coarse and settle within a short distance of construction area. Therefore, impact in nearby inhabited area will be direct but temporary and restricted within the closed vicinity of the construction activities only.

Localized emissions are also anticipated from hot mix plants and batching plants. These emissions would be in the form of coarse particulate matter and will settle down in close vicinity of construction site. Further, this will be a temporary phase. Hence, no significant impact is expected during the construction phase.

Odour, dust and volatile organic compounds will be generated from compaction of the asphalt pavement. In addition, the generators and powered equipment that supply crushed rock and asphalt will also generate dust and other air emission which will be rapidly dispersed.

Table 7-8 Impact Analysis on Sensitive Receptor

SL	Name	GPS Location	Description	Affected by	Distance from the edge of the road
1	Sapla Resource Development Center, Digharkanda Bypass Road, Mymensingh Sadar	24.72040 N 90.41133 E	Social Association for people Livelihood Advancement, Resource Development NGO	Noise, Dust, Air pollution, Vibration	Within the road

SL	Name	GPS Location	Description	Affected by	Distance from the edge of the road
2	ASPADA Training Academy, Digharkanda University Road Bypass, Mymensingh	24.72138 N 90.41165 E	Five storied building used as a training academy which is a non-political social development voluntary organization	Noise, Dust, Air pollution, Vibration	Within the road
3	Bangladesh Agricultural Development Corporation (BADC), Bolashpur, Kewatkhali Bypass, Mymensingh	24.74334 N 90.42267 E	One storied government building under the ministry of agriculture	Noise, Dust, Air pollution, Vibration	Within the road
4	220 KVA Electrical Substation BADC, Bolashpur, Kewatkhali Bypass, Mymensingh	24.74317 N 90.42277 E	Electrical substation under BADC	Noise, Dust, Air pollution, Vibration	Within the road
5	Momenshahi Etimkhana (shishusodon) Balika, 94 kalibari (Patgudam), Mymensingh	24.74553 N 90.42126 E	Orphanage for girls used for educational and religious activities	Noise, Air Pollution	725 meters from the edge of the road
6	Tourist Police Mymensingh Zone, Mymensingh	24.74565 N 90.42119 E	Law enforcement building (5 storied)	Noise, Air Pollution	755 meters from the edge of the road
7	Hotel le Marian, Mymensingh Bypass mor, Mymensingh	24.71664 N 90.41029 E	4 storied Residential Hotel	Noise, Dust, Air pollution, Vibration	Within the Road Acquisition required
8	Reneta Pharmaceuticals, Digharkanda Bypass, Mymensingh	24.71749 N 90.40926 E	Pharmaceutical Agency	Noise, Dust, Air Pollution	90 meters from the edge of the road
9	United Model School, Mymensingh	24.74555 N 90.42124 E	Multistoried School Building	Noise, Dust, Air pollution, Vibration	Within the road
10	Notre Dame College, Mymensingh	24.74555 N 90.42124 E	Multistoried School Building	Noise, Air Pollution	200 meters from the edge of the road
11	Police Bureau of Investigation (PBI), Mymensingh	24.73139 N 90.41601 E	Five storied law enforcement building	Noise, Dust, Air pollution, Vibration	Within the road
12	Gasoline Filling Station	24.71848°N 90.41064°E	Filling Station	Noise, Dust, Air pollution, Vibration	Within the road
13	Janata Bank Regional Staff College, Kewatkhali Bypass mor, Mymensingh	24.74263 N 90.42314 E	Commercial Building	Noise, Dust, Air pollution, Vibration	30 meters from the edge of the road
14	Anowara Memorial Nursery, 65 Kalibari road, Bolashpur, Mymensingh	24.74263 N 90.42314 E	Institution for supplying of different kinds of fruits, flowers and fishes	Noise, Air Pollution	200 meters from the edge of the road
15	Office of the Assistant General, Agricultural Extension Department, Mymensingh	24.74237 N 90.42328 E	Government organization building for Agriculture expansion	Noise, Air Pollution	320 meters from the edge of the road
16	Bolashpur Bazar	24.73757 N 90.42216 E	Commercial Area	Noise, Dust, Air pollution, Vibration	Within the road
17	Durus Salam Jame Masjid, Kewatkhali, Bypass Mor, Mymensingh	24.73537 N 90.42042 E	Religious Place	Noise, Dust, Air pollution, Vibration	Within the road

SL	Name	GPS Location	Description	Affected by	Distance from the edge of the road
18	Sahid Sriti Non-Govt. Polytechnic Institute	24.73139 N 90.41601 E	NGO building	Noise, Dust, Air pollution, Vibration	Within the road
19	Sri Shibmondir, Patgudam Bridge Mor, Mymensingh	24.74610 N 90.42071 E	A Temple place of Hindus for religious purposes	Noise, Air Pollution	815 meters from the edge of the road
20	Muktijuddher Sritishoudho Mymensingh	24.74627 N 90.42062 E	Landmark & Historical Place in Mymensingh	Noise, Air Pollution	830 meters from the edge of the road
21	Madrasha Hakimul Ummah Momenshahi, Bypass mor, Hakkanir mor, Mymensingh	24.73980 N 90.41982 E	Madrasha	Noise, Air Pollution	340 meters from the edge of the road
22	Kewatkhali High School, Kewatkhali, Sadar, Mymensingh	24.73739N 90.42455 E	Educational Institution for students, tinshed school building	Noise, Air Pollution	230 meters from the edge of the road
23	Kewatkhali Eidgah, Kewatkhali, Mymensingh	24.73636 N 90.42528 E	Eidgah for Eid prayer	Noise, Air Pollution	300 meters from the edge of the road
24	PDB Office, Mymensingh	24.73513 N 90.42406 E	Government Office building	Noise, Air Pollution	310 meters from the edge of the road
25	Hakkani Anjuman Masjid, Mymensingh	24.73750 N 90.42156 E	Two Storied mosque is used for religious activities	Noise, Air Pollution	60 meters from the edge of the road
26	PDB-PGCB Jame Masjid, Mymensingh	24.73508N 90.42907 E	One storied building used for religious activities	Noise, Air Pollution	645 meters from the edge of the road
27	Kewatkhali Bypass mor, Mymensingh	24.73992 N 90.42991 E	Central Bypass Mor	Noise, Air Pollution	240 meters from the edge of the road
28	Darus Suffa Muslim Academy, Dokkhin Chorkalibari, Mymensingh	24.74224 N 90.42860 E	Madrasa used for religious activities	Noise, Dust, Air pollution, Vibration	Within the road
29	Chor Jhaugora Government Primary School, Mymensingh	24.76034 N 90.44231 E	Two storied building govt. educational institution	Noise, Dust, Air pollution, Vibration	Within the road
30	Dokkhin Chor Masjid, Mymensingh	24.74230 N 90.42848 E	Mosque used for educational and religious activities	Noise, Dust, Air pollution, Vibration	Within the road
31	Dokkhin Chorkalibari Vumihin Somobay Somiti, Mymensingh	24.74244 N 90.42842 E	Somobay Somiti for landless people	Noise, Dust, Air pollution, Vibration	20 meters from the edge of the road
32	Bangladesh Railway Staff and Labor Organization, Kewatkhali Branch, Mymensingh	24.73984 N 90.42528 E	One storied tinshed building used by railway loco running staffs and labors	Noise, Dust, Air pollution, Vibration	Within the Road Acquisition required
33	Kewatkhali Bazar, Mymensingh	24.73892N 90.42561 E	Commercial area	Noise, Dust, Air Pollution	90 meters from the edge of the road
34	Loco Running Room, Bangladesh Railway, Kewatkhali, Mymensingh	24.73834 N 90.42585 E	Two storied building with open front yard	Noise, Air Pollution	160 meters from the edge of the road
35	Dormitory building Horticulture centre, Kewatkhali, Mymensingh	24.73868 N 90.42592 E	Two storied building adjacent to Kewatkhali bazar area	Noise, Dust, Air pollution	135 meters from the edge of the road

SL	Name	GPS Location	Description	Affected by	Distance from the edge of the road
36	Bangladesh railway Karigor Porishod, Kewatkhali, Mymensingh	24.73981 N 90.42518 E	One storied tinshed building adjacent to rail-line in Kewatkhali bazar	Noise, Dust, Air pollution, Vibration	Within the Road Acquisition required
37	Bangladesh Institute of Nuclear Agriculture, Mymensingh	24.72276N 90.43198 E	Five storied research building inside the BAU area	Noise, Air Pollution	1.95 km from the edge of the road
38	Botanical Garden, Mymensingh	24.72396 N 90.44010 E	Garden/Nursery area	Noise, Air Pollution	2.75 km from the edge of the road
39	Bangladesh Agricultural University Post Office, Mymensingh	24.72252 N 90.44127 E	Government building	Noise, Air Pollution	2.75 km from the edge of the road
40	Horticulture Center, Mymensingh	24.73446 N 90.42921 E	Govt. Office buildings	Noise, Air Pollution	700 m from the edge of the road
41	Baitur Rahman Jame Masjid, Mymensingh	24.73917N 90.42401 E	Jame Mosque for educational and religious activities	Noise, Dust, Air pollution, Vibration	Within the road
42	Bangladesh Agriculture University	24.73446 N 90.42921 E	Main Gate for the Entrance of the Campus	Noise, Air Pollution	700 m from the edge of the road
43	Mrkajut Takwa Ideal School, Bolashpur, Mymensingh	24.73907 N 90.42389 E	Educational Institution	Noise, Dust, Air pollution, Vibration	Within the road
44	103 no. Digharkanda Government Primary School, Mymensingh.	24.72374 N 90.41553 E	One storied govt. Educational buil ding	Noise, Air Pollution	300 m from the edge of the road
45	Digharkanda Central Jame Masjid, Mymensingh	24.72330N 90.41739 E	Central Mosque used for religious activities	Noise, Air Pollution	495 meters from the edge of the road
46	Digharkanda Madrasha Masjid, Mymensingh	24.72440 N 90.41289 E	Madrasha used for religious and educational activities	Noise, Dust, Vibration, Air pollution	18 m from the edge of the road
47	Mymensingh Independent College Moddhopara, Digharkanda, Mymensingh	24.72467 N 90.41228 E	Three storied Building used for Educational activities	Noise, Dust, Vibration, Air pollution	25 m from the edge of the road
48	RFL Factory Mymensingh	24.72746 N 90.41358 E	Industrial area	Noise, Dust, Air pollution, Vibration	Within the road
49	Baitul Nur Jame Masjid, Mymensingh	24.72852N 90.41425 E	Mosque	Noise, Dust, Air pollution, Vibration	Within the road
50	Electrical Tower, Mymensingh	24.74131 N 90.42933 E	Electric Tower	Noise, Dust, Air Pollution	80 m from the edge of the road
51	Kewatkhali Railway Colony Jame Masjid & Frokania Madrasha, Nodir par colony, Mymensingh	24.74036 N 90.42591 E	Mosque and Madrasa	Noise, Dust, Air pollution, Vibration	Within the Road Acquisition required

The significance of the impact has been assessed as High particularly for the sensitive receptors, as shown in Table 6-5.

Mitigation: To mitigate deterioration of air quality and generation of dust, the following measures will be taken:

- Contractor will prepare and implement the PPP prior to the start of work.

- All conditions of DoE permits and local guidelines will be followed.
- The equipment and vehicles used during the construction process will comply with the national legislation;
- Concrete batching and asphalt plants will be located in agreement with the local district or municipality. They should be located downwind of and minimum 500m away from residential areas as well as sensitive receptors (Table 7-8) and be fitted with high stack (30m) to allow adequate dispersion of emissions; dust suppression equipment will be installed at asphalt and batching plants;
- Contractor will implement dust prevention measures such as watering of roads near the residential areas;
- The construction area where local roads are used for hauling shall be kept in serviceable condition, and any damage will be repaired promptly without interference to local travel routes;
- Loose material such as sand will be covered with tarpaulin when being transported on trucks and store piled at the site;
- Regular air monitoring will be carried out near the sensitive receptors (Table 7-9) to ensure ambient air quality remains within the limits defined by national standards;
- Measures will be taken to protect the workers from excessive dust (i.e., usage of personal protective equipment);
- Project vehicles will avoid passing through the communities as far as possible. If unavoidable, speed will be reduced to 15 km/h to avoid excessive dust emissions.
- Road pavement design should be such that tire friction due to vehicle movement will be reduced. Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered to reduce dust pollution on existing road. The stockpiles of construction material shall be sprinkled with water. Water should be sprayed at asphalt mixing site and temporary service and access roads. After compacting, water should be sprayed on the earthwork regularly to prevent dust. Air pollution monitoring shall be carried out as per monitoring plan and corrective action shall be taken in case of deviation.
- Regular maintenance of machinery and equipment shall be carried out.
- Diesel Generator (DG) sets shall be fitted with stacks of adequate height. Low Sulphur

diesel will be used in DG sets as well as machineries.

- Place the DG sets and other powered equipment away from sensitive receptors to avoid complaints.
- A 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.

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 significance of residual impact is likely to be Minimal, as shown in Table 6-5.

7.6.5 Solid Waste Management

Various types of solid wastes will be generated by different construction activities of this project, including dredged and excavated materials, construction spoils, domestic wastes and other construction wastes including hazardous wastes. They are discussed in the following sections respectively.

7.6.5.1 Dredged/Excavated Materials

Impact: The dredging in the Old Brahmaputra riverbed may be needed to ensure barge movement if Large Block Construction Method is applied for the bridge construction, but the dredging activities will be very limited. For the bridge pier construction, excavation will be needed. For embankment protection, there could be some containment structure construction along the riverbed that would have some river sand excavated from the riverbed. As discussed in section of baseline analysis, parameters of sediment were observed to be well below the threshold limits for Intervention as per the Dutch Standards where almost some of the parameters are not yet standards according Dutch Standards. Thus, no special dredged material chemical treatment will be necessary. For construction of bridges and culverts on the approach road, similar impact of excavated materials in drainage canals is also estimated limited. However, if the dredged/excavated materials are not disposed properly, they may cause water and soil contamination.

The significance of this impact is assessed as Moderate, as shown in Table 6-5.

Mitigation:

- Excavated/dredged material should not be disposed near the bank permanently to avoid runoff during rainy season as well as re-filling drainage channel;
- Volume of dredged/excavated material has to be estimated prior to starting of works and the way of disposal shall be planned;
- In this scheme, dredged materials should be identified for filling of embankment work and other construction purpose in consultations with local population including local government and community leaders;
- If used for fertilizer purpose, the dredged materials should be tested and meet the concerned standards; and
- WMOs should be consulted for identification of these areas and to allow the public to carry the materials and also for setting up a monitoring procedure for transport of material without causing any environment degradation.

Residual impacts: With the help of the above measures, the potential impacts of the project on the biological resources of the area will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal,

7.6.5.2 Generation of Spoils

Impact: Excavation activities for road construction particularly for foundation of interchange structures will generate excess spoils. Disposal of this spoil in cultivation fields will affect the crops and irrigation. Similarly, spoil disposal in built-up area will cause hindrance and traffic congestion. The spoils will also act as a source of dust. The significance of the impact has been assessed as Moderate, as shown in Table 6-5.

Mitigation: The first step towards addressing the impacts of spoil is to minimize the generation of spoils by recycling the excavated soil to the maximum extent possible by using it as filling material in the road section. The excess spoils should be stored in the lands provided by local communities or in the areas approved by the project management/local authorities. Further guidance is provided in the EMP.

Residual Impacts: With the help of the above mitigation measures, the potential impacts associated with spoil generation are likely to be adequately addressed and hence the residual impact is likely to be Low in significance, as shown in Table 6-5.

7.6.5.3 Other construction and domestic wastes

Impact: The construction works generate large quantities of excess materials from construction sites (concrete, discarded material, vegetation), demolition wastes (dismantled asphalt and other facilities), and wastes from construction yards, including garbage, recyclable waste, food waste, and other debris. The construction process will take 2- 3 years and as a result, the construction camps will take a semi-permanent appearance. The majority of waste generated from construction camps will include papers, plastic containers, residues of food, fruits etc. and liquid waste: from kitchen and bathroom etc. A large part of such wastes is

biodegradable or recyclable.

In addition, small quantities of hazardous waste will also be generated mainly from the vehicle maintenance activities (bitumen, 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).

If these wastes are not responsibly disposed, it can cause adverse environmental, human health and aesthetic impacts. Significance of such impacts has been assessed as High, as shown in Table 6-5.

Mitigation: The following mitigation measures will be implemented:

- Contractor will prepare and implement the PPP which includes a Waste Management Plan.
- Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. Segregate and reuse or recycle all the wastes, wherever practical. Provide reuse containers at each worksite.
- The dismantled asphalt will be recycled and reused for approach road or other constructions.
- The contractor will identify suitable sites for temporary storage of wastes from construction sites and demolished wastes in consultation with communities and government authorities. The wastes shall be transported for disposal in a timely manner;
- A waste disposal site should be away from settlements, water streams and or any archaeological and historical monuments while barren lands are preferable for this purpose.
- The contractor will identify suitable sites for disposal of hazardous and nonhazardous waste. The selection will be carried out in consultation with the local government authorities.
- No dumping on private property is carried out without written consent of the owner.
- No dumping should be allowed on wetlands, forest areas, and other ecologically sensitive areas.
- Transport waste of dangerous goods, which cannot be recycled, to a designated disposal site approved by DOE.

- 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 disposal practices and procedures as a component of the environmental induction process.
- Provide absorbent and containment material (e.g., absorbent matting) where hazardous material is used and stored and personnel trained of the correct use.
- Make sure all containers, drums, and tanks that 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.
- Prohibit burning of solid waste.
- Request suppliers to minimize packaging where practicable.
- Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials.
- 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.

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 Minimal in significance, as shown in Table 6-5.

7.6.6 Blockage of/or Damage to Canals and Drainage Channels and Culverts

Impact: The road construction activities particularly near these irrigation canals and drainage channels as well as the bridge construction activities can potentially cause damage to the side slopes of the canals and drainage channels and even block them. The piling of construction may require diverting of water or temporary cofferdam in the canals and drainage channels. The damage to or blockage of irrigation canals can cause reduction of water availability for irrigation purposes thus causing loss of agriculture produce. Similarly, any damage or blockage of drainage channels can cause local flooding, adversely affecting the road as well as the nearby cultivation fields.

Drainage

Run off from storage of construction material near water bodies, or uncontrolled disposal may

cause temporary drainage congestion, especially near the locations of small bridges, culverts and construction sites. Drainage congestion may result due blockage by waste, soil and other kinds of debris.

There are many flood prone areas as shown in previous sections above. Project design has made provisions of about many smaller culverts. Hence, no significant impact is anticipated on these water bodies during this phase as drainage will be maintained through temporary culverts if required. The above impact has been assessed as High, as shown in Table 6-5.

Mitigation Measures: The following mitigation measures will be implemented to address the damage or blockage of canals and channels caused by the project:

- Contractor will prepare Bridge Construction Management Plan including plan of water diverting to address environmental impacts of bridge construction.
- No debris, soil, waste material or access construction material will be released in the canals or channels.
- Construction material will not be stockpiled near water bodies.
- Vehicle movement near the water bodies will be avoided.
- Liaison with irrigation authority and keep the stakeholders informed in case of any damage to or blockage of irrigation canals.
- Any damage to the canals or drainage channels will be restored immediately.
- Construction shall be so planned that there is no drainage congestion. Wastes should not be disposed near any water body. All waste depending on its characteristics, should be disposed of in a controlled manner.
- All channels should be kept clear to facilitate drainage. It shall be ensured that drainage along the road is maintained to prevent water logging along the road.

Residual Impacts: After implementation of the above mitigation measures, the impacts of the project on the canals and drainage channels will be adequately mitigated. Hence the significance of residual impacts will be Minimal, as shown in Table 6-5.

7.6.7 Impact on biological environment

7.6.7.1 Impacts on ecosystem

Impact: The proposed road runs through areas with wetlands, agricultural, canals, low lying areas and urban ecosystems. Construction activities particularly camp establishment and construction of interchanges can potentially cause loss of natural vegetation and disturbance to wildlife of the area. However, most of the construction activities will be carried out on the Roads and Highways Department

existing road on the south west side in Mymensingh urban area. On the east side the roadway corridor will be constructed in a greenfield and the roadway will past through some homestead treed area, that would require removal of trees. The environmental impacts on the environmental features and eco-sensitive are listed in Table 7-9.

Table 7-9 Impact on Environmental and Eco Sensitive Features

Environmental Impact of Right Side

Environmental Impact (Right Side-Approach Road 1)				
Environmental Features (Right Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Pond, Homestead Vegetation, Garden, Canal	0+000 to 1+000	No significant impact by the activities	Existing homestead vegetation and garden could be damaged. Few terrestrial & aquatic floras in canal may be disturbed. Water quality in canal may deteriorate which could affect aquatic fauna. Canal flow may be disrupted. Minor loss of Terrestrial and Aquatic Flora and Minor disturbance of Terrestrial and Aquatic Fauna.	Hazardous materials or debris might pollute the water quality. Disturbance of aquatic habitat.
Pond, Homestead Vegetation, Ditch	1+000 to 2+000	No significant impact by the activities	Existing homestead vegetation might be damaged. Water quality in ditches and pond may deteriorate.	Minor degradation of water quality. Minor disturbance of aquatic habitat in ditches.
Pond, Homestead Vegetation	2+000 to 3+000	No significant impact by the activities	Existing homestead vegetation might be damaged. Water quality in ditches and pond may deteriorate.	Minor degradation of water quality. Minor disturbance of aquatic habitat in ditches.

Environmental Impact (Right Side-Approach Road 1)				
Environmental Features (Right Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Pond, Homestead Vegetation	3+000 to 3+500	No significant impact by the activities	Existing homestead vegetation and garden could be damaged. Water quality in ditches and pond may deteriorate.	Minor degradation of water quality. Minor disturbance of aquatic habitat in ditches.
Environmental Impact				
Environmental Features (Upstream)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Homestead Vegetation, Sand, Pond, River	3+500 to 4+300	No significant impact by the activities	Existing homestead vegetation might be damaged. Few terrestrial & aquatic floras in River may be disturbed. Water quality in canal may deteriorate which could affect aquatic fauna. Canal flow may be disrupted. Minor loss of Terrestrial and Aquatic Flora and Minor disturbance of Terrestrial and Aquatic Fauna.	Hazardous materials or debris might pollute the water quality of the river. Disturbance of aquatic habitat in River.
Environmental Impact (Right Side-Approach Road 2)				
Environmental Features (Right Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**

Environmental Impact (Right Side-Approach Road 1)				
Environmental Features (Right Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Orchard, Homestead Vegetation	4+300 to 5+000	No significant impact by the activities	Existing homestead vegetation and orchard might be damaged.	Very minor loss of vegetation during O & M
Homestead Vegetation, Graveyard, Pond, Orchard,	5+000 to 5+920	No significant impact by the activities	Existing homestead vegetation and orchard might be damaged. Graveyard area may be affected.	Very minor loss of vegetation during O & M

Environmental Impact of Left Side

Environmental Impact (Left Side-Approach Road 1)				
Environmental Features (Left Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Canal, Ditch, Homestead vegetation, Lowland, Orchard, Pond	0+000 to 1+000	No significant impact by the activities	Existing homestead vegetation and orchard might be damaged. Few terrestrial & aquatic floras in canal and low-lying area may be disturbed. Water quality in canal may deteriorate which could affect aquatic fauna. Canal flow may be disrupted. Minor loss of Terrestrial and Aquatic Flora and Minor disturbance of Terrestrial and Aquatic Fauna.	Hazardous materials or debris might pollute the water quality to nearby canal. Disturbance of aquatic habitat. Very minor loss of vegetation during O & M
Homestead Vegetation, Lowland, Pond	1+000 to 2+000	No significant impact by the activities	Existing homestead vegetation might be damaged. Water quality in lowland and pond may deteriorate.	Minor degradation of water quality. Minor disturbance of aquatic habitat in ditches. Very minor loss of vegetation during O & M
Ditch, Lowland, Pond	2+000 to 3+000	No significant impact by the activities	Water quality in ditches, lowland and pond may deteriorate.	Minor degradation of water quality.

Environmental Impact (Left Side-Approach Road 1)				
Environmental Features (Left Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
				Minor disturbance of aquatic habitat in ditches.
Lowland, Homestead Vegetation, Pond	3+000 to 3+500	No significant impact by the activities	Existing homestead vegetation might be damaged. Water quality in lowland and pond may deteriorate.	Minor degradation of water quality. Minor disturbance of aquatic habitat in ditches. Very minor loss of vegetation during O & M
Bridge		**Environmental Impact**		
Environmental Features (Downstream)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Homestead Vegetation, Sand, Pond, River	3+500 to 4+300	No significant impact by the activities	Existing homestead vegetation might be damaged. Few terrestrial & aquatic floras in River may be disturbed. Water quality in canal may deteriorate which could affect aquatic fauna. Canal flow may be disrupted. Minor loss of Terrestrial and Aquatic Flora and Minor disturbance of Terrestrial and Aquatic Fauna.	Hazardous materials or debris might pollute the water quality of the river. Disturbance of aquatic habitat in River.

Environmental Impact (Left Side-Approach Road 1)				
Environmental Features (Left Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Environmental Impact (Left Side-Approach Road 2)				
Environmental Features (Left Side)	**Chainage (km)**	**Pre-Construction Phase**	**Construction**	**Operation and Maintenance**
Orchard, Lowland, Sand, Homestead Vegetation, Wetland	4+300 to 5+000	No significant impact by the activities	Existing homestead vegetation and orchard could be damaged. Few terrestrial & aquatic floras in wetland and lowland may be disturbed. Water quality may deteriorate which could affect aquatic fauna. Flow may be disrupted.	Hazardous materials or debris might pollute the water quality. Disturbance of aquatic habitat in wetland & lowland. Very minor loss of vegetation during O & M
Pond, Orchard, Homestead Vegetation, Graveyard, Lowland	5+000 to 5+920	No significant impact by the activities	Existing homestead vegetation and orchard could be damaged. Few terrestrial & aquatic floras in lowland may be disturbed. Water quality may deteriorate which could affect aquatic fauna. Flow may be disrupted.	Very minor loss of vegetation during O & M. Disturbance of aquatic habitat in wetland & lowland.

Mitigation: The following mitigation measures are proposed based on the previous table which elaborates the potential impacts:

- Mitigation measure for this impact is proper landscaping. Construction camps should be constructed at suitable place to minimize this impact. Vegetation clearing has to be at minimum level as possible. Felled commercial trees will be compensated in accordance with the RP/SIA. After completion of road construction, trees shall be planted along sections of road near the populous residential areas to mitigate impact of traffic noise to residents living along the road, and to improve landscape along the road. All the affected areas will be restored to their original levels. These mitigation measures apply for both left and right side of the proposed alignment.

- Compensation for tree cutting is calculated in the RP. Compensatory tree plantation will be carried out (e.g., along the periphery of road). The tree species and plantation location will be decided in consultation with the concerned department including authorities of the Mymensingh municipality.

- Coordinate with the DOE authorities for any additional mitigation measures such as installing fence along the water bodies, low lying areas.

- Maintain liaison with the authorities on an on-going basis to ensure regular monitoring of the wildlife protection and to identify the need of any additional measures.

Residual Impacts: With the help of the above measures, the potential impacts of the project on the biological resources of the area will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal, as shown in Table 6-5.

7.6.7.2 Disturbance to Wildlife

Impact: There are 17 species of mammals and 14 species of reptiles found in the MKBIP project corridor as described in section 0 . Among the species there are Endangered and Vulnerable species according IUCN classification. Among the mammals and reptiles, there are 1 Vu and 1 CR category as shown in The proposed road on the north west side will cause some disruption and disturbance to the habitat including fragmentation of the agricultural ecosystem. There might be instance of accidental kill of mammalian animals and the reptilian animal during vehicle movements. Efforts will have to be made to minimize the accidental kill. The proposed culverts will serve as a mean of wildlife passage as lot of the wildlife use the drainage/canal corridor for movement. As the proposed Kewatkhali bridge does not encroach the bank of the river thus will not hamper any movement of the wildlife along the bank.

The vibration of equipment, noise, wastewater and exhausts gas are often considered to be disturbances to animals. These could drive animals away from their current habitats. However, impacts caused by construction works to terrestrial animals are considered manageable, due to the fact that the amphibians found along the project road inhabit mainly in the cultivated farmlands or brooks.

During the construction phase, trees around the construction sites may be cut down and cause damage to the habitat of wild animals. Illegal hunting may also occur and pose the threat to wild animals. The practice of consuming wild animals as food may happen. It promotes catching and hunting wild animals such as reptiles (frogs, snakes), birds and beasts (hare).

Ditching and construction of temporary construction sites and access roads, as well as air pollution, wastewater, and solid waste may lead to damage and deterioration of habitats. This will include temporary and permanent dumping areas, which will need to be managed. Spoil stockpiling in small valleys or river banks will directly affect the habitat of animals. However, these animals may find alternate habitats in the areas around the project road, and return to their previous habitat when the vegetation is recovered after the completion of construction.

The mudflats and sandy beaches are the major staging grounds for migratory birds within the project area. During the construction period if construction activities coincide with the migratory birds that utilize this habitat, potential disturbance will occur. Construction activities, such as pilling, dredging and human traffic in the mud flat has the potential to negatively affect mud flat dwelling animals, including migratory birds. As some uncommon and rare winter visitors (Comb Duck, Ruddy Shelduck, Grey Headed Lapwing, Black Headed Ibis, Indian River Tern, Long-Legged Buzzard, Short Eared Owl, and Common Tern) are seen in project area and breed in these mud flat. Noise from different equipment, vehicles, and human traffic has the potential to disturb migratory birds, compelling them to leave these areas. Noise and the movement of workers may also disturb the migratory birds, which may leave or change their flight route until the activities are over.

The impact on wildlife is estimated High as shown in Table 6-5.

Mitigation: To prevent accidentally killing of animal, it is proposed to make provisions in the road design for culverts low width under passes as well as provision of small net on the both side of the road shall be made where the animal movement is frequent. Conservation activities need to be included without causing harm to the species. Almost all protected species are widely distributed and are less common to common within the area. Therefore, the species will not be at further risk due to much localized intervention. However, contractor shall:

- Contractor will prepare Fauna and Flora Conservation Plan prior to the start of work and submit through CSC for PIU's approval.

- A detailed wildlife survey will be conducted prior to the construction, which will identify and locate the protected species and their habitats along the alignment and provide recommendations for conservation during construction.
- Set up and implementation code of conducts to workers, including no catching or hunting fish and poaching of wildlife, and no consumption of wildlife products.
- Establish procedures for reporting and conservation in case of find of Endangered or Vulnerable species on IUCN's Red List. DOE authorities should be informed if such species are found in the project sites and the works should be suspended until the conservation measures are taken.
- Provide adequate knowledge to the workers regarding protection of flora and fauna, and relevant government regulations and punishments for illegal poaching.
- Provide environmental training with information of Endangered and Vulnerable species and procedures for reporting and protection such species; the training will also be on the importance of biological diversity, and its relationships with sustainable development.
- Limit the construction works within the designated sites allocated to the contractors.
- 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.
- 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 equipment, materials and human resources;
- The ponds and burrow pits could be netted before filling for removing turtles and its subsequent safe release elsewhere;
- Ensure the riverine transports, vessels and ships are well maintained and do not have oil leakage to contaminate river water;
- Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in the river;
- Regular monitoring of the worksite for animals trapped in, or in danger will be done and contractor will use a qualified person to relocate them.

Residual impacts: With the help of the above measures, the potential impacts of the project on the biological resources of the area will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal, as shown in Table 6-5.

7.6.7.3 Potential impacts on Ganges River Dolphin

Impacts: As discussed in the baseline section, dolphins love deep water pool and were only sighted at Tin Ganger More by locals near the proposed bridge site during monsoon season when water level can go up to about 18m while in dry season the water depth may decrease to 7m or less. This would mean that the dolphins take this route for movement from Jamuna to Meghna river only in high water levels, as discussed in the baseline section. Therefore, dredging and in-water construction can block the route of its movement. Construction of bridge

piers that will take place on mud flat when water level is low and flow is weak. Since dolphins do not like shallow water for travelling or dwelling, dry-season construction will not hamper the dolphin from moving in the river.

Similarly, the small block construction method will only be used at low water level season when dolphins do not likely move in this river. If large block construction method will be used, the passage in water will not be blocked but the increase of barges and small works of dredging for the use of barges might disturb the dolphin. However, the construction of bridge arch will probably not be conducted during monsoon season, so the likelihood of such impact dolphin is lower. Thus, avoiding dredging and underwater activities during the monsoon will mostly minimize the impact on dolphin movement. On a positive note, dredging that is being conducted by BIWTA will create much deeper water at the bridge site which in turn allow the dolphins much greater space for moving freely.

In addition, some river training works will be carried out which is possible source of disturbing the water environment. Since this will take place on the bank of the river, the impacts of water will be minimal.

However, the other type of impact might be generation of noise, especially from piling. For all cetaceans, including dolphins, sound serves three main functions: (i) it provides information about their environment, (ii) it is used for communication and (iii) it enables the remote detection of prey. The sounds generated by these animals often extend beyond the range audible to the human ear. Vocalizations of Dolphins will be in range of 125-173 (dB at 1m) for whistles and 218- 228 (dB at 1m) for clicks.

Pile drive generated noise has the potential to impact dolphin populations as this noise is capable of masking dolphin's vocalization. The threshold peak impulse source pressure for direct physical trauma in marine mammals is generally considered to be >200 dB and hence dolphins would not be expected to experience permanent hearing impairment from sound pressures generated by pile driving. Effects on behavior are more likely. Behavioral studies indicate a temporary displacement of dolphins from the area where pile drivers are operating. Wu¨rsig et al. (2000) recorded the impact of pile driving into the seabed, in 6–8m depths of water, on humpbacked dolphin behavior. No overt behavioral changes were observed in response to the pile-driving activities, but the animals' speed of travel increased and some dolphins remained within the vicinity while others temporarily abandoned the area. Dolphin numbers returned close to normal once pile driving had ceased.

From the experience of construction of large bridges in Bangladesh, specially drawing from the experience of Bangabandhu Jamuna Multipurpose Bridge where the local birds and animals fled away due to high pitch noise, it can be expected that, during piling the noise generated from piling driver might keep the dolphins away from the region. Although the pile driving

activity in the Old Brahmaputra River mud flat will happen during dry season, precautionary measures should be taken to minimize potential effects.

Experience from Jamuna Bridge Project:

The foundation of the Jamuna Bridge comprises 121 numbers of 2.5 to 3.5 m diameter, 80 m long piles. The piles were installed using a Menck MHU hydraulic hammer with a 1,700 kN-M energy. Such pile driving easily produces noise levels of about peak 205 dB, RMS 200 dB and SEC 180 dB at a distance of 100 m (Figure 7-5). No mitigation measures to reduce sound levels were adopted during the pile driving activities in this project. However, no fish killings or adverse impacts on fishes were reported near the bridge site during construction activities. However, it is to be noted the Jamuna Bridge was constructed in 1998 when the monitoring system was not quite organized and developed in Bangladesh. Compared to then, Bangladesh has now developed dolphin sanctuaries, Ecological Critical Areas and Protected areas and strengthen the monitoring and reporting system. Therefore, the mitigation measures stipulated in the later paragraphs needs to be strictly followed to avoid the impacts on dolphin movement in the site.

To conclude, the impact on Ganges River Dolphin is considered Low as shown in Table 6-5.

Mitigation:

Precautionary measures are recommended in this EIA for the pile driving activities. Similar mitigation measures taken in the construction of Padma bridge can be adopted. In Padma bridge, it is agreed that piling activities should be restricted in the whole river with a water column depth of 7m during March to July. The same strategy will be adopted in this project.

In the worse scenario that pile driving will happen during other season (August-February), mitigation measures recommended by the Joint Nature Conservation Committee (JNCC)[13] will be adopted to minimize the impacts on dolphins. JNCC guidelines recommend that an exclusion zone of 500m radius should be monitored for at least 30 minutes before the start of piling. If dolphins are observed in the exclusion zone, piling works should be delayed until they have left the area. If dolphins enter the exclusion zone after piling has commenced, piling works should cease until they have left. JNCC guidelines also recommend the adoption of a 'soft start'; using a low energy start to the operations would give dolphins an opportunity to leave the area. The contractors are recommended to adopt these mitigation measures during pile driving activities.

In addition, the following mitigation measures are proposed:

[13] Joint Nature Conservation Committee. (2004) Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Acoustic Surveys. Joint Nature Conservation Committee, Aberdeen.

- Pile driving should be conducted during non–monsoon season time (winter, summer, pre-monsoon and post monsoon).
- Pile drive should meet the criteria of noise level listed in Table 7-7.
- Before starting of piling 500 meters radius should be monitored around the piling area. If dolphins are observed in the area, then the piling work should be delayed until they left the area.
- Using a low energy start to the operations would give dolphin an opportunity to leave the area. The contractors are recommended to adopt these mitigation measures during pile driving activities.
- Gradually ramp up the sound levels to scare the dolphins and other cetaceans away before piling proper commences.
- In order to avoid impacts on these species, the construction works will be limited within the designated sites to the contractors. Regular monitoring of the worksite for dolphins trapped in, or in danger will be done and contractor will use a qualified person to relocate them.
- Acoustic enclosure will be placed to cover the hammer and the exposed pile to reduce the air noise. The air noise levels can be reduced to about 60 dB with these measures.

Residual impacts: With the help of the above measures, the potential impacts on the dolphin will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal.

7.6.8 Impact on Fisheries

Impacts: As discussed in section 0, fisheries resources of the study area are rich and diversified. Study area consists of Brahmaputra river and some temporary wetlands. Fish habitats of the area are mainly rivers and some aquacultures ponds.

Impacts along the alignment: There are several wetlands and lowland of fisheries importance are located in the project site. These lands are located within flood plain of the river which is nourished with seasonal floods and nutrients carried out by it and also the breeding grounds of fish habitat and other aquatic fauna. As such site development will have negative impacts. These will have effect on beel, fish pond, spawning & breeding ground and fish product. The impact is medium during high floods; and during the low annual flood the impact is very low.

There will be in water construction in the low lying and wetland area on the north east side of

Old Brahmaputra River where the roadway will be developed in green fields. Based on the fisheries survey, the fishery activity is mainly in the river and fishery activity in the wetlands and khals are limited. There are some aquaculture ponds in the project area that could potentially be affected due to the project. If not fully acquired due to the project, appropriate mitigation measures will be required for this aquaculture ponds. There would be loss of fish productivity in the pond fishery, borrow pit fishery due to filling of the ponds along the road areas.

Impacts in the main river channel: Information of fish migration routes in Old Brahmaputra River is not well studied. Survey during the EIA preparation reveals that the river is an important spawning ground of fisheries and lot of local fishermen depend on fishing in the river. Piling and dredging activities in the Old Brahmaputra river may affect the fishing activities as well as fish breeding.

However, it has been confirmed form the engineering designs that there will be very limited in water construction in the Old Brahmaputra River, so impact of localized sediment due to in water construction will be limited. There could be some sediment generation due to construction of the pier footings on mud flat, however the generation of sediment will be limited to affect the fisheries in the Old Brahmaputra River, as the pier construction will take place in dry season.

Transportation of construction materials would also increase the number of barges on the river, although the number is not expected to be significantly higher since road transport will be used simultaneously for brining construction materials.

Impacts of construction of culverts and bridges along the alignment: Noise and Vibration through Pile Driving and dredging activities will affect the fish and other aquatic fauna. There will be temporary reduction of the benthic fauna within the dredged area would not substantially reduce foraging opportunities for the river's fish populations. Once construction is completed, the dredged channels would be restored over time to their original elevations by action of natural sedimentation, and the river's benthic community would recolonize those areas as well. The rate of this transformation would begin at approximately 1 foot per year, likely decreasing as the bed nears it natural pre-dredged elevation. These impacts would occur, in part, as a result of a localized reduction in benthic fauna. The construction period would minimize the potential impacts to fish spawning. Thus, there will be temporary reduction in the number of fish species. Additional impacts are:

- Behavioural responses by fishes to increased suspended sediment concentrations include impairment of feeding, impaired ability to locate predators and reduced breeding activity.

- Decrease in dissolved oxygen concentrations in the surrounding waters and effects on growth rate.
- Effects on fish associated with noise from pile driving include damage to body tissue that can potentially result in death, sub-lethal effects that could result in temporary decreases in fitness, or to temporary or long-term changes in behaviour.
- The degree of damage to fish and their hearing organs from pile driving is related to the received level and duration of the sound exposure

Based on the above analysis, the impact on fisheries is estimated Moderate as shown in Table 6-5.

Mitigation: For constructions in the Old Brahmaputra River, the following mitigation measures should be taken:

- Ensure the riverine barges and vessels 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 equipment, materials and human resources.
- Do not dump wastes, hazardous or non-hazardous into the nearby or in the river.
- During dewatering for piling activities when fish might be temporarily contained separately, all fish shall be captured and released unharmed in adjacent fish habitat.
- Ensure the pile driver meet the criteria of noise level presented in Table 7-7.
- Install and maintain fish screens etc. on any water intake with drawing water from any water body that contain fish.
- Ensure the earth filling is done in dry season to avoid killing of the floodplain and many burrow pit fishes.

- Sediment fences are recommended to minimize sediment discharge locally into the river.

For the fisheries of ponds and wetlands along the alignment of approach road, the following mitigation measures will be taken:

- Adequate cross drainage structure shall be provided in all water logged or pond extending both sides of the road areas as per the detailed design. No construction shall

be undertaken during the spawning and breeding period between June and September at these activity aquatic sensitive locations.

- Provisions of compensation for loss of fisheries resources listed in the RP/SIA should be implemented to compensate the impact on the local aquaculture ponds.
- Implement the mitigation measures for water contamination and waste management.
- All earth stockpile that has potential to leak into local wetland, aquaculture ponds should be constrained with appropriate methods especially with sediment fence and geotextiles.

Residual impacts: With the help of the above measures, the potential impacts of the project on the fisheries will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal, as shown in Table 6-5

7.6.9 Crop Damage

Impact: The loss of cultivation field/produce as a result of the land acquisition has already been discussed earlier. In addition, the construction activities along the cultivation fields have a potential to damage crops caused by vehicle movement, material stockpiling, or releasing wastes inside cultivation fields. This will cause economic loss and livelihood impacts on the farmers. The significance of this impact has been assessed as High, as shown in Table 6-5.

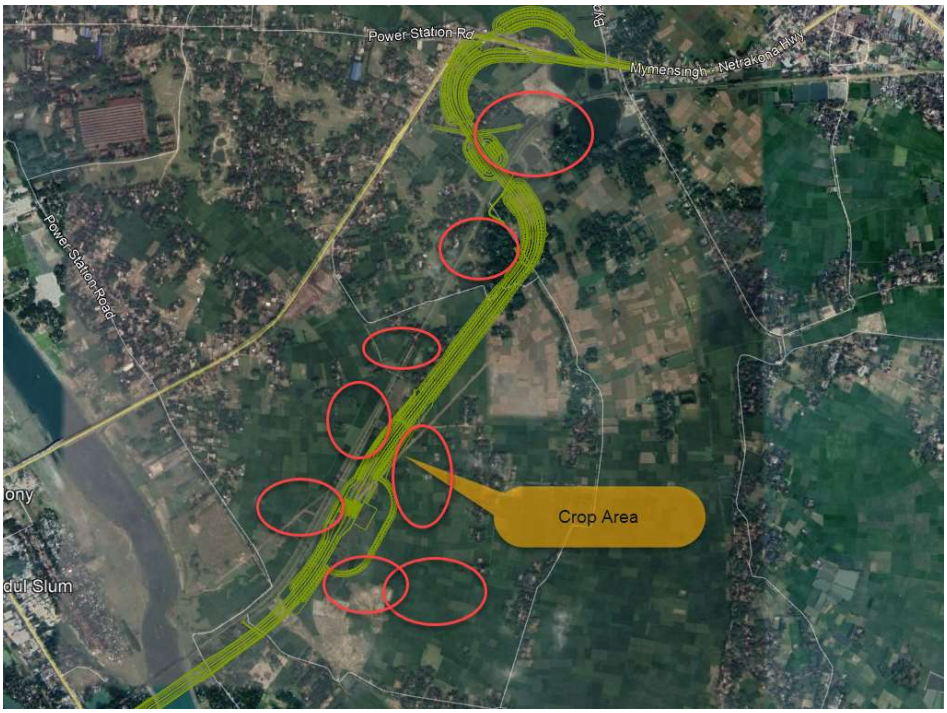


Figure 7-2 Crop Area

As shown in figure encircled in 'red color' the crop areas are mostly on the north east side of the project where the crop will be affected during construction. In addition to permanent loss of the crop land, some additional crop lands are likely to be affected by construction related pollution such as contaminated water runoff, sedimentation, dust, smoke etc.

This impact is assessed Moderate as shown in Table 6-5.

Mitigation: A significant amount of land including agricultural land will be lost permanently; a few poor and marginal farmers will become vulnerable to meet their food security and livelihoods. An indirect negative impact will also take place in nearby agricultural fields in the project corridor. A compensation program for creation of employment for victim families, initiatives to reduce negative impact on agricultural lands and increased crop production needs to be arranged by RHD through proper agencies, such as DAE. RHD needs to organize such training programmes for the affected farmers with technical expertise form DAE to increase crop production, introduce integrated farming procedures, crop rotation techniques, application of organic manure, techniques of reserving water etc.

In addition, the following mitigation measures should be taken:

- Fertile land where two or more crops grow at present or the land which has such potentiality, that land could be avoided. Non-agriculture khash land should be

considered on a priority if non-agriculture khash land becomes available.

- Top soils of adjacent land could be preserved as these are most fertile and suitable for crop production.
- Install drainage system to drain out excessive water during rainy season. Irrigation and drainage system should be installed and reconstructed for a sustainable agricultural production.
- Shallow and deep tube well could be used for irrigation to cultivate Boro rice and Rabi crops. Winter cropping area may be increased by installing of deep tube wells.
- Movement of heavy vehicles and machineries should be confined within the right of way; if necessary, a minimum strip of land can only be used.
- Precaution should be maintained to keep soil erosion and flight of dust at a minimum level, wetting of soil may be helpful.
- Ensure maximum possible cleanliness of construction activity.
- There might have a provision of cattle pass at a regular interval, each width should be enough for cattle movement and agricultural machinery movement.

During construction, much of the above described impacts can be readily avoided through proper construction planning and awareness raising of the construction workers. In case of any inadvertent damage to the crops, adequate and immediate compensation will be paid to the farmers/growers. GRM will also capture any related complaints raise by the affected people.

Residual impacts: With the help of the above measures, the potential impacts of the project related to crop damages will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal, as shown in Table 6.7.

7.6.10 River morphology and Sedimentation from river training works

Impacts on River Ecology: Lower (underwater) slope erosion protection placed on a dredged slope with the toe of the slope set at various elevations depending on the location and cross section type. Rock riprap placed on a geotextile/bamboo fascine mattress is used to provide the erosion protection. A falling apron placed along the toe of the underwater slope protection, to provide temporary protection from future undermining by boat-launching down the scoured slope. Rock riprap will be used for the falling apron. The slope protection work will have temporary impact on river ecology during construction. Protected stable riverbanks with underwater slope coverage have the potential positive impact of providing more shelter to fish and other aquatic life compared with present embankments. There are no direct mitigation measures possible for the temporary disturbance of habitat, but the impacts support the need for compensation.

7.6.11 Additional pressure on Local Resources

Impact: The construction work and camp operation will require supplies such as water, fuel, and camp supplies. Obtaining these supplies from the local sources can exert additional pressure on these sources which may already be over-exploited and therefore adversely affect the local communities. Any such impact on the local community can increase their hardship and even result in disruption of the construction works. Significance of this impact has been assessed as Moderate, as shown in Table 6.7.

Mitigation: The mitigation measures to address impacts associated with the availability of local resources and supplies are listed below:

- The contractor will prepare and implement a plan to obtain key supplies such as water and fuel, in consultation and coordination with the local community;
- The plan will ensure that there is no significant impact on the local community and local resources;
- Liaison with the community will be maintained;
- The GRM described earlier will also address community grievances related to usage of local resources.

Residual Impacts: After implementing the above-listed mitigation measures, the impacts of the project associated with usage of local resources will be adequately mitigated. Hence the significance of residual impacts will be Minimal, as shown in Table 6.7.

7.6.12 Impacts of Borrow pits/borrow areas

Impact: The road construction activities may need significant quantities of soil, which need to be obtained from borrow areas. These borrow areas may cause a number of adverse impacts, including loss of fertile soil, damage to cultivation fields, soil erosion, devaluation of land value, and safety hazards.

The current RHD practice is to borrow earth from the roadside. During the previous construction activities, earth has been borrowed mostly within ROW. The borrowed areas are seen left without rehabilitation or interconnectivity to maintain the natural drainage at various locations. These borrow pits are being used as fishpond. However, these are also causing water logging since no drainage is planned in these areas. Additionally, RHD has the practice of issuing of contract for sourcing borrow earth without specified controls for borrowing the earth or preservation of top soil or borrow areas rehabilitation. Similar practice for proposed road widening activity will have direct impact on land use, top soil preservation and drainage pattern

around the road.

Loss of topsoil is one of the impacts with respect to borrowing of earth. Besides this loss of productive soil, compaction of soil along the haulage route may also take place if proper mitigate measures are not employed.

Such impacts are considered High in significance, as shown in Table 6-5.

Mitigation: GoB has adopted the practice of encouraging construction of roadway embankment with river sand rather than clayey agricultural soil. The same option is proposed for the project road. Wherever earth to be borrowed for cladding with cohesive soil, following mitigation measures should be taken to minimize the impact on land use:

Preference shall be given to borrow earth from ROW itself wherever feasible. However, due care shall be given for protecting the road embankment with slope protection measures. Each borrow pit shall have a side opening for flow of accumulated water. It shall be put to community preferred used for fishing or other activity. Alternatively, it shall be rehabilitated and used for tree plantation using the preserved top soil.

Wherever borrow earth not available from the ROW, preference shall be given to land, which farmers want to convert either into a fishpond or lowering the agriculture field level to increase its water retention capacity. No land acquisition shall be made for borrow areas. Additional mitigation measures are:

- While borrowing the earth topsoil shall be preserved. The borrow pits shall be rehabilitated after borrowing the earth.
- Borrow areas should not be located on cultivable lands. However, if it becomes necessary to borrow earth from temporarily acquired cultivated lands, their depth should not exceed 45 cm. The topsoil to a depth of 15cm shall be stripped and set aside. Thereafter, soil may be dug out to a further depth not exceeding 30cm and used in forming the embankment.
- Priority should be given to the borrowing from humps (including from digging of wells) above the general ground level within the road land;
- Priority should be given to the borrowing by excavating/enlarging existing borrow areas;
- In case of settlements, borrow pits shall not be selected within a distance 800m from towns or villages. If unavoidable, earth excavation shall not exceed 30cm in depth.
- The haulage distance from site should not be too far.

- Wherever borrow earth not available from the ROW, preference shall be given to land, which farmers want to convert either into a fishpond or lowering the agriculture field level to increase its water retention capacity. No land acquisition shall be made for borrow areas.

- While borrowing the earth top soil shall be preserved. The borrow pits shall be rehabilitated after borrowing the earth

Residual Impacts: After implementation of the above mitigation measures, the residual impacts on borrowing areas will be greatly mitigated. Hence the significance of residual impacts will be Moderate, as shown in Table 6-5.

7.6.13 Impact of construction camps

Impact: The precise locations of construction camps will be finally decided by CSC and RHD in consultation with Contractors. The siting of construction camps may cause a number of issues such as loss of plantation and vegetation, permanent physical and visual impact on the area, siltation and pollution risks. The construction process will take several years, with the result that the camps will take on a semi-permanent appearance. Major impacts of construction camps include pollution risk of soil and surface water due to sanitation of the camps and wastes from the camps.

This impact is estimated as Moderate as shown in Table 6-5.
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Mitigation measures: 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 500m 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.
- Contractor will prepare Construction Camp Management Plan and submit to the PIU 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 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.
- 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.
- 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.
- Locate the garbage pit/waste disposal site min 500 m away from the residence so that peoples are not disturbed with the odour 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.
- Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellent sprays during monsoon.

Residual Impact: Given the implementation of the mitigation measures above, the impact will be minimal as shown in Table 6-5.

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7.6.14 Occupational Health and Safety

Impact: Construction activities such as site preparation, excavation, asphalting/concreting, operation of construction machinery and equipment, vehicular traffic, and the use of temporary workers' accommodation pose potential risks to the health, safety, security and therefore wellbeing of construction workers. Health and safety issues associated with the use of temporary accommodation sites include those relating to sanitation, disease, fire, cultural alienation, sleeping space, quality and quantity of food, personal safety and security, temperature control and recreation, amongst others.

Some of the Occupational Health and Safety (OHS) risks which are likely to arise during the construction phase of the Project, and are typical to many construction sites, include: exposure to physical hazards from working on heights, use of heavy equipment including cranes; trip and fall hazards; exposure to dust, noise and vibrations; falling objects; exposure to hazardous materials; and exposure to electrical hazards from the use of tools and machinery.

Workers on the Project, particularly sub-contracted construction workers, are vulnerable to risks to their wellbeing, health and safety on a daily basis. Significance of the above impacts has been assessed as High.

Mitigation: The mitigation measures to address the project impacts on workers' health and safety are listed below:

- The contractor will prepare and implement an Occupational Health and Safety (OHS) Plan.
- Job hazard analysis will be carried out for each type of construction activities.
- Contractors will have dedicated and qualified staff for ensuring compliance with the OHS Plan.
- Regular trainings will be provided to the workers on OHS aspects.
- Awareness raising material will be used including posters, signage, booklets, and others.
- All site personnel will be screened for communicable diseases including sexually transmitted infections.
- Use of appropriate personal protective equipment (PPE) will be mandatory. No worker (or even visitor) will be allowed on the site without the required PPE (such as hard hat, safety shoes).
- Firefighting equipment will be made available as required at construction sites, camp sites, and particularly near the fuel storage.
- The project drivers will be trained in defensive driving. They will maintain low speed while driving through / near the communities.
- Suitable scaffolds from the ground shall be provided for the work force, who are working at elevated heights, if a ladder is used a proper foot holds and hand holds shall be provided on the ladder.
- Persons having to operate electrical equipment should be fully instructed as to any possible danger of the equipment concerned.
- All the electrical equipment should be inspected before it is taken into use to ensure that it is suitable for its purpose.
- The transport tanks, storage tanks and dispensing container should be designed, used, cleaned and disinfected at suitable intervals in a manner approved by the competent authority.
- Safety provisions shall be brought to the notice of all concerned by displaying or notice board at a prominent place at the work locations.
- The contractor shall be responsible for observance, by his sub-contractors, of the foregoing provisions.
- At every workplace, there shall be maintained in readily accessible place first aid appliances including an adequate supply of sterilized dressing and cotton wool as prescribed in the factory rules.

- The contractor should take adequate measures for the control of malaria, jaundice, Chickongunia, dengue etc.
- Forced and child labor is forbidden.
- Complete record of accidents and near-misses will be maintained.
- First aid facilities will be made available at the work sites and in the camps. The contractors will engage qualified first aider(s).
- The drivers and operators of vehicles and materials handling equipment should be medically fit, trained and tested and of a prescribed minimum age as required by the government rules and regulation.
- Location and telephone numbers of the nearest hospital will be displayed at appropriate places at work sites and in construction camps. If necessary, the contractor will have an ambulance available at the site.
- Adequate housing, safe and reliable water supply for all workers.
- Accommodation for taking meals and for shelters during interruption of work due to adverse weather conditions.
- 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.
- Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible.
- Provide adequate health care facilities and first aid facility round the clock within construction sites. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse.
- Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work.
- Provide appropriate security personnel (police/home guard or private security guards) and enclosures to prevent unauthorized entry in to the camp area.
- The contractor should educate the work force about HIV/AIDS and launch awareness campaign among the work force.
- There should be proper enforcement of the labour laws at the work place.
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First aid: The employer should be responsible for ensuring that first aid, including the provision of trained personnel, is available. Arrangements should be made for ensuring the removal for medical attention of workers who have suffered an accident or sudden illness. The manner in which first aid facilities and personnel are to be provided should be prescribed by

national laws or regulations, and drawn up after consulting the competent health authority and the representative organizations of employers and workers concerned.

- First-aid kits or boxes, as appropriate, should be provided at the workplaces, including isolated locations and the motor vehicles used for construction like dumpers and tippers.
- First-aid kits and boxes should not contain anything besides material for first aid emergencies.
- First- aid kits and boxes should simple with clear instructions to be followed, be kept under the charge of a responsible person qualified to render first aid and be regularly inspected and kept properly stocked not running short of medicines.

Fire fighting: There should be firefighting facility at construction locations. The staff should face any emergency situations without many problems. There should be adequate measures as listed below:

- Secure storage areas should be provided for flammable liquids, solids and gases such as liquefied petroleum gas cylinder, paints and other such materials in order to deter trespassers.
- Smoking should be strictly prohibited and no smoking notices be predominantly displayed in all places containing readily combustible or flammable materials
  Only suitably protected electrical installations and equipment, including portable lamps, should be used.
  Oil rags, waste and clothes or other substances liable to spontaneous ignition should be removed without delay to a safe place.
  Adequate ventilation should be provided.
- Combustible materials such as packing materials sawdust, greasy/oily waste and scrap wood or plastic should not be allowed to accumulate in work places but should be kept in closed metal containers in a safe place.
- Regular inspections should be made to places where there are fire risks. These include the vicinity of heating appliance, electrical installation, and conductors, stores of flammable and combustible material, hot welding and cutting operations
- Places where workers are employed should, if necessary, to prevent the danger of fire, be provide suitable and sufficient fire-extinguishing equipment, which should be easily visible and accessible
- An adequate water supply at ample pressure.
- Fire-extinguishing equipment should be properly maintained and inspected at suitable intervals by a competent person.
- Where appropriate, suitable visual signs should be provided to indicate clearly the direction of escape routes in case of fire.
- The escape routes should be kept clear at all times.

Residual Impacts: Even after implementing the above-listed mitigation measures, the health impacts on site personnel cannot be fully mitigated. Hence the significance impacts will be Moderate, as shown in Table 6-5. Strict monitoring will be ensure that mitigation measures are effectively and strictly enforced.

7.6.15 Community Health and Safety

Impact: The construction activities will cause significant health and safety risks to the local community particular children. These risks and impacts include, among others, dust, noise, and vibration from construction vehicle transit, and communicable diseases associated with the influx of temporary construction labor, and operation of heavy construction machinery as well as movement of construction vehicles. Significance of these impacts has been assessed as High as shown in Table 6.7.

Noise and vibration: Although the noise levels are of temporary, construction activities can create noise levels sufficient to cause community annoyance and interfere with daily activities. Similarly, construction activities can cause vibration levels that may result in structural damage which leads for the community annoyance or interference with construction activities. Construction noise differs from traffic noise in a number of ways, including the following:

- Construction noise continues for a temporary time period.
- Construction activities generally take place for a limited period of time at any specific location;
- Construction noise may be intermittent and variable depending upon the type of construction activities taking place at a specific location and time period; and
- Construction noise is sporadic in nature, whereas traffic noise occurs continuously over the life of a facility.

Movement of construction materials: There will be impact on the surrounding areas due to the truck movement carrying the construction material. The traffic management issues are also arising due to the movement of fully loaded trucks on the haul roads and on the regular roads. This movement of trucks may give raise to the increase in the dust levels. The traffic control should be prime importance for the contractor and for the CSC and PIU.

Other disturbance and impacts on community may include:

- Traffic congestion and detours;
- Disrupted access to residences and businesses;
- Loss of roadside parking;
- Disruption of utility services;

- Presence of construction workers, equipment, materials and staging areas including potential concrete batch;
- Noise and vibrations from construction equipment and vehicles;
- Airborne dust and possible mud on roadway surfaces; and
- Removal of or damage to vegetation.

Mitigation:

General: The mitigation measures to address the project impacts on communities' health and safety are listed below:

- Construction camps will be located at least 500 m away from the communities. Entry of the site personnel in the local communities will be minimized to the extent possible/appropriate;
- The contractor will prepare and implement an Occupational Health and Safety (OHS) Plan that will also cover communities' health and safety aspects;
- The contractor will prepare and implement a Traffic Management Plan that will also address traffic safety for communities;
- Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related vehicular traffic.
- The community will be informed about the nature of construction activities and the associated health and safety risks; awareness raising of the communities will be carried out for this purpose with the help of training sessions, posters, signage, and other similar means;
- Awareness raising of communities will be carried out, in a culturally-sensitive manner, about the communicable diseases including sexually transmitted infections;
- Regular safety monitoring will be carried out at the sensitive receptors
- The construction sites will be fenced as appropriate to minimize entry of the local communities particularly children in the work areas;
- Construction camps and other site facilities will be fenced; there should be proper demarcation of work areas with sign boards showing the work areas should be placed. The signboards should be in local language.
- Suitable warning should be displayed at all places where contact with or proximity to electrical equipment can cause danger.
- All vehicles used in the construction yard should have reverse horns
- Liaison with the community will be maintained;
- GRM will be established to address community grievances related to health and safety aspects.

Residual Impacts: Even after implementing the above-listed mitigation measures, the health

and safety impacts on local communities cannot be fully mitigated. Hence the significance of residual impacts will be Moderate, as shown in Table 6-5. Strict monitoring will be required to ensure that mitigation measures are effectively and strictly enforced.

7.6.16 Social Conflict and Influx of Workers

Impact: The construction process will take several years, with the result that the camps will take on a semi-permanent appearance. Most of the employees/workers during construction phase are likely to be employed from outside the project area. The people and the changes they bring can have significant impacts on the local communities and social structures. Substantial numbers of workers will inhabit the area in temporary camps loading local infrastructure and causing ambient social influence. The influx of a large number of workers from other parts of the Country can potentially cause conflict between the project personnel and the local community. This could be because of differences in culture, religion, social norms, acceptable social behavior, and even dress code. In addition, the construction activities can potentially affect the women economic activities. Any such impact can be detrimental to the project since it can potentially cause tension between the project and local communities and even disruption of construction works.

Mitigation: The mitigation measures to address impacts associated with the social conflict are listed below.

- The World Bank Guidance Note[14] will be used to address potential impacts caused by temporary project induced labor influx;
- The contractor will prepare and implement a Code of Conduct for all site personnel, in consultation and coordination with the local community;
- All site personnel will be provided orientation and training on Code of Conduct. Awareness raising materials such as posters and signage will be used as appropriate;
- All site personnel will be provided awareness and training to prevent communicable diseases, sexually transmitted infections, Human immunodeficiency virus (HIV) infections / Acquired Immune Deficiency Syndrome (AIDS);
- Privacy of women will be respected; routes and places used by them will be avoided as far as possible;
- As described earlier, construction camps will be located at least 500 m away from the communities. Entry of the site personnel in the local communities will be minimized to the extent possible/appropriate.
- No child labor or forced labor will be engaged by the project or its contractors.
- Liaison with the community will be maintained.

- The GRM described earlier will also address community grievances related to social conflict.

7.6.17 Blocked Roads, Damages to Local Infrastructure, and traffic congestion

Impact: Large quantities of materials will be transported by water transport, some of the material will be transported by train and land transport. These additional transports will cause traffic congestion on the existing transportation system.

The construction activities will cause traffic disruption along the Kewatkhali road. In addition, the construction activities can potentially block local roads and routes and also cause traffic congestion. This can adversely affect the local communities particularly in urban areas on the south west side of the MKBIP and also in areas where accessibility is already an issue on the north east side, as shown in Figure 7-3. Any such disturbance to the local community can also result in disruption of the construction works. In addition, the local roads are not designed to these heavy axle loads and as such may suffer damage from being used by these heavy transports.

There are major traffic safety and risks involved for procuring and transporting materials. In addition, all contractors are encouraged to verify suppliers' eligibility and environmental permits prior to sign any suppliers' agreements.

Significance of the above impacts has been assessed as High, as shown in Table 6-5.

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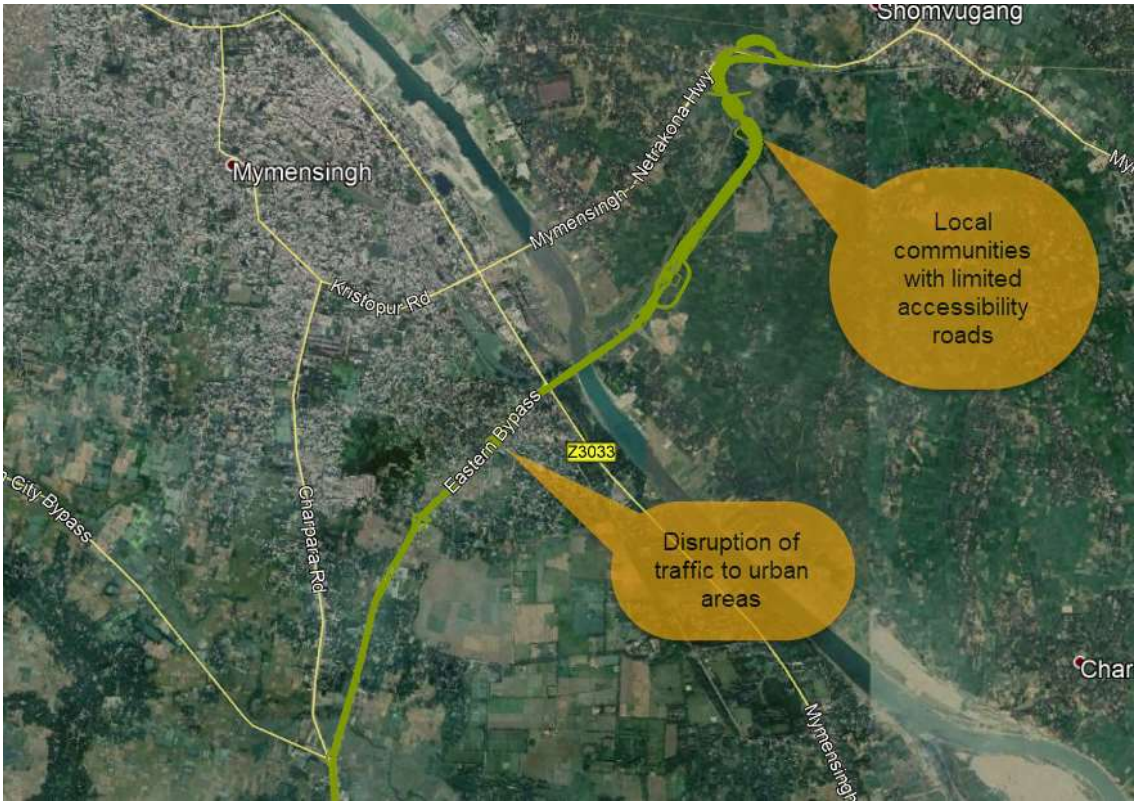

Figure 7-3 Local Communities with Limited Accessibility

Mitigation: The mitigation measures to address impacts associated with the blockage of local routes are listed below:

- The contractor will prepare and implement a Traffic Management Plan, in consultation and coordination with the local community;
- The community will be informed about the nature of construction activities and possibility of any blocked route; alternate routes will be identified with the help of local/affected community. Duration of such blockage will be minimized to the extent possible;
- Construction works on the road will be planned and implemented in a manner to minimize traffic disruption. All road safety measures including road signage, warning lights, lane dividers, and safety railings will be installed.
- Liaison and coordination will be maintained with relevant authorities such as Mymensingh City Corporation, Local Government Engineering Department (LGED)

etc

- Liaison with the community will be maintained.
- The GRM described earlier will also address community grievances related to any blockage.

Residual Impacts: After implementing the above-listed mitigation measures, the impacts of the project associated with blockage roads will be adequately mitigated. Hence the significance of residual impacts will be Minimal, as shown in Table 6-5.

7.6.18 Damage to and relocation of public utilities

Impact: Construction activities particularly in the urban areas can potentially damage the public utilities such as electricity wires, water pipelines, and drainage structures. Such damages will have severe impacts on the local communities. Therefore, the significance of this impact has been assessed as High, as shown in Table 6-5.

Mitigation: Before the start of construction activities, all public utilities requiring relocation will be identified. Subsequently, the concerned departments/authorities will be contacted for the relocation of these utilities. It will be ensured that there is a minimum disruption of services such as electricity and water. Any infrastructure damaged by the construction activities will be repaired. GRM will also capture any related complaints.

Residual impacts: With the help of the above measures, the potential impacts of the project related to relocation of utilities will be adequately mitigated and therefore the significance of the residual impacts has been assessed as Minimal, as shown in Table 6-5.

Site Clearance and Restoration

Impact: 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 Moderate, as shown in Table 6-5.

Mitigation: The contractors will be required to remove all left-over construction material, debris, spoils, and other wastes from the construction sites in a timely manner. The camps sites will be completely cleaned and restored in original condition to the extent possible. No waste disposal will be carried out in the streams and canals. Photographic record will be maintained for pre-construction and post-construction condition of the sites.

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 Minimal in significance, as shown in Table 6-5.

7.7 Impacts during Operation and Maintenance Phase

7.7.1 Air quality

Impact

The bad road conditions, the idling of vehicles and congestions are the main causes of the air pollution at present. The improved road conditions will change this scenario, which will result in the improved ambient air quality.

According to the calculation of predicted emissions of NOx under the project scenario as presented in Section 7.4 the vehicular emissions (CO, NOx, SOx, PM_{10}, $PM_{2.5}$) during the operation of this project in 2041 will decrease. This impact is estimated positive, even though the traffic volume is increased.

Mitigation

Mitigation measures are still proposed to further reduce vehicle emissions, including:

- It is proposed to maintain the road conditions especially the shoulders and embankment turfing.
- Setting up of a system to monitor air quality along project area in accordance with the applicable standards/limits;
- Roadside tree plantations as applicable and feasible under harsh climatic conditions; plants should be selected in accordance to their ability to absorb emissions;
- Densely populated trees shall be planted close to school, and religious places.
- Provision of slip road shall be made in urban and congested areas as feasible to separate slow moving and localized traffic.
- Regular road maintenance to ensure good surface condition;
- Regular vehicle checks to control/ensure compliance with air quality standards;
- Best traffic management practices shall also be adopted to regulate the traffic. Enforcement and penalties against traffic rules violators.

Residual impacts: The above measures can help reduce the air emissions from vehicles on the proposed road and bridge. The residual impact will be positive.

7.7.2 Waste Management

Impact: The operation and maintenance (O&M) activities at the Kewatkhali road will generate wastes such as oily run-off from the road surface, spilled oil and other lubricants, broken vehicle parts such as pieces of tires, asphalt/concrete scrapping, road kills, and other similar wastes. Some of these are hazardous wastes. Significance of these impacts has been assessed as High, as shown in Table 6-5.

Mitigation: A Waste Management Plan will be prepared a as part of the standard operating procedures. The non-hazardous waste will be disposed through the city or district services whereas hazardous wastes will be disposed by agreement with local organizations for the disposal of solid and hazardous wastes.

Residual Impact: With the help of the above measures, the negative impacts associated with waste generation from Kewatkhali road operation and maintenance will be adequately addressed and hence the significance of residual impact would be Nominal, as shown in Table 6-5.

7.7.3 Noise and vibration

Impact

The main source of noise during the operation phase is the traffic. During the operation phase, the noise levels are anticipated to increase due to traffic related noise pollution; vibrations from engines and tires and mainly use of pressure horns. It can be estimated that ambient noise level will increase due to the increased traffic. However, the better road condition and less congestion on roads will reduce the net noise levels at market and other crowded places. The noise levels are likely to reach the acceptable levels at a distance of 500 m from the road. Some sensitive locations within 500m of the road may be affected due to higher noise levels than the stipulated 45 dB(A). Overall, impact on noise environment is considered Moderate during the operation phase.

RHD will carry out a separate noise assessment study through noise modeling for the O&M phase. The study report will be treated as the addendum to this EIA report.

Mitigation

This impact is permanent and moderate negative in nature. Mitigation measures will include:

- It is suggested that suitable engineering measures such as noise barriers, road pavement design, underpasses/foot over bridges at market areas as feasible should be adopted to minimize the noise generation.
- According to monitoring results, additional sound barriers in form of trees and hedges will be discussed with the affected people and planted if agreed;
- It is also suggested that surface roughness of the roads is maintained as per the design characteristics and honking should be discouraged through signboard displays.
- Signs for sensitive zones (health centres / educational institutions etc.) to disallow the use of pressure horns;
- Enforcement and penalties against traffic rules violators; and
- Noise monitoring shall be carried out as per the suggested monitoring plan.

Residual impact: With the above mitigation measures, the impact of traffic noise is estimated

as Low, but will be confirmed by the noise assessment study.

7.7.4 Occupational Health and Safety during Operation and Maintenance

Impact: The maintenance activities on the road Kewatkhali will pose OHS risks for the maintenance staff. These risks may include exposure to physical hazards from working on heights, use of heavy equipment including cranes; trip and fall hazards; exposure to dust, noise and vibrations; falling objects; exposure to hazardous materials; exposure to electrical hazards from the use of tools and machinery; and risks associated with working close to vehicular traffic. Significance of these impacts has been assessed as High, as shown in Table 6-5

Mitigation:

- As part of the O&M procedures, an OHS plan will need to be prepared and implemented. The Plan will define procedures and protocols for each type of activities to be carried out as part of the O&M activities.
- Job hazard analysis will be carried out for each type of O&M activity
- Dedicated and qualified staff will be employed for ensuring compliance with the OHS Plan
- Regular trainings will be provided to the O&M workers on OHS aspects.
- Awareness raising material will be used including posters, signage, booklets, and others
- All site personnel will be screened for communicable diseases including sexually transmitted infections.
- Use of appropriate personal protective equipment (PPE) will be mandatory. No worker will be allowed on the site without the required PPE (such as hard hat, safety shoes).
- Firefighting equipment will be made available as required at appropriate places.
- Complete record of accidents and near-misses will be maintained.
- First aid facilities will be made available at the offices.
- Location and telephone numbers of the nearest hospital will be displayed at appropriate places.

Residual Impact: Even after implementing the above-listed mitigation measures, the health and safety impacts on site personnel cannot be fully mitigated. Hence the significance of residual impacts will be Moderate, as shown in Table 6-5. Strict monitoring will be required to ensure that mitigation measures are effectively and strictly enforced.

7.7.5 Community Health and Safety during Operation and Maintenance

Impact: With the increase in the traffic volume and vehicular speeds, risk of traffic accidents will also increase. The project road passes through some settlements also and also some sensitive receptors (see Table 6.5). At such locations, the increased traffic volume poses additional and severe risks to pedestrian and other road users. Significance of these impacts has been assessed as High, as shown in Table 6-5.

Mitigation: The project road needs to meet highway safety standards including traffic signage, warning signs, traffic lights, reflectors, and pedestrian crossings (overhead or underground

where possible/appropriate). Emergency services (ambulance, rescue vehicles) will also need to be arranged. In addition, liaison with the community will need to be maintained in addition to raise their awareness regarding safety risks associated with vehicular traffic.

Residual impact: With the help of the above measures, the significance of residual impacts has been assessed as Moderate.

8 CHAPTER: ENVIRONMENTAL MANAGEMENT PLAN , INSTITUTIONAL FRAMEWORK AND GRIEVANCE REDRESS MECHANISM

8.1 Introduction

The Environmental Management Plan (EMP) for the proposed MKBIP would be constructed over the Old Brahmaputra River connecting the Mymensingh Sadar includes a Mitigation Plan for eliminating or reducing the potentially significant adverse impacts identified in Chapter 6, an Enhancement Plan for improving the beneficial impacts, and a Monitoring Plan to facilitate environmental assessment during and after project implementation. A summary of the EMP is given in a tabular form.

The EMP has been prepared combined for each road with specific mention for road specific action. The combined EMP has been prepared since there are many actions, which are common for all the roads.

8.2 Objectives of the EMP

Environmental management plan (EMP) is prepared for all the identified environmental impacts (as illustrated in Chapter 6) during pre-construction, construction and operation stages due to implementation of various Project activities and associated development. The EMP includes mitigation plan, monitoring plan and environmental cost.

The aim of the EMP is to ensure implementation of the recommended mitigation measures effectively. The mitigation measures are designed either to prevent impacts or by mitigating those to reduce the effect to an acceptable level that complies with the environmental guidelines of DoE and with the guidelines of the AIIB's ESF (2016) by adopting the most suitable techno-economic options. The EMP also ensures that the positive impacts are conserved and enhanced. The main objectives of the EMP for the construction of the MKBIP are:

- Define the responsibilities of the project proponents in accordance with the three project phases (design, construction and operation);
- Facilitate the implementation of the mitigation measures by providing the technical details of each project impact, and proposing an implementation schedule of the proposed mitigation measures;
- Define a monitoring mechanism and identify monitoring parameters to ensure that all proposed mitigation measures are completely and effectively implemented;
- Identify training requirements at various levels and provide a plan for the implementation of training sessions;
- Identify the resources required to implement the EMP and outline corresponding financing arrangements; and
- Providing a cost estimate for all proposed EMP actions.

8.3 The Environmental Management Plan (EMP)

Mitigation measures for each of the impacts listed in the EMP table in accordance with the chapter 6. Responsible institutions/departments for the implementation and supervision of each of the environmental issues have also been illustrated. Mitigation measures have been suggested based on the knowledge of the Environmental Specialist, suggestions of the stakeholders collected during public consultation, and opinions from other relevant specialists.

The mitigation measures will be considered successful when comply with the Environmental Quality Standards (EQS), policies, legal requirements set by DOE and other relevant GOB organizations. In absence of DOE's own EQS, other relevant international or other recognized organization's quality standard will have to be followed. The Environmental Code of Practices (ECP) is given at Appendix 15

8.4 Environmental Mitigation Plan

The following summarize the proposed environmental and social mitigation plan for construction and operational phases of the project. The monitoring itself is implemented by the contractor; the RHD is in the first position to supervise the monitoring activities.

Table 8-1 Environmental Mitigation Plan

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
Pre-Construction Phase							
1.	Siting of the project	1.1	Land acquisition	The Abbreviated Resettlement Plan will be implemented	RC	CSC	Compensation payment received by the affected entities; Number of grievances received
		1.2	Loss of farm income	The Abbreviated Resettlement Plan will be implemented	RC	CSC	Compensation payment received by the affected entities; Number of grievances received
Construction Phase							
2	Contractor mobilization and demobilization	2.1	Traffic management	The approved TMP will be followed. It will be ensured that disruption of traffic on road MKBIP is minimized Traffic management, such as speed limits and signal lights, are to be strengthened Coordination will be maintained with the local traffic authorities to engage traffic police at the busy junctions	Contractor	CSC	Number of any non-compliance reports Number of complaints / grievances. Number of traffic accidents/incidents involving project vehicles and lorries bringing materials and supply to project
		2.2	Soil Erosion and Contamination	Vehicular traffic on unpaved roads will be avoided as far as possible. Operation of vehicles and machinery close to the water bodies will be minimized. Vehicles and equipment will not be repaired in the field. If unavoidable,	Contractor	CSC	Number of any non-compliance reports Number of complaints / grievances.

Ref	Project		Mitigation Measures	Responsibility	

	Activity	Environmental /Social			Implementation	Monitoring	Target / Indicator /
				Noise barriers will be installed where needed particularly near sensitive receptors such as schools Vehicles will have exhaust mufflers (silencers) to minimize noise generation. Nighttime traffic will be avoided near the communities. Local population will be taken in confidence if such work is unavoidable. Vehicular traffic through the communities will be avoided as far as possible. Vehicle speeds will be kept low, and horns will not be used while passing through or near the communities. Compliance with national standards and WHO Guidelines will be			Noise measurement data Number of community complaints.
		2.5	Public Safety	Occupational health and safety procedures and OHS Plan will be enforced. Implement fuels and hazardous substances management plan The Traffic Management Plan will	Contractor	CSC	Number of any non-compliance reports; Number of any related public complaints Number of accidents, incidents and near

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				preventing of unsafe situations, especially near schools, housing areas, construction areas, camps and offices. Special attention should be focused on safety training for workers to prevent and restrict accidents and on the knowledge how to deal with emergencies. Road signage will be fixed at appropriate locations to reduce safety hazard associated with project-related vehicular traffic. Liaison with traffic police will be maintained Project drivers will be trained on defensive driving. Vehicle speeds near / within the			
		2.6	Damage to Infrastructure	All damaged infrastructure will be restored to original or better condition.	Contractor	CSC	Number of any non-compliance reports; Number of any public
		2.7	Damage to cultural	No vehicle movement will be carried out near any cultural	Contractor	CSC	- Number of any non-compliance reports;

Ref	Project Activity	Environmental /Social Impact	Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
				Implementation	Monitoring	

							- Number of any public complaints.
		2.8	Crop damage	No vehicle movement will be allowed inside any cultivated area Any damage caused by the camp	Contractor	CSC	Number of non-compliance reports Number of related
		2.9	Damage to natural vegetation, threat to wildlife	- No vehicle movement will be carried out inside Environmental Sensitive Area.	Contractor	CSC	Number of any non-compliance reports Number of trees felled Number of sighting of key wild species
3	Construction camp establishment	3.1	Soil erosion; soil and water contamination	Camp management plan will be implemented location of camp will be selected after obtaining CSC's approval and in consultation with local community Photographs will be taken to record the site conditions prior to the establishment of the camp. Land clearing, leveling and grading will be minimized, and carried out in a manner to minimize soil erosion.	Contractor	CSC	Compliance to the Camp Management Plan, Waste Management Plan Number of any non-compliance reports Results of soil and water quality analysis Number of related complaints

Ref	Project Activity	Environmental /Social Impact	Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
				Implementation	Monitoring	

				water channel and water bodies will be minimized. Contractors will prepare and implement a Waste Management Plan. For the domestic sewage, appropriate treatment and disposal system (e.g., septic tank and soaking pits) will be constructed having adequate capacity Waste oils will be collected in drums and sold to the recycling contractors. The inert recyclable waste from the site (such as cardboard, drums, and broken/used parts) will be sold to recycling contractors. The hazardous waste will be kept separate and handled according to the nature of the waste. Domestic sold waste from the camp site will be disposed of in a manner that does not cause soil contamination			

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- ECP-1, ECP-2, ECP-3, ECP 4, and ECP-11 will be implemented.			
		3.2	Air pollution	-Pollution prevention plan will be implemented. Generators and vehicles will be kept in good working condition and properly tuned, in order to minimize the exhaust emissions. dust emissions will be minimized by appropriate methods, such as spraying water on soil, where required and appropriate. Air quality will be properly	Contractor	CSC	Number of any non-compliance reports Air quality monitoring data Number of related grievances
		3.3	Vegetation loss; threat to wildlife	Camp will not be established inside or adjacent to Environmental Sensitive Area Clearing natural vegetation will be avoided as far as possible. The camp will be established in a natural clearing, to the extent possible. Any loss or damage to crops or cultivation land will be compensated in accordance with	Contractor	CSC	Number of any non-compliance reports Number of trees felled Number of sighting of key wild species Number of related complaints.

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Include information on wildlife protection in all tool-box orientation briefings for camp staff* - *ECP-8 will be implemented.*			
		3.4	*Noise*	- *-Pollution prevention plan will be implemented.* - *Noise barriers will be installed where needed particularly near sensitive receptors* - *Generators and vehicles will have exhaust mufflers (silencers) to minimize noise generation.* - *Liaison with the communities will be maintained* *Noise monitoring will be carried out.* - *compliance with national standards and AIIB ESP will be ensured* *ECP-7 will be implemented.*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Noise monitoring data* - *Number of grievances regarding noise*
		3.5	*Health and Safety*	- *OHS plan will be prepared and implemented* - *Implement fuels and hazardous substances management plan* - *Protective fencing to be installed around the Camp to avoid any accidents.* - *Contain all fuel tanks in a fully bunded area with a storage capacity of at least 110 percent of the potential storage volume.* - *Spill control arrangements to be made for hazardous substances (e.g., fuels)*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of trainings conducted* - *Number of accidents, incidents, and near misses.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				Firefighting equipment will be made available at the camps. *The camp staff will be provided OHS training.* *All safety precautions will be taken to transport, handle and store hazardous substances, such as fuel.* - *Construction camps will have first aid kits* - *Camp crew will be provided with awareness for transmissible diseases and gender issues (eg, HIV, hepatitis B and C; GBV).* *ECP-13 will be implemented.*			
		3.6	*Social and Gender Issues*	- *Local norms and customs will be respected* - *Camp crew will avoid entering the settlements* *No child labor or forced labor will be employed in the camps.* - *Liaison with the community will be maintained.* - *The World Bank Guidance Note[15] will be used to address potential impacts caused by temporary project induced labor influx;* - *The World Bank Guidance Note on gender-based violence (GBV) will be used to address potential impacts caused by temporary project induced labor influx;*	*Contractor*	*CSC*	- *Number of non-compliance reports;* - *Number of related complaints*

[15] **https://www.aiib.org/en/policies-strategies/_download/environment-framework/20160226043633542.pdf**

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *The contractor will prepare and implement a Code of Conduct for all site personnel, in consultation and coordination with the local community;* - *All site personnel will be provided orientation and training on Code of Conduct. Awareness raising materials such as posters and signage will be used as appropriate;* - *Privacy of women will be respected; routes and places used by them will be avoided as far as possible;* - *Construction camps will be located at least 500 m away from the communities. Entry of the site personnel in the local communities will be minimized to the extent possible/appropriate.* - *The GRM described earlier will also address community*			
		3.7	*Damage to sites of cultural heritage*	- *In case any artifacts or sites of archeological, cultural, historical, or religious significance are discovered at the camp site, the concerned department and local groups will be informed* - *ECP 12 will be implemented.*	*Contractor*	*CSC*	- *Number of non-compliance reports* - *Number of reports of any discovery of cultural heritage sites/artifacts*
		3.8	*Increased Load on Local Services and Supplies*	- - *The contractor will prepare and implement a plan to obtain key supplies such as water and fuel, in consultation and coordination with the local community;*	*Contractor*	*CSC*	*Number of related public grievances*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *The plan will ensure that there is no significant impact on the local community and local resources;* - *Liaison with the community will be maintained;* - *The GRM described earlier will also address community grievances related to usage of local resources*			
		3.9	*Damage to crops*	- *Camp will not be established inside any cultivated area* - *Any damage caused by the camp establishment will be compensated*	*Contractor*	*CSC*	- *Number of non-compliance reports* - *Number of related complaints*
4.	*Construction equipment and material transportation*	*4.1*	*Traffic management*	*Same as Item 2.1.*	*Contractor*	*CSC*	*Same as Item 2.1*
		4.2	*Soil Erosion and Contamination*	*Same as Item 2.2*	*Contractor*	*CSC*	*Same as Item 2.2*
		4.3	*Air pollution*	*Same as Item 2.3*	*Contractor*	*CSC*	*Same as Item 2.3*
		4.4	*Noise*	*Same as Item 2.4*	*Contractor*	*CSC*	*Same as Item 2.4*
		4.5	*Public Safety*	*Same as Item 2.5*	*Contractor*	*CSC*	*Same as Item 2.5*
		4.6	*Damage to Infrastructure*	*Same as Item 2.6*	*Contractors*	*CSC*	*Same as Item 2.6*
		4.7	*Damage to cultural heritage*	*Same as Item 2.7*	*Contractor*	*CSC*	*Same as Item 2.7*
		4.8	*Blocked routes*	- *The contractor will prepare and implement the TMP, in consultation and coordination with the local community;*	*Contractors*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *The community will be informed about the nature of construction activities and possibility of any blocked route; alternate routes will be identified with the help of local/affected community. Duration of such blockage will be minimized to the extent possible;* - *Construction works on the road MKBIP will be planned and implemented in a manner to minimize traffic disruption. All road safety measures including road signage, warning lights, lane dividers, and safety railings will be installed.* - *Liaison and coordination will be maintained with relevant authorities* - *Liaison with the community will be maintained.* - *The GRM described earlier will also address community grievances related to any*			
		4.9	*Crop damage*	*- Same as Item 2.8*	*Contractor*	*CSC*	*Same as Item 2.8*
		4.10	*Damage to natural vegetation, threat to*	*- Same as Item 2.9*	*Contractor*	*CSC*	*Same as Item 2.9*
5	*Excavation*	*5.1*	*Soil erosion; water and soil contamination,*	*Contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work.*	*Contractor*	*CSC*	*- Number of any non-compliance reports* *- Number of complaints / grievances*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the soil;* - *Contractor will confine the contaminants immediately after such accidental spillage;* - *Contractor will collect contaminated soils, treat and dispose them in environment friendly manner;* - *Top soil to be stripped and stockpiled where practical, particularly in cultivation fields.* - *Vehicles and equipment will not be repaired in the field. If unavoidable, impervious sheathing will be used to avoid soil and water contamination.* - *Temporary stockpile of soil to be protected from wind and water erosion*			
		5.2	*Air pollution*	- *Pollution prevention plan will be implemented.* - *The equipment and vehicles used during the construction process will comply with the national legislation as well as AIIB ESPGuidelines on exhaust emissions;* - *Contractor will implement dust prevention measures such as watering of roads near the residential areas;* - *Regular air monitoring will be carried out near the sensitive receptors (Table 6.5) to*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of complaints / grievances.* - *Air quality monitoring data*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				ambient air quality remains within the limits defined by national standards and Guidelines; *Measures will be taken to protect the workers from excessive dust (i.e., usage of personal protective equipment);* - *A 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.* - *ECP 6 for air quality management will be*			
		5.3	*Noise*	- *-Pollution prevention plan will be implemented.* - *Noise barriers will be installed where needed particularly near sensitive receptors such as schools* - *Equipment will have exhaust mufflers (silencers) to minimize noise generation.* - *Nighttime works will be avoided near the communities. Local population will be taken in confidence if such work is*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of complaints / grievances* *Noise monitoring data*

Ref	Project Activity	Environmental /Social impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Compliance with national standards and WHO Guidelines will be ensured.* - *Noise monitoring will be carried out particularly near settlements and sensitive receptors* - *ECP-7 will be enforced.* - *Continued consultations with the affected communities will be carried out.*			
		5.4	*Damage to water bodies*	- *No debris, soil, waste material or access construction material will be released in the canals or channels.* - *Construction material will not be stockpiled near water bodies.* - *Vehicle/equipment movement near the water bodies will be avoided.* - *Liaison with irrigation authority and keep the stakeholders informed in case of any damage to or blockage of irrigation canals.* - *Any damage to the canals or drainage channels will be*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of complaints / grievances.*
		5.5	*Public safety*	- *The contractor will prepare and implement an Occupational Health and Safety (OHS) Plan* - *Job hazard analysis will be carried out for each type of construction activities* - *Contractors will have dedicated and qualified staff for ensuring compliance with the OHS Plan*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of complaints / grievances* - *Number of accidents*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Construction area will be cordoned off to avoid unauthorized entry into the construction area* - *Regular trainings will be provided to the workers on OHS aspects.* - *Awareness raising of communities will be carried out on safety aspects* - *Liaison will be maintained with the local communities.* - *Awareness raising material will be used including posters, signage, booklets, and others* - *All site personnel will be screened for communicable diseases including sexually transmitted infections.* - *Use of appropriate personal protective equipment (PPE) will be mandatory. No worker (or even visitor) will be allowed on the site without the required PPE (such as hard hat, safety shoes).* *Firefighting equipment will be made available as required at construction sites, particularly near the fuel storage.* - *The project drivers will be trained in defensive driving. They will maintain low speed while driving through / near the communities.* - *Complete record of accidents and near- misses will be maintained.* - *First aid facilities will be made*			

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Location and telephone numbers of the nearest hospital will be displayed at appropriate places at work sites and in construction camps. If necessary, the contractor will have an ambulance available at the site.* - *ECP 13 will be implemented*			
		5.6	*Loss of vegetation / trees*	- *Tree and shrub cutting will be minimized.* - *Compensation for tree cutting is calculated in RP provided later in the document. Compensatory tree plantation will be carried out (e.g., along the periphery of road).* - *The tree species and plantation location will be decided in consultation with the concerned department* - *All construction activities or equipment/machinery should avoid entering the* - *The same species that has been removed will be planted at the ratio of 1:10 (i.e., 10 saplings planted for each tree felled).* - *ECP 8 will be implemented*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of complaints / grievances* *Number of trees felled* - *Number of trees planted* - *Number of related complaints*
		5.7	*Threat to wildlife*	- *Warning signs will be installed along the MKBIP road passing through the Environmental Sensitive . warning the drivers about the presence of wildlife in the area.* - *Hunting, trapping, or*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of sighting of key wild species* - *Number of related*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		5.8	*Damage to infrastructure and public utilities*	*Same as Item 2.6.* *Before the start of construction activities, all public utilities requiring relocation will be identified.* *Subsequently, the concerned departments/authorities will be contacted for the relocation of these utilities.* *It will be ensured that there is a minimum disruption of services such as electricity and water.* *Any infrastructure damaged by the construction activities will be repaired.* *GRM will also capture any related complaints*	*Contractor*	*CSC*	*Same as Item 2.6.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		5.9	*Social conflict due to the Influx of Workers and In-migrants*	- *Local norms and customs will be respected* - *No child labor or forced labor will be employed in the camps.* - *Liaison with the community will be maintained.* - *The World Bank Guidance Note[16] will be used to address potential impacts caused by temporary project induced labor influx:* - *The World Bank Guidance Note on gender-based violence (GBV) will be used;* - *The contractor will prepare and implement a Code of Conduct for all site personnel, in consultation and coordination with the local community:* - *All site personnel will be provided orientation and training on Code of Conduct. Awareness raising materials such as posters and signage will be used as appropriate;* - *Privacy of women will be respected: routes and places used by them will be avoided as far as possible:* - *Entry of the site personnel in the local communities will be minimized to the extent*	*Contractor*	*CSC*	*Same as Item 3.6.*

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Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		5.10	*Damage to cultural resources*	*Same as Item 3.7*	*Contractor*	*CSC*	*Same as Item 3.7*
		5.11	*Blockage of roads and local routes*	- *The contractor will prepare and implement TMP, in consultation and coordination with the local community:* - *The community will be informed about the nature of construction activities and possibility of any blocked route: alternate routes will be identified with the help of local/affected community.* - *Duration of such blockage will be minimized to the extent possible:* - *Construction works on the road MKBIP will be planned and implemented in a manner to minimize traffic disruption. All road safety measures including road signage, warning lights, lane dividers, and safety railings will be installed.* - *Liaison and coordination will be maintained with relevant authorities* - *Liaison with the community will be maintained.* - *The GRM described earlier*	*Contractor*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*
		5.12	*Spoil generation*	*- Minimize the generation of spoils by recycling the excavated soil to the*	*Contractor*	*CSC*	*Number of any non-compliance reports*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				maximum extent possible by using it as filling material in the road section. *- Excess spoils should be stored in the lands provided by local communities or in the areas approved by the project*			*Number of related grievances*
		5.13	*Damage to crops*	- *Crop damage will be minimized to the extent possible* - *If unavoidable, compensation will be paid to the*	*Contractor*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*
6	*Road construction (base, sub-base, asphalting)*	*6.1*	*Water and soil contamination,*	- *Contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work.* - *Contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the soil:* - *Contractor will confine the contaminants immediately after such accidental spillage:* - *Contractor will collect contaminated soils, treat and dispose them in environment friendly manner:* - *Vehicles and equipment will not be repaired in the field. If unavoidable, impervious*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints / grievances.*
		6.2	*Air pollution*	*- Same as Item 5.2.*	*Contractor*	*CSC*	*Same as Item 5.2*
		6.3	*Noise*	*Same as Item 5.3.*	*Contractor*	*CSC*	*- Same as Item 5.3*
		6.4	*Damage to water bodies*	*Same as Item 5.4.*	*Contractor*	*CSC*	*- Same as Item 5.4*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		6.5	*Public safety*	- *Same as Item 5.5.* - *Special care needs to be employed while laying the concrete for the pavement: required PPE such as safety shoes must be used by all site personnel*	*Contractor*	*CSC*	*- Same as Item 5.5*
		6.6	*Loss of vegetation / trees*	*Same as Item 5.6.*	*Contractor*	*CSC*	*- Same as Item 5.6.*
		6.7	*Threat to wildlife*	*Same as Item 5.7.*	*Contractor*	*CSC*	*- Same as Item 5.7.*
		6.8	*Damage to infrastructure and public utilities*	*Same as Item 5.8.*	*Contractor*	*CSC*	*Same as Item 2.6.*
		6.9	*Social conflict due to the Influx of Workers and In-migrants*	*Same as Item 5.9.*	*Contractor*	*CSC*	*Same as Item 3.6.*
		6.10	*Damage to cultural resources*	*Same as Item 3.7*	*Contractor*	*CSC*	*Same as Item 3.7*
		6.11	*Blockage of roads and local routes*	*Same as Item 5.11*	*Contractor*	*CSC*	*Same as Item 5.11*
		6.12	*Spoil generation*	*Same as Item 5.12*	*Contractor*	*CSC*	*Same as Item 5.12*
		6.13	*Damage to crops*	*Same as Item 5.13*	*Contractor*	*CSC*	*Same as Item 5.13*
7	*Bridge /culvert construction*	*7.1*	*Water and soil contamination,*	*- Same as Item 6.1.*	*Contractor*	*CSC*	*Same as Item 6.1*
		7.2	*Air pollution*	*Same as Item 5.2.*	*Contractor*	*CSC*	*- Same as Item 5.2*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		7.3	*Noise*	*Same as Item 5.3.*	*Contractor*	*CSC*	*- Same as Item 5.3*
		7.4	*Damage to water bodies*	*- Contractor will prepare Bridge Construction Management Plan including plan of water diverting to address environmental impacts of bridge construction.* *- No debris, soil, waste material or access construction material will be released in the canals or channels.* *- Construction material will not be stockpiled near water bodies.* *- Vehicle movement near the water bodies will be avoided.* *- Liaison with irrigation authority and keep the stakeholders informed in*	*Contractor*	*CSC*	*- Number of any noncompliance reports* *- Number of complaints / grievances.*
		7.5	*Public safety*	*Same as Item 5.5.* *Special care needs to be employed while laying the concrete for the bridges; required PPE such as safety shoes must be used by all site personnel.*	*Contractor*	*CSC*	*- Same as Item 5.5*
		7.6	*Loss of vegetation / trees*	*Same as Item 5.6.*	*Contractor*	*CSC*	*- Same as Item 5.6.*
		7.7	*Threat to wildlife*	*Same as Item 5.7.*	*Contractor*	*CSC*	*Same as Item 5.7.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		7.8	*Damage to infrastructure and public utilities*	*Same as Item 5.8.*	*Contractor*	*CSC*	*Same as Item 5.8.*
		7.9	*Social conflict due to the Influx of Workers and In-migrants*	*Same as Item 5.9.*	*Contractor*	*CSC*	*Same as Item 5.6.*
		7.10	*Damage to cultural resources*	*Same as Item 5.7*	*Contractor*	*CSC*	*Same as Item 5.7*
		7.11	*Blockage of roads and local routes*	*Same as Item 5.11*	*Contractor*	*CSC*	*Same as Item 5.11*
		7.12	*Spoil generation*	*Same as Item 5.12*	*Contractor*	*CSC*	*Same as Item 5.12*
		7.13	*Damage to crops*	*Same as Item 5.13*	*Contractor*	*CSC*	*Same as Item 5.13*
8	*Interchange construction*	*8.1*	*Water and soil contamination,*	*Same as Item 6.1.*	*Contractor*	*CSC*	*Same as Item 6.1*
		8.2	*Air pollution*	*Same as Item 5.2.*	*Contractor*	*CSC*	*Same as Item 5.2*
		8.3	*Noise*	*Same as Item 5.3.*	*Contractor*	*CSC*	*Same as Item 5.3*
		8.4	*Damage to water bodies*	*Same as Item 5.4.*	*Contractor*	*CSC*	*Same as Item 5.4*
		8.5	*Public safety*	- *Same as Item 5.5.* - *Special care needs to be employed while laying the concrete and asphalt for the interchanges; required PPE such as safety shoes must be used by all site personnel*	*Contractor*	*CSC*	*Same as Item 5.5*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		8.6	Loss of vegetation / trees	- Same as Item 5.6. - Special care will be employed for interchanges near the wetland.	Contractor	CSC	Same as Item 5.6.
		8.7	Threat to wildlife	- Same as Item 5.7. - Special care will be employed for interchanges near the wetland.	Contractor	CSC	Same as Item 5.7.
		8.8	Damage to infrastructure and public utilities	Same as Item 5.8.	Contractor	CSC	Same as Item 2.6.
		8.9	Social conflict due to the Influx of Workers and In-migrants	Same as Item 5.9.	Contractor	CSC	Same as Item 3.6.
		8.10	Damage to cultural resources	Same as Item 3.7	Contractor	CSC	Same as Item 3.7
		8.11	Blockage of roads and local routes	Same as Item 5.11	Contractor	CSC	Same as Item 5.11
		8.12	Spoil generation	Same as Item 5.12	Contractor	CSC	Same as Item 5.12
		8.13	Damage to crops	Same as Item 5.13	Contractor	CSC	Same as Item 5.13
9	Borrow areas	9.1	Borrow area management	- Borrow areas will not be selected inside cultivation fields. near any water body, or inside Environmental Sensitive Area; - Borrow areas will be kept up to 1 m deep;	Contractor	CSC	Number of any non-compliance reports Number of related grievances

Ref	Project Activity	Environmental /Social impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Borrow areas will be restored to minimize safety hazards, blockage of routes, or devaluation of land.* - *Crushed stone, gravel, and sand should be imported from specially designated quarries (having licenses for the extraction of building materials);* - *In quarries, regulatory requirements for environmental protection must be followed;* - *When carrying out construction work,*			
10	*Asphalt plan*	*10.1*	*Water and soil contamination,*	- *Asphalt plan will be located at least 500 m away from any water body* - *Contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work.* - *Contractor will be required to take appropriate measures to avoid and contain any spillage and pollution of the soil;* - *Contractor will confine the contaminants immediately after such accidental spillage;* - *Contractor will collect contaminated soils, treat and dispose them in environment friendly manner;*	*Contractor*	*CSC*	- *Number of any non-compliance reports* - *Number of complaints / grievances.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Asphalt tanks will be placed in a secondary containment area, to retain the molten asphalt in case of any leakage* *ECP 3 and ECP 9 will be implemented*			
		10.2	*Air pollution*	- *Asphalt plant will be established downwind of and at least 500 m away from any settlement or sensitive receptors, downwind from such areas.* - *Pollution prevention plan will be implemented.* - *The equipment used for Asphalt Plan will comply with the national legislation as well as WHO Guidelines on exhaust emissions;* - *Measures will be taken to protect the workers from excessive dust and asphalt fumes (i.e., usage of personal protective equipment);* - *A 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*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints / grievances.* - *Air quality monitoring data*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		10.3	*Noise*	- *-Pollution prevention plan will be implemented.* - *Asphalt plant equipment will have exhaust mufflers (silencers) as appropriate to minimize noise generation.* - *Compliance with national standards and WHO Guidelines will be ensured.* - *ECP-7 will be enforced.* - *Continued consultations with the affected communities will be carried*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints / grievances* *Noise monitoring data*
		10.4	*Damage to water bodies*	*Asphalt plant will be established at least 500 m away from any water body,*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints /*
		10.5	*Public safety*	- *Same as Item 5.5.* - *Special care needs to be employed while handling asphalt; required PPE such as safety shoes, gloves and goggles must be used by all site personnel*	*Contractor*	*CSC*	*- Same as Item 5.5.*
		10.6	*Loss of vegetation / trees*	- *Asphalt plant will not be established inside the Environmentaly Sensitive or area* - *Tree and shrub cutting will be minimized.* - *Compensation for tree cutting is calculated in RP provided later in the document. Compensatory tree plantation will be*	*Contractor*	*CSC*	*Same as Item 5.6.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *The tree species and plantation location will be decided in consultation with the concerned department* - *ECP 8 will be implemented*			
		10.7	*Threat to wildlife*	- *Asphalt plant will not be established inside the Environmentaly Sensitive* - *ECP 8 will be implemented.*	*Contractor*	*CSC*	*Same as Item 5.7.*
		10.8	*Damage to infrastructure and public utilities*	*Same as Item 5.8.*	*Contractor*	*CSC*	*Same as Item 2.6.*
		10.9	*Social conflict due to the Influx of Workers and In-migrants*	*Same as Item 5.9.*	*Contractor*	*CSC*	*Same as Item 3.6.*
		10.10	*Damage to cultural resources*	*Same as Item 3.7*	*Contractor*	*CSC*	*Same as Item 3.7*
		10.11	*Damage to crops*	- *Asphalt plant will not be established in any cultivated area* - *Any crop damages will be compensated.*	*Contractor*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*
11	*Batching plant*	*11.1*	*Water and soil contamination,*	- *Batching plan will be located at least 500 m away from any water body* - *Contractor will prepare and implement a Pollution Prevention Plan prior to the start of the work.* - *Contractor will be required*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints / grievances.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				contain any spillage and pollution of the soil: - *Contractor will confine the contaminants immediately after such accidental spillage:* - *Contractor will collect contaminated soils, treat and dispose them in environment friendly*			
		11.2	*Air pollution*	- *Batching plant will be established downwind of and at least 500 m away from any settlement or sensitive receptors, downwind from such areas.* - *Pollution prevention plan will be implemented.* - *The equipment used for Batching Plan will comply with the national legislation as well as WHO Guidelines on exhaust emissions:* - *Measures will be taken to protect the workers from excessive dust (i.e., usage of personal protective equipment):* - *A 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*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints / grievances.* - *Air quality monitoring data*

Ref	Project Activity	Environmental /Social impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				be carried out during construction phase. *- ECP 6 for air quality management will be implemented*			
		11.3	*Noise*	- *-Pollution prevention plan will be implemented.* - *Batching plant equipment will have exhaust mufflers (silencers) as appropriate to minimize noise generation.* - *Compliance with national standards and WHO Guidelines will be ensured* - *ECP-7 will be enforced.* - *Continued consultations*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints / grievances.* - *Noise monitoring data*
		11.4	*Damage to water bodies*	*Batching plant will be established at least 500 m away from any water body,*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of complaints /*
		11.5	*Public safety*	*- Same as Item 5.5.*	*Contractor*	*CSC*	*- Same as Item 5.5.*
		11.6	*Loss of vegetation / trees*	- *Batching plant will not be established inside the Environmentaly Sensitive or Sensitive receptor area* - *Tree and shrub cutting will be minimized.* - *Compensation for tree cutting is calculated in RP provided later in the*	*Contractor*	*CSC*	*Same as Item 5.6.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				plantation will be carried out (e.g.. along the periphery of road). *- The tree species and plantation location will be decided in consultation with the concerned department* *ECP 8 will be implemented*			
		11.7	*Threat to wildlife*	*- Batching plant will not be established inside the sensitive receptor or ecologically significant area r ECP 8 will be implemented*	*Contractor*	*CSC*	*Same as Item 5.7.*
		11.8	*Damage to infrastructure and public utilities*	*Same as Item 5.8.*	*Contractor*	*CSC*	*Same as Item 2.6.*
		11.9	*Social conflict due to the Influx of Workers and In-migrants*	*Same as Item 5.9.*	*Contractor*	*CSC*	*Same as Item 3.6.*
		11.10	*Damage to cultural resources*	*Same as Item 3.7*	*Contractor*	*CSC*	*Same as Item 3.7*
		11.11	*Damage to crops*	*- Batching plant will not be established in any cultivated area* *- Any crop damages will be compensated.*	*Contractor*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*
12	*Spoil management*	*12.1*	*Spoil management*	*- Minimize the generation of spoils by recycling the excavated soil to the maximum extent possible by using it as filling material*	*Contractor*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*

Ref	Project Activity	Environmental /Social impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				communities or in the areas approved by the project management/local authorities. - *No spoil to be stored or disposed inside the Environmentaly Sensitive Area* - *No spoil to be stored or disposed near water bodies* - *No spoil to be stored or disposed in a manner that it can block natural drainage* - *No spoil to be stored or disposed in a manner that it blocks local roads or routes* - *ECP 1 to be implemented.*			
13	*Waste management*	*13.1*	*Waste management*	- *Contractors will implement the Waste Management Plan.* - *Appropriate hazardous. industrial and domestic waste disposal facilities must be established* - *For the domestic sewage, appropriate treatment and disposal system (e.g., septic tanks and soaking pits) will be constructed having adequate capacity* - *Waste oils will be collected in drums and sold to the recycling contractors.* - *The inert recyclable waste from the site*	*Contractor*	*CSC*	*Number of any non-compliance reports* *Number of related grievances*

Ref	Project Activity	Environmental /Social impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				- *Domestic solid waste will be disposed off in a manner that does not cause soil contamination.* - *Awareness raising for minimizing use of non-biodegradable substances* - *Regular maintenance of waste management facilities will be undertaken* - *No waste dumping/release will be carried out in the Environmentaly Sensitive area* - *No waste dumping/release will be carried out in or near any water body* - *No waste dumping/release*			
14	*Clearing and Restoration*	*14.1*	*Clearing and Restoration*	- *The contractors will be reauired to remove all left-over construction material, debris, spoils, and other wastes from the construction sites in a timely manner.* - *The camps sites, asphalt plant site, batching plant site and any other temporary facility established by contractor will be completely cleaned and restored in original condition to the extent possible.* - *No waste disposal will be*	*Contractor*	*CSC*	- *Number of any noncompliance reports* - *Number of related grievances* - *Photographic record.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
O&M Phase							
15	*Pavement maintenance*	*15.1*	*Water and soil contamination,*	*Same as Item 6.1*	*Maintenance Contractor*	*RC*	*Same as Item 6.1*
		15.2	*Air pollution*	*Same as Item 5.2.*	*Maintenance Contractor*	*RC*	*Same as Item 5.2*
		15.3	*Noise*	*Same as Item 5.3.*	*Maintenance Contractor*	*RC*	*Same as Item 5.3.*
		15.4	*Damage to water bodies*	*Same as Item 5.4.*	*Maintenance Contractor*	*RC*	*Same as Item 5.4.*
		15.5	*Public safety*	- *Same as Item 5.5.* - *Special care needs to be employed while laying the concrete or asphalt for the pavement: required PPE such as safety shoes must be used by all site personnel*	*Maintenance Contractor*	*RC*	*Same as Item 5.5.*
		15.6	*Loss of vegetation / trees*	*Same as Item 5.6.*	*Maintenance Contractor*	*RC*	*Same as Item 5.6.*
		15.7	*Threat to wildlife*	*Same as Item 5.7.*	*Maintenance Contractor*	*RC*	*Same as Item 5.7.*
		15.8	*Damage to infrastructure and public utilities*	*Same as Item 5.8.*	*Maintenance Contractor*	*RC*	*Same as Item 2.6.*
		15.9	*Social conflict due to the Influx of Workers and In-migrants*	*Same as Item 5.9.*	*Maintenance Contractor*	*RC*	*Same as Item 3.6.*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
		15.10	Damage to cultural resources	Same as Item 3.7	Maintenance Contractor	RC	Same as Item 3.7
		15.11	Blockage of roads and local routes	Same as Item 3.11	Maintenance Contractor	RC	Same as Item 3.11.
		15.12	Spoil generation	Same as Item 3.12	Maintenance Contractor	RC	Same as Item 3.12.
		15.13	Damage to crops	Same as Item 3.13	Maintenance Contractor	RC	Same as Item 3.13.
16	Road Operation	16.1	Waste management	- A Waste Management Plan will be prepared a as part of the standard operating procedures. - The non-hazardous waste will be disposed through the city or district services - hazardous wastes will be disposed by agreement with local organizations for the disposal of solid and hazardous wastes ECP-1 will be implemented	O&M Staff	RC	Number of any non-compliance reports Number of related grievances
		16.2	Air pollution	- Tree plantation will be carried out along the road particularly near the settlements and sensitive receptors (Table 6.5). - The project proponents will also coordinate with the relevant government department to introduce stricter regulations for	O&M Staff	RC	Number of any non-compliance reports Number of related grievances

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				particularly near settlements and sensitive receptors.			
		16.3	*Noise and vibration*	- *The tree plantation along the road proposed earlier can marginally address the noise generated from the vehicular traffic.* - *Road signage for Silence Zone will be installed near the*	*O&M Staff*	*RC*	*Number of any non-compliance reports* *Number of related grievances*
		16.4	*Public safety*	- *As part of the O&M procedures, an OHS plan will need to be prepared and implemented. The Plan will define procedures and protocols for each type of activities to be carried out as part of the O&M activities.* - *Job hazard analysis will be carried out for each type of O&M activity* - *Dedicated and qualified staff will be employed for ensuring compliance with the OHS Plan* - *Regular trainings will be provided to the O&M workers on OHS aspects.* - *Awareness raising material will be used including posters, signage, booklets, and others* - *All O&M personnel will be screened for communicable diseases including sexually transmitted infections.* - *Use of appropriate personal*	*O&M Staff*	*RC*	*Number of any non-compliance reports* *Number of related grievances* *Number of accidents*

Ref	Project Activity	Environmental /Social Impact		Mitigation Measures	Responsibility		Target / Indicator / Performance Requirement
					Implementation	Monitoring	
				without the required PPE (such as hard hat, safety shoes). *- Firefighting equipment will be made available as required at appropriate places.* *- Complete record of accidents and near- misses will be maintained.* *- First aid facilities will be made available at the offices.* *- Location and telephone numbers of the nearest hospital will be displayed at appropriate places.* *- Implement highway safety standards including traffic signage, warning signs, traffic lights, reflectors, and pedestrian crossings (overhead or underground where possible/appropriate).* *- Emergency services (ambulance, rescue vehicles) will also need to be arranged.* *- Liaison with the community will need to be maintained in addition to raising their awareness regarding safety risks associated with vehicular traffic.*			

8.5 Institutional Arrangements

Roads and Highways Department (RHD) under the Ministry of Road Transport and Bridges (MoRTB)) is representing the Government of Bangladesh as the Executing Agency (EA) of the MKBIP. RHD is responsible for undertaking all studies, design, and construction of this Project. It will also be responsible for operation and maintenance (O&M) of the project after its completion. RHD is mandated to undertake steps, as per guidelines of the MoRTB and advice of the Government, to secure required funds both from external and internal sources for the implementation of the Project.

For efficient and smooth implementation of the project, suitable institutional arrangements are necessary to manage and implement the RP. The MKBIP Institutional arrangement consist of PSC, PIU, RSEC and PIC. Institutional arrangements required for implementation of Resettlement Plan includes capacity augmentation of RHD head office, RHD field offices, Deputy Commissioners offices, appointment of INGO/consulting firm, formation of various committees like: GRC, PAVC, RAC, etc. The Deputy Project Director at Head Office will function as the Chief Resettlement Officer (CRO). The CRO will have overall responsibility relating to resettlement and rehabilitation policy guidance, coordination, planning, monitoring and reporting. Secretarial Staffs at Head Office will assist the CRO. At the field level, the CRO will be assisted by PIC. Besides, an NGO will be appointed for the implementation of resettlement plan. The resettlement expert of the project Implementation Committee (PIC) would be engaged to carry out internal monitoring and evaluation of the project. External Monitoring Agency will be engaged for the project.

8.6 Implementation arrangements

Environmental management of the project requires a multidisciplinary approach with consolidated and coordinated efforts from a number of agencies. Various institutions will be involved during implementation of the Project. While contractor is responsible for implementation of EMP during construction works, Construction Supervision Consultant (CSC) is primarily responsible for supervision of monitoring of the implementation of the ESMP and also reporting the progress to RHD. Ministry of Road Transport and Bridges (MoRTB) is the Executing Agency (EA). The RHD will be involved in the implementation and management of the works for which they are responsible by establishing a Project Implementation Unit (PIU). The Key organizations and people involved in environmental management of the project are as presented in Figure 8-1.

8.7 Authorities and their Responsibilities for Implementation of EMoP

The most essential component of the Environment Monitoring Plan is the execution of the Plan in accordance with the monitoring schedule provided therein. The Field Officer (Environment) will be responsible for timely monitoring of various parameters and compliance with the mitigative measure proposed. A resultant database is proposed to be maintained. A Management Information System (MIS) is also put in place for effective flow of information between various levels and functions within PIU/RHD.

8.7.1 Institutional Responsibilities

The proposed organisation structure to implement the project and the environmental management plan is shown at Figure 8-1.

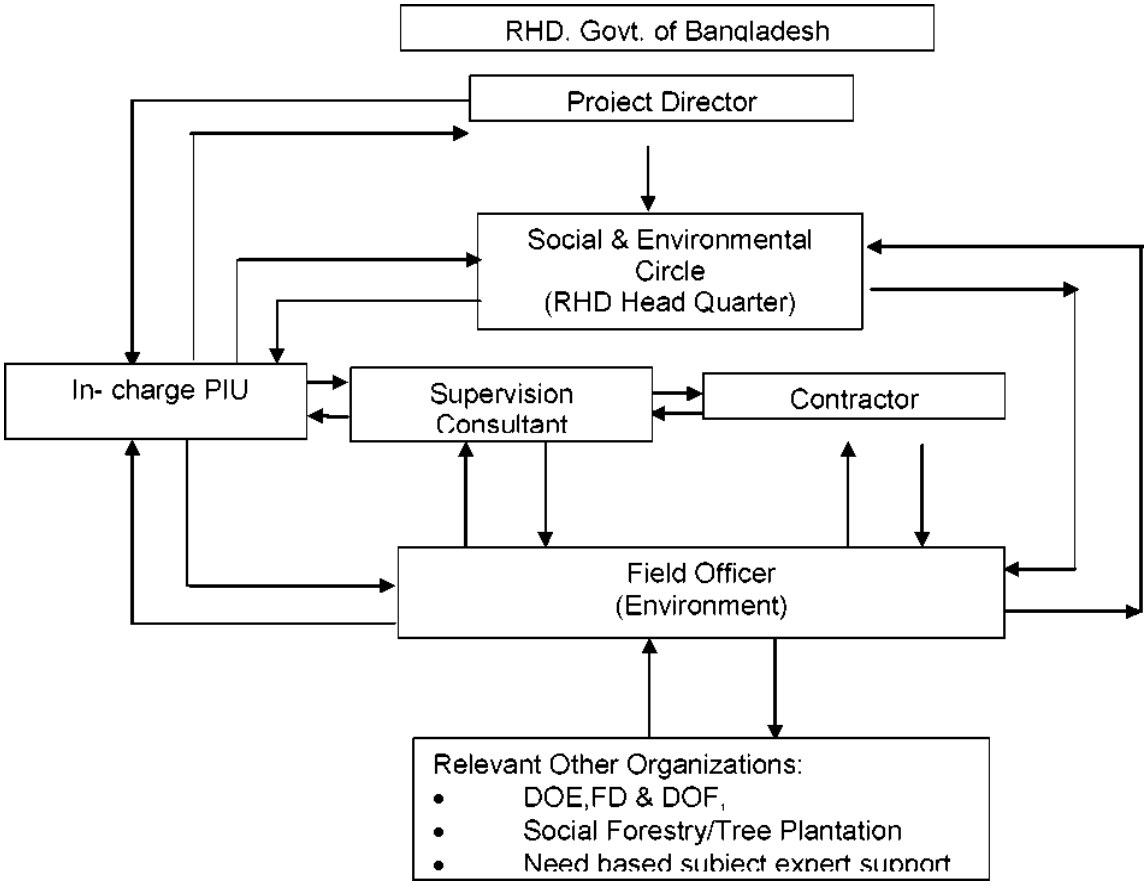

Figure 8-1 Proposed Organisation Structure

To enhance the capacity of the RHD Environmental and Social Circle and PIU for effective implementation of proposed mitigation measures and monitoring the resultant effect, some training programs and awareness workshop are proposed. The detailed training plan is provided at Appendix It would be essential to understand the legislative framework and enhance capacity of Environmental and Social Unit of RHD and Field Officer (Environment) for analysing the applicability of various environmental legislations and clearances, approvals and compliance monitoring requirements. An environmental legislation applicability matrix framework has already been given in Chapter III above for ready reference.

A PIU, under RC will be established at the national level to implement the project. As stated earlier, an E&S specialist will be engaged in PIU. The main duties of the E&S Specialist would be to ensure that the project activities are implemented in compliance with the AIIB's ESP, National EIA regulations and procedures, as well as in compliance with the present ESIA/ESMP.

8.7.1.1 Ministry of Road Transport and Bridges (MoRTB)

MoRTB as the Executing Agency of the Project will have the overall responsibility of ensuring that the environmental safeguard requirements of the project are fulfilled through the Road and Highways Department. The main responsibilities of the MoRTB are to:

- Ensure that the project, regardless of financing source, complies with the provisions of the ESMP and AIIB Environment and Social Framework (ESF), 2016.
- Ensure that project implementation complies with government environmental policies and regulations;
- Ensure that project environmental management is implemented and reported to the Steering Committee and the financing agency as required.

8.7.1.2 Inter-ministerial Steering Committee

A Steering Committee with representatives from related Ministries and Government agencies covering will be established at the time of implementation of this project. This committee will facilitate the coordination of various agencies under the ministries in the environmental management and monitoring process.

8.7.1.3 Roads and Highways Department

The Roads and Highways Department (RHD), as the main project implementing agency, is responsible for the effective execution of the environmental safeguards. Although not directly involved in the day to day monitoring activities, RHD will have oversight on the monitoring activities carried out by the CSC and contractor through PIU and will report to MoRTB.

8.7.1.4 The Social and Environmental Circle

There is a dedicated Social and Environmental Circle (RSEC) as a technical wing who is responsible for ES management of all RHD development projects. This RSES has two divisions namely Environment and Resettlement. The Resettlement division consist of 4 members comprise of one Executive engineer, one sub-divisional engineer and two assistant engineers. There is no dedicated social specialist with this Resettlement division. As RSEC will be the part of PIU, the RSEC will be responsible for overseeing the RAP implementation, supervision and monitoring with coordination of PIU Social Specialist/s. RSEC together with PIU is also responsible to monitor CSE to ensure safeguard compliance of the project. Senior Social/Resettlement specialist will keep good coordination with the RSEC to ensure compliance of social due-diligence.

8.7.1.5 Project Implementation Unit

The Project Implementation Unit will be established under the RHD will include an environmental unit (EU). The EU will consist of one Executive engineer, one sub-divisional engineer and two assistant engineers to monitor environmental compliance. The EU will be responsible for overseeing of the monitoring activities conducted by the CSC on its behalf. It will also be responsible for overseeing the activities of contractor through PIU. The main activities of the EU with regard to environmental safeguards are:

- Planning and implementation of EMP
- Ensuring that environmental protection and mitigation measures in the EMP are incorporated in the Construction Environmental Management Plan (CEMP);
- Ensuring that the CSC commits and retains dedicated staff as environment and safety managers to oversee CESMP implementation
- Supervision and monitoring of the progress of activities of the consultants and contractors for implementation of different components of EMP
- Provide guidance to PIU, CSC and contractors in conducting subsequent monitoring and reporting and in undertaking corrective options
- Responsible for modifications of the EMP when there were adaptation/changes during implementation.

- Ensure submission of periodical environmental management and monitoring reports to steering committee and co-financers through RHD;
- Submit semi-annual monitoring reports on EMP implementation for co-financers review through RHD;
- Ensure establishment and implementation of an environmental management system;
- Implementation of environmental monitoring measures (such as environmental quality monitoring, tree plantation, landscaping, wild life monitoring) during O/M stage of the Project.
- Promote improved social and environment performance through the effective use of management systems;
- External communications with other government, semi-government and non-government organizations, universities, research institutes in the country on the matters of mutual interest related to environmental management and filming of activities to be carried out under the project development.

8.7.1.6 Construction Supervision Consultant (CSC)

The CSC functioning under the RHD will be directly responsible for contract administration and day-to-day project supervision including environmental management. The CSC will consist of an environmental unit with 1 international and 1 national environmental expert. The CSC will advise the RHD and the PIUs on ESMP implementation, and monitor the work of the contractors in the field. The consultants will also help the PIUs prepare quarterly progress reports to be submitted to the RHD, who will submit semi-annual reports to co-financier for review. The CSC will, inter alia, be responsible for the following:

- Engage international/national environment specialists to ensure proper implementation of ESMP provisions;
- Undertake regular monitoring of the contractor's environmental performance, as scheduled in the ESMP;
- Conduct periodical environmental audits;
- Prior to construction, review and approve CEMPs/method statements prepared by the contractors;
- Supervise site environmental management system of the contractors, and provide corrective instructions;
- Monitor the implementation of the CEMP and review the environmental management and monitoring reports prepared by the contractor;
- Review and report on CEMP implementation by the contractor.

Overall, CSC is responsible for ensuring proper and timely implementation of all their tasks specified in the EMP.

8.7.1.7 Contractor

The contractor will be primarily responsible for preparing an implementing the CEMP. Each contractor will be recommended to have one Environmental Specialist and one Occupational, Health and Safety (OHS) Specialist, who will be working in close coordination with the environmental staff of CSC and PIU. The main functions of the contractor with regard to environmental management and monitoring are to:

- Prior to start of construction, prepare the CESMP and other method statements and management plans according to requirements of ESMP and get them approved by CSC.

- Recruit qualified environmental and safety officers (ESO) to ensure compliance with environmental statutory and contractual obligations and proper implementation of CESMP;
- Provide sufficient funding and human resources for proper implementation of CESMP;
- Prepare monthly reports on environmental management and monitoring for review and verification by the CSC;
- Prepare and implement an Environmental Management system according to requirement specified in EIA/ ISO 14001.

8.7.2 Summary of responsibilities

The following table summarized the roles and responsibilities of the agencies/institutions in implementing the EMP (Table 8-2).

Table 8-2 Summary of responsibilities of the responsible authorities in implementing the EMP

Phase	Responsible Agencies	Environmental Responsibilities
Project Preparation	EA	Submit EIA and request local DoE to issue general permits Conduct EIA in accordance with AIIB ESF 2016. Also collect permissions from local authorities (Zilla Parishad) and District Commissioner (DC) of Mymensingh.
	AIIB	Review and approve EIA, including EMP. Disclose on AIIB website
Conceptual and Detailed Design	Design firms	Incorporation of environmental mitigation measures in detailed designs and bidding documents
	PMU, IAs	Update EMP based on approved detailed design, if necessary
	AIIB	Approve updated EMP, if necessary
Tendering	PMU, IAs, design firms	Incorporate mitigation measures and the EMP clauses in tendering documents, civil contracts and contractors' construction management plans
	AIIB	Review tendering documents, confirm project's readiness
Construction	EA, IAs	Advise on implementation of mitigation measures
	Contractors, EHSOs	Implementation of mitigation measures and conduct internal monitoring, supervision
	PMU	Coordinate grievance redress mechanism; supervise EMP implementation; conduct regular site inspections; conduct training; support PIU in preparing annual environmental progress report
	Licensed laboratory	Conduct quarterly environmental monitoring, prepare monitoring reports
	Local DoE	Advise on mitigation measures; provide comprehensive technical support to PMU, EA and IAs for environmental management; conduct training; conduct annual EMP compliance review

Phase	Responsible Agencies	Environmental Responsibilities
	AIIB	Conduct review missions; review and approve annual environmental progress reports, including disclosure
O & M	PMU	Conduct EMP compliance review, instruct IA on environmental management requirements; prepare annual environmental progress report for first year of operation
	IAs	Implementation of mitigation measures as defined in EMP; conduct environmental monitoring following approved monitoring plan
	AIIB	Review and approve environmental progress report, disclose on AIIB project website

8.8 Inclusion of Relevant Components of EMP in Contract Documents

The ESMP of the project will be included in the construction bid documents and also reflected in the construction contracts. The technical specifications of the bid documents will clearly state that contractor will need to comply with the mitigation measures provided in ESMP and Environmental Codes of Practice (ECPs); AIIB ESP and ESSs, and national regulatory requirements.

8.8.1 Bill of Quantities in Bid Documents

A lump sum item for ESMP implementation will be included in the bill of quantities (BOQs) of construction bid documents. This item refers to:

- Preparation and implementation of SSESMP in compliance with ESMP, AIIB ESP and Environmental and Social Standards, and national standards on air, noise, water quality, and others;
- Provision of an Environmental Officer and an Occupational Health and Safety Officer (for the duration of construction phase);
- Providing and maintenance of Noise Meters and Dust Measurement Meters for spot measurement;
- Dust monitoring and noise monitoring as planned in the ESMP at locations specified by the CSC.

After award of the contract and before mobilization, the Contractor will need to prepare an SSESMP with site specific mitigation measures for approval by PIU.

PIU will ensure that contractors and their subcontractors carry out their responsibility of implementing the mitigation measures, monitoring plan as well as other environmental and safety measures provided in the ESMP.

8.8.2 Payment Milestones

Payments to contractors would be linked to environmental and social performance, measured by completion of the prescribed environmental and social mitigation measures. Contractors would be required to join forces with the PIU, CSC and local population for the mitigation of adverse impacts of the project. 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 PIU for the cost (as assessed by PIU) of contracting a third party to carry out the remediation work.

8.8.3 Environmental Code of Practices for Construction

The environmental codes of practice (ECPs) are generic and non-site-specific guidelines for the construction phase. The ECPs consist of environmental and social management guidelines and practices to be followed by the contractors for sustainable management of all environmental issues. The contractors will be required to follow them and also use them to prepare SSESMP. The ECPs are presented in Appendix 15 Environmental Code of Practice.

ECP 1: Waste Management

ECP 2: Fuels and Hazardous Substances Management

ECP 3: Erosion and Sediment Control

ECP 4: Topsoil Management

ECP 5: Borrow Areas Management

ECP 6: Air Quality Management

ECP 7: Noise and Vibration Management

ECP 8: Protection of Flora and Fauna

ECP 9: Water Quality Management

ECP 10: Road Safety and Traffic Management

ECP 11: Construction Camp Management

ECP 12: Cultural Heritage and Chance Find Procedure

ECP 13: Occupational Health and Safety.

8.8.4 Performance Indicators

For evaluating the performance of the environmental and social management and monitoring, performance indicators are identified to for efficient and timely implementation of measures/actions proposed in ESMP. The indicators are defined both for construction phase and operation phase. CSC will be responsible for compiling the information on these indicators and report to PIU.

To measure the overall environmental and social performance of the project, a tentative list of performance indicators is given below.

- Number of inspections carried out by CSC per month.
- Number of non-compliances observed by CSC or PIU.
- Availability of environmental, social and OHS specialists in CSC.
- Availability of EHS specialists with contractors.
- Timely reporting of documents (as defined in ESMP and monitoring plan).
- Number of training programs conducted for stakeholders/other capacity building initiatives.
- Timely disbursement of compensation/ timely resettlement of project affected.
- Timely implementation of resettlement schedule.
- Number of grievances received.
- Number of grievances resolved.
- Number of construction-related incidents, accidents, injuries, and fatalities.

8.9 Mechanisms for Feedback and Adjustment

Field Officer with the help of contractors and Supervision Consultant will submit a six- monthly progress report on implementation level of EMP to the PIU. Any deviation from the contract requirements with respect to proposed EMP should be corrected within a fortnight and records will be maintained for the same. As part of the feedback mechanism, the PIU shall monitor project compliance with respect to:

- Environmental Management Plan
- Applicable laws, rules and regulations

Public involvement shall be encouraged and ensured throughout the lifecycle of the project. The PIU shall gather and maintain information on any damage or public concern that may be raised by the local people, NGOs and local authorities. While immediate solutions are to be worked out with the help of contractor, and supervision consultant, a detailed report will be submitted to the PIU/RHD for information or detailed consideration, as the case may be. An initial coordination cum training workshop will need to be conducted for clarification of roles and responsibilities and effective implementation of the EMP.

8.10 Environmental Monitoring Plan

Environmental monitoring and inspection will consist of: (i) environmental impact monitoring; and (ii) EMP performance verification (compliance monitoring). Environmental impact monitoring will assess the degree to which the project environmental management and mitigation measures are successful in avoiding impacts to the biophysical environment (soils, air quality, water quality) and the socio-economic environment (livelihoods, quality of life, occupational health and safety, public health and safety) during the project's construction and operation phases. The PMU will engage an environmental specialist for monitoring and reporting. EMP performance verification will assess the performance of design consultants, contractors, facility operators and PMU in complying with, or adhering to, the EMP and CEMPs, beginning with documentary checks, clearances, and specialized implementation plans that must be obtained or developed before construction can begin. Performance verification monitoring will continue through the construction and operation phases. The PMU will conduct performance verification during the pre-construction and construction phases, after which this will become the responsibility of the IAs. Summary of the monitoring requirements and tasks covering all sites and all three project implementation phases are compiled in an Environmental Monitoring Table (EMoT), presented in Table 8-3. The detail monitoring plan with schedule and implementation method has been presented in Table 8-7

Table 8-3 Summary monitoring Table

Environmental Criterion	Method, Location, Parameters	Responsibility & Frequency
Pre-Construction Phase		
Project readiness	• Method: Review of PMU's and contractors' readiness to implement all component projects based on assessment of project readiness indicators • Parameters: Readiness indicators (as per Table 8-3)	• AIIB – once before construction
Detailed designs	• Method: Review detailed designs for each project facility and discuss with design firms as needed for clarification as per Table 8-3. • Parameters: Monitoring indicators listed for each design item	• AIIB and PMU - once before approval of detailed designs

Environmental Criterion	Method, Location, Parameters	Responsibility & Frequency
Plans	• Method: Review specialized plans prescribed in as per Table 8-3. • Parameters: Preparation of each plan item listed in Table 8-3.	• PMU/AIIB - once before approval of each prescribed plan
Construction Phase		
Soil erosion and contamination	• Method: Visual inspection • Location: All project construction sites, including borrow pits and access roads as applicable • Parameters: (i) adequacy of soil erosion prevention; measures; (ii) adequacy of soil contamination prevention techniques; (iii) evidence of excessive soil erosion or soil contamination	• EHSOs - daily during construction phase • PIU – quarterly
Surface and ground water	• Method: Visual inspection; worker interviews as needed • Location: All project construction sites, including borrow pits and access roads as applicable • Parameters: (i) adequacy of spill and leak prevention; measures, including storage of chemicals, fuels, lubricants; (ii) worker awareness of spill response plan; (iii) evidence of spills and leaks on ground surface; (iv) appropriate use of settling basins for process water; (v) appropriate connections to sewers and septic tanks	• EHSOs - daily during construction phase • PIU – quarterly
Air quality	• Method: Observation; interviews with local people • Location: At construction site perimeters nearest to residences; by side of access and haul roads as applicable; at borrow pits as applicable • Parameters: Airborne dust level, appearance of machinery exhaust	• EHSOs - daily during construction phase • PIU – monthly
Livelihoods	• Method: Interviews with workers and site managers • Location: At all project construction sites • Parameters: Percentage of local workers on site	• PIU - quarterly
Noise	• Method: Observation; interviews with local residents • Location: At perimeter of all sites nearest to residences • Parameters: (i) adherence to prohibition on noisy site activity between dusk and dawn; (ii) presence of functional mufflers on motorized equipment; (iii) complaints of local residents	• EHSOs - daily during construction phase • PIU - quarterly
Worker health and safety	• Method: Visual inspection; and interviews with workers • Location: At all project construction sites • Parameters: (i) worker use of personal protective equipment; (ii) adherence to the approved Health and Safety Management Plan (HSMP); (iii) performance of the EHSO; (iv) worker complaints and concerns	• EHSOs - daily during construction phase • PIU - quarterly
Public health and safety	• Method: Observation; interviews with nearby residents, interviews with local police • Location: In the vicinity of all project construction sites • Parameters: (i) adherence to approved temporary traffic management plan; (ii) adequacy of construction site signage, fencing and security presence; (iv) accidents involving public and workers; (v) emergencies and responses; (v) public complaints	• EHSOs - daily during construction phase • PIU - quarterly
Solid waste management	• Method: Visual inspection • Location: All project sites • Parameters: (i) adequacy of solid waste collection, storage, containment and disposal system; (ii) absence of solid waste dumps or evidence of waste burning; (iii) proper disposal of construction waste in legal landfill	• EHSOs - daily during construction phase • PIU - quarterly
EMP Compliance	• Method: Review of (i) monitoring reports and data; (ii) documentation of corrective action; (iii) overall contractor compliance with terms of CEMPs; (iv) project's overall adherence to EMP and loan covenants • Location: all sites • Parameters: Contractor performance relative to CEMPs and contracts; project performance relative to stipulations of EMP	• PMU, PIU - yearly
Construction Completion and Operation Phase		
Post-construction site inspection	• Method: Visual inspection • Location: All completed project facilities • Parameters: (i) general site environmental conditions; (ii) all equipment and waste removed from site; (iii) all site components, including landscaping and parking, complete	• Environmental inspection and report twice: one week before completion, once after completion

8.11 Environmental monitoring Schedule

A monitoring schedule has been sketched based on the environmental components that may be affected during the construction and operation of the project. Since project is likely to have impact

on various components of environment, a comprehensive monitoring plan covering terrestrial and aquatic ecology, soil erosion, drainage congestion, tree plantation, air quality, noise, and vibration are provided in Appendix 9. Monitoring Plan has been separately suggested for construction phase and operation phase. Monitoring points have been selected based on the sensitivity of the location with respect to sensitive receptors.

8.12 Environmental reporting

8.12.1 Quarterly reports

Concise quarterly environmental monitoring reports will be composed by the PMU, based on (i) monthly progress reports submitted by the contractors, which will include monitoring data collected by the site EHSOs; (ii) quarterly impact monitoring reports prepared PMU appointed independent environmental specialist; and (iii) its own performance verification activity. The environmental monitoring reports will reference national standards where appropriate (such as for air quality and noise), as well as benchmarks for project compliance and progress.

8.12.2 Semi-annual environmental monitoring reports

To ensure proper and timely implementation of the EMP and adherence to the agreed environmental covenants, the PMU will submit to AIIB semi-annual environmental monitoring reports, based on quarterly progress reports of the PMU. The reports should confirm the project's compliance with the EMP and identify any environment-related implementation issues and necessary corrective actions and reflect these in a corrective action plan. The performance of the contractors will also be reported on with respect to environmental protection and impact mitigation. The operation and performance of the project GRM, a well as environmental institutional strengthening and training, will be included in the annual environmental progress report as well. Table 8-5 summarizes the project's environmental reporting requirements and responsibilities.

Table 8-4 Environmental reporting requirements and responsibilities

Report	Frequency	Purpose	From	To
Contractor's Progress Report	Monthly	Satisfy EMP	Contractor	PMU
Environmental Monitoring Report	Quarterly	Monitoring of environmental effects	PMU Environmental Specialist	PMU
Semiannual monitoring report	Six-monthly	Adherence to environmental covenants and EMP	PMU	AIIB

8.12.3 Mechanism for Feedback and Adjustment

Based on environmental monitoring results, the PMU will assess whether further mitigation measures are required as corrective action, or if any other improvement in environmental management practices is called for. If the PMU identifies a substantial deviation from the EMP, or

if any changes are made to the project scope that may cause significant adverse environmental impacts or increase the number of affected people, then the PMU shall immediately consult with the AIIB to identify appropriate adjustments to the EMP.

8.12.4 Institutional Strengthening and Training

It has been acknowledged in the course of the project's preparation that expertise in the area of environmental safeguards application, and the capacity of institutions to implement safeguards programs, are well adopted in Bangladesh, although implementation process often gets neglected. Training and institutional strengthening, aimed at personnel responsible for implementing and supervising various aspects of the project EMP on behalf of the EA PMU and contractors, have been included in the project's outputs for that reason. All parties involved in implementing and supervising the EMP must have an understanding of the goals, methods, and practices of project environmental management.

Institutional strengthening: The capacities of the IA/EA and PMU to coordinate environmental management has been strengthened through engagement of national environmental consultants appointed by both PMU and ADB under the grant implementation consultancy. The PMU will lead the implementation of the EMP assisted by the consultants, with responsibility for such key tasks as ensuring project readiness; reviewing and approving designs and plans; ensuring that environmental information in bid documents and environmental clauses in construction contracts are on target; providing training on environmental mitigation measures; supervising and directing environmental monitoring; and providing guidance on environmental matters whenever needed. The work and leadership of the environmental consultants will strengthen environmental management and supervision capacity of the EA, IAs, PMU and contractors, and ensure the project's full compliance with the AIIB ESF 2016.

In addition to the activity of the environmental consultants, the project's environmental management and supervision will be enhanced by engagement of a licensed laboratory to undertake quarterly site monitoring, including quantitative measurement of air quality and noise levels at all active construction sites; this importation of technical monitoring expertise will ensure adherence to DoE standards. Finally, all contractors will be required to hire an Environment, Health and Safety Officer (EHSO) for each site under their control and empower that officer to manage the implementation of an Environment, Health and Safety Management Plan (EHSMP) for the site. With the guidance, support and supervision of the environmental consultants, the EHSOs will play a key role in ensuring sound implementation of environmental mitigation measures prescribed by the EMP. It is believed that these institutional strengthening measures will enable competent and efficient environmental management of the project. The institutional strengthening plan is summarized in Table 8-6.

Table 8-5 Institutional Strengthening Measures

Target Agencies	Institutional strengthening measures	Timing
EA	• Define institutional arrangements for environmental management, monitoring and supervision • Define positions and responsibilities	During project preparation
PMU	• Recruit and contract one national environmental consultant for environmental management, environmental training, EMP compliance review, and reporting	At start of pre-construction phase
PMU	• Recruit and contract licensed laboratory for quarterly environmental monitoring before and during • construction phase	Prior to start of construction

Target Agencies	Institutional strengthening measures	Timing
Contractors	• Hire Environment, Health and Safety Officers for each construction site	Prior to start of construction

Training: Selected personnel of the EA, PMU, IAs and contractors will receive training in environmental management, environmental monitoring and supervision, mitigation planning, emergency response, public consultation and use of the GRM, occupational and community health and safety, and other environmental management topics. The topics, methods, and estimated costs of the training are outlined in Table 8-7. Training sessions will use a workshop format. Training will be developed and provided by the environmental consultants with support of other experts engaged under the grant implementation consultant services.

Table 8-6 Training Program and implementation cost

Training Topic	Targeted Agencies	Timing	Duration, Costs
EMP Implementation: Roles and Responsibilities, Monitoring, Supervision and Reporting Procedures Grievance Redress Mechanism: Roles and Responsibilities, Procedures, Occupational and Community Health and Safety, Emergency Preparedness and Response, Pollution Control and Environmental Monitoring, Inspection and Reporting, Public Consultation Contractor Engagement and Management, including EMP Enforcement, Operation-Phase Environmental Management and Monitoring	IAs (local, regional, national), PMU, Contractors EHSOs	Prior to construction phase	2-day training BDT 200,000

Table 8-7 Environmental Monitoring Requirement

Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling, (No./year)	Responsibility	
					Implementation	Supervision
Pre-Construction Stage						
Dredged materials	Lead (Pb), Cadmium (Cd), Chromium (Cr), Copper (Cu), Zinc (Zn), Manganese (Mn), Arsenic (As), Selenium (Se), and Mercury (Hg)	Government of Bangladesh (GoB) and international standard	Proposed dredging sites	Once prior to start dredging	Contractor	RHD/Consultants
Air Quality	H2S, SOx, NOx, CO, TVOC, SPM, PM_{10}	Air quality standard by DOE, Bangladesh	Major road intersections	Once	Contractor	RHD/Consultants
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabited locations and sensitive areas	Once	Contractor	RHD/Consultants
Water Quality	Surface water: pH, TDS, EC, TSS, Fe, NH3 - N, Cl_2 DO, COD, BOD5,	Surface water quality standard by DOE, Bangladesh	Surface water near project site	Once	Contractor	RHD/Consultants
	Groundwater: pH, Mn, As, Fe, Cl", Total hardness, TC, FC	Groundwater quality standard by DOE, Bangladesh	Groundwater near project site	Once	Contractor	RHD/Consultants
Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Once	Contractor	RHD/Consultants
Tree felling	■Monitoring activities outlined in RP; ■Check whether proper compensation as mentioned in RP is received by PAPs.	Inspection	ROW along the alignment	During tree felling and site clearing operations	Contractor/ NGOs/RHD	RHD/Consultants

Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring	Responsibility	
				Period/ Frequency/ Sampling, No/year	Implementation	Supervision
Construction Stage						
Air Quality	H2S, SOx, NOx, CO,, TVOC, SPM, PM10	Air quality standard by DOE, Bangladesh	Hot mix plant, concrete mixing plant/stone crushers at construction sites	2/year	Contractor	RHD\Consultants
Dust	Dust Control	Air quality standard by Doe Bangladesh	Construction site and ROW along the alignment	Regularly	Contractor	RHD\Consultants
Noise Level	DB A	Noise Pollution Control Rules (2006)	Construction sites and inhabited location and sensitive areas	2/year	Contractor	RHD\Consultants
Water Quality	Surface water ; pH, TDS, EC, TSS, FE, NH3-N, Cl_2, DO, COD BOD_5, Oil and Greases	Water Quality Standard by MoEF, Bangladesh	Surface water near project site	2/year	Contractor	RHD\Consultants
	Ground water : pH, Mn, As, FE, Cl, Total hardness TC, FC	Water Quality Standard by MoEF, Bangladesh	Drinking water to made available to construction camps and ground water near project	2/year	Contractor	RHD\Consultants
Soil Erosion	Visual Check for Soil erosion situation		All major water bodies	Once during rainy seasons of the construction period	Contractor	RHD\Consultants
Drainage congestion	■Check drainage plan implemented correctly ■Conduct regular inspection	Monitoring	Construction site	Weekly during monsoon	Contractor	RHD\Consultants

Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring Period/ Frequency/ Sampling	Responsibility	
					Implementation	Supervision
Soil Pollution	▪ Check liquid waste is carried out by experience personnel and in proper way ▪ Careful and proper handling of	Monitoring	Constriction Yard dumping site	Regularly	Contractor	RHD\Consultants
Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Bi yearly	Contractor	RHD\Consultants
Fisheries	Impact on fish productivity breeding and spawning		All major water bodies	One in a year	Contractor	RHD\Consultants
Waster	▪ Check storage, transportation disposal handling of hazarders waste ▪ Waste and effluents to be collected and disposed safely from all camps. ▪ Vastest and garbage from bridges construction sites to be disposed safely	Monitoring	Constriction Yard dumping site	2/monthly	Contractor	RHD\Consultants
Health and Safety	▪ Check quality of food and accommodation at construction camp; ▪ Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; ▪ Check toilets are close to construction site	Monitoring	Construction site and labor camp	Regularly	Contractor	RHD\Consultants

Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring	Responsibility	
				Period/ Frequency/ Sampling, No/year	Implementation	Supervision
	separate toilet for female workers; ■ First Aid Box with required tools and medicines; ■ The heavy construction material to handled and stored safely putting due care on public safety; ■ Heavy construction materials at bridges construction sites to be stored and handled safely; and ■ Check of personal protective equipment (PPE) for worker at the sites					
Operation Stage						
Tree Plantation	Check that the planted trees are maintained as mentioned in tree plantation plan	Inspection to ensure proper plantation with proper species	Along the road	Regular during June/July	RHD	RHD\DOE
Air Quality	H2S, SOx, NOx, CO,, TVOC, SPM, PM_{10}	Air quality standard by DOE, Bangladesh	Major Road Intersections	1/year	RHD	RHD\DOE
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Major Road Intersections and inhabited locations and sensitive areas	1 /year	RHD	RHD\DOE

Environmental Components	Parameters/ Units	Standards/ Guidelines	Location	Monitoring	Responsibility	
				Period/ Frequency/ Sampling, No/year	Implementation	Supervision
Water Quality	Surface water: pH, TDS, EC, TSS, Fe, NH3 - N, Cl_2, DO, COD, BOD_5, Oil and Greases	Water quality standard by DOE Bangladesh	Surface water near project site	1/year	RHD	RHD\DOE
	Groundwater: pH, Mn, As, Fe, Cl", Total hardness, TC, FC		Groundwater near project site	1/year	RHD	RHD\DOE
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	Thought out the project section	Regularly	RHD	RHD
Soil Erosion	Visual check for soil erosion and siltation		All major water bodies	After first precipitation	RHD	RHD
Soil Quality	Heavy metals		At each construction camp post restoration of construction camp site	Once at each construction site	RHD	RHD\DOE
Wildlife	Wildlife habitat and movement	None Specific	Areas alongside the road alignment	Quarterly	RHD	RHD\DOE
Fisheries	Impact on fish productivity , breeding and spawning		All major water bodies	End of First year of Operation	RHD	RHD\DOE

8.12.5 Cost for Implementation of Environmental Management Plan

In implementation of the environmental Management Plan the contractor will play an active role. He will also be responsible for monitoring and reporting any compliance issue relevant to implementation of EMP. The following items shown in will be included in the Bill of Quantities (BOQ) for the civil works and the contractor will quote rate for these items.

Table 8-8 Mitigation Cost

No.	Activities/item	Unit	No	Rate (USD)	Quantity Per site	Amount (USD)
A. EMP Cost as PIU Budget						
1	Environmental Specialist for CSC	MM				
2	Tree Plantation*	No				
3	Fisheries	LS				
4	Transport	Veh.M				
5	Reporting	LS				
6	Health and Safety					
	(i) First Aid Box	Nos				
	(ii) Medicine	Month				
	(iii) EHSM (Environment Manager)	MM				
	(iv) Personal protective equipment	LS				
	(v) Consumable Items including Bottle Water	Month				
7	Allowance and others	LS				
8	Miscellaneous	LS				
	Subtotal (A)					
B. EMP Cost as part of the Civil works						
9	Water Supply and Sanitation					
10	Drainage Infrastructure					
	Subtotal (B)					
	Total (A+B)					

Budget for implementing various activities and mitigation measures proposed in this EMP have been estimated as XXX USD

Table 8-9 Cost of environmental monitoring during construction

No.	Activities/item	Unit	No	Rate (USD)	Quantity Per site	Amount (USD)
	A. Monitoring Cost					
1.	External Monitor	MM				
2.	Transportation for Site Visits	RT				
3.	Water Quality Testing	No				
4.	Riverbed Material Quality Testing Cd, (Pb, Cr, Cu, Zn, Mn, As, Se and Hg)	No				
5	Contingency	LS				
	Total					

8.13 Grievance Redress Mechanism

8.13.1 Introduction

Given the features of this project, in general, complaints may arise at any stage of the project cycle. To manage and efficiently resolve resettlement and project-related disputes, concerns and complaints, a Grievance Redress Mechanism (GRM) for Project-affected Peoples (PAPs) will be established by this project. Along with an IT-based GRM, a local level GRM has been designed to resolve resettlement benefits, relocation, and other assistance related issues. The GRM will be officially recognized as a community-based system to resolve disputes to resolve project level disputes emanating from land acquisition, compensation and resettlement, environment, safety, and social concerns. Moreover, a separate GRM focusing on labour issues, including wage rates, lack of appropriate facilities, and lack of protection for female workers from GBV, sexual exploitation, and abuse by labour suppliers, supervisors, and others who deal with workers will also be established.

8.13.2 Objectives of the GRM

The following are the objectives of the GRM:

- Provide a transparent, inclusive, and consultative framework for the timely identification and resolution of issues affecting the project and the people at the local level. The grievances can be related to environmental and social impact, and resettlement and compensation program when triggered.
- Act as a feedback mechanism
- Strengthen accountability to beneficiaries and PAPs.

GRM will be an accessible channel through which individuals and communities will be able to lodge complaints and obtain feedback if they feel that project intervention or actions of personnel will harm them. This mechanism promotes an efficient method of identifying, lodging, processing, and resolving complaints with the help of the stakeholders. Decisions will be reached by the committee based on consensus, and the mechanism will aid in the resolution of issues amicably and rapidly, thereby preventing the aggrieved party from resorting to expensive and time-consuming legal proceedings. Further, the establishment of the GRM strengthens the transparency and accountability of the project to the project beneficiaries and workers. A grievance redress system established in the spirit described thus far should reduce project risks and serves as an essential feedback mechanism that may allow the benefits of the project to be inclusively and equitably shared.

PAPs will be informed about their rights and procedures for lodging complaints (whether verbally or in writing) during the consultation sessions, survey, and at the time of compensation[17]. A robust GRM will ensure that project-related grievances are locally mitigated consensually and rapidly. Nonetheless, the project design and implementation strategies using sound consultation and communication methods and technical assistance will aim to reduce or prevent any grievances from arising. A combination of careful planning and design of land acquisition and resettlement strategies, along with utilizing feedback from PAPs

[17] Consultations and FGDs will be carried out throughout the project cycle

obtained through regular, meaningful, consultation, and strengthening coordination among the affected communities, RHD, and the government is expected to reduce project level grievances from occurring.

The following sections provide information on the GRM protocol to be implemented, disseminated, and monitored.

8.13.3 Grievance Redress Committee

The GRM will be accessible to all internal and external stakeholders, including affected people, community members, civil society, media, vulnerable people, and other interested parties. The GRM is expected to address the various issues raised robustly, timely, and cost-effectively. The GRM will cover a variety of ranging from land acquisition, resettlement, the dispute over ownership, the value of an affected asset, assets not accounted for in census, and compensation payment as well as construction-related concerns. A Grievance Redress Committee (GRC) will be formed. The grievance redress procedures and operational rules will be widely publicized during community meetings, and pamphlets in the local language will be distributed to ensure that stakeholders are aware of their rights and procedures to redress grievances.

The RHD will post a manager or deputy manager in the rank of Executive Engineer (SDE) or above at the worksite. This officer will also be responsible for the implementation of the resettlement plan and will also work closely with the Project Implementation Unit (PIU). The gazette notification on the formation and scope of work of the GRC will be required from the RHD/MoRTB. The GRC will be comprised of:

- One representative of RHD, at least of the level of SDE, to be nominated by the RHD as convener.
- The Area Manager of the PIU as Member Secretary.
- The Chairman or his representative of the UP/Municipality where the complaint is registered.
- One representative of the PAPs as Member.
- Women member of local Union Parishad / Municipality as Member.

A legal advisor may be appointed by the PIU to obtain suggestions concerning the resolution of disputes and to ensure that the affected parties get justice outside the courts. However, the legal advisor will not be part of the GRC. For this project, the conveyor and the representative of the DC office land acquisition section will be fixed; however, other members may vary depending on the location of meetings the members[18]. The GRC will be empowered to resolve resettlement, compensation, and environmental issues that are currently not under review by the courts. The PIU will facilitate and forward the grievances received from the impacted individuals to the GRC.

Moreover, the PIU will assist the PAPs and other aggrieved parties in lodging their complaints in a format that is acceptable to the GRC. The PIU will ensure that that the PAPs and other

[18] Meetings may take place across various Upazila and unions and hence members may change.

stakeholders are informed about the GRM system, the composition and role of the GRC, and the procedure of lodging complaints and seeking redress. However, it is essential to define the exact scope of the GRC to reduce confusion among PAPs and improve efficiency in the grievance redressal process. The following are the scope and jurisdiction of work of the GRC:

8.13.4 The scope of work and jurisdiction of GRC

(i) After receiving the complaints/grievances, the GRC will review, consider, and resolve grievances related to social/resettlement and environmental issues during implementation, as received by the committee.
(ii) Any grievances presented to the GRC should ideally be resolved on the first day of the hearing. In cases of complicated cases requiring additional investigations, it should be resolved within a period of one month.
(iii) GRC will also review the grievances of indirectly displaced persons and/or persons displaced during project implementation.
(iv) The GRC will not engage themselves in any review of the legal standing of an "awardee" other than indirect losses or distribution of shares of acquired property among the legal owners and associated compensation or entitlement issues.
(v) GRC decisions should ideally be arrived at through consensus, failing which resolution will be based on a majority vote. Any decision made by the GRC must be within the purview of social, resettlement, and environmental policy framework.
(vi) The GRC will not deal with any matters pending in the court of law. But if the parties agree on through a written appeal, GRC can mediate. The parties will withdraw the litigation.
(vii) A minimum of three (3) members shall form the quorum for the meeting of the GRC.

GRC meetings will be held in the RU field office in the project area or any other location, as agreed by the committee members. If required, the GRC members may undertake a field visit to investigate and review the issues causing the grievance, including land ownership, the reason for any delay in a compensation payment, or other relevant matters. Moreover, all the GRC members, including the Convener, will be given a sitting allowance of BDT 800 for each meeting and BDT 15 per km as conveyance allowance. All costs related to the meeting, which may include travel etc. will be borne by the PEA through the PIU.

The PAP will be able to file their grievances without any fear or coercion. Where required, the implementing NGO will assist the PAPs in drafting the grievances. All grievances must be submitted in writing to the Chair of the GRC, and a grievance log will be created. includes a sample grievance log. The aggrieved party may be represented by the PAP themselves or by an appointed agent such as a local elected representative and or legal advisor. The judgment made by the GRC will be communicated to the concerned PAP in writing. If dissatisfied, the PAP through GRC may request a further review of the judgment by the Project Director. In such situations, the case will be forwarded to the PD with all documents. If the aggrieved party remains dissatisfied after this stage, he/she may go to the formal court of law. The grievance redress system of the project does not bar any aggrieved persons from seeking resolution from the court of law at any stage.

GRC procedures and operational rules governing it will be publicized widely through community meetings and pamphlets in the local language (Bangla) so that PAPs are aware of their rights, obligations, and procedures related to seeking the redressal of grievances. Figure 1 illustrates the GRM process. All GRC documents, including a grievance log, will be maintained by PIU for review and verified by supervision consultants and AIIB. RHD Field Office(s) will act as the Secretariat to the GRCs as it is the office of the Convener. As a result, the records will be up-to-date and easily accessible onsite.

Table 8-10 Sample Grievance Log

a.	Individual Reference Number
b.	Name of the person submitting the complaint, question, or other feedback, address and/or contact information (unless the complaint has been submitted anonymously)
c.	Details of the complaint, feedback, or question/her location and details of his / her complaint.
d.	Date of the complaint.
e.	Name of the person assigned to deal with the complaint (acknowledge to the complainant, investigate, propose resolutions, etc.)
f.	Details of the proposed resolution, including person(s) who will be responsible for authorizing and implementing any corrective actions that are part of the proposed resolution
g.	Date when the proposed resolution was communicated to the complainant (unless anonymous)
h.	Date when the complainant acknowledged, in writing if possible, being informed of the proposed resolution
i.	Details of whether the complainant was satisfied with the resolution, and whether the complaint can be closed out
j.	If necessary, details of GRC referrals, activities, and decisions
k.	Date when the resolution is implemented (if any).

Below Table highlights the steps involved in redressing grievances. If aggrieved PAPs continues to remain dissatisfied after stage 7, the GRC will forward the cases to the Project Director (PD) for further review. Convener and Member Secretary of GRC will present the case records to the PD and facilitate impartial review of the complaints. Proceedings of such review meetings will be available for review by AIIB. Member secretary will present the case of the aggrieved DPs in the upper review and settlement focal points in the presents of the Convener, GRC.

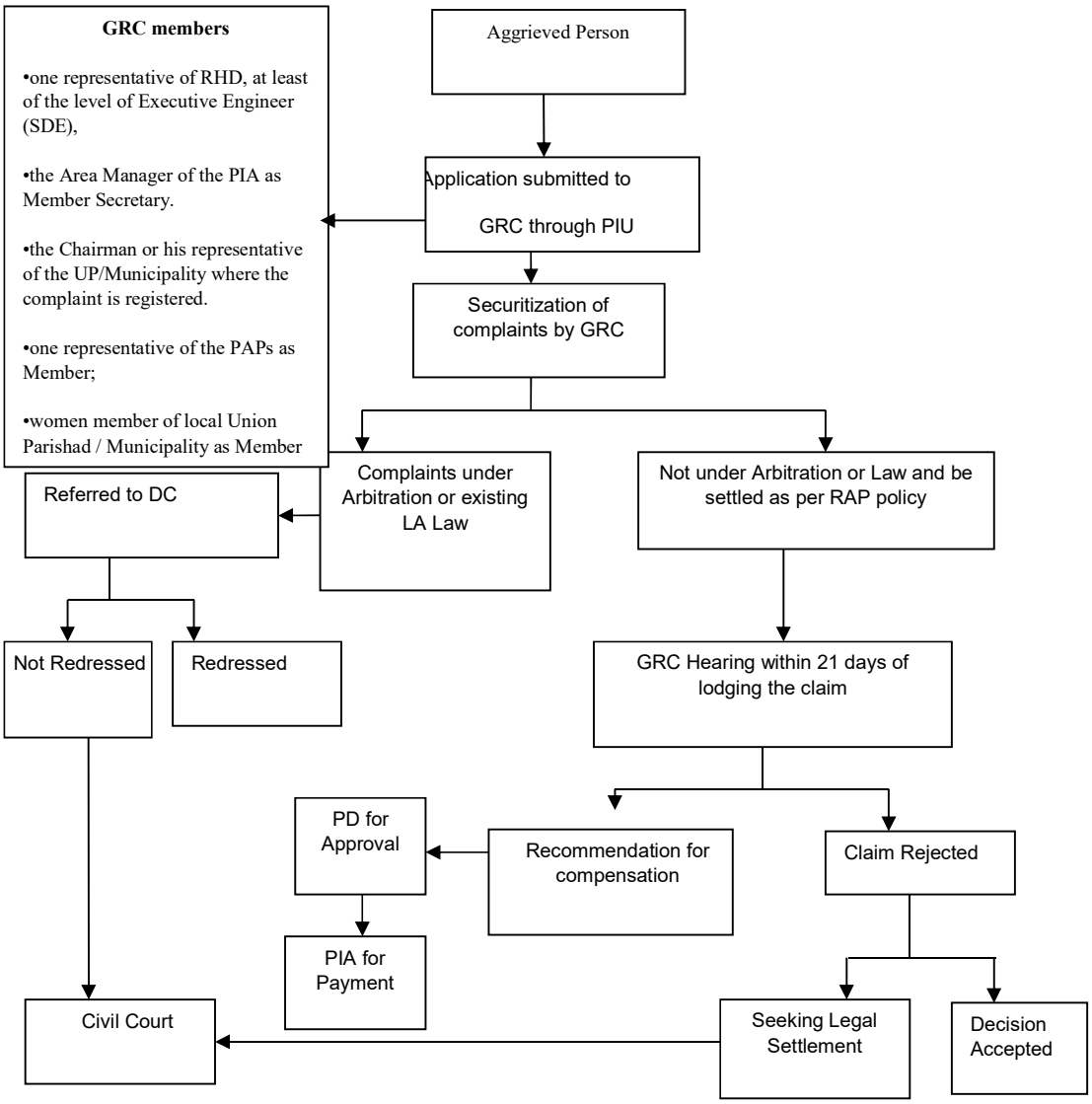

Figure 8-2 GRM Mechanism

Figure 8-3 Steps in Grievance Redressal

Steps

	The Project Implementing Unit (PIA) informs PAPs about their losses and entitlements. If satisfied, the PAP claims resettlement payments to the PEA. If confused, proceed to Step 2
	The PAP approaches the IA field level officials for clarification. The IA will inform and clarify the PAPs about their losses & entitlements as per RAP policy. If resolved, the DP claims resettlement payments, the PEA should be implementing agency. If not resolved, proceed to Step 3
	The PAP approaches the GRC. PIU staff assists the PAPs in producing the complaints and organize hearing within 21 days of receiving the complaints. Both written complaints in the local dialect and verbal complaints are acceptable. IA shall assist the PAPs to prepare a written form for succeeding procedures at no cost to PAPs. Then proceed to Step 4
	GRC to scrutinize applications, cases referred to Deputy Commissioner through PIU if the case is under arbitration law and beyond their mandate as per the scope of work. If the case is within the mandate of GRC, proceed to Step 5
	GRC sessions held in the presence of the aggrieved PAPs, minutes recorded. If resolved, the Project Director approves the decision of the GRC. If not addressed, proceed to Step 6
	The PAP may accept the GRC decision. If not, he/she may file a case to the PPD for settlement. Then proceed to Step 7
	The PPD, with the help of CRO and Convener and Member Secretary of GRC, reviews the case, and the decisions are conveyed through the concerned PAP. If the decisions are not accepted, it moves to Step 8
	The GRC minutes, approved by the Project Director, received at Conveners' office back. The approved verdict is communicated to the complainant PAP in writing. The PAP then claims resettlement payments to PEA. If the decisions are not excepted, the PAP moves to Step 9
	When the PPD's decisions are not accepted, the PAP may go to the court of law, which takes the final decisions and the resettlement benefits are given accordingly

8.13.5 Grievance Redressed Procedures

i) All complaints from the PAPs will be received at the field office of the PIU, with a copy to the concerned local government representatives.

ii) The PIU, upon receipt of complaints, will inform the Convener of GRC, and the Convener will organize a hearing session for the complainants in the local government office where the complaint was received.
iii) The GRC will review the issues gathered through the hearing and pass verdict to convey to the concerned PAP through the PIU.
iv) If there are matters relating to arbitration or compensation under the existing law, the case will be referred to the DC for necessary lawful decisions.
v) The PAPs will be assisted by the PIU in this process and will monitor the progress.
vi) The GRC will settle the disputes within a maximum of 21 days of receiving the complaints from the PAPs.
vii) The resolution of the GRCs will be sent to the PPD for approval. After approval, these will be adopted in the process of resettlement for issuance of ID cards, determination of loss and entitlements, and payment thereof.
viii) If the PAP does not agree with the GRC decisions, he is free to go to the court of law, and this must be accepted as the final decision.
ix) PAP will have to accept the decisions, and the entitlements of compensation, along with amounts, will be prepared following the policy matrix of this RAP.
x) The PEA will bear all the GRM costs through the PIU.

8.13.6 IT (Mobile Technology)-Based GRM

An IT-based GRM will be developed to document the complaints filed by the PAPs for improved screening. The use of IT enhances the overall communication between the PAPs and the PIU.

Grievances raised by PAPs are considered as a dispute in response to project interventions, and they have formally registered following grievance redressal the procedures. The core principals underpinning any sound GRM strategy include directing sincere attention to the grievance and resolving the complaints in a timely and cost-effective manner locally by the project authority. A mutually beneficial attitude is desired from both parties to resolve the grievances effectively. To resolve the disputes, the following procedure will be made available to the PAPs to establish a conversation or dialogue with the Project Authority. The procedure of lodging grievances using mobile technology solutions is as follows-

- PAPs will send SMS (Toll-free) to a fixed number to communicate with the Project Authority expressing their problems for which they seek a resolution.
- The project authority will provide a fixed mobile number/mask address (toll-free).
- The project authority will promptly recognize the problems and to take necessary measures to resolve the problems within their legal capacity.
- The project Authority will inform the decision concerning the problems to the PAPs via SMS.

In the current project, a Grievance Management System will be introduced using IT Solutions. Such a system and can be monitored by the relevant ministries, development partners, and the project authority and other relevant agencies.

8.13.7 GRM for Dealing with Labor Issues

The GRM, in its present scope, seeks to address grievances raised by PAPs and other local stakeholders. However, there is a need to establish a separate GRM to manage labor-related

issues exclusively. Recent international experience suggests that labour GRM becomes more pertinent in projects that involve heavy civil works and labour influx into the project area.

A GRM mainly focused on labour seeks to resolve issues concerning wage rates and unpaid overtime work; irregular and partial payments; inadequacy of living accommodations; lack of clean drinking water and sanitation facilities; lack of medical care in emergencies; lack of protection against gender-based violence, sexual exploitation and abuse (GBV/SEA) of female workers by labor suppliers / sardars, supervisors, and others who also deal with workers.

The GRCs dealing with labour grievances/complaints will have members who are either directly or indirectly associated with the construction and other works under the individual Contract packages. Each GRC will have five members:

(a) PEA official who is in charge of all construction and other activities at individual worksites will act as Convener;

(b) Resident engineer of the Construction Supervision Consultant;

(c) A male worker representing the workers;

(d) A female worker representing the workers;

(e) A PEA official, designated by the Project Director, who is not associated with the construction activities in the field, but a member of the PIU.

9 DISASTER IMPACT ASSESSMENT (DIA) AND EMERGENCY RESPONSE PLAN

9.1 Disaster Impact Assessment (DIA)

Disaster Impact Assessment (DIA) is a methodology to assess development projects from the viewpoint of disaster risk reduction by identifying the improvement points of the project. Based on the findings revisions to the project can be made to improve environmental and in-situ disaster performances.

9.1.1 Disaster Management

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes cyclonic storms, heatwave, fire and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of rail way track and rail stations. The potential causes are excessive load, cracks, failure and malfunctioning of sensing instruments, accident, etc. These need to be looked into with care.

Disaster can create considerable losses and damages related to development projects. Therefore, measures should be taken from the beginning of the project to avoid any potential damage or loss from the project implementation and operation.

If DIA system is incorporated in the project planning and implementation system, the extent of damages and losses can be avoided or minimized to a higher degree. Therefore, DIA is a necessity now a days for development projects.

Related to development projects there are three types of disasters: i. disaster caused by development actions in the surrounding area; ii. Disasters due to development actions itself; and iii. Disasters due to the surrounding area caused by the development action and natural causes (i.e. earthquake, cyclonic storm, heatwave, lightning etc) which had been damaged by disasters. Common disaster from project and natural causes analysis may involve 5 major steps: Screening; Criticality; narrative; workshop and detailed analysis.

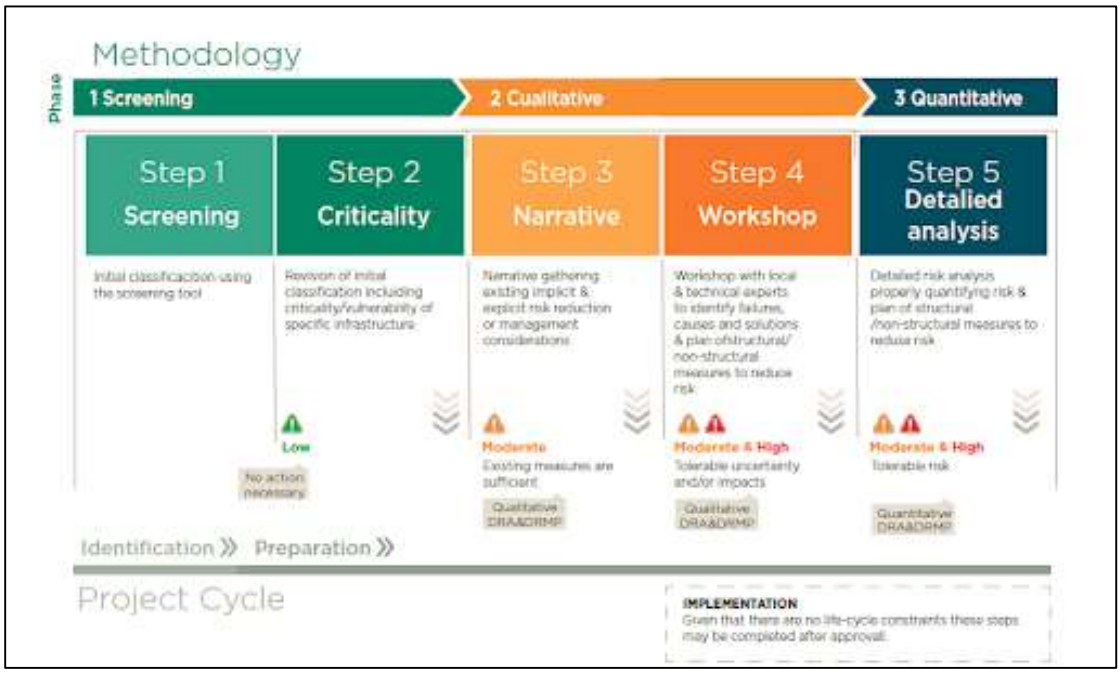

Figure 9-1 Common disaster assessment framework

9.1.2 Concept of DIA

The concept of DIA involves both technical and natural disaster (Figure 9-2). While for natural disasters, we can only plan how to reduce damage, for technical disaster the plan is made to prevent damage.

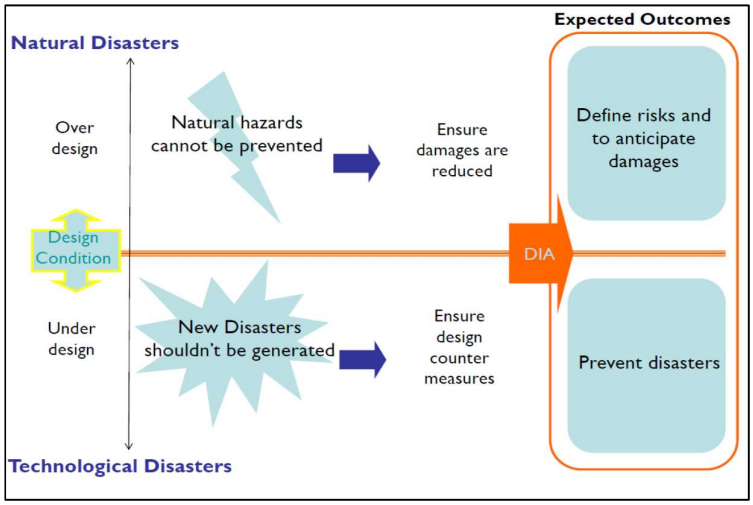

Figure 9-2 Concept of DIA

DIA is done at the feasibility stage. Assessment of any development project before its construction takes highest importance from the disasters point of view. Again, disaster can happen during construction and maintenance. See Figure 9-3 for details.

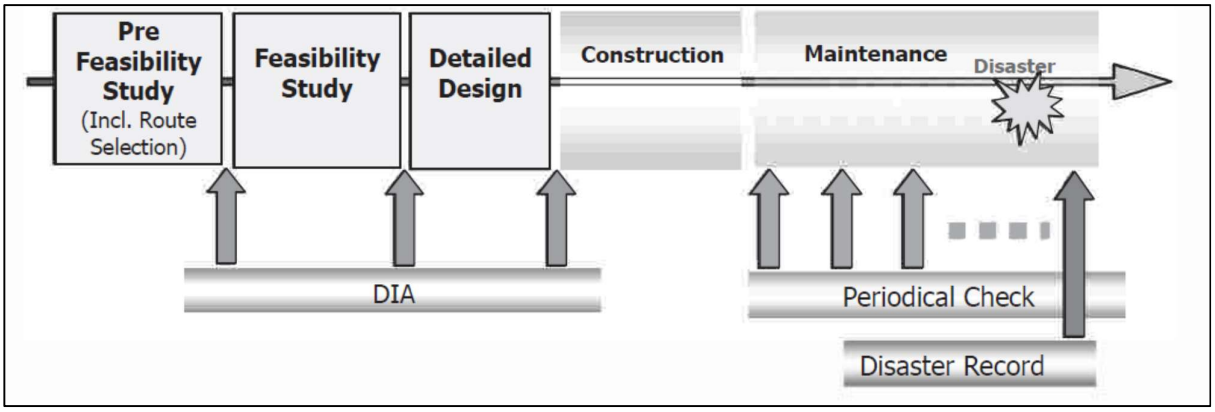

Figure 9-3 Ideal state of DIA

The following paragraphs contain general prevention plan that came out from DIA. However, the DIA should be a separate study and planned according to the project's feasibility.

9.1.2.1 Prevention action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Engineers responsible for preventive action should identify sources of repair equipment, materials, labour and expertise for use during emergency.

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details.

The Engineer-in-Charge should notify the officer for the following information:

- Exit points for the public,
- Safety areas along the railway, and
- Nearest medical facilities.

9.1.2.2 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

9.1.2.3 Emergency Response Committee (ERC)

To ensure coordinates action, an Emergency Response Committee (ERC) should be constituted. The civic administrator may be the Chairman of this Committee. The committee may comprise of:

- Representative of the Project Director (PD)
- Representative Engineer in charge from BR
- Representatives from local police stations
- Representative from railway police
- Representative from local fire brigade stations
- Representative of Public relations from BR
- Local NGO representative

Emergency Response Committee (ERC) will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,
- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of joint control room.

All personnel involved in the Emergency Response Plan (ERP) should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

9.2 Emergency Response Plan (ERP)

The mission of this Emergency Response Plan (ERP) is to maximize the use of combined resources of the proposed rail development project to:

i. Control and/or extinguish fires or explosions;
ii. Contain leakages or spillages;
iii. Rescue people and bring for treatment if necessary;

iv. Safeguard human lives; and
v. Minimize damage to property and environment.

9.2.1 Objective

The Objectives of this Plan include:

1) Define the Emergency Response Organizational Structure;
2) Define Emergency Response terminology;
3) Define criteria for establishing Response Objectives;
4) Define Resources (personnel & equipment) that can be accessed and/or released in the event of an incident; and
5) Define the roles and responsibilities of Command and Support staff;

9.2.2 Scope

This plan applies to emergency response activities carried out by the IMTs and ISTs of consortium, regardless of incident type and size. This Plan also supports, but DOES NOT REPLACE, Local and/or Corporate-Level Procedures, including Local Procedures and Plans that are maintained and utilized by the Emergency Response Team (ERT) and Implementation Management Team (IMT).

9.2.3 Emergency Response Tool-Kit

Incident Command System (ICS) Form, Incident Management & Incident Support Handbooks and other resources are available, to provide in greater detail of the Reactive, Proactive, and Post-Active Incident Command Systems/Structure.

9.2.4 Incident Classification

The level of emergency defines the severity of the incident, the potential hazards to the public and the environment, and the appropriate response. A level is assigned when the emergency meets one or more conditions of the higher level. For example, if an incident meets several conditions under Level 1 (minor) and Level 2 (serious) in the table below the level of Emergency.

CONDITION	LEVEL 1 – MINOR	LEVEL 2 – SERIOUS	LEVEL 3 – CRITICAL
Threat or Injury to Workers or Public	No immediate threat.	Some injury or threat.	Serious injury or fatality and/or ongoing threat.
Containment within Company Property	No threat to company facility infrastructure. No effects outside company property.	Potential threat to company facility infrastructure. No immediate threat outside company property, but potential exists to extend beyond boundaries.	Ongoing or imminent threat to facility infrastructure. Effects extend beyond company boundaries.
Control of Product	Control completed or pending.	Control likely imminent.	Uncontrolled release of product continues and control is not imminent.
Potential Environmental Effects	Minimal.	Moderate.	Significant and ongoing.
Media Interest	Little or no interest.	Local or regional interest.	National or regional interest.
Response Capability	Incident is handled by ZICOM	First responders and government agencies are likely to be directly involved.	Immediate and significant government agency involvement.
Potential to escalate	Low.	Moderate, based on potential for fire, explosion, increased release of product, or other hazard.	High, based on potential fire, explosion, increased release, or other hazard.
Examples	• Vehicle accident involving facility with moderate to major damage to facility • Damage to facility equipment and/or piping with gas release <LEL beyond 3m; control expected within 4 hours • Gas release beyond site affecting public safety, area successfully evacuated • Underground leak on pipeline and outside of facilities not entering structures or underground utilities	• Unable to control damage on site, requiring control off site • Damage to facility equipment and/or piping with gas release >LEL beyond 3m • Underground leak on pipeline entering structures or underground utilities; control expected within 4 hours • Facility overpressure condition discovered and controlled • Gas release beyond site affecting public safety; area evacuated within 1 hour • Failure of facility to deliver downstream supply; <10,000 customers without service	• Underground leak on pipeline, entering structures or underground utilities; control not expected for more than 2 hours • Facility overpressure condition discovered and not controlled • Failure of facility to deliver downstream supply; >10,000 customers without service

Figure 9-4 Level of emergency

The procedure aims identifying potential emergency situations that can have adverse impacts on safety, health or environment and to employees, property and the general public. The procedure has also identified appropriate mitigation and response actions to be taken in the event of occurrence of emergencies.

Emergency response management is the process of preparing for, mitigating, responding to and recovering from an emergency. Emergency response management is a dynamic process. Planning, though critical, is not the only component. Training, conducting drills, testing equipment and coordinating activities with the community are other important functions.

To be successful, emergency response management requires upper management support. The chief executive sets the tone by authorizing planning to take place and directing senior management to get involved. Among others, the advantage of having a properly designed ERP includes:

- It helps companies to protect employees, the community and the environment;
- It facilitates compliance with regulatory requirements;
- It enhances a company's ability to recover from financial losses, regulatory fines, loss of market share, damages to equipment or products or business interruption;
- It reduces exposure to civil or criminal liability in the event of an incident;
- It enhances a company's image and credibility; and
- It reduces the company insurance premiums.

9.2.5 Contents of ERP

Contents of ERP documents are listed below:

a. Classification of emergencies;
b. Implementation schedule;
c. Consequences of defaults or non-compliance;
d. Statutory requirements;
e. Pre-emergency planning;
f. Emergency mitigation measures;
g. Emergency preparedness measures;
h. Emergency response procedures and measures;
i. Emergency organization and responsibilities;
j. Infrastructure requirements;
k. Declaration of on-site and off-site emergency;
l. Resources for controlling emergency;
m. Medical facilities;

9.2.6 Classification of emergencies

ERP has been developed to deal with emergency incidents which occur within the Narsingdi and Titas location C gas fields. Emergency incidents will be classified by the level of response that will be required. The actual classification will be made by the Location-In -charge (LIC) or his nominee as information first becomes available on an incident. The level of response may change as more information becomes available or conditions change. Where information is lacking the worst-case scenario will dictate the level of response. In both locations (Narsingdi and Titas C) premises, probable emergencies can be categorized into three broad levels on the basis of seriousness and response requirements, which are given as under-

Level - 1 Emergency: This is an emergency or an incident which can be effectively and safely managed, and contained within the site, location or installation by the available resources. It has no impact outside the site, location or installation.

Level- 2 Emergency: This is an emergency or an incident which cannot be effectively and safely managed or contained at the site, location or installation by available resource and additional support is required. It is having, or has the potential to have an effect beyond the

site, location or installation and where external support of mutual aid partner may be involved. It is likely to be danger to life, to the environment, to company assets or reputation.

Level- 3 Emergency: This is an emergency or an incident which could be catastrophic and is likely to affect the population, property and environment inside the installation of compressors, and management and control is done by consortium. Based on the nature of emergency & severity, the levels of type of emergency to be declared will be decided by the location in charges. Various possible types of emergencies are tabulated as below: Note: Level-I has been considered for fire drill followed with onsite emergency. However, Level-II shall normally be considered as onsite emergency and Level-III as off-site emergency.

Table 9-1 Type of emergency levels

SL. No.	Type of Emergency	Applicable EAP	Description of Emergency
1	Level-1	On site	• Minor injuries inside camps, within construction site • Power failure
2	Leve-2	On site	• Spillages from storage vessel during receipt. • Leakage from waste water bund, bentonite clay • Failures caused by corrosion defects, accidental spillage of sediment into the agricultural lands • Local accident with construction transport trucks, primary level injuries
3	Leve-3	Off Site	• Fatal accidents • Vapor cloud explosion. • BLEVE (Fireball) • Agitation / forced entry by external group of people. • Natural Perils – Earthquake, flood, tsunami • Sabotage, Bomb explosion / Threat

Personal Protection Kits: Consortium's operations personnel who could be dispatched as a first responder to a gas field incident should have the following as standard personal equipment:

- Combustible gas indicator
- Fire-resistant coveralls
- Hard hat
- Safety Eyewear
- Safety Footwear
- High Visibility Apparel
- Gloves
- Hearing protection
- First aid kit
- Cell phone
- Flashlight (with extra batteries)
- Notepad, pen, pencil

- Emergency Response Plan at both sites
- Transmission Pipeline & Compression Emergency Response Guide (Orange Card)
- Standard Field Guidelines for Gas Emergencies (Pink Card)
- Road Tanker Emergency Guidelines (Blue Card)
- Responding to Spills (Green Card)

9.2.7 Organization of ERP

A general ERP organization is depicted in Figure 9-2:

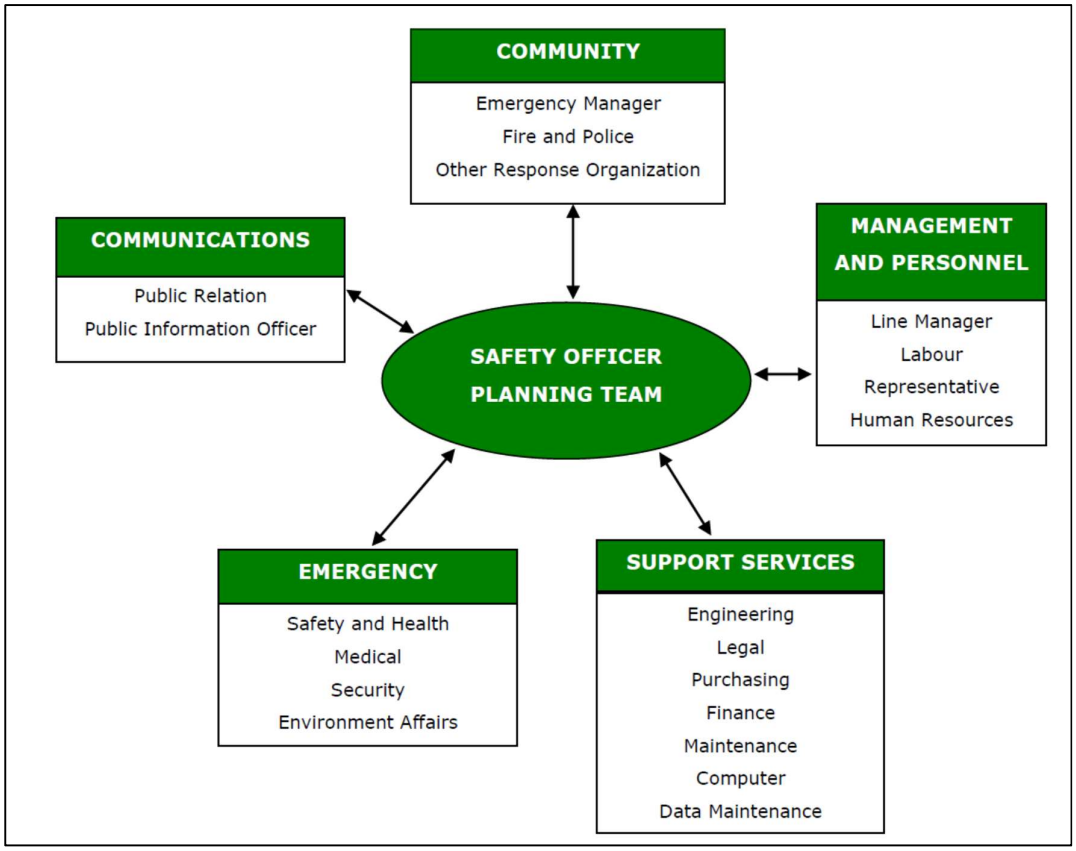

Figure 9-5 General organogram of ERP

9.2.7.1 Execution of Emergency Response Procedures

The purpose of this ERP is to ensure that any form of emergency, which interrupts normal and safe working conditions in the RHD facility, can be dealt with in a systematic manner. Operational procedures are spelt out to enable a coordinated plan of action to be carried out to control the emergency situation and to restore it back to normal.

9.2.7.1.1 Procedures of Evacuating Employees and Visitors

Effective warning systems are already in place. The order to evacuate shall only be given by the Incident Commander (IC). Normal format of the evacuation announcement is as follows:

> "Attention to all employees and visitors. There is a major fire at …… please remain calm. Everybody shall leave his/her workplace immediately and proceed to their nearest assembly point".

9.2.7.1.2 Direction and Control

The system for managing resources, analysing information and making decisions in an emergency is called direction and control. For the proposed facilities, since the number of workers as well as the population in the surrounding community is relatively small, the structure for command control will be relatively simple.

Emergency Management Group (EMG): The EMG is the team responsible for the big picture. It controls all incident-related activities. The Incident Commander (IC) oversees the technical aspects of the response. The EMG supports the IC by allocating resources and by interfacing with the community, the media, outside response organizations and regulatory agencies. The EMG is headed by the Emergency Director (ED), who should be the facility manager. The ED is in command and control of all aspects of the emergency. The central EMG should be selected by the ERC at the beginning of the construction and operation stage who can determine the station-wise EMGs. The central EMG members should be senior managers who have the authority to:

- Determine the short- and long term effects of an emergency;
- Order the evacuation or shutdown of the facility;
- Interface with outside organizations and the media; and
- Issue press releases.

Incident Command System (ICS): The ICS provides for coordinated response and a clear chain of command and safe operations. The Incident Commander (IC) is responsible for front-line management of the incident, for tactical planning and execution, for determining whether outside assistance is needed and for relaying request for internal resources or outside assistance through the Emergency Operations Centre (EOC). The EOC should be placed at BR headquarters and should be headed by central EMG (Figure 9-6).

The IC can be any employee, but a member of management (i.e. EMG) with the authority to make decisions is usually the best choice. The IC must have the capability and authority to:

- Assume command;
- Assess the situation;
- Implement the ERP;
- Determine response strategies;

- Activate resources;
- Order an evacuation;
- Oversee all incident response activities; and
- Declare that the emergency is over.

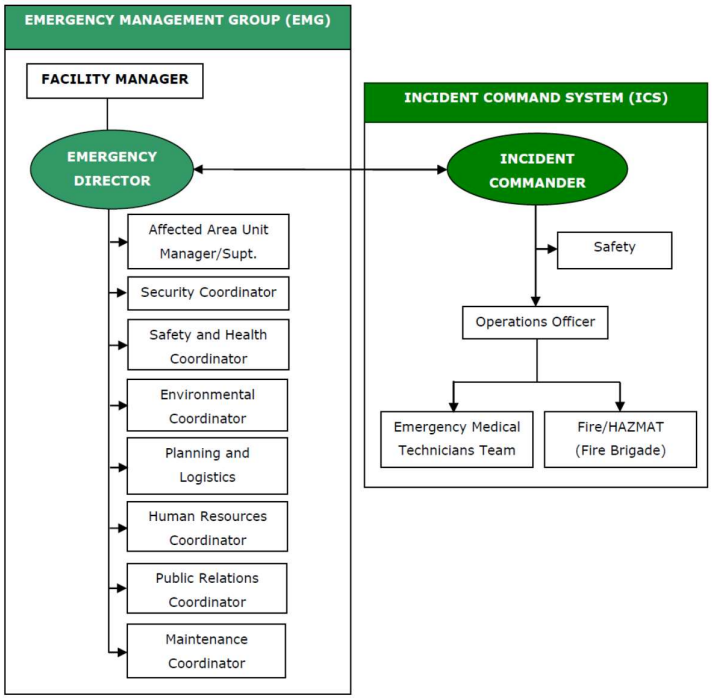

Figure 9-6 Relation between EMG and ICS

Emergency Operations Centre (EOC): The EOC serves as a centralized management centre for emergency operations. Here, decisions are made by the EMG based upon information provided by the IC and other personnel. The EOC is a dedicated area equipped with communications equipment and all the tools necessary to respond quickly and appropriately to an emergency.

9.2.8 Communication

Communications are needed to report emergencies, to warn personnel of the danger, to keep families and off-duty employees informed about what's happening at the facility to coordinate response actions and to keep in contact with customers and suppliers.

9.2.8.1 Contingency Planning of Communication

Contingency plan for temporary or short-term disruption to a total communications failure must be established. In case of failures, procedures for restoring communications system via some agreed arrangements with the communication vendors must be ascertained. The options to include communication systems such as messengers, telephones, portable microwave, amateur

radios, point-to-point private lines, satellite or high-frequency radio is necessary.

9.2.8.2 Emergency Communications

Systems to facilitate the communication between the various emergency management respondents must be clearly stated and in-place. These include the requirement for effective communications between:

- Emergency responders;
- Responders and the Incident Commander (IC);
- The IC and the Emergency Operations Centre (EOC);
- The IC and employees;
- The EOC and outside response organizations;
- The EOC and neighboring business;
- The EOC and employees' families;
- The EOC and customers; and
- The EOC and media.

The system is tested at reasonable frequency. In addition, the alarm systems are tested on a monthly. Methods of communication include telephone, two-way radio, fax machine, microwave, satellite, dial-up modems, local area networks, hand signals and public address (PA) system.

9.2.8.3 Family Communications

During an emergency, employees need to know whether their families are safe and therefore proper plan for communication with families of all employees must be designed. Also, encourage employees to:

- Consider how they would communicate with their families in case they are separated from one (1) another or injured in an emergency;
- Arrange for an out-of-town contact for all family members to call in an emergency; and
- Designate a place to meet family members in case they cannot get home in an emergency.

9.2.8.4 Notification

Procedures for employees to report an emergency must be clearly spelled out and employees must be well-informed on the issue. Emergency telephone numbers are posted near each telephone, on employee bulletin boards and in other prominent locations. Updated list of addresses contact number and pager numbers of key emergency response personnel (from within and outside the facility) are maintained. Notification is made immediately to local government Roads and Highways Department

agencies when an emergency has the potential to affect public health and safety.

9.2.8.5 Warning

Effective warning system is configured. The system is audible or within viewed by all people in the facility, have an auxiliary power supply and have a distinct and recognizable signal. The system is instantaneous such that effectively 30 minutes are available for the intended evacuation. The system is tested at least monthly.

9.2.8.6 Human Safety

Protecting the health and safety of everyone in the facility is the first priority during an incident or emergency. In this case, it involves an evacuation of employees and visitors during major fire or explosion. Based on theoretical modelling, the most hazardous event, vapour cloud explosion as a result from flammable released from both existing and the proposed plant but it does not reach the residential areas nearby.

As soon as the first sign of emergency is detected, the employees and visitor within the vicinity of the clinical waste treatment plant will immediately be directed to go to the assembly area inside the construction/maintenance/disaster site. An emergency door needs to be built in order to facilitate the evacuation during emergencies.

9.2.8.7 Evacuation Planning

One (1) common means of protection is evacuation. In the case of fire or explosion, an immediate evacuation to a predetermined area away from the facility is necessary.

9.2.8.7.1 Evacuation Routes and Exits

Designate primary and secondary evacuation routes and exits are clearly marked and well lit. Emergency lighting is strategically installed in case of power outage occurs during and evacuation. The evacuation routes and emergency exits are:

Wide enough to accommodate the number of evacuating personnel;

- Clear and unobstructed at all times; and
- Unlikely to expose evacuating personnel to additional hazards. Have evacuation routes evaluated by someone not in the organization.

Consider on how to access important personal information about employees (home phone, next-of-kin, medical and etc.) in case of emergency, are stored and made available on computer disks.

9.2.8.7.2 Assembly Areas and Accountability

The number of head count at assembly areas will depend on the employees and visitors present at the site. In case of an incident, with proper warning system, all personnel will be directed to assembly area. The procedures below are followed:

- Designate assembly areas where personnel should gather after evacuating;

- Take a head count after the evacuation. The names and last known locations of personnel not accounted for are determined and given to the EOC. (Confusing in the assembly areas can lead to unnecessary and dangerous search and rescue operations);
- Establishment of method for accounting of non-employees such as suppliers and customers through registration; and
- Establishment of procedures for further evacuation in case the incident expands. This may consist of sending employees home by means of providing them with transportation to an off-site location.

9.2.8.7.3 Shelter

In some emergencies, the best means of protection is to take shelter either within the facility or away from the facility in a public building.

- Consider the conditions for taking shelter;
- Identify shelter space in the facility and in the community. Establish procedures for sending personnel to shelter;
- Determine needs for emergency supplies such as water, food and medical supplies;
- Designate shelter managers, if appropriate; and
- Coordinate plans with local authorities.

9.2.8.7.4 Training and Information

Train employees in evacuation, shelter and other safety procedures by conducting sessions at least annually or when:

- Employees are hired;
- Evacuation wardens, shelter managers and others with special assignments are designated;
- New equipment, materials or processes are introduced;
- Procedures are updated or revised; and
- Exercises show that employee performance is improved.

Provide emergency information such as checklists and evacuation maps. Post evacuation maps in strategic locations. Consider the information needs of customers and others who visit the facility.

9.2.8.7.5 Family Preparedness

Consider ways to help employees prepare their families for emergencies. This will increase their personal safety and help the facility get back up and running. Those who are prepared at home will be better able to carry out their responsibilities at work.

9.2.8.7.6 Property Protection

Protecting facilities, equipment and vital records is essential to restore operations once an emergency has occurred. Planning Considerations include establishing procedures for:

- Fighting fires;
- Containing material spills;
- Closing or barricading doors and windows;
- Shutting down equipment;
- Covering or securing equipment;
- Moving equipment to a safe location; and
- Identify sources of backup equipment, parts and supplies.

Designate personnel to authorize, supervise and perform a facility shutdown. Train them to recognize when to abandon the effort. Obtain materials to carry out protection procedures and keep them on hand for use only in emergencies.

9.2.8.7.7 Protection Systems

Determine the needs for systems to detect abnormal situations provide warning and protect property. Consider the followings:

- Fire protection systems;
- Lighting protection systems;
- Automatic shutoffs; and
- Emergency power generation systems.

9.2.8.7.8 Mitigation

Consider ways to reduce the effects of emergencies, such as using the highest standards of materials and diesel tank. Other physical retrofitting measures include installing fire sprinkler systems or fire-resistant materials and furnishing.

9.2.8.7.9 Fire Shutdown

Facility shutdown is generally a last resort but always a possibility. Improper or disorganized shutdown can result in confusion, injury and property damage. Some facilities require only simple actions such as turning off equipment, locking doors and activating alarms. Others require complex shutdown procedures. Train personnel and establish shutdown procedure. Include information about when and how to shut off utilities. Identify:

- The conditions that could necessitate a shutdown;
- Who can order a shutdown;
- Who will carry out shutdown procedures;

- How a partial shutdown would affect other facility operations; and
- The length of time required for shutdown and restarting.

9.2.8.7.10 Records Preservation

Preserving vital records is essential to the quick restoration of operations. Vital records may include:

- Financial and insurance information;
- Engineering plans and drawings;
- Product lists and specifications;
- Employee, customers and supplier databases;
- Formulas and trade secrets; and
- Personnel files.

Next, establish procedures for protecting and accessing vital records. Among the many approaches considered are:

- Labelling vital records;
- Backing up computer systems;
- Making copies of records;
- Storing tapes and disks in insulated containers;
- Storing data off-site where they would not likely be damaged by an event affecting EMSB facility;
- Increasing security of computer facilities;
- Arranging for evacuation of records to backup facilities;
- Backing up systems handled by service bureaus; and
- Arranging for backup power.

9.2.8.7.11 Coordination with Outside Organizations

Meet periodically with local government agencies and community organizations. Inform appropriate government agencies that you are creating an emergency management plan. While their official approval may not be required, they will likely have valuable insights and information to offer. Determine the state and local requirements for reporting emergencies, and incorporate them into procedures. Determine protocols for turning control of a response over to outside agencies. Determine what kind of identification authorities will require to allow your key personnel into your facility during an emergency.

9.2.8.7.12 Recovery and Restoration

Immediately after an emergency, take steps to resume operations:

i. Establish a recovery team, if necessary. Establish priorities for resuming operations;

ii. Continue to ensure the safety of personnel on the property. Assess remaining hazards. Maintain security at the incident scene;

iii. Conduct an employee briefing;

iv. Keep detailed records. Consider audio recording all decisions. Take photographs or videotape of the damage;

v. Account for all damage-related costs. Establish special job order numbers and charge codes for purchase and repair work;

vi. Follow notification procedure. Notify employees' families about the status of personnel on the property. Notify off duty personnel about work status. Notify insurance carriers and appropriate government agencies;

vii. Protect undamaged property. Close up building openings. Remove smoke, water and debris. Protect equipment against moisture. Restore sprinkler systems. Physically secure the property. Restore power;

viii. Conduct an investigation. Coordinate actions with appropriate government agencies;

ix. Conduct salvages operations. Segregate damaged from undamaged property;

x. Take an inventory of damaged goods;

xi. Restore equipment and property. For major repair work, restoration plans with the insurance adjuster and appropriate government agencies;

xii. Assess the value of damaged property. Assess the impact of business interruption; and

xiii. Maintain contact with customers and suppliers.

10 PUBLIC PARTICIPATION AND CONSULTATION WITH STAKEHOLDERS

10.1 Introduction

Participation is a process, through which stakeholders influence development initiatives, the decisions and the resources, which affect them. The effectiveness of environment and social management plan is directly related to the degree of continuing involvement of stakeholders in the project development process. Participation of stakeholders in the projects is also a primary requirement in developing an appropriate EMP that addresses project's requirement and suited to the needs of the stakeholders. Stakeholder's engagement is also vastly increases the probability of successful implementation of management plan. In order to make consultation and disclosure process effective and fruitful, comprehensive planning is required to assure that local government, local communities and project staff interacts regularly and purposefully, throughout all stages of the project and contribute toward a common goal.

10.2 Approach and Methodology for Consultation

The approach undertaken for information disclosure and consultation involved the following key processes.

- Mapping and Identification of key stakeholders such as primary (direct project influence) and secondary (indirect project influence) stakeholders;
- Undertaking expert consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Undertaking structured on field consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Assessing the influence and impact of the project on these stakeholder groups;
- Summarizing of key findings and observations from the consultations; and
- Preparing a future stakeholder engagement strategy consultation plan for a more detailed assessments at a microscopic level taking into account the various project lifecycle phases and their implications on the stakeholder.

10.3 Stakeholder Assessment

A stakeholder is defined as "a person, group, or organization that has direct or indirect stake in a project/ organization because it can affect or be affected by the Project or its Proponent's actions, objectives, and policies". Stakeholders vary in terms of degree of interest, influence and control they have over the Project or the proponent. In the present study, all the stakeholders have been primarily categorized into two categories that have been identified as:

- Primary Stakeholders: include people, groups, institutions that either have a direct influence on the project or are directly impacted (positively or adversely) by the project and its activities; and
- Secondary stakeholders: are those that have a bearing on the project and its

activities by the virtue of their being closely linked or associated with the primary stakeholders and due to the influence they have on the primary stakeholder groups.

- Apart from categorization, the stakeholders have also been classified in accordance with the level of influence they have over the project as well as their priority to the project proponent in terms of importance.
- The influence and priority have both been primarily rates as:

  - S High Influence/Priority: This implies a high degree of influence of the stakeholder on the project in terms of participation and decision making or high priority for project proponent to engage that stakeholder.

  - S Medium Influence/Priority: This implies a moderate level of influence and participation of the stakeholder in the project as well as a priority level for project proponent to engage the stakeholder who are neither highly critical nor are insignificant in terms of influence.

  - S Low Influence/Priority: This implies a low degree of influence of the stakeholder on the project in terms of participation and decision making or low priority for project proponent to engage that stakeholder.

Based on the above attributes, the following delineates the stakeholders identified for the project and their analysis. Table 10-1 shows the results of stakeholder identification.

Table 10-1 Stakeholder Assessment

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Roads and Highway Department(RHD)	Primary	• RHD is the primary project proponent own a controlling stake of 100% in the project	Highest	• Are the primary project proponents • Responsible for establishment and operation of this project • Primary financial beneficiaries • Responsible for all the project related risks and impact liabilities
Vulnerable Groups (poor, old aged, and destitute)	Primary	• The marginal groups within the project area primarily comprises of landless households as a result of acquisition, households below poverty threshold, women headed households, old aged & destitute	Low	• Employment opportunity during construction. • Job prospect for their children • Compensation paid to male member of family • Little control over compensation amount • Employment opportunities
Fisherman	Secondary	• Fisherman in the area are primarily engaging in small scale fishing in the river		• Low scale for self-consumption

Local Community	Primary	• Primarily includes adjacent community to the project site	Medium	• Project will bring development to the area • Increase in employment opportunities and preference in job • Improvement in infrastructure in the area

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Dept. of Environment, Bangladesh	Primary	• The Department of Environment is the primary government regulatory authority for Environmental protection in Bangladesh.	High	• Government Regulatory agency to provide Environmental Clearance (EC) to the project based on evaluation and approval of Environmental Impact Assessment (EIA) study • Responsible for monitoring project's Environmental compliance throughout the project lifecycle

Dept. of Social Welfare (DSW)	Secondary	• Local governmental agency responsible for implementation of governmental social welfare schemes and activities	Low	• No major influence on project related activities • However participation level and influence may increase in case community welfare activities proposed by the project proponent are implemented in coordination with this agency
Other Regulatory & Permitting Authorities	Primary		High	• Agencies required for obtaining permits and licenses for establishment and operation of the project • Primary involvement during pre-construction and operation phases
Upazilla (sub District	Secondary	• Elected representative of people at sub-District level	Medium	• Key linkage between the community and the project proponent

10.4 Focused Group Discussion

Focus Group Discussion (FGD) is a tool for managing two-way communication between the project sponsor and the public. Its goal is to improve decision-making and build understanding by actively involving individuals, groups and organizations with a stake in the project. This involvement will increase a project's long-term viability and enhance its benefits to locally affected people and other stakeholders.

"To consult" means to seek information or advice, or to take into consideration. In the present context, consultation and discussion is essentially a tool or mechanism for citizens' participation – which can inform and assist the local authority in its decision-making. If the project considers that there is a "spectrum" of decision making (as illustrated), consultation sits somewhere between notification and negotiation. While it may require something less than negotiation, it nevertheless encompasses abroad range of situations in which the public may have some input.

Stakeholder engagement is an integral part of EIA good practice and is a statutory requirement of the national EIA legal framework in Bangladesh. The FGD program for the Project is based on informed consultation and participation with affected people, and is designed to be both fair and inclusive. Focus Group Discussion activities have been conducted during the environmental survey in March 2020.

10.4.1 Rationale of the Focus Group Discussion (FGD)

Consultation and discussion were done with various cross sections of the people in Kewatkhali Bridge project for improved better transportation planning and implementation process of the project. Inhabitants in the project surrounding areas and other stakeholders are to be consulted meaningfully at the initial stage of the project to obtain their knowledge and experience about the baseline information, potential impacts, and feasible mitigation measures. Consultation and participation increase the level of support of the stakeholders to the project activities that can speed up processing and reducing challenges during implementation. Views of community level stakeholders are needed to be considered in decision-making about project design, impact assessment, mitigation measures, and implementation.

10.4.2 Objectives of the Focus Group Discussion

The FGD are conducted to ensure that adequate and timely information is made available to the affected people and communities. Sufficient opportunities should be provided to them to express their opinions and participation in influencing the upcoming project decisions and processes. The main objective of the FGD is to ensure timely, effective, and multi-directional communications between the project and the affected people and communities. Therefore, that people can get the benefits of the project.

10.4.3 Scope of Work

The scope of work of the Focused Group Discussion (FGD) includes conducting consultation meetings with the affected people and other stakeholders in Kewatkhali Bridge project. These meetings were also to let them know the goals and objectives of the project, implementation arrangements, roles of

the local people in the project process, seek their opinion about the project, find alternative routes/location if required to avoid or minimize adverse impacts.

10.4.4 Key Stakeholder

During the field survey, significant efforts were made to identify the possible categories of stakeholders and their stakes. A stakeholder is any person, group, or institution that has an interest in an activity, plan, or program. This includes intended beneficiaries and intermediaries, winners and losers, and those involved or excluded from decision-making processes.

Among the participants, most of them are farmers and businesspersons and few are fisherman, local persons etc. Female participation in the consultation meetings is found in satisfaction level along the Kewatkhali bridge project.

10.4.5 Approach and Methodology

Total Four (04) FGD meetings were arranged in different places of Kewatkhali bridge alignment with a total of 58 (male 47 and female 11) people and other stakeholders such as elected representatives, affected people, teachers, journalists, land owners, businessmen, local elites, day laborers, farmers, and housewives. The stakeholders were made aware about the impact of the project with project information being disclosed. To maximize exposure and participation in the meeting different techniques like prior communication with the participants. Potentially affected people and different level of stakeholders were informed verbally. Each of the participants availed the opportunity to take part in the discussion and give their opinion about the project. Consultant teams drafted meeting minutes, collected attendance sheet, pictures and stored as well. Based on this collected information this consultation report is prepared.

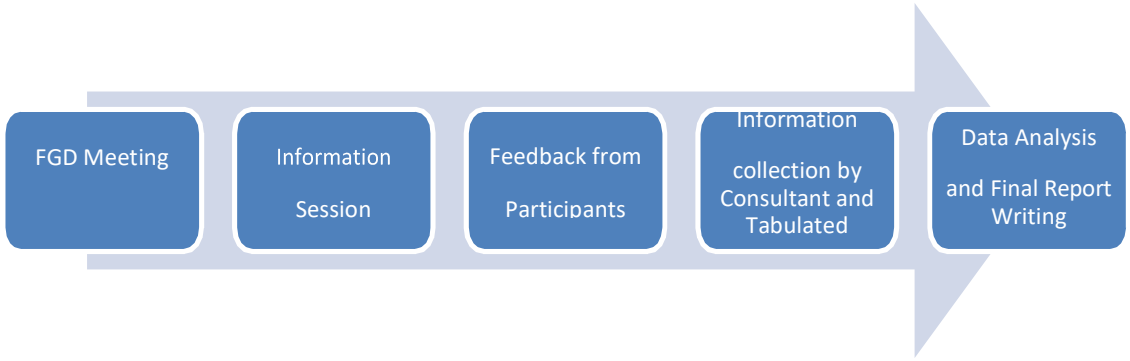

Figure 10-1 Approach of Focus Group Discussion (FGD)

10.4.6 FGD Outcome and Policy Issue

Participants were informed about the project objectives, goals, and made aware of the probable project impacts, and the process for defining the mitigation measures. During construction period some environmental and social impact might occur. Air, noise, and water might be contaminated due to project activities. Some impact might occur in local wildlife also. They (participants) were informed

that the Kewatkhali Bridge Project would be constructed on Khas Land and might be some part of Private land. The participants were also made informed that, employment opportunity for local people may be possible during the construction period, and both positive and adverse environmental impacts of the project during construction and operation will be negotiated with mitigation measures.

10.4.7 Particulars of the FGDs

04 FGD were held with the different stakeholders such as local leaders, farmers, businessperson, service holder, housewives, day laborers, etc. In the FGD, discussions held on project description, scope of the project, social safeguard issues, probable environmental and social impacts and mitigation measures about the project. These FGDs were conducted on 16th to 18th March 2020. Detailed information of FGD is given in Table. 4.1. List of participants of FGD is given in Appendix 11 of the report.

Table 10-2 List of Consultation Meeting

Sl. No.	Date	Place	Participants		
			Male	Female	Total
1	16 March 2020	Dakkhin Charkalibari, Mymensingh Sadar, District: Mymensingh GPS Location: 24.55887°N; 90.44029°E	13	4	17
2	17 March 2020	Charkalibari, Mymensingh Sadar, District: Mymensingh GPS Location: 24.72230°N; 90.42848 °E	10	2	12
3	17 March 2020	Kewatkhali Nodir Par Colony, Mymensingh Sadar, District: Mymensingh GPS Location: 24.74036 N; 90.42591 E	12	5	17
4	18 March 2020	Digharkanda Bypass More, Mymensingh Sadar, District: Mymensingh GPS Location: 24.716953 N; 90.410072 E	9	0	12

Source: Environmental Team, 2020

10.4.8 Result and Discussions

Focused Group Discussion-01

Location: Dakshin Chor-kalibari, Mymensingh Sadar, Mymensingh

GPS Coordinates: 24.55887°N; 90.44029°E

Date: 16 March 2020

Time: 12:30 pm

Participants: 17

Question/information from project team	Issue or Questions/Comments of the Participants
Mr. Tonmoy Pandit (Facilitator) thanks all participants those attended this meeting. This Bridge will be constructed by the govt. of Bangladesh and people will be able to travel different parts of the country quite easily. Now we are conducting the consultations as part of the Project preparation in your area. By this meeting, overall impact of the project on the people will be assessed. Based on the assessment, an environmental assessment will be prepared to mitigate negative impacts. People will face several problems due to this project. Consequently, people may suffer. Additionally, the construction activities will create several environmental pollutions that may affect the local ecology. This is why I am here to learn about your problems and how to solve the problem that may occur from project activities. The location is almost finalized by a team of professionals based on engineering point of view. However, people's opinion will be taken in to account. People's opinion will be brought into the notice of the project authority for further consideration.	The existing Shambhuganj Bridge is heavily traffic congested and it is not able to meet the demand of the people. So, Kewatkhali bridge project is a must for them.

Question/information from project team	Issue or Questions/Comments of the Participants
Are you aware about the activities of the project? If yes, what are they?	Yes, first we heard from our Local Elite Persons, Land Surveyor and Electronic media.
Any air pollution due to the project activities? If yes, how to mitigate?	There is some possibility to pollute air during construction period. If project authority spread water properly, it should be minimized. If we plant trees then it should be mitigated.
Any impact on local soil and noise due to the project activities? If yes, how to mitigate	Some noise impact will occur during construction time but no soil will be polluted.
Any impact on the surface water body (river, pond, khal, beel, canal etc.) and ground water? If yes, how to mitigate?	There is some water pollution due to construction of bridge project. River will lose their natural flow due to rail line. Some birds, snakes, crabs, will lose their habits.
Is wildlife (birds, snakes, crabs, fox etc.) available in the area? If yes, mention their name. Among them which are endangered?	During construction period bird and wild animal will go far due to sound and vibration impacts. After construction if we plant more tree then problem will be solved. Tree plantation can solve this problem.
Is the proposed area inundated during flood? If yes, how much?	During rainy season sometime our area gets flooded. When bridge construction starts, River and canal will go shallow due to sediment and sometime river will change its course
Is any Environmental Protected Area (EPA)/Environmental Sensitive Area located nearby the project? If yes, where & how far from the project?	No environmental protected area in our locality.
Will the project affect your social and economic sector? If yes, how?	Yes, it will help our economic development and better communication. People can work here during Construction period.
Are you in favor of this project? Why?	Yes, we are in favor of this project. This project will aid our economic development.

Major Issue Raised

- They use the rail bridge to cross the river, sometimes it becomes risky for them to use the rail bridge, so they are happy to have a bridge for the people to cross over.
- They believe that this bridge project will lower the amount of road accident and traffic congestion and will help in their better life style.

- Most of the land in this area is Khas land. So, the poor people living in this area are concerned about their resettlement.
- Most of the people in this area are fishers, farmers or day laborers, so they are hope-full that this project might benefit them in the future.
- There is a lack of educational institutions in the area so, people are hope-full that this project will benefit in the educational sector as it will improve transportation communication across the districts.

Figure 10-2 Photographs of Focus Group Discussion (FGD)-01

Focused Group Discussion-02

Location: Char kalibari, Mymensingh Sadar, Mymensingh

GPS Coordinates: 24.72230°N; 90.42848 °E

Date: 17 March 2020 Time: 02:00 pm Participants: 12

Issue/Questions	Responses from Project Team/ Participants
Mr. Tonmoy Pandit (Facilitator) thanks all participants those attended this meeting. This Bridge will be constructed by the govt. of Bangladesh and people will be able to travel different parts of the country quite easily. Now we are conducting the consultations as part of the Project preparation in your area. By this meeting, overall impact of the project on the people will be assessed. Based on the assessment, an environmental assessment will be prepared to mitigate negative impacts. People will face several problems due to this project. Consequently, people may suffer. Additionally, the construction activities will create several environmental pollutions that may affect the local ecology. This is why I am here to learn about your problems and how to solve the problem that may occur from project activities. The location is almost finalized by a team of professionals based on engineering point of view. However, people's opinion will be taken in to account. People's opinion will be brought into the notice of the project authority for further consideration.	
Are you aware about the activities of the project? If yes, what are they?	Last year and couple of days ago some people come here for survey and we learn from electronic media and newspaper.
Any air pollution due to the project activities? If yes, how to mitigate?	There is a possibility of air pollution during construction period. Tree plantation is only solution. Social forestry can reduce air pollution.

Issue/Questions	Responses from Project Team/ Participants
Any impact on soil and noise due to the project activities? If yes, how to mitigate and Soil	Some noise impact will be found during construction time. No soil will be polluted but farmer loss their cultivated land. Many people will lose their homestead and commercial place. Do not use hydraulic Horn. Tree plantation can solve all problem.
Any impact on the surface water body (river, pond, khal, beel, canal etc.) and ground water? If yes, how to mitigate?	There is no possibility of ground water pollution > But in response to surface water pollution river, pond, khal, beel, river and canal will lose their natural flow.
Is wildlife (birds, snakes, crabs, fox etc.) available in the area? If yes, mention their name. Among them which are endangered?	Yes, some wild animal lives in our locality such as different types of birds, fox, Guysap, snake, crabs are available in our area and sometime migratory birds come to our area. Fish production will reduce during construction period. Some animal is possible of extinction due to this project because they lose their habits. Environmental Protected area is required for saving extinction animal.
Is the proposed area inundated during flood? If yes, how much?	During rainy season sometime our area flooded. If we put bridge and culvert properly then we can solve water logging problem.
Is any Environmental Protected Area (EPA)/Environmental Sensitive Area located nearby the project? If yes, where & how far from the project?	No Environmental protected Area in our locality. When construction starts, River and canal will go shallow due to sedimentation and sometime river will over flow and change its course.
Will the project affect your social and economic sector? If yes, how?	Yes, it will improve our trade and industry. People can work here during construction period.
Are you in favor of this project? Why?	Yes, we are in favor of this project after construction work finished it will change our whole economic condition. We request project authority to engage local labor during construction period.
Any other Issue	Fish production will reduce. Income and livelihood opportunities would increase due to project

	intervention. The standard of living will be high. Land value would increase.

Major Issue Raised

- They want clean and safe construction site during project work.
- The project should be finished during the proposed time schedule.
- Most of the people of this area are day laborers. Local Labors should be prioritized when construction work ahead.
- Require proper land compensation for the affected people due to construction of proposed connecting road.
- Safe water discharging procedures for irrigation purposes.
- People are hoping that they will ultimately benefit from the project.
- ❖ Development of environmental mitigation plan and proper drainage congestion during the construction period.

Figure 10-3 Photographs of Focus Group Discussion (FGD)-02

Focused Group Discussion-03

Location: Kewatkhali Nodir Par Colony, Mymensingh Sadar, Mymensingh

GPS Coordinates: 24.74036 N; 90.42591 E

Date: 17 March 2020 Time: 01:30pm Participants: 17

Issue/Questions	Responses from Project Team/ Participants
This Bridge will be constructed by the govt. of Bangladesh and people will be able to travel different parts of the country quite easily. Now we are conducting the consultations as part of the Project preparation in your area. By this meeting, overall impact of the project on the people will be assessed. Based on the assessment, an environmental assessment will be prepared to mitigate negative impacts. People will face several problems due to this project. Consequently, people may suffer. Additionally, the construction activities will create several environmental pollutions that may affect the local ecology. This is why I am here to learn about your problems and how to solve the problem that may occur from project activities. The location is almost finalized by a team of professionals based on engineering point of view. However, people's opinion will be taken in to account. People's opinion will be brought into the notice of the project authority for further consideration.	
Are you aware about the activities of the project? If yes, what are they?	Few days ago, some people came here for survey. We also learnt from electronic media and newspaper.
Any air pollution due to the project activities? If yes, how to mitigate?	There is a possibility of air pollution during construction period. Water spray can solve this problem.
Any impact on soil and noise due to the project activities? If yes, how to mitigate and Soil	Some noise effect will be found during construction period. No impact on soil but farmer loss their

Issue/Questions	Responses from Project Team/ Participants
	cultivated land. Many people lose their homestead and commercial place.
Any impact on the surface water body (river, pond, khal, beel, canal etc.) and ground water? If yes, how to mitigate?	There is no possibility on groundwater. But surface water is being polluted due to construction of bridge. The Brahmaputra river change and losses the natural flow of water.
Is wildlife (birds, snakes, crabs, fox etc.) available in the area? If yes, mention their name. Among them which are endangered?	Yes, some wild animal lives in our locality. Such as birds, fox, Mechobagh, Leopards Guysap, snake crabs are available in our area.
Is the proposed area inundated during flood? If yes, how much?	During rainy season sometime our area flooded. If we put bridge and culvert properly then we can solve water logging problem.
Is any Environmental Protected Area (EPA)/Environmental Sensitive Area located nearby the project? If yes, where & how far from the project?	There is no environmental protected Area. When construction start River and channel will go shallow due to sediment and sometime river will change its dimension.
Will the project impact on your social and economic sector? If yes, how?	Yes, it will advance our trade and industry. People can work here during construction period.
Are you in favor of this project? Why?	Yes, we are in favor of this project. We request project authority to engage local labor during construction period.
Any other Issue	Most of the comments came from audience side was the employment opportunities for the local people. They believe that the local young people and other people will get employment opportunities during the construction phase. Different local business would emerge. Livelihood will be disturbed

Major Issue Raised

- Proper lands pay should be paid to the exploited population.
- Rehabilitation and Resettlement activity plan ought to be required extraordinarily the general population who have just a single land.
- Improvement of financial conditions and improvement of transportation framework.
- Ensure the remuneration to the first influenced individuals neither inclusion of voracious, muscle man of political pioneer.
- Most of the people are fishermen, farmers, day laborers and the don't own any land. They are concerned about their livelihood during the construction period.

Roads and Highways Department

- All the people are supportive of the project as it will bring prosperity in the region through better transportation and communication facilities.
- A lot of people live in the government land including minority people whose livelihood is dependent on the river Brahmaputra. Some of them encountered within the project alignment. If they are moved away it is a request by them to think for their alternative livelihood.

Focused Group Discussion-04

Location: Digharkanda Bypass More, Mymensingh Sadar, Mymensingh

GPS Coordinates: 24.716953 N; 90.410072 E

Date: 17 March 2020 **Time:** 06:00pm **Participants:** 12

Issue/Questions	Responses from Project Team/ Participants
This Bridge will be constructed by the govt. of Bangladesh and people will be able to travel different parts of the country quite easily. Now we are conducting the consultations as part of the Project preparation in your area. By this meeting, overall impact of the project on the people will be assessed. Based on the assessment, an environmental assessment will be prepared to mitigate negative impacts. People will face several problems due to this project because the proposed rail project will go over private land. The government needs to acquire the land for this project. Consequently, people may suffer. Additionally, the construction activities will create several environmental pollutions that may affect the local ecology. This is why I am here to learn about your problems and how to solve the problem that may occur from project activities. The location is almost finalized by a team of professionals based on engineering point of view. However, people's opinion will be taken in to account. People's opinion will be brought into the notice of the project authority for further consideration.	These existing roads was very busy and traffic congestion due to excessive motorized vehicles.
Are you aware about the activities of the project? If yes, what are they?	Last year some people come here for measuring road. We also learn from electronic media, newspaper and other sources.
Any air pollution due to the project activities? If yes, how to mitigate?	There is a possibility of air pollution during construction period. Water spraying at

	regularly reduce the problem.

Issue/Questions	Responses from Project Team/ Participants
Any impact on soil and noise due to the project activities? If yes, how to mitigate and Soil	Some noise impact will be found during construction time. No soil will be polluted but farmer loss their cultivated land. Due to this project, some people will change their occupation.
Any impact on the surface water body (river, pond, khal, beel, canal etc.) and ground water? If yes, how to mitigate?	There is no possibility of ground and surface water pollution but river, pond, khal, beel, river and canal will lose their natural flow due to rail line construction. Establish Bridge and culvert in appropriate place for easy water movement.
Is wildlife (birds, snakes, crabs, fox etc.) available in the area? If yes, mention their name. Among them which are endangered?	Yes, some wild animal lives in our locality. Such as different type of birds, fox, Otter, Mechobagh, Guysap, snake, crabs are available in our area and sometime migratory birds come to our area. During construction period, bird and wild animal will go far due to sound. Fish productions will reduce during construction. Some animal is possible of extinction due to this project because they lose their habits. Environmental Protected area is required for saving extinction animal.
Is the proposed area inundated during flood? If yes, how much?	During rainy season sometime our area flooded. If we put bridge and culvert properly then we can solve water logging problem.
Is any Environmental Protected Area (EPA)/Environmental Sensitive Area located nearby the project? If yes, where & how far from the project?	No Environmental protected Area in our locality. When construction starts River and canal will go shallow due to sediment and sometime river will change its dimension.
Will the project affect your social and economic sector? If yes, how?	Yes, it will improve our economic and better communication. People can work here during construction period. Some industry will be established here and people can work there.
Are you in favor of this project? Why?	Yes, we are in favor of this project. After construction work finished it will change our whole economic condition. We request project authority to engage local labor during construction period.

Any other Issue	Our economy will grow rapidly. Improvement of livelihood and transport facility

Major Issue Raised

- They are particularly thankful to Government of Bangladesh for this proposed venture and they believe that it will be an essential task for the general population of Mymensingh region.
- Traffic blockage will be reduced in the bypass mor due to the project inclusion.
- Different neighbourhood business would develop and Local work would increment.
- Auto, car, easy bike drivers who drive in this road are ready to use alternative route during the construction works, they are very eager to have the road and bridge soon.
- The road ought to be developed in an ecological and environment supportable way.
- People are willing to sacrifice a little during the construction phase of the road and the bridge as this project will ultimately benefit them.
- There occurs a lot of accidents in the Kewatkhali bypass road. People believe that the accidents will reduce due to the proposed project.

10.4.9 Summary of FGDs

A total of 04 Focus Group discussion have been conducted at the community level to make aware of the people about the project. People have taken active participation in the discussion and have given opinion about project process and alternatives to minimize adverse impacts.

10.5 Consultation Framework

Stakeholder consultation is a two-way process. For stakeholders, the consultation process is an opportunity to obtain project information, to understand its potential impacts, to raise issues and concerns, and ask questions. For the project proponents, the consultation process offers an opportunity to understand the stakeholders and their concerns about the project, their needs and aspirations, and also their suggestions that can potentially help shape the project and its design. Listening to stakeholders' concerns and feedback can be a valuable source of information that can improve project design and outcomes and help the project proponent to identify and control external risks. It can also form the basis for future collaboration and partnerships.

04 FGD were held with the different stakeholders such as local leaders, farmers, businessperson, service holder, housewives, day laborers, etc. In the FGD, discussions held on project description, scope of the project, social safeguard issues, probable environmental and social impacts and mitigation measures about the project. The expressed views and comments Roads and Highways Department

of all stakeholders including vulnerable groups such as women, members of the low-income families, and students were recorded and included in the present report for addressing them in the project design and implementation.

Participants of the workshop answered about the details of the project design related to safety and interchanges. The staff asked to put additional road signs for safety of animals.

The stakeholder consultation in the project area and citizen engagement is an ongoing process and will continue throughout the project implementation. A framework has been developed for the consultations to be carried out during the project implementation; see

Table 10-3 Consultation Framework

Description	Target Stakeholders	Timing	Responsibility
Public awareness campaigns/ scoping sessions to share EIA, RPs with the PAPs, communities and other stakeholders. Dakkhin Charkalibari, Charkalibari,Kewatkhali Nodir Par Colony, Digharkanda Bypass More	Communities within project area, general public; and line departments/ agencies.	Before commencement of project activities.	PIU /Design Consultants/ Supervision Consultants
Consultations with the communities during EIA, RP implementation Location: Dakkhin Charkalibari, Charkalibari,Kewatkhali Nodir Par Colony, Digharkanda Bypass More	Communities at/around subproject area	Before commencement of project activities.	PIU / Supervision Consultants
Establishment of GRM and GRCs Location: Dakkhin Charkalibari, Charkalibari,Kewatkhali Nodir Par Colony, Digharkanda Bypass More	Communities at/around project area	Before commencement of project activities.	PIU
Grievance redress Location: Dakkhin Charkalibari, Charkalibari,Kewatkhali	PIU staff; consultants; relevant line departments; and communities (as needed).	Project implementation Stage	PIU/ Supervision Consultants
Informal consultations and discussions.	Communities at/around project area	Project implementation Stage	PIU / Supervision Consultants; contractor

Description	Target Stakeholders	Timing	Responsibility
Location: Dakkhin Charkalibari, Charkalibari,Kewatkhali Nodir Par Colony, Digharkanda Bypass More			
Consultations with the communities during internal monitoring Location: Dakkhin Charkalibari, Charkalibari,Kewatkhali Nodir Par Colony, Digharkanda Bypass More	Communities at/around project area	Construction Stage	PIU / Supervision Consultants
Monthly meetings at project sites Location: District departments	PIU staff; consultants; and communities (as needed).	Construction Stage	PIU / Supervision Consultants
Consultation workshops to review EIA/ and RP implementation, any outstanding issues and grievances, views and concerns of communities; and actions needed to address them. Location: Dakkhin Charkalibari, Charkalibari,Kewatkhali Nodir Par Colony, Digharkanda Bypass More	Rural and Urban Communities at the project area; relevant line department; relevant NGOs	Six-monthly during implementation phase	PIU / Supervision Consultants
Consultations with the Communities relating to the leftover tasks Location: District RHD	Communities at/around project area	After completion of projects	PIU / Supervision Consultants
Consultations with the communities during the site visits by the AIIB Review Missions. Location: rural and urban communities and District departments Road	PIU; Communities at/around subproject area	Construction/ Operation Stage	PIU / Supervision Consultants

11 CONCLUSION AND RECOMMENDATIONS

11.1 Conclusion

The EIA has been prepared for Mymensingh Kewatkhali Bridge Improvement Project including the Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach Road (including Service Road), Mymensingh, Bangladesh project according to the requirement of DoE for necessary environmental clearances as it is made mandatory in ECA'95, for any new development work and to meet the requirements of AIIB's ESP. The EIA has been prepared through identifying the potential impacts, assessing them and recommending possible mitigating and enhancing measures for negative and positive impacts, respectively.

The environmental analysis has revealed that the project can be set up according to the proposed design and configuration in the proposed site and location. The environmental impacts are of limited nature upon implementation of mitigation measures, whereas the benefits of the project are many.

This EIA has identified that there is the potential for moderate negative environmental and social impacts as a result of the Project. However, this EIA has also determined that if comprehensive and effective management and mitigation measures are implemented as proposed, that the potential negative impacts should be reduced to non-significant level in some aspects and be moderate for some environmental parameters during operation and maintenance.

Further, this EIA has determined that the potential benefits of the Project are significant and that with the application of the management measures presented, these potential benefits may be promoted and enhanced to the advantage of people in the Project area. This EIA has been developed to identify and comply with relevant GoB legislation specifically the Environment Conservation Act 1995 and the Environment Conservation Rules 1997 as well as AIIB's ESP.

In conclusion, Dowha/DDC Consulting limited under the aegis of RHD consider that the overall potential negative impacts can be effectively mitigated and that the Project has the potential to result in several positive benefits. It is recommended that the proposed bridge project proceed with the effective implementation of the management and mitigation measures presented in this EIA. An Environmental Clearance Certificate (ECC) is accordingly requested for the proposed bridge over Old Brahmaputra River in Mymensingh in favor of RHD.

The main potential environmental problems, which may arise as a result of construction of project, can be grouped as follows:

- Atmospheric emissions and Air quality
- Water pollution and waste water disposal
- Noise
- Solid Waste

All these aspects have been examined and the findings are as follows:

However, no infrastructure development can be expected without any adverse impact on environment. The beneficial impacts on the nation as well as human beings would only be meaningful and sustainable development would only be possible if the adverse effects are minimized through strict maintenance and control measures as mentioned for this project. All this would need vigilant care and cost money, and the project authority should take these into consideration.

The environmental analysis has revealed that the project can be set up according to the proposed design and configuration in the proposed site and location. The environmental impacts are of limited nature, whereas the benefits of the project are many.

11.2 Recommendations

Having reviewed all the potential environmental impacts, and following our proposed mitigation measures the project is expected to proceed without having unacceptable environmental pollution. Therefore, we expect DoE will issue site clearance certificate to the proposed MKBIP (**Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach Road (including Service Road), Mymensingh, Bangladesh project).**

It is anticipated that there is no major adverse impact to be associated during operation phase which creates long term and irreversible effect on the environment. On the other hand, the project has a positive impact in terms of economic development in the area, developed transport system and enhanced tourism and employment during its operation phase. A detailed Environmental Monitoring and Management Plan have been included in the EIA.

Our study contributes rigorous scientific knowledge to ongoing debates on the ecological impacts of large-scale waterways development in regulated rivers in Bangladesh particularly related to the proposed project in the Old Brahmaputra. The Endangered Ganges River Dolphin is a flagship species for river conservation .Forthcoming species recovery and conservation action plans for the species need to recognize underwater noise as an important and emerging threat during the construction phase of the MKBIP, thus work towards scientific monitoring and mitigation of noise impacts on endangered riverine fauna.

Appendix 1 Approval of TOR by DOE

Government of the People's Republic of Bangladesh
Department of Environment
Head Office, Paribesh Bhaban
E-16 Agargaon, Sher-e-Bangla Nagar, Dhaka-1207
www.doe.gov.bd

Subject: Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) in favor of Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensiiigh with Railway Overpass and Approach (including Service Road) Road Project.

Date: 1^/03/2020

Memo No: 22.02.0000.18.72.035.20 • 3 2

Ref:Your application on 20/02/2020.

With reference to your application dated 20/02/2020 for the subject mentioned above, the Department of Environment hereby gives Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) in favor of Construction of Kewatkhali Bridge over the river Brahmaputra at Mymensingh with Railway Overpass and Approach (including Service Road) Road Project subject to fulfilling the following terms and conditions.

1. The Project Authority shall conduct a comprehensive Environmental Impact Assessment (EIA) study considering the overall activity of the said Project in accordance with the ToR submitted to the DOE and additional suggestions provided herein.

2. The EIA report should be prepared in accordance with following indicative outlines:

1. Executive summary
2. Introduction: (Background, brief description, scope of study, methodology, limitation, EIA team, references)
3. Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

4a. Project activities: A list of the main project activities to be undertaken during site clearing, construction as well as operation.

4b. Project schedule: The phase and timing for development of the Project

4c. Resources and utilities demand: Resources required to develop the project, such as soil and construction material and demand for utilities (water, electricity, sewerage, waste disposal and others), as well as infrastructure (road, drains, and others) to support the project.

4d. Map and survey information

Location map, Cadastral map showing land plots (project and adjacent area), Geological map showing geological units, fault zone, and other natural features.

1. Baseline Environmental Condition should include, inter alia, following:

® Physical Environment: Geology, Topology, Geomorphology, Soils, Meteorology, and Hydrology.

• Biological Environment: Habitats, Aquatic life and fisheries, Terrestrial Habitats and Flora and Fauna

® Environment Quality: Air, Water, Soil and Sediment Quality.

2. Socio-economic environment should include, inter alia, following:

® Population: Demographic profile and ethnic composition

® Settlement and housing ® Traffic and transport

® Public utilities: water supply, sanitation and solid waste

© Economy and employment: employment structure and cultural issues in employment

• Fisheries: fishing activities, fishing communities, commercial important species, fishing resources, commercial factors.

3. Identification, Prediction and Evaluation of Potential Impacts (identification, prediction and assessment of positive and negative impacts likely to result from the proposed project).

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In identification and analysis of potential impacts'-the 'Analysis' part shall include the analysis of relevant spatial and non-spatial data. The outcome of the analysis shall be presented with the scenarios, maps, graphics etc. for the cases of anticipated impacts on baseline. Description of the impacts of the project on air, water, land, hydrology, vegetation-man maid or natural, wildlife, socio-economic aspect shall be incorporated in detail.

4. Management Plan/Procedures:
For each significant major impact, proposed mitigation measures will be set out for incorporation into project design or procedures, impacts, which are not capable of mitigation, will be identified as residual impacts Both technical and financial plans shall be incorporated for proposed mitigation measures.
An outline of the Environmental Management Plan shall be developed for the project.
In Environmental Monitoring Plan, a detail technical and financial proposal shall be included for developing an in-house environmental monitoring system to be operated by the proponent's own resources (equipment and expertise).

5. Consultation with Stakeholders/Public Consultation (ensures that consultation with interested parties and the general public will take place and their views taken into account in the planning and execution of the project)

Beneficial Impacts (summarize the benefits of the project to the Bangladesh nation, people and local community and the enhancement potentials).

6. Emergency Response Plan & disaster Impact Assessment.

7. Conclusion and Recommendations

3. Without approval of EIA report by the Department of Environment, the Project authority shall not be able to open L/C in favor of importable machineries.
4. Without obtaining Environmental Clearance, the Project authority shall not start operation of the projects.

5. The project authority shall submit the EIA report along with the filled-in application for Environmental Clearance in prescribed form, the feasibility study report, the applicable e Environmental Clearance fee in a treasury chalan, the applicable VAT on clearance fee in a separate treasury chalan, the No Objection Certificate (NOC) from local authority, NOC from Forest Department (if it is required in case of cutting any forested plant, private or public) and NOC from other relevant agencies for operational activity etc. to the Mymensingh District Office of DOE in Mymensingh with a copy to the Head Office o, DoE in Dhaka.

(Syed Nazmul Ahsan)
Director (Environmental Clearance)
Phone #02-8181673

Project Director
Study for Identification Prioritization and Pre-Feasibility of PPP Project
Roads & Highways
Department 132/4 New
Baily Road, Dhaka.

COPY Forwarded to :

1) PS to the Secretary, Ministry of Environment, Forest and Climate Change, Bangladesh Secretariat, Dhaka.
2) Director, Department of Environment, Mymensingh Divisional Office, Mymensingh.
3) Deputy Director/Office In-charge, Department of Environment, Mymensingh District Office, Mymensingh.
4) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Appendix 2 Environmental Quality Assessment Survey Methods

SL	Item of work	Brief outline
A. Environmental Quality Test		
1.	Ambient Air Quality Monitoring - 05 locations	SPM, PM2.5, PM10, SO2, Carbon Monoxide (CO), Nox and Pb Ambient air quality data will be monitored for 8 hours continuous by the modern dust particle measurement meter
2.	Noise Level - 06 locations	Leq (30 minutes duration at day & night time)
3.	Vibration Level - 05 locations	Vibration Measurement with standard procedures (only day time)
4.	Surface Water Quality - 04 locations	pH, Temperature, Turbidity, Electric conductivity (EC), Chemical Oxygen Demand (COD), Biochemical Oxygen demand (BOD), Total Dissolve Solids (TDS), Total suspended Solids (TSS), and Dissolved Oxygen (DO),
5.	Groundwater Quality - 02 locations	pH, Electric conductivity (EC), Turbidity, Salinity, Total coliform (TC), Fecal Coliform (FC), Total suspended Solids (TSS), Total Dissolved Solid (TDS), Chlorides (Cl),
6.	Riverbed Sediment Quality -02 locations	Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb), & Zinc (Zn).
7.	Soil Quality -02 locations	Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb), & Zinc (Zn).
8.	Benthos Species - 02 locations	Benthic Compounds
9.	Plankton Species - 02 locations	Phytoplankton and Zoo planktonic Compounds
10.	Ecological Survey	
10.1	Vegetation & Flora Survey	According to above requirements
10.2	Wildlife Survey	According to above requirements
10.3	Fisheries Survey	According to above requirements
10.4	Dolphin Survey	According to above requirements
11.	Important Environmental Features	According to above requirements
12.	Focused Group Discussion (fGd)	According to above requirements

Methodology

Air Quality Monitoring

The ambient air quality monitoring was carried out at 05 locations along the project corridor from 14 to 18 March 2020. All the locations are summarized with address in Table 2.1. The parameters were Suspended particulate matter (SPM), particulate Matter PM2.5 and PM10, SO2, Carbon Monoxide (CO), Nitrogen Oxides (NOx) and Lead (Pb). LATA Envirotech APM 250 with Combined PM10 Sampler was used for the measurement of particulate matters and for gaseous pollutants LATA Envirotech LES 411 was used for monitoring (Figure 2.1).

Figure 11-1 Equipment used for Air Quality Sampling

To monitor carbon monoxide (CO) HTC CO-01 meter was used and value is expressed in ppm. The weather was mostly sunny during the monitoring period. The duration of monitoring was 8 hours. Proper Personal Protective Equipment (PPE) including vests and helmets were used during the monitoring period.

Table 2.1: Air Quality Sampling Locations

Parameters	Locations	Samples Collected (No.)
Carbon Monoxide (CO),	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh	1

Oxides of Nitrogen (NOx), Sulphur Oxide (SO2), SPM PM2.5, PM10, O3 Pb	Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh	1
	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh	1
	Dakshin Char kalibari, Mymensingh Sadar, Mymensingh	1
	Char Jhaugora, Mymensingh Sadar, Mymensingh	1

Noise Measurement

Noise Level Measurement was analyzed at 6 project influenced locations encompassing both sides of the proposed bridge and connecting approach road. The sampling locations with details address are summarized in Table 2.2. The monitoring started on 15 March 2020 and ended on 19 March 2020. Noise measurement at each location was done continuously for 30 minutes both at day and night time. Lightning vests and helmets were used as PPE during the noise measurement period for both day and night time. Noise level was measured using a calibrated HTC Sound Level Meter set to A-weighting, slow response and statistical analysis settings (Figure 2.2).

Figure 2.2: Sound Level Meter

Table 2.2: Noise Measurement Sampling Locations

Locations		Samples Collected (no.)
	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh	1

Noise Level (dBA) (Leaq)	Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh	1
	Hakkani More, Balaspur Bypass, Mymensingh Sadar, Mymensingh	1
	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh	1
	Dakshin Char kalibari, Mymensingh Sadar, Mymensingh	1
	Char Jhaugora, Mymensingh Sadar, Mymensingh	1

Vibration Measurement

Vibration Level Measurement was analyzed at 6 locations along the project corridor encompassing both of the sites of propose bridge and connecting approaches road. The locations along with details address are summarized in table 2.3. The monitoring was started on 15 March 2020 and ended on 19 March 2020. Vibration level data were taken continuously for 15 minutes during day time. Within these 15 minutes, velocity data was taken for 05 minutes, acceleration data was taken for 05 minutes and displacement data was taken for another 05 minutes. Vests and helmets were used as PPE during the vibration measurement period. Vibration was recorded using HTC VB-8205 vibration meter (Figure 2.3).

Figure 2.3: Vibration Meter

Table 2.3: Vibration Measurement Sampling Locations

Locations		Samples Collected (no.)
Vibration Level (5 minutes acceleration, 5 minutes velocity and 5 minutes displacement)	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh	1
	Dakshin Char kalibari, Mymensingh Sadar, Mymensingh	1
	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh	1
	Char Jhaugora, Mymensingh Sadar, Mymensingh	1
	Char kalibari, Mymensingh Sadar, Mymensingh	1

Surface Water Quality

Surface Water samples were collected from Four (04) project influenced locations on 18 March 2020 (Figure 2.4). The sampling locations along with details address are given in Table 2.4. The parameters measured were pH, Temperature, Turbidity, Electric conductivity (EC), Chemical Oxygen Demand (COD), Biochemical Oxygen demand (BOD), Total Dissolve Solids (TDS), Total suspended Solids (TSS), and Dissolved Oxygen (DO), Total coliform (TC), and Fecal Coliform (FC), Nitrate and Phosphate. All samples were collected in plastic sampling bottles, kept in an ice cooler, after necessary stabilization/fixing, and analyzed within 72 hours of being collected. The sampling bottle was washed by distilled water before sampling. EZDO 8200 Multimeter (Figure 2.4) was used to conduct the on-site test of pH, TDS, EC and Temperature. Lutron DO-5509 (Figure 2.4) was used to conduct the on-site test of Dissolved

Oxygen (DO). The samples were sent to Department of Public Health Engineering (DPHE) and Dhaka University (DU) Laboratories for testing remaining parameters within 72 hours of being collected. For Total Coliform (TC) and Faecal Coliform (FC), the samples were sent to DPHE within 12 hours of collection.

		
Kemmerer Bottle	*Lutron DO-5509 Meter*	*EZDO- 8200 Multimeter*

Figure 2.4 Equipment used for Surface water Sampling and On-site Testing Table 2.4 Sampling Locations of Surface Water

Parameters	Locations	Samples Collected (No.)
pH, Temperature, Turbidity, Electric conductivity (EC), Chemical Oxygen Demand (COD), Biochemical Oxygen demand (BOD), Total Dissolve Solids (TDS), Total suspended Solids (TSS), Dissolved Oxygen (DO), Total Coliform (TC) Fecal Coliform (FC) Nitrate	Digharkanda, Mymensingh Sadar, Mymensingh	1
	Brahmaputra River Downstream, Mymensingh	1
	Brahmaputra River Upstream, Mymensingh	1
	Char Kalibari, Mymensingh Sadar, Mymensingh	1

Phosphate		

Groundwater Quality

Groundwater samples were collected from 03 project influenced locations on 18 March 2020. The locations with details address are summarized in Table 2.5. The parameters measured were pH, Electric Conductivity (EC), Turbidity, Salinity, Total Coliform (TC), Fecal Coliform (FC), Total Suspended Solids (TSS), Total Dissolved Solid (TDS), Chlorides (Cl-), Arsenic (As), Iron (Fe) and Manganese. All samples were collected in 1-liter plastic sampling bottles and then kept in an ice cooler. PPE including vests and helmets were used during the sample collection period. EZDO 8200 Multimeter (Figure 4.4) was used to conduct the on-site test of pH, TDS, EC and Salinity. The samples were sent to DPHE & DU Laboratory within 72 hours of being collected.

	
EZDO- 8200 Multimeter	Lutron DO-5509 Meter

Figure 2.5 Equipment used for On-site Testing of Groundwater Table 2.5 Sampling Locations of Groundwater

Parameters	Locations	Samples Collected (No.)
pH, EC Turbidity Salinity	Bypass More, Darul Ulum Madrasha Mosque, Mymensingh Sadar, Mymensingh	1

Total coliform (TC), Fecal Coliform (FC), Total Dissolved Solid (TDS), Total Suspended Solid	Balaspur, Baitul Rahman Jame Mosque, Mymensingh Sadar, Mymensingh	1
(TSS), Manganese Chlorides (Cl), Arsenic (As) Iron (Fe)	Charjahugara, Mymensingh Sadar, Mymensingh	1

Soil Quality

Soil samples were collected from 02 project influenced locations on 16 and 17 March 2020. The sampling locations with details address are describe tin Table 2.6. The samples were collected in a composite sampling method by Auger boring from 10 inch below the surface level (Figure 2.6). The samples were first placed in zipped lock plastic bags and then transferred to plastic jars. The Parameters are Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb), and Zinc (Zn). The collected soil samples were tested from Department of Soil, Water & Environment, Dhaka University (DU) Laboratory.

Figure 2.6:Hand Auger

Table 2.6:Sampling Locations of Soil Quality

Parameters	Locations	Samples Collected (No.)
Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe),	Digharkanda Bypass, Mymensingh Sadar, Mymensingh	1
Manganese (Mn), Lead (Pb), and Zinc (Zn).	Char Kalibari, Mymensingh Sadar, Mymensingh	1

Riverbed Sediment Quality

Riverbed Sediment samples were collected from 02 locations (Table 2.7) (upstream and downstream of the Brahmaputra River) along the proposed bridge alignment and analyzed for the heavy metals. Any construction or alteration of watercourse severely affects the bottom living benthos and planktons. The samples were collected in a single sampling method by Ekman Dredger (Figure 2.7). The samples were first placed in zipped lock plastic bags and then transferred to plastic jars. The Parameters are Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn), Lead (Pb), and Zinc (Zn). The collected sediment samples were tested from Department of Soil, Water & Environment, Dhaka University (DU) Laboratory.

Figure 2.7 Ekman Dredger

Table 2.7:Sampling Locations of Riverbed Sediment Quality

Parameters	Locations	Samples Collected (No.)
Cadmium (Cd), Chromium (Cr), Cupper (Cu), Iron (Fe), Manganese (Mn),	Brahmaputra River Downstream, Mymensingh	1
Lead (Pb), and Zinc (Zn).	Brahmaputra River Upstream, Mymensingh	1

Benthos Species

Benthos is the community of organisms that live on, in, or near the seabed, river, lake, or stream bottom, also known as the benthic zone. Benthos samples were collected from 02 locations (upstream and downstream) of the Brahmaputra river where the proposed bridge will be constructed (Table 2.8). To collect the benthos samples Ekman Dredger was using for grabbing the sediments (figure 2.8). The sediment was placed on a stack of five different mesh sizes sieves. The benthos species was differentiated through the sieves. The samples were placed in small plastic bottle by mixing with 1 ml formalin. The collected benthos samples were tested from Department of Zoology, Dhaka University (DU) Laboratory for further analysis of samples.

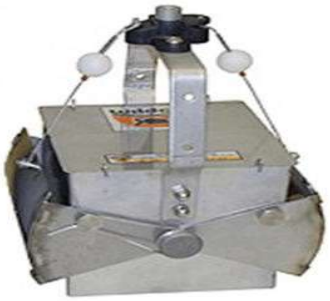
	
Ekman Dredger	Sieves

Figure 2.8: Equipments to collect Benthos Sample Table 2.8:Sampling Locations of Benthos Species

Parameters	Locations	Samples Collected (No.)
Benthos Species	Brahmaputra River Downstream, Mymensingh	1
	Brahmaputra River Upstream, Mymensingh	1

Plankton Species

Plankton are the diverse collection of organisms that live in large bodies of water and are unable to swim against a current. The individual organisms constituting plankton are called plankters. They provide a crucial source of food to many small and large aquatic organisms, such as bivalves, fish etc. Plankton samples were collected from 02 locations (upstream and downstream) of the Brahmaputra river where the proposed bridge will be constructed (Table 2.9). Plankton samples was collected by a Plankton net (Figure 2.9). For sample collection 40 liters of water will be poured by a bucket through Plankton net. The samples were placed in

small plastic bottle by mixing with 1 ml formalin. The collected plankton samples were tested from Department of Zoology, Dhaka University (DU) Laboratory for further analysis of samples.

	
Plankton Net	Bucket

Figure 2.9: Equipment to collect plankton species

Table 2.9:Sampling Locations of Plankton Species

Parameters	Locations	Samples Collected (No.)
Plankton Species	Brahmaputra River Downstream, Mymensingh	1
	Brahmaputra River Upstream, Mymensingh	1

Criteria of Location Selection

The study area shall cover 5 Km Radius of the proposed project as per the EIA guidelines of Department of Environment, Government of Bangladesh. However, all work will be site specific. The 5 km radius study area will be categorized as core zone and buffer zone and the upstream/downstream of the River will be considered for better assessment purpose during the study. All assessments, survey, investigation, testing and stakeholder consultations mentioned in the scope of works should be assessed within core zone of the proposed project but it can be extended to more if there is critical area exits where impacts can be extent.

Considering the project activities and EIA guidelines of Department of Environment, the team of environmental specialist (Client) has selected significant locations for environmental quality test which can represents existing baseline condition and it can also help to identify possible impacts and mitigation measures for construction period. Accordingly, the team of construction supervision can do same test at the same locations for further necessary action if there are any signification changed occurred during construction period.

Health & Safety

During this survey, proper health and safety measures were taken. Surveyors worked near the surface water sources wore life jackets and other safety gears. Bad weather condition was avoided to ensure surveyor's safety. During late night works, surveyors wore lightning vests to avoid accidents. The surveyors wore helmets during sample collection period for safety.

KB_AAQ_01(Digharkanda Bypass More, Mymensingh Sadar, Mymensingh)

KB_AAQ_02 (Hridoyer More, Digharkanda, Mymensingh)

KB_AAQ_03 (Kewatkhali Bypass, Mymensingh sadar, Mymensingh)

KB_AAQ_04 (Dakshin Char kalibari, Mymensingh Sadar, Mymensingh)

KB_AAQ_05 (Char Jhaugora, Mymensingh Sadar, Mymensingh)

Figure 2.10: Air Quality Monitoring in the Project Locations

***KB_NM_01 (*Digharkanda Bypass More, Mymensingh Sadar, Mymensingh)**

KB_NM_02 (Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh)

KB_NM_03 (Hakkani More, Balaspur Bypass, Mymensingh)

KB_NM_04 (Kewatkhali Bypass, Mymensingh Sadar, Mymensingh)

KB_NM_05 (Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh)

KB_NM_06 (Char Jhaugora, Mymensingh Sadar, Mymensingh)

Figure 2.12: Noise Level Monitoring at Project

KB_VB_01 (Kewatkhali Bypass More, Mymensingh Sadar, Mymensingh)

KB_VB_02 (Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh)

KB_VB_03 (Digharkanda Bypass, Mymensingh Sadar, Mymensingh)

KB_VB_04 (Char Kalibari, Mymensingh Sadar, Mymensingh)

KB_VB_05 (Char Jhaugara, Mymensingh Sadar, Mymensingh)

Figure 2.13: Vibration Level Monitoring at Different Project Influenced Locations

KB_SW_01 (Digharkanda, Mymensingh Sadar, Mymensingh)

KB_SW_02 (Brahmaputra River Downstream)

KB_SW_03 (Brahmaputra River Upstream)

KB_SW_04 (Char Kalibari, Mymensingh Sadar, Mymensingh)

Figure 2.15: Surface Water Sampling form the project influenced areas

KB_GW_01 (Bypass More, Darul Ulum Madrasha Mosque, Mymensingh Sadar, Mymensingh)

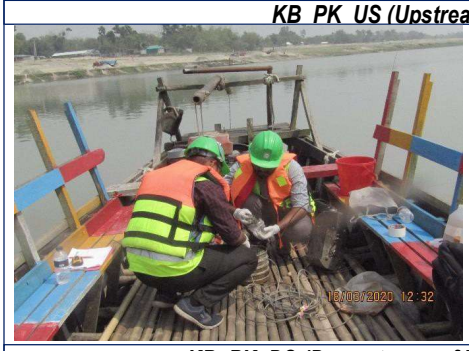
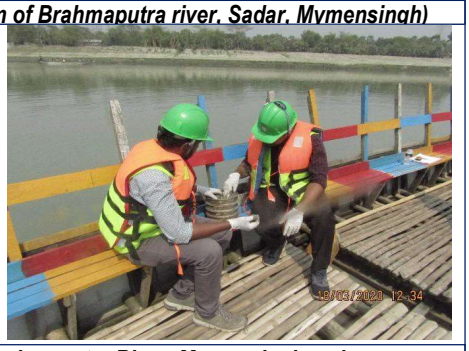
KB_GW_02 (Balaspur, Baitul Rahman Jame Mosque, Mymensingh Sadar, Mymensingh)


KB_GW_03 (Charjahugara, Mymensingh Sadar, Mymensingh)

Figure 2.17: Ground Water Sampling of Project

Benthos Species Sampling at Project Influenced Areas


KB_PK_US (Upstream of Brahmaputra river, Sadar, Mymensingh)

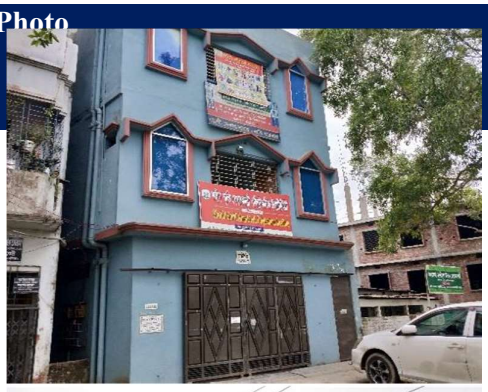
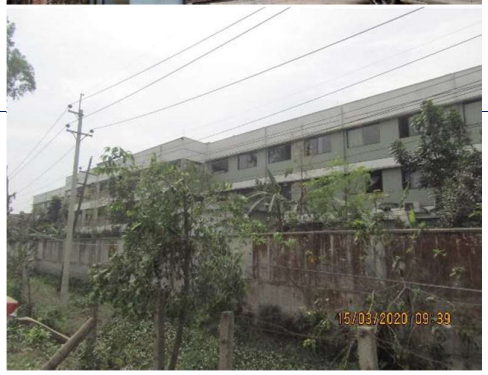
KB_PK_DS (Downstream of Brahmaputra River ,Mymensingh sadar,

Figure 2.23: Plankton Species Sampling at Project Influenced Areas

Appendix List of Sensitive Receptors

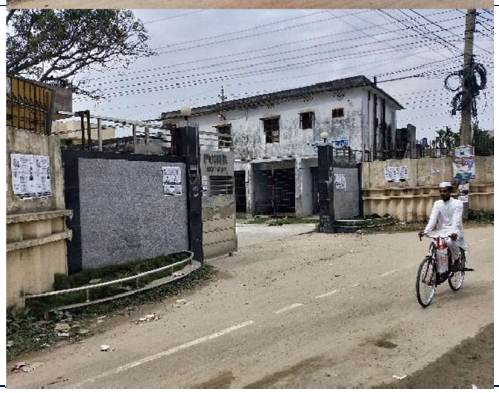
Name	GPS Location	Description	Photo
Sapla Resource Development Center, Digharkanda Bypass Road, Mymensingh Sadar.	24.72040 N 90.41133 E	Social Association for people Livelihood Advancement, Resource Development NGO.	
ASPADA Training Academy, Digharkanda University Road Bypass, Mymensingh.	24.72138 N 90.41165 E	Five storied building used as a training academy which is a non-political social development voluntary organization.	
Bangladesh Agricultural Development Corporation (BADC), Bolashpur, Kewatkhali Bypass, Mymensingh.	24.74334 N 90.42267 E	One storied government building under the ministry of agriculture.	
220 KVA Electrical Substation BADC, Bolashpur, Kewatkhali Bypass, Mymensingh.	24.74317 N 90.42277 E	Electrical substation under BADC.	

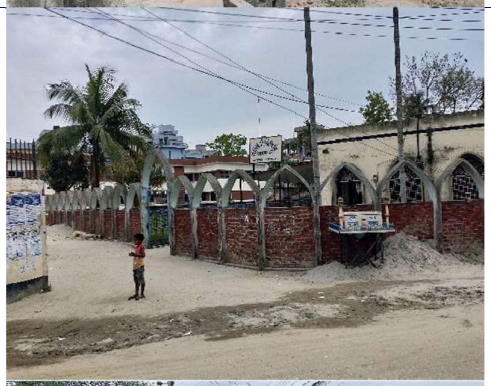
Name	GPS Location	Description	Photo
Momenshahi etimkhana (shishusodon) Balika, 94 kalibari (Patgudam), Mymensingh.	24.74553 N 90.42126 E	Orphanage for girls used for educational and religious activities.	
Tourist Police Mymensingh Zone, Mymensingh.	24.74565 N 90.42119 E	Law enforcement building. (5 storied)	
Hotel le Marian, Mymensingh Bypass mor, Mymensingh.	24.71664 N 90.41029 E	4 storied Residential Hotel	
Reneta Pharmaceuticals, Digharkanda Bypass, Mymensingh.	24.71749 N 90.40926 E	Pharmaceutical Agency	

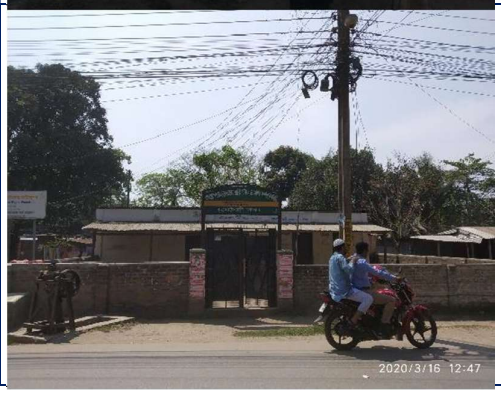
Name	GPS Location	Description	Photo
United Model School, Mymensingh.	24.74555 N 90.42124 E	Multistoried School Building.	
Notre Dame College, Mymensingh.	24.71717 N 90.40781 E	Educational Institution	
Police Bureau of Investigation (PBI), Mymensingh	24.73139 N 90.41601 E	Five storied law enforcement building	
Gasoline Filling Station	24.71848° N 90.41064°E	Filling Station	

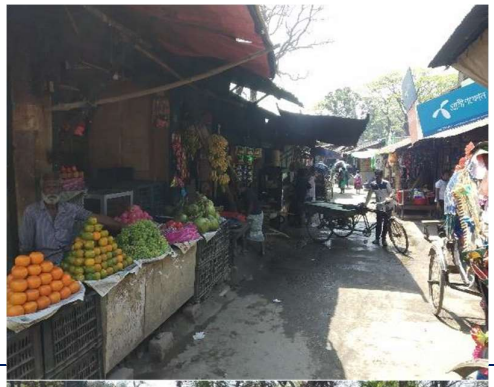
Name	GPS Location	Description	Photo
Janata Bank Regional Staff College, Kewatkhali Bypass mor, Mymensingh.	24.73191 N 90.41600 E	Commercial Building	
Anowara Memorial Nursery, 65 kalibari road, Bolashpur, Mymensingh.	24.74263 N 90.42314 E	Institution for supplying of different kinds of fruits, flowers and fishes.	
Office of the Assistant General, Agricultural Extension Department, Mymensingh.	24.74237 N 90.42328 E	Government organization building for Agriculture expansion.	
Bolashpur Bazar	24.73757 N 90.42216 E	Commercial Area	

Name	GPS Location	Description	Photo
Nurus Salam Jame Masjid, Kewatkhali Bypass Mor, Mymensingh.	24.73537 N 90.42042 E	Religious Place	
Sahid Sriti Non-Govt. Polytechnic Institute,	24.73139 N 90.41601 E	NGO building	
Sri Shibmondir, Patgudam Bridge Mor, Mymensingh.	24.74610 N 90.42071 E	A Temple place of Hindus for religious purposes.	
Muktijuddher Sritishoudho Mymensingh.	24.74627 N 90.42062 E	Landmark & Historical Place in Mymensingh	

Name	GPS Location	Description	Photo
Madrasha Hakimul Ummah Momenshahi, Bypass mor, Hakkanir mor, Mymensingh.	24.73980 N 90.41982 E	Madrasha	
Kewatkhali High School, Kewatkhali, Sadar, Mymensingh	24.73739N 90.42455 E	Educational Institution for students, tinshed school building.	
Kewatkhali Eidgah, Kewatkhali, Mymensingh	24.73636 N 90.42528 E	Eidgah for Eid prayer	
PDB Office, Mymensingh	24.73513 N 90.42406 E	Government Office building	

Name	GPS Location	Description	Photo
Hakkani Anjuman Masjid, Mymensingh.	24.73750 N 90.42156 E	Two Storied mosque is used for religious activities.	
PDB PGCB Jame Masjid, Mymensingh	24.73508N 90.42907 E	One storied building used for religious activities.	
Kewatkhali Bypass mor, Mymensingh	24.73992 N 90.42991 E	Central Bypass Mor	
Darus Suffa Muslim Academy, Dokkhin Chorkalibari, Mymensingh	24.74224 N 90.42860 E	Madrasa used for religious activities.	

Name	GPS Location	Description	Photo
Chor Jhaugora Government Primary School, Mymensingh.	24.76034 N 90.44231 E	Tow storied building govt. educational institution.	
Dokkhin Chor Masjid, Mymensingh	24.74230 N 90.42848 E	Mosque used for educational and religious activities.	
Dokkhin Chorkalibari Vumihin Somobay Somiti, Mymensingh	24.74244 N 90.42842 E	Somobay sanity for landless people.	
Bangladesh Railway Staff and Labor Organization, Kewatkhali Branch, Mymensingh.	24.73984 N 90.42528 E	One storied tinshed building used by railway loco running staffs and labors.	

Name	GPS Location	Description	Photo
Kewatkhali Bazar, Mymensingh	24.73892N 90.42561 E	Commercial area	
Loco Running Room, Bangladesh Railway, Kewatkhali, Mymensingh	24.73834 N 90.42585 E	Two storied building with open front yard	
Dormitory building Horticulture centre, Kewatkhali, Mymensingh	24.73868 N 90.42592 E	Two storied building adjacent to Kewatkhali bazar area	
Bangladesh railway Karigor Porishod, Kewatkhali, Mymensingh.	24.73981 N 90.42518 E	One storied tinshed building adjacent to rail-line in Kewatkhali bazar.	

Name	GPS Location	Description	Photo
Bangladesh Institute of Nuclear Agriculture, Mymensingh	24.72276N 90.43198 E	Five storied research building inside the BAU area.	
Botanical Garden, Mymensingh	24.72396 N 90.44010 E	Garden/Nursery area	
Bangladesh Agricultural University Post Office, Mymensingh	24.72252 N 90.44127 E	Government building	
Horticulture Center, Mymensingh.	24.73446 N 90.42921 E	Govt. Office buildings.	

Name	GPS Location	Description	Photo
Baitur Rahman Jame Masjid, Mymensingh	24.73917N 90.42401 E	Jame Mosque for educational and religious activities.	
Bangladesh Agriculture University	24.73446 N 90.42921 E	Main Gate for the Entrance of the Campus.	
Mrkajut Takwa Ideal School, Bolashpur, Mymensingh	24.73907 N 90.42389 E	Educational Institution	
103 no. Digharkanda Government Primary School, Mymensingh.	24.72374 N 90.41553 E	One storied govt. Educational building	

Name	GPS Location	Description	Photo
Digharkanda Central Jame Masjid, Mymensingh	24.72330N 90.41739 E	Central Mosque used for religious activities.	
Digharkanda Madrasha Masjid, Mymensingh	24.72440 N 90.41289 E	Madrasha used for religious and educational activities.	
Mymensingh Independent College, Moddhopara, Digharkanda, Mymensingh	24.72467 N 90.41228 E	Three storied Building used for Educational activities.	
RFL Factory, Mymensingh.	24.72746 N 90.41358 E	Industrial area	

Name	GPS Location	Description	Photo
Baitul Nur Jame Masjid, Mymensingh	24.72852N 90.41425 E	Mosque	
Electrical Tower, Mymensingh	24.74131 N 90.42933 E	Electric Tower	
Kewatkhali Railway Colony Jame Masjid & Frokania Madrasha, Nodir par colony, Mymensingh	24.74036 N 90.42591 E	Mosque and Madrasa	

Appendix 3Air Quality Monitoring Results

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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Ambient Air Quality
Sampling Location	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh
Sampling ID and GPS	KB_AAQ_01 (24.71695°N; 90.41014°E)
Sample Collector	Collected by DSCL Personnel
Sampling Date	14 March 2020

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration Present KB_AAQ_01	Bangladesh Standard**	WHO Standards***	Duration (hours)	Weather Condition	Method of Analysis
SPM	µg/m³	120.45	200	NYS	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	58.23	65	25	24		Gravimetric
PM_{10}	µg/m³	78.21	150	50	24		Gravimetric
NOx	µg/m³	35.67	100	40	Annual		Jacob and Hochheiser
SO_2	µg/m³	16.32	365	20	24		West-Geake
Lead	µg/m³	0.04	0.5	0.5	Annual		AAS Method
CO*	mg/m³	1.15	9	10	8		CO Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO Standards for Air Quality, 2005; NYS: Not Yet Standardized*

Sample Site Description

Location and Sample ID	Sample Site Description
Digharkanda Bypass More, Mymensingh Sadar, Mymensingh **KB_AAQ_01**	➢ The weather was mostly sunny ➢ People movement was High ➢ Traffic volume was high. ➢ Huge amount of dust particle present due to traffic movement. ➢ Temporary CNG Stand Area.

Test Performed By:
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Jr. Environmental Specialist

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Checked By:
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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Ambient Air Quality
Sampling Location	Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh
Sampling ID and GPS	KB_AAQ_02 (24.72303°N, 90.41205°E)
Sample Collector	Collected by DSCL Personnel
Sampling Date	15 March 2020

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration Present KB_AAQ_02	Bangladesh Standard**	WHO Standards***	Duration (hours)	Weather Condition	Method of Analysis
SPM	µg/m³	90.13	200	NYS	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	36.31	65	25	24		Gravimetric
PM_{10}	µg/m³	5612	150	50	24		Gravimetric
NOx	µg/m³	26.43	100	40	Annual		Jacob and Hochheiser
SO_2	µg/m³	09.39	365	20	24		West-Geake
Lead	µg/m³	0.02	0.5	0.5	Annual		AAS Method
CO*	mg/m³	1.15	9	10	8		CO Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO Standards for Air Quality, 2005; NYS: Not Yet Standardized*

Sample Site Description

Location and Sample ID	Sample Site Description
Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh **KB_AAQ_02**	➢ The weather was mostly sunny ➢ Moderate amount of dust particles is present. ➢ Low people movement ➢ Beside main road. ➢ Traffic volume was moderate.

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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Ambient Air Quality
Sampling Location	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh
Sampling ID and GPS	KB_AAQ_03 (24.73991°N, 90.42509°E)
Sample Collector	Collected by DSCL Personnel
Sampling Date	16 March 2020

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration Present KB_AAQ_03	Bangladesh Standard**	WHO Standards***	Duration (hours)	Weather Condition	Method of Analysis
SPM	µg/m³	112.32	200	NYS	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	50.98	65	25	24		Gravimetric
PM_{10}	µg/m³	73.34	150	50	24		Gravimetric
NOx	µg/m³	38.21	100	40	Annual		Jacob and Hochheiser
SO_2	µg/m³	18.23	365	20	24		West-Geake
Lead	µg/m³	0.03	0.5	0.5	Annual		AAS Method
CO*	mg/m³	2.29	9	10	8		CO Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO Standards for Air Quality, 2005; NYS: Not Yet Standardized*

Sample Site Description

Location and Sample ID	Sample Site Description
Kewatkhali Bypass, Mymensingh Sadar, Mymensingh **KB_AAQ_03**	➢ The weather was mostly sunny ➢ Huge amount of dust particle present due to traffic movement. ➢ People movement was high ➢ Traffic Volume was high and huge smoke coming from vehicles. ➢ Crowded Area

Test Performed By:
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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Ambient Air Quality
Sampling Location	Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh
Sampling ID and GPS	KB_AAQ_04 (24.74203°N; 90.42829°E)
Sample Collector	Collected by DSCL Personnel
Sampling Date	17 March 2020

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration Present KB_AAQ_04	Bangladesh Standard**	WHO Standards***	Duration (hours)	Weather Condition	Method of Analysis
SPM	µg/m³	68.13	200	NYS	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	29.90	65	25	24		Gravimetric
PM_{10}	µg/m³	45.67	150	50	24		Gravimetric
NOx	µg/m³	22.11	100	40	Annual		Jacob and Hochheiser
SO_2	µg/m³	10.34	365	20	24		West-Geake
Lead	µg/m³	0.0001	0.5	0.5	Annual		AAS Method
CO*	mg/m³	0.95	9	10	8		CO Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO Standards for Air Quality, 2005; NYS: Not Yet Standardized*

Sample Site Description

Location and Sample ID	Sample Site Description
Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh **KB_AAQ_04**	➢ Adjacent to Kewatkhali rail bridge ➢ Lower amount of dust particles is present ➢ Weather was sunny ➢ Beside Brahmaputra river bank ➢ Moderate People Movement ➢ Low traffic volume ➢ The place is in residential area

Test Performed By:
Saiful Islam Imran
Jr. Environmental Specialist

Development Solutions Consultant Limited * DSCL *

Checked By:
Tonmoy Pandit
Deputy Manager

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DSCL Environmental Laboratory

Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Ambient Air Quality
Sampling Location	Char Jhaugora, Mymensingh Sadar, Mymensingh
Sampling ID and GPS	KB_AAQ_05 (24.76036°N; 90.44234°E)
Sample Collector	Collected by DSCL Personnel
Sampling Date	18 March 2020

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration Present KB_AAQ_05	Bangladesh Standard**	WHO Standards***	Duration (hours)	Weather Condition	Method of Analysis
SPM	µg/m³	99.54	200	NYS	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	41.87	65	25	24		Gravimetric
PM_{10}	µg/m³	61.17	150	50	24		Gravimetric
NOx	µg/m³	29.56	100	40	Annual		Jacob and Hochheiser
SO_2	µg/m³	11.87	365	20	24		West-Geake
Lead	µg/m³	0.02	0.5	0.5	Annual		AAS Method
CO*	mg/m³	0.95	9	10	8		CO Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO Standards for Air Quality, 2005; NYS: Not Yet Standardized*

Sample Site Description

Location and Sample ID	Sample Site Description
Char Jhaugora, Mymensingh Sadar, Mymensingh **KB_AAQ_05**	➢ Beside Mymensingh-Netrokona Highway. ➢ Moderate amount of dust particles is present. ➢ People movement was high. ➢ Traffic volume was high.

Test Performed By:
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Appendix 4 Noise Level Measurement Results

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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Noise Level Measurement
Sample Collector	Collected by DSCL Personnel
Sampling Date	15 March 2020 to 19 March 2020

Test Result of Noise Level Measurement

Sample ID	Location	GPS Location	Land Use Category	Measurement Time				Noise Level dB(A) (L_{Aeq})		Bangladesh Standard*		WB EHS Standards**	
				Day		Night							
				Start	End	Start	End	Day	Night	Day	Night	Day	Night
KB_NM_01	Digharkanda Bypass More, Mymensingh Sadar, Mymensingh	24.71659°N 90.41022°E	Commercial	09:21 am	09:51 am	09:11 pm	09:41 pm	69.98	63.70	65	55	70	70
KB_NM_02	Hridoyer More, Digharkanda, Mymensingh Sadar, Mymensingh	24.72303°N 90.41205°E	Commercial	10:39 am	11:09 am	08:56 pm	09:06 pm	67.11	61.29	65	55	70	70
KB_NM_03	Hakkani More, Balaspur Bypass Mymensingh	24.73751°N 90.42212°E	Commercial	12:24 pm	12:59 pm	08:00 pm	08:30 pm	66.31	62.89	65	55	70	70
KB_NM_04	Kewatkhali Bypass, Mymensingh Sadar, Mymensingh	24.73992°N 90.42491°E	Commercial	01:04 pm	01:39 pm	09:22 pm	09:52 pm	71.97	66.40	65	55	70	70
KB_NM_05	Dakshin Char Kalibari, Mymensingh Sadar, Mymensingh	24.74196°N 90.42845°E	Residential	09:12 am	09:42 am	08:38 pm	09:08 pm	57.78	47.28	55	45	55	45
KB_NM_06	Char Jhaugora, Mymensingh Sadar, Mymensingh	24.76037°N 90.44227°E	Commercial	11:06 am	11:39 am	08:48 pm	09:18 pm	68.17	62.56	65	55	70	70

Notes:
- *Land use category is based on the classification provided in the Noise Pollution Control Rules (2006).*
- *The sound level standard for residential area at day time is 55 dBA and night time is 45 dBA.*
- *The sound level standard for commercial at day time is 65 dBA and night time is 55 dBA.*
- *Noise Level is the average noise recorded over the duration of the monitoring period.*

**Bangladesh National Standard for Noise Level According to Noise Pollution Control Rules (2006)*

***World Bank Noise Standard according to WB Environmental, Health and Safety (EHS) Guidelines*

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Sample Site Description

Sample Location and ID	Sample Site Description
Digharkanda Bypass More, Mymensingh sadar, Mymensingh **KB_NM-01**	➢ People movement was high ➢ Traffic volume was high ➢ Commercial area ➢ Some grocery shop is present. ➢ Temporary CNG stand
Hridoyer More, Digharkanda, Mymensingh sadar, Mymensingh **KB_NM_02**	➢ People movement was moderate ➢ Traffic volume was high. ➢ Commercial area ➢ Beside Eastern Bypass Road
Hakkani More, Balaspur Bypass Mymensingh **KB_NM_03**	➢ Commercial area ➢ Beside bazar ➢ People movement was High. ➢ Traffic volume was high
Kewatkhali Bypass, Mymensingh sadar, Mymensingh **KB_NM_04**	➢ People movement was high. ➢ Traffic volume was high. ➢ Commercial area. ➢ Crowded Area.
Dakshin Char Kalibari, Mymensingh sadar, Mymensingh **KB_NM_05**	➢ People movement was low. ➢ Traffic volume was low. ➢ Residential area. ➢ Beside Brahmaputra River. ➢ Adjacent to existing Kewatkhali Railway Bridge
Char Jhaugora, Mymensingh sadar, Mymensingh **KB_NM_06**	➢ People movement was high ➢ Beside Main Road ➢ Traffic volume was high. ➢ Beside Char Jhaugora Primary school.

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Appendix 5 Vibration Level Measurement Results

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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Vibration Level Measurement
Sample Collector	Collected by DSCL Personnel
Sampling Date	15 March 2020 to 19 March 2020

Test Result of Vibration Level Measurement

Sample ID	Location	Velocity (mm/s)				Acceleration (m/s²)				Displacement (mm)			
		Max.	Min.	Standard Deviation	Mean Value	Max.	Min.	Standard Deviation	Mean Value	Max.	Min.	Standard Deviation	Mean Value
KB_VB_01	Kewatkhali Bypass, Sadar, Mymensingh	12.83	0.05	2.173	2.813	43.4	0	5.945	4.241	3.246	0	0.224	0.034
KB_VB_02	Dakshin Chor kalibari, Sadar, Mymensingh	0.35	0.35	0.000	0.350	0	0	0.000	0.000	0.207	0	0.052	0.020
KB_VB_03	Digharkanda Bypass, Sadar, Mymensingh	0.21	0.05	0.071	0.150	15	0	6.001	4.900	0.021	0	0.002	0.002
KB_VB_04	Chor kalibari, Sadar, Mymensingh	0.43	0.43	0.000	0.430	14.7	0	3.460	4.321	0.015	0	0.003	0.003
KB_VB_05	Charjahugara, Sadar, Mymensingh	25.19	0.09	10.240	7.170	4.2	0	1.356	2.100	0.019	0	0.005	0.005

Test Performed By:
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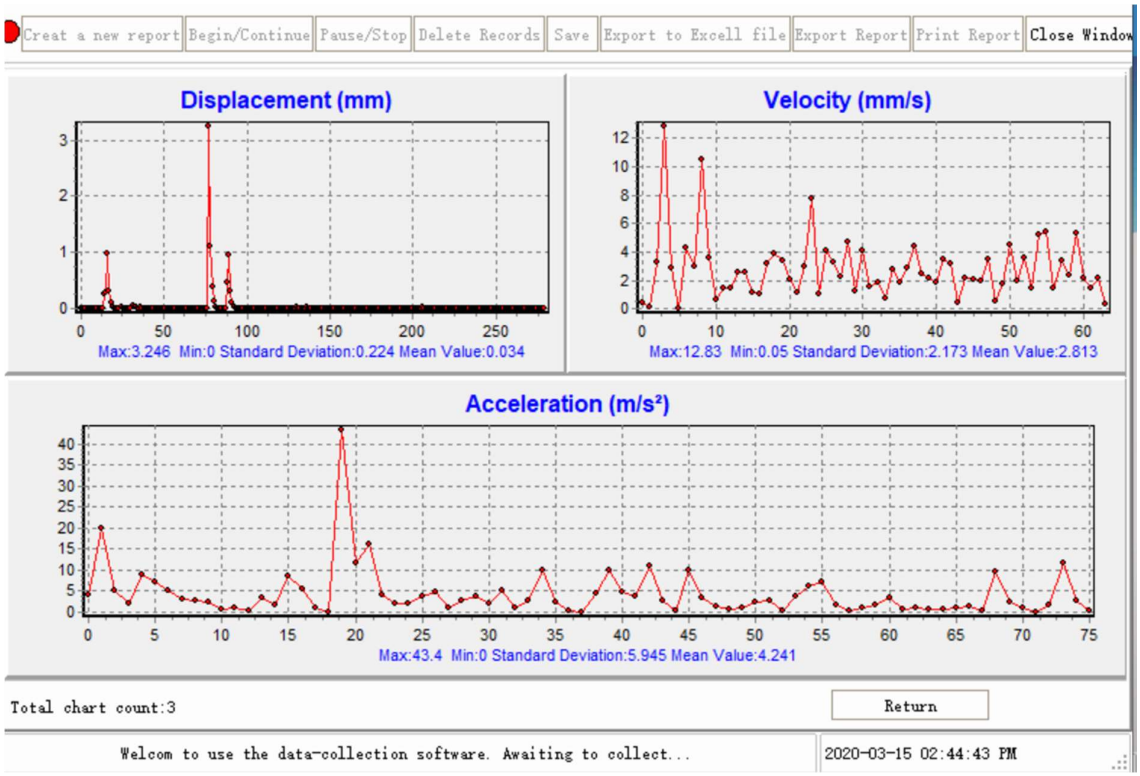
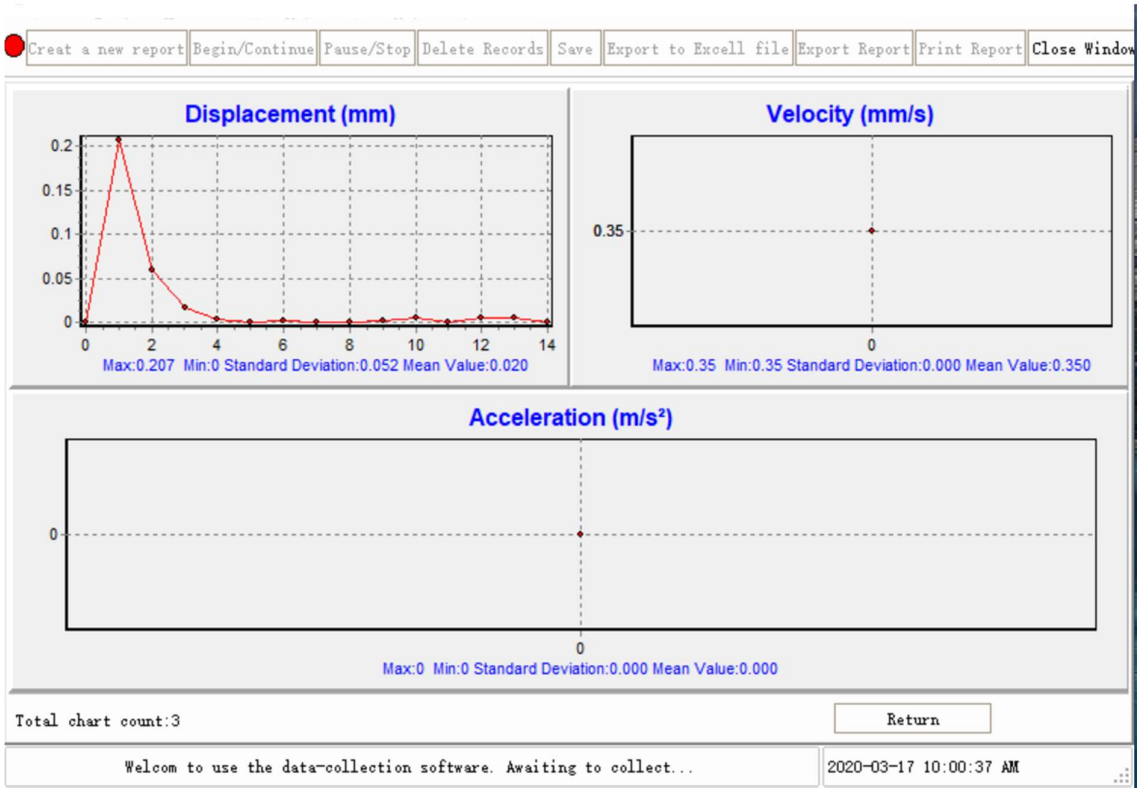
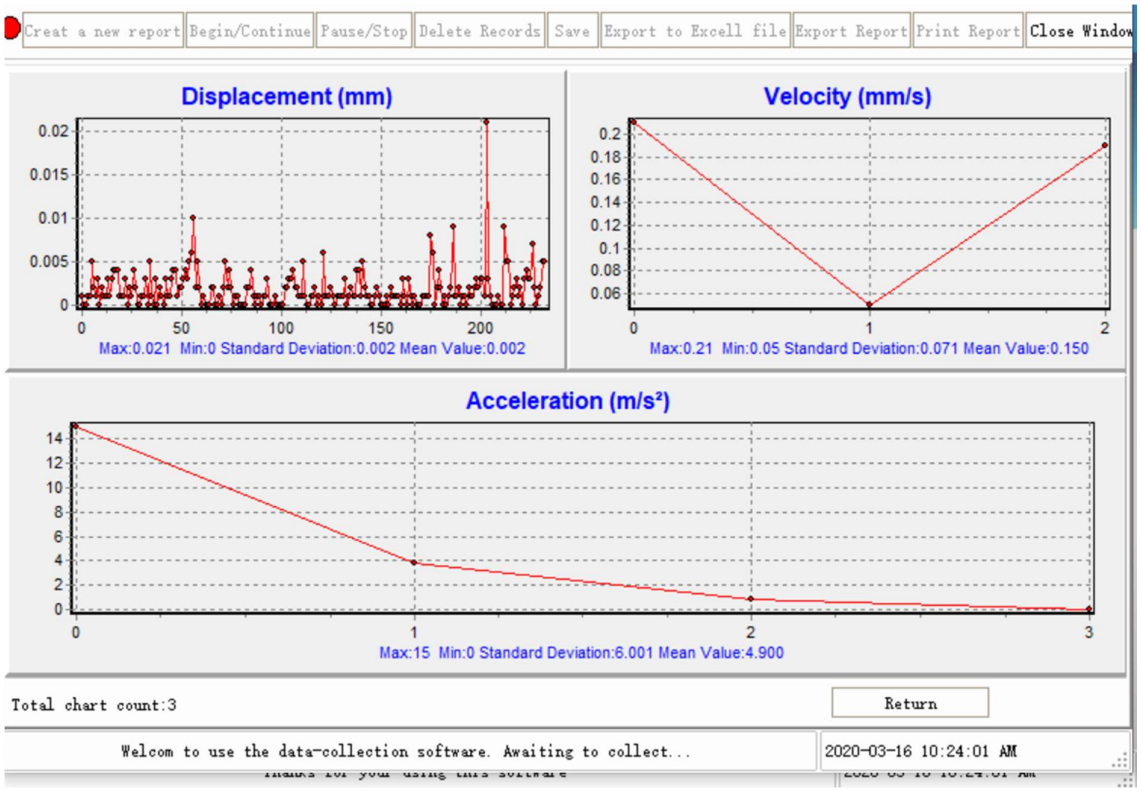
KB_VB_01 (Kewatkhali Bypass, Mymensingh Sadar, Mymensingh)



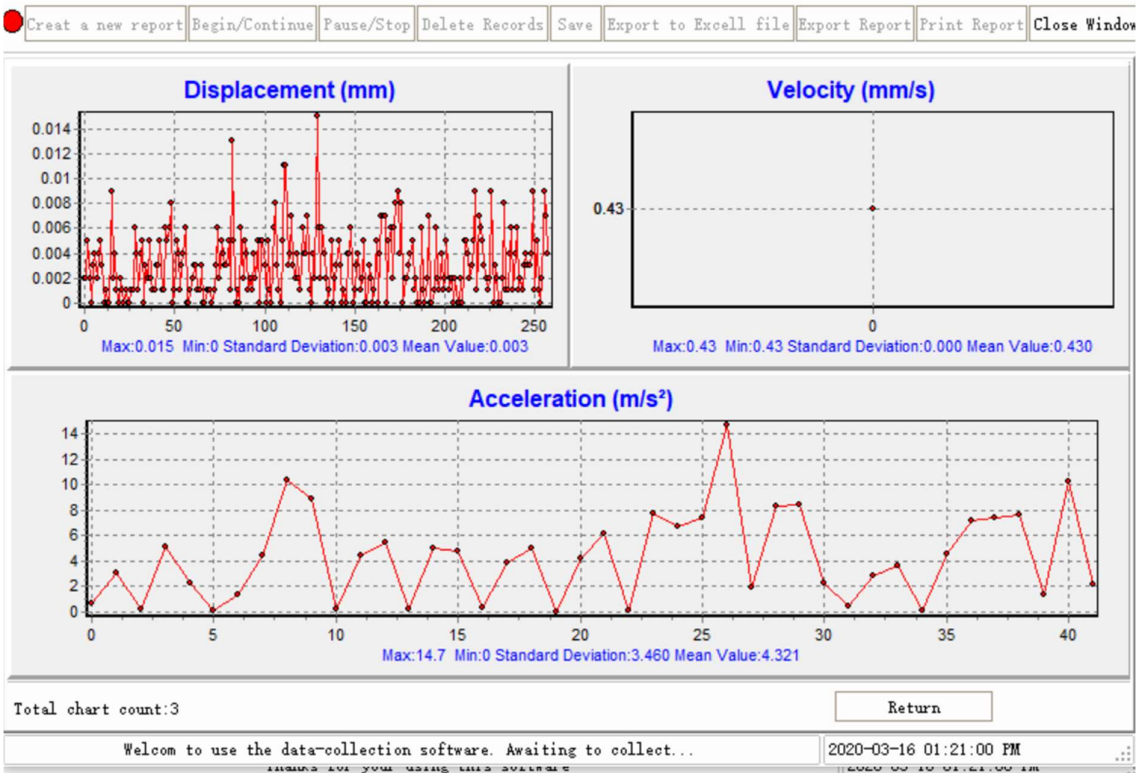
KB_VB_02 (Dakshin Char kalibari, Mymensingh Sadar, Mymensingh)



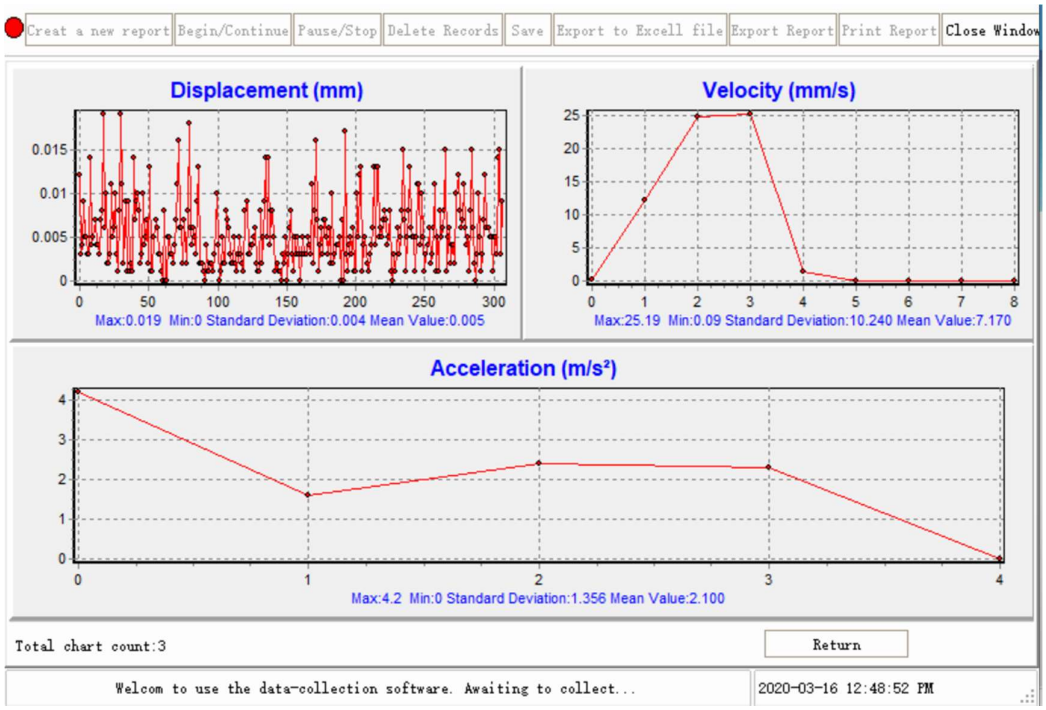
KB_VB_03 (Digharkanda Bypass More, Mymensingh Sadar, Mymensingh)



KB_VB_04 (Char Jhaugora, Mymensingh Sadar, Mymensingh)



KB_VB_05 (Char kalibari, Mymensingh Sadar, Mymensingh)



Appendix 6 Surface Water Quality Test Results

On-site Test Result of Surface Water

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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Surface Water Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	18 March 2020

On-site Test Result of Surface Water Quality

Parameters	Unit	KB_SW_02 24.73925°N 90.42802°E Brahmaputra River Downstream River Water	KB_SW_04 24.75986°N 90.44095°E Inland surface water Pond Water	Standards for Inland Surface Water** (best practice for fishing)	Analysis Method
pH*	-	8.34	8.28	6.5-8.5	Multi Meter
Temperature*	°C	31.4	28.7	NYS	Multi Meter
Total Dissolved Solids (TDS)*	mg/L	1532	1369	NYS	Multi Meter
Electric Conductivity*	µS/cm	387	402	NYS	Multi Meter
Dissolved Oxygen (DO)*	mg/L	5.1	5.4	5 or more	DO Meter

Note:
** On site Test Result*
***Standards for Inland Surface Water is followed Environmental Conservation Rule (ECR)'97*
NYS: Not Yet Standardized

Sample Site Description

Sample Location and ID	Sample Site Description
Brahmaputra River Downstream, Mymensingh **(KB_SW_02)**	➢ Sample collected from the downstream of Brahmaputra River ➢ The depth from where sample was collected is approximately 6 inches ➢ Water remains all around the year ➢ Water sample is collected from low tide.
Char Kalibari, Mymensingh Sadar, Mymensingh **(KB_SW_04)**	➢ The sample is collected from a Pond ➢ The depth from where sample was collected is approximately 6 inches ➢ Water remains all-round the year. ➢ Rain water washes into the Pond. ➢ Fish cultivated in this pond.

Test Performed By:
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Jr. Environmental Specialist

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Checked By:
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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Surface Water Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	23 December 2020

On-site Test Result of Surface Water Quality

Parameters	Unit	KB_SW_01 24.718798°N 90.410887°E Inland surface water Khal Water	KB_SW_03 24.74477°N 90.42699°E Brahmaputra River Upstream River Water	Standards for Inland Surface Water** (best practice for fishing)	Analysis Method
pH*	-	9.85	8.35	6.5-8.5	Multi Meter
Temperature*	^{0}C	24.7	25.7	NYS	Multi Meter
Total Dissolved Solids (TDS)*	mg/L	1289	1322	NYS	Multi Meter
Electric Conductivity*	µS/cm	266	347	NYS	Multi Meter
Dissolved Oxygen (DO)*	mg/L	4.4	5.3	5 or more	DO Meter

Note:
** On site Test Result*
***Standards for Inland Surface Water is followed Environmental Conservation Rule (ECR)'97*
NYS: Not Yet Standardized

Sample Site Description

Sample Location and ID	Sample Site Description
Digharkanda, Mymensingh Sadar, Mymensingh **(KB_SW_01)**	➢ The sample is collected form inland water source ➢ It is more like waste water in a khals. ➢ The depth from where sample was collected is approximately 6 inches ➢ Water is so much polluted
Brahmaputra River Upstream, Mymensingh **(KB_SW_03)**	➢ The water sample is collected from Upstream of Brahmaputra River ➢ The depth from where sample was collected is approximately 6 inches ➢ Water remains all around the year ➢ Water sample is collected from low tide.

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Lab Memo: 578/ CC, DPHE, CL, Dhaka

Date: 03-01-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021010001	Sample Receiving date: 23-12-2020
Ref. Memo No: DSCL/2020/Nill & Dated: 23-12-2020	Sample Source: Suface Water
Sent by:Md. Mashiur Rahman ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka.	Dist:Mymensingh, Upa:Mymensingh Sadar
Care Taker: DSCL (Sample ID : KB_SW_01)	Union:, Vill.:
Sample Collection date:	Date of Testing: 23/12/2020-31/12/2020

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	12	mg/L	5 days Incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	52	mg/L	CRM	-
3	Nitrogen (Nitrate)	10.0	2.0	mg/L	UVS	0.10
4	Phosphate	6.0	0.43	mg/L	UVS	0.10
5	Total Suspended Solid (TSS)	10	13	mg/L	Gravimetric Method	-
6	Turbidity	10	46.2	NTU	Turbidity Meter	-

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, UVS- UV-Visible Spectrophotometer, MFM- Membrane Filtration Method, CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.01.2021	1.) Name: Mita Sarker Designation: Senior Chemist	
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.1.2021	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	3/01/2021 Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka

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Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 578/ CC, DPHE, CL, Dhaka — Date: 03-01-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021010002	Sample Receiving date: 23-12-2020
Ref. Memo No: DSCL/2020/Nill & Dated: 23-12-2020	Sample Source: Suface Water
Sent by:Md. Mashiur Rahman ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka.	Dist:Mymensingh, Upa:Mymensingh Sadar
Care Taker: DSCL (Sample ID : KB_SW_02)	Union:, Vill.:
Sample Collection date:	Date of Testing: 23/12/2020-31/12/2020

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	20	mg/L	5 days Incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	80	mg/L	CRM	-
3	Nitrogen (Nitrate)	10.0	1.5	mg/L	UVS	0.10
4	Phosphate	6.0	0.38	mg/L	UVS	0.10
5	Total Suspended Solid (TSS)	10	8	mg/L	Gravimetric Method	-
6	Turbidity	10	13.6	NTU	Turbidity Meter	-

Comments: Sample was collected & supplied by client.
N.B. AAS- Atomic Absorption Spectrophotometer, UVS- UV-Visible Spectrophotometer, MFM- Membrane Filtration Method, CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.01.2021	1) Name: Mita Sarker Designation: Senior Chemist	
2) Name: Taslima Akhter Designation: Sample Analyzer	03.01.2021	2) Name: Md. Biplab Hossain Designation: Chief Chemist	03/01/2021 Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka

Page 1 of 1

Appendix 7: Groundwater Quality Test Results

On-site Test Result of Groundwater

DSCL

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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Groundwater Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	18 March 2020

On-site Test Result of Groundwater Quality

Parameters	Unit	KB_GW_03 24.76089°N 90.44208°E Deep Tubewell Water	Standards for Potable Water**	Analysis Method
pH*	-	7.26	6.5-8.5	Multi Meter
Electric Conductivity (EC)*	µS/cm	284	NYS	Multi Meter
Salinity*	ppt	<1	>1ppt	Multi Meter
Total Dissolved Solids (TDS)*	mg/L	190	1000	Multi Meter

Note:
**Bangladesh Standard for Drinking Water (ECR) '97*
** On-site Test*

Sample Location:

- *Char-Jhaugora, Mymensingh sadar, Mymensingh (KB_GW_03)*

Sample Location and ID	Sample Site Description
Char-jhaugasa, Mymensingh sadar, Mymensingh **(KB_GW_03)**	➢ The sample is collected from Tube well ➢ Nearest latrine is about 4 meters away ➢ Water used for drinking and domestic purpose ➢ Depth is approximately 400m.

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Checked By:
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Name of the Project	Construction of Kewatkhali Bridge over Brahmaputra River at Mymensingh
Description of Sample	Groundwater Quality
Sample Collector	Collected by DSCL Personnel
Sampling Date	23 December 2020

On-site Test Result of Groundwater Quality

Parameters	Unit	KB_GW_01 24.724706°N 90.412088°E Deep Tubewell Water	KB_GW_02 24.739312°N 90.424061°E Deep Tubewell Water	Standards for Potable Water**	Analysis Method
pH*	-	7.82	7.98	6.5-8.5	Multi Meter
Electric Conductivity (EC)*	µS/cm	323	343	NYS	Multi Meter
Salinity*	ppt	<1	<1	>1ppt	Multi Meter
Total Dissolved Solids (TDS)*	mg/L	269	287	1000	Multi Meter

Note:
**Bangladesh Standard for Drinking Water (ECR) '97*
** On-site Test*

Sample Location:

- *Bypass More-Darul alam Madrasa Masjid, sadar, Mymensingh (KB_GW_01)*
- *Baytur Rahman Jame Masjid, Balashpur, sadar, Mymensingh (KB_GW_02)*

Sample Location and ID	Sample Site Description
Bypass More-Darul alam Madrasa Masjid, sadar, Mymensingh **(KB_GW_01)**	➢ The sample is collected form deep tubewell water. ➢ The water is used for drinking and bathing purposes. ➢ Septic tank is far 100 distance from the water source ➢ The owner of the source is mosque authority ➢ Depth is approximately 350 m
Baytur Rahman Jame Masjid, Balashpur, sadar, Mymensingh **(KB_GW _02)**	➢ The sample is collected form deep tubewell water. ➢ The water is used for drinking and bathing purposes. ➢ Septic tank is far adjacent to the water source ➢ The owner of the source is mosque authority ➢ Depth is approximately 380-400 m

Test Performed By:
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Lab Memo: 862/3, CC, DPHE, CL, Dhaka — Date: 04-06-2020

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2020050042	Sample Receiving date: 19-03-2020
Ref. Memo No: DSCL/WT/2020/Nill & Dated: 19-03-2020	Sample Source: Ground Water
Sent by:Saiful Islam Imran ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka.	Dist:Mymensingh, Upa:Mymensingh Sadar
Care Taker: DSCL. (Sample ID: KB-GW-03)	Union:, Vill.:Char Jhaugora
Sample Collection date: 19-03-2020	Date of Testing: 19/03/2020-31/05/2020

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Arsenic (As)	0.05	0.001	mg/L	AAS	0.001
2	Chloride	150-600	40	mg/L	Titrimetic	-
3	Iron (Fe)	0.3-1	0.22	mg/L	AAS	0.05
4	Manganese (Mn)	0.1	1.65	mg/L	AAS	0.03
5	Total Suspended Solid (TSS)	10	2	mg/L	Gravimetric Method	-
6	Turbidity	10	2.2	NTU	Turbidity Meter	-

Comments: Sample was collected & Supplied by client.
N.B: AAS-Atomic Absorption Spectrophotometer, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer	04-06-2020	1.) Name: Mita Sarker Designation: Senior Chemist	04/06/2020
2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	04.06.2020	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	04/06/2020 Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka

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Government of the People's Republic of Bangladesh
Office of the Chief Chemist
Department of Public Health Engineering
Central Lab, 38-39, Mohakhali C/A, Dhaka-1212
Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 578/ CC, DPHE, CL, Dhaka

Date: 03-01-2020

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021010003	Sample Receiving date: 23-12-2020
Ref. Memo No: DSCL/2020/NIII & Dated: 23-12-2020	Sample Source: Tube Well
Sent by:Md. Mashiur Rahman ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka.	Dist:Mymensingh, Upa:Mymensingh Sadar
Care Taker: DSCL (Sample ID : KB_GW_01)	Union:, Vill.:
Sample Collection date:	Date of Testing: 23/12/2020-31/12/2020

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Arsenic (As)	0.05	0.003	mg/L	AAS	0.001
2	Chloride	150-600	15	mg/L	Titrimetic	-
3	Iron (Fe)	0.3-1	0.18	mg/L	AAS	0.05
4	Manganese (Mn)	0.1	0.04	mg/L	AAS	0.03
5	Total Suspended Solid (TSS)	10	1	mg/L	Gravimetric Method	-
6	Turbidity	10	0.36	NTU	Turbidity Meter	-

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, UVS- UV-Visible Spectrophotometer, MFM- Membrane Filtration Method, CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.01.2021	1.) Name: Mita Sarker Designation: Senior Chemist	
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.01.2021	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	03/01/2021 Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka

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Government of the People's Republic of Bangladesh
Office of the Chief Chemist
Department of Public Health Engineering
Central Lab, 38-39, Mohakhali C/A, Dhaka-1212
Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 578/ CC, DPHE, CL, Dhaka — Date: 03-01-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021010004	Sample Receiving date: 23-12-2020
Ref. Memo No: DSCL/2020/Nill & Dated: 23-12-2020	Sample Source: Tube Well
Sent by:Md. Mashiur Rahman ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka.	Dist:Mymensingh, Upa:Mymensingh Sadar
Care Taker: DSCL (Sample ID : KB_GW_02)	Union:, Vill.:
Sample Collection date:	Date of Testing: 23/12/2020-31/12/2020

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Arsenic (As)	0.05	0.001	mg/L	AAS	0.001
2	Chloride	150-600	16	mg/L	Titrimetic	-
3	Iron (Fe)	0.3-1	0.20	mg/L	AAS	0.05
4	Manganese (Mn)	0.1	0.03	mg/L	AAS	0.03
5	Total Suspended Solid (TSS)	10	1	mg/L	Gravimetric Method	-
6	Turbidity	10	0.37	NTU	Turbidity Meter	-

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, UVS- UV-Visible Spectrophotometer, MFM- Membrane Filtration Method, CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.01.2021	1.) Name: Mita Sarker Designation: Senior Chemist	
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.01.2021	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	03/01/2021 Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka

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Office of the Chief Chemist
Department of Public Health Engineering
Central Lab, 38-39, Mohakhali C/A, Dhaka-1212
Phone: 88-02-9881927, Fax: 88-02-9882003 , Email: wqmsc_central_lab@yahoo.com

Lab Memo: 578/ CC, DPHE, CL, Dhaka

Date: 03-01-2021

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2021010005	Sample Receiving date: 23-12-2020
Ref. Memo No: DSCL/2020/Nill & Dated: 23-12-2020	Sample Source: Tube Well
Sent by:Md. Mashiur Rahman ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka.	Dist:Mymensingh, Upa:Mymensingh Sadar
Care Taker: DSCL (Sample ID : KB_GW_03)	Union:, Vill.:
Sample Collection date:	Date of Testing: 23/12/2020-31/12/2020

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Coliform (Faecal)	0	0	N/100ml	MFM	-
2	Coliform (Total)	0	0	N/100ml	MFM	-

Comments: Sample was collected & supplied by client.
N.B: AAS- Atomic Absorption Spectrophotometer, UVS- UV-Visible Spectrophotometer, MFM- Membrane Filtration Method, CRM-Closed Reflex Methods, LOQ- Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	03.01.2021	1.) Name: Mita Sarker Designation: Senior Chemist	03/01/2021
2.) Name: Taslima Akhter Designation: Sample Analyzer	03.01.2021	2.) Name: Md. Biplab Hossain Designation: Chief Chemist	Md. Biplab Hossain Chief Chemist Department of Public Health Engineering Central Laboratory Mohakhali, Dhaka

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Appendix 8: Soil Quality Test Result

মৃত্তিকা, পানি ও পরিবেশ বিভাগ
ঢাকা বিশ্ববিদ্যালয়, ঢাকা ১০০০, বাংলাদেশ

Department of Soil Water and Environment
University of Dhaka, Dhaka 1000, Bangladesh

Reference No. SWE-DU/AS/0052-82/20 Date: 27 December 2020

Development Solutions Consultant Limited
House # 734 (5-B0, Road # 10, Avenue # 4
DOHS Mirpur, Dhaka-1216, Bangladesh.

Project Name: "Environmental Quality Assessment of EIA for Construction of Kewatkhali Bridge Over Brahmaputra River".

Analytical Report

As per your request, the supplied soil samples have been analyzed and the following results have been found.

Name of Sample	Parameters	Amount
KB_SL_01 (Location: Digharkanda Bypass More, Mymensingh)	Cadmium (Cd)	2.43 ppm
	Chromium (Cr)	16.56 ppm
	Copper (Cu)	13.84 ppm
	Lead (Pb)	14.46 ppm
	Zinc (Zn)	45.21 ppm
	Iron (Fe)	2.30 %
	Manganese (Mn)	0.017 %
KB_SL_02 (Location: Char Kalibari, Mymensingh Sadar, Mymensingh)	Cadmium (Cd)	1.61 ppm
	Chromium (Cr)	5.76 ppm
	Copper (Cu)	6.66 ppm
	Lead (Pb)	11.08 ppm
	Zinc (Zn)	15.76 ppm
	Iron (Fe)	0.74 %
	Manganese (Mn)	0.013 %

Thanking you for availing yourself of the service offered by the Analytical Service of the Department of Soil, Water and Environment, University of Dhaka. Please let us know if you have any queries regarding the analysis report.

27/12/2020

(Professor Dr. Md. Khalilur Rahman)
Chairman
Department of Soil, Water and Environment
University of Dhaka

Dr. Md. Khalilur Rahman
Professor & Chairman
Dept. of Soil, Water & Environment
University of Dhaka
Dhaka-1000, Bangladesh

Telephone : 9661920-73/7470, Fax: (880-2) 9667222, e-mail: swed@du.ac.bd

Appendix 9 Riverbed Sediment Quality Test Result

মৃত্তিকা, পানি ও পরিবেশ বিভাগ
ঢাকা বিশ্ববিদ্যালয়, ঢাকা ১০০০, বাংলাদেশ

Department of Soil Water and Environment
University of Dhaka, Dhaka 1000, Bangladesh

Reference No. SWE-DU/AS/0052-83/20 Date: 27 December 2020

Development Solutions Consultant Limited
House # 734 (5-B0, Road # 10, Avenue # 4
DOHS Mirpur, Dhaka-1216, Bangladesh.

Project Name: "Environmental Quality Assessment of EIA for Construction of Kewatkhali Bridge Over Brahmaputra River".

Analytical Report

As per your request, the supplied riverbed sediment samples from Brahmaputra River, Location: Char Kalibari, Mymensingh Sadar, Mymensingh have been analyzed and the following results have been found.

Name of Sample	Parameters	Amount
KB_RBM_US	Cadmium (Cd)	1.18 ppm
	Chromium (Cr)	6.88 ppm
	Copper (Cu)	6.20 ppm
	Lead (Pb)	10.95 ppm
	Zinc (Zn)	15.89 ppm
	Iron (Fe)	1.17 %
	Manganese (Mn)	0.012 %
KB_ RMB_DS	Cadmium (Cd)	1.27 ppm
	Chromium (Cr)	4.50 ppm
	Copper (Cu)	5.42 ppm
	Lead (Pb)	11.37 ppm
	Zinc (Zn)	15.52 ppm
	Iron (Fe)	0.79 %
	Manganese (Mn)	0.010 %

Thanking you for availing yourself of the service offered by the Analytical Service of the Department of Soil, Water and Environment, University of Dhaka. Please let us know if you have any queries regarding the analysis report.

27.12.2020

(Professor Dr. Md. Khalilur Rahman)
Chairman
Department of Soil, Water and Environment
University of Dhaka

Dr. Md. Khalilur Rahman
Professor & Chairman
Dept. of Soil, Water & Environment
University of Dhaka
Dhaka-1000, Bangladesh

Telephone : 9661920-73/7470, Fax: (880-2) 9667222, e-mail: swed@du.ac.bd

Appendix 10 Benthos Species Test Results

Department of Zoology
University of Dhaka
Analysis of Benthic Samples

Sampling procedure : Unknown
No of Samples : 2
Sample received on : 27th December 2020
Sample analyzed by : 29th December 2020 (URGENT)
Locations : Old Brahmaputra River, Freshwater
Client : DSCL, Development Solutions Consultant Ltd.

Sample No	Sample ID	Ecosystem	Results	Comments (if any)
1	KB_BH_US	Freshwater	*Bellamya* sp. (Gastropoda)-19 *Melania* sp. (Gastropoda)- 3 *Planorbis* sp. (Gastropoda)-3 Micromollusc bivalves (Bivalvia) -6	Minute sands materials appeared
2	KB_BH_DS	Freshwater	*Bellamya* sp. (Gastropoda)-7 Micromollusc bivalves (Bivalvia) -8	Samples with silt traces

M Niamul Naser PhD
Professor

1 | Page Sample Analysis from Prof M Niamul Naser PhD, DoZ, DU

Appendix 11 Plankton Species Test Results

Department of Zoology
University of Dhaka
Analysis of Benthic Samples

Sampling procedure : Unknown, 100 L sieved through plankton net
No of Samples : 2
Sample received on : 27th December 2020
Sample analyzed by : 29th December 2020 (URGENT)
Locations : Old Brahmaputra River, Freshwater
Client : DSCL, Development Solutions Consultant Ltd.
Working reference : Environmental Quality Assessment for Construction of Kewatkhali Bridge over Old Brahmaputra River

Sample No	Sample ID	Site, Ecosystem	Results (In 01 ml SR cell)	Count (unit/m³)
1	KB_PK_US	Old Brahmaputra River Freshwater	Zooplankton: *Cyclops* (Copepoda)- 4	1800
2	KB_PK_DS	Old Brahmaputra River Freshwater	Zooplankton: *Cyclops* (Copepoda)- 2	1200

M Niamul Naser PhD
Professor

DIGITALLY SUBMITTED

1 | Page Sample Analysis from Prof M Niamul Naser PhD, DoZ, DU

Appendix 12 Dolphin Survey Questionnaire

Name:

Gender: Male/ Female/ Others

Age:

Occupation:

Education Qualification:

How long have you been living in this area?

Ans: ----------Year

Mobile No.:

Questionnaire

Ques1: Do you know dolphin?

Ans: Yes/ No

Ques2: Have you ever seen a dolphin?

Ans: Yes/ No

Ques3: Have you seen dolphins in this river?

Ans: Yes/ No

Ques4: For how many days dolphins are seen in this area?

Ans: ---------Year

Ques5: How many dolphins/ How many groups of dolphins have been seen in this river?

Ans: ---------/-------Group

Ques6: Is the same quality of dolphin seen all year long? If answer is No, What time of year these are seen?

Ans: Yes/ No. ----------Month

Ques7: Are these dolphins resident in this area or coming to visit this area?

Ans:

Ques8: If resident, how many times in a day they are seen?

Ans:

Ques9: Are dolphins of any good for us?

Ans: Yes/ No

Ques10: At present the number of dolphins has decreased or increased?

Ans: Increase/ Decrease

Ques11: What is the reason for the increase or decrease?

Ans:

1 River filling up

2 Lack of food in the river

3 River water pollution

4 Plying of mechanical vessels in the river

5 Contaminated fluid/ waste emitted from mills & factories

6 Disposal of waste in the river by the people

7 Unplanned dam/ bridge construction

8 Others: Mention

Ques12: What do you think are the reasons for the threat to the dolphins?

Ans:

1

2

3

Ques13: Has the pollution of the river water in this area has increased ever since?

Ans: Yes/ No

Ques14: If yes, why do you think the cause of water pollution?

Ans:

1

2

3

Ques15: Has polythene contamination increased in the river here?

Ans: Yes/ No

Ques16: Is there any increase in the movement of mechanical vessels in this area?

Ans: Yes/ No

Ques17: If yes, what kind of boat travel through this area?

Ans: Non-mechanical vessels, mechanical vessels, transportation of passengers, Carrying sand by vessels, transporting goods by river vessels.

Ques18: Approximately how many boats / ships do you think travel through this area every day?

Ans:

Ques19: Are locals aware of dolphin conservation?

Ans: Yes/ No

Ques20: What do you know about the proposed bridge?

Ans: Yes/ No

Ques21: Are there any dolphins seen in the proposed bridge area?

Ans:

Ques22: Are there any dolphins seen upstream in the proposed bridge area?

Ans:

Ques23: Do you think the dolphins will have any threat when the proposed bridge is completed?

Ans:

1

2

3

Ques24: If the answer is yes, what do you think will be the threat?

Ans:

1

2

3

Ques25: How do you think dolphins can be preserved?

Ans:

Appendix 13: GRID Report of Ecological Survey

GRID Report-01

GRID Report ID: 01	**Habitat Type:** Roadside
Location: China Town, Mymensingh Sadar, Mymensingh	
GP coordinates: 24.76118°N; 90.43610°E	**Grid Size:100m*100m**

Sl	Local Name	Scientific Name	Species Count
1.	Akash Moni	*Acacia auriculiformis*	2
2.	Amm	*Mangifera indica*	6
3.	Amra	*Spondias mombin*	1
4.	Arjun	*Terminalia arjuna*	2
5.	Bash	*Bambusa balcooa*	15
6.	Bel	*Aegle marmelos*	2
7.	Boroi	*Ziziphus mauritiana*	1
8.	Chamble	*Albizia recardiana*	5
9.	Dumur	*Ficus sycomorus*	3
10.	Eucaliptus	*Eucalyptus globulus*	1
11.	Jam	*Syzygium cumini*	2
12.	Jambura	*Citrus maxima*	1
13.	Jibon	*Trema Orentalis*	2
14.	Jolpai	*Olea europaea*	1
15.	Kadam	*Neolamarckia cadamba*	3
16.	Kalo Koroi	*Albizia lebbeck*	1
17.	Kamranga	*Averrhoa carambola*	1
18.	Kat Badam	*Terminalia catappa*	1
19.	Kathal	*Artocarpus heterophyllus*	3
20.	Khejur	*Phoenix sylvestris*	2
21.	Khoi Babla	*Vachellia nilotica*	1
22.	Kola	*Musa acuminata*	11
23.	Lebu	*Citrus auranticola*	2
24.	Mahagoni	*Swietenia macrophylla*	10
25.	Mandar	*Erythrina ovalifolia*	2
26.	Narikel	*Cocos nucifera*	2
27.	Neem	*Azadirachta indica*	1
28.	Pepe	*Carica papaya*	1
29.	Peyara	*Psidium guajava*	1
30.	Pitoli	*Mallotus nudiflora*	3
31.	Shimul	*Bombax ceiba*	1
32.	Sishoo	*Dalbergia sissoo*	1
33.	Supari	*Areca catechu*	8
34.	Tetul	*Tamarindus indica*	3

GRID Report-02

GRID Report ID: 02	**Habitat Type:** Home Stead
Location: Char Kalibari, Mymensingh Sadar, Mymensingh	
GP coordinates: 24.74502°N; 90.43195°E	**Grid Size:100m*100m**

Sl	Local Name	Scientific Name	Species Count
1.	Amm	*Mangifera indica*	10
2.	Amloki	*Phyllanthus emblica*	1
3.	Amra	*Spondias mombin*	3
4.	Arjun	*Terminalia arjuna*	1
5.	Ata	*Annona squamosa*	10
6.	Bash	*Bambusa balcooa*	22
7.	Bel	*Aegle marmelos*	5
8.	Bon Jam	*Ardisia solanacea*	1
9.	Boroi	*Ziziphus mauritiana*	1
10.	Bot	*Ficus benghalensis*	1
11.	Chalta	*Dillenia indica*	1
12.	Chamble	*Albizia recardiana*	2
13.	Debdaru	*Polyalthia longifolia*	1
14.	Dewa	*Artocarpus lacucha*	1
15.	Dumur	*Ficus sycomorus*	7
16.	Eucaliptus	*Eucalyptus globulus*	3
17.	Gab	*Diospyros discolor*	1
18.	Jam	*Syzygium cumini*	2
19.	Jambura	*Citrus maxima*	2
20.	Jamrul	*Syzygium samarangense*	2
21.	Jarul	*Lagerstroemia speciosa*	4
22.	Jibon	*Trema Orentalis*	1
23.	Jog Dumur	*Ficus racemosa*	3
24.	Jolpai	*Olea europaea*	2
25.	Kadam	*Neolamarckia cadamba*	1
26.	Kalo Koroi	*Albizia lebbeck*	1
27.	Kathal	*Artocarpus heterophyllus*	4
28.	Khejur	*Phoenix sylvestris*	4
29.	Khoi Babla	*Vachellia nilotica*	4
30.	Kola	*Musa acuminata*	4
31.	Lebu	*Citrus auranticola*	1
32.	Lichu	*Litchi chinensis*	1
33.	Mahagoni	*Swietenia macrophylla*	14
34.	Mandar	*Erythrina ovalifolia*	1
35.	Narikel	*Cocos nucifera*	4
36.	Neem	*Azadirachta indica*	2
37.	Pepe	*Carica papaya*	1
38.	Sada Shimul	*Ceiba pentandra*	1
39.	Sajina	*Moringa oleifera*	1
40.	Shaora	*Streblus asper*	1

41.	Shil Koroi	*Albizia procera*	1
42.	Sishoo	*Dalbergia sissoo*	1
43.	Supari	*Areca catechu*	5
44.	Tal	*Borassus flabellifer*	1
45.	Tetul	*Tamarindus indica*	1

GRID Report-03

GRID Report ID: 03	**Habitat Type:** Home Stead
Location: Railway Colony, Kewatkhali, Mymensingh	
GPS Coordinates: 24.74063°N; 90.42587°E	**Grid Size:100m*100m**

Sl	Local Name	Scientific Name	Species Count
1.	Amloki	*Phyllanthus emblica*	1
2.	Amm	*Mangifera indica*	3
3.	Amra	*Spondias mombin*	2
4.	Ata	*Annona squamosa*	1
5.	Bash	*Bambusa balcooa*	34
6.	Bel	*Aegle marmelos*	2
7.	Boroi	*Ziziphus mauritiana*	5
8.	Chamble	*Albizia recardiana*	3
9.	Debdaru	*Polyalthia longifolia*	1
10.	Dewa	*Artocarpus lacucha*	1
11.	Dumur	*Ficus sycomorus*	4
12.	Eucaliptus	*Eucalyptus globulus*	7
13.	Jam	*Syzygium cumini*	1
14.	Jambura	*Citrus maxima*	1
15.	Jamrul	*Syzygium samarangense*	2
16.	Jarul	*Lagerstroemia speciosa*	2
17.	Jibon	*Trema Orentalis*	2
18.	Jog Dumur	*Ficus racemosa*	1
19.	Jolpai	*Olea europaea*	1
20.	Kadam	*Neolamarckia cadamba*	3
21.	Kalo Koroi	*Albizia lebbeck*	2
22.	Kat Badam	*Terminalia catappa*	1
23.	Kathal	*Artocarpus heterophyllus*	6
24.	Khejur	*Phoenix sylvestris*	2
25.	Khoi Babla	*Vachellia nilotica*	2
26.	Kola	*Musa acuminata*	3
27.	Koromcha	*Carissa carandas*	1
28.	Lebu	*Citrus auranticola*	4
29.	Lichu	*Litchi chinensis*	1
30.	Mahagoni	*Swietenia macrophylla*	11
31.	Mandar	*Erythrina ovalifolia*	2
32.	Narikel	*Cocos nucifera*	3
33.	Neem	*Azadirachta indica*	1
34.	Pepe	*Carica papaya*	3
35.	Peyara	*Psidium guajava*	1
36.	Sajina	*Moringa oleifera*	2

37.	Shaora	*Streblus asper*	1
38.	Shil Koroi	*Albizia procera*	3
39.	Shimul	*Bombax ceiba*	1
40.	Sishoo	*Dalbergia sissoo*	1
41.	Supari	*Areca catechu*	1
42.	Tal	*Borassus flabellifer*	1
43.	Tetul	*Tamarindus indica*	1

GRID Report-04

GRID Report ID: 04	**Habitat Type:** Artificial (Commercial)
Location: Moynar More, Mymensingh Sadar, Mymensingh	
GP coordinates: 24.731688°N; 90.416458°E	**Grid Size:100m*100m**

Sl	Local Name	Scientific Name	Species Count
1.	Akash Moni	*Acacia auriculiformis*	3
2.	Amloki	*Phyllanthus emblica*	1
3.	Amm	*Mangifera indica*	8
4.	Amra	*Spondias mombin*	2
5.	Bash	*Bambusa balcooa*	12
6.	Bel	*Aegle marmelos*	1
7.	Boroi	*Ziziphus mauritiana*	2
8.	Chamble	*Albizia recardiana*	1
9.	Debdaru	*Polyalthia longifolia*	1
10.	Dewa	*Artocarpus lacucha*	1
11.	Dumur	*Ficus sycomorus*	1
12.	Eucaliptus	*Eucalyptus globulus*	2
13.	Jam	*Syzygium cumini*	1
14.	Jambura	*Citrus maxima*	3
15.	Jamrul	*Syzygium samarangense*	1
16.	Jarul	*Lagerstroemia speciosa*	1
17.	Jibon	*Trema Orentalis*	1
18.	Jog Dumur	*Ficus racemosa*	2
19.	Jolpai	*Olea europaea*	1
20.	Kadam	*Neolamarckia cadamba*	1
21.	Kathal	*Artocarpus heterophyllus*	5
22.	Khejur	*Phoenix sylvestris*	1
23.	Khoi Babla	*Vachellia nilotica*	1
24.	Kola	*Musa acuminata*	13
25.	Lebu	*Citrus auranticola*	1
26.	Lichu	*Litchi chinensis*	1
27.	Mahagoni	*Swietenia macrophylla*	8
28.	Narikel	*Cocos nucifera*	2
29.	Neem	*Azadirachta indica*	1
30.	Pepe	*Carica papaya*	1
31.	Peyara	*Psidium guajava*	1
32.	Shimul	*Bombax ceiba*	1
33.	Sishoo	*Dalbergia sissoo*	2
34.	Supari	*Areca catechu*	24

35.	Tal	*Borassus flabellifer*	1
36.	Tetul	*Tamarindus indica*	1

Appendix 14: List of Participants for Focus Group Discussion (FGD)

(This has been removed as it contains sensitive information.)

Appendix 15 Environmental Code of Practice

ECP 1: Waste Management

Project Activity/	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 BBA 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. • 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

ECP 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 BBA 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 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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
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.

ECP 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, and accidental spillage	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 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	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 a 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.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
of fish and other aquatic biology.		
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 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 contaminated with arsenic purposes.	Groundwater at shallow depths is and hence not suitable for drinking	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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• 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

ECP 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. • 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

ECP 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 • 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

ECP 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. The impact of soil erosion are (i)	• 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	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 erosion and/or deposition of sediment damaging the spawning grounds of fish, and (iii) destruction of vegetation by burying or gullying.	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 • 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.

ECP 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.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• 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 outside ROW or temporary access roads will affect the soil fertility of the agricultural lands	• Limit equipment and vehicular movements to 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

ECP 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 and rails, 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

ECP 9: Borrow Areas Development & Operation

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines

Development and operation of borrow areas	Generally dredge spoils will be used as borrow material for filling of construction sites to the 100 year flood level. In case, the borrow pits developed by the Contractor, there will be impacts on local topography, landscaping and natural drainage.	The Contractor shall
		• Use dredge spoils from the Padma river as borrow materials to the maximum extent possible
		• Identify borrow pits in consultation with the local governments and BBA.
		• Obtain the borrow material from:
		  • barren land or land without tree cover outside the road reserve;
		  • excavating land and creating new water tanks/ponds;
		  • land acquired temporarily outside the road reserve;
		  • excavation of proposed culverts;
		• Do not dug the borrow pits within 5m of the toe of the final section of the road embankment.
		• Dig the borrow pits continuously. Ridges of not less than 8 m widths shall be left at intervals not exceeding 300 m and small drains shall be cut through the ridges to facilitate drainage
		• Slope the bed level of the borrow pits, as far as possible, down progressively towards the nearest cross drain, if any, and do not lower it than the bed of the cross-drain, to ensure efficient drainage. .
		• Do not dig the depth of borrow pits exceeding 45 cm when it becomes necessary to borrow earth from temporarily acquired cultivable lands. Strip the topsoil to a depth of 15 cm and stockpile for later rehabilitation of the pit. Thereafter, dug out soil to a further depth not exceeding 30 cm and use in forming the embankment. Spread the stockpiled top soil back on the land once the borrow pit is no longer required.
		• Do not locate the borrow pits within 500 m of any identified archaeological, religious or cultural sites if any.
		• Haul the borrow materials to embankments, or other areas of fill, only after sufficient spreading and compaction plant is operating at the place of deposition.
		• Follow the below for restoration of borrow areas are:
		  • Return stockpiled topsoil to the borrow pit if is used for agriculture;
		  • Stabilize the banks of the borrow pit with the top soil if it is used for fish ponds

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
by compaction;		• return stockpiled topsoil to the borrow pit and all worked areas to be stabilized through re-vegetation using local plants. • Control at each site by ensuring that base of the borrow pit drains into a sediment trap prior to discharging from the site.

ECP 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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• 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
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

ECP 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 minimizing construction noise on the work site

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
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

ECP 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,	The Contractor shall • Reduce disturbance to surrounding vegetation • Use appropriate type and minimum size of machine to avoid disturbance to adjacent

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	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.	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

ECP 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	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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
quality,.		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.

ECP 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 equipment, materials and human resources • Do not dump wastes, be it hazardous or non-hazardous into the nearby water bodies or in

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ ManagementGuidelines
		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 ECP 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

ECP 15: Road Transport and Road Traffic Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ ManagementGuidelines
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 BBA 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 arrangements showing all detours, temporary road, temporary bridges temporary diversions, necessary barricades, warning signs / lights, road signs etc. • 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:

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• 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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
ECP 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 Padma 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 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.

ECP 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 PIU for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
that are to be constructed together 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 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	The Contractor shall

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
to environment	minimize impacts on the	• 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 equipment/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.
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	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.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	spreading sexually transmitted infections and HIV/AIDS.	• 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
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 fire fighting equipment 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

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• 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 by BBA. • 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 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 Padma project.

ECP 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 PIU • Provide separate prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		people • Allow the workers to participate in praying 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

ECP 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 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

Project Activity / Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		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 health and 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 substandard living standards and health hazards.	The Contractor shall provide the following facilities in the campsites to improve health and hygienic conditions as mentioned in ECP 17 Construction Camp Management • Adequate ventilation facilities • Safe and reliable water supply. Water supply from deep tube wells that meets the national 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 ECP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for trainings • Paved internal roads. • Security fence at least 2 m height.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• 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 • ECP 2: Fuels and Hazardous Goods Management • ECP 4: Drainage Management • ECP 10: Air Quality Management • ECP 11: Noise and Vibration Management • ECP 15: Road Transport and Road Traffic Management • ECP 16: River Transport management
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce, make them susceptible to potential diseases.	The Contractor shall • 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.