Bangladesh Inland Water Transport Authority (BIWTA)
Ministry of Shipping
Government of the People's Republic of Bangladesh

Project: Bangladesh Regional Waterway Transport Project-1
(BRWTP-1)
(IDA Credit No.: 5842-BD, Contract # BRWTP-S6)

Environmental and Social Impact Assessment of proposed new and upgradation of Cargo and Passenger River Terminals

Final Report

ESIA for Cargo and Passenger River Terminals
Environmental and Social Impact Assessment Report

(EC5706-DRAFT-FINAL-ESIA-REPORT-BRWTP-S6-D04)

FEBRUARY 2022

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- Cargo and Passenger River Terminals
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LIST OF ABBREVIATIONS

ARIPA	Acquisition and Requisition of Immovable Property Act of 2017
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BIWTA	Bangladesh Inland Water Transport Authority
BIWTMAS	Bangladesh Inland Water Transport Master Plan
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BRWTP	Bangladesh Regional Waterway Transport Project
CEAP	Contractor's Environmental Management Plan
CEDAW	Convention on Elimination of All Forms of Discrimination against Women
CIA	Cumulative Impact Assessment
CSC	Contractor´s Supervision Consultant
CT	Cargo Terminal
DC	Deputy Commissioner
DEPTC	Deck and Engine Personnel Training Center
DFR	Draft Feasibility Report
DGPS	Differential Geographic Positioning System
DoE	Department of Environment
DTR	Diurnal Temperature Range
ECA	Ecologically Critical Area
ECAP	Environmental Corporate Action Program
ECC	Environmental Clearance Certificate
ECoP	Environmental Code of Practices
ECR	Environment Conservation Rules
EMF	Environmental Management Frameworks
EQS	Environmental Quality Standards
ESIA	Environmental and Social Impact Assessment
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental Management Plan
ESR	Environmental and Social Receptors
FFR:	Final Feasibility Report
FGD	Focus Group Discussion
GBM	Ganges, Brahmaputra, Meghna
GBV	Gender-Based Violence
GCM	General Circulation Models
GoB	Government of Bangladesh
GRC	Grievance Redress Committees
GRM	Grievance Redress Mechanism
HP:	Horsepower
ICT	Inland Container Terminal
IEE	Initial Environmental Examination
IMTP:	Integrated Multimodal Transport Policy
IUCN	International Union for Conservation of Nature
IWT	Inland Waterway Transport
kN	Kilonewton
kV	Kilovolt

- kVA Kilovolt ampere
- LNG Liquified Natural Gas
- MARPOL International Convention for the Prevention of Pollution from Ships
- MoEF Ministry of Environment and Forest
- MoS Ministry of Shipping
- NEMAP National Environmental Management Action Plan
- NEP National Environment Policy
- NIMTP National Integrated Multimodal Transport Policy
- NPV Net Present Value
- OHS Occupational Health and safety
- OP: Operational Policy
- OSPAR Oslo/Paris convention for the Protection of the Marine Environment of the North-East Atlantic)
- PA Protected Area
- PIU Project Implementation Unit
- PT Passenger Terminal
- RAP Resettlement Action Plan
- REB: Rural Electrification Board
- RFP Request for Proposal
- RPF Resettlement Policy Framework (RPF)
- SDG Sustainable Development Goal
- SIA Social Impact Assessment
- SMF Social Management Framework
- SMRC SAARC Meteorological Research Center
- SPM Shore Protection Manual
- STP: Sewage Plant
- TOR Terms of Reference
- IUCN International Union for Convervation of Nature
- WB World Bank

1. INTRODUCTION

1.1. BACKGROUND OF THE PROJECT

Bangladesh lies predominately within the Bangla basin, the world' largest delta formed by the Ganges, Brahmaputro (Jamuna) and Meghna (GBM) river system and its tributaries and distributaries. Bangladesh is a riverine country with some 700 rivers, streams and canals with a total length of about 24,000 kilometers (km). Approximately 6,000 km are navigable during the monsoon (wet) period for different size vessels, shrinking to about 3,900 km in the dry periods. While the larger rivers are up to 50 meters (m) depth in place and the lower Meghna (the main trafficked rout on the Dhaka Chittagong Corridor or DCC) is generally 10-20m depth, navigation is hindered by very shallow depths on bars, especially in the delta area, at the confluences of the major rivers and their tributaries, river bends and mouths. Navigation is further complicated by the braided nature of the main rivers. These are characterized by high sediment delivery and extremely low gradients, landing to very low sediment throughput. In total, the GBM System annually carries up to one billion tons of sediment and drains into the Bay of Bangle principally through the Shahbazpur and Hatia estuaries in the Mouths of the Ganges – feeding the Bangle Fan, the largest depositional system in the world.

Inland Water Transport carries over 50 present of all Bangladesh's cargo traffic and one quarter of all passenger traffic. There are over 22,300 registered vessels engaged in this trade, mainly transporting dry and liquid cargoes in bulk or break-bulk form. Investment by the vibrant shipping and inland water transport industry in Bangladesh total approximately US$ 4 billion.

The Government has identified 65 main river navigation routs that are essential to passenger and ferighat transport within Bangladesh. The routes are categorized as Classes I through IV depending on their advertised depth as tabulated blew:

Class	Max Vessel Draft/Least Advertised River Depth	Length	%
I	3.65 m/ 3.96 m	683 km	11%
II	2.13m/ 2.43 m	1,000 km	17%
III	1.52m/ 1.82 m	1,886 km	32%
IV	<1.52m	2,400 km	40%

The development and control of Inland Water Transport (IWT) is the responsibility of the Bangladesh Inland Water Transport Authority (BIWTA), under the Ministry of shipping (MoS). Among its functions for passenger traffic, BIWTA is responsible to:

- Develop, maintain and operate inland river routs to maintain the advertised Least Available Depth (LAD) and width by necessary surveys and dredging works including maintaining the necessary navigation measures to operate the vessel effectively
- Develop, maintain and operate inland river ports, landing ghats and terminal facilities in such ports or ghats and,
- Develop the most economical facilities for passenger traffic to ensure comfort, safety and speed on mechanized craft.

The Government of Bangladesh intends to improve key multi-modal transport corridors and networks for addressing current transport bottlenecks in Bangladesh. For meeting this objective, Dhaka- Chittagong IWT route (branching into Ashuganj, Ghorashal etc.) which is one of the key corridors, has been envisaged for development under World Bank funding scheme. Bangladesh Inland water transport authority (BIWTA) (under the Ministry of Shipping (MoS)), a nodal agency, is responsible for implementing the project. *(Source: Environmental and Social Impact Assessment_ Report Bangladesh Regional Waterway Transport Project 1_May 2016 and Revival of Inland Water Transport: Options and Strategies Report World Bank)*

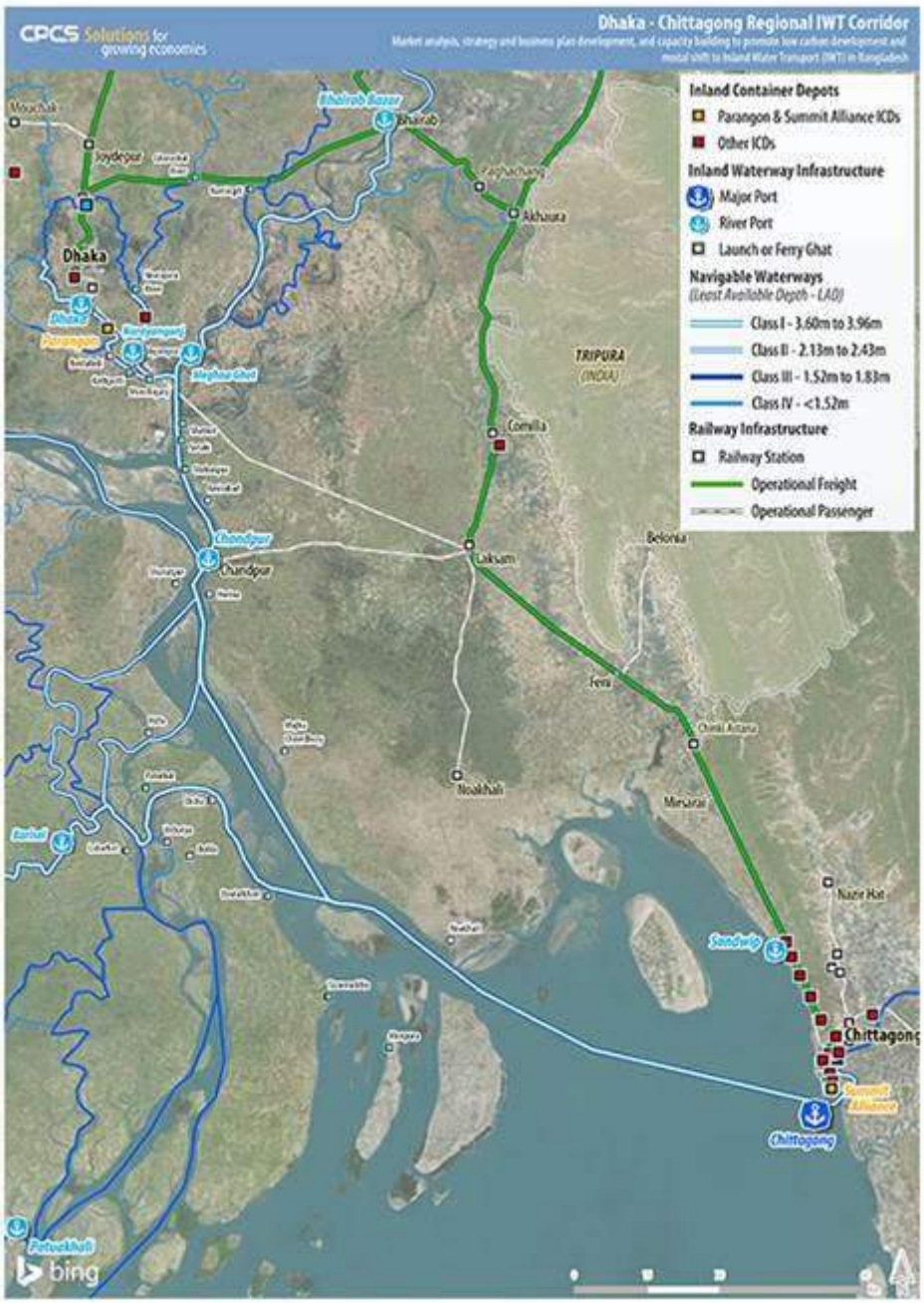

Figure 1. Dhaka-Chittagong IWT Route

Source: Bangladesh Waterways official page

1.1.1. Bangladesh Regional Waterway Transport Project 1

The Bangladesh Inland Water Transport Authority (BIWTA), under the Ministry of Shipping, is implementing the '***Bangladesh Regional Waterway Transport Project 1'***, which involves investments in development of **Inland Water Transport (IWT)** routes and infrastructure between **Dhaka – Chittagong IWT Corridor**, including branches to Ashuganj, Narayanganj and Barishal. The World Bank is financing the Project.

Key components of this program are:

- Component 1 Improved Inland Waterway Navigation and 6 vessel storm shelters.
- Component 2 Improved Services at Priority Inland Waterway Terminals and Landing Ghats/Stations.
- Component 3 Institutional capacity development and sector sustainability.

Under Component 2 the Bangladesh Inland Water Transport Authority (BIWTA), intends to develop works to improve six common user cargo and passenger terminals with last mile connectivity access infrastructure. The passenger terminals included are a new terminal at Shasanghat near Dhaka, and rehabilitation/ upgrading of three existing terminals at Narayanganj (refurbishment/expansion of Narayanganj DEPTC), Chandpur (reconstruction or completely new construction) and Barishal. The cargo terminals included in the project are a new terminal at Pangaon near Dhaka and rehabilitation/upgrade of existing Ashuganj cargo terminal. Additionally, BIWTA intends to develop 15 river landings and 6 vessel storm shelters. These facilities would improve the multimode transport networks reducing the current transport bottlenecks in Bangladesh. Component 2 comprises the following sub-components:

Table 1. BRWTP 1 Component 2 Subcomponents

Package	Name of Contract
BRWTP-S3	Feasibility study, detailed survey, design, and supervision of new construction/upgrade of Passenger Terminals at a) Shasanghat, b) Chandpur, c) Barishal, d) Narayanganj/ DEPTC
BRWTP-S4	Feasibility study, detailed survey, design, and supervision of new construction/upgrade of Cargo Terminals at a) Pangaon b) Ashuganj
BRWTP-S5	Feasibility study, detailed survey, design, and supervision for newly proposed and upgrading of a) Existing 15 launch ghats/stations; and b) 6 Vessel Storm Shelters along Dhaka -Chittagong inland water route.

Package **BRTW S6** is related to Environmental and Social Impact Assessment of proposed new and up-gradation of Cargo and Passenger River Terminals. Landing Ghats and Vessel Storm Shelters, covering ESIA and RAP preparation for packages 3, 4 and 5. ESIA is developed in two reports

- ESIA for Passenger and Cargo terminals, S3 and S4 packages
- ESIA FOR Launch Ghats/Stations and Vessel Storm Shelters

This ESIA is related to BRWTP S3 Passenger Terminals and BRWTP -S4 Cargo terminals. The present ESIA does not include the BRWTP–S5 sub-component.

1.2. NEEDS FOR PROJECT

Need for Improvement of Dhaka – Chittagong – Ashuganj IWT Corridor

River corridors between Dhaka and Chittagong; and between Dhaka and Ashuganj (with extensions to Narayanganj and Barishal) are identified as high priority routes for domestic trade and bilateral trade with India. About 80% of the country's IWT transport is routed through these corridors and daily about 200,000 passengers use these routes. Inland river terminals at Dhaka, Narayanganj, Chandpur and Barishal along these routes play very important roles in transporting and handling passenger and cargo. Food grains, fertilizers and consumer goods are the main commodities which are transported by cargo vessels and cargo/passenger launches. The cargo terminal at Ashuganj is a key terminal for Bangladesh – India trade and is connected by road to the northeastern states of India.

Need for Improvement of Inland River Ports and Landing Stations

Cargo transport is heavily orientated towards imports and in volume terms, most is trafficked on the Class 1 river routes, primarily between Chittagong, Narayanganj and Dhaka. Cargo is mainly: dry bulks (including clinker, fertilizers, food grains, coal, salt, gypsum and fly ash); liquid bulks (petroleum products); and, general dry cargo (bagged cargo, machinery and steel). The main dry and liquid bulks are typically offloaded at private jetties or terminals, most of which are equipped with dedicated bulk handling equipment. Some break bulks and other smaller general cargoes are handled at a limited number of common user facilities or directly over the riverbanks by manual labor. There is some cross-border traffic on protocol routes between Bangladesh and India, however bilateral trade volumes are very small, accounting for just 3% of total IWT freight traffic in Bangladesh. Most of this consists of fly ash (and some wheat), mostly collected from India on Bangladesh registered vessels. Improved maintenance of advertised depths along the protocol route waterways will ideally spur increased trade.

Inland river terminals at Dhaka, Narayanganj, Chandpur and Barishal along the Project routes play very important roles in transporting and handling passengers and cargo. These four river ports together transport annually some 53 million tonnes of cargo and 22 million passengers (in 2013-2014). The facilities built at these terminals are not enough to meet the growing demand of IWT as they lack in adequate facilities for berthing, parking and storage areas, along with passenger comfort. The port facilities at Sadharghat terminal at Dhaka and surrounding areas are highly congested with commercial and residential development leading to traffic congestion and inefficient use of port facilities, additionally there is no space around the current terminal for further expansion. The GoB would like to augment the facilities at Sadarghat terminal in Dhaka by building a new passenger terminal at Shasanghat (2.5 km downstream), develop a cargo terminal at Pangaon, and augment and modernize the existing facilities at Ashuganj, Narayanganj, Chandpur and Barishal river terminals.

In addition to river terminals, there are several landing stations along the Project corridor which are very important for people living in the rural and remote areas. The landing stations (also known as launch ghats) are berthing points of high importance for the local communities that they serve, yet lack proper infrastructure and

other essential facilities such as toilets and drinking water, as well as basic safety features for users, and many are in a highly dilapidated state. They usually consist of one pontoon with shore connection for embarking and disembarking passengers and cargo. They play an important role in the lives of the rural people, as without them vessels would not berth, and they would not receive much needed food, medicines, fuel and other essentials consumable goods.

In view of the importance of the waterway transportation for promoting trade and commerce, improvement of existing and construction of new ghats/cargo terminals in different locations of the country is urgent, as an integrated waterway transportation system would contribute to economic development of the country through linking waterways transportation to the roads and railways transportation system. To that end, the Government of Bangladesh stressed the need to develop and improve Cargo & Passenger Terminals, Landing stations (launch Ghats) and storm vessel shelters with modern facilities in different parts of the country.

To improve key multi-modal transport corridors and networks, BIWTA undertook Bangladesh Regional Waterway Transport Project 1 (BRWTP 1), that would address current transport bottlenecks in Bangladesh, with financial assistance from the World Bank under the Ministry of Shipping (MoS). The project is centered on the main Dhaka Chittagong IWT route, with branches to Ashuganj, Ghorashal and Barishal. This BRWTP 1, currently under implementation, intends to improve the following inland waterway ports and terminals comprising of several packages:

- Dredging and Navigation Aids of the Class I IWT River Route (major Portion).
- Development of Cargo Terminals at Pangaon (Green Field Development) adjacent to the existing Pangaon ICT and Upgrade the Cargo Terminal at Ashuganj.
- Development of new Passenger Terminals at Sashanghat and Chandpur, Upgrade the Existing facility at Narayanganj and Barishal.
- Development of 15 Landing stations (launch ghats) and 6 vessel shelters.

1.3. OBJECTIVES OF THE ESIA

The overall objective of the ESIA is to ensure that the Project is developed in an environmentally sound and sustainable manner ensuring that all negative effects are mitigated as practical and positive impacts are enhanced. More specifically, the ESIA aims to identify the likely potential impacts likely to be generated by the Project; to quantify and where possible value these impacts, providing BRWTP with a set of mitigation measures to meet national and international environmental safeguard Standards.

This ESIA report clearly identifies the environmental parameters/resources to be impacted by the project, makes a quantitative and/or qualitative assessment of the magnitude of each impact and devises mitigation measures to eliminate or reduce adverse environmental impacts as well as enhancement measures for the improvement of current environmental conditions. The Report also contains a monitoring program as a tool for continuous evaluation of situation during implementation and operation of the project.

1.4. SCOPE OF THE ESIA

Scope of ESIA is related to BRWTP-S3 Passenger Terminals and BRWTP-S4 Cargo terminals, referred to as Package S3 and Package S4 in this document.

The ESIA's scope is to present the current state of the environment within and around the site areas; to describe the project, its vision and actions involved; to address the impacts that this project would have on the main environmental factors and the people, as well as to suggest a set of prevention and mitigation measures for the

impacts foreseen. The ESIA contains maps, photographs, figures and tables to better illustrate and present its contents.

The ESIA follows the Environmental and Social Impact Assessment (ESIA) for **Component 1**, and the **Environmental Management Framework (EMF)** and **Social Management Framework (RPF)** for **Component 2 prepared earlier by BIWTA** for the Bangladesh Regional Inland Water Transport Project 1

The ESIA complies with the World Bank safeguards requirements and standards and the National environmental requirements defined in the Bangladesh Environmental Conservation Act, 1995 and subsequent regulations and guidelines.

The ESIA Report complies with the requirements of the Department of Environment (DoE) which are attached in Annex-1.

The scope of works includes:

- Review of environmental information of the study area and legislative requirements.
- Conduct field visit, reconnaissance survey and consultation with local stakeholders.
- Collect primary data on water resources, air, noise, river sediments, land resources, agriculture, livestock, fisheries, ecosystems and socio-economic condition through questionnaire survey, public consultation, and other method for the establishment of baseline conditions of the Project; Identify important environmental and social components likely to be impacted by the proposed Project;
- Project description from environmental aspects. Analysis of environmental and social impacts of the proposed interventions.
- Assessment of environmental and social impacts.
- Identification of mitigation measures/ plan for adverse impact management with provisions for environmental enhancement.
- Preparation of Environmental Management Plan (ESMP) to reduce or eliminate significant environmental impacts.

1.5. LOCATION AND BRIEF DESCRIPTION OF THE PROJECT

The passenger terminals included are:

(i) new terminal at Shasanghat near Dhaka,
(ii) rehabilitation / upgrade of Narayanganj terminal,
(iii) rehabilitation / upgrade of Deck and Engine Personnel Training Centre
(iv) rehabilitation / upgrade of Chandpur terminal and
(v) rehabilitation / upgrade of Barishal. terminal

The cargo terminals included in the project are

(vi) a new terminal at Pangaon near Dhaka and
(vii) rehabilitation / upgrade of existing Ashuganj cargo terminal.

The proposed Passenger terminals will be developed in four locations. Following figures show locations of each one.

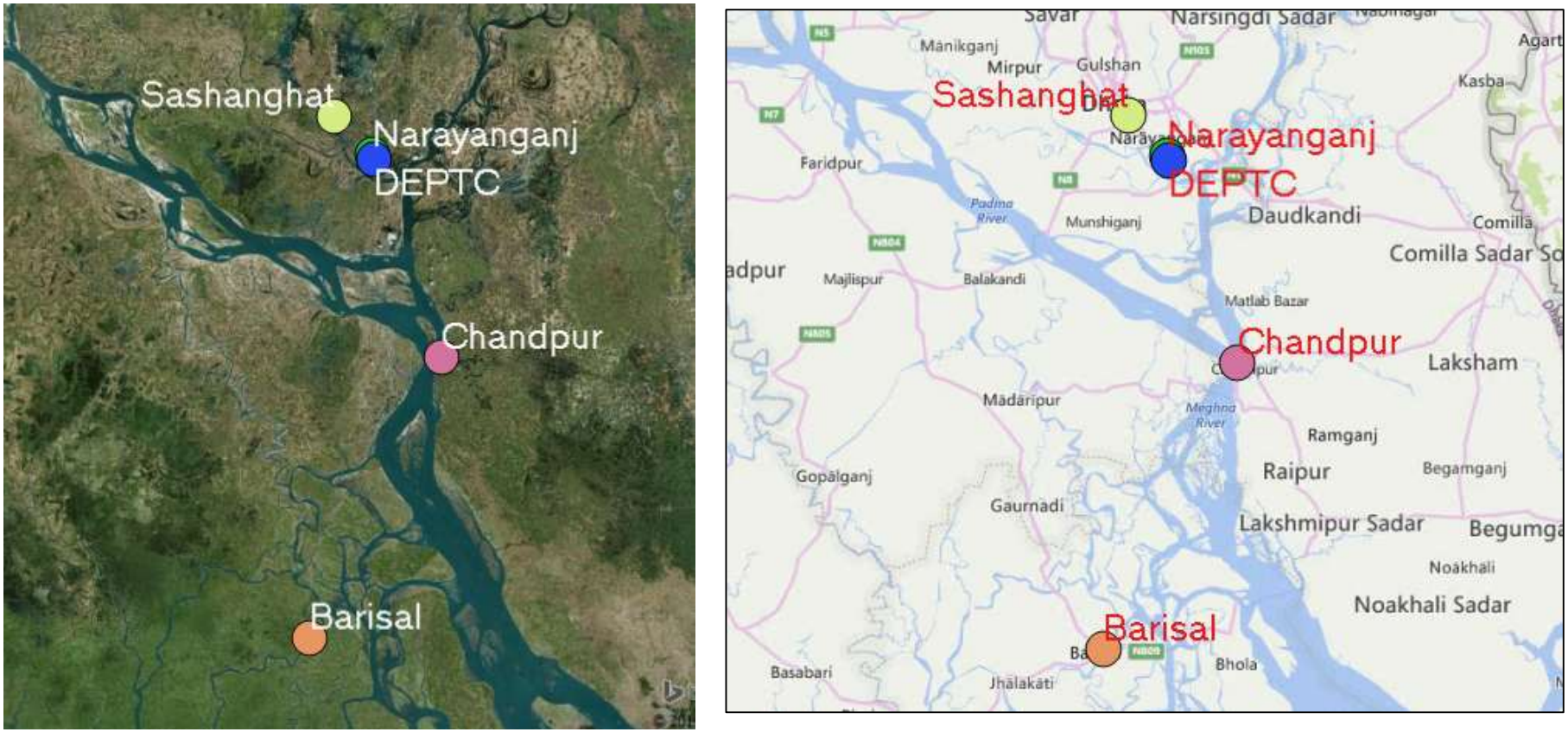

Figure 2. Location of proposed Passenger Terminals

The proposed cargo terminals will be developed in two locations. Following figure shows locations of each one.

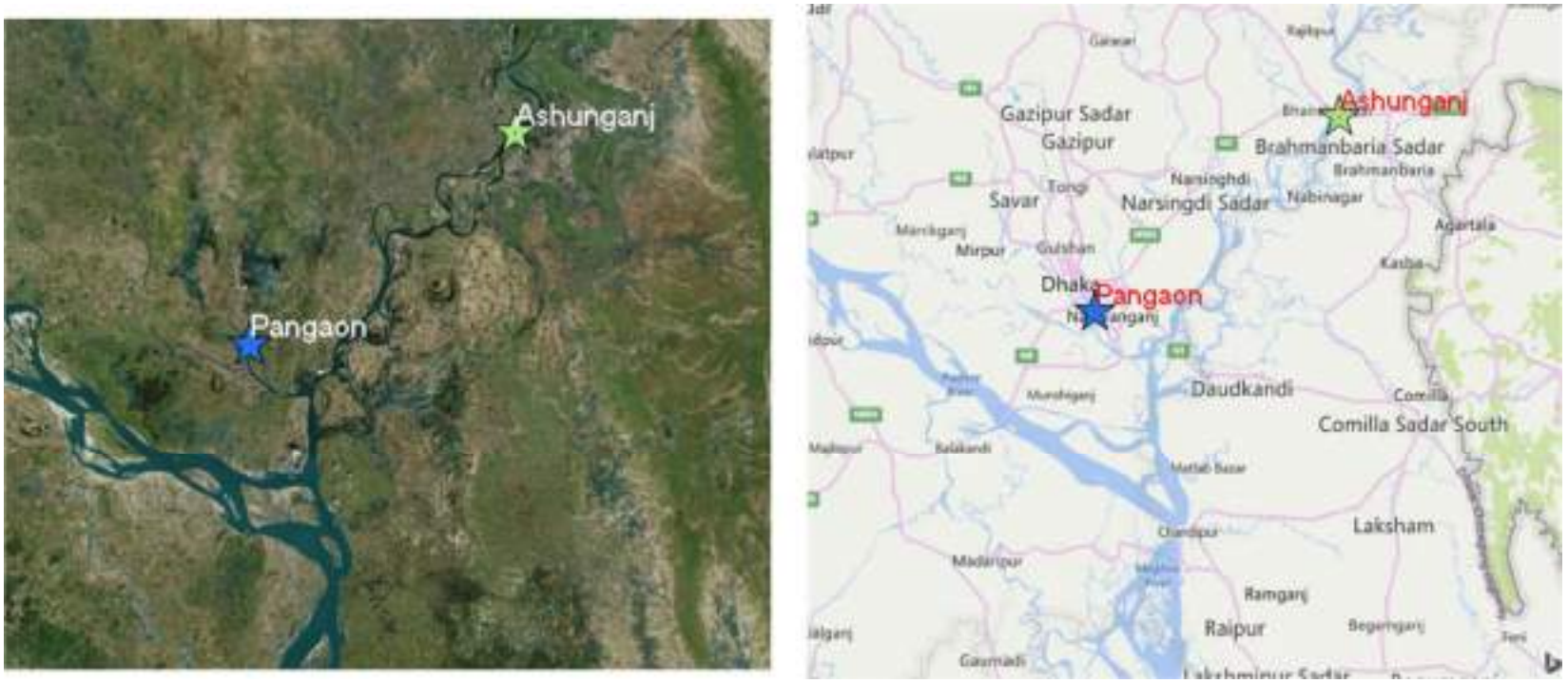

Figure 3. Location of proposed Cargo terminals

Descriptions of the existing and the proposed facilities at the Passenger and Cargo terminal sites are given in Table 2:

Table 2. Description of the existing and the proposed facilities at the Passenger and Cargo terminal sites

Shasanghat Passenger Terminal	Existing Facilities	Proposed Facilities
Located 2.5 km downstream of the Sadharghat terminal at Dhaka on the Buriganga River	Brownfield site There are no existing passenger facilities however the site is used for both ship breaking (scrapping) and receipt of sand minded from the river. Fatullah: Gangway, Jetty, Pontoon (2Nos.)	The proposed facilities to be developed include: ▪ Preparation of Master layout plan with all facilities and utility services ▪ A six-storey terminal building, with a total floor area of approximately 20,000 square meters ▪ A quay wall (bank protection) of approximately 250 m length ▪ Three terminal pontoons of approximately 200m length and five steel gangways ▪ Pontoons – 3 Nos. ▪ Vessel idling berth adequate capacity ▪ Six steel spuds ▪ A parking yard of approximately 2,000 square meters ▪ New landside pedestrian and vehicle access roadways ▪ Pedestrian and vehicle turn-outs, drop-off, collection and waiting facilities ▪ Renovation of Fatullah passenger launch station, one of the nearby stations, including berthing, loading unloading and parking facilities ▪ Take away corner, etc.

Chandpur Passenger Terminal.	Existing Facilities	Proposed Facilities
▪ Located on Lower Meghna River	▪ Brownfield site Established in 1995 ▪ Existing facilities include ▪ a walkway (167 m2), ▪ steel jetty – 2 Nos, ▪ steel spud – 6 nos. ▪ pontoon – 4 nos ▪ passenger waiting shed (74 m2) and ▪ parking yard (8010 m2) ▪ Puran (old) Bazaar Ghat: Pontoon (1 No.)	▪ The proposed facilities include: ▪ Preparation of Master layout plan with all facilities & utility services ▪ Land development (21,669 m^3) ▪ 3-storied terminal Building (4061 m^2) ▪ Bank protection (253 m) ▪ Boundary wall (231 m) ▪ RCC Ramp- 3 Nos ▪ Steel gangway – 3 Nos ▪ Spud and spud ring -22 Nos ▪ Terminal pontoon -4 Nos. ▪ Steel jetty (267.65m^2) ▪ RCC jetty-(2 + 2) = 4 Nos ▪ Vessel idling berth adequate capacity ▪ Widening of 265 m of access road ▪ Take away corner, etc.
Barishal Passenger Terminal	**Existing Facilities**	**Proposed Facilities**
Located on Kirtonkhola River (Lower Meghna Tributary)	Established in 1964. ▪ Existing facilities include: ▪ Two-storeyterminal building, ▪ passenger waiting space, ▪ 6 Nos of pontoons, ▪ 4 Nos of gangway, ▪ cargo shed, ▪ transit shed, ▪ parking yard and access road.	The proposed facilities include: ▪ Preparation of Master layout plan with all facilities and utility services considering existing land and structures belonging to BIWTA ▪ Extension of existing terminal building (346 m2) ▪ Construction of 4-storey multipurpose building for port facilities (5600 m2) ▪ RCC Ramp- 2 nos. ▪ Pontoon – 2 Nos. ▪ Vessel idling berth adequate capacity ▪ Steel spud – 6 Nos. ▪ Steel Gangway 2 nos. ▪ Bank Protection works ▪ Take away corner etc.

Narayanganj Passenger Terminal	Existing Facilities	Proposed Facilities
Located on Sitalakhya River	Established in 1972 a single storied building, ▪ 4 pontoons, ▪ 3 gangways, ▪ an RCC jetty and ▪ an administrative office ▪ Existing facilities also include cargo-handling facilities with 4 pontoons. DEPTC: Established in 1970. ▪ Administrative cum Academic Building, ▪ one two-storey Tin-shed Hostel	▪ Preparation of Master layout plan with all facilities and utility services ▪ Extension of existing terminal building ▪ RCC ramps ▪ 2 steel gangways ▪ Vessel idling berth adequate capacity ▪ Take away corner etc.
Narayanganj Passenger Terminal	**Existing Facilities**	**Proposed Facilities**
Deck and Engine Personnel Training Centre	DEPTC: Established in 1970. ▪ Administrative cum Academic Building, ▪ one two-storey Tin-shed Hostel	▪ Renovation and upgrade of Academic and Hostel Building and others (if necessary) of DEPTC, (contingent upon recommendations of feasibility and market study to be separately commissioned)

Pangaon Cargo Terminal	Existing Facilities	Proposed Facilities
Located next to existing Pangaon Container terminal on Buriganga River, near Dhaka	Greenfield site. No existing facilities but used as a landing station for small river crossing boats.	The proposed facilities include: ▪ Two berths, constructed on RCC piles with a suspended deck – total length 190m with expansion joint.; ▪ An apron area of approximately 2,750 square meters ▪ An open storage area of 2,220 square meters; ▪ A transit Shed of 1,500 square meters; ▪ Vehicle parking areas of 5000 square meters; ▪ Office building (1500m2) ▪ Bank Protection (375m) ▪ Boundary wall (700m) ▪ A new port road of 400m length together with a gate house. ▪ ▪ Electrical work (substation, flood light) ▪ Firefighting system ▪ Provision of crane, forklift and other handling equipment.

Ashuganj Cargo Terminal	Existing Facilities	Proposed Facilities
Located on Upper Meghna River	Established in 2004. Existing facilities include: ▪ office (150 m2), ▪ RCC Jetty (425 m2), ▪ steel jetty (90 m2) ▪ pontoons – 2nos. ▪ gangway, ▪ warehouse (225 m2) ▪ parking area (1000 m2)	Proposed facilities include: ▪ Office building (1000m2), ▪ RCC Jetty (2x425m2=850m2), ▪ steel jetty – (2x45m), ▪ Apron area 2750m2 ▪ Open storage area=2220m2 ▪ Steel Gangway (02 nos) ▪ Terminal pontoon- 2nos., ▪ gangway – 2nos., ▪ bank protection (400m), ▪ warehouse (225 m2), and ▪ parking area (2000 m2) ▪ Port road (1600 m) ▪ Boundary wall (500m) ▪ RCC ramp (02nos) ▪ SPUD ▪ Electrical work (substation, flood light) ▪ Firefighting system ▪ provision of crane, forklift and other handling equipment.

1.6. ENVIRONMENTAL CLASSIFICATION OF PROJECT

The project is WB fund and Red category as per ECR 1997 according to guideline of DoE. According to World Bank OP 4.01 -Environmental Assessment the World Bank requires an Environmental Assessment (EA) for all projects proposed for Bank financing to ensure that these projects are environmentally sound and sustainable. The proposed BIWTA project within BRWTP-1 is classified Category A, because of the scope of the expected impacts from dredging operation, river training, vessel shelter construction and operation, the impacts of land acquisition, and the expected impacts on the natural environment. New or upgraded Passenger and Cargo Terminals are within BRWTP-1.

The World Bank Environment, Health, and Safety (EHS) Guidelines will be applicable to the Project particularly with respect to air emissions, ambient air and noise quality standards, wastewater quality, hazardous material and waste management, together with occupational and community health and safety management.

Rule 7 of the Environmental Conservation Rules 1997 and its amendments provide a classification of industrial units and projects into four categories, depending on environmental impact and location. These categories are:

(a) Green;

(b) Orange-A

(c) Orange-B

(d) Red

Construction of passenger/cargo terminals are not listed in the Schedule -1 of ECR '97. However, based on similar projects/industries listed in Schedule -1 of the ECR '97 the passenger/cargo terminal construction project can be categorized as "Red". Such similar listed projects/industries are:

- ECR'97, Schedule 1 Item 52 Ship manufacturing.
- ECR'97, Schedule 1 Item 54 Metallic boat manufacturing.
- ECR'97, Schedule 1 Item 60 Engineering works: capital above 10 (ten) hundred thousand Taka.

  The terminals will have ship repairing and maintenance facilities to some extent. The facilities will need some engineering provisions.
- ECR'97, Schedule 1 Item 64 Water, power and gas distribution line laying/relaying/extension.

  The terminal buildings will need power, gas and water pipelines laying works.
- ECR'97, Schedule 1 Item 66 Construction/reconstruction/expansion of flood control embankment, polder, dike, etc.

  The terminal buildings will need some river training works including excavation and embankments

1.7. ESIA TEAM

The following team members have actively participated in the preparation of the ESIA Report.

Table 3. ESIA Team

POSITION	NAME	Organization
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1.8. METHODOLOGY OF FIELD WORK SURVEYS

1.8.1. Environmental Quality. Materials and Methods

1.8.1.1. Data collection Process

The objectives of the data collection process are to identify significant (i) environmental and social issues early enough to feed them back to the planning team before engineering decisions are made, (ii) environmental and social components that will be affected during pre-construction, construction, and O/M stages of the Project, and (iii) environmental and social impacts during various stages of the Project that need to be thoroughly assessed and addressed for mitigation and management.

The scoping framework for the Project has been developed based on the:

- Detailed review of all the proposed Project activities and civil works,
- Detailed review of pre-feasibility and feasibility study reports of the Project,
- Experience gained from past similarly sized projects in Bangladesh,
- Stakeholder and public consultations,
- Collection and analysis of baseline environment of the Project area,
- Anticipated induced development in the region after the Project completion, and

- Catering to harmonized environmental safeguard requirements.

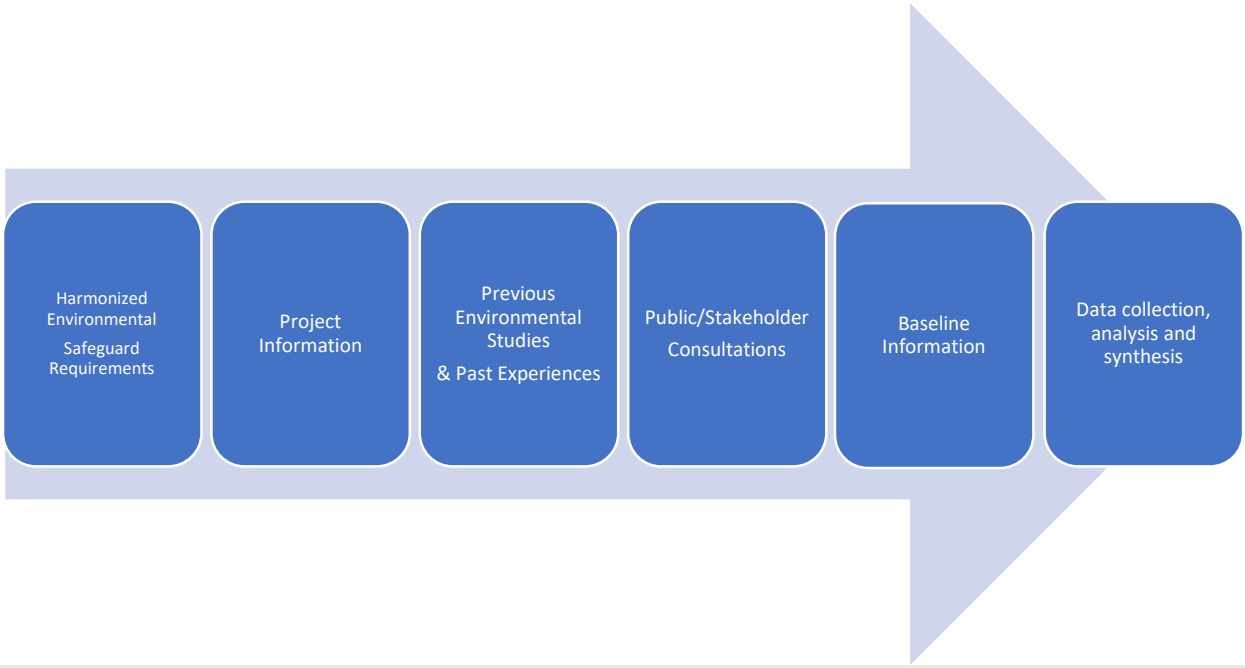


Figure 4. Data collection process used in this ESIA

1.8.1.2. Data collection framework

A data collection framework was devised 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 ESIA.

Table 4 presents the resources/receptors considered in the data collection scoping stage, together with the changes that might indicate a potential Project-related impact.

Table 4. Example of Scoping of potential risks on receptors that influenced the data collection framework.

Resources/Receptors	Changes that May Indicate Potential Impacts
Environmental	
Geology	Changes to geology, geomorphology, topography
Soil	Changes to physical and chemical properties and soil ecology
Surface Water	Changes to physical, chemical or biological quality of rivers, lakes, seas and other surface water bodies; Introduction of exotic species, changes in habitat quality, abundance, diversity; Effluent discharges
Groundwater	Contamination of shallow or deep groundwater resources, change in ground water resources

Resources/Receptors	Changes that May Indicate Potential Impacts
Sediments	River/waterbed morphology, physical and chemical properties, benthic organisms.
Fisheries	Changes in fisheries productivity
Vegetation	Changes to vegetation population, health, species abundance and diversity and impact on endangered and economic species, food chain effects
Wildlife	Changes to wildlife assemblages, propagation, impact on endangered and economic species, food chain effects
Air	Emissions of NOx, SO_x, PM, CO etc. greenhouse gases
Noise	Change in noise levels
Aesthetics	Physical presence of facilities, increased nighttime light
Waste	Generation of wastes – hazardous and non-hazardous
Socio-economic	
Population and physical displacement	Changes in total population, gender ratio, age distribution. Physical displacement from residence as a result of Project land take, or activities.
Social and Cultural Structure	Disruption in local authority and governance structure; change in social behaviors; alterations to social and cultural networks; intra and inter-ethnic conflict;
Economy and employment	Change in national/local economy, employment, standard of living, occupation
Resource ownership and use	Temporary or permanent restriction for accessing or using land or water, changes in livelihood activities based on natural resources; changes in ownership of such resources.
Cultural Resources	Physical disturbance of shrines, burial grounds, archaeological resources or other desecration or change in access to cultural resources, rituals or celebrations carried out in their premise.
Education and skills	Change in availability or quality of education or skills provision, supply and demand in certain skill sets etc.
Infrastructure and public services	Improvement or pressure on existing urban/rural infrastructure or services including transportation; power, water, sanitation, security, waste handling facilities etc.
Community Health and Safety	
Environmental Change	Decreased air quality (e.g. NO_x, SO_x, CO, PM), contamination of surface waters and potable ground water, increased vibration and noise, increased nighttime light beyond acceptable limits, changes to the visual environment.
Communicable and Non-Communicable Diseases	Change in incidence and/or prevalence of communicable and non-communicable diseases or disease-causing factors

Resources/Receptors	Changes that May Indicate Potential Impacts
Vector Borne Diseases	Changes in the incidence and or prevalence of vector borne diseases, the density of these vectors and their breeding grounds.

1.8.1.3. Environmental baseline surveys methods

- Secondary Data Collection process

The purpose of the secondary data collection is to provide a review of the relevant physical, ecological and socio-economic information available for the Project area. Sources of secondary data used in the study include information gathered from government departments, research institutes, and published literature. Secondary sources are cited within the document. In the case of secondary data involving geographic information within the Project area, this data is validated during the environmental and socio-economic baseline surveys.

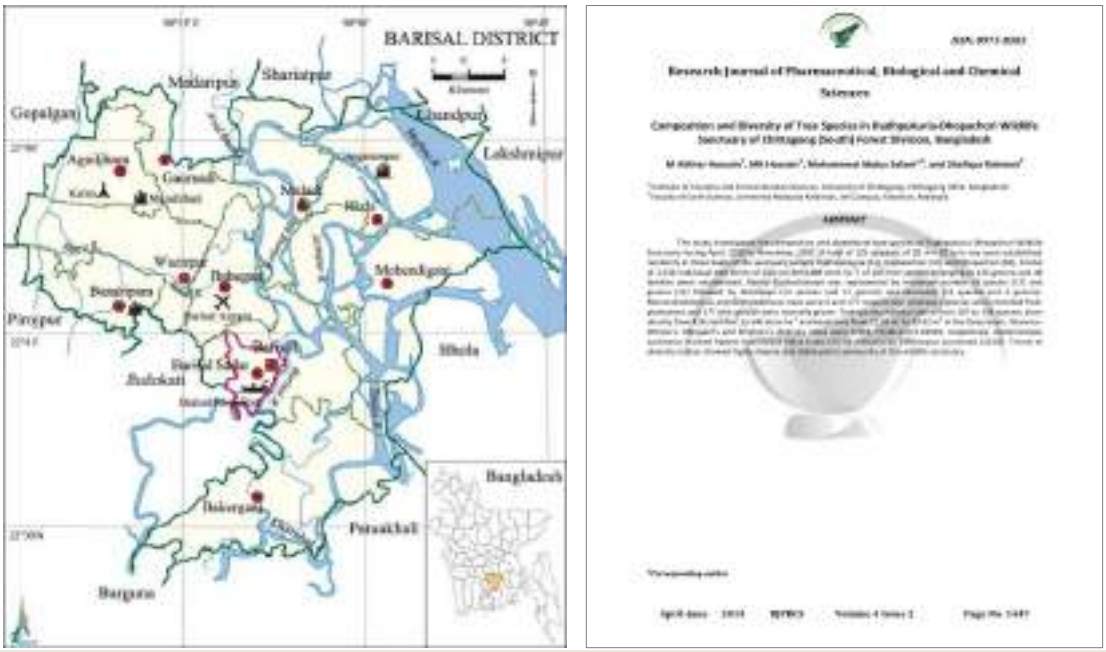


Figure 5. Example of secondary data collection sources; map and journal article

- Primary Data Collection

In order to establish the baseline biophysical conditions within the Project area, relevant primary data were identified and reviewed, then a comprehensive field visit program was established.

Environmental quality assessment services cover a wide range of quality testing and assessment of different environmental parameters, as shown below, around the project area. The field survey aimed to perform environmental quality assessment within the project area. During the survey, the Consultants focused on investigation of ambient air quality, water quality (both surface water and groundwater), noise and vibration levels, riverbed materials, benthos, plankton study and ecological and bio-marine investigations. The Consultants hired an external company equipped with modern weather equipment, auger, drill, noise receiver, air quality sampler etc. to collect environmental samples.

- The air quality sampling was done in all six locations for eight hours. The parameters monitored were Carbon Monoxide (CO), Oxides of Sulphur (SOx), Oxides of Nitrogen (NOx), Ozone (O3),

Particulate Matter (PM2.5), Particulate Matter (PM10), Humidity, Wind Direction, Wind Speed and Temperature.

- Noise level was measured in six different locations for both day and night times for 1-hour duration.
- Surface water quality is of prime concern not only for drinking and irrigation but for maintenance of ecology, aquatic life, other consumption, aesthetic uses and sustainability. Objective of water quality analysis for present study is to provide baseline information for the surface water bodies present at the project site. Scope of surface water quality provided baseline information of the physico-chemical characteristics of the surface water body at project site. Baseline parameters selected for the study are: pH, Temperature, Turbidity, Electric Conductivity (EC), Dissolved Oxygen (DO), Salinity, Biochemical Oxygen Demand (BOD), Total Organic Carbon (TOC), Total Dissolves Solids (TDS), Total Suspended Solids (TSS), Sulphate, Iron (Fe) and Oil and grease.
- Riverbed Sediment samples were collected and analyzed for physical, chemical and biological parameters. Total of 6 riverbed sediment samples were collected from the river site. The construction activity may affect the sediment quality. The riverbed sediment has been tested for Total Organic Carbon (TOC), Total PO43-, Water soluble Phosphate, Total Arsenic (As), Total Cadmium (Cd), Total Mercury (Hg), Total Lead (Pb), Total Chromium (Cr), Total Zinc (Zn) and Total Nickel (Ni).
- Soil samples were collected and analyzed for physical, chemical and biological parameters. Total of 6 soil samples were collected across the project site. The construction activity may affect the soil quality. The soil has been tested for pH, Organic Carbon, Phosphate and Bacterial Count.

- Air quality survey and analysis method

The air quality monitoring was carried out at six locations of the project. The parameters were Carbon Monoxide, Nitrogen Dioxide, Sulphur Di-oxide, Ozone, PM10, PM2.5, Temperature, Humidity, Wind Speed and Wind direction. 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 6).

Figure 6. Equipment used for Air Quality Sampling and Weather Quality Monitoring

To monitor carbon monoxide (CO) an HTC CO-01 meter was used, and value is expressed in ppm. For weather data collection Oregon WMR 200 Professional Weather Centre was used, shown in the following figure. The air quality monitoring was performed from 22 October 2019 to 29 October 2019. All the locations of sample collection are shown in the following map.

The weather was partially sunny and partially cloudy during the monitoring period. The duration of air quality monitoring was 8 hours which would be calculated for a duration of 24hrs as per DoE requirements. Proper Personal Protective Equipment (PPE) including vests and helmets were used during the monitoring period.

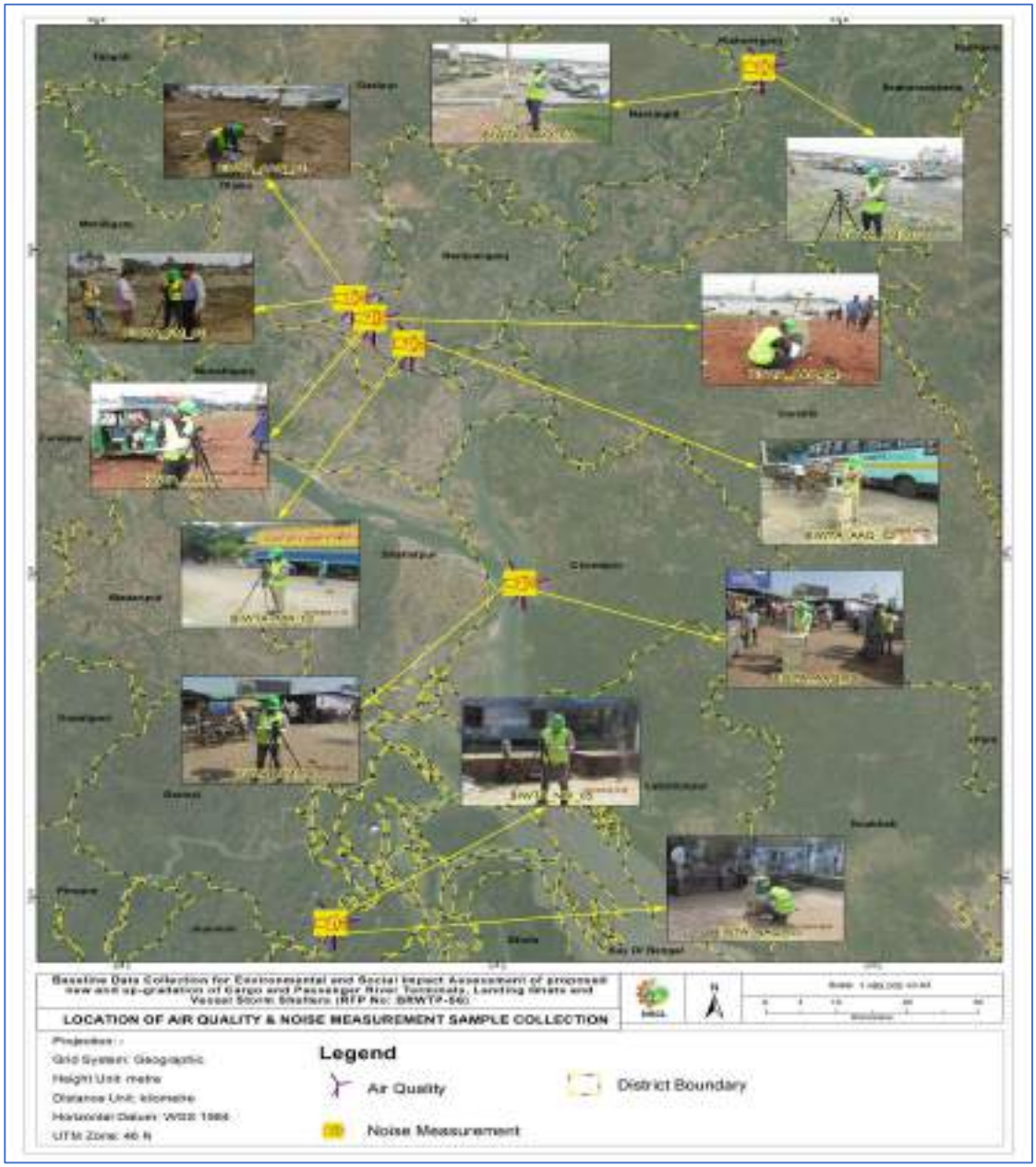


Figure 7. Air Quality and Noise Sample Collection Map

- Noise quality survey and analysis method

Noise Level Measurements were analyzed at the same 6 locations as for air quality monitoring. The monitoring was performed from 22 October 2019 to 29 October 2019 for both day and night-time. Noise measurement at each location was done continuously for 1hour both at day and night-time. Sample collection map showing all the sampling location is attached (previous figure). Lightning vests and helmets were used as PPE during the noise measurement period for daytime. Noise level was measured using a calibrated HTC Sound Level Meter set to A-weighting, slow response and statistical analysis settings. Figure 8 shows this instrument.

Figure 8. Noise level meter

- Water quality survey and analysis method

Surface Water samples were collected from 6 project locations from 22 October 2019 to 29 October 2019. To measure Iron (Fe), surface water samples were collected from 6 project influenced locations from 13 January 2020 to 15 January 2020. The locations of sample collection are shown in the next map. The parameters measured were pH, Temperature, Turbidity, Electric Conductivity (EC), Dissolved Oxygen (DO), Salinity, Biochemical Oxygen Demand (BOD), Total Organic Carbon (TOC), Total Dissolves Solids (TDS), Total Suspended Solids (TSS), Sulphate, Iron and Oil and Grease.

The sample was collected and then transferred in 1-liter plastic sampling bottles which had been washed with distilled water. The sampling bottles were then kept in an ice cooler. For Oil & Grease testing only, the samples were collected in 500ml amber glass bottles. Vest and helmets were worn during the sample collection. An EZDO 8200 Multimeter (next figure) was used to conduct the on-site test of pH, TDS, EC, Temperature and Salinity. Lutron DO-5509 (next figure) was used to conduct the on-site test of Dissolved Oxygen (DO). The samples were sent to Department of Public Health Engineering (DPHE) and Department of Soil, Water & Environment, Dhaka University (DU) Laboratories for physicochemical parameters testing within 12 hours of being collected.

Figure 9. Equipment used for Surface Water Sampling and On-site Testing.

- Riverbed Sediment Quality

Riverbed Sediment samples were collected from 6 project locations from 22 October 2019 to 29 October and analyzed for 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, shown in next figure. The location of sample collection is showed in the next map. The samples were first placed in zipped lock plastic bags and then transferred to plastic jars. The Parameters are Total Organic Carbon, Total PO43-, Total As, Total Cd, Total Hg, Total Pb, Total Cr, Total Zn and Total Ni. The collected sediment samples were tested from Department of Soil, Water & Environment, Dhaka University (DU) Laboratory.

Figure 10. Equipment used for Riverbed Sediment Sampling

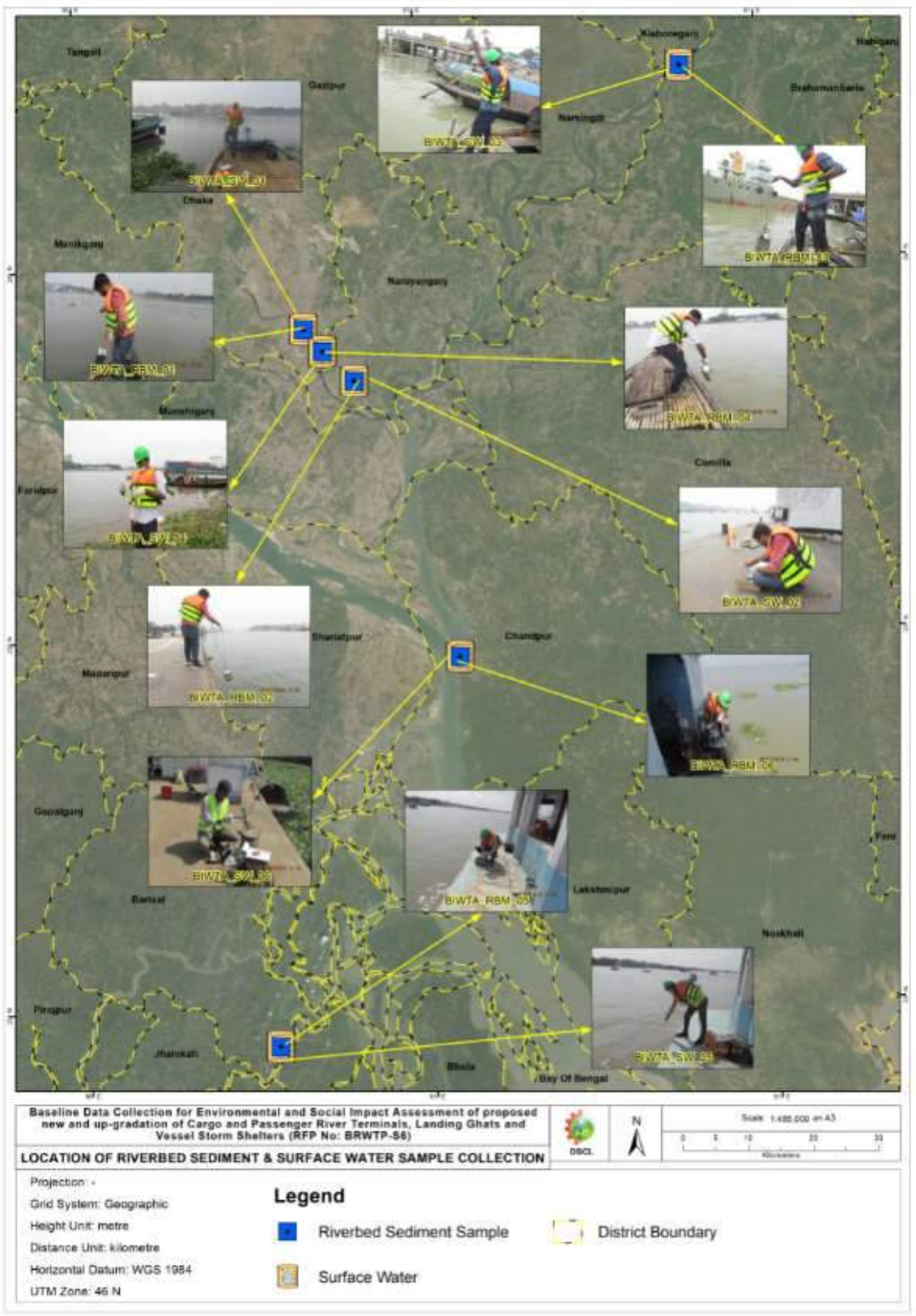


Figure 11. Surface Water and Riverbed Sediment Sample Collection Map

- Soil Quality

Soil samples were collected from 6 project influenced locations from 13 January 2020 to 15 January 2020. The samples were collected in a composite sampling method by hand Auger boring from 10 inch below the surface level. The samples were first placed in zip lock plastic bags and then transferred to plastic jars. The sample collection map is attached in next page. The samples were sent to Dhaka University Laboratory for testing within 72 hours of sample collection. The parameters tested were pH, Organic Carbon, Bacterial Count and Phosphate.

Figure 12. Hand Auger used in the study.

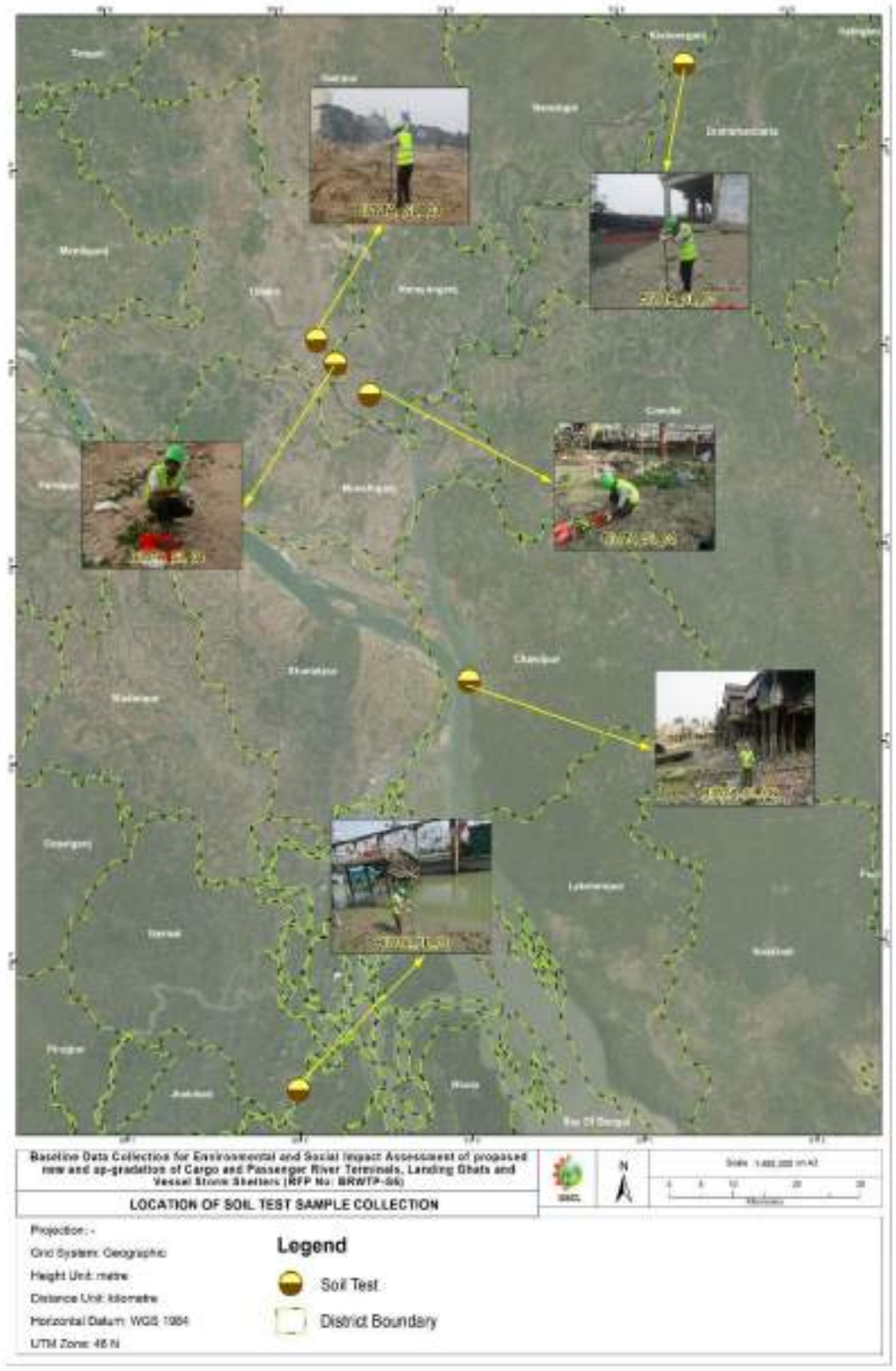


Figure 13. Soil Sample Collection Map

1.8.2. Baseline Ecological Survey. Materials and Methods

The purpose of the Ecological Study was to (i) document the flora and fauna, and the ecosystem components of the project sites in order to describe and characterize the project environment, and (ii) assess the conservation significance of each individual project sites through identifying the critical species and critical habitats within each project site to define the ecological constraints to the BIWTP-1development aimed at guiding the design of mitigation measures for safeguarding the local environment.

The core ideas stated above allow identification of the specific activities to be undertaken for field surveys, method and tools to be applied in gathering and interpreting information on. The identified survey methods and tools for different fauna and flora groups are shown in the following Table. The ecological surveys were undertaken both for aquatic and terrestrial habitats in each project site.

Table 5. Methods and Techniques used for Ecological Surveys

Fauna and Flora Groups	Methods and Techniques Used for Data Collection	Data Outputs
Birds	Direct field observation/transect walk, local interviews	Faunal inventories and relative abundance
Amphibia and small slow-moving reptiles	Direct observation/ opportunistic survey, local accounts	Faunal inventories and relative abundance
Large mammals	Transect survey/opportunistic survey	Faunal inventories and relative abundance
Fish	Catch assessment/ market survey and fishermen interviews	Faunal inventories and relative abundance
Benthic sediment fauna	Sampling by Ekman Dredger and laboratory microscopic analysis	No. indiv. by species/m2
Zooplankton	Collection by plankton net and microscopic analysis in laboratory	No. indiv. By species/l water
Herbs and shrubs	Quadrant survey and local interviews	Floral inventories and relative abundance
Trees	Direct observation	Inventory and relative abundance

The following activities were undertaken for conducting the terrestrial and aquatic field surveys:

The following activities were undertaken for conducting the terrestrial and aquatic field surveys:

a) Literature review: Several literatures were consulted to verify, validate and collect some information from secondary sources. The major literatures were consulted are mentioned in Table 6

Table 6. List of major literature consulted for information collection from secondary sources.

Sl No.	Title of Literature	Purposes of use	Reference
1	Encyclopedia of Flora and Fauna of Bangladesh	Verification and validation of species, species description	Ahmed *et al.* 2008
2	Encyclopedia of Flora and Fauna of Bangladesh	Verification and validation of species, species description	Ahmed *et al.* 2008
3	Red Data Book of Vascular Plants of Bangladesh	Screening of recorded species for identifying the threatened category of plants	Rahman et al. 2001
4	Red List of Bangladesh	Screening of recorded species for identifying the threatened category of animals	IUCN, 2015
5	Study on the Faunal Diversity of Buriganga River	Check for faunal occurrences in the river, validation of survey findings and understanding the trend in fauna communities.	DoZ, 2003

b) Direct Observations: Direct observations on the occurrence and abundance of flora and fauna were made through transect walkalong creek banks, road verges, and sometimes across the agricultural fields and settlement areas and sometimes travel by boats. Observations were made within 500 m and n case of aquatic survey, survey was within two kilometers from the project boundary, both upstream and downstream. In addition to direct sightings of animals, identification of animal presence was also based on observation of animal trails, footprints (peg marks), feeding signs and animal/bird calls.

c) Local Interviews: Information on cryptic and seasonally available flora and fauna species, not otherwise encountered using standard field sampling methods, was obtained by interviewing local people. These data are anecdotal, but nonetheless provided useful supplementary information. Information on occurrences of animal and plant species, behavior breeding, distribution and seasonal appearance of the species were also collected during interviews.

d) Inspection of Fishers' Catches: Whenever available, fish catches of local fishermen were examined to assess species composition and on other aquatic animals that were represented in bycatches of the fish catches (e.g., crabs, prawn, mollusks). Before recording any species, it was ascertained that the catches came from the Study Area. Interviewees provided information on the occurrence and abundance of species, seasonality in appearance, etc. This survey was conducted within two kilometers from the project boundary. The fishers were also interviewed on the occurrence and abundance of fishes within the project site and its area of influences.

e) Fish Market Survey: The fish markets located within and around the Study Area and adjacent to the project sites, including the local fish landing centers and retail markets, were visited to record the local fish species. Sources of the fish were ascertained prior to making any observation on the fishes.

f) Benthic sampling: Sediment samples (Figures 14-16) were collected from three randomly selected locations within each project site boundary by using an Ekman Dredge from which composite samples were prepared for laboratory analysis of benthic fauna. Samples were then passed through a series of sieves of different mesh sizes.

Benthic organisms were sorted out from sediment materials, transferred to vials containing 5% formalinμ. The benthic organisms were identified generic/species levels under different groups. The abundance of sediment fauna is expressed as number of individuals / m^2 surface area.

Figure 14. Benthos Sampling in Barishal (source S6)

Figure 15. Plankton Sampling in Barishal (source S6)

Figure 16. Benthos Sampling in Chandpur (source S6)

g) Zooplankton Analysis: Samples for zooplankton studies were collected (Figure 14) using a plankton net of 69 μm mesh size. A total of 30 litres of water was passed through the net. The filtered samples (approx. 30 ml) were then transferred to plastic bottles containing 5% formalin. As with benthic sampling, water for zooplankton study were also taken from three locations within the site boundary to make a composite sample. Both zooplankton

and benthic organisms were brought to the Department of Zoology, University of Dhaka for subsequent laboratory analysis. Zooplankters were identified down to species/genera and enumerated to obtain density by species and are expressed as numbers of individuals / L of water.

h) Quadrant Survey: Herbaceous plants were surveyed by applying the quadrant method. Within each terrestrial habitat 1m x 1m quadrant was randomly selected and looked for the occurrences of different species with a note on their relative abundances. Depending on the project sites, 3 to 6 quadrants were sampled per site.

i)Prepare Floral and Faunal Inventories: The information collected from the field were compiled to prepare standard faunal and floral inventories with a number of attributes. Determination of local status/abundance were mainly based on the surveyors' judgement which took into consideration the frequency of sightings within each survey area, fish catch inspection, market survey and interview of fishermen. The threatened status/category and national protection status of the individual recorded animal were made by checking with appropriate reference materials (Ahmed et al, 2007a, 2007b, 2007c; IUCN (2015), Wildlife (Conservations and Security) Act, 2012) .

Assessment of Conservation Significance of the Project Sites: The purpose of the assessment was to determine the status of the project sites regarding the presence of critical species and habitats by applying several criteria stated below. This required critical review of the relevant documents, laws, protocols, treaties and conventions.

Identification of Critical and Significant Species: Checks were made with the following items to evaluate and identify the critical species of the recorded fauna and flora:

(a) IUCN's threatened category (Red Data Book-both National and global threatened category),

(b) Species protected under Wildlife (Conservation and Security Act), 12,

(c) Species included in CITES and CMS;

(d) Species protected under any other protocol, conventions and any other agreement to which Bangladesh is a signatory.

(e) Species considered as flagship species, keystone species or other significant species.

(f) Endemicity of the species; and

(g) Any wild species that contains the genetic resources of any domesticated variety. This exercise resulted in making a list of species that are evaluated critical and require protection and/ or precautionary/ mitigation measures are required to save them from causing any damages.

Identification of Critical and Sensitive Areas: The individual project sites were checked against the following criteria to ascertain their respective protection and conservation significance and priority for conservation:

(a) Whether the project site or part of it is a national park, wildlife sanctuary, community conserved area, ECA, fish sanctuary, etc.

(b) Whether the project site or part of it is a staging ground or flyway of migratory birds.

(c) Whether project area is part of a biodiversity hotspots or mega biodiversity

(d) Whether the project area or part of it is an animal corridor; and

(e) Whether the project site is a breeding or nursing ground of fish or other aquatic animals

Identification of Potential Biological Impacts: Potential biological impacts of the project development on flora, fauna and ecosystems and ecosystem functions were identified against each planned project activity through use of expert knowledge and consultation.

The following checks, among others, were made while assessing the impacts:

(a) Loss or damage to habitats and its biota.

(b) Lethal or sub-lethal effects on biota;

(c) Disturbances to animals (frightening, avoidance, etc.);

(d) Reduction/disturbances to natural breeding and recruitment;

(e) Permanent degradation of staging grounds and migratory patterns of animals;

(f) Disturbance to resting and roosting sites of animals;

(g) Hindrance to the natural regeneration process;

(h) Reduction in the aesthetic values of habitats/ecosystems.

Appropriate field guides, reference materials and data collection proformas were used for this activity so that information was accurately recorded.

1.8.3. Stakeholder Consultation. Methodology

A stakeholder is any person, group or institution that has an interest in an activity, plan or program of any development initiative. This includes intended beneficiaries and intermediaries, winners and losers, and those involved or excluded from decision-making processes. These can be divided into two broad groups (see Figure 17).

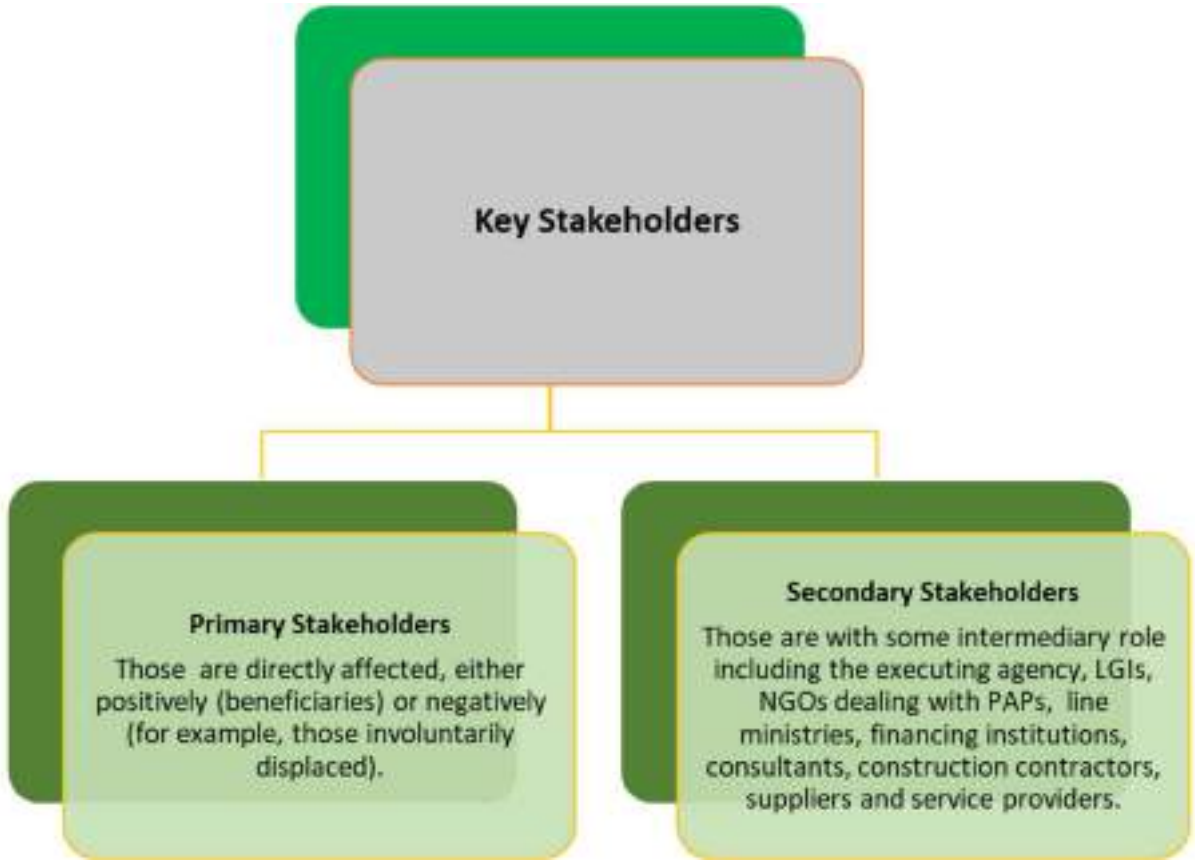


Figure 17. Key Stakeholders

Consultation with various cross sections of the people is essential for better planning and implementation processes of a project. Affected people in the project footprint and other stakeholders, including local government representatives, have been meaningfully consulted at the cargo and passenger terminals to obtain their knowledge and experience about the baseline information, potential impacts, and feasible mitigation measures. The consultations were conducted to ensure dissemination of adequate and timely information to the project-affected people and communities and to enable stakeholders to voice their opinions in the project planning and implementation processes.

Through the public consultations, timely, effective, and multi-directional communications between the Project and the affected persons and communities were ensured to maximize the benefits of the Project. The cut-off date (COD) for the non-titled PAPs, i.e. the date of commencement of the census survey, was declared in the consultation meetings. Cut-off dates for the titled PAPs will be date of serving notice under section-4 of the Acquisition and Requisition of Immovable Property Act 2017 (ARIPA 2017). Cut –off dates for the Non-titled PAPs were declared in the stakeholder consultation meetings prior to starting the census and inventory of losses survey.

Cut-off dates for each of the Cargo and Passenger terminals was different since census and IOL survey was started on different dates. Census survey was started on the day after consultation meetings. Table 7 underneath describes the cut -off dates for Six Cargo and Passenger terminals

Table 7. Table: Cut –off date for non-titled PAPs for Six terminals under S-3 and S-4

Date of Consultation Meetings	Locations/Sites	Commencement date of Census & IOL survey	Cut-Off date for the Non-titled PAPs
22 October 2019	Shashanghat Cargo Terminal	23 October 2019	23/10/2019
22 October 2019	Pangaon Cargo Terminal	23 October 2019	23/10/2019
23 October 2019	Narayanganj Passenger terminal	24 October 2019	24/10/2019
29 October 2019	Chandpur Passenger terminal	30 October, 2019	30/10/2019
24 October 2019	Ashuganj Cargo terminal	25 October 2019	25/10/2019
27 October 2019	Barishal Passenger Terminal	28 October 2019	28/10/2019

Stakeholder Consultation meetings were held at 6 terminals before conducting census and socioeconomic surveys. A total of 393 (male 373 and female 20) were present in the consultation meetings. Female participants in the consultation meetings were far fewer since the meetings were conducted in market/bazaar areas. Women have been contacted personally during census and inventory of losses survey. They were also consulted through focus group discussion. The affected people and other stakeholders including landowners, representatives of local government institutions, squatters, businessman, cargo and passenger vessel owners, tenants, passengers, local influential people, fishermen, day laborers and housewives had information disclosed to them and were made aware of the impacts of the Project. The meetings were held with prior notice provided to the people regarding dates and venue, issues, and necessity of discussion. Consultation meetings will be continued throughout the implementation of the resettlement action plans.

To maximize exposure and participation in meetings, different communication techniques were used, such as: prior communication with the participants; handing over letters of BIWTA to local government offices; and announcing at marketplaces and mosques. Potentially affected people and different levels of stakeholders were informed verbally and locally influential people were invited at least one day ahead of the meeting. Stakeholders were informed as to the time, location and objectives of the meeting. Senior officials from the PIU (BRWTP-1), TYPSA and KS Consultants facilitated consultation meetings. Each of the participants was given the opportunity to take part in the discussion and provide their opinion about the Project. Consultants drafted minutes of meetings, collected attendance sheets and took photos.

Social safeguard documents for the passenger and cargo terminals have been prepared considering the opinions of the people consistent with the project policy. A banner describing the project name and executing agency was displayed during the consultation meetings and information was disseminated in the local language (Bangla) to the participants. Methodologies adopted in the consultation meeting are presented in Figure 18.

Figure 18. Approach of Consultation Meeting

1.8.4. Social Survey

A complete (100%) census and inventory of losses (IOL) survey was conducted among the affected HHs and people in the footprint of the terminals demarcated by the PIU, BRWTP. All of the affected entities including landowners, structure owners, squatters, tenants, lessees, vendors and day laborers were covered through census and IOL survey. Separate structured questionnaires for census and IOL survey, socioeconomic survey (SES), tenants, while vendors and day laborers survey were administered.

For conducting the study, a group of professionals and field level staff were deployed. Before the formal survey PAPs and local community were consulted through formal consultation meetings and the affected HHs were briefed about the project impact by the field staff and obtained broader community support for conducting the survey. The field staff visited each of the affected entities (house or shops) while conducting the survey.

HH heads or their senior proxies were interviewed through printed questionnaires to collect data. A day-long orientation session was held at TYPSA Dhaka office for the field staff on the technique of data collection including identification of affected people within the footprint and filling out the questionnaire. Collected data were checked and verified by the senior officials and coded before the data entry. A data entry screen has been developed by MIS Expert for insertion of the data.

After necessary checking and validation, the MIS Expert has generated tables as per requirement of the ESIA and RAP using touch-driven software. The generated data from the SES survey has been used in the preparation of this ESIA.

2. LEGISLATIVE, REGULATION AND POLICY CONSIDERATION

2.1. INTRODUCTION

Bangladesh has a strong commitment for the conservation of biodiversity and preserving the functional and structural integrity of the ecosystems within the country. This is reflected in the promulgation of national laws and acts, policies, rules, and ratification of international conventions, treaties, protocol, etc. The purpose of these legal documents is to safeguard the country's biodiversity and environmental quality and to guide undertaking activities that are likely to affect the country's biodiversity and environmental functions.

The project needs to be aware of these regulations and address the requirements in the project design and implementation to comply with these legal documents. The purpose of this section is to review the applicable legal and policy documents and briefly summarize the relevant information, particularly relevant to the project. The World Bank environmental and social safeguard policies are also highlighted

2.2. ENVIRONMENTAL POLICY, LEGAL, AND INSTITUTIONAL FRAMEWORK

Regulatory requirements toward protection and conservation of environment and various environmental resources and also toward protection of social environment from adverse impact of projects and activities associated with them have been enunciated by the GoB as well as WB among these requirements are summarized as under. Also reviewed in the Chapter are the relevant international treaties of which Bangladesh is a signatory. The World Bank environmental and social safeguard policies are also highlighted.

2.3. GOVERNMENT ENVIRONMENTAL POLICY, REGULATIONS, AND GUIDELINES

The next sections discuss major environmental policies that shape the government's planning and implementation of construction projects.

2.3.1. National Environmental Policy, 1992

The Bangladesh National Environmental Policy, approved in May 1992, sets out the basic framework for environmental action together with a set of broad sectoral action guidelines. Key elements of the Policy are:

- Maintaining ecological balance and ensuring sustainable development of the country through protection and conservation of the environment
- Protecting the country from natural disasters
- Identifying and regulating all activities that pollute and destroy the environment
- Ensuring environment-friendly development in all sectors
- Ensuring sustainable and environmentally sound management of the natural resources
- Maintaining active association, as far as possible, with all international initiatives related to environment

The Environmental Policy of 1992, which amongst other policies, seeks to ensure that transport systems, including roads and inland waterways, do not pollute the environment or degrade resources. The Policy states that Environmental Impact Assessments (ESIA) should be conducted before projects are undertaken.

2.3.2. National Environment Management Action Plan (NEMAP), 1995

The National Environmental Management Action Plan (NEMAP) is a wide-ranging and multifaceted plan, which builds on and extends the statements, set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2005 and set out of the framework

within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP was developed based on the following broad objectives:

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

To this end, it has grouped all the relevant necessary actions under four heads: institutional, sectoral, location-specific and long-term issues. The institutional aspects reflect the need of intersectoral cooperation to tackle environmental problems those need new and appropriate institutional mechanisms at national and local levels. The sectoral aspects reflect the way the Ministries and agencies are organized and make it easier to identify the agency to carry out the recommended actions.

The location-specific aspect focuses on particularly acute environmental problems at local levels that need to be addressed on a priority basis. The long-term issues include environmental degradation of such degree that it might become more serious and threatening than they seem to be if their cognizance is not immediately taken.

2.3.3. The Environment Conservation Act, 1995 (amendments in 2000, 2002 and 2003)

The provisions of the Act authorize the Director General (DG) of Department of Environment to undertake any activity he deems fit and necessary to conserve and enhance the quality of environment and to control, prevent and mitigate pollution. The main highlights of the act are:

- Declaration of Ecologically Critical Areas.
- Obtaining Environmental Clearance Certificate.
- Regulation with respect to vehicles emitting smoke harmful for the environment.
- Regulation of development activities from environmental perspective.
- Promulgation of standards for quality of air, water, noise, and soils for different areas and for different purposes.
- Promulgation of acceptable limits for discharging and emitting waste.
- Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation, and improvement of environment.

2.3.4. Environment Conservation Rules, 1997 (subsequent amendments in 2002 and 2003)

The Environment Conservation Rules, 1997 are the first set of rules promulgated under the Environment Conservation Act, 1995. These Rules provide for, inter alia, the following:

- The national Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust.
- Categorization of industries, development projects and other activities based on actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load.
- Procedure for obtaining environmental clearance.

- Requirement for undertaking IEE and ESIA as well as formulating ESMP according to categories of industries/development projects/activities.
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

Depending upon location, size and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories: Green, Orange A, Orange B and Red respectively, to nil, minor, medium and severe impacts on important environmental components (IECs). Corresponding categories of passenger terminals, cargo terminals, storm shelters and ghats projects are not directly being mentioned in the ECR 97 but similar project are:

Orange B category:

- Item 44. Repairing of metal vessel
- Item 45. Engineering works (up to 10 hundred thousand Taka capital.)
- Item 63. Construction, re-construction, and extension of road (feeder road, local road).
- Item 65. Public toilet.

Red category

- Item 54. Metallic boat manufacturing.
- Item 60. Engineering works: capital above 10 (ten) hundred thousand Taka.
- Item 66. Construction/reconstruction/expansion of flood control embankment, polder, dike, etc.
- Item 67. Construction/reconstruction/expansion of road (regional, national & international).

2.3.5. The ESIA Guidelines for Industry, 1997

The ESIA Guidelines is a handbook for procedures for preparing the EIAs and for reviewing them for the benefit of the development partners, ESIA Consultants, reviewers, and academicians. While preparing these guidelines, the present environmental status as well as the need for rapid economic development of Bangladesh has been kept in view. These considerations have essentially resulted in simpler procedures to be followed for preparing the EIAs and their review.

2.3.6. Integrated Multi-modal Transport Policy (IMTP)

The national IMTP has been in force since 2013 and aims to build a secure, dependable and uninterrupted transport network addressing the relative problems in road, rail and inland waterways including the access to the sea and airports. It states about adjusting the road vehicular emission standards and enforcing. However, the issues of waterborne vessels are still nonexistent in the policy.

2.3.7. Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

The BCCSAP document came into play in 2009, which was built on six pillars. The fifth pillar focuses on “mitigation and low carbon development”. The objective of this fifth pillar to evolve low carbon development options and implement these within the frame of the country’s economic growth and energy demand. Under this fifth pillar the government has expressed its interest to 5 work plans, of which 3 work plans may contribute to the IWT sector in general:

- Work plan #1: Develop a strategic energy plan and investment portfolio to ensure national energy security and lower greenhouse gas emissions.
- Work plan #2: Seek the transfer of state-of the art technologies developed countries to ensure that we follow a low carbon development path (e.g., ‘clean coal’ and other technologies).

- Work plan #3: Review energy and technology policies and incentives and revise these, where necessary, to promote efficient production, consumption, distribution and use of energy.

2.3.8. BDP 2100 (2017)

Bangladesh Delta Plan 2100 (BDP 2100) is envisioned as a long term integrated and holistic plan that takes a long term view on water resource management, climate change and environmental challenges with a view to supporting long term development of Bangladesh. The opportunities, risks and vulnerabilities emerging from the interface of water, climate change and environmental issues are long term in nature. The strategies, policies and programs must also be formulated with a long term perspective. Yet there are immediate and medium term challenges that must be addressed now or in the near future. The associated short to medium term strategies, policies and programs will have implications for long term developments. As a result, long term planning is complicated by considerable uncertainties. Water, climate change and environment are heavily influenced by the behavior of nature that is not often predictable.

BDP 2100 Specific Goals

- Goal 1: Ensure safety from floods and climate change related disasters;
- Goal 2: Enhance water security and efficiency of water usages;
- Goal 3: Ensure sustainable and integrated river systems and estuaries management;
- Goal 4: Conserve and preserve wetlands and ecosystems and promote their wise use;
- Goal 5: Develop effective institutions and equitable governance for in-country and trans-boundary water resources management; and
- Goal 6: Achieve optimal and integrated use of land and water resources.

Strategy at National Level

Strategy FR 1: Protecting Economic Strongholds and Critical Infrastructure

Supporting economic development implies that those areas that are essential for the economic growth of Bangladesh require a high flood protection standard. This is required to attract the investments that allow the economy to grow. Typical measures that can provide this level of protection include embankments, barriers, erosion control (e.g. by integrating the measures proposed by this BDP 2100 and the FRERMIP1 project), and efficient drainage systems. Most of these measures are already in place, albeit at a basic level. In addition, adapted flood proof building is needed for key facilities such as hospitals, power stations, industrial plants and major communication networks between these facilities. Flood control measures will need to ensure that projects do not create inundation problems elsewhere by creating room for rivers that allow them to follow their natural courses and find their pathways to the sea. Sub-strategies include:

- Sub-strategy FR 1.1: Protection by development and improvements of embankments, barriers and water control structures (incl. ring dikes) for economic priority zones & and major urban centers;
- Sub-strategy FR 1.2: Construct adaptive and flood-storm-surge resilient building;
- Sub-strategy FR 1.3: Adopt spatial planning and flood hazard zoning based on intensity of flood;
- Sub-strategy FR 1.4: Improvement of Flood Early Warning System services (both basin and hotspot wise);
- Sub-strategy FR 1.5: Improvement of Drainage.

2.3.9. Marine Fisheries Ordinance 1983

Marine Fisheries Ordinance, 1983 was prepared for the management, conservation and development of marine fisheries in the Bangladesh fisheries waters and to deal with certain matters connected there with. These ordinances empower the director for the management, conservation, supervision and development of marine fisheries and the implementation of the objectives of this ordinance. This ordinance describes the types, classes and numbers of fishing vessels, matters for which license is valid, duty to provide information regarding catches, license to be subject to certain conditions, local fishing vessel to hold valid certificate of inspection, use of explosives, fishing, dredging, etc. prohibited in marine reserves, power to stop vessel etc. But climate change impacts, monitoring and evaluation, transparency and accountability issues are not clearly spelled out in this ordinance.

2.3.10. The National Land Use Policy, enacted in 2001

The National Land Use Policy, enacted in 2001, aims at managing land use effectively to support trends in accelerated urbanization, industrialization, and diversification of development activities.

2.3.11. National Policy for Ports, Ocean Shipping, and Inland Water Transport (2000)

The National Policy for Ports, Ocean Shipping and Inland Water Transport adopted by the Ministry of Ports and Shipping in 2000 established the Government's aim for Inland Water Transport of ensuring that Bangladesh has a safe and efficient inland and coastal water transport system able to support the national development aspirations. The policy provides a comprehensive guidance for the sector covering its management and administration, IWT infrastructure, services, safety and environment, technology and financing.

2.3.12. Coastal Zone Policy (CZPo), 2005

Coastal Zone Policy (CZPo), 2005 that provides a general guidance to all concerned for the management and development of the coastal zone in a manner so that the coastal people are able to pursue their life and livelihoods within secure and conducive environment without impairing the integrity of the natural environment. The goal of integrated coastal zone management is to create conditions in which the reduction of poverty, development of sustainable livelihoods and the integration of the coastal zone into national processes can take place. The government has made the coastal zone policy statements in relation to development objectives. Transparency and accountability and corruption perspective is neglected in coastal zone policy because coastal zone planning, and budgeting are not transparent and civil society or community participation is not encouraged. The enforcement of existing legal coverage is a key issue in sustainable coastal management. This policy will be given effect, if needed, through revision, modification of existing laws, rules and regulations specifying provisions of the coastal zone policy to facilitate its implementation. The coastal zone policy is unique in the sense that it is a harmonized policy that transcends beyond sectoral perspectives. The CZPo initiates a process that commits different ministries, departments, and agencies to agree to harmonize and coordinate their activities in the coastal zone and elaborates the basis for a firm co-ordination mechanism.

2.3.13. National Water Policy 1999

National Water Policy, 1999 is designed to ensure continued progress towards fulfilling the national goals of economic development, poverty alleviation, food security, public health and safety, decent standard of living for the people and will guide management of the country's water resources by all the concerned ministries, agencies, departments and local bodies that are assigned responsibilities for the development, maintenance and delivery of water and water related services as well as the private users and developers of water resources.

According to this policy, the Water Resources Planning Organization (WARPO) will delineate the hydrological regions of the country, based on appropriate natural features, for planning the development of their water resources and will prepare and periodically update, a National Water Management Plan (NWMP) addressing the

overall resource management issues in each region and the whole of Bangladesh and providing directions for the short, intermediate and long runs. The governance and management of the national water resources require a great deal of coordination of existing institutions and in some cases reform and creation of new community based institutions. Properly functioning institutions are essential for effective implementation and administration of the country's water related environmental resource management policies and directives. This policy should have commitment to anticorruption, transparency and separate policy, planning and regulatory functions from implementation and operational functions at each level of government and each institution must be held accountable for financial and operational performance, but these issues are not clearly spelled out in this policy document.

2.3.14. Bangladesh Water Act 2013

The 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, rainwater, 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. The priority order as depicted in the Act is as follows: drinking water>domestic usage>irrigation>fish culture> biodiversity>wildlife>instream flow>industry>salinity control>power generation>recreation>miscellaneous. It should be noted that only drinking water and domestic usage are considered as basic rights.

2.3.15. Biodiversity Conservation Act 2017

The object of this Regulation is to make provision for matters that are required or authorized to be prescribed by the regulations because of the enactment of the Biodiversity Conservation Act 2017. This Act, consisting of nine Chapters, regulates the Biodiversity conservation and sustainable use of its resources, biota and the fair and equitable share of the benefits derived from their use of and other matters. The Act is divided into the following sectors: Biodiversity and related activities undertaken and transfer restrictions, approved and rejected applications; Functions of the National and Technical Committees on Biological Diversity; Biodiversity management teams, associations etc.

This Regulation deals with:

- The protection of native animals and plants (including the continuation of the special protections for marine mammals and provisions relating to the issue of biodiversity conservation licenses),
- The declaration of areas of outstanding biodiversity value (including the continuation of the special protections that apply to the manly little penguin and Wollemi pine declared areas),
- The listing criteria for threatened species and ecological communities,

- Private land conservation agreements (including the criteria for the designation of biodiversity stewardship sites that generate biodiversity credits under the biodiversity offsets scheme),
- The biodiversity offsets scheme established by the act and the biodiversity stewardship payments fund under the scheme (including provisions relating to the rules for the operation of the scheme, the determination of serious and irreversible impacts on biodiversity values and the preparation of biodiversity assessment reports),
- Biodiversity assessments and approvals under the environmental planning and assessment act 1979 (including the determination of the development threshold for the application of the biodiversity offsets scheme),
- The biodiversity certification of land (including approved conservation measures for certification),
- Public consultation on various regulatory instruments under the act and public registers of licenses, agreements, and other matters under the act,
- The biodiversity conservation trust (including provisions relating to the preparation of its business plan),
- Regulatory compliance mechanisms,
- The retention, destruction or disposal of seized animals, plants or other things under the act,
- Criminal and civil proceedings under the act and under the native vegetation provisions of the local land services act 2013 (including prescribing the offences for which penalty notices may be issued and the amount of the penalty payable),
- Other miscellaneous matters.

2.4. PROJECT RELEVANT NATIONAL POLICIES, LAWS AND REGULATIONS

- National Environmental Policy, 1992

The National Environment Policy (NEP) sets out the basic framework for environmental action, together with a set of broad sector action guidelines. The Policy provides the broader framework of sustainable development in the country. The policy addresses 15 sectors in all, in addition to providing directives on the legal framework and institutional arrangements. Transport, water pollution and marine environment are some of the key sectors covered in this policy. The main policy requirements related to the water sector are to ensure environmentally sound utilization of resources, so that developments do not create any significant adverse impacts on the environment; and that all water bodies and water resources are kept free from pollution. The policy also emphasizes on biodiversity conservation and sustainable uses of natural resources.

The policy mentions that, an ESIA should be conducted before projects are undertaken.

Relevance and compliances: The Project needs to ensure that project activities do not degrade the environmental and its biota and needs to undertake ESIA Study and address the potential impacts.

- Environment Conservation Act, 1995 (amended in 2000, 2002, 2007 and 2010)

The Bangladesh Environment Conservation Act is the key legislation relating to environment protection in Bangladesh, articulates and expands upon the environmental management and sustainable development goals of the NEP, defining the environmental regulatory regime and DoE's mandate with respect thereto. It provides guidance for conservation of the environment, improvement of environmental standards and control and mitigation of environmental pollution. It includes provisions for the declaration of ECAs (ecologically Critical Areas), restrictions on vehicle emissions, restrictions on the manufacture and sale of articles injurious to the environment, remedial measures (including compensation and/or corrective measures), restrictions on environmental pollution discharges, environmental clearances and formulation of environmental guidelines. The

Act has an overriding effect in that notwithstanding anything contained to the contrary in any other law for the time being in force, the provisions of the Act, and rules and directions issued under the Act shall have effect. . Failure to comply with any part of this Act may result in punishment.

This Act has established the Department of Environment (DoE), to take measures as it 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, and Environmental Clearance Certificate (ECC) from the Director General of DoE.

The amended Act has provision for putting objections for taking legal actions against the polluters or any entity creating nuisance to affected person. The Act also emphasizes on the protection of country's biodiversity that are likely to be affected by any damaging activities.

Relevance and required compliance: According this Act, all projects require to obtain clearances from the DoE prior to project work to begin anto d need undertake ESIA Study, if required, and prepare an ESMP for safeguarding the environment. It is the requirement of the Act that environmental soil, air and water qualities are preserved while undertaking any developmental activities.

- Environment Conservation Rules 1997 (ECR) (amended in 2002 and 2003)

The Environmental Conservation Rules (ECR) promulgated under the Environmental Conservation Act, 1995, specifies the environmental approvals processes for various project types and provides allowable limits for air and water parameters and noises. Based on location, size and severity of pollution loads of the projects/ activities have been classified into four categories: Green, Orange A, Orange B and Red respectively from nil, minor, medium and severe impacts on important components of the environment (IECs).

The project activities are likley to cause changes in the air, water, soil and noise quality affecting the health, biodiversity and the ecosystem integrity. As per Item 67, 63 of the Act the BRWITP-1 falls under the Red category requiring a full length ESIA Study and prepare an ESMP.

Relevance and required compliance**:** The BRIWTP-1 falls under the DoE's Red Category project and as such the project requires to undertake a complete ESIA Study to getting an Environment Clarence Certificate (ECC). The project needs to follow some procedural steps for obtaining IEE, ECC from the DoE. The project also needs to demonstrate that the ESMP is in place to keep the air, water and noise parameters within the DoE's standards. It is also required to submit environmental monitoring reports to DoE during implementation of the project..

- National Biodiversity Strategy and Action Plan (NBSAP) (1995)

Prepared as a commitment under the CBD, the NBSAP proposes a National Biodiversity Policy for Bangladesh based on the principles of the CBD. It forms a national framework for both initiating and executing activities leading to the conservation and sustainable use of biodiversity and establishing mechanisms to ensure equitable sharing of the benefits derived from such activities. It outlines 16 strategies and subsequent actions to be implemented under the proposed biodiversity policy, including a prioritization of those actions.

The relevant strategies to the project are: (i) conserve and restore the biodiversity of the country for the wellbeing of the present and future generations, (ii) maintain and improve environmental stability for ecosystems (iii) ensure preservation of the unique biological heritage of the nation for the benefit of the present and future generations, and)iv) guarantee the safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country; and

Relevance and required compliances: The project construction activities are likely to negatively affect the water quality affecting the aquatic biodiversity. Protection of migratory birds. As per the Action Plan, and preserve t

Ecological Critical Area (ECA) Rules, 2016

- The Environmental Conservation Act (1995) and amendments

The ECA Rules, dedicated to the protection of ECA sites, developed under the ECR, 1997, The Rules explain and guide the management mechanism of the ECA sites in the country. Among others, the Rules also define the prohibited activities in the ECA, (Article 18) and provision for requiring permission from DoE for implementing some activities that might cause changes in the physiographic features of an ECA.

***Relevance and required compliances*:** Two ECA sites, the Buriganga River and the Shitalakhya River, are located within the project boundary of the Zone 1 project sites. The project needs obtaining permission from the DoE for undertaking project activities in the ECA sites.

- National Fisheries Policy, 1998 (amended in 2010)

The National Fisheries Policy aims to develop and increase fish production through optimum utilization of resources, while preserving the environmental balance and biodiversity. The policy recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy suggests, among others, that biodiversity will be maintained in all natural water bodies and in marine environment and control measures are to be taken against activities that have a negative impact on fisheries resources. National Fisheries Policy focuses on aquaculture and marine fisheries development and includes the following mandates: (i) maintaining biodiversity in all natural water bodies and in marine environment, (ii) ensuring that chemicals harmful to the environment will not be used in fish shrimp farms; (iii) using environment friendly fish and shrimp culture technology; (iv) expanding fisheries areas and integrating rice, fish and shrimp cultivation; (v) undertaking control measures against activities that have a negative impact on fisheries resources; (v) formulating laws to ban the disposal untreated industrial effluents into the water bodies, if any. The policy also suggests for establishing Fish Sanctuaries for protecting breeding fish population and immature fish.

***Relevance and required compliances*:** This policy is relevant as the project development activities are likely to produce pollutants leading to environmental degradation, affect aquatic biodiversity, including fish, and may also affect the fish migratory routes and fish sanctuary, negatively impacting the fish production. The project needs to devise measures to address the negative effects.

- Protection and Conservation of Fish Act, 1950 (Amended in 1963, 1970, 1982,1985, 2000, 2010)

The Act aims at protecting the open water fisheries resources through sustainable use of the resource and provides various measures for the protection and conservation of fish including s limiting size of certain fishes at catching, season closure, ban on catching gravid fish and destructive fishing, ban on use of fixed engine and use of poison for fishing, etc. The Act has provision for issuing license to fishers in controlling fishing. The amended Act prohibits collection of fry or post larvae of fish shrimp and prawns of any kind, in any form and in any way, in estuary and coastal waters, blocking water flow that hinders fish diverting or blocking water flow that hinders fish movement/migration. The Act also contains a provision for conservation by empowering the government to declare any fish sanctuary in which fishing and any other detrimental activities can be prohibited.

Relevance and required compliances: The development works under BRWITP-1 in the aquatic habitat are likely to damage fish, pollute aquatic environment affecting production of fish and other aquatic biota, hinder fish migration and affect fish sanctuary. The project will require to take into consideration these issues to minimize the adverse impacts on fisheries.

- Wildlife (Conservation and Security) Act, 2012

Earlier the Act was known as Bangladesh Wildlife (Preservation) Act 1974. The Act mainly focuses on conserving the country's wildlife resources. The Act provides lists of animals (includes fish, amphibians, reptile, birds, mammals, crabs, mollusks, prawns) specifying which animals shall not be killed, trapped, captured and which animals may be killed, captured upon permission from the competent authority. The Act has provision for declaring different categories of Protected Area (PA) and sets out activities restricted activities in the PAs.

***Relevance and required compliances*:** Many animal species, including dolphin, marine turtles, river terrapins, critically endangered migratory birds, otter and many other significant species, are protected under the Act and known to occur within the Project Area and likely to be affected by the project activities. The Project needs to ensure that mitigation measures are designed for safeguarding these species.

- Coastal Zone Policy, 2005

Coastal Zone Policy is a harmonized policy that transcends beyond sectoral perspectives. The policy provides general guidance so that the coastal population can pursue their livelihoods under secured conditions in a sustainable manner without impairing the integrity of the natural environment. The policy framework underscores sustainable management of natural resources like inland fisheries & shrimp, marine fisheries, mangrove and other forests, land, livestock, salt, minerals, sources of renewable like tide, wind and solar energy. It also emphasizes conservation and enhancement of critical ecosystems.

Relevance and required compliance: A major part of the project area comprises the coastal islands and estuaries, containing mangroves, staging grounds of birds, fish nursing and breeding grounds having massive role in fish recruitment and provides a mosaic of critical habitats. It is to be ensured that the policy issues are taken care of through minimizing the adverse impacts on them

- Forest Act, 1927 (Amended 1990, 2000)

The Act empowers the Government to declare any area of forest as Reserved and by doing that it may take measures for *in-situ* conservation of biological diversity. According to the Act, the Government may also establish some control over private forests through the Private Forest Ordinance. With the introduction and expansion of Community Forestry, the government is gradually trying to introduce community-oriented co-management. Any act or omission detrimental to the natural resources of reserve and protected forests is prohibited including clearing forest lands, removing timber, setting fires, felling or otherwise damaging trees, clearing or breaking up any land for cultivation or any other purpose, hunting and the poisoning of water.

Being a coastal and inland water-environment related project, following a detail of the contains of those more relevant to the project and a review or their relevance and required compliances. Following Table presents an outline of the other National legal instruments that will have relevance to the proposed project with respect to the social and environment considerations.

The ESIA will be prepared in compliance with these national policies.

Table 8. Review of Relevant Laws, Regulations and National Policies

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
Environment Court Act, 2000 and subsequent amendments in 2002	GOB has given highest priority to environment pollution and passed 'Environment Court Act, 2000 for completing environment related legal proceedings effectively	Relevant. The ESIA shall ensure that the project is being implemented with the less amount or 'zero' pollution.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
Bangladesh Climate Change Strategy and Action Plan of 2009	Enhances the capacity of government ministries, civil society and private sector to meet the challenges of climate change	Relevant. The ESIA shall Integrate adaptation measures for buildings in consideration of extreme climatic events
National Environmental Policy, 1992	Bangladesh National Environmental Policy 1992 sets out the basic framework for environmental action, together with a set of broad sector action guidelines. 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. The main policy requirements related to the water sector are to ensure environmentally sound utilization of resources, so that developments do not create any significant adverse impacts on the environment; and that all water bodies and water resources are kept free from pollution. Key elements of the policy are: ▪ Maintenance of the ecological balance and overall progress and development of the country through protection and improvement of the environment; ▪ ensure that all steps are taken for flood control, including construction of embankments, dredging of rivers, digging of canals, etc., be environmentally sound at local, zonal and national levels; ▪ keep the rivers, canals, ponds, lakes, harbors and all other water bodies and water resources free from pollution;; ▪ Identification and regulation of all types of activities, which pollute and degrade the environment; ▪ Ensuring sustainable utilization of all-natural resources, and ▪ Conduct environmental impact assessment before undertaking projects for water resources development and management.	According to this policy the proposed project needs full environmental assessment. The proposed interventions are required to comply with all the policy directives emphasizing particularly on reducing adverse environmental impacts. The ESIA studies are required to address the potential impacts and propose mitigation measures. In compliance to the policy detail ESIA shall be prepared.
Environment Conservation Act (ECA) 1995 and subsequent amendments (2000, 2002 and 2010)	ECA '95 is currently the main legislation related to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standard development and environment pollution control and abatement. The main strategies of the Act, that are relevant for this project, can be summarized as: ▪ Declaration of ecologically critical areas and restriction on the operation and process, which can or cannot be carried/initiated in the ecologically critical areas; ▪ Environmental clearance requirement for certain projects, which potentially create significant adverse environmental impacts; ▪ Regulation of the industries and other development activities' discharge permit. ▪ Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes. ▪ Promulgation of standard limit for discharging and emitting waste and, ▪ Formulation and declaration of environmental guidelines.	The ESIA study shall be prepared following guidelines of this Act. In accordance with the Act, the IWT project will need DoE's clearance prior to the commencement of the project. Also the Ecologically Critical Areas, defined by DoE under this act, will be considered while planning and designing of the project interventions.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
	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. The amendment 2010 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.	
Environment Conservation Rules 1997 and Subsequent amendments (2002 and 2003)	The rule among others categorizes the industries and projects into four categories. As per ECR 1997, the project falls under Red Category needing detail ESIA to obtain environmental clearances from DoE prior to commencement of any physical activities. Under the Rules, the following aspects, among others, are covered. ▪ Declaration of ecologically critical areas ▪ Procedures for issuing the Environmental Clearance Certificate (ECC) ▪ 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 1995. 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	The ESIA report shall be prepared in consideration of the procedure set in this rule.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
	requirement, for every Red category proposed industrial unit or project, the application must be accompanied with feasibility report, Initial Environmental Examination (IEE), Environmental Impact Assessment (ESIA) based on approved terms of reference (ToR) by DoE, Environmental Management Plan (ESMP). As per ECR'97, water resources development projects fall under 'Red' category project. Therefore, the project is 'Red' category project which requires IEE, ESIA and ESMP for environmental clearance from DoE. The rules however provide the Director General a discretionary authority to grant Environmental Clearance to an applicant exempting the requirement of site/location clearance, provided he considers it appropriate. [Section 7(4), 2nd Paragraph, Page 3105 of the Bangladesh Gazette of 27 August 1997].	
National Water Policy, 1999	The policy aims to provide guidance to the major players in water sector for ensuring optimal development and management of water. The policy emphasizes efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. It also addresses issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation and water need for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc. The policy has several clauses related to the project for ensuring environmental protection. Some of the relevant clauses are: ▪ Clause 4.9b: Measures will be taken to minimize disruption to the natural aquatic environment in streams and water channels. ▪ Clause 4.12a: Give full consideration to environmental protection, restoration and enhancement measures consistent with National Environmental Management Action Plan (NEMAP) and the National Water Management Plan (NWMP). ▪ Clause 4.12b: Adhere to a formal environment impact assessment (ESIA) process, as set out in ESIA guidelines and manuals for water sector projects, in each water resources development project or rehabilitation program of size and scope specified by the Government from time to time.	A number of clauses of this policy are applicable to the project as the RCC piling and some dredging operation will affect water quality including change in aquatic habitats. The proposed interventions are designed and implemented with due consideration of the relevant clauses of the policy.
National 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, rainwater and atmospheric water) within the territory of Bangladesh	The Act is considered relevant as the intervention involves improvement of navigability of the major water ways in the country. The ESIA study shall be conducted in consideration of relevant section of the Act.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
	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.	
The National Environment Management Action Plan (NEMAP, 1995)	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.	Relevant section of NEMAP is complied with in design and implementation of the project.
Bangladesh Environment Court Act, 2010	Bangladesh Environment Court Act, 2010 has been enacted to resolve the disputes and establishing justice over environmental and social damage raised due to any development activities. This act allows government to take necessary legal action against any parties who creates environmental hazards/ damage to environmentally sensitive areas as well as human society.	According to this act, government can take legal actions if any environmental problem occurs due to project interventions.
The National Land Use Policy (NLUP), enacted in 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.	The project intervention is designed adhering to the NLUP so that there is no and/or minimal change.
The National Water Management Plan (NWMP) 2001	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	The project ESIA study shall be conducted with due consideration of NWMP sub-sector clusters i), iii) and viii).

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
	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.	
Coastal Zone Policy, 2005	Coastal zone policy initiated as a harmonized policy that transcends beyond sectoral perspectives. The policy provides general guidance so that the coastal population can pursue their livelihoods under secured conditions in a sustainable manner without impairing the integrity of the natural environment. The policy framework underscores sustainable management of natural resources like inland fisheries & shrimp, marine fisheries, mangrove and other forests, land, livestock, salt, minerals, sources of renewable energy like tide, wind and solar energy. It also emphasizes conservation and enhancement of critical ecosystems.	In line with this policy the operation is conducted with minimal disturbance to the natural resources (benthic species, inland fisheries & shrimp, marine fisheries, mangrove forest, etc.) in the coastal area with fragile ecosystem. The ESIA shall be prepared with due note of this policy.
Inland Water Transport Policy (IWTP), 2009	The objective of the IWTP is to revive inland waterways traffic. This policy for IWT development has direct bearing on overall improvement of BIWT sector including dredging navigation routes, provision of inland port facilities and navigation aids, conducting hydrographic survey, vessel development, etc. The salient points of IWT Policy are: Inland Waterways Network: For this to be achieved, waterways shall be re-classified. In short term however, a core waterways network shall be identified to keep existing infrastructure and facilities running. Inland River Ports and Launch Landing Stations: More investments shall be made in ports and landing stations to make IWT more attractive and efficient. Proper passenger and cargo infrastructure and facilities shall be developed or augmented; accesses by roads shall be provided so that multi-modal traffic is ensured; waterways access shall be improved to reduce congestion at the berths; mechanical handlings shall be introduced to enhance efficiency and increase turn-round of vessels; and provide secured operational areas by security walls in order to improve passenger and cargo handlings. Network Maintenance: Funds shall be required to be committed by the Government only to maintain existing navigational asset. Hydrographic surveys shall be required to be carried out regularly to assess condition of waterways network and identify channels needing dredging works. Safety: Special focus is to be given on accident prevention, largely in the areas of inspection and enforcement. Design of vessels and construction shall be checked stringently. Institutional Issues: Considering transport sector as a whole, adequate government support in decision making and prioritization shall be given to IWT mode not only to maintain its present level of services but also to make improvements.	The proposed interventions integrated on this project have to be in line with this policy (revive inland waterways traffic). Compliance to the policy shall be addressed properly in the ESMP Section of the ESIA and proper monitoring arrangement by the project proponent ensured in the study.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
Inland Shipping Ordinance 1976 and Inland Shipping (Amendment) Act 1990	Deals with the administration, registration, competency and pollution control, etc., of inland water transport. Primarily addresses pollution in the coastal and national waters and seaports of Bangladesh. The Act provides control for oil or pollutants discharged, spilled or dumped into Bangladesh water from ships, ship transfer to land, land, ports, exploration of the sea bed, pipelines and offshore installations.	The proposed intervention has close relationship with the ordinance and Act. ESMP section of the ESIA shall address relevant issues and BIWTA is committed to ensure proper compliance to these through proper monitoring arrangement.
Draft Rules for Inland Ship Safety 1994	The proposed Rules control impacts from all inland water transport, ports, ship-related facilities, and ship related activities for the protection of inland water in regard to air emissions, handling and storage of harmful materials, solid and liquid waste discharges, dredging, and disposal of dredged sediments.	The major activities of proposed interventions are in line with the rules and shall be addressed in the ESMP.
Bangladesh Labor Act 2006	The Act 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. Provides for safety of work force during construction period.	This act is relevant to the project intervention as there will be involvement of skilled and unskilled labor in operation. The ESMP shall be prepared to address relevant section of this Act.
National Land Use Policy, 2001	The Policy aims at managing land use effectively to support trends in accelerated urbanization, industrialization and diversification of development activities;	Compliance to this Act shall be observed through ESMP and monitoring during sandfilling and development activities.
Land Acquisition and Requisition Ordinance 1984	This Ordinance governs acquisition and requisition by the government of immovable property for any public purpose or in the public interest.	The project may require land acquisition for cargo and passenger terminals. RAP will be prepared to deal these aspects.
The Bangladesh National Building Code (BNBC)	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."	The project will create facilities including construction of terminal on land and RCC piling on water. These will involve construction of infrastructures. All civil construction works will be carried out following the BNBC Code.
National Agriculture Policy, 1999	This policy aims to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure a dependable and secure food system for all. The policy particularly stresses on research and 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 and salinity and provide irrigation facilities for crop production.	The proposed project is expected to contribute to achieve the objectives of the agriculture policy by avoiding construction on agricultural land.
National Fisheries Policy, 1998	The policy recognizes that fish production has declined due to environmental imbalances, adverse environmental impact and improper implementation of fish culture and management programs. The policy suggests, among others, that biodiversity will be maintained in all-natural water bodies and in marine environment and control measures will be taken against activities that have a negative impact on fisheries, resources and vice-versa. National Fisheries Policy focuses on aquaculture and marine fisheries development and includes the following mandates: (i) Maintaining biodiversity in all	This policy is relevant as the RCC piling and some dredging activities involve in some major river system of the country, which are important fish feeding, breeding, spawning and migration routes. The proposed ESIA shall be conducted in compliance with the relevant directives including maintaining biodiversity in inland water ways.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
	natural water bodies and in marine environment, (ii) Ensuring that chemicals harmful to the environment will not be used in fish shrimp farms; (iii) Using environment friendly fish shrimp culture technology; (iv) Expanding fisheries areas and integrating rice, fish and shrimp cultivation; (v) Undertaking control measures against activities that have a negative impact on fisheries resources and vice-versa; and (v) Formulating laws will to ban the disposal of any untreated industrial effluents into the water bodies.	
Protection and Conservation of Fish Act, 1950 (Amended 1963, 1970, 1982, 1995, 2000)	This Act provides various measures for the protection and conservation of fish including specifying waters in which the catching of certain fish species is prohibited without a valid license, and specifying fish species of which the catching or sale in certain periods is prohibited; prohibiting the erection of fixed engines in rivers and canals; prohibiting the destruction of fish through the use of poison or explosives; and licensing and regulations with regard to frogs. In recognition that fish fry collection from nature may result in long term ecological destruction the government, in 2000, prohibited the collection of fry or post larvae of fish, shrimp and prawns of any kind, in any form and in any way, in estuary and coastal waters, diverting or blocking water flow that hinders fish movement/migration. The Rules contain a provision for conservation by empowering the government to declare any fish reserve in which fishing and any other detrimental activities can be prohibited.	Relevant as intervention area is located within Hilsha fish migratory route of the country. The project will be implemented with due care so that minimal/no damage occur to fishery for conservation of fishery resources. No intervention will be in place during Hilsha breeding periods.
The Forest Act, 1927 and amendment1989	The Forest Act of 1927 as amended in 1989 grants the government several basic powers, largely for conservation and protection of government forests, and limited powers for private forests. The 1927 version of the act was amended in 1989 for extending authority over "any [Government-owned] land suitable for afforestation".	Relevance to the study in question. ESMP shall be prepared in consideration of this Act.
Bangladesh Wildlife (Conservation & Security) Act, 2012 (previously known as Bangladesh Wildlife (Preservation) Order, 1973; amended as Bangladesh Wildlife (Preservation) Act 1974)	The previous Wildlife (Preservation) Order, 1973 & Wildlife (Preservation) (Amendment) Act, 1974 have been revamped to Wildlife (Conservation & Safety) Act of 2012. The Act has adopted new types of protected areas for conservation and protection of wildlife resources, created avenue for community conserved areas and also community-based management of protected areas. This Act protects 1,307 species of plants and animals: and mandates imprisonment and fines for wildlife poaching, capturing, trapping, and trading. Bangladesh Wildlife (Preservation) Order (1973) and Act (1974) regulates the hunting, killing, capture, trade and export of wild life and wild life products. It designates a list of protected species and game animals.	Relevant, as intervention may affect wildlife habitation, obstruct movement. The ESMP shall be prepared to address this aspect.
Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009	The Government of Bangladesh has prepared the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009. The BCCSAP is built on six pillars: i. Food security, social protection and health to ensure that the poorest and most vulnerable in society, including women and children, are protected from climate change and that all programs focus on the needs of this group for food security, safe housing, employment and	Relevant as the country particularly the project area is vulnerable to climate change effect. Proposed interventions are designed to address climate induced effect.

Policies, Laws and Regulations	Description (Policies, Laws and Regulations)	Project Compliance
	access to basic services, including health. ii. Comprehensive disaster management to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities. iii. Infrastructure to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit for purpose and that urgently needed infrastructures (cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change. iv. Research and Knowledge management to predict that the likely scale and timing of climate change impacts on different sectors of economy and socioeconomic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change. v. Mitigation and low carbon development to evolve low carbon development options and implement these as the country's economy grows over the coming decades. vi. Capacity building and Institutional strengthening to enhance the capacity government ministries, civil society and private sector to meet the challenge of climate change. RMIP will contribute towards achieving the objective of pillars such as (i), (ii), (iii), (iv), and (vi).	
Bangladesh Wildlife (Conservation & Security) Act, 2012 (previously known as Bangladesh Wildlife (Preservation) Order, 1973; amended as Bangladesh Wildlife (Preservation) Act 1974)	This Act protects 1,307 species of plants and animals including 32 species of amphibian, 154 species of reptile, 113 species of mammal, 52 species of fish, 32 species of coral, 137 species of mollusk, 22 species of crustacean, 24 species of insect, six species of rodent, 41 species of plant and 13 species of orchid. Of these, eight amphibian, 58 reptile, 41 bird, and 40 mammal species are listed as endangered in the IUCN Red Data Book (2000); and mandates imprisonment and fines for wildlife poaching, capturing, trapping, and trading. Bangladesh Wildlife (Preservation) Order (1973) and Act (1974) regulates the hunting, killing, capture, trade and export of wild life and wild life products. It designates a list of protected species and game animals.	Relevant as intervention may affect wildlife habitation, obstruct movement. EPM section of the ESIA shall deal with this issue.
The Embankment and Drainage Act, 1952	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.	Disposal of dredged spoil may create drainage obstruction. So adherence to relevant section of the Act shall be addressed in the ESIA.

Acquisition and Requisition of Immovable Property Act, 2017

Relevant Section under	Steps in the Process	Responsibility
Section 4 (1)	Publication of preliminary notice of acquisition of property for a public purpose	Deputy Commissioner
Section 4 (3) (1)	Prior to the publication of section 4(1) notice; Identify the present status of the land, structures and trees through videography, still pictures or appropriate technology.	Deputy Commissioner

	After the publication of the section 4(1) notice, a joint verification is conducted with potentially affected households and relevant organizations.	Deputy Commissioner
Section 4 (7)	After publication of preliminary notice under the section 4(1), if any household has changed the status of the land for beneficial purposes, changed status will not be added to the joint verification notice.	Deputy Commissioner
Section 4 (8)	If the affected person is not happy with the joint verification assessment, he/she can complain to Deputy Commissioner within seven days of issuing sec 4(1) notice.	Affected Person
Section 4 (9)	Hearing by Deputy Commissioner within 15 working days after receiving the complaints. In case of government priority projects, hearing will be within 10 working days.	Deputy Commissioner
Section 5 (1)	Objections to acquisition by interested parties, within 15 days of the issue of section 4 (1) Notice	Affected Person
Section 5 (2)	Deputy Commissioner submits hearing report within 30 working days after the date of the section 5(1) notice. In the case of government priority projects, it will be within 15 working days.	Deputy Commissioner
Section 5 (3)	DC submits his report to the (i) government (for properties that exceed 16.50 acres; (ii) Divisional Commissioner for properties that do not exceed 16.50 acres. Deputy Commissioner makes the final decision, if no objections were raised within 30 days of inquiry. In case of government priority project, it will be 15 days	Deputy Commissioner
Section 6 (1) (1)	Government makes the final decision on acquisition within 60 working days after receiving report from the Deputy Commissioner under section 5(3) notice.	Divisional Commissioner
Section 6 (1) (2)	Divisional Commissioner makes the decision within 15 days or with reasons within 30 days since the submission of the report by Deputy Commissioner under section 5(3) notice.	Divisional Commissioner
Section 7 (1)	Publication of the Notice of final decision to acquire the property and notifying the interested parties to submit their claims for compensation.	Deputy Commissioner
Section 7 (2)	Interested parties submit their interests in the property and claims for compensation within 15 working days (in case of priority project 7 days).	Affected Person
Section 7 (3)	Individual notices have to be served to all interested persons including the shareholders within 15 days of issuing Section 7(1) notice	Deputy Commissioner
Section 8 (1)	Deputy Commissioner makes a valuation of the property to be acquired as at the date of issuing Section 4 Notice; determine the compensation; and apportionment of compensation among parties interested.	Deputy Commissioner
Section 8 (3)	Deputy Commissioner informs the award of compensation to the interested parties and sends the estimate of compensation to the requiring agency/person within 7 days of making the compensation decision.	Deputy Commissioner

Section 8 (4)	The requiring agency deposits the estimated award of compensation with the Deputy Commissioner within 120 days of receiving the estimate.	Requiring Agency
Section 9 (1)	During valuation of assets, Deputy Commissioner will consider the following: (i) Average market price of land of the same category in the last 12 months; (ii) Impact on existing crops and trees; (iii) Impact on other remaining adjacent properties; (iv) Impact on properties and income; and (v) Relocation cost for businesses, residential dwellings etc.	Deputy Commissioner
Section 9 (2)	Additional 200% premium on transacted deeds collected from Sub-Registrar's office is added to the estimated value. If land is acquired for private organizations, added premium will be 300%.	Deputy Commissioner
Section 9 (3)	Additional 100% compensation on top of the market price for impacts mentioned under sections 9(1) and (2)	Deputy Commissioner
Section 9 (4)	Appropriate action will be taken for relocation on top of the above-mentioned subsections.	
Section 11 (1)	Deputy Commissioner awards the compensation to entitled parties within 60 days of receiving the deposit from the requiring agency/person.	Deputy Commissioner
Section 10 (2)	If an entitled person does not consent to receive compensation, or if there is no competent person to receive compensation, or in the case of any dispute with the title to receive compensation, Deputy Commissioner deposits the compensation amount in a deposit account in the Public Account of the Republic. Thereafter, Deputy Commissioner acquires the land. (Landowners can obtain such deposited money at any time, having appealed to the Deputy Commissioner, and providing evidence in support of his/her claim.	Deputy Commissioner Affected Persons
Section 12	When the property acquired contains standing crops cultivated by Bargadar (registered tenants),the apportion of compensation due to him will be determined by the Deputy Commissioner and will be paid to the bargadar in cash.	Deputy Commissioner

2.5. INTERNATIONAL TREATIES

Bangladesh is signatory to several International conventions and treaties including MARPOL 73/78 (Prevention of Pollution from Ships), OPRC (Oil Pollution Preparedness Response and Cooperation) or the LC Convention 72 (dumping of ship wastes).The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) is subject to enforcement in Bangladesh marine and coastal waters.

Therefore, ships in Bangladesh Ports are subject to inspection for the purpose of enforcing MARPOL 73/78. 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 and conventions is shown in Table 9.

Table 9. International Treaties, Conventions, Protocol, and their relevancy to the proposed project

Treaty or Convention	Brief Description	Project Compliance
London Convention	The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter1972, commonly called the "London Convention" or "LC '72" and also abbreviated as Marine Dumping, is an agreement to control pollution of the sea by dumping and to encourage regional agreements supplementary to the Convention. It covers the deliberate disposal at sea of wastes or other matter from vessels, aircraft, and platforms. It does not cover discharges from land-based sources such as pipes and outfalls, wastes generated incidental to normal operation of vessels, or placement of materials for purposes other than mere disposal, providing such disposal is not contrary to aims of the Convention. It entered into force in 1975. As of 2013, there were 87 Parties to the Convention. The London Convention consists of 22 Articles and three Annexes. The main objective of the London Convention is to prevent indiscriminate disposal at sea of wastes that could be liable for creating hazards to human health; harming living resources and marine life; damaging amenities; or interfering with other legitimate uses of the sea. The 1972 Convention extends its scope over "all marine waters other than the internal waters" of the States and prohibits the dumping of certain hazardous materials. It further requires a prior special permit for the dumping of a number of other identified materials and a prior general permit for other wastes or matter. Since its entering into force in 1975, the convention has provided a framework for international control and prevention of marine pollution within which the contracting parties have achieved continuous progress in keeping the oceans clean. Among its milestones are the 1993 ban on ocean disposal of low-level radioactive wastes and the resolutions to end the dumping and incineration of industrial wastes. The efforts of the Parties are supported by a permanent secretariat hosted by the International Maritime Organization (IMO). On 17 November 1996, a special meeting of the Contracting Parties adopted the "1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972" which is to replace the 1972 Convention, subject to ratification. In line with UNCED's Agenda 21, the 1996 Protocol reflects the global trend towards precaution and prevention with the parties agreeing to move from controlled dispersal at sea of a variety of land-generated wastes towards integrated land-based solutions for most, and controlled sea disposal of few, remaining categories of wastes or other matter. Among the most important innovations brought by the 1996 protocol is the codification of the "*precautionary approach*" and the "polluter pays principle." Reflecting these principles,	The Convention is indirectly relevant for the present ESIA as dredging operation is planned not only in the major river routes but also in the delicate coastal ecosystem of the country.

Treaty or Convention	Brief Description	Project Compliance
	the protocol embodies a major structural revision of the convention the so-called "reverse list" approach. Now, instead of prohibiting the dumping of certain (listed) hazardous materials, the parties are obligated to prohibit the dumping of any waste or other matter that is not listed in Annex 1 ("the reverse list") of the 1996 protocol. Dumping of wastes or other matter on this reverse list requires a permit. Parties to the protocol are further obligated to adopt measures to ensure that the issuance of permits and permit conditions for the dumping of reverse list substances comply with Annex 2 (the Waste Assessment Annex) of the protocol. The substances on the reverse list include dredged material; *sewage sludge*; industrial *fish processing* waste; vessels and offshore platforms or other man-made structures at sea; inert, inorganic geological material; organic material of natural origin; and bulky items including iron, steel, concrete and similar materials for which the concern is physical impact, and limited to those circumstances where such wastes are generated at locations with no land-disposal alternatives. In addition, the 1996 protocol prohibits altogether the practice of incineration at sea, except for emergencies, and prohibits the exports of wastes or other matter to non-Parties for the purpose of dumping or incineration at sea. The 1996 protocol has effectively moved the scope of the original London convention landwards, relating it to the policy and management issues of land as well as sea wastes disposal.	
MARPOL Convention	The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. The MARPOL Convention was adopted on 2 November 1973 at IMO. The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. As the 1973 MARPOL Convention had not yet entered into force, the 1978 MARPOL Protocol absorbed the parent Convention. The combined instrument entered into force on 2 October 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on 19 May 2005. MARPOL has been updated by amendments through the years. The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes. Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983) Covers prevention of pollution by oil from operational measures as well as from accidental discharges; the 1992 amendments to Annex I made it mandatory for new oil	The Convention is in line with the study in question. Most of the Annexes of MARPOL is required to be observed by the project proponent strictly as per ESMP recommendation advocating strict observance to this and other relevant Conventions as Bangladesh is a signatory to this Convention.

Treaty or Convention	Brief Description	Project Compliance
	tankers to have double hulls and brought in a phase-in schedule for existing tankers to fit double hulls, which was subsequently revised in 2001 and 2003. Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983) Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992). Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003) Contains requirements to control pollution of the sea by sewage; the discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; sewage which is not comminuted or disinfected has to be discharged at a distance of more than 12 nautical miles from the nearest land. Annex V Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988) Deals with different types of garbage and specifies the distances from land and the manner in which they may be disposed of; the most important feature of the Annex is the complete ban imposed on the disposal into the sea of all forms of plastics. Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005) Sets limits on sulfur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone depleting substances; designated emission control areas set more stringent standards for SOx, NOx and particulate matter. A chapter adopted in 2011 covers mandatory technical and operational energy efficiency measures aimed at reducing greenhouse gas emissions from ships.	
Ramsar Convention	Protection of wetlands. Broadly applicable for wetlands in and around the project influence area.	The operation may affect wetland habitat. Mitigation measures shall be included in ESMP to address potential impacts on wetlands and associated resources as well.
Protocol on Waterfowl Habitat	Amendment of Ramsar Convention to protect specific habitats for waterfowl.	Broadly applicable for wetlands in and around the project influence area. Mitigation measures shall be included in ESMP address potential impacts on wetlands and associated ecological resources as well.
CITES Convention (Washington)	Ban and restrictions on international trade in endangered species of wild fauna and flora.	Not directly relevant to the project intervention since the project does not involve in any international trade of endangered species of wild fauna and flora. General restrictions have however been included in the Environmental Management Plan in this ESIA.

Treaty or Convention	Brief Description	Project Compliance
Prevention and Control of Occupational hazards (Geneva)	Protect workers against occupational exposure to carcinogenic substances and agents.	Compliance to this shall be taken care of in the ESMP of the ESIA report due to the fact that interventions involve occupational risks to some extent.
Occupational hazards due to air pollution, noise & vibration (Geneva)	Protect workers against occupational hazards in the working environment.	Relevant as there will be pollution due to construction machineries, and vehicle movement. Noise Appropriate mitigation and protective measures shall be included in the ESMP.
Occupational safety and health in working environment (Geneva)	Prevent accidents and injury to health by minimizing hazards in the working environment.	Broadly applicable to the project activities under the project. Compliance is attached in the ESIA to ensure health and safety to workers through prevention of accidental risks. Appropriate mitigation and protective measures shall be included in the ESMP.
Occupational Health Services (Geneva)	To promote a safe and healthy working environment.	Broadly applicable to the project activities under the project. Compliance to this will be adopted as there will be involvement of both skilled and unskilled manpower. Appropriate mitigation and protective measures shall be included in the ESMP.
Bonn Convention	Conservation of migratory species of wild animals.	Broadly applicable to the migratory birds in and around the project influence area. Project activities are not likely to have any significant impacts on these species; precautionary measures have nonetheless shall be included in ESMP.
Civil liability on transport of dangerous goods (Geneva)	Safe methods for transport of dangerous goods by road, railway and inland vessels.	Broadly applicable to transportation of substances such as fuels during the project construction phase. Appropriate mitigation measures shall be included in the ESMP.
UN Framework convention on climate change (Rio de Janeiro)	Regulation of greenhouse gases emissions (GHGs).	The study will take due care of the convention as the intervention area is located within climate vulnerable zone. Appropriate mitigation and protective measures shall be included in the ESMP to minimize emissions of GHGs.
Convention on Biological Diversity (Rio de Janeiro)	Conservation of bio-diversity, sustainable use of its components and access to genetic Resources.	The ESIA will be prepared addressing conservation of biological species as these are subject to be affected by the project intervention. Appropriate mitigation and protective measures shall include in the ESMP for the conservation of biodiversity.
International Convention on Climate Changes (Kyoto Protocol)	International treaty on climate change and emission of greenhouse gases.	The ESIA will be prepared with due note to the Kyoto Protocol as the project interventions are in the climate vulnerable area. Appropriate mitigation and protective measures shall be

Treaty or Convention	Brief Description	Project Compliance
		included in the ESMP to minimize emissions of GHGs.

2.6. WORLD BANK SAFEGUARD POLICIES

2.6.1. Overview of OPs and Guidelines

The main purposes of the Bank's safeguard policies are to (i) avoid harm to the environment and affected people and provide affected people an opportunity to participate in the development process; (ii) improve project design and performance; and (iii) protect the reputation of the Bank. The current set of safeguard policies cover a broad range of topics from environmental assessment to natural habitats, forests, resettlement, and Indigenous Peoples and others. The policies are the reflection of international conventions and internationally accepted principles of good practice in project preparation and implementation precisely presents World Bank Safeguard Policies and their applicability to the Project.

Table 10. World Bank Safeguard Policies and Their Applicability to the Project

OP Number	Brief Description	Project Compliance
OP 4.01 - Environmental Assessment	The World Bank requires an Environmental Assessment (EA) for all projects proposed for Bank financing to ensure that these projects are environmentally sound and sustainable. The proposed Cargo and Passenger terminals project is classified Category A because of the scope of the expected impacts from dredging operation, river training, vessel shelter construction and operation, the impacts of land acquisition, and the expected impacts on the natural environment. The launch terminals project can be categorized as B due to the lesser size of environmental impacts.	Triggered. ESIA shall be prepared considering A Category project as per OP 4.01.
OP 4.04 - Natural Habitats	There are no designated conservation areas or nature reserves in the project area. However, OP 4.04 does apply since the intervention area covers major navigation routes including lower Meghan and part of estuary which consists of natural char lands in the active Meghan floodplain, with typical floodplain habitats and breeding grounds that might be affected by the project.	Triggered. The ESIA report shall be prepared in consideration of all ecological sensitive areas.
OP 4.10 Indigenous People	For purposes of this Policy, the term 'Indigenous Peoples' is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:[1] self-identification as members of a distinct indigenous cultural group and recognition of this identity by others; collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories; customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and an indigenous language, often different from the official language of the country or region. The OP defines the process to be followed if the project affects the indigenous people.	Not triggered. The site visit assessment of the Project indicates that there are no indigenous communities residing in the project influence area and therefore, no impacts on them are expected under the project. This has been confirmed in the selected reach where operation will be carried out under the proposed project. Therefore, this OP is not triggered.

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

OP Number	Brief Description	Project Compliance
OP 4.11 Physical Cultural Resources	The World Bank's general policy regarding cultural properties is to assist in their preservation, and to seek to avoid their elimination. The specific aspects of the Policy are given below.[2] The Bank normally declines to finance projects that will significantly damage non-replicable cultural property, and will assist only those projects that are sited or designed so as to prevent such damage. The Bank will assist in the protection and enhancement of cultural properties encountered in Bank-financed projects, rather than leaving that protection to chance. In some cases, the project is best relocated in order that sites and structures can be preserved, studied, and restored intact in situ. In other cases, structures can be relocated, preserved, studied, and restored on alternate sites. Often, scientific study, selective salvage, and museum preservation before destruction is all that is necessary. Most such projects should include the training and strengthening of institutions entrusted with safeguarding a nation's cultural patrimony. Such activities should be directly included in the scope of the project, rather than being postponed for some possible future action, and the costs are to be internalized in computing overall project costs. Deviations from this policy may be justified only where expected project benefits are great, and the loss of or damage to cultural property is judged by competent authorities to be unavoidable, minor, or otherwise acceptable. Specific details of the justification should be discussed in project documents. This policy pertains to any project in which the Bank is involved, irrespective of whether the Bank is itself financing the part of the project that may affect cultural property.	Triggered. A full baseline has been prepared to identify the Physical Cultural Resources (PCR) and an ESMP and RAP will be formulated to mitigate identified issues.
OP 4.12 - Involuntary Resettlement	The project will require land acquisition and resettlement for construction of terminals, vessels storm shelters and management of dredged material.	Triggered. Separate social studies including census and inventory of losses survey have been carried out and resettlement action plans (RAP) are being prepared. These aim to mitigate adverse impacts on the potential displaced people by offering adequate compensation or settlement alternatives in conformity with World Bank policies and Bangladesh law.
OP 4.36 Forests	This Policy recognizes the need to reduce deforestation and promote sustainable forest conservation and management in reducing poverty. The Bank believes that forests are very much essential for poverty reduction and sustainable development irrespective of their location in the world. The Bank assists borrowers with forest restoration activities that maintain or enhance biodiversity and ecosystem functionality. The Bank also assists borrowers with the establishment and sustainable management of environmentally appropriate, socially beneficial, and economically viable forest plantations to help meet growing demands for forest goods and services. The Bank does not finance projects that, in its opinion, would involve significant conversion or degradation of critical forest areas or related critical natural habitats. Furthermore, the Bank does not finance projects that contravene applicable international environmental agreements.	Not Triggered. There is no Forest Department designated forest within the vicinity of the proposed terminals
OP 4.09 Pest Management	Through this OP, the WB supports a strategy that promotes use of biological or environmental control methods and reduces reliance on	Not triggered

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

OP Number	Brief Description	Project Compliance
	synthetic chemical pesticides. Rural development and health sector projects have to avoid using harmful pesticides. Other pesticides can be used, but only as an element of an Integrated Pest Management Plan (IPMP) that emphasizes environmental and biological controls.	
OP 4.37 Safety of Dams	The Policy seeks to ensure that appropriate measures are taken and sufficient resources provided for the safety of dams the WB finances.	Not triggered. This OP is not relevant since the proposed Project does not involve construction of dams.
OP 7.50 Projects on International Waterways	Projects on international waterways may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections.	Triggered. This Policy is triggered since the navigation route include international waterway. However, as Bangladesh is the most downstream country of the Major river system, the proposed project is not expected to adversely change the quality or quantity of water flow to the other riparian countries.
OP 7.60 Projects in Disputed Areas	Projects in disputed areas may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the borrower and one or more neighboring countries. In order not to prejudice the position of either the Bank or the countries concerned, any dispute over an area in which a proposed project is located is dealt with at the earliest possible stage. The Bank may proceed with a project in a disputed area if the governments concerned agree that, pending the settlement of the dispute, the project proposed for country A should go forward without prejudice to the claims of country B. [3]	Not triggered. This OP is not triggered since no part of the Project influence area is located in any disputed territory.
BP 17.50 - Public Disclosure of Information	According to the Bank Policy as well as ToR obligation the EA should be made available to the public by disclosure at public libraries or other places accessible to project affected groups, including a Summary EA in the local language.	The ESIA/ESMP, SMP and RAP will be disclosed for Public by BIWTA web site. The ESIA Executive Summary will be translated in Bangla. The ESIA, EMF and Executive Summary, and its Bangla version will be placed on BIWTA website and also in relevant offices in the project influence area, and will be sent to WB InfoShop.

2.6.2. Land acquisition and resettlement

Land acquisition and resettlement issues will be taken care of following the GOB land acquisition laws and **World Bank Operational Policy 4.12,** this policy states that involuntary resettlement should be avoided. Where involuntary resettlement is unavoidable, it will be minimized and appropriate measures to mitigate adverse impacts on displaced persons (and on host communities receiving displaced persons) will be carefully planned and implemented. It also suggests paying compensation for affected land and other properties at replacement cost[4]. Sections of the Acquisition and Requisition of Immovable Property Act (ARIPA), 2017 and process of land acquisition is presented in Annex 5

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

[4] "Replacement cost" is defined as a method of valuation yielding compensation sufficient to replace assets, plus necessary transaction costs associated with asset replacement. .

2.6.2.1. World Bank Operational Policy (OP) 4.12

a. The project interventions in the first-year contract will acquire additional private lands and displace people from the existing embankment and from lands proposed for acquisition. The interventions will thus induce involuntary resettlement of persons displaced from their housing, productive resources and means of livelihoods. As per census of PAPs, communities will also lose places and establishments of their common interest. The project triggers the World Bank's OP 4.12 on Involuntary Resettlement that requires that the economic, social, and environmental risks out of involuntary resettlement are mitigated and livelihoods of the physically and economically displaced persons[5] are restored. Involuntary resettlement may cause severe long-term hardship, impoverishment, and damage unless appropriate measures are carefully planned and carried out. For these reasons, the overall objectives of the policy of involuntary resettlement are the following:

(a) Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs.

(b) Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits.

(c) Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs.

(d) Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

b. The policy requires the following measures to be taken to achieve the above objectives:

(a) The resettlement plan includes measures to ensure that the displaced persons are

i. informed about their options and rights pertaining to resettlement.

ii. consulted on, offered choices among, and provided with technically and economically feasible resettlement alternatives; and

iii. provided prompt and effective compensation at full replacement cost for losses of assets attributable directly to the project.

(b) If the impacts include physical relocation, the resettlement plan or resettlement policy framework includes measures to ensure that the displaced persons are

i. provided assistance (such as moving allowances) during relocation; and

ii. provided with residential housing, or housing sites, or, as required, agricultural sites for which a combination of productive potential, convenient relocation sites, and other factors is at least equivalent to the advantages of the old site.

(c) Where necessary to achieve the objectives of the policy, the resettlement plan also include measures to ensure that displaced persons are

[5] People who lose residential structures and relocated elsewhere are called physically displaced while people who lose their land and commercial structures are called economically displaced. Displaced persons include legal owners, squatters, tenants, lessees and sharecroppers.

i. offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living; and

ii. provided with development assistance in addition to compensation measures such as land preparation, credit facilities, training, or job opportunities.

c. The policy links implementation of resettlement plan to the implementation of the investment component of the project to ensure that displacement or restriction of access does not occur before necessary measures for resettlement are in place. Resettlement measures include provision of compensation and of other assistance required for relocation, prior to displacement, and preparation and provision of resettlement sites with adequate facilities, where required. In particular, taking of land and related assets may take place only after compensation has been paid and, where applicable, resettlement sites and moving allowances have been provided to the displaced persons.

d. The Bank policy does not bar compensation and assistance to the displaced persons under the resettlement plan in absence of their legal title to land. The non-titled rights may come from continued possession of public land where the government has not sought eviction or from customary and traditional law and usage.

2.6.2.2. Acquisition and Requisition of Immovable Property Act-2017

The principal legal instrument governing land acquisition in Bangladesh is Acquisition and Requisition of Immovable Property Act of 2017. The ARIPA 2017 requires that compensation be paid for (i) land and assets permanently acquired (including standing crops, trees, houses); and (ii) any other damages caused by such acquisition. The Act also provides for the acquisition of properties belonging to religious organizations like mosques, temples, pagodas and graveyards if they are acquired for public interest. The ARIPA, however, excluded the acquisition of properties used by the public for the purpose of religious worship, graveyards and cremation grounds. The Act stipulates certain safeguards for the landowners and provides for payment of “fair value” for the properties acquired.

The Acquisition and Requisition of Immovable Property Act, 2017 [10th July, 2017]

Section-4. Publication of preliminary notice of acquisition of immovable property:

(1) Whenever it appears to the Deputy Commissioner that any property in any locality is needed or is likely to be needed for any public purpose or in the public interest, he shall cause a notice to be published at convenient places on or near the property in the prescribed form and manner stating that the property is proposed to be acquired.

(2) In case of acquisition of immovable property for any non-governmental person or organization, whatever be the amount of the immovable property, sanction of the government must be taken before the initiation of acquisition proceeding.

(3) The Deputy Commissioner, under sub-section (1)-
(a) before the publication of notice, in the prescribed manner and form, shall record the real nature, condition and infrastructures built therein, crops and trees of the proposed immovable property in video or still picture or any other technology and thereafter prepare a report accordingly; and

(b) after the publication of notice, in the prescribed manner and form, shall prepare a joint-list of Requiring persons or organizations and persons interested.

(4) If the nature of land is changed in reality from its recent record of rights, the Deputy Commissioner, at the time of preparation of the joint list, shall decide about the change of the nature of the land.
(5)The Deputy Commissioner shall mention in the joint list, in the prescribed manner, if any house or infrastructure is built or is being built in the proposed immovable property for acquisition, in contravention of public purpose for illegal gain.

(6) The joint list prepared under sub-section 3(b) shall be affixed in the notice board of the local land office and in the convenient place of the project.

(7)The Deputy Commissioner shall not record the change of the nature of land in the joint list, if after the initiation of proceedings under sub-section 3(a), the nature of the land is changed by building houses or infrastructures in bad motive.

(8) If any person is aggrieved by the decision of the Deputy Commissioner under sub-section 7, he may file an appeal tithe Commissioner within the next 7 working days.

(9) The Commissioner, in the prescribed manner, shall hear the appeal under sub-section 8 and shall provide with the decision within next 15 working days and in case of a nationally important project, shall provide with the decision within the next 10 working days.

(10) The decision of the Commissioner under sub-section 9 shall be deemed to be final.

(11)If there is any disposal of appeal under sub-section 9 or no appeal is preferred within the prescribed period in sub-section 8, within the next 24 hours, the concerned persons shall in his own cost remove the houses or infrastructures from the proposed immovable property, otherwise the Deputy Commissioner shall take steps to evict those in accordance with the existing provisions of law.

(12) The Deputy Commissioner may, after choosing the place for nationally important project, by order, impose control over the sale of plots and building of infrastructures thereon.

(13) Generally religious places, graves or crematoriums can be taken into acquisition; Provided that, if it essential in public purpose or public interest, by relocating and rebuilding, in the own money of the Requiring persons or organizations, it may be taken into acquisition.

Explanation: The term “purpose in contravention of public interest‟ in this section means the purpose for obstructing in the implementation of the project, creating hindrance or doing anything that retards the implementation of a project or doing something to get monetary benefit by compensation.

Section-5. Objections against acquisition:

(1) Any person concerned may file an objection against the acquisition proceeding to the Deputy Commissioner within 15 working days.

(2) The Deputy Commissioner shall, speedily hear the objection filed under sub-section 1 in the presence of the appellant or an agent, after hearing all such objections and after making such further inquiry, if any, as

he thinks necessary, prepare a report within thirty working days, and in case of a nationally important project within 15 working days, following the expiry of the period specified under sub-section (1) containing his opinion on the objections.

(3) The Deputy Commissioner-
(a) if the property exceeds 50 [fifty] standard bighas (or 16.5 acre) of land, submit the record of the proceedings held by him, together with his opinion, for the decision of the Ministry of Land; and (b) if the property does not exceed 50 [fifty] standard bighas (or 16.5 acre) of land, submit the record of the proceedings held by him, together with his opinion, for the decision of the Commissioner:
Provided that if no objection is raised within the period specified in sub-section (1), the Deputy Commissioner shall, instead of submitting the records of the proceedings to the Divisional Commissioner, make a decision within ten days of the expiry of the aforesaid period, or within such further period but not exceeding thirty days, as the Divisional Commissioner permits on the request of the Deputy Commissioner in writing] and in case of a national important project within 15 days, about the acquisition of the property and such decision of the Deputy Commissioner shall be final

Section-6. Final decision regarding acquisition:

(1) Under section 5(3), after considering the report of the Deputy Commissioner, as the case may be-
(a) The government shall, not exceeding 60 days after the submission of the report, and
(b) within 15 days of the submission of the report of the Commissioner or recording the report of delay within not exceeding30 days-shall take final decision.

(2) When the Government, the Divisional Commissioner or the Deputy Commissioner, as the case may be, makes a decision for acquisition of the property under sub-section (1) of this section or section 5(3), as the case may be, such decision shall be conclusive evidence that the property is needed for a public purpose or in the public interest.

Section 7. Notice to persons interested:
(1) When the Government, the Divisional Commissioner or the Deputy Commissioner, as the case may be, has made a decision for acquisition of any property under section 5 or the proviso to section 6, as the case may be, the Deputy Commissioner shall cause public notice to be given in the prescribed manner at convenient places on or near such property stating that the Deputy Commissioner, has decided to acquire the property and intends to take possession thereof.

(2) Such notice shall state the particulars of the property to be acquired and taken possession of, and shall require all persons interested in the property to appear personally or by agent before the Deputy Commissioner at a time, fifteen days after the date of publication of the notice or in case of a nationally important project after 7 days, and such notice shall also contain the time and place to be present and state the nature of their respective interests in the property and the amount and particulars of their claims to compensation for such interests.

(3) The Deputy Commissioner shall also serve notice to the same effect in the prescribed form on the occupier, if any, of such property and on all persons known or believed to be interested therein.

(4) The Deputy Commissioner may also, by notice, require any such person to make or deliver to him at a time, not being earlier than fifteen days after the date of service of the notice, and place mentioned therein a statement containing, so far as may be practicable, the name of every other person possessing any

interest in the property or any part thereof as co-sharer, mortgagee or otherwise, and of the nature of such interest and profits, if any, received or receivable on account thereof.

(5) Every person required to make or deliver a statement under this section shall be deemed to be legally bound to do so within the meaning of sections 175 and 176 of the Penal Code (XLV of 1860).

Section-8. Award of compensation by Deputy Commissioner:
(1) On the date so fixed, or on any other date to which the enquiry has been adjourned, the Deputy Commissioner shall proceed to enquire into the statement, if any, which any person has made pursuant to a notice given under section 7 and into the value of the property at the date of the publication of the notice under section 4, and into the respective interests of the persons claiming the compensation and shall make an award of
(a) the compensation which, in his opinion, shall be allowed for the property; and
(b) the apportionment of the said compensation among all the persons known or believed to be interested in the property, of whom, or of whose claims, he has information from the latest record of the proposed mouza for acquisition.
(2) The award made by the Deputy Commissioner shall, except as hereinafter provided, be final.

(3) The Deputy Commissioner shall, within seven days from the date of making award of compensation,-
(a) give notice of his award to the person interested;
(b) send the estimate of the award of compensation to the Requiring persons or organizations.

(4) The Requiring persons or organization shall pay the estimated amount within 120 working days after receiving the estimation under sub-section 3 to the Deputy Commissioner.

(5) within 30 working days of the publication of notice under section 7 or in case of a national important project 15working days the preparation of the estimated amount of the award of compensation shall be complete.

Section-9. Matters to be considered in determining compensation:
(1) In determining the amount of compensation to be awarded for any property to be acquired under this Part, the Deputy Commissioner shall take into consideration-

(a) the market value of the property at the date of publication of the notice under section 4: Provided that in determining such market value, the Deputy Commissioner shall take into account the average value, to be calculated in the prescribed manner, of the properties of similar description and with similar advantages in the vicinity during the twelve months preceding the date of publication of the notice under section 4;

(b) the damage that may be sustained by the person interested, by reason of the taking of any standing crops or trees which may be on the property at the time of the making of the joint list;

(c) the damage that may be sustained by the person interested by reason of severing such property from his other property;
(d) the damage that may be sustained by the person interested by reason of the acquisition injuriously affecting his other properties, movable or immovable, in any other manner, or his earnings; and

(e) if in consequence of the acquisition of the property, the person interested is likely to be compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change.

(2) While the government is acquiring land, it shall provide the persons interested with compensation of 200 per centum of the market price as defined in sub-section 1(a):Provided that if the government acquires the land for any non-government person then the amount of compensation shall be 300 per centum.

(3) In cases of injuries made under sub-section 1(b), (c), (d) and (e), additional 100 per centum compensation shall be provided.

(4) Notwithstanding any compensation provided under this section, necessary steps may be taken to rehabilitate evicted persons due to acquisition in the prescribed form.

Section-10. Matters not to be considered in determining compensation:

In determining the amount of compensation to be awarded for any property to be acquired under this Part, the Deputy Commissioner shall not take into consideration-
(a) the degree of urgency which has led to the acquisition.

(b) any disinclination of the person interested to part with the property to be acquired.

(c) any damage that may be sustained by him which, if caused by a private person, would not render such person liable to a suit;

(d) any damage which is likely to be caused to the property to be acquired, after the date of service of notice under section 7, by or in consequence of the use to which it will be put;

(e) any increase to the value of the property to be acquired likely to accrue from the use to which it will be put after the publication of notice under section 7; or(f) any alteration or improvement in, or disposal of, the property to be acquired, made or effected without the sanction of the Deputy Commissioner after the date of publication of the notice under section 4.

Section-11. Payment of compensation:

(1) On making of an award under section 8, before taking possession of the property, after the submission of the estimated amount of compensation by the Requiring persons, the Deputy Commissioner shall pay the aforesaid compensation within not exceeding 60 days from the date of deposit by the Requiring persons under sub-section 2.

(2) If the persons entitled to compensation do not consent to receive it, or if there be no person competent to receive the compensation, or if there be any dispute as to the title to receive the compensation or as to the apportionment of it, the Deputy Commissioner shall keep the amount of the compensation in a deposit account in the Public Account of the Republic which shall be deemed payment for the purpose of taking over possession of the property without any prejudice to the claim of the parties to be determined by the Arbitrator: Provided that any person admitted to be interested may receive such payment under protest as to the sufficiency of the amount: Provided further that no person who has received the amount otherwise than under protest shall be entitled to make any application under section 30.

(3)The Deputy Commissioner shall, realizing the compensation from the recipient, who may have received the whole or any part of the compensation awarded under this Part, take measures to give to pay the same to the person lawfully entitled thereto.

Section-12. Payment of compensation to bargadar (Sharecroppers):

Notwithstanding anything contained in this Act, when the property acquired under this Part contains standing crops cultivated by bargadar, such portion of the compensation as may be determined by the Deputy Commissioner for the crops shall be paid to the bargadar.
Explanation. In this section "bargadar" means a person who under the system generally known as adhi, barga or bhag cultivates the land of another person on condition of delivering a share of produce of such land to that person.

Section-13. Acquisition and possession:

(1) When the compensation mentioned in the award has been paid or is deemed to have been paid in pursuance of section 11, the property shall stand acquired and vest absolutely in the Government free from all encumbrances, and the Deputy Commissioner shall thereupon take possession of the property.

(2) Immediately after the acquisition of the property under sub-section (1), a declaration by the Deputy Commissioner in the prescribed form to that effect shall be published in the official Gazette

Section-15. Acquisition of part of a house or buildings:

1) an acquisition cannot be made if the owner desires that the whole of such house, manufactory or building should be so acquired: Provided that the owner may, at any time, before the Deputy Commissioner has made his award under section 8, by notice in writing withdraw or modify his expressed desire that the whole of such house, manufactory or building should be so acquired.

(2) If any question arises as to whether any property proposed to be taken under this Part does or does not form part of a house, manufactory or building within the meaning of this section, the decision of the Deputy Commissioner shall be final.

Bangladesh Labor Act and It's application

Bangladesh Labor Act 2006 and *Amendment 2013, National Occupational Health and Safety (OHS) Policy 2013* that illustrate rights and responsibilities of employers and workers, conditions of employment, child and force labor issues. This section describes about OHS requirements, requirement related to communicable diseases especially COVID-19. The principles and procedures presented below represent minimum requirements, but are not an exhaustive list of requirements.

As specified in the Labor Act and ESS 2 of WB ESF, the employment of project workers will be based on the principles of non-discrimination and equal opportunity. There will be no discrimination with respect to any aspects of the employment relationship, such as recruitment, compensation, working conditions and terms of employment, access to training, promotion or termination of employment. The following measures will be developed by the contractors and monitored by PIU to ensure fair treatment of all employees:

- As per Labor Code requirements, recruitment procedures will be transparent, public and non-discriminatory with respect to ethnicity, religion, disability, gender, and other grounds included in the Labor Code
- Applications for employment will be considered in accordance with the application procedures

established by the Contractor

- Labor will be preferentially recruited from the local areas
- The contracted workers will not pay any hiring fees. If any hiring fees are to be incurred, these will be paid by the Contractor
- The labor contracts will be developed in *Bangla* so as to be understandable by all workers
- In addition to written documentation, an oral explanation of conditions and terms of employment will be provided to workers who may have difficulties with understanding the documentation
- While communicating with women workers, it is to be ensured that they understand their rights and process of raising issues and grievances related to their employment
- PIU will include in contracts that no forced or child labor would be allowed

The health and safety procedure illustrated in the Labor Acts, WB Environmental and Health Safety Guidelines (EHSG), (General including Construction and Decommissioning), Bank's labor influx guideline of December 2016 (2nd para).,ESS 2, Communicable Diseases (Prevention, Control and Eradication) Act 2018 as well as guidelines to address COVID-19 issues will be referenced all activities under the Project. PIU is expected to carry out field visits and inspections of the construction from time to time. However, the WBG's EHSG (General Guidelines and for Construction and Decommissioning) may not have sufficient details and specific requirements to deal with various occupational health and safety issues posed by the project, thus the PIU should put in place specific standards meeting Good International and Industry Practices (GIIP) in the bidding documents and contracts reflecting appropriate level of risk.

PIU will include into the bidding documents specific OHS standard requirements that all contractors will meet under this project. The standards will be consistent with local regulations, WBG EHS guidelines, COVID-19 Protocols and GIIP. The following OHS standard requirements should be borne in mind:

- Risk Assessment Procedure;
- Work permitting for hazardous work (working at heights, hot work, work on energized lines, work within confined spaces);
- Rules for life threatening works;
- Emergency response procedure;
- Fall prevention and working at heights;
- Excavations safety, Ladders and scaffolding safety; welding and cutting safety; Cranes, Derricks, and forklifts safety; power and hand tools safety;
- Respiratory prevention to chemical and airborne hazards (including dust, silica and asbestos); Electrical safety (hazardous energies control, safe distance work, wiring and design protection, grounding, circuit protection, arc fault protection, PPE etc.); hazards communication; Noise and vibration safety; Steel erection safety; fire safety; material handling safety; concrete and masonry safety;
- PPE and other protective gear including training on usage;

Contractors will provide a safe workplace, therefore a risk assessment will be completed before the commencement of any construction activities, and safety measures will be implemented in accordance with applicable safety standards. PPEs and other preventive measures will be provided at no cost to employees. Periodic OHS meetings will be conducted to discuss preventive measures, deviations and non-compliances, accidents and corrective actions. Contractors will conduct internal OHS surveys and audits to verify compliance of OHS practices.

Non-compliances will be documented and reported internally. A time frame for a corrective action will be set and followed up. Daily OHS briefings will be conducted before the commencement of the works highlighting the hazards and preventive measures from each job, especially those related to COVID-19 outbreak. Contractors will

document and report to PIU all accidents and illness, especially symptoms of COVID-19, fatalities or serious injuries that may happen at work site. There must be on site resources for first aid and for more serious injuries there must be a pre-approved health facility for medical treatment, as well as appropriate transportation of injured/sick/symptomatic workers. Contractors will control the access to the construction site only to authorized people and verify if workers are meeting training and capacity requirements to carry out their jobs. All workers must complete at minimum an OHS induction to have access to the construction site.

PIU will arrange periodic supervision of Contractor's OHS performance, including site visits, at least monthly. These supervisions will cover compliance with above mentioned standards, accidents, violations of rules, recommendations, and progress of ongoing corrective actions.

PIU will inform WB promptly about any incident or accident related to the project which has, or is likely to have a significant adverse effect on the environment, the affected communities, the public or workers (labor, health and safety, or security incident, accident or circumstance) as soon as reasonably practicable. Such events can include COVID-19 cases and symptoms, labor protests, serious worker injuries or fatalities, project-caused injuries to community members or property damage.

The Contractor will develop and implement Code of Conduct (CoC). The CoC will reflect the Contractors' core values and overall working culture, provisions relating to GBV/SEA, waste management and disease prevention, work ethics and special illustration on COVID-19 protocols. CoCs will have to be understood and signed by all workers. The content of the CoCs will be included in the Standard Bidding Documents (SBD).

The Contractor will be required to provide the periodic information on the performance in terms of labor and OHS issues. The information will be included in the Contractor's monthly report and will be reviewed by PIU.

2.6.2.3. Social Safeguards Policy Compliance

Legal framework on land acquisition in Bangladesh is only compensatory and lacks any measures for livelihood restoration and social inclusion of the affected persons. It covers only the legal title holders and does not recognize the non-titled persons like squatters/encroachers, informal tenants of acquired lands and leaseholders without legally constituted agreement. The legal framework does not deal with social and economic consequences of land acquisition or population displacement due to vacating project sites for civil works construction. Under legal framework compensation for assets is provided at market price determined through legal procedure which does not ensure replacement value (RV) of the property acquired.

Apart from the compensation for the lost assets, the vulnerable group will be brought under ILRP and provided special assistance with training on IGA and seed grant. Besides, they will be eligible for preferential employment in the civil works. Grievance redress mechanism has been formulated to address claims/grievances of the affected people, laborers, procurement, SEA/SH/GBV, etc.

Payment of compensation is conclusive for dispossession of the acquired property. Relocation and livelihood restoration rest solely with the affected persons receiving compensation. As a result, land acquisition potentially diminishes productive base of farm families and imposes risks of impoverishment of those affected and displaced by the project.

Following are the specific shortfall of the legal framework in Bangladesh with respect to the WB OP 4.12:

- The affected persons including landowners are not informed about their options and rights pertaining to resettlement.
- They are not consulted on, offered choices among, and provided with technically and economically feasible resettlement alternatives.

- They are not provided prompt and effective compensation at full replacement cost for losses of assets attributable directly to the project.
- Any physical relocation is not assisted and supported with residential housing, or housing sites, or, as required, agricultural sites equivalent to the advantages of the acquired sites.
- The affected persons are not offered support after displacement, for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living.
- The affected persons are not provided with development assistance other than compensation such as assistance for land preparation, credit facilities, training, or job opportunities.
- No efforts are taken for ensuring socially inclusive design and implementation of project interventions.
- The embankment settlers are not covered under the land acquisition law and hence evicted without any assistance.

2.6.2.4. Project's Social Management and Resettlement Policy

Since ARIPA, 2017 falls short of the requirements of the WB safeguard policies, the project has been developed following the ARIPA, 2017 and in compliance with the WB's social safeguard requirements including OP 4.12. The ARIPA, 2017 will be the instrument to legalize land acquisition for the project, and the WB OP 4.12 will be the basis to implement impact mitigation measures. The project resettlement policy has also been benefited from the experience in the resettlement of similar other projects within BIWTA and other infrastructure agencies of the GoB.

2.6.2.5. Policy Principles

BIWTA will undertake land acquisition process ahead of the award of civil works contracts to facilitate DCs to complete land acquisition for respective Terminals (expected at Ashuganj site only) before the start of civil works construction. BIWTA will prepare land acquisition plans (LAPs) for the same and submit to concerned DC office for processing with prior consultation with the landowners. In case of delay of land acquisition, an informal agreement is supposed to be documented with the potential land owners that civil works construction will continue pending compensation payment but compensation will be paid to all legal owners without dispute on titles within six months of signing the agreement.

Compensation funds will be placed with the DCs for payment and the payment process will be coordinated to ensure timely disbursement to the land owners. Crops and trees owners will be eligible for compensation and benefits for the affected trees and crops as per ARIPA 2017.

In addition to the above, BIWTA will use the following principles to minimize adverse impacts on affected persons and their community:

- Avoid or minimize acquisition of private lands and use as much public land as possible;
- Avoid or minimize displacement of people from homesteads, land valued higher in terms of productivity and uses, buildings/structures that are used for permanent business and/or commercial activities, dislocation of squatters/encroachers; and impacts on community facilities, such as educational institutions, places of worship, cemeteries, etc., and buildings/structures that are socially and historically important.
- Where the portion of a plot remaining after acquisition becomes economically unviable, the landowner will have the option to offer the entire plot for acquisition.
- Avoid or minimize adverse impacts on Indigenous Peoples.

2.6.2.6. Impact Mitigation Principles

Where adverse impacts are found unavoidable, BIWTA will plan to mitigate them in accordance with the following principles:

- Compensation for acquired land will be paid at replacement cost ahead of civil construction is started.
- Compensation and other benefits for the affected trees and crops will be assessed at current market price and paid directly by BIWTA with assistance from RAP Implementing Agency.
- The absence of legal titles in cases of public land users will not be considered a bar to resettlement and rehabilitation assistance, especially for the socio-economically vulnerable groups.
- Vulnerability, in terms of socio-economic characteristics of the PAPs/ households, will be identified and mitigated according to the provisions in the RAP.
- Crops owners will be allowed to harvest the crops if it is near or at harvesting stage.
- Trees owners will be allowed to fell and take away the trees free of cost.
- BIWTA will undertake the following measures in consultation with the concerned communities and design supervision consultant:
- Plan and implement the construction works in a manner to avoid/minimize inconvenience and disruption to the embankment/road users, and to business/trading activities where applicable.
- Ensure payment of benefits to the sharecroppers and lessees of land if they are even socially recognized
- Where the project activities cause community-wide impacts affecting community facilities, access to common property resources, etc., BIWTA will rebuild them with project finance or provide alternatives in consultation with the user communities.

2.6.2.7. Eligibility of Cut-Off Dates

Eligibility to receive compensation and resettlement assistance will be limited by cut-off date (COD). The cut-off date for payment of cash compensation under law (CCL) by DC office is considered for those identified on the project location/ right of way land proposed for acquisition at the time of service of notice under section 4 or joint verification by DCs whichever is earlier (legal COD). The social cut off dates were declared during consultation meetings at each of the six terminals.

The commencement date of the census and IOL survey will be considered as “cut-off” date for eligibility for any non-titled persons such as squatters/encroachers or other informal settlers living in the project right of way or similar designated date by BIWTA (social COD).

Any persons moving into the project area after the cut-off dates will not be entitled to have compensation by DCs or any assistance from BIWTA. However, any displaced persons (PAPs) not covered in the enumerations before the CODs can be enlisted with sufficient proof and approval from the GRCs. In case, land acquisition and RAP implementation delays more than a year, BIWTA will adopt revised CODs for the applicable Terminals.

Details of the legal and policy issues to be followed in this project will be discussed in the Resettlement Action Plan.

2.6.3. World Bank EHS Guidelines

Table 11. World Bank Environmental, Health and Safety Guidelines and Project Compliance

Guidelines	Description	Project relevancy
Environmental Health and Safety Guidelines	The Environment, Health, and Safety (EHS) Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities or project by existing technology at reasonable costs.	These Guidelines will be applicable to the Project particularly with respect to air emissions, ambient air and noise quality standards, waste water quality, hazardous material and waste management, and occupational and community health and safety management.
Environmental, Health, and Safety Guidelines PORTS, HARBORS, and TERMINALS	Technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document, which provides guidance to users on common EHS issues potentially applicable to all industry sectors. For complex projects, use of multiple industry-sector guidelines may be necessary. The EHS Guidelines for Ports, Harbors, and Terminals are applicable to commercial ports, harbors, and terminals for cargo and passengers transfer. Shipping (including repair and maintenance of ships), fuel terminals, or railways are addressed in separate industry sector EHS Guidelines, specifically the EHS Guidelines for Shipping, Crude Oil and Petroleum Product Storage, Railways, respectively.	Relevant as the project includes provision of improved navigation routes and terminal facilities. ESMP section of the ESIA report shall be dedicated to mitigate adverse impact due to the proposed intervention.
The EHS Guidelines for Shipping	The EHS Guidelines for Shipping include information relevant to the operation and maintenance of ships used for the transport of bulk cargo, and goods. Cargo handling, vessel maintenance, and other in-port activities are covered under the EHS Guidelines for Ports and Harbors while issues specific to the transfer and storage of bulk fuels are covered in the EHS Guidelines for Crude Oil and Petroleum Product Terminals.	Broadly applicable as the project provides improved navigation routes and terminal facilities. The ESMP shall be prepared to address mitigation measures due to proposed interventions.

2.6.4. Compliance Status with Bangladesh Legislation and World Bank Policies

The present compliance status of the project with Bangladesh legislation and World Bank safeguard policies is indicated in the Table 12.

Table 12. Compliance of Project with GoB Legislation and World Bank Safeguard Policies

	Legislation/Policy	Actions Taken to Comply
GoB requirements	Environmental Conservation Act	BIWTA will submit the ESIA report of Component 2 works to DOE for environmental clearance
	International treaties	Verification of protected sites, Red List and protection of vulnerable habitats in all environmental screenings and assessments under the project. Inclusion of relevant mitigation measures in each ESMP for each subproject/activity.
	Public information and disclosure	The draft ESIA, ESMP reports have been disclosed on BIWTA's website. Public consultations meetings were held site specifically to disclose the project information and ESIA and to solicit stakeholder feedback.
World Bank requirements	OP 4.12 Participatory approach	Key informant interviews, participatory rural appraisals, consultation meetings and focus group discussions were held between October 2019 and January 2020.
	OP 4.01 Integrate environmental and	Natural environment, public health, and social aspects are integrated in planning documents.
	OP 4.04 Natural Habitats	Verification of protected sites and ecosystems, Red List and endangered flora and fauna has been done for all proposed activities.
	OP 4.01 Risk assessment	Health and safety risks for population and workers are identified in the ESIA and BIWTA EMF, and management measures will be included in tender documents. BIWTA's capacity will also be strengthened on health and safety risk management.
	OP 4.01 Climate Change and floods	Impact of climate change effects are assessed and design of infrastructure facilities (river terminals, landing stations, vessel shelters) will consider climate change adaptation in the designs
	OP 4.01 Cumulative Impacts	Cumulative impact assessment has been conducted as part of the ESIA to cover the impacts from all components of the Project and other related developments in the Project area.
	OP 4.01 Alternatives	Alternatives considered included: "without project" case in the ESIA for terminals

	Legislation/Policy	Actions Taken to Comply
World Bank requirements	OP 4.01: Pollution	Baseline survey of environmental quality has been carried out. Environmental standards of GoB and World Bank will be complied. Environmental Code of Practices (ECoPs) will be included in contractors' bidding documents of all subprojects.
	OP 4.11 Physical Cultural Resources	No physical cultural resources which warrant special treatment under the World Bank OP 4.11 were identified in the project impact area. Chance find procedures will be included in bidding documents.
	OP 4.01 Social impacts	For negative social impacts on land/assets/livelihood/access to resources etc. mitigation plans will be prepared in keeping with the Bank's Operational policies triggered.
	OP 4.01 OP 4.20 Gender	Gender consultations, including women only consultation meetings, were carried out during social assessment. Female friendly aspects will be incorporated into designs for river terminals and landings.
	OP 4.01 Public Health	Public health aspects were studied, and public health impacts are covered in ESIA and EMF
	OP 4.01 OP 4.12 Consultation and access to information	The ESIA, EMF and RPF have been disclosed in country (on BIWTA website and hard copies will be made available in locally accessible locations in the project area, including BIWTA offices at the existing terminals) and also sent to WB Info Shop. Public consultations were held at every of the 6 project sites in October 2019. Further planned public consultations, including a second national level workshop, are expected.
	OP 4.01 Labor Influx Management (including child labor, etc.)	A labor management procedure has been developed as a standalone document to guide the contractor to prepare labor management plan during project implementation. Bangladesh Labor Act 2006 (amendment 2013) and World Bank's labor influx guideline of December 2016 (2nd para) will be applicable.
	OP 4.12 Disadvantaged or vulnerable groups	Resettlement Action Plan for the affected people including vulnerable groups has been developed following the GoB law and World Bank OP 4.12. Vulnerable people will be provided additional support with training on IGA, seed money, and preferential employment opportunity in the civil works. World Bank Directive of August 2016 on risks and impacts of disadvantaged or vulnerable individuals or groups will be applied.

2.7. ESIA APPROVAL FRAMEWORK

Department of Environment (DoE) under the Ministry of Environment and Forest (MoEF) is the sole entity to issue environmental clearance to any Governmental, Non-Governmental, or private Organization intending to develop a project or set up an industry. Environmental Impact Assessments (ESIA) should be conducted before projects are undertaken.

All existing and proposed industrial units and projects, that are low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange-A,

Orange-B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be required. A detailed description of these four categories of industries has been given in Schedule-1 of ECR'97. Apart from general requirement, for every Red category proposed industrial unit or project, the application must be accompanied with feasibility report, Initial Environmental Examination (IEE), Environmental Impact Assessment (ESIA) based on approved terms of reference (ToR) by DoE, Environmental Management Plan (ESMP). As per ECR'97, water resources development projects fall under 'Red' category project. Therefore, the project is also categorized as 'Red' which requires IEE, ESIA and ESMP for environmental clearance from DoE.

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

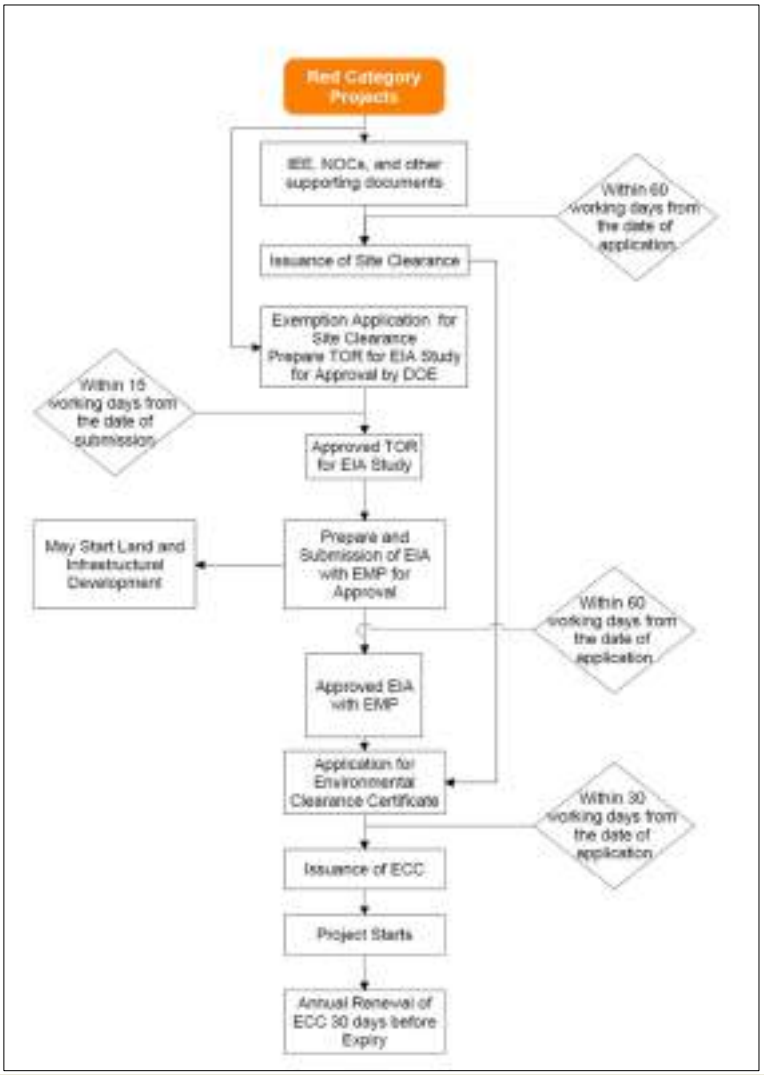


Figure 19. Steps followed by DoE for Red category projects

As part of the ECC application, a detailed ESIA with ESMP satisfactory to the doe will be prepared. The Department of Environment (DOE) may take up to sixty (60) days to approve the ESIA and thirty (30) more days to issue the environmental clearance, provided everything complies with the requirements. This may be quite a lengthy process if doe uses the full extent of the time limits.

2.7.1. Environmental Clearance Procedures

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:

- Application through prescribed form-3 under ECR 1997
- Prescribed fee under the schedule of ECR 1997 (Amended in 2002)
- Report on Feasibility of the industrial unit or project
- Initial Environmental Examination (IEE) Report or ESIA as per the Terms of Reference Provided by the DoE
- ESMP for the proposed project
- No Objection Certificates (NOC) from the Local Authorities.
- Emergency plan relating adverse environmental impact and plan for mitigation of the effect of pollution
- Outline of Relocation and rehabilitation plan
- 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 20.

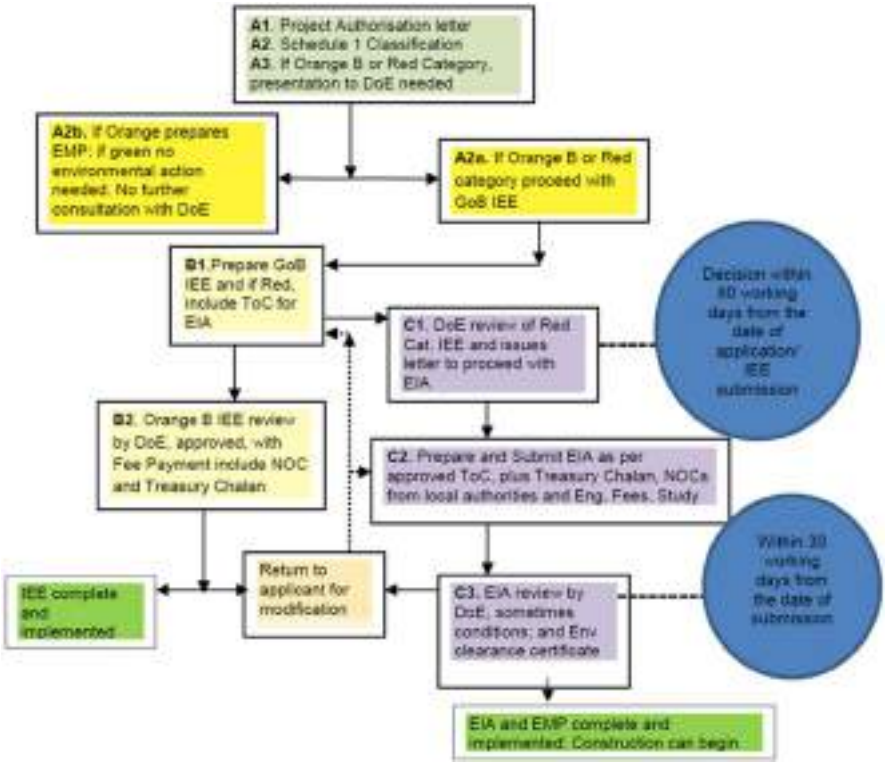


Figure 20. Government of Bangladesh Environmental Assessment Process

3. DESCRIPTION OF THE PROJECT

Main data, figures and tables within this chapter have been sourced from:

- Final Feasibility Reports for Shasanghat, Chandpur, Narayanganj, DEPTC and Barihsal IWT terminals. December 2019, prepared by Package S3 Consultant: Voyants Solutions Private Limited (VSPL), i-maritime Consultancy Private Limited (ICPL) and Unicom Intellext Limited (UIL), led by VSPL,
- Final Feasibility Reports, June, 2019, and Draft Detailed Report, October 2019, for Pangaon and Ashunganj Cargo Terminal, prepared by Package S4 Consultant: Development Design Consultants Ltd, Bangladesh Joint Venture with Ramboll Denmark A/S, (Denmark) and STUP Consultants Private Limited (India) – DRS JV.

Other sources of data, tables, and figures different for those are also included and its source shown.

3.1. INTRODUCTION AND BACKGROUND

Bangladesh Inland Water Transport Authority (BIWTA) is the sole authority of the inland water transport network in Bangladesh. BIWTA is also responsible for the development, operation and maintenance of inland water transport network of the country.

Bangladesh is a land of rivers covered by the Bengal Delta, the largest delta on the Earth. The country has 700 rivers and 8,046 kilometers (5,000 miles) of inland waterway of which only about 5,968 kilometers are navigable by mechanized vessels during monsoon. The waterway shrinks to about 3,900 kilometers during dry period. The Inland Water Transport (IWT) sector carries about 50 percent of all arterial freight traffic and one quarter of all passenger traffic. Bangladesh has three seaports and 22 river ports. All these seaports and 22 river ports are contributing to the county's economy significantly through transportation of goods & passengers. There are about 22,300 registered vessels belonging to dry cargo vessels, barges, tankers, double bottom vessels etc. In addition to the registered vessels, there are about 750,000 country boats of different shapes and sizes. The carriers play an important role in transporting goods and passengers particularly in rural areas.

3.2. ANALYSIS OF ALTERNATIVES

3.2.1. No-action alternative

The definition of the no action alternative for newly proposed development seems clear, no action for a new proposed development, considers what would happen if the new development is not implemented.

A no action alternative for an ongoing infrastructure considers what would happen if the infrastructure continued to operate without modifications.

Both assessment of no action options should be based on current baseline conditions.

No-action option is a case that BRWTP S3 package and BRWTP S4 package Projects will not be implemented. In terms of BRWTP-1 program means that these sub-components will never be implemented.

Therefore, objectives of component- 2 of BRWTP-1 program will never be achieved, at least by the implementation of upgrading and new proposal of these identified terminals, owned by BIWTA:

- New cargo terminal at Pangaon site
- Upgrading existing cargo terminal at Ashunganj
- New passenger terminal at Shasanghat site

- Upgrading existing passenger terminal at Barishal, Chandpur, and Narayanganj.

Therefore, the scenario of no-action under environmental and social impact alternative assessment is:

- For Pangaon site and Shasanghat site is a case of new development.
- For Ashunganj, Barishal, Narayanganj and Chandpur is a case of continuing operation of existing infrastructure without improvement.

3.2.1.1. No-Action scenario vs. Project implementation assessment.

Currently in most terminals there is a Lack of proper wastes management. Presently there are no facilities at the terminals for collection of liquid waste from the ships. The ships usually dispose these wastes in the river. Drainage for rainwater/liquid waste or wastewater don´t exist or are under minimum requirement. Some presently impacts related to water and soil contamination in the port environment are: leakage and spillage of cargo storages including fuels, waste disposal sites and accidents. The waste generated from ships mainly include inert materials such as food packaging, and food waste. Solid waste is being collected by the ships and are being dumped into the municipal dust bins located near the terminals.

During operations of terminals, the sources of air pollution are the combustion emissions from the vessels. Land-based operations of the cargo terminals will also generate emissions from vehicles and equipment.

Noise sources in port operations include cargo handling, vehicular traffic, and loading / unloading containers and ships.Important to note that for a proper comparison between no action alternative and project implementation alternative the assessment must be done for the operational scenario for the existing terminals. Considering that negative/positive effects during construction period of the project can´t be compare to the current operation condition of existing terminals.

Table 13 presents a comparison of environmental and social factors for the no-action and project implemented options.

No-action scenario is based on existing environmental impacts, while terminals up-gradation project´s impacts are a summary of major likely impacts for upgradation of existing passenger and cargo terminals. Table 13 refers for existing terminals: Narayanganj, Barishal, Chandpur and Ashunganj.

Table 13. Comparison of Environmental and Social Impacts of No-action vs Implemented Options

Environmental factor	No-Action option. Baseline conditions to Project forecast 2040	Project implementation option
Air quality	• Deteriorated by the dust and toxic gas generated from land-based operations and traffic.	• Tank and piping leak detection and repair programs could be implemented • Regularly sweeping docks and handling areas
Noise	• Noise sources in terminal operations include vehicular traffic, cargo handling, and loading / unloading containers and ships.	Upgradation and harmonization of terminal layout may decrease noise emission

Environmental factor	No-Action option. Baseline conditions to Project forecast 2040	Project implementation option
Water quality, ground water, soil and biological environment	• Discharges of untreated wastewater from terminal operations, storm water discharge, discharges of waste, runoff from roads which carries contaminated soil and soot particles. Debris thrown overboard from ships. • Spillage, leakage and accidents, equipment failure or operating procedures, arising either directly from vessels, fuel oil and lubricants, or from their cargoes. • Wastewater releases from ships are covered under a separate section.	• Establishment of containment basins in areas with a high risk of accidental releases of oil or hazardous materials (e.g. fueling or fuel transfer locations), and oil / grit or oil / water separators in all runoff collection areas. Oil / water separators and trapping catch basins would be maintained regularly to keep them operational. • Recovered contaminated solids or liquids disposed of as hazardous materials. • Fuel dispensing equipment should be equipped with "breakaway" hose connections that provide emergency shutdown of flow.
Terminals and ships waste	• Liquid effluents associated with ships are sewage, bilge water (e.g. from oil tankers), and vessel cleaning wastewater from ships. • Ship sewage and wastewater contains high levels of BOD and Coliform bacteria, with trace concentrations of constituents such as pharmaceuticals, and typically low pH levels. • Wash water may contain residues such as oil. Pollutants in bilge water contain elevated levels of BOD, COD, dissolved solids, oil, and other chemicals that accumulate as the result of routine operations	• Reception facilities establishment for collection of wastes from ships. • Dust bins and recycling or chemical toilets in the terminal building and on the ships..
Climate change	• Greenhouse gases such as carbon dioxide are be released, from terminal operations.	Greenhouse gases such as carbon dioxide still released, from terminal operations. Efficiency of new

Environmental factor	No-Action option. Baseline conditions to Project forecast 2040	Project implementation option
		terminals and operations may decrease Greenhouse gases.
Health and safety	• Physical hazards associated with cargo handling and use of associated machinery and vehicles. • Port workers can be exposed to chemical hazards especially if their work entails direct contact with fuels or chemicals or depending on the nature of bulk and packaged products transferred in port activities. • Work with fuels may present a risk of exposure to volatile organic compounds (VOC) via inhalation or skin contact during normal use or in the case of spills. • Fuels, flammable liquid cargo, and flammable dust may also present a risk of fire and explosions. • Exposure to dust from handling of dry cargo and from roads. • Noise from cargo handling, including vehicular traffic, and loading / unloading containers and ships.	• Establishment of Safety Management System. • This safety system could include procedures to regulate the safe movement of vessels within the harbor, protect the general public from dangers arising from marine activities at the harbor. • Prevent events that may result in injury to workers, the public, or the environment. • Comprehensive emergency preparedness and response plans.
Land acquisition and subsequent resettlement,	• People are dealing in on private land (at Ashuganj) and GoB (mainly BIWTA) land in all six terminals and leading livelihood • Other agencies land (RHD and Bangladesh Railway) is being used by the businessmen over the decades for their livelihood	• Ashuganj is a business hub. Land Acquisition is taking place at Ashuganj site. Land price is too high there due to scarcity of land for business. • Displacement of business and housing premises at six locations will have temporary impact on their standard of living.
Loss of Livelihoods,	All of the affected businessmen enlisted during census and IOL survey were found on the BIWTA or others land. They have been dealing	Implementation of the project will temporarily affect their means of livelihood. Necessary mitigation measures including compensation,

Environmental factor	No-Action option. Baseline conditions to Project forecast 2040	Project implementation option
	in at the terminals without major disturbances. They lead their families by the business or employment /wage.	assistance, employment opportunity and relocation facilities can restore their livelihood.
Inconvenience and nuisance during construction,	During the present situation the terminal users do not experience major incoveniences since they are habituated witht the regular activities of the terminals.	During construction of the terminals, the users will face inconveniences and nuisance if necessary mitigation measures are not adequately taken. Necessary lighting, signals, safety and security measures can reduce inconveniences during construction.
Loss of access to CPRs	Four CPRs (Two Mosques and two Madrasahs) are affected at Chandpur site out of these, the mosque is the the terminal for the terminal users. The Madrasahs are beside the approach road and partially affected (not required displacement). The mosque will need to be relocated.	Due to the project interventions, the local people especially terminal users will face troubles to go to the mosque until a new mosque is built elsewhere. But the new mosque should have easy accessibility by the terminal users. The Madrasah students and teachers will experience inconveniences during construction of the approach road.
Likely increase in transport costs	Now the passengers and Cargo terminal usners are paying fares & Taxes at the GOB rate which is accepted by the users.	Development of the terminals (cargo and Passenger) under the project at an international standard will generate additional tax/levies/fares on the terminal users which will eventually increase the transport cost of the people.

New passenger terminal; Shasanghat.

The Shasanghat proposed site which belongs to BIWTA is currently used / occupied for Sand storage business This Sand storage business and the laborers working on the same will be directly affected due to development of IWT Terminal. Environmental conditions are at present very bad. Air, noise, soils, water are under low level of quality due to negative effects derived from human activities. No vegetation or habitats can be found, severe impacts are currently ongoing affecting soils, river margin and surface water.

It is, therefore, expected that the construction of a new terminal can improve environmental conditions at the site just by removing and relocating the current high pollutant activity and introducing to the new terminal, water drainage management, waste water management, spills dumps and debris control, between others.

New cargo terminal Pangaon

Area identified for the proposed Terminal facility is presently a green field site / vacant land. Although some vegetation can be found and the terminal area will be developed partially on water pound expected impacts could be characterize as low. Vegetation and fauna habitats doesn´t have ecological significance, species of flora and fauna are common and largely distributed around the region. The Project implementation scenario even it will not preserve current conditions does not imply high level of environmental impact, while there are some significant expected socio-economic positive effects.

Social impacts

Most likely negative impacts related to S3 and S4 packages are the loss of little to insignificance amount of private owned land, mostly are Government owned lands. A few business enterprises, small and medium sizes and some Chital business will affect. No major impacts on living & livelihood of the people under the project is expected. Laborers working in different business enterprises particularly employed in the Chital business may have some impact temporarily.

The other occupational groups such as boat & other land transport owners/operators are expected to continue their activities even during construction, being will not disrupt travelling of the passengers to different destinations using the existing ferry ghats.

It is expected that the establishment of Safety Management System will regulate the safe movement of vessels within the harbor, protect the general public from dangers arising from marine activities at the harbor and prevent events that may result in injury to workers, the public, or the environment. Gender issues could also be integrated within new terminals.

3.2.1.2. Conclusions

No-action alternative does not imply the preservation of natural values, positive environmental quality or social and economic high, even medium, standards. Project implementation is, therefore, an acceptable alternative in terms of environment and social issue.

3.2.2. Assessment of proposed alternatives

Proposed Alternatives for passenger terminals and cargo terminals are now assessed. Alternatives considered are those proposed in the feasibility studies for Passenger and cargo terminals. Description of the proposed alternative is done in following section of this Chapter. Layout of alternatives are collected in Annex 2 for reference.

3.2.2.1. Passenger terminals

Layout of landside development and requirements

For every terminal two options were proposed for landside development: option 1 and option 2. Option was the preferred option in all terminals proposal and is described in the section related to Description of the project. Option 2 for the four different passenger terminals is collected in Annex 2.

Footprint of both options, option 1 and 2, are developed in the same area proposed and at the same available land, therefore, no distinction in regards of surface affected. Additionally, both options meet the fix requirements in terms of same breakdown of areas and facilities.

As a result, for every site the two options will have similar effects on environment and social factor: same place and same requirements implies very similar or even same likely impacts. Thus, other than environmental and social factor must determine the alternative selection for landside development.

Waterside development

Alternative proposal for water side development is based on IWT facility requirements, planning considerations, site-specific conditions and challenges. Feasibility study for passenger terminals (s3 package) developed six (6) alternative concept a multi-criteria-matrix (MCM) analysis was carried out for selection of best layouts.

Main differences between the said 6 alternatives related to environmental issue and with significance impact are based on the berthing system developed.

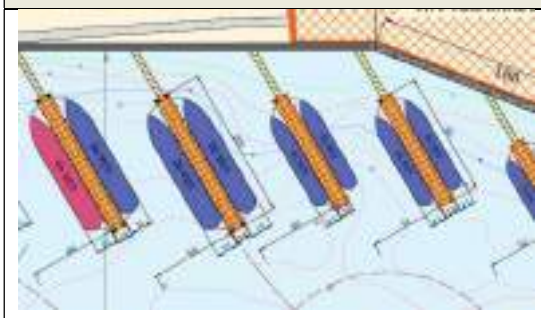
These 6 alternatives for water side were developed for all four passenger terminals under study: Shasanghat, Narayanganj, Barishal and Chandpur with the same concept design.

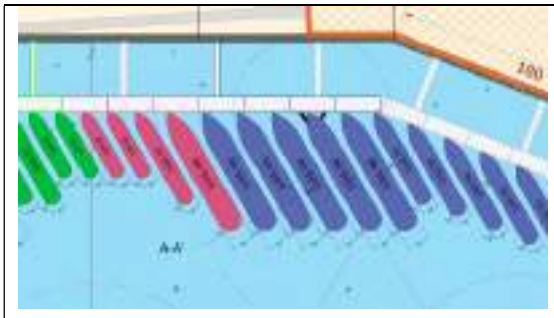
The 6 layout alternatives are:

- 1: Finger Pier Berthing Arrangement (with Pontoons acting as Berths)
- 2: RCC Pile Deck Finger Pier Berthing
- 3: Bow Berthing Arrangement
- 4: Guided Berthing Arrangement with Donut Fenders
- 5: Parallel Berthing
- 6: Staggered Berthing Arrangement

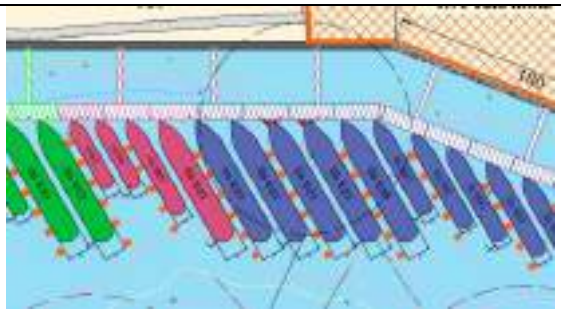
Alternative layouts are presented in Figure 21 (Shasanghat terminal site is shown for example):

Figure 21. Waterside alternatives layout proposed for Passenger terminal (alternatives 1 to 6)

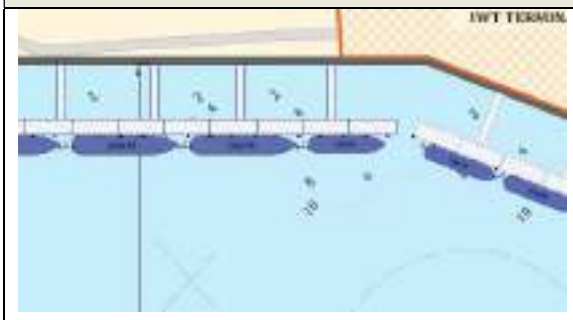
1: Finger Pier Berthing Arrangement (with Pontoons acting as Berths)	2: RCC Pile Deck Finger Pier Berthing
	
3: Bow Berthing Arrangement	4: Guided Berthing Arrangement with Donut Fenders



5: Parallel Berthing



6: Staggered Berthing Arrangement



Finger Pier berthing arrangement (alternative 1), bow berthing arrangement (alternative 3) and parallel berthing (alternative 5), consists of pontoons and linkspan system, steel pontoon is envisaged as the berthing structure. The water side and land side integration shall be made through installation of steel Linkspan (gangway) arrangement.

For finger pier arrangement, berthing system will be oriented perpendicular (with an inclination of about 600) to the shoreline, thereby enabling a twin-berthing of vessels i.e. vessels can be berthed on both sides. For bow berthing parallel berthing pontoons are placed parallel to the shoreline and vessel berthing will be on vessel bow, perpendicular to pontoon berth, for parallel berthing pontoons and vessel are placed in parallel.

Bow berthing scenario (alternative 3) is being followed currently in the Passenger IWT system in Bangladesh.

Regarding alternative 2, the notable element in this alternative is, instead of pontoon acting as berth (as mentioned in alternative-1,3 and 5), a berth will be constructed with a superstructure (Beam / Slab) and sub-Structure (pile foundation) made of Reinforced Cement Concrete (RCC).

The Staggered berthing facility, alternative 6, is provided using RCC pile deck oriented parallel to shoreline in staggered form, vessels are oriented parallel to shoreline in Staggered.

For optimization of length required for berthing facility or to reduce the size of piers and for ideal berthing of vessels Alternative 4 is designed on doughnut fenders with guide piles acting as breasting dolphins providing five (5) m spacing between vessels.

Based on the MCM analysis carried out in the feasibility study, alternative layout no.-1 Pontoon based Finger Pier Berthing Arrangement, and alternative layout no.-5 with Pontoon based Parallel-Alongside Berthing Arrangement is recommended for implementation. Also, considering the existing operational model which is derived based on market forces, S3 consultant has kept the provision of Alternative-3 (Bow- Berthing). Thus, the following alternative layout were kept for further evaluation:

- 1: Finger Pier Berthing Arrangement (with Pontoons acting as Berths)
- 3: Bow Berthing Arrangement
- 5: Parallel Berthing

Environmental and social impact assessment for the 6 alternatives considers main likely impact for each one expressed on air, water, soils and aquatic ecology. Regarding Social aspects all alternatives shown similar characteristics, therefore any of them will reach the same level of impact on socio-economic environment.

Table 14 shows Impact Alternative assessment for proposed alternatives. Environmental factors a place in rows and alternatives in columns. Score of impact significance is expressed in values where 1 corresponds to low negative effects, 2 corresponds to medium negative effects, and 3 corresponds to high negative effects.

Table 14. Environmental and social assessment matrix for alternative proposed waterside development. Passenger terminal.

	Alternative layouts proposed for waterside development					
Environmental factor	**1: Finger Pier Berthing Arrangement**	**2: RCC Pile Deck Finger Pier Berthing**	**3: Bow Berthing Arrangement**	**4: Guided Berthing Arrangement with Donut Fenders**	**5: Parallel Berthing**	**6: Staggered Berthing Arrangement**
Air quality	1	2	1	1	1	2
Water quality	1	2	1	2	1	2
Soils and sediments	1	3	1	2	1	2
Biological environment	1	2	1	1	1	2
Total	4	9	4	6	4	8

The discussion of the environmental best alternative deals on berthing system proposed and its capacity to impact aquatic ecosystem during construction and on the likely disruption of riverbank by permanent construction: piling, RCC deck or mooring dolphins.

From the environmental point of view, berthing system of pontoons and linkspan are better than RCC deck or staggered berthing (alternative 2 and 6) due to its less impact on river sediment, water quality and riverbank, while alternative 4 scores worse due to the construction of breasting dolphins who will modify the riverbank and water shoreline permanently.

Conclusions

Thus, the following alternative layout shows lesser Environmental impact and should be were kept for further evaluation:

- 1: Finger Pier Berthing Arrangement (with Pontoons acting as Berths)
- 3: Bow Berthing Arrangement
- 5: Parallel Berthing

3.2.2.2. Cargo Terminals

Pangaon Cargo terminal

A total of five preliminary layout proposals are presented in the feasibility study for the future cargo terminal in Pangaon, which are summarized below.

Alternative A . RFP requirements, 2 berths, 190 m

Configuration of berths in layout Alternative A follows the RFP requirements where the quay structure is a 190 m long pile supported concrete deck with two berths. The platform, width of 25 m, is connected to the terminal area by 2 two-lane jetty bridges, one in the southern end and one in the northern end.

Three warehouses are proposed to be located in the terminal as arriving cargo are limited by only two berths.

Considering the SLWL for Pangaon of +0.26 m MSL and the design vessel draught of 3.66 m, it is highly recommended that the berths are placed where the water depth is minimum 4.0 m relative to MSL to ensure a sufficient under-keel clearance for the vessels. The quayside is therefore located to respect the -4.0 m MSL contour line in the river such that the largest vessels are able to call the port during dry season.

As berths must be parallel to the river flow, the entire quay structure will have to be moved away from the river bank in order to respect the shallow waters to the north. The consequence of placing berths closer to the river bank will be significant initial and maintenance dredging to ensure a sufficient under-keel clearance for the large vessels. The presented layout is expected to reduce operational expenditures considerably.

Alternative B1 . 4 Fixed berths Aligned with ICT 364 m

For this alternative, the quay structure is constructed as a 364 m long pile supported concrete deck which yields 4 berths for LOA = 82.5 m ships. Following the construction principle from Alternative A, the width of the concrete platform is 25 m.

This layout alternative is included to show the consequence of aligning future quay structure in Pangaon with the existing ICT quay.

The terminal will contain 4 warehouses (approx. 7200 m2). An area of approx. 5400 m2 is allocated to silos with the purpose of storing and bagging food grains. Food grain silos and fertilizer warehouses will be connected to the apron by conveyor systems.

Alignment of the future quay will lead to shallow waters when approaching the port as well as shallow waters by the berths. Since the port is to be operated also during dry season, significant initial and maintenance dredging will be required.

Alternative B2 . 4 Fixed berths Optimum depth 364 m

Similar to layout Alternative B1. The only difference between the layouts is the location of the concrete platform. Considerations regarding water depths and structures are the same as previously described.

For this layout alternative, the concrete platform is located further from the river bank such that the quay front respects the -4.0 m MSL contour and provides sufficient under-keel clearance for the largest vessels all year around. Extent of initial and maintenance dredging is thereby expected to be minimized.

Alternative C . 4 Pontoons Optimum Depth

Layout Alternative C consists of 4 separate floating pontoon berths connected to land by gangways. Due to the tremendous water level variations during a year in Pangaon, the level of the pontoons can potentially vary up to 7 m in a year. The connecting gangways therefore need to be flexible structures capable of adapting to this and at the same time be robust enough to sustain loads from light service vehicles and cargo on conveyors.

Considerations regarding vessel under-keel clearance is the same as for the two other alternatives, and a minimum water depth for the vessels of 4 m relative to MSL is proposed.

Besides considering the under-keel clearance for the vessels, it must also be ensured that pontoons remain floating all year around including dry season. If the pontoon is grounded some days during the dry season, it can potentially move back and forth on the riverbed and be damaged from rocks and other sharp objects. This can result in considerable maintenance costs and even replacement of the pontoon in the long term. Also, the slope of the riverbank can lead to only a part of the pontoon being grounded while the more offshore part is still floating. This will tilt the pontoon and disable port operations leading to less throughput. Pontoons should therefore also be located at an acceptable distance from the riverbank.

The entire pontoon is proposed to be located at a water depth of minimum 2.5 m relative to MSL such that an under-keel clearance of minimum 0.5 m is ensured for the pontoon. The pontoon is then expected to stay afloat all year around without being damaged. It is initially assumed that the pontoon will have a draught of approx. 2 m.

Configuration of warehouses and silos are similar to Alternative B1 and B2 however, port operations are quite different. Conveyors are installed on each of the gangways connecting the floating piers to the terminal.

Alternative D . Lagoon solution

The main purpose of preparing Alternative D is to investigate the possibility of constructing a lagoon behind the terminal area.

Considering the vicinity of the existing ICT, the most rational configuration of a lagoon will include an entrance in the upstream part of the project site. The lagoon entrance limits the quay length to 267 m on the river side and yields 3 berths for LOA = 82.5 m vessels. A slightly smaller berth of approx. 65 m could be located in the entrance of the lagoon. A fixed quay structure is proposed for this layout alternative similar to Alternative A, B1 and B2, where a concrete platform is supported by piles.

The lagoon solution could provide bow to quay berthing for smaller vessels inside the lagoon.

The quay structure on the river side is proposed to be a pile supported concrete platform with a design similar to Alternative A, B1 and B2. Following the same requirements regarding water depth and dredging, the quay front is located to respect the -4.0 m MSL contour line.

To allow for safe vessel maneuvering and at the same time keep as much terminal area as possible, a lagoon width of 62 m is proposed as well as a turning area with a diameter of 80 m. Similar to the maneuvering areas in the river, the entrance channel and the lagoon will need a water depth of -4.0 m MSL to ensure vessel under-keel clearance.

The proposed dimensions of the lagoon will require significant dredging and excavation of the project area.

In order to obtain enough storing facilities for imported cargo, land acquisition and subsequent land reclamation of the adjacent homestead area is necessary. This land acquisition will provide space for warehouses and silos.

Besides the land acquisition, construction of the lagoon will necessitate demolition of the existing embankment/dyke currently protecting the areas around the pond against flooding. Tearing down the existing embankment would therefore require construction of a new embankment to provide flood protection for residential areas in the village.

It is clear from the above that a lagoon will have significant adverse environmental and social impact on the local community.

Evaluation and Recommendation of Layout Alternative

All Layout Alternatives for Pangaon are compared and evaluated based on operational conditions, navigational conditions, expenditures and structural considerations. This is carried out by in the feasibility study arranging all alternatives in two matrices.

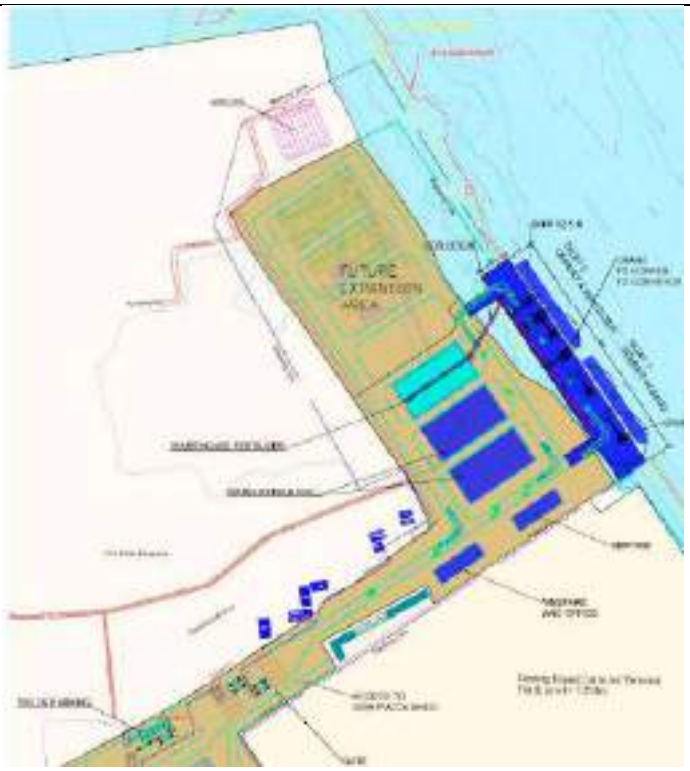
One matrix will provide an illustrative and simple weighted comparison of the layout alternative while the other matrix contains a Multi Criteria Analysis (MCA). The MCA is provided with scores on various weighted parameters for all alternatives.

From the two comparisons the following is remarked and recommended: Fixed berths are preferable, as they have the best operational functionality, have more flexible use (and thus highest capacity), are proven solutions and are most robust.

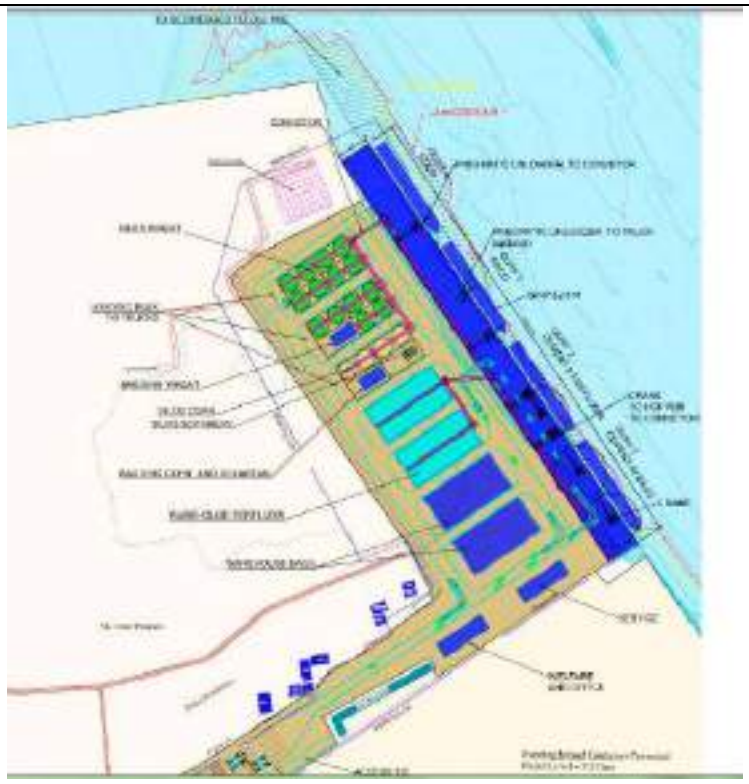
- Pontoon solutions are well-suited for variation of water levels and when using manual handling of cargo. However, there are more uncertainties with regards to reliability, more possible weak links in the operational chain, and it is a less proven solution with mechanical handling of cargo.
- Pontoon solutions are not recommended, especially not when aiming at modern and mechanized operations.
- Solutions with less impacts on hydraulic conditions are preferred, as they will also result in less maintenance
- Solutions with less impacts on social and environmental conditions are preferred

A weighted comparison and multi-criteria analysis were conducted for the five different layout alternatives at Pangaon (Table 15)

Figure 22. Sketches of proposed alternatives for Pangaon terminal

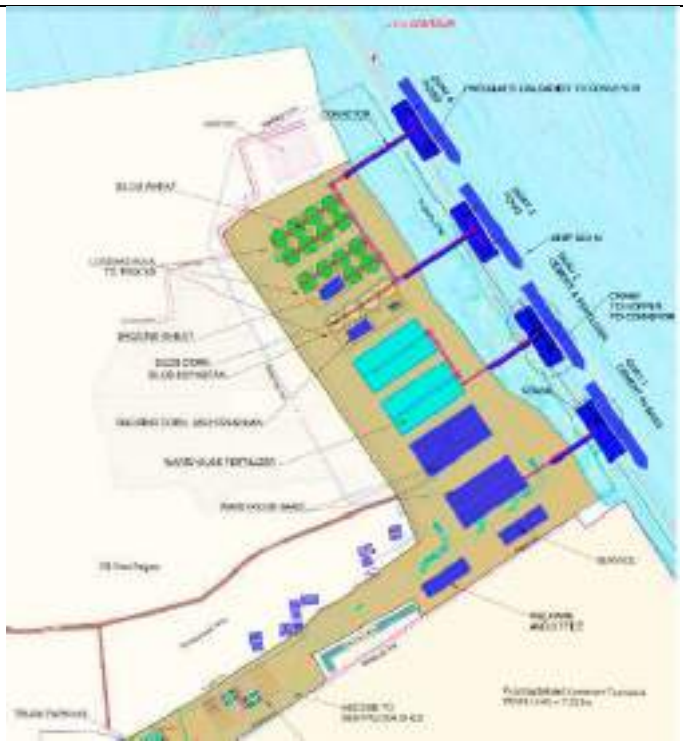


Alternative A . RFP requirements, 2 berths, 190 m



Alternative B1 . 4 Fixed berths Aligned with ICT 364 m

Alternative B2 . 4 Fixed berths Optimum depth 364 m



Alternative C . 4 Pontoons Optimum Depth

Alternative D. Lagoon Solution

Table 15. Weighted Comparison and Multi Criteria Analysis of the Five Different Layout Alternatives at Pangaon.

Only "particulars" (in rows) used in the feasibility study with repercussion on environmental and social factors are presented

	Alternative A	Alternative B1	Alternative B2	Alternative C	Alternative D
Particulars	**RFP requirements, 2 berths, 190 m**	**4 Fixed berths Aligned with ICT 364 m**	**4 Fixed berths Optimum depth 364 m**	**4 Pontoons Optimum depth**	**Lagoon solution**
Initial and Maintenance Dredging	The presence of the piles could disturb the free flow and could cause some sedimentation. However, expected to be limited.	Significant initial and maintenance dredging in approach area and berth area is expected.	The presence of the piles could disturb the free flow and could cause some sedimentation. However, expected to be limited.	Little impact on flow patterns and possible dredging costs are expected to be low	Entrance channel and harbor basin will need to be dredged and maintained. Significant dredging needed.
Respect of project boundary	Project boundary is slightly exceeded to allow for vessel under-keel clearance	Project boundary is hardly exceeded	Project boundary is slightly exceeded to allow for vessel under-keel clearance	Project boundary is slightly exceeded to allow for pontoon under-keel clearance	Project boundary is exceeded to allow for sufficient terminal area
Respecting dyke protecting the hinterland	Respecting	Respecting	Respecting	Respecting	Not Respecting

Multi Criteria Analysis of Layout Alternatives in Ashunganj.

Only Criteria for environmental and social impacts are presented. Score from 1 to 5. Maximum possible score is 5

	Alternative A	Alternative B1	Alternative B2	Alternative C	Alternative D
Environmental and social impacts					
Impacts on environment	3	3	3	3	1
Respect of protective dyke	5	5	5	5	1
Respect of project boundary	3	3	3	3	1

The multi-criteria analysis indicates, that alternatives B1 or B2 are most favorable. Alternative A has less capacity and should be considered as short-term alternative only.

Alternative D (lagoon solution) is less favorable, due to important issues such as significant exceedance of project boundaries into homestead area, non-respect of dyke protective structure – and less favorable conditions.

Considering both comparisons, the recommended solutions are Alternative B1 and B2 (Fixed continuous berths).

It was decided by the Client that the Cargo terminal Consultant should continue the feasibility study with Layout Alternative B1 for Pangaon.

Environmental and social impact assessment for the 5 alternatives (Table 16)considers main likely impacts for each one expressed on air, water, soils and aquatic ecology. Environmental factors a place in rows and alternatives in columns. Score of impact significance is expressed in values where: 1 corresponds to low negative effects, 2. corresponds to medium negative effects, and 3 corresponds to high negative effects.

Table 16. Comparison of Environmental and Social Impacts Across the Five Alternatives

	Alternative layouts proposed for Pangaon terminal				
	Alternative A	**Alternative B1**	**Alternative B2**	**Alternative C**	**Alternative D**
Environmental factor	**RFP requirements, 2 berths, 190 m**	**4 Fixed berths Aligned with ICT 364 m**	**4 Fixed berths Optimum depth 364 m**	**4 Pontoons Optimum depth**	**Lagoon solution**
Air quality	1	2	2	1	3
Water quality	1	2	2	1	3
Soils and sediments	2	1	2	1	3
Biological environment	1	2	2	1	2
Socio-economic	1	2	1	1	3
Total	6	9	9	5	14

The discussion of the environmental best alternative deals on berthing system proposed and its capacity to impact aquatic ecosystem during construction and on the likely disruption of river bank by permanent construction: piling, RCC deck or pontoon, the distance to the shoreline and he land to be taken exceeding Project boundary.

For environmental and social view, the presence of the piles for alternatives A, B1, B2 and D could disturb the free flow and could cause some sedimentation. Alternative B1 will have significant initial and maintenance dredging in approach area and berth area.

For alternative D, “The lagoon solution” will involve important earth movement and excavations and will need to be dredged and maintained frequently, therefore significant impacts could be expected on water system.

Alternative 4 shows better scoring since Berthing system of pontoons has lesser negative effects than RCC deck.

Conclusions

Thus, the following alternative layout shows lesser environmental and social impact and should be retained for further evaluation:

- Alternative A. **RFP requirements, 2 berths, 190 m**
- Alternative C. **4 Pontoons Optimum depth**

Secondly the following alternative can be further discussed, and mitigation measures should widely propose to mitigate expected impacts:

- Alternative B1: **4 Fixed berths Aligned with ICT 364**
- Alternative B2: **4 Fixed berths Optimum depth 364 m**

Ashunganj Cargo terminal

A total of six preliminary layout proposals are presented in the feasibility study for the future cargo terminal in Ashungan.

Alternative A – as per RFP Requirements (2 additional berths)

Layout Alternative A in Ashuganj follows the RFP requirements, which includes construction of a new fixed concrete berth and a new floating pontoon pier. The areas have been changed from the original RFP requirements in order to have more efficient port operations such that the concrete platform has an area of 1250 m2, and the pontoon has an area of 750 m2.

A gangway with a conveyor will connect the pontoon berth to the terminal area whereas a jetty bridge will connect the concrete platform to the terminal area.

Considering the SLWL for Ashuganj of +0.60 m MSL and the design vessel draught of 3.66 m, it is highly recommended that the berths are placed where the water depth is minimum 3.5 m relative to MSL to ensure a sufficient under-keel clearance for the vessels.

The quayside is therefore located to respect the -3.5 m MSL contour line in the river such that the largest vessels can call the port during dry season. Pontoons must stay afloat during all seasons and a minimum water depth of 2.5 m is provided by respecting the -2.5m MSL contour line.

Alternative B – Existing RCC Jetty and 4 Fixed Berths as 2 Double Berths

It is proposed to construct 4 fixed berths in Layout Alternative B. This solution requires that the existing pontoon quay and gangway is being removed such that two identical concrete double quay structures will be placed downstream and upstream of the existing concrete berth.

For this layout, 4 vessels of LOA = 82.5 m and a smaller vessel at existing concrete berth can be operated simultaneously. The two new quay structures (quay 2 and 3) are each constructed as two pile supported concrete platforms located at a water depth of 3.5 m relative to MSL. The platforms are connected to each other and to the terminal area by jetty bridges as this configuration will reduce the amount of construction materials and still provide good operational conditions.

Smaller vessels berthing at the existing concrete structure might face maneuvering difficulties when two LOA = 82.5 m vessels are berthed at quay 3 and 4 at the same time.

Existing concrete berth and the two new berths located downstream are dedicated to handle bagged cement. Four warehouses of 900 m2 each are placed in the downstream side of the terminal area and are intended to store cement bags. In order to provide sufficient space for the warehouses, some land reclamation and construction of new revetments is necessary.

Alternative D1 – Existing Berths and 3 Additional Pontoon Berths

Configuration of berths in Layout Alternative D1 involves keeping the two existing berths and establishing 3 new pontoon piers connected by gangways to the terminal.

Smaller vessels will call quay 1 & 2, and large vessels with LOA = 82.5 m are expected to call quay 3.

Considering the distance between quay 1 and 4, vessels calling quay 1 might face maneuvering challenges.

Four cement warehouses with a total area of 3,000 m2 will be in the terminal as well as a fertilizer warehouse of 1,800 m2. Several food grain silos are proposed to be constructed in the upstream part of the terminal.

Similar to Alternative B and C, the proposed layout includes land reclamation and new revetments.

Alternative D2 – Expansion of Existing Berths and 3 Additional Pontoon Berths

Alternative D2 is identical to Alternative D1 except for configuration of the existing concrete berth. In this layout, the existing concrete quay is expanded offshore to investigate if larger vessels will be able to berth this quay since this could lead to more throughput.

Having a vessel with LOA = 82.5 m berthed at both quay 4 and existing concrete quay might compromise maneuvering and berthing safety requirements. However, smaller vessels will face less maneuvering challenges for layout D2 compared to layout D1.

Alternative E - 4 Continuous Fixed Berths, Nearshore

In Layout Alternative E, a continuous quay structure of 363 m is constructed as a pile supported concrete deck located at the -3.5 m MSL contour. This quay structure will yield 4 berths for vessels with LOA = 82.5 m.

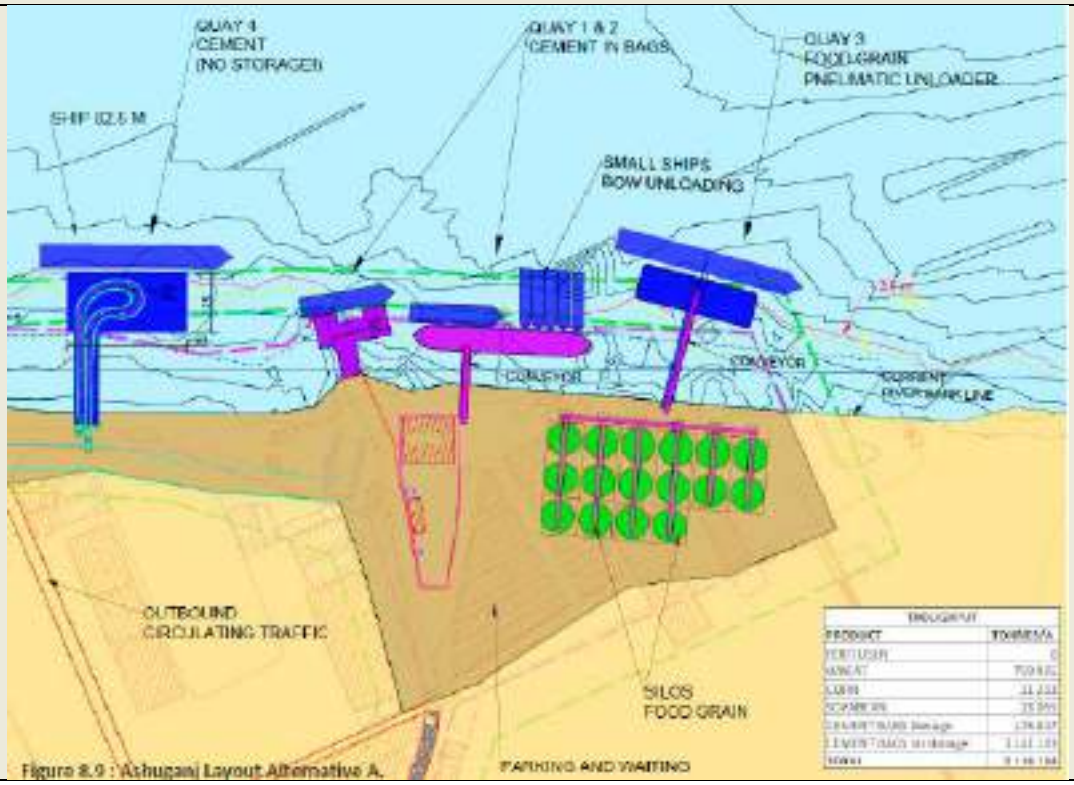
The area between the concrete deck and the existing terminal area will be reclaimed, and new revetments for the land reclamation will be constructed below the concrete deck. All storing facilities are located close to the quay. That includes 4 cement warehouses, a fertilizer warehouse and multiple silos for food grains. Conveyor systems are installed from quay 3 and 4 and to the respective storing facility.

Evaluation and Recommendation of Layout Alternative

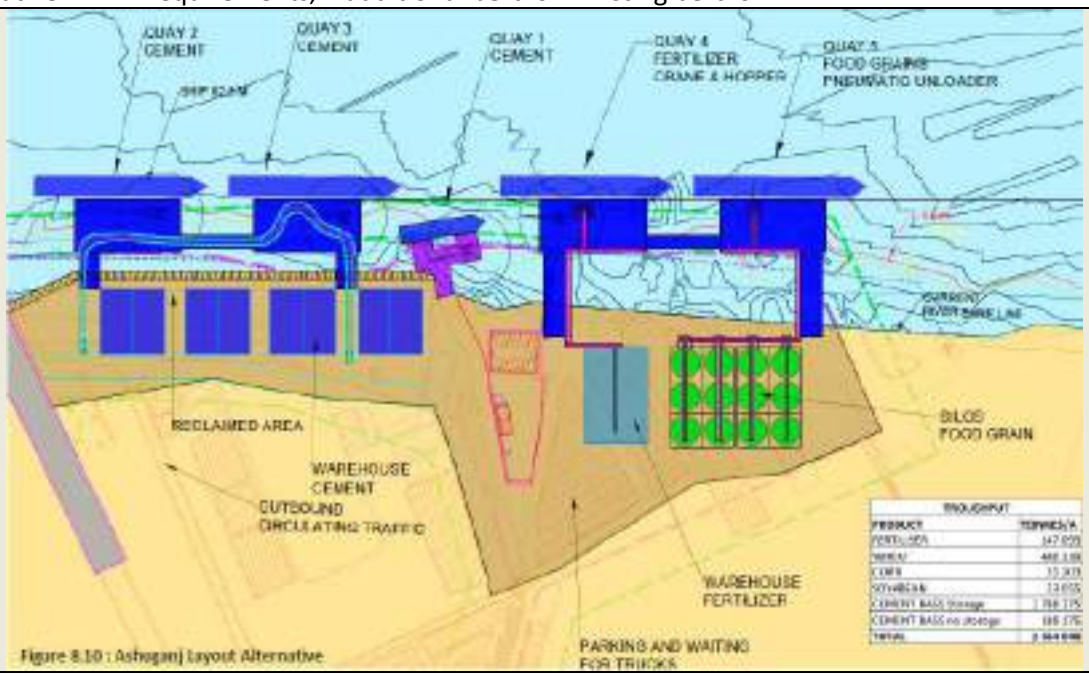
All Layout Alternatives for Ashunganj are compared and evaluated based on operational conditions, navigational conditions, expenditures and structural considerations.

This is carried out by in the feasibility study arranging all alternatives in two matrices: a weighted comparison of the layout alternative and a multi-criteria analysis (MCA) (Table 17), similar to Pangaon cargo terminal.

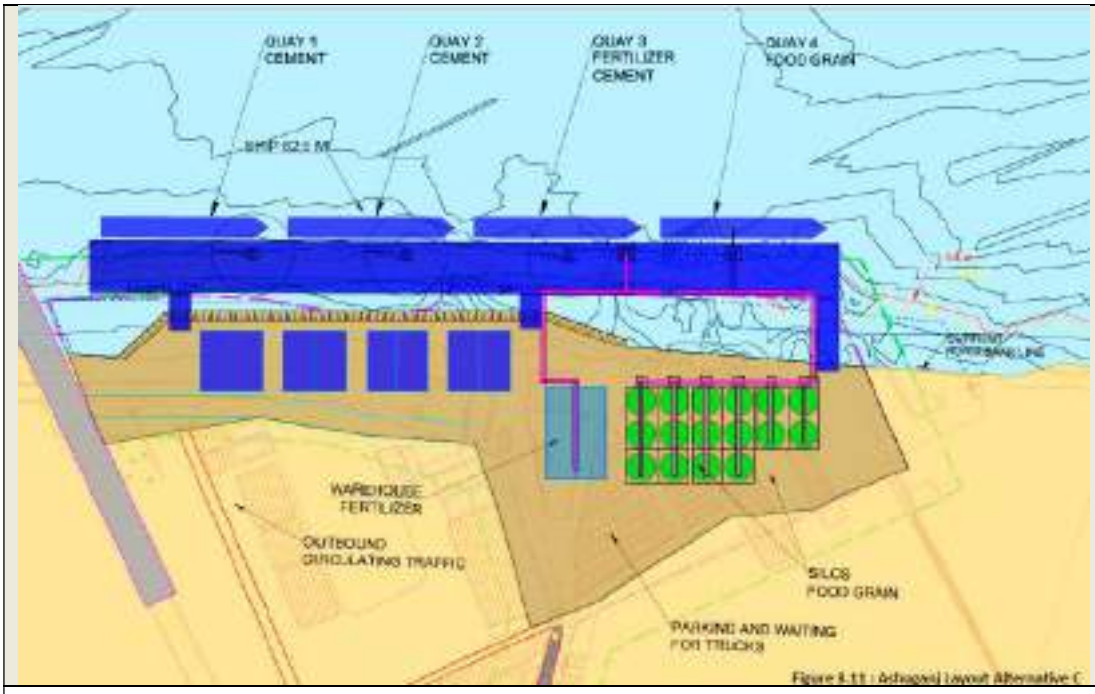
Figure 23. Figure Sketches of proposed alternatives for Ashunganj terminal



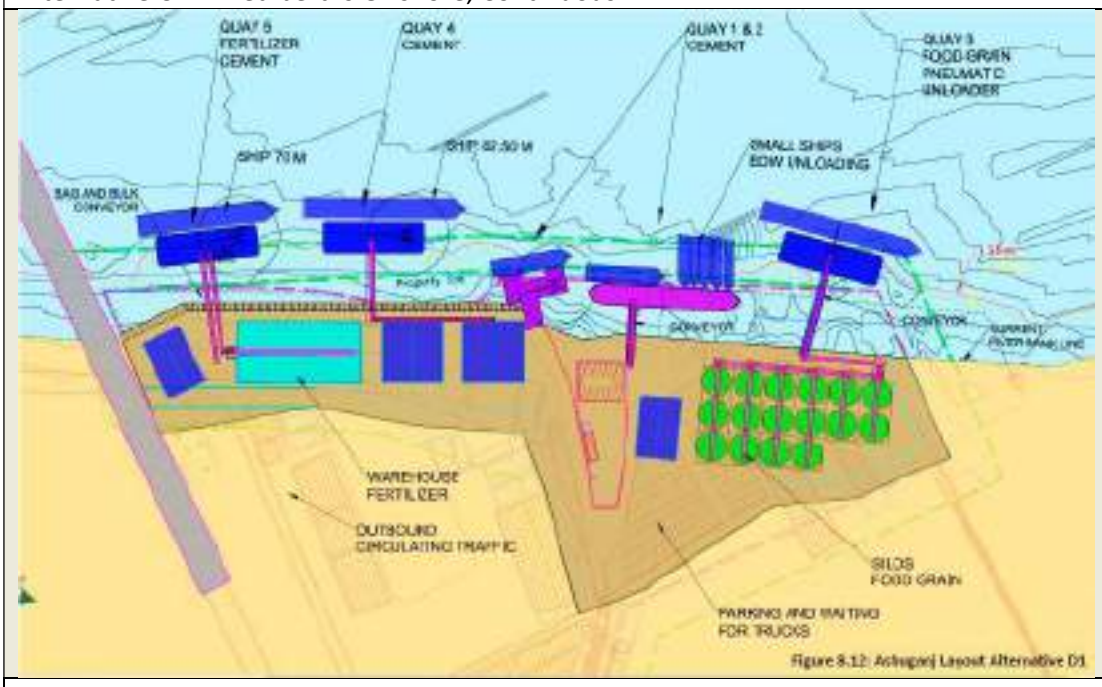
Alternative A. RFP requirements, 2 additional berths 2 Existing berths



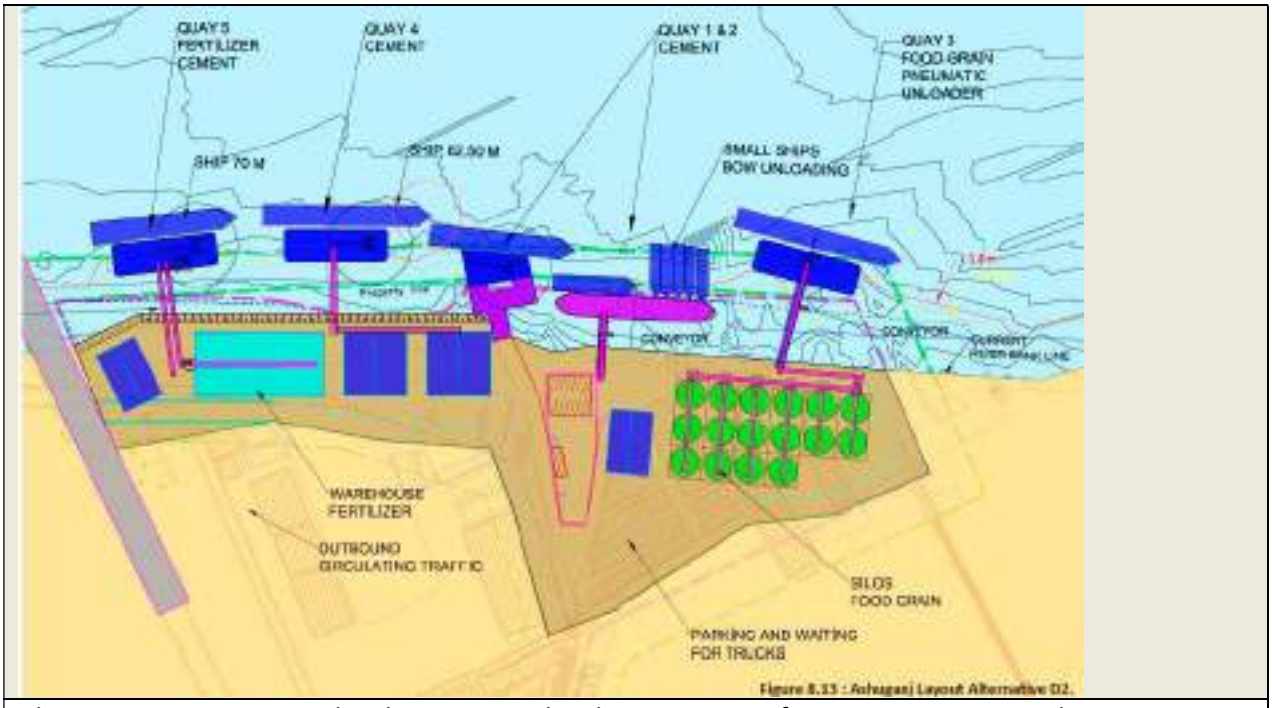
Alternative B. 4 Fixed berths 2 pairs offshore. Existing RCC Jetty



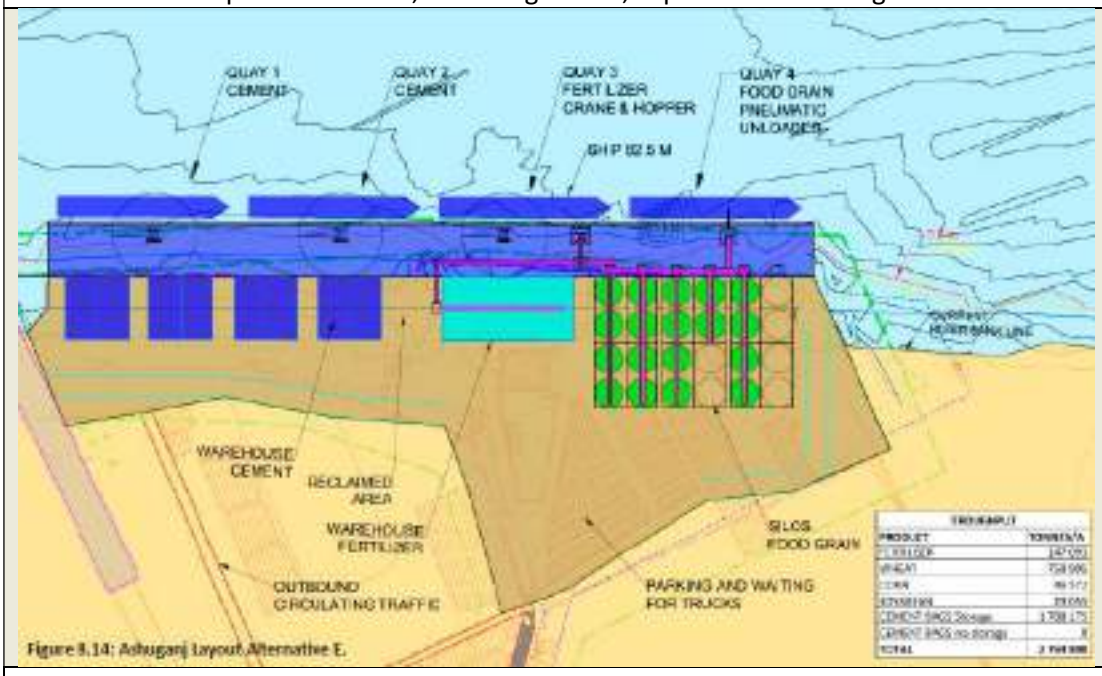
Alternative C. 4 Fixed berths Offshore, Continuous



Alternative D1. 3 pontoon berths 2 Existing berths



Alternative D2. 3 pontoon berths, 2 Existing berths, Expansion of Existing Concrete Berth



Alternative E .4 Fixed berths Attached to land, Continuous

Table 17. Weighted Comparison and Multi Criteria Analysis of the six different Layout Alternatives in Ashunganj.

Only "particulars" (in rows) used in the feasibility study with repercussion on environmental and social factors are presented

Particulars	Alternative A RFP requirements, 2 additional berths 2 Existing berths	Alternative B 4 Fixed berths 2 pairs offshore Existing RCC Jetty	Alternative C 4 Fixed berths Offshore, Continuous	Alternative D1 3 pontoon berths 2 Existing berths	Alternative D2 3 pontoon berths, 2 Existing berths, Expansion of Existing Concrete Berth	Alternative E 4 Fixed berths Attached to land, Continuous
Initial and Maintenance Dredging	The presence of the piles could disturb the free flow and could cause some sedimentation. However, expected to be limited.	The presence of the piles could disturb the free flow and could cause some sedimentation. However, expected to be limited.	The presence of the piles could disturb the free flow and could cause some sedimentation. However, expected to be limited	Little impact on flow patterns and possible dredging costs are expected to be low	Little impact on flow patterns from pontoons and possible dredging costs are expected to be low. Presence of piles in berth expansion could disturb the free flow, but disturbance will be small compared to other alternatives	The presence of the piles could disturb the free flow and could cause some sedimentation. However, expected to be limited. Could be larger impact on coastal stability.
Respect of project boundary	Project boundary is slightly exceeded to allow for vessel under-keel clearance	Project boundary is slightly exceeded to allow for vessel under-keel clearance	Project boundary is slightly exceeded to allow for vessel under-keel clearance	Project boundary is slightly exceeded to allow for pontoon under-keel clearance	Project boundary is slightly exceeded to allow for pontoon under-keel clearance and also exceeded by berth expansion	Project boundary is slightly exceeded to allow for vessel under-keel clearance

Multi Criteria Analysis of Layout Alternatives in Ashunganj.

Only Criteria for environmental and social impacts are presented. Score from 1 to 5. Maximum possible score is 5

	Alternative A	Alternative B	Alternative C	Alternatives D	Alternative E
Environmental and social impacts					
Impacts on environment	3	3	3	3	2
Respect of project boundary	4	4	4	4	4

The analysis indicates that alternatives B, C or E are most favorable.

Alternative A has less capacity and should be considered as short-term alternative only Considering both comparisons, the recommended solutions are Alternative B, C or E (Fixed continuous berths or 2 double berths).

All layout alternatives were presented to the Client on the meeting at March 6th, 2019. At this meeting, it was informed by the Client that the applied downstream project boundary would interfere with the future bridge expansion. It was however, decided by the Client that the feasibility study should be based on the concept of Layout Alternative E for Ashuganj. Future cargo terminal in Ashuganj will be developed based on the conceptual layout of Alternative E. The continuous quay structure provides a high level of functionality and is a flexible solution capable of adapting to changes in the market and daily operations. Versatility and functionality have been the main priorities in the configuration of the layouts. It is therefore accepted that the chosen solution is more costly compared to some of the other preliminary alternatives.

As was previously mentioned, the original project boundary interfered with the future expansion of the nearby Bhairab Bridge, and a new project boundary was therefore provided.

The updated project boundary has confined the available area and thereby reduced the number of berths. For the draft final proposal, all imported bulk will be bagged at the port which requires less bulk storage and more bag storage inside the terminal. Also, it has been ensured that small vessels transporting bagged cargo can be operated all year.

- Besides of the abovementioned modifications the following has been implemented in the layout:
- More open space for dry and break bulk inside the terminal;
- Port logistics and traffic layout; and
- Slight rotation of the quay to follow depth contours, obtain better slope conditions and reduce costs.

Environmental and social assessment for the 6 alternatives considers main likely impact for each one expressed on air, water, soils and aquatic ecology. Regarding Social aspects all alternatives shown similar characteristics, therefore any of them will reach the same level of impact on socio-economic environment.

Table 18 shows the assessment of environmental and social impacts for the six proposed alternatives. Environmental factors a place in rows and alternatives in columns. Score of impact significance is expressed in values where 1 corresponds to low negative effects, 2 corresponds to medium negative effects, and 3 corresponds to high negative effects.

Table 18. Environmental and social alternative assessment matrix. Ashunganj cargo terminal

Environmental factor	Alternative A RFP requirements, 2 additional berths 2 Existing berths	Alternative B 4 Fixed berths 2 pairs offshore Existing RCC Jetty	Alternative C 4 Fixed berths Offshore, Continuous	Alternative D1 3 pontoon berths 2 Existing berths	Alternative D2 3 pontoon berths, 2 Existing berths, Expansion of Existing Concrete Berth	Alternative E 4 Fixed berths Attached to land, Continuous
Air quality	1	2	2	1	1	2
Water quality	1	2	2	1	1	2
Soils and sediments	1	1	1	1	1	2
Biological environment	2	2	2	2	2	1
Socio-economic	1	1	1	1	1	1
Total	6	8	8	6	6	8

The discussion of the environmental best alternative deals on berthing system proposed and its capacity to impact aquatic ecosystem during construction and on the likely disruption of river bank by permanent construction: piling, RCC deck or pontoon, the distance to the shoreline and he land to be taken exceeding Project boundary.

For environmental and social view, the presence of the piles for alternatives A, B, C and E could disturb the free flow and could cause some sedimentation.

Alternative D1 and D2 show better scoring since Berthing system of pontoons has lesser negative effects than RCC deck.

For all alternatives project boundary is slightly exceeded on water side to allow for vessel under-keel clearance.

Conclusions

Alternatives A to D shows similar impact on environment and social factors thus, any of them show lesser Environmental impact.

- Alternative A: RFP requirements, 2 additional berths 2 Existing berths
- Alternative B: 4 Fixed berths 2 pairs offshore Existing RCC Jetty
- Alternative C: 4 Fixed berths Offshore, Continuous
- Alternative D1: 3 pontoon berths 2 Existing berths
- Alternative D2: 3 pontoon berths, 2 Existing berths, Expansion of Existing Concrete Berth

Alternative E: **4 Fixed berths Attached to land** can be further discussed, and mitigation measures should widely propose to mitigate expected impacts.

3.3. PASSENGER TRANSPORTATION

Bangladesh's network of 3,900 kilometers of inland waterways is the only mode of transport for 12 percent of country's rural communities. Carrying about 194 million tons of cargo and roughly 25 percent of all of Bangladesh's passenger traffic each year, inland waterway transport is less expensive for the poor and essential for trade among the country's biggest cites and with neighboring India and Bhutan. (Bangladesh: Improving Transport Lifelines, World Bank, 2016)

Inland water transport has always been a natural and relatively cheaper means of transport. In certain areas, it is the only mode of transport. (Banglapedia, 2020).

Inland river terminals at Dhaka, Narayanganj, Chandpur and Barishal along the Project routes play very important role in transporting and handling passenger and cargo. These four river ports together transport annually about 53 million tonnes of cargo and 22 million passengers (in 2013-2014) (BRWTP-1, Environmental Impact assessment report for component-1, May 2016).

3.4. DESCRIPTION OF EXISTING AND PROPOSED PASSENGER TERMINALS

3.4.1. Project Location

The proposed Passenger terminals will be developed in four locations. Table 19 and Figure 24 indicate the locations of each one.

Table 19. Proposed IWT Terminals with Co-ordinates

Sl. No.	Terminal Name	Latitude	Longitude
1.	Shasanghat	23°41'24.55"N	90°25'34.72"E
2.	Chandpur	23°13'59.61"N	90°38'54.65"E
3.	Narayanganj	23°36'58.86"N	90°30'20.53"E
4.	Barishal Port	22°41'59.44"N	90°22'31.39"E

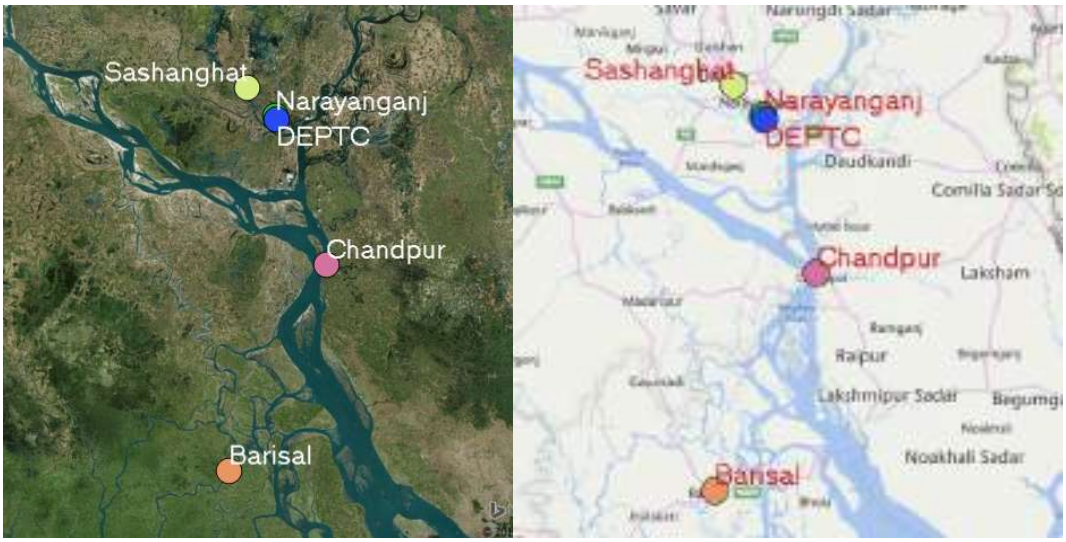


Figure 24. Location of proposed Passenger Terminals

3.4.2. IWT Terminal Facility Requirements

General requirements of Passenger Terminal designs major facilities required are:

- Link span / Gangway
- Bank Protection
- Terminal Building with all requisite facilities
- Parking yard of public and private vehicles
- Internal Roads and External Roads
- Landscaping & Green cover
- Utilities (Power, Water Supply, Drainage etc.)

3.4.3. Feasibility Study

Feasibility Study Report carry out feasibility studies on possible alternatives. Study is divided into two areas: Water side development and land side development. Regarding water side planning, different alternatives are presented, and asses based on different types of regular berthing plus idle berthing.

Passenger Terminal Package Consultants developed six (6) alternative concept layouts for the four (4) different Passenger Terminals. Further, a multi-criteria-matrix (MCM) analysis was carried out for selection of best layouts. Final Master Planning is done on the recommended alternatives.

Six alternatives are assessed using a multi-criteria analysis, using the following criteria:

- Safe Embarking and Disembarking of passengers
- Safe Berthing and deberthing of vessels
- Compliance of Berth with international Standards and Codal Provisions
- Length required for waterfront development
- Design and Operational & Maintenance Challenges of Berths and associated aspects
- Development of Quay Line /Berth in Shallow. Medium and Deep-Water Depths.
- Suitability of infrastructure for operations in peak traffic
- Mobility and adaptability for phased manner
- Capital Cost of development
- Operation and Maintenance cost
- Envisaged Restriction to Navigation Channel, Present and Future
- Durability of Infrastructure
- Ease of Construction
- Local availability of Construction materials
- Suitability of Berth at all seasons (Water Levels)
- Proven track record in the similar site conditions
- Environmental risk during construction

3.4.4. Sashangat Site

3.4.4.1. Project Location and Brief Summary

The main IWT terminal of Dhaka city is located in Sadharghat (Near to Dhaka and also called as Dhaka River Port / Terminal) and falls in the downstream of Buriganga River, on the left bank (Figure 25). The proposed Shasanghat

Terminal is a greenfield site located on left bank of Buriganga River and will be used as a satellite terminal to Sadarghat for development of passenger IWT terminal (Figure 25) mainly to relieve / relax/ divert the long-distance traffic (towards Barishal & Chandpur and other destinations). Shasanghat site geographical coordinates of 23°41'24.55"N latitude 90°25'34.72"E longitude , is about 2.5 Km (towards east) from Sadarghat.

Figure 25. Satellite Imagery showing Sadarghat &Shasanghat

Source: FFR Shasanghat IWT terminal, December 2019. Package Passenger S3 Consultant

Shasanghat can be approached via multiple roads. However, the main road approach is from two key directions.

- One via road through Sadarghat terminal which runs parallel to the river line from west to East.
- Second North side of proposed Shasanghat site i.e. from Dhaka-Mawa highway bridge.

The connecting road from Sadarghat to Shasanghat is occupied / chocked with the non-licensed markets (street hawkers) and truck parking alongside the road, thereby making the connecting road too much narrow for both passengers' walkthrough movement & vehicular movement. Adjacent to Shasanghat site, it is observed that, the steel scrap market / shops have been setup over a period and the same is found to be an illegal encroachment (majority but not all the shops). There is existing bridge crossing near the proposed terminal, clearance height has to be considered for the navigation of the vessels.

Figure 26. Passenger IWT site at Shasanghat

Source: FFR Shasanghat IWT terminal, December 2019. Package Passenger S3 Consultant

Figure 27 shows the areas of potential land for terminal development. The earmarked Land Area for proposed IWT Terminal Development at Shasanghat is about 2.4 acre (120 m x 80 m approx.). The earmarked area is under

Dhaka South City Corporation, Ward number 54. Further, adjacent (Northern Side) to the proposed site, about 2.5 to 3 acres of land is available which is owned by Bangladesh Railway and the same could be used by BIWTA if required.

Figure 27. Earmarked Land Area for proposed IWT Terminal Development at Shasanghat

Source: FFR Shasanghat IWT terminal, December 2019. Package Passenger S3 Consultant

3.4.4.2. Terminal capacity and main features

Feasibility Study carried out by the S3 Consultants (FFR Shasanghat IWT terminal, December 2019. Package Passenger S3 Consultant) established that being Shasanghat the extended facility to existing Sadarghat river port and taking into consideration planning constraints, it is considered that Shasanghat will be designed taking into consider the passenger traffic along Dhaka – Chandpur and Dhaka – Barishal (Direct routes & routes passing through Barishal for e.g. Dhaka – Borguna, Dhaka – Jholkati etc.). These routes accounts for 40% of the total Sadarghat traffic in terms of total Passenger travelled (as of 2018). It is assumed that this proportion will remain constant even in future. Thus, the Passenger traffic to be considered for Shasanghat is summarized in Table 20 with detailed passenger traffic. Table 21 indicates vessel size and seating capacity.

Table 20. Passenger Traffic Forecast Summary for the Shasanghat River Port

Source: FFR Shasanghat IWT terminal, December 2019. Voyants, I-maritime-unicom intelext

Particulars	20 Year Design Period					
	2018	2022	2027	2032	2037	2042
Sadarghat Passenger Traffic Forecast (No.)	1,06,735	1,11,069	96,476	1,14,583	1,36,089	1,61,631
Shasanghat Passenger Traffic Forecast (No.) *(49% of the Sadarghat Traffic)*	42,694	44,428	38,590	45,833	54,436	64,652
Peak Hour Duration (Hrs)	8	8	8	8	9	9
Break-up of the Passenger Traffic at Shasanghat						
Departure	16,437	17,105	14,857	17,646	24,768	29,417
Arrival	1,926	1,901	1,651	1,961	2,752	3,269
Total Traffic During Peak Hour	18,363	19,005	16,508	19,606	27,520	32,685
Per Hour	4,566	4,751	4,127	4,902	6,116	7,263

Table 21. Vessel Size and Passenger Seating Capacity Distribution for Sadarghat RiverPort

Vessel Category	No. of Departures Per Day based upon Time Schedule	% of Total Departures Per Day According to Time Schedule	Total Seating Capacity carried by Respective Vessel Categories	% of the Seating Capacity Carried by Respective Vessel Categories
Super Large (70 m – 90 m)	13	11%	9,374	20%
Large (50 m – 70 m)	41	35%	20,737	43%
Medium (30 m – 50 m)	56	48%	17,079	36%
Small (10 m – 30 m)	6	5%	583	1%
Total	117	100%	47,773	100%

Final Vessel scenario trend for proposed Shasanghat river port is as presented in Table 22.

Table 22. Future Vessel Scenario for Proposed Shasanghat River Port

Source: FFR Shasanghat IWT terminal, December 2019. Voyants Solutions (VSPL), maritime Consultancy (ICPL) and Unicom (UIL)

Vessel Category	Passenger Share carried by Various Categories of Vessels				
	Yr. 2018	Yr. 2022	Yr. 2029	Yr. 2036	Yr. 2042
Super Large (70 m – 90 m)	32 %	34 %	34 %	36 %	36 %
Large (50 m – 70 m)	34 %	32 %	32 %	30 %	30 %
Medium (30 m – 50 m)	34 %	34 %	34 %	34 %	34 %
Small (10 m – 30 m)	0 %	0 %	0 %	0 %	0 %

3.4.4.3. Passenger Terminal

All data and tables and figures have been sourced from FFR Shasanghat IWT terminal, December 2019, Package Passenger S3 Consultant.

Terminal building requirements.

Table 23 provides a summary of facilities and area requirement for Shasanghat terminal.

Table 23. Shasanghat Terminal Building Area Requirements

Sl. No.	Description	Area Requirement for Phase 1 (sq.mt.) (up to Yr. 2029)	Additional Area Required for Phase 2	Additional Area Required for Phase 3
1	Terminal Facilities	4,506	Theoretically about 1500-2000 Sqm is required) *The area provided as per Phase 1 requirement will suffice for Phase 2 (traffic of up to Yr 2036) as well*	An additional area of **3,350 Sq. m** will have to be provided during Phase 3 for increment in the passenger traffic
2	Services	168		
3	Amenities	2,306		
4	Management Offices	2,560		
5	Rentable Area	5,727		
6	Accommodations	512		
7	Miscellaneous	3,116		
	Total Area	**18,896**		

Parking area requirement

Table 24 provides a summary of parking areas required for Shasanghat terminal

Table 24. Shasanghat Parking area requirement

Sl. No.	Particulars		Phase - I	Phase - II	Phase - III
A	Peak Hour Traffic		4,751	1,671	841
B	Peak Hour Traffic Considered for Parking Calculation*		4,514	1,588	799
C	30 Minutes Traffic Considered for Parking and Dropping		2,257	794	399
Sl. No.	**Particulars**	**Proportion**	**Total Area (m^2)**	**Total Area (m^2)**	**Total Area (m^2)**
1	Bus (50 Seater)	20%	325	114	58
2	Cycle Rickshaw (2 Seater)	20%	677	238	120
3	CNG (3 Seater)	30%	903	318	160
4	Mini VAN	20%	301	106	53
5	Car and Taxi (PCU)	10%	790	278	140
Total Area Required for parking of vehicles			3,000	1,100	600
Area Considered for Planning and Design *(60% area additional considered for Parking Clearance and Circulation and stops)*			**4,800**	**1,800**	**1,000**

Internal Roads

Two-lane one way internal road of width 7 and 928 m long m is provided all around the terminal wherein road which would act as drop-in / drop-off as well as enable the accessibility from all sides of terminal during emergency situation.

External Roads.

External roads will serve the purpose of last-mile connectivity to major road junctions for the passengers arriving/departing the terminal. It is suggested that the external connecting roads should be at least two-(2) lane road of 7 m width, considering the area/land availability. Further expansion of road width shall be discussed with the PWD department considering the Masterplan Landscaping and green overall Landscaping & Green cover should be provided for minimum of about 20% of the land development area. The Landscaping and Green cover proportion may vary with site specific condition and space utilization factor of site.

The establishment of the new Sashangaht terminal will increase the traffic in the nearby area that can be a cause of hassle for some people. It is expected that the congestion in the surrounding area will increase but the overall impact of the project on the transportation system of the country will be positive. Especially, the pressure on the existing Sadargaht river port is expected to be reduced after the establishment of the new port. Furthermore, the new terminal is supposed to improve the road connectivity and it will slightly reduce traffic jam on the roads of Dhaka city.

Power Requirements

The electricity supply to proposed Shasanghat river port could be supplied through any of the following to sub-stations: i. IG Gate 33/11V sub-station which is almost 1000m from the site ii. Postogola 33/11KV sub-station which is about 500m from the project site.

Water requirements

The proposed terminal needs daily use of water for drinking of the passengers, toilet, baths, washing, firefighting, gardening, cooking, washing of floors, parking, ablution for prayers and other works.

Quantity Calculation for water consumption:

- The calculated passenger is 6431 per hour (peak hour).

- Considering 20 percent of passenger's i.e. about 1287 passengers will use W.C, urinals, drinking, washing and as per BNBC (Bangladesh National Building Code) guidelines, quantity of water required 8 liters per capita per day.
- Water required =1287 passengers' x 8 liters x6 hours =61776 liters. (Considering peak period as 6 hours).
- For firefighting operation and considering 1-hour period with 4 fires at a time, the quantity of water will be required =1100 liter/minute x 60 minutex4 fires =264000 liter.
- For other works like washing of floors, gardening etc. =20000 liter.
- For people (BIWTA) employed for operation and maintenance of terminal building, considering= 500x8 liters=4000 liters,
- For Vessels-considering consumption of water for drinking, washing, using toilets into water vessels =10000 liters/vesselx20 vessels=200000 liters.

Total quantity = 54,9776 liter of water will be required per day, but minimum quantity of 28,5776 liter, (ignoring fire work as daily basis). Considering loss of water as 20%, the minimum water requirement 34,2931 liter per day.

The water can be sourced from Dhaka Water Supply and Sewerage Authority through any of the following two sources: i. Doyagonj water pump house ii. Jatra Bari (WASA MOD zone 1 and 7), Both sources are located within 3 Km from proposed Shasanghat terminal location. Water can be purchased from Dhaka WASA at unit price and can be availed from nearby location within 100m from Shasanghat area by branch line conveying water. Besides these sources of Dhaka WASA, as a back-up option, it is suggested to install a separate deep tube well at terminal premises with a permission from Dhaka WASA.

Sewage treatment

According to Final Feasibility Report of S3 package, Sashangaht passenger terminal: "Considering the quantum of passenger traffic flow in Shasanghat, Consultants recommend Sewage Treatment Plant (STP) for treating the sewage before discharging the same. In Phase-1, Septic Tank will be provided and in Phase- 2, BIWTA will build the STP." The said Final Feasibility Report does not give more information on surrounding sewerage facilities and does not discuss technical feasibility in connecting the STP to the Pagla STP.

With respect to sewerage, the system will be a pipeline network around the building and the sewerage water will come in the septic tank and soak well. The soak well will filter the liquid part of the sewerage and finally will be discharge into the river.

3.4.4.4. Recommended layout for water side

Based on the analysis, alternative layout no.-1 (with Pontoon based Finger Pier Berthing Arrangement) and alternative layout no.-5 (with Pontoon based Parallel-Alongside Berthing Arrangement) were recommended for implementation in phased manner, considering the existing operational model which is derived based on market forces, Passenger Terminal Package S3 Consultant has kept the provision of Alternative-3 (Bow-Berthing) for further evaluation by the client.

Thus, three alternatives for Water Side were recommended, and corresponding Master Plan developed as follows:

- Alternative layout no. 5 (with Pontoon based Parallel-Alongside Berthing Arrangement). Recommended Water Side Layout – Option-1
- Alternative layout no. 1 (with Pontoon based Finger Pier Berthing Arrangement). Recommended Water Side Layout – Option 2
- Alternative layout no. 3 (Bow Berthing Arrangement). Recommended Water Side Layout – Option 3

3.4.4.5. Water side development: pontoons and linkspan

The proposed berthing system is designed as pontoons and linkspan. Number of pontoons and linkspan depends on system berthing options, parallel, finger pier or bow berthing. Figure shows a schematic figure of the berthing system selected.

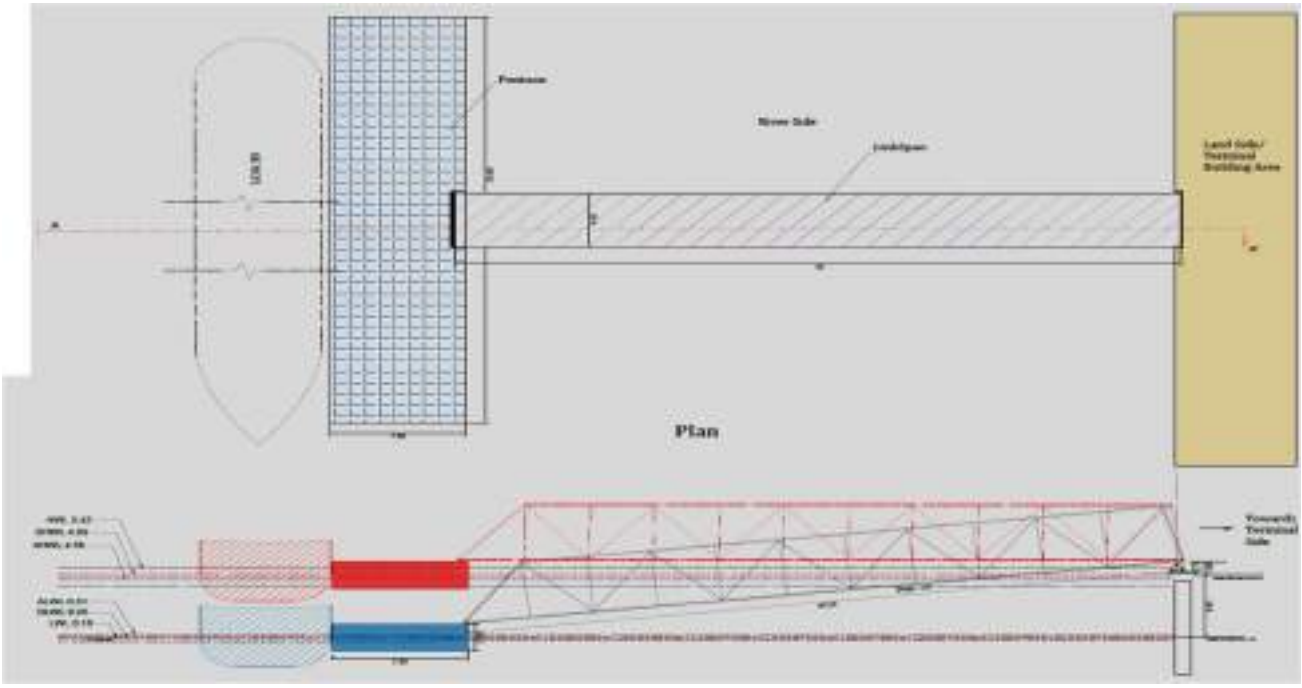


Figure 28. Pontoon and linkspan berthing system

Bank protection along berthing system shall be provided. Armor stone or concrete blocks can be used for bank protection. Geo-textiles may be used as a part of the filtering system, either with or instead of the granular filter. A typical image of bank protection is shown in Figure 29.

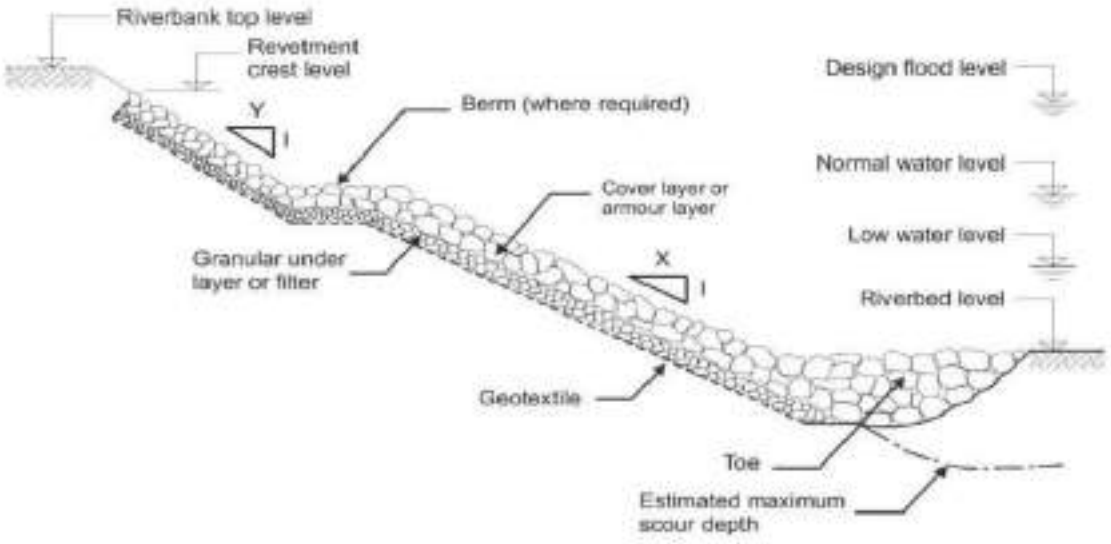


Figure 29. Image Showing Cross Section of Bank Protection

3.4.4.6. Land Side Plan

Based on the facility area requirement analysis the land side Master Plan is prepared for implementation in the phased manner. Master Plan options are:

- Land Side Master Plan Option 1
- Land Side Master Plan Option 2

Land Side Master Plan: Option 1 is shown in Figure 30 and discussed below. (Land Side Master Plan – Option 2 is presented in Annex 2):

Figure 30. Land Side Master Plan: Option 1

3.4.4.7. Integrated Master Plan

The Land Side Master Plans and the Water Side Master plan for year 2042 is integrated together and is presented as below:

- 1. Integrated Master Plan-Option-1 (Approved layout by BIWTA)
- 2. Integrated Master Plan-Option-1 with Idle Berthing (Approved layout by BIWTA)
- 3. Integrated Master Plan-Option-2

- 4. Integrated Master Plan-Option-2 with Idle Berthing
- 5. Integrated Master Plan-Option-3
- 6. Integrated Master Plan-Option-3 with Idle Berthing

Integrated Master Plan option 1 and option 1 with idle Berthing are presented in Figure 31and Figure 3132 (Options 2 and 3 are presented in Annex2

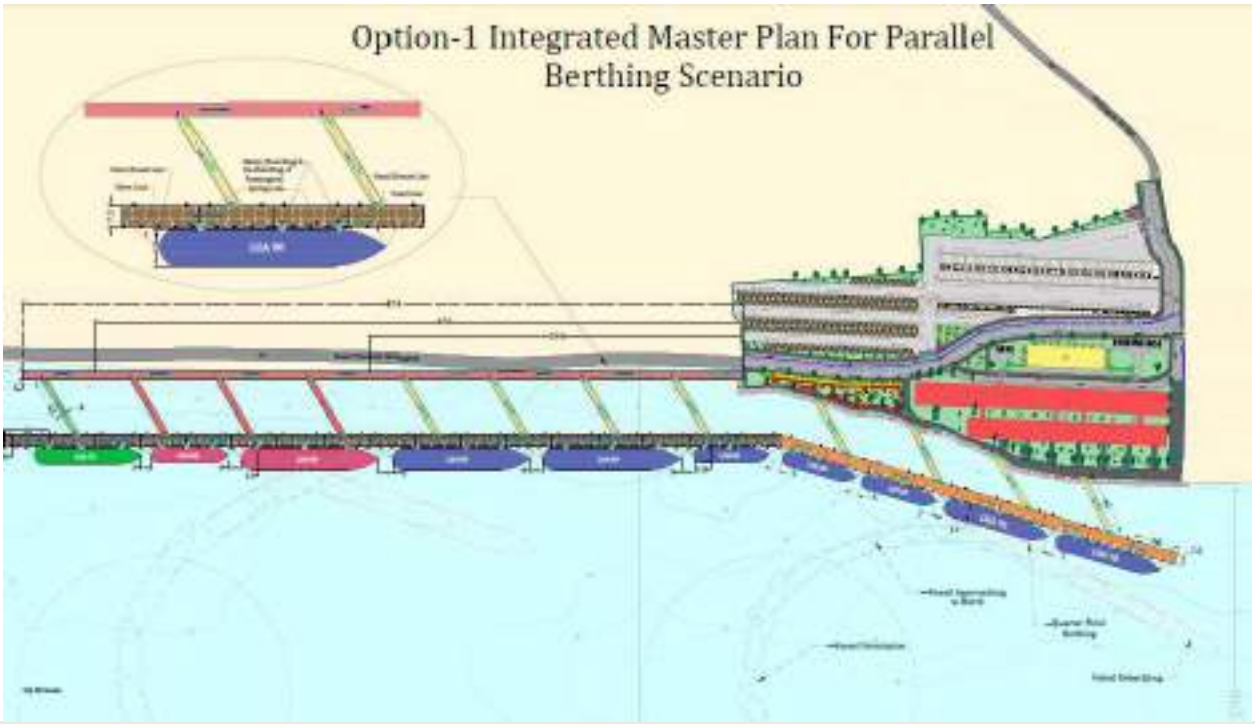


Figure 31. Integrated Master Plan option 1 for Sashangaht. Option 1

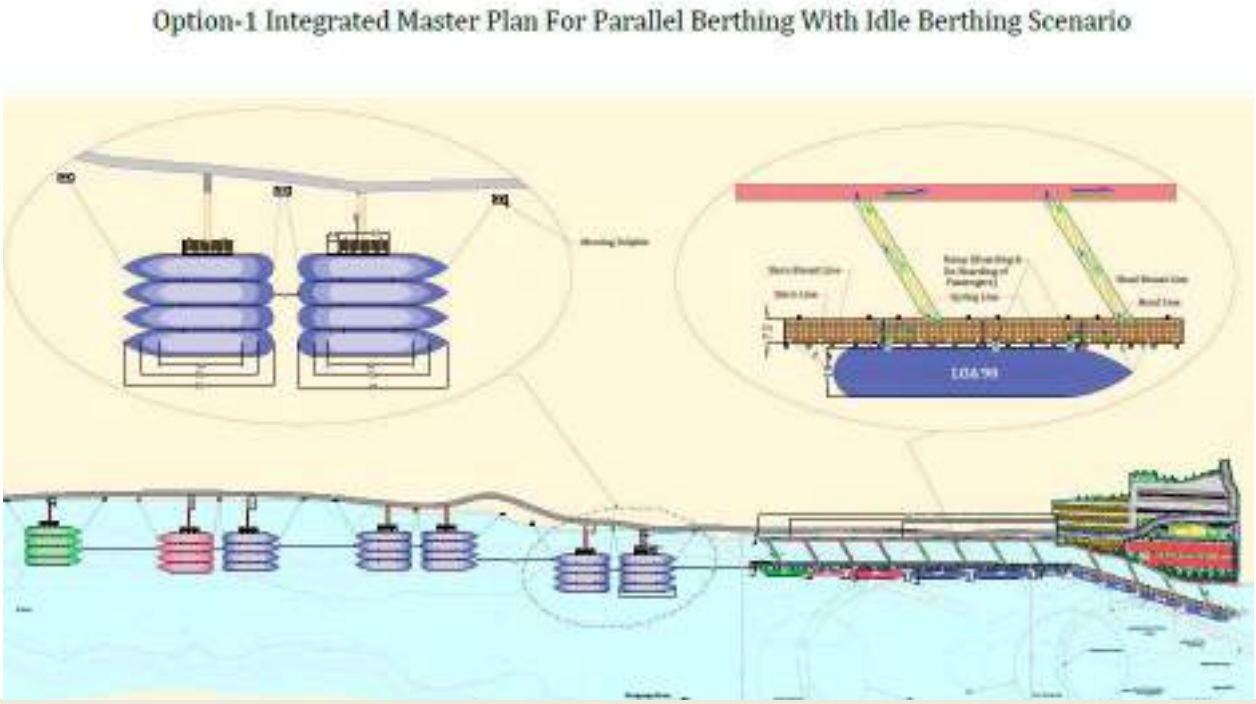


Figure 32. Integrated Master Plan for Shasanghat. Option 1 with idle berthing.

3.4.5. Chandpur Site

3.4.5.1. Project location and brief summary

The Chandpur terminal is located at the center of Bangladesh passenger IWT system (0). Chandpur terminal acts as transit point for people who want to go to Chittagong from Dhaka or south-western regions and vice versa. Chandpur is close to confluence of Padma and Meghna rivers. Chandpur is about 60-70 Km from Sadarghat.

Figure 33. Satellite Imagery showing Sadarghat, Sashangat, Narayanganj & Chandpur Site

Source: FFR Chandpur IWT terminal, December 2019. Passenger Package S3Consultant

Chandpur terminal is situated on the confluence of the river Padma and the river Upper Meghna and it has a larger availability of river width (0). Though the available river width is large, because two rivers are meeting, there are swirl currents which possess great energy and these currents could drift the vessels. At this place sometimes, vessels are not able to navigate properly.

Figure 34. Confluence of Rivers near Chandpur terminal & Existing Width.

Source: FFR Chandpur IWT terminal, December 2019. Passenger Package S3Consultant

The proposed Terminal facilities will be on the eastern side of the existing facilities.

Figure 35 shows the existing landside facilities at Chandpur. Chandpur is a very old Port, having multi-modal connection with steamer, rail and road transport system. Steamer routes existed from Calcutta (Kolkata) to Narayanganj via Chandpur and vice versa, with railway connections to big cities of Chittagong and Dhaka.

The old port was situated on the bank of river Dakatia, at the confluence of rivers Meghna and Dakatia. The terminal buildings and other installations at the old site have collapsed, due to excessive current and erosion. Currently, a short-term solution / arrangement for berthing of vessels has been made at Madrasaghat. About 2.4 acres of land has been acquired at this site and there is huge railway land available nearby. BIWTA intends to develop new port facilities at this new site on bank of river Meghna. This development will be a greenfield project.

Following inventory was available for the Chandpur Port Terminal (at Madrasaghat).

- Terminal office building: 1 Semi-pucca bldg. (30mx9.2m = 280 Sq. m)
- River Traffic Police Barrack: Semi-pucca (280 Sq. m)
- Public Toilet : Semi-pucca (34 Sq. m)
- Parking yard : 1 no. (2.4 Acre)
- Steel Jetty : 2 nos.
- Steel Pontoons : 2 nos.
- Steel Gangway : 2 nos. (6.0m x 28.35m – 3.20 depth)
- Spuds : 4 nos.
- Passenger Shed : 1 no. Semi-pucca (74 Sq. m)
- Walkway : 150 Sq. m semi-pucca

Figure 35. Existing land side facilities at Chandpur Terminal

Source: FFR Chandpur IWT terminal, December 2019. Passenger Package S3Consultant

Chandpur is more exposed (than any other sites) to open sea conditions though the terminal is way inside the coastline. No major hydrodynamic influence is seen. However, due to two rivers meeting in the vicinity, a swirl is expected and therefore the vessel approaching scenario shall be very carefully planned near the terminal.

Currently there is no proper shelter / waiting sheds / Terminal building for passengers. The nose berthing of vessels is observed in Chandpur also. Further, very narrow walkway without handrails or the part of the vessels overlapping with pontoons is used as entry and exit for the passengers. This is not a safe method for boarding and de-boarding of people.

It is observed that the shelters were constructed on the pontoons, which resulted in tilting of the pontoons making it unstable.

The water side is protected with rip-rap arrangement of concrete blocks.

As per BIWTA about 2.4-acre land was available of which about 0.5-0.6 acres of land was subsided into water over the period of time (Figure 36). However, currently, 1.8 Acre land is available for terminal building

development. BIWTA intends to develop new port facilities at this new site on the bank of river Meghna. This development will be a green-field project.

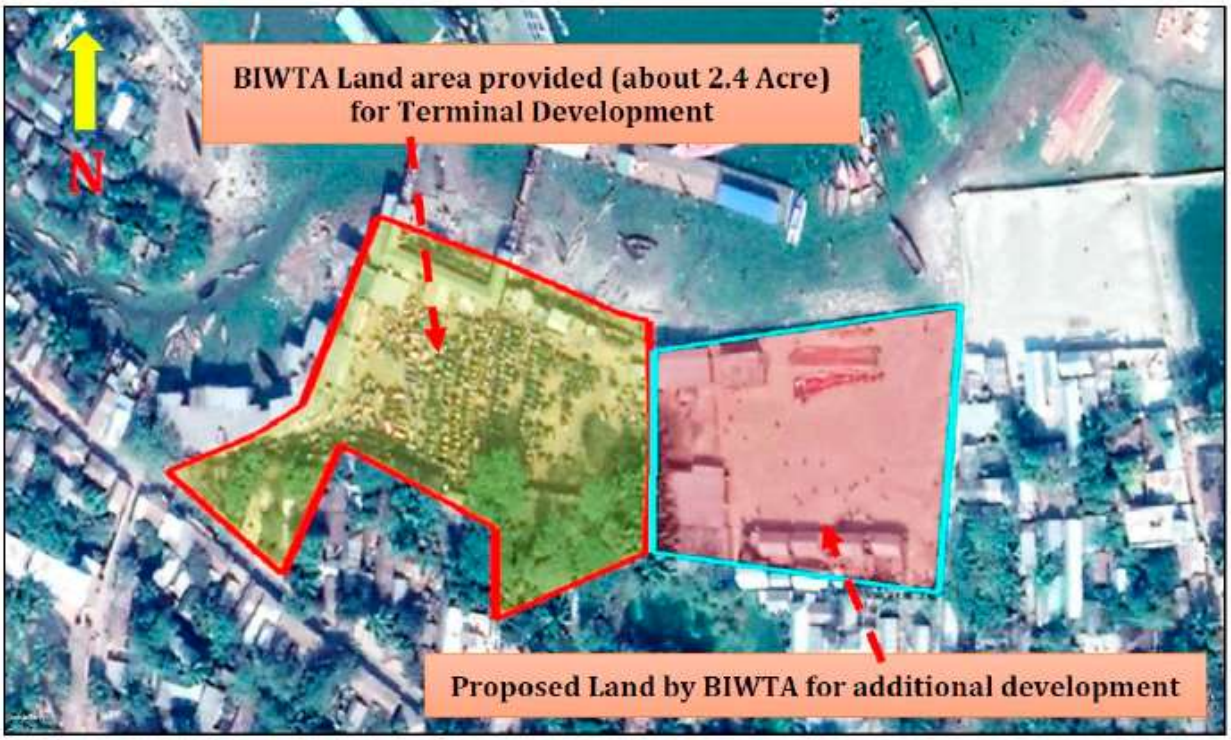


Figure 36. Area Earmarked for Chandpur Terminal Development

Source: FFR Chandpur IWT terminal, December 2019. Passenger Package S3Consultant

3.4.5.2. Terminal capacity and main features

All data and tables and figures have been sourced from FFR Shasanghat IWT terminal, December 2019, Package Passenger S3 Consultant.

About 30,000 people commute daily via Chandpur terminal which may increase by two to threefold during EID and other festivals. The key destination points from Chandpur are Sadarghat, Barishal, Narayanganj and other multiple short routes.

Thus, the Passenger traffic to be considered for Chandpur is summarized in Table Table 26 with vessel sizes and passenger seating capacities shown in Table 26.

Table 25. Phase wise passenger Traffic Forecast Summary for the Chandpur River Port

Particulars	Phase - I	Phase - II	Phase - III
Passenger Traffic (No.)	46,227	58,814	72,297
Peak Hour Duration (Hrs.)	9	11	12
Passengers Traffic in Peak Duration (No.)	24,038	37,641	50,608
Passengers Traffic per Peak hour (No.)	2,671	3,422	4,217

Table 26. Vessel Size and Passenger Seating Capacity Distribution for Chandpur RiverPort

Vessel Category	No. of Departures Per Day based upon Time Schedule	% of Total Departures Per Day According to Time Schedule	Total Seating Capacity carried by Respective Vessel Categories	% of the Seating Capacity Carried by Respective Vessel Categories
Super Large (70 m - 90 m)	4	6%	3,278	12%
Large (50 m - 70 m)	26	41%	15,394	55%
Medium (30 m - 50 m)	19	30%	6,512	24%
Small (10 m - 30 m)	15	23%	2,620	9%
Total	64	100%	27,804	100%

Final Vessel scenario trend for proposed Chandpur port is as presented in Table 28.

Table 27. Future Vessel Scenario for Proposed Chandpur River Port

Vessel Category	Passenger Share carried by Various Categories of Vessels				
	Yr. 2018	Yr. 2022	Yr. 2029	Yr. 2036	Yr. 2042
Super Large (70 m - 90 m)	12 %	14 %	14 %	14 %	15 %
Large (50 m - 70 m)	55 %	55 %	55 %	53 %	50 %
Medium (30 m - 50 m)	24 %	22 %	22 %	24 %	26 %
Small (10 m - 30 m)	9 %	9 %	9 %	9 %	9 %

3.4.5.3. Passenger Terminal

All data and tables and figures have been sourced from FFR Shasanghat IWT terminal, December 2019, Package Passenger S3 Consultant.

Terminal building requirements

Table 28 provides a summary of facilities and area required for Chandpur terminal.

Table 28. Chandpur Terminal Building Area Requirements

Sl. No.	Description	Area Requirement for Phase 1 (sq.mt.) (up to Yr. 2029)	Additional Area Required for Phase 2	Additional Area Required for Phase 3
1	Terminal Facilities	1,858	Additional area of 819 Sq. m will have to be provided during Phase 2 for increment in the passenger traffic	Additional area of 869 Sq. m will have to be provided during Phase 3 for increment in the passenger traffic
2	Services	216		
3	Amenities	696		
4	Management Offices	714		
5	Rentable Area	270		
6	Accommodations	94		
7	Miscellaneous	290		
	Total Area	**4,138**		

Parking area requirement

Table 29 provides the summary of parking areas required Chandpur terminal

Table 29. Chandpur Parking area requirement

Sl. No.	Particulars		Phase – I	Phase - II	Phase - III
A	Peak Hour Traffic		2,671	751	795
B	Peak Hour Traffic Considered for Parking Calculation*		2,537	713	755
C	30 Minutes Traffic Considered for Parking and Dropping		1,269	357	378
Sl. No.	**Particulars**	**Proportion**	**Total Area (m²)**	**Total Area (m²)**	**Total Area (m²)**
1	Bus (50 Seater)	10%	108	36	72
2	Cycle Rickshaw (2 Seater)	10%	192	57	111
3	CNG (3 Seater)	50%	848	252	492
4	Mini VAN	20%	170	60	100
5	Car and Taxi (PCU)	10%	446	140	263
Total Area Required for parking of vehicles			1,800	600	600
Area Considered for Planning and Design *(50% area additional considered for Parking Clearance and Circulation and slope)*			**2,900**	**1,000**	**1,000**

Internal Roads

A 621 m long two-lane one way internal an around the terminal road of width 7 m is provided all around the terminal wherein road which would act as drop-in / drop-off as well as enable the accessibility from all sides of terminal during emergency.

External Roads.

External roads will serve the purpose of last-mile connectivity to major road junctions for the passengers arriving/departing the terminal. It is suggested that the external connecting roads should be at least two-(2) lane road of 7 m width, considering the area/land availability. Further expansion of road width shall be discussed with the PWD department considering the Masterplan. The main approach and exit from Chandpur Port site are through Madrasa Road to the Station Road and then to the town. There is a bottle-neck bridge at the entrance

of Madrasa Road. This old bridge needs to be reconstructed with sufficient width and proper design. The Madrasa Road also needs to be widened to at least two-lane road, for use by two trucks.
There is another narrow lane from the port area is connecting to Nishi Building road and then to the Station Road. This lane should also be widened for the exit of the port traffic. Alternate exit road may also be investigated, in the newly acquired land, directly to the station road.

Landscaping and green

Overall Landscaping & Green cover should be provided for minimum of about 20% of the land development area. The Landscaping and Green cover proportion may vary with site specific condition and space utilizations factor of site.

Power Requirements

The power demand for the proposed Chandpur terminal building including other necessary function is approx. 400KVA including present and future requirement

Water requirements

The proposed terminal needs daily use of water for drinking of the passengers, toilet, baths, washing, firefighting, gardening, cooking, washing of floors, parking, ablution for prayers and other works.
Quantity Calculation for water consumption:

- Quantity of water consumption: The calculated passenger is 2671 per hour (peak hour)
- Considering 20 per cent of passengers that is about 534 passengers will use W.C, urinals, drinking, washing and as per BNBC (Bangladesh National Building Code) guidelines, quantity of water required 8 liters per capita per day.
- Water will be required =534 passengers' x 8 liters x6 hours =25632litres. (Considering peak period as 6 hours).
- For off-peak hour it is considered as half the quantity i.e. 12816litres for use of terminal staff who are operating the terminal.
- For firefighting operation and considering 1-hour period with 4 fires at a time, the quantity of water will be required =1100 liter/minute x 60 minutex4 fires =264000 liter.
- For other works like washing of floors, gardening etc. considering =10000 liter, considering consumption of water for drinking, washing, using toilets into water vessels =2000 liters/vessel x30 vessels=60,000 liters.

So, total quantity =3, 72,448 liter/day. But minimum quantity 1, 08,448 liter, (ignoring firefighting work as daily basis).Considering loss of water as 20%, the minimum water requirement 1, 30,137 liter per day.

Chandpur Municipal Corporation is unable to supply the above requirement of water from their own source nearby pipeline.So, it needs to install a deep tube well nearby terminal taking permission from Municipal Corporation.

Chandpur Municipal Corporation is unable to supply the above requirement of water from their own source nearby pipeline. Therefore, a complete deep tube well will be installed at terminal premises with the permission from Chandpur Municipal Corporation.Water from deep tube well will be stored into the underground water tank and will be lifted by high pressure water pump to overhead water tank of the terminal building and will be delivered through pipeline network within the terminal area. Water will be delivered from overhead water tank of the terminal building through pipeline network under gravity pressure.

At present there is no information on water quality of deep aquifer therefore water quality analysis should be taken before the establishment of a swwp tube well as water source for the terminal.

Sewage treatment

Considering the quantum of passenger traffic flow in Chandpur, Passenger Package S3 Consultants recommend Sewage Treatment Plant (STP) for treating the sewage before discharging the same. In Phase-1, Septic Tank will be provided and in Phase- 2, Client will build the STP.

3.4.5.4. Recommended layout for water side

Alternative layout no.-5 (with Pontoon based Parallel-Alongside Berthing Arrangement) were recommended for implementation in phased manner, considering the existing operational model which is derived based on market forces, Passenger Terminal Package consultant has kept the provision of Alternative-3 (Bow-Berthing) for further evaluation by the client.
Thus, three alternatives for Water Side were recommended, and corresponding Master Plan developed as follows:

- Alternative layout no. 5 (with Pontoon based Parallel-Alongside Berthing Arrangement). Recommended Water Side Layout – Option-1
- Alternative layout no. 1 (with Pontoon based Finger Pier Berthing Arrangement). Recommended Water Side Layout – Option 2
- Alternative layout no. 3 (Bow Berthing Arrangement). Recommended Water Side Layout – Option 3

3.4.5.5. Water side development pontoons and linkspan

This alternative follows the same design to that proposed for Shasanghat Terminal.

3.4.5.6. Land Side Plan

The master plan for land side development in Option 1, as presented in Figure 37 was approved and the same has been considered for planning and design. Option 2 has been provided in Annex 2

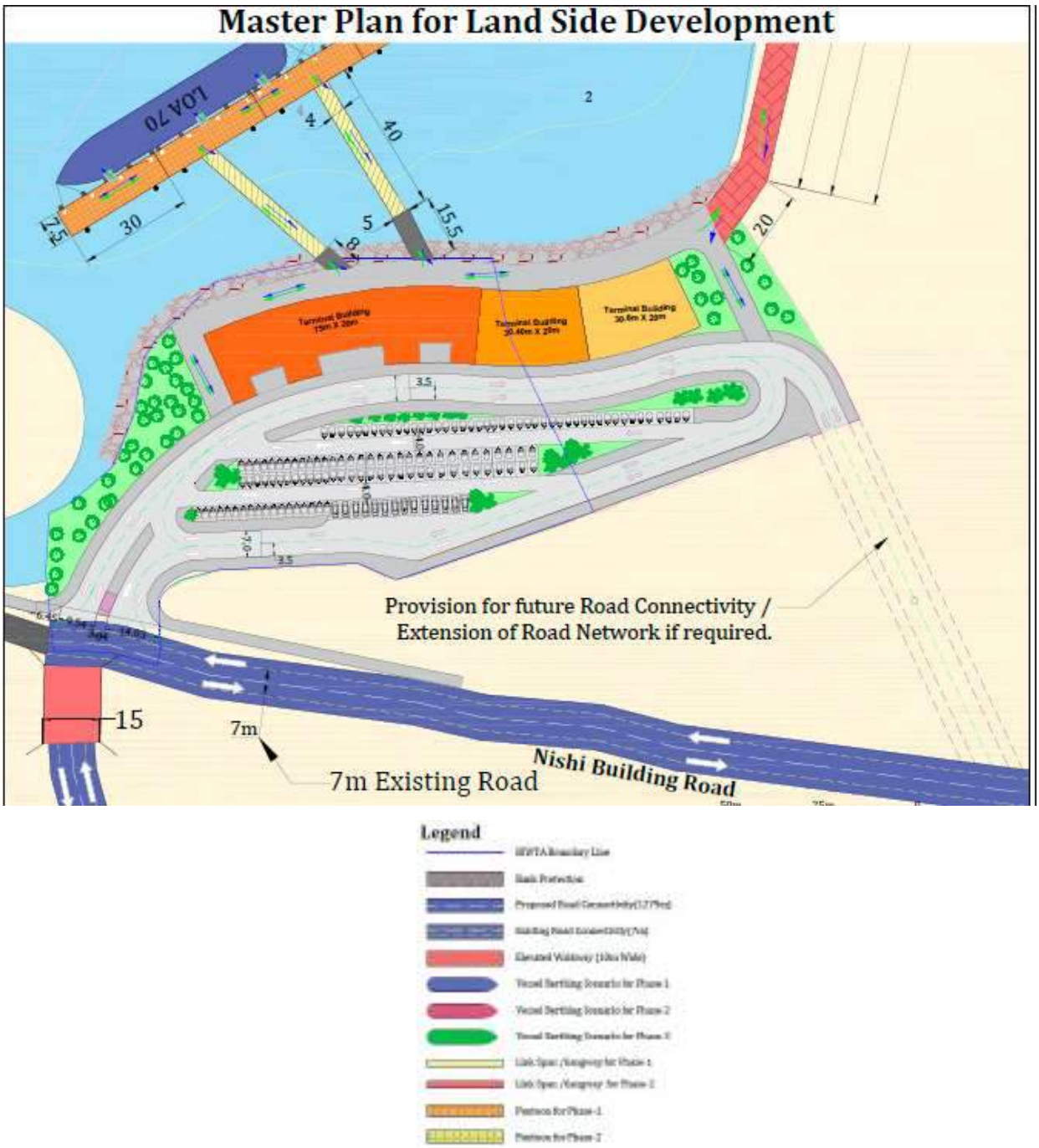


Figure 37. Chandpur Land side Master Plan

3.4.5.7. Integrated Master Plan

The Land Side Master Plans and the Water Side Master plan for the year 2042 are integrated together and is presented as below:

- 1. Integrated Master Plan-Option-1 (Approved layout by BIWTA)
- 2. Integrated Master Plan-Option-1 with Idle Berthing (Approved layout by BIWTA)
- 3. Integrated Master Plan-Option-2

- 4. Integrated Master Plan-Option-2 with Idle Berthing
- 5. Integrated Master Plan-Option-3
- 6. Integrated Master Plan-Option-3 with Idle Berthing

Integrated Master Plan Option 1 and Option 1 with idle Berthing are presented in 0 (Options 2 and 3 Land are presented in Annex 2).

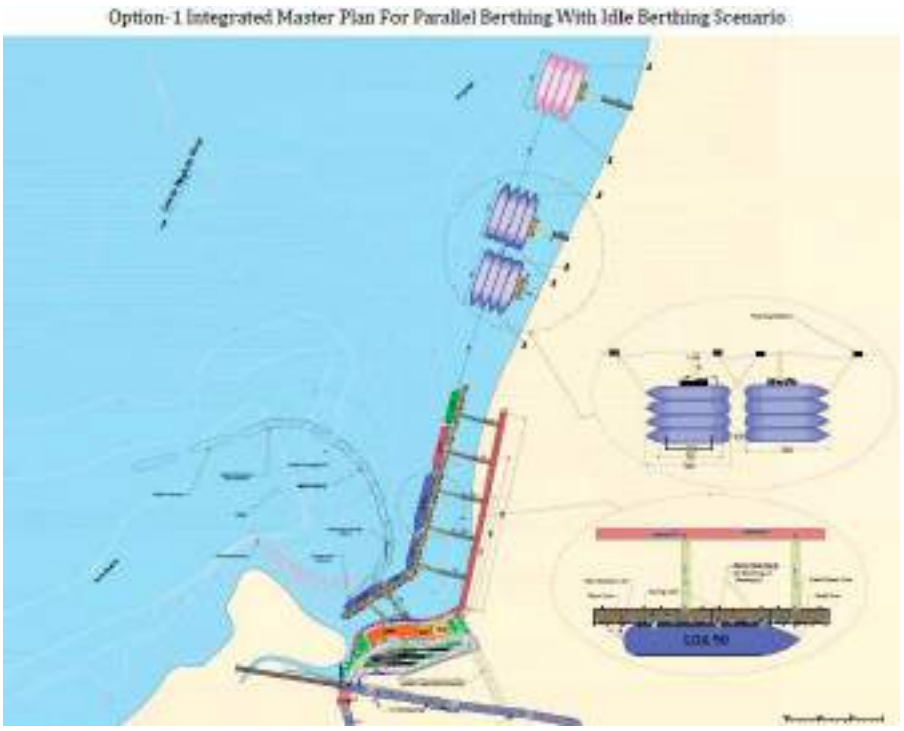


Figure 38. Integrated Master Plan for Chandpur Terminal.

3.4.6. Narayanganj Site

3.4.6.1. Project Location and summary

Narayanganj IWT Passenger Terminal (0) is situated on right bank of Shitalakshya River. Shitalakshya River goes further and meets the Dhaleshwari River and further Dhaleshwari meets Meghna River and runs downstream.

Narayanganj IWT Passenger Terminal is situated at about 20 Km while travelling by road from Dhaka / Sadarghat. However, via waterways, the distance is about 35 Km from Sadarghat.

The Narayanganj Terminal is situated next to Narayanganj Railway Station. In older days there were very good connections between these two and the multi-modal transport was very effective. Narayanganj IWT Port was established in 1972. Existing facilities (Figure 41) include a single storied building, 4 pontoons, 3 gangways, an RCC jetty and an administrative office. Existing facilities also include cargo-handling facilities with 4 pontoons.

Figure 39. Satellite Imagery showing Narayanganj Site

Source: FFR Narayanganj IWT terminal, December 2019. Package Passenger S3 Consultant

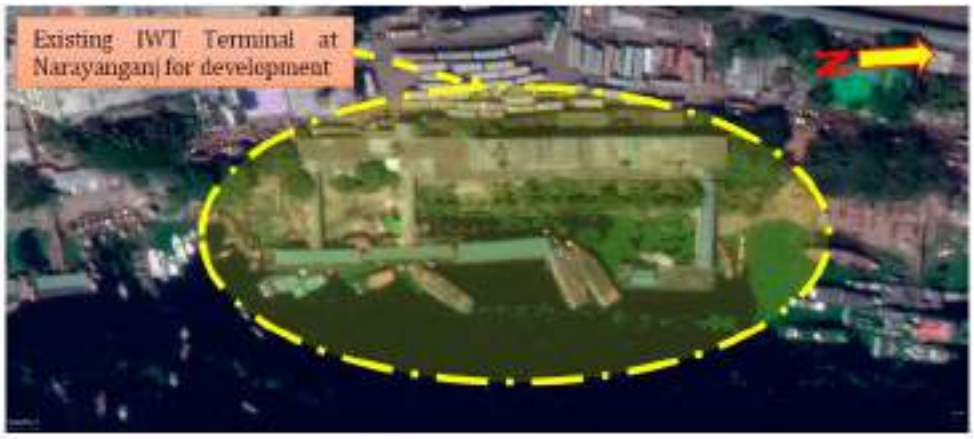


Figure 40. Satellyte Imagery of Narayanganj IWT Terminal

Source: FFR Narayanganj IWT terminal, December 2019. Package Passenger S3 Consultant

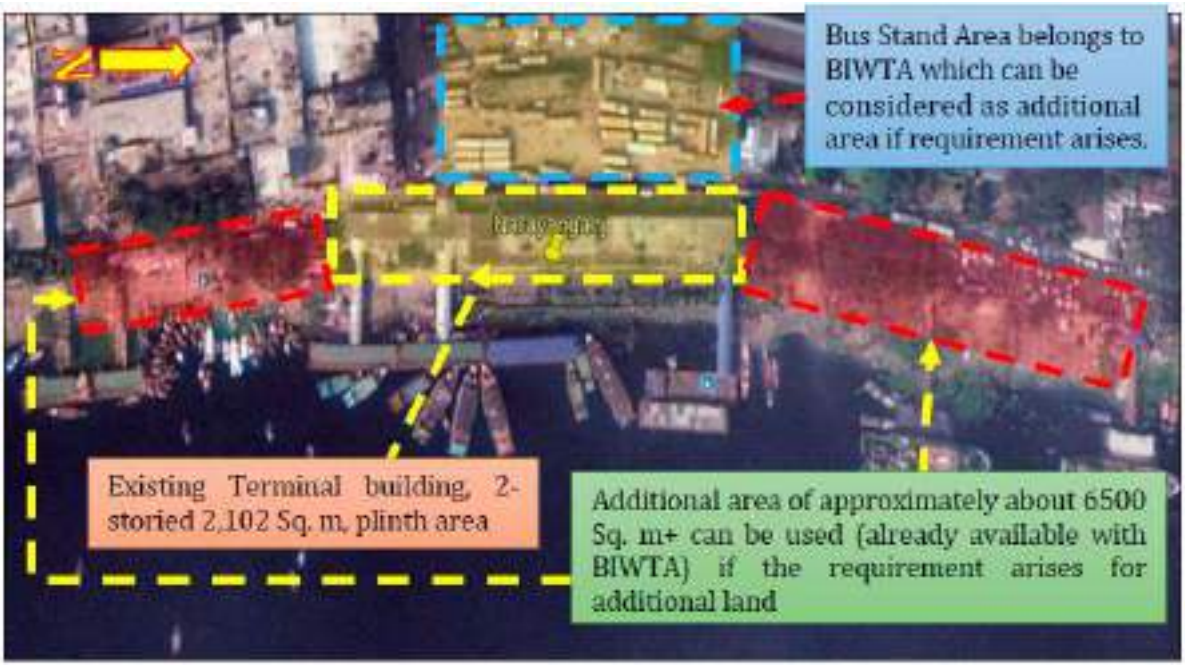


Figure 41. Land Availability with BIWTA Authorities

Source: FFR Narayanganj IWT terminal, December 2019. Package Passenger S3 Consultant

The channel has an average width of about 200 m near the terminal and depth is about 4-5 m. Due to bottle neck width, there is space constraints and it is very challenging to plan a new terminal.

Figure 42. Available Width at Narayanganj Terminal

Source: FFR Narayanganj IWT terminal, December 2019. Package Passenger S3 Consultant

3.4.6.2. Terminal capacity and main features

Passenger traffic forecasts for Narayanganj are summarized by project phase in Table 30.

Table 30. Phase wise passenger Traffic Forecast Summary for the Narayanganj River Port

Particulars	Phase - I	Phase - II	Phase - III
Passenger Traffic	12,160	15,470	19,017
Peak Hour Duration	18	18	18
Passengers Traffic in Peak Duration	12,160	15,470	19,017
Passengers Traffic per Peak hour	676	859	1,057

Table 31 identifies vessel sizes and seating capacities for Narayanganj.

Table 31. Vessel Size and Passenger Seating Capacity Distribution - Narayanganj Riverport

Vessel Category	No. of Departures Per Day based upon Time Schedule	% of Total Departures Per Day According to Time Schedule	Total Seating Capacity carried by Respective Vessel Categories	% of the Seating Capacity Carried by Respective Vessel Categories
Super Large (70 m - 90 m)	0	0%	0	0%
Large (50 m - 70 m)	0	0%	0	0%
Medium (30 m - 50 m)	0	0%	0	0%
Small (10 m - 30 m)	62	100%	7,607	100%
Total	62	100%	7,607	100%

Final vessel scenario trend for proposed Narayanganj terminal is presented in Table 32.

Table 32. Future Vessel scenario for Narayanganj river port

Vessel Category	Passenger Share carried by Various Categories of Vessels				
	Yr. 2018	Yr. 2022	Yr. 2029	Yr. 2036	Yr. 2042
Super Large (70 m - 90 m)	0 %	0 %	0 %	0 %	0 %
Large (50 m - 70 m)	0 %	0 %	0 %	0 %	0 %
Medium (30 m - 50 m)	0 %	0 %	0 %	0 %	0 %
Small (10 m - 30 m)	100 %	100 %	100 %	100 %	100 %

3.4.6.3. Passenger Terminal

Terminal building requirements

Table 33 provides the summary of facilities and area requirement for Narayanganj terminal

Table 33. Narayanganj Terminal Building Area Requirements

Sl. No.	Description	Area Requirement for Phase 1 (sq.mt.) (up to Yr 2029)	Additional Area Required for Phase 2	Additional Area Required for Phase 3
1	Terminal Facilities	1,139	Additional area of **1,000 Sq. m** will have to be provided during Phase 2 for increment in the passenger traffic	Additional area of **1,000 Sq. m** will have to be provided during Phase 3 for increment in the passenger traffic
2	Services	472		
3	Amenities	740		
4	Management Offices	876		
5	Rentable Area	2291		
6	Accommodations	141		
7	Miscellaneous	559		
	Total Area	**6,219**		

Parking area requirement

Table 34 provides the summary of parking areas required Narayanganj terminal

Table 34. Narayanganj Parking area requirement

Sl. No.	Particulars		Phase - I	Phase - II	Phase - III
A	Peak Hour Traffic		676	184	197
B	Peak Hour Traffic Considered for Parking Calculation*		642	175	187
C	30 Minutes Traffic Considered for Parking and Dropping		321	87	94
Sl. No.	**Particulars**	**Proportion**	**Total Area (m^2)**		
1	Bus (50 Seater)	35 %	108	36	36
2	Cycle Rickshaw (2 Seater)	20 %	99	27	30
3	CNG (3 Seater)	20 %	88	24	28
4	Mini VAN	15 %	40	10	10
5	Car and Taxi (PCU)	10 %	114	35	35
	Total Area Required for parking of vehicles		500	200	200
	Area Considered for Planning and Design *(60% area additional considered for Parking Clearance and Circulation and stops)*		**800**	**350**	**350**

Internal Roads

720 m long internal roads of minimum two-lane road, one way road around the terminal, width i.e. 7 m shall be provided to serve as circulation space all around the terminal. The road will serve the dual purpose of Drop-In and Drop-Off purpose at entry/exit of the terminal as well as providing emergency services.

External Roads.

External roads will serve the purpose of last-mile connectivity to major road junctions for the passengers arriving/departing the terminal. It is suggested that the external connecting roads should be at least two-(2) lane road of 7 m width, considering the area/land availability. Further expansion of road width shall be discussed with the PWD department considering the Masterplan requirement.

Landscaping and green

Overall Landscaping & Green cover should be provided for minimum of about 20% of the land development area. The Landscaping and Green cover proportion may vary with site specific condition and space utilization factor of site.

Power Requirements

Rural Electrification Board (REB) is responsible for power supply at Narayanganj terminal. 11KV overhead line was drawn along the road from the REB's 33/11KV sub-station. The terminal was catered power from the 11KV overhead line.

The power demand for the proposed Narayanganj terminal building including other necessary function is approx. 800KVA including present and future requirement.

Water requirements

The proposed terminal needs daily use of water for drinking of the passengers, toilet, baths, washing, firefighting, gardening, cooking, washing of floors, parking, ablution for prayers and other works.

Quantity Calculation for water consumption:

- The calculated passenger is 676 per hour (peak hour).
- Considering 20 percent of passengers that is about 136 passengers will use W.C, urinals, drinking, washing and as per BNBC (Bangladesh National Building Code) guidelines, quantity of water required 8 liters per capita per day.
- Water will be required =136 passengers' x 8 liters x6 hours =6528 liters. (Considering
- Peak period as 6 hours).
- For off peak hour it is considered as half the quantity i.e. 3264 liters for use of terminal
- Staff who are operating the terminal.
- For firefighting operation and considering 1-hour period with 4 fires at a time, the quantity of water will be required =1100 liter/minute x 60 minutex4 fires =264000 liter. For other works like washing of floors, gardening etc. considering =20000 liter.
- For people (BIWTA) employed for operation and maintenance of terminal building, considering= 200x8 liters=1600 liters,
- Considering consumption of water for drinking, washing, using toilets into water vessels =1000 liters/vesselx20 vessels=20000 liters.

So, total quantity =315392 liter /day. But minimum quantity 51392 liter, (ignoring firefighting works as daily basis). Considering loss of water as 20%, the minimum water requirement 61670 liters per day.

Roughly it can be predicted that about 65000 liter of water will be required each day. So, it needs to install a deep tube well nearby terminal taking permission from Municipal Corporation.

Narayanganj WASA can supply the above requirement of water from their own source nearby pipe line. But it needs to install a deep tube well nearby terminal taking permission from WASA. Ground water quality at the deep aquifer is not well known, therefore water quality analysis must be carried prior to establishing a deep water well as water source for the terminal.

The deep tube well may operate as a backup option or full operation. If the deep tube well operates as full operation, then it need not to purchase water from WASA.

Sewage treatment

Final Feasibility Study of Narayanganj terminal considers the following: Considering the quantum of passenger traffic flow in Narayanganj, Consultants recommend Sewage Treatment Plant (STP) for treating the sewage before discharging the same. However, due to the space limitations, STP is not considered in Phase-1. Further, this matter is discussed with client and it was jointly finalized that, in Phase-1, Septic Tank will be provided and in Phase-2, Client will build the STP. Once STP for Phase is finally design Operation and monitoring manual should be included.

3.4.6.4. Recommended layout for water side

Based on the analysis, alternative layout no.-1 and alternative layout no.-5 were recommended for implementation in phased manner, considering the existing operational model which is derived based on market forces, Passenger Terminal Package consultant has kept the provision of Alternative-3 for further evaluation by the client. Thus, three alternatives for Water Side were recommended, and corresponding Master Plan developed as bellow:

3.4.6.5. Water side development pontoons and linkspan

Like Shasanghat Terminal, pontoons and linkspan.

3.4.6.6. Land Side Plan

In Narayanganj, a new terminal building was proposed to be developed in DFR (by demolition of the existing old building). However, post DFR submission, it was found that, Narayanganj City Corporation is coming up with a plan of Integrated Multimodal transport terminal (IWT- BUS and RAIL) and the concept of the same is under advanced stage of discussions. Further, a high-level workshop/presentation was also conducted in Nov-2019 (in which Shipping Minister, Shipping Secretary, BIWTA Chairman and officials was also present). Therefore, it was mutually agreed between BIWTA and Consultants about retaining the existing building and adding an extension only. The cost saving in Narayanganj shall be distributed to DEPTC and other IWT terminals (if required). The concept plan prepared by Narayanganj City Corporation is provided in Figure 43.

Figure 43. Concept plan for the development of Multi-Model Transit hub at Narayanganj Terminal

Source: FFR Narayanganj IWT terminal, December 2019. Package Passenger S3 Consultant

3.4.6.7. Integrated Master Plan

The Land Side Master Plans and the Water Side Master plan for year 2042 is integrated together and is presented as below:

- 1. Integrated Master Plan-Option-1 *(approved layout by client)*
- 2. Integrated Master Plan-Option-2
- 3. Integrated Master Plan-Option-3

Option 1 is presented in Figure 42. Integrated Master Plans Option 2 and 3 are attached as annexes.

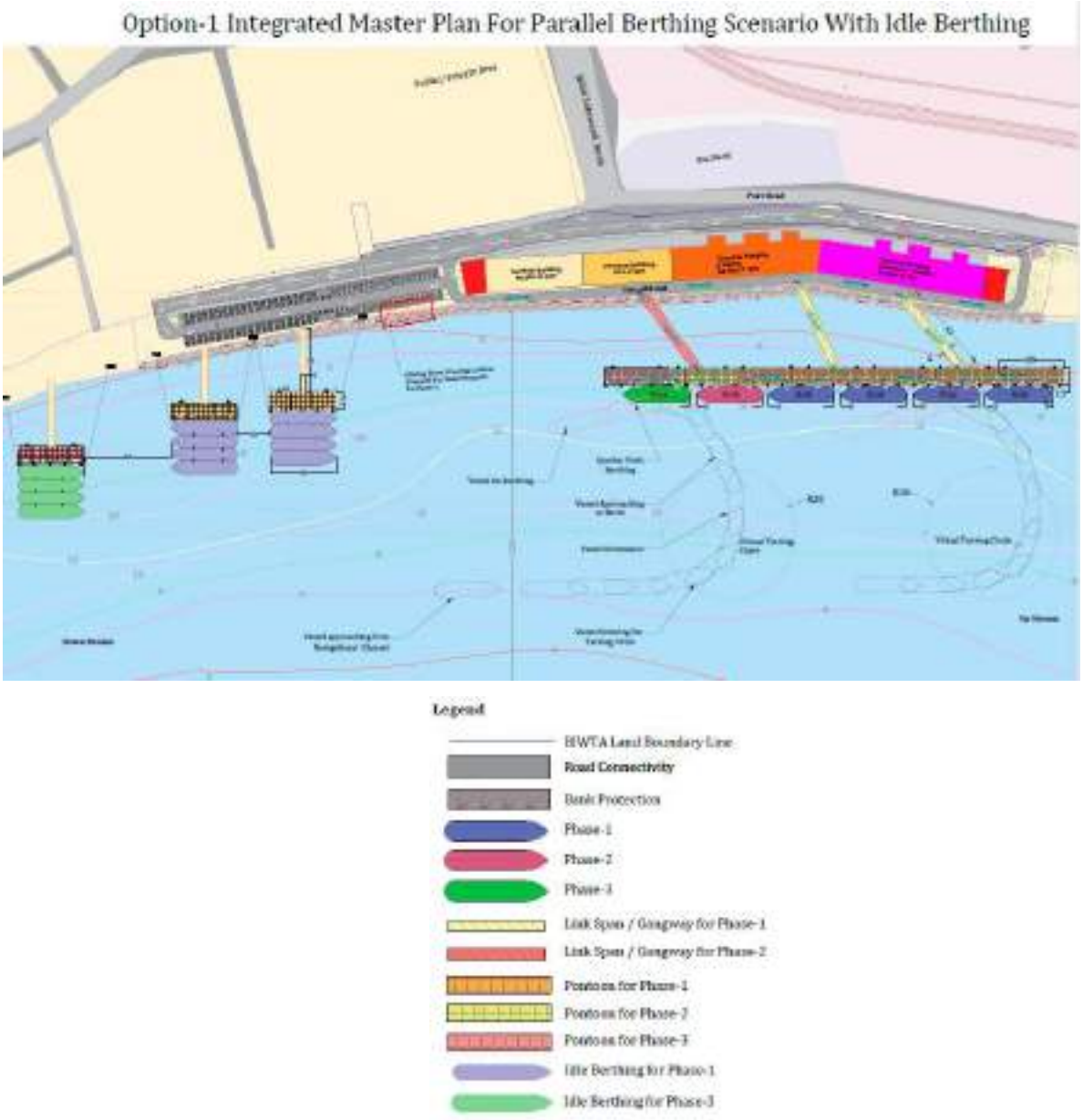


Figure 44. Integrated Master Plan for parallel Berthing scenario with idle berthing for Naryanganj terminal

3.4.7. DEPTC (Deck and Engine Personnel Training Centre)

3.4.7.1. DEPTC Project location and brief summary

Integrated within Narayanganj Project Design, the Deck and Engine Personnel Training Centre (DEPTC) is a training center situated on the left bank of Shitalakshya River and is very close to Narayanganj IWT terminal location.

This training institute currently has the Admin building, Hostel (for 200 personals) and staff quarters. However, all the buildings are very old (about 40 years) and needs substantial renovation / up-gradation. New Admin Building shall consider the provision of Bridge Simulator Space + New hostel for 500 personals + Staff Quarters (Multi storied – 3-5 floors) + Directors / Principal Bungalow etc. (as per the requirement suggested by DEPTC Principal) A total area of 4.12 Acre of land is earmarked for DEPTC development. DEPTC is having its own pontoon and Link span for berthing of vessels.

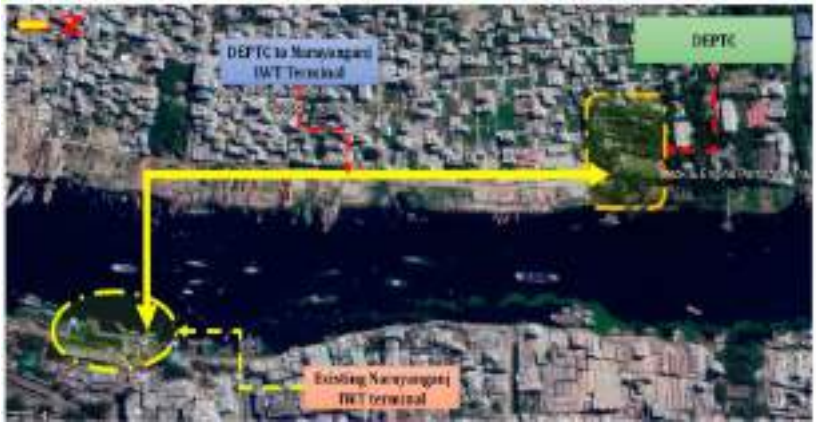


Figure 45. Location of DEPTC site

Source: FFR DEPTC, December 2019. Package Passenger S3 Consultant

3.4.7.2. Existing Infrastructure

Table 35 provides a summary of the existing infrastructure facility at DEPTC site.

Table 35. Existing infrastructure facility at DEPTC site

Existing Infrastructural facilities	
Two storied Admin Building	1 no. (floor area – 10400 sft)
Two storied Hostel Building	1 no. (20600 sft)
One storey Building (workshop)	1 no. (760 sft)
D-Type Residential Building	1 no. (3564 sft)
E-Type Residential Building	1 no (3329 sft)
F-Type Residential Building	1 no. (2623.5 sft)
One training Vessel	Name – TS Siddique

Figure 46 shows the DEPTC site in greater detail.

Figure 46. Eagle eye view of the DEPTC Site

Source: FFR DEPTC, December 2019. Package Passenger S3 Consultant

3.4.7.3. Utilities at DEPTC

Power / Electricity source

Rural Electrification Board (REB) is supplying the electricity at DEPTC, Narayanganj. 11 kV overhead line was drawn up to DEPTC premises. The campus was catered power from the REB's 11 kV overhead line. The present electricity demand of DEPTC is approximately 200 KVA which is supplied through REB's existing 11 kV overhead line passing along the road from the REB's 33/ 11 kV sub-station.

Water supply source

DEPTC has a deep tube well of its own. The capacity of the deep tube well is 10 HP and capable to supply water to the campus. Water from deep tube well store into the underground water tank and lifted to the overhead water tank by the heavy-duty pressure pump and supply sufficient water to the campus with the gravitational forces from the overhead water tank. The buildings of the campus are interconnected with a pipeline network to supply water from the tank.

The prime source of water is the deep tube well which is installed in January 2019. Sufficient water can supply as per the requirement of DEPTC. About 200 students and 15 teachers and 25 peoples for logistic supply in DEPTC. As per Bangladesh National Building Code (BNBC), Item No. 8.5.1 (d), occupancy type A1, use of water for mess, hostels, or boarding house with full facilities will be 135 liters per capita per day, mathematically the present demand of water for use of drinking, washing, ablution =135 x 240=32400 liter. For other use like washing of floors, gardening, and losses=2000 liters. So, the total quantity of water requires is 34400 liters. The deep tube well which is installed in the DEPTC campus can supply the full demand for water.

Drainage & Sewerage

The existing hostel buildings of the students, staff quarters, and administrative buildings are connected with open surface drains built with brick wall and width 300 mm. The drains are connected with a network and proper slope maintained and no water logging problem exists. But all drains are without a cover slab. There is no source of surface water except Shitalakshya river but water from the river is not fit for drinking and household use. The river water is constantly being contaminated by the blind discharge of commercial and pathological wastage, partially treated or untreated sewage effluents, untreated wastage from adjacent industries and from residential area.

3.4.7.4. Master Plan for DEPTC

A single Alternative is presented for DEPTC.

Based on the facility requirement, the area required for the Master plan is provided in Table 36.

Table 36. Area statement for DEPTC

Sl. No.	Item	Unit	Master Plan	Phase I	Phase II	Phase III
1	Administration Building Plinth Area	sq. m	790	790	0	0
2	Admin Building (8 storied)	Sq. m	6314	3701	2613	0
3	Number of Floors of Administration Building	Nos.	8	5	3	0
4	Hostel Building Plinth Area	sq. m	1616	1616	0	0
5	Number of Floors in Hostel Building	Nos.	8	6	2	0
6	Playground Area	sq. m	1720	0	0	0
7	Swimming Pool Area(approx)	sq. m	194	0		194
8	Gym Building Area(approx)	sq. m	129	0		129
9	Staff Quarters Plinth Area	sq. m	316	0	316	0
10	Number of Floors in Staff Quarters	Nos.	8	0	8	0
11	Principal and Vice Principal Quarters Plinth Area	sq. m	116	0	116	0
12	Number of Floors in Principal and Vice Principal Quarters	Nos.	2	0	2	0
13	Internal Road	sq. m	1442	1169	233	80
14	Footpath	sq. m	541	541	0	0
15	Land scaping	sq. m	1070			1070
16	Mosque	sq. m	225		225	

For phase II and III, additional staff quarter, principal residence, and Mosque has to be designed. A playground is also kept in provision in the masterplan. For Phase I the admin building 5-storey and the hostel building will be 6-storeys. Later in the phases, the hostel and the admin building shall be constructed till 8-storeys. The site has lush green landscape incorporated.

DEPTC is surrounded by a boundary wall, and the total area inside is owned by DEPTC. So, there is no requirement of land acquisition.

Based on the facility requirement and planning consideration, two options were presented during the Draft Feasibility Report submission. Further to which Option – 1 as presented below was approved and the same has been considered for planning and design. However, the option-2 presented in DFR is reproduced in Annex2to this ESIA Report. based on the facility requirement, a master plan only for Phase I is provided in Figure 47.

With respect to sewerage, the system will be pipeline network around the building with proper slope and will be discharged into the septic tank. The septic tank will relate to the soak well with pipe. The soak well will filter the wastewater that comes from septic tank and will discharge into the river.

With respect to Storm water drain, the rainwater will pass through the pipeline network around the project area and ultimately will be discharged into the river directly without any treatment. Considering the no. of students, instructors & staffs at DEPTC, S3 Consultants recommend Sewage Treatment Plant (STP) for treating the sewage before discharging the same. However, due to the budget limitations, STP is not considered in Phase I. Further, this matter is discussed with the client and it was jointly finalized that, in Phase I, Septic Tank will be provided and in Phase II, Client will build the STP.

Power Requirements

The power demand for the proposed DEPTC building including other necessary function is approx. 800 KVA.

As per rule if the demand is more than 50 KW then the consumer will be supplied power through the consumer's own installed sub-station. As the load forecast of the proposed terminal is more than 50 KW, so a sub-station shall be required for the DEPTC.

Water Supply

The DEPTC needs daily use of water for the drinking of the students/officials, in toilets, baths, washing, firefighting, gardening, cooking, washing of floors, parking, ablution for prayers and other works.

Quantity of water required per day:

- At present, the total number of students is 200. It can be predicted that in future the number of students will be increased and it may be as 400.
- As per BNBC (Bangladesh National Building Code) guidelines, the quantity of water required
- 135 liters per capita per day.
- Water require =400 students x 135 liters =54000 liters.
- For use of administrative buildings, staff quarters =40 people x 135 liters =5400 liter.
- For firefighting operation and considering 1-hour period with 4 fires at a time, the quantity of water will be required =1100 liter/minute x 60-minute x 4 fires =264000 liter.
- For washing of floors, gardening etc.=20000 liters.
- So, the total quantity of water requires 343400 liters per day.
- But minimum quantity 79400 liters, (ignoring fire work as daily basis).
- Considering the loss of water as 20%, the minimum water requirement 95280 liters per day.
- DEPTC installed a deep tube well with a pump house and one more deep tube well will be installed for back up option.

Sources of water

Water from deep tube well will be supplied through the pipeline network to be installed in the campus. Water from deep tube well will be stored into the underground water tank and will be lifted by water pump to the roof top water tank or overhead water tank and will be delivered to the campus by gravitational forces through pipeline network.

Drainage and Sewerage

With respect to sewerage, the system will be pipeline network around the building with proper

slope and will be discharged into the septic tank. The septic tank will be connected with the soak well with pipe. The soak well will filter the wastewater that comes from septic tank and will discharge into the river.

The capacity of Septic tank to be provided is 18 m^3 and also 1 soak well will be required for sewerage digestion operation if the septic tank cleans each year. One more tank will be installed for back up option.

With respect to Storm water drain, the rainwater will pass through the pipeline network around the project area and ultimately will be discharged into the river directly without any treatment. Considering the no. of students, instructors & staffs at DEPTC, Consultants recommend Sewage Treatment Plant (STP) for treating the sewage before discharging the same. However, due to the budget limitations, STP is not considered in Phase I. Further, this matter is discussed with the client and it was jointly finalized that, in Phase I, Septic Tank will be provided and in Phase II, Client will build the STP.

Figure 47. DEPTC master plan for Phase I

3.4.8. Barishal Site

3.4.8.1. Project Location and Brief Summary

The Barishal River port is located on south western region of lower Meghna River. Barishal River Port is on the right bank of Kirtonkhola River (which branches from lower Meghna River). The waterway distance from Sadarghat to Barishal is about 150 Km towards south.

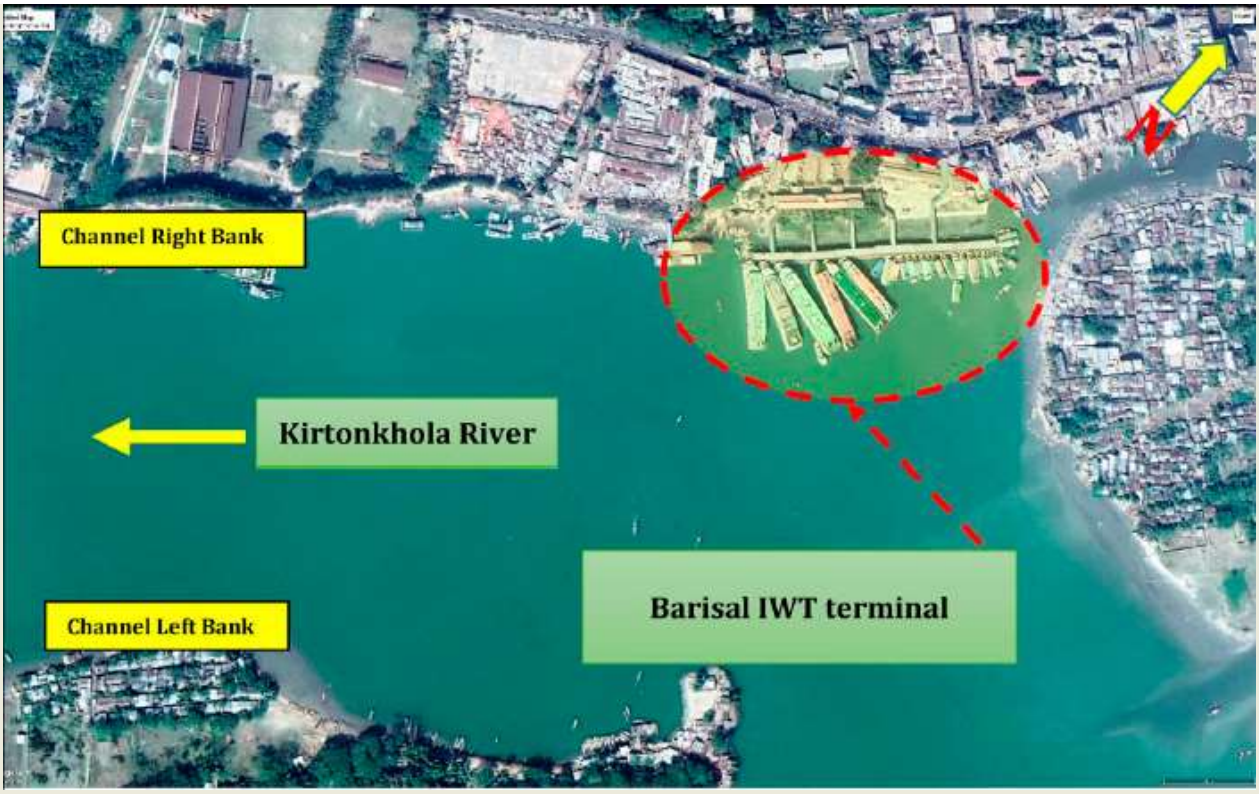


Figure 48. Satellite Imagery showing Barishal Site

Source: FFR Shasanghat IWT terminal, December 2019. Package Passenger S3 Consultant

Barishal port was established long back during the British period, the port was used by Streamer Company, for their steamer route from Calcutta (Kolkata) to Chandpur and Narayanganj. The company had their own buildings and ghat. The present port buildings were constructed in 1964. Existing facilities include two-storied terminal building, passenger waiting space, 6 nos. of pontoons, 4 nos. of gangway, cargo shed, transit shed, parking yard and access road. The land area of Barishal is confined between the Steamer Ghat Main road on the West and the river Kirtonkhola on East side.

The available width at the Barishal passenger terminal is about 450 m. Here also space constraints due to bottle neck conditions of the Kirtankhola River, and it might create hurdle for planning the terminal and navigation of the vessels. After Sadarghat, Barishal is the second largest IWT Passenger terminal in terms of traffic Origin / Destination is concerned.

Similar to Sadarghat, even in Barishal, nose berthing of vessels is done. However, in VIP jetty (in Steamer Ghat) alongside berthing is done for special speed boats / vessels.

It is observed that there are no handrails on the side of pontoons and vessels which is essential for passenger safety. BIWTA has leased about 2 Acres of area earmarked for new terminal building to Municipal Corporation which in turn has sub leased to small shop keepers (about 200 shops) who are utilizing that area as Barishal City Market (Figure 49). Therefore, this poses a social and resettlement challenge.

Figure 49. Entrance of Market at Barishal Port

Source: FFR Barishal IWT terminal, December 2019. Package Passenger S3 Consultant

It is observed that many encroachments to the connecting roads were present which would pose difficulty in passenger arrival and evacuation from these terminals.

The waste from the vegetable market is directly disposed into the river (0). It is creating water pollution and can make difficult to navigation. There shall be proper disposal facility for the waste.

Figure 50. Garbage thrown directly into the river

3.4.8.2. Terminal capacity and main features

All data and tables and figures have been sourced from FFR Shasanghat IWT terminal, December 2019, Package Passenger S3 Consultant. Passenger traffic forecasts for Barishal are summarized by project phase in Table 37.

Table 37. Phase wise Passenger Traffic Details for Barishal River Port

Particulars	Phase - I	Phase - II	Phase - III
Total Passenger Traffic (No.) (Including local and long distance traffic)	23,888	28,166	34,623
On Saturdays – When Departure Traffic is at its peak			
Evening Peak Hour Duration (Hrs.) (For Long Distance Routes)	3	3	3
Passenger Traffic (Departure)during Evening Peak Hour for Long Distance Routes	3,403	3,267	3,899
On Fridays – When Arrival Traffic is at its peak			
Morning Peak Hour Duration (Hrs.) (For Local Connectivity Routes)	2	2.5	2.5
Passenger Traffic during Morning Peak Hour for Local Connectivity Routes	886	901	1,108
Morning Peak Hour Duration (Hrs.) (For Long Distance Routes)	2	2	2
Passenger Traffic during Morning Peak Hour for Long Distance Routes (No.)	5,105	4,905	5,438

Table 37 identifies vessel sizes and seating capacities for Barishal.

Table 38. Vessel Size and Passenger Seating Capacity Distribution for Barishal Riverport

Vessel Category	No. of Departures Per Day based upon Time Schedule	% of Total Departures Per Day According to Time Schedule	Total Seating Capacity carried by Respective Vessel Categories	% of the Seating Capacity Carried by Respective Vessel Categories
Super Large (70 m – 90 m)	6	13%	5,015	36%
Large (50 m – 70 m)	2	4%	924	7%
Medium (30 m – 50 m)	8	17%	3,174	23%
Small (10 m – 30 m)	30	65%	4,703	34%
Total	46	100%	13,815	100%

Final Vessel scenario trend for proposed Barishal river port is as presented in Table 38.

Table 39. Future Vessel Scenario for Proposed Barishal River Port

Source: FFR Shasanghat IWT terminal, December 2019. Voyants Solutions (VSPL), maritime Consultancy (ICPL) and Unicom (UIL)

Table 5.7 : Vessel Size Trend over the Design Period for Barishal River Port for Vessels along Long Distance Routes

Vessel Category	Passenger Share carried by Various Categories of Vessels				
	Yr. 2018	Yr. 2022	Yr. 2029	Yr. 2036	Yr. 2042
Super Large (70 m – 90 m)	66 %	66 %	66 %	68 %	68 %
Large (50 m – 70 m)	12 %	14 %	14 %	16 %	18 %
Medium (30 m – 50 m)	22 %	20 %	20 %	16 %	14 %
Small (10 m – 30 m)	0 %	0 %	0 %	0 %	0 %

Table 5.8 : Vessel Size Trend over the Design Period for Barishal River Port for Vessels along Local Connectivity Routes

Vessel Category	Passenger Share carried by Various Categories of Vessels				
	Yr. 2018	Yr. 2022	Yr. 2029	Yr. 2036	Yr. 2042
Super Large (70 m – 90 m)	0 %	0 %	0 %	0 %	0 %
Large (50 m – 70 m)	0 %	0 %	0 %	0 %	0 %

Vessel Category	Passenger Share carried by Various Categories of Vessels				
	Yr. 2018	Yr. 2022	Yr. 2029	Yr. 2036	Yr. 2042
Medium (30 m – 50 m)	50 %	50 %	50 %	50 %	50 %
Small (10 m – 30 m)	50 %	50 %	50 %	50 %	50 %

3.4.8.3. Passenger Terminal

All data and tables and figures have been sourced from FFR Barishal IWT terminal, December 2019. Voyants Solutions (VSPL), maritime Consultancy (ICPL) and Unicom intelext (UIL)

Terminal building requirements

Table 40 provides the summary of facilities and area requirement for Barishal terminal

Table 40. Barishal Terminal Building Area Requirements

Sl. No.	Description	Area Requirement for Phase I (sq.mt.)	Area Requirement for Phase II (sq.mt.)	Area Requirement for Master Plan
1	Terminal Facilities	4,017	For Phase II, additional development of 3,962 Sq. m. is envisaged	For Master plan requirement additional development of 850 Sq m. is envisaged
2	Services	708		
3	Amenities	4,349		
4	Management Offices	2,560		
5	Rentable Area	539		
6	Accommodations	94		
7	Miscellaneous	386		

Parking area requirement

Table 41 provides the summary of parking areas required Shasanghat terminal

Table 41. Barishal Parking area requirement

			Phase - I	Phase - III
A	Peak Hour Traffic		632	496
B	Peak Hour Traffic Considered for Parking Calculation*		600	471
C	30 Minutes Traffic Considered for Parking and Dropping		300	236
Sl. No.	Particulars	Proportion	Total Area (m²)	Total Area (m²)
1	Bus (50 Seater)	20%	72	30
2	Cycle Rickshaw (2 Seater)	10%	48	36
3	CNG (3 Seater)	50%	204	160
4	Mini VAN	10%	30	20
5	Car and Taxi (PCU)	10%	114	88
	Total Area Required for parking of vehicles		500	400
	Area Considered for Planning and Design *(60% area additional considered for Parking Clearance and Circulation and steps)*		**800**	**700**

Internal Roads

Two lane internal road of width 7 m is provided all around the terminal wherein road which would act as drop-in / drop-off as well as enable the accessibility from all sides of terminal during emergency situation.

External Roads.

External roads will serve the purpose of last-mile connectivity to major road junctions for the passengers arriving/departing the terminal. It is suggested that the external connecting roads should be at least two-(2) lane road of 7 m width, considering the area/land availability. Further expansion of road width shall be discussed with the PWD department considering the Masterplan Landscaping and green overall Landscaping & Green cover should be provided for minimum of about 20% of the land development area. The Landscaping and Green cover proportion may vary with site specific condition and space utilization factor of site.

Power Requirements

Bangladesh Power Development Board (BPDB) is responsible for power supply at Barishal terminal area. 11KV overhead line of BPDB was passed along the road nearby the terminal. The terminal will be feed from this overhead 11KV line. As per rule if the demand is more than 50KW then the consumer will be supplied power through consumer's own installed sub-station. As the load forecast of the proposed terminal is more than 50KW, so a sub-station shall be required for the terminal.

The power demand for the proposed Barishal terminal building including other necessary function is approx. 1600KVA including present and future requirement

Water requirements

The proposed terminal needs daily use of water for drinking of the passengers, in toilet, baths, washing, firefighting, gardening, cooking, washing of floors, parking, ablution for prayers and other works.

Quantity of Water required per day:

- The calculated passenger is about 7,220 per hour (peak hour).
- Considering 10 percent of passengers that is about 722 passengers will use W.C, urinals, drinking, washing and as per BNBC (Bangladesh National Building Code) guidelines, quantity of water required 8 liters per capita per day. Water will be required =722 passengers' x 8 liters x6 hours = 34,656 liters. (Considering peak period as 6 hours).
- For firefighting operation and considering 1-hour period with 4 fires at a time, the quantity of water will be required =1100 liter/minute x 60 minute x 4 fires =264000 liter.

- For other works like washing of floors, gardening etc. considering =10000 liter. For people (BIWTA) employed for operation and maintenance of terminal building, considering= 500x8 liters=4000 liters,
- Considering consumption of water for drinking, washing, using toilets into water vessels =1000 liters/vesselx30 vessels=60000 liters.

So, total quantity =3,37,320 liter of water will be required per day. But minimum quantity 73,320 liter, (ignoring firefighting works as daily basis). Considering loss of water as 20%, the minimum water requirement 87,984 liter per day. It is estimated that, about 90,000 liter of water will be required each day.
Barishal terminal has a water supply connection from City Corporation. Barishal terminal installed a deep tube well with a pump house. The deep tube well has a capacity of 2 Horsepower only. The water from deep tube well as well as supply from City Corporation capable to meet its present demand of the existing terminal. At present there is no information on water quality of deep aquifer therefore water quality analysis should be taken before the establishment of a swwp tube well as water source for the terminal.

Sewage treatment

Considering the quantum of passenger traffic flow in Shasanghat, Consultants recommend Sewage Treatment Plant (STP) for treating the sewage before discharging the same. In Phase-1, Septic Tank will be provided and in Phase- 2, BIWTA will build the STP.

3.4.8.4. Recommended layout for water side

Based on the analysis, alternative layout no.-1 (with Pontoon based Finger Pier Berthing Arrangement) and alternative layout no.-5 (with Pontoon based Parallel-Alongside Berthing Arrangement) were recommended for implementation in phased manner, considering the existing operational model which is derived based on market forces, Passenger Terminal Package consultant has kept the provision of Alternative-3 (Bow-Berthing) for further evaluation by the client.
Thus, three alternatives for Water Side were recommended, and a corresponding Master Plan developed as discussed below.

3.4.8.5. Water side development pontoons and linkspan

Same design as Shasanghat terminal.

3.4.8.6. Land Side Plan

Based on the facility area requirement analysis the land side Master Plan is prepared for implementation in the phased manner. Land Side Master Plan is presented hereinafter.

Figure 51. Barishal Terminal Land Side Master Plan

3.4.8.7. Recommended layout for water side

Based on the analysis, alternative layout no.-1 and alternative layout no.-5 were recommended for implementation in phased manner, considering the existing operational model which is derived based on market forces, Passenger Terminal Package consultant has kept the provision of Alternative-3 for further evaluation by the client. Thus, three alternatives for Water Side were recommended, and corresponding Master Plan developed as bellow:

Recommended alternatives include:

- Alternative layout no. 5 (with Pontoon based Parallel-Alongside Berthing Arrangement). Recommended Water Side Layout – Option-1
- Alternative layout no. 1 (with Pontoon based Finger Pier Berthing Arrangement). Recommended Water Side Layout – Option 2
- Alternative layout no. 3 (Bow Berthing Arrangement). Recommended Water Side Layout – Option 3

3.4.8.8. Integrated Master Plan

The Land Side Master Plans and the Water Side Master plan for year 2042 is integrated together and is presented as below:

- 1. Integrated Master Plan-Option-1 *(Approved layout by client)*
- 2. Integrated Master Plan-Option-2
- 3. Integrated Master Plan-Option-3

Integrated Master Plans Option 1 for Barishal is illustrated in Figure 52.

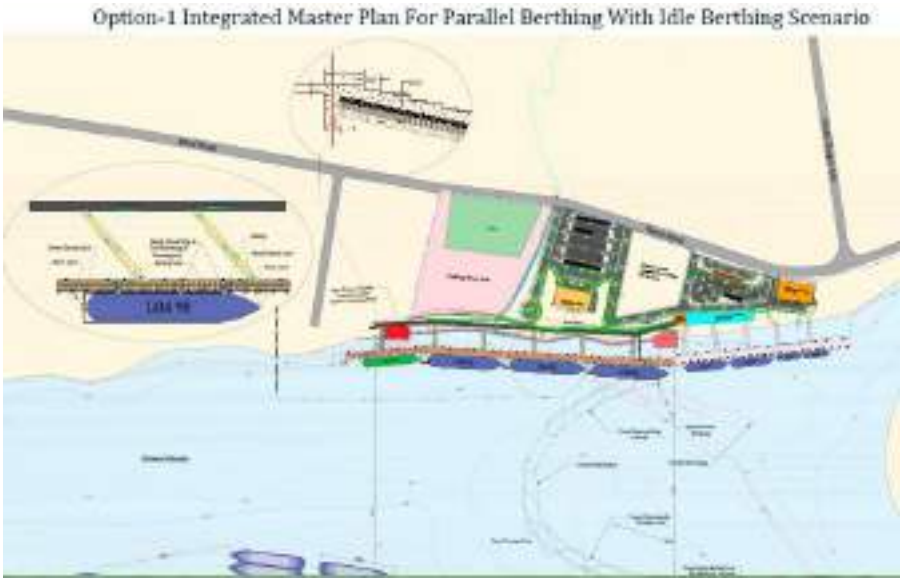


Figure 52. Integrated Master Plans Option 1 for Barishal Terminal

3.5. CARGO TRANSPORTATION

3.5.1. General

Bangladesh is one of the largest deltaic countries and constitute large Inland Water Transport (IWT) sector. About 6,000 kms of river length are navigable during the monsoon period, decreasing to about 3,900 km in the dry periods. IWT carries approximately 194 million tons (MT) of cargo and about 25% of all passenger traffic. BIWTA under the Ministry of Shipping (MOS) is responsible for the Development and control of IWT. BIWTA's network by category is presented in Table 42.

Table 42. BIWTA Network by Category

IWT Route Classification	LAD (m)	List of Rivers under IWT Classification of BIWTA
Class- I	3.66 m	Meghna River, Buriganga River, Shitalakhya River (Lower), Kirtonkhola River, Illisha River, Mower Meghna River, Kacha River, Sarupkati River.
Class- II	2.13 m	Gumti River, Jayanti River, Shitalakhya River (Upper), Padma River, Jamuna River, Shurma River, Dharmaganj River
Class -III	1.52 m	Buriswar River, Tentulia River, Lohalia River, Galachipa River
Class -IV	< 1.52 m	

Cargo transportation occurred mainly on the Class-I river routes between Chittagong, Narayanganj, Dhaka and also between Mongla and Khulna. Commodity profile includes dry bulks (clinker, fertilizers, food grains, coal etc.), liquid bulks (petroleum products) and general dry cargo (sand, cement, bricks, stone, Paddy, etc.). The dry and liquid bulks are generally off loaded at private jetties. General cargoes are handled at limited number common user facilities or directly over the riverbanks mainly by manual labor.

Within this chapter, data, figures and tables have been sourced from Final Feasibility report, June 2019, and Draft Detailed Report dated October 2019, prepared by Package Cargo Terminal S4 Consultant DDC and Ramboll.

3.5.2. Expected Commodity for proposed cargo terminals.

Based on the study performed by the consultants the following commodities as shown in Table 43 have been identified as the major contributor in the IWT system using freight Vessels.

Table 43. Major contributor in the IWT system commodities using freight Vessels

Imported Cargo	Domestic Cargo
Clinker	Cement
Lime Stone	Stone
Gypsum	Sand
Fertiliser	Bricks
Wheat	Paddy
Log	
Maize/ Corn	
Sugar	
Soybean	
Coal	
Stone Dust	

From the Feasibility Study and Sector study carried out expected commodity for proposed Pangaon and Ashunganj Terminal are indicated in Table 44:

Table 44. Expected commodity for proposed Pangaon and Ashunganj Terminal

Pangaon	Ashunganj
Fertiliser Wheat Maize/ Corn Stone Dust Cement	Fertiliser Wheat Cement Paddy

Table 45 summarizes future potential IWT traffic for Pangaon and Ashunganj cargo terminals.

Table 45. Summary of Future Potential IWT Traffic (MMTPA).

Source : Feasibility Study Report, S4 Consultant, DDC - Ramboll, 2019

Commodity Reference		Pangaon							Ashuganj						
		Dry Bulk	Dry Bulk Grains				Bagged		Dry Bulk	Dry Bulk Grains				Bagged	
		Fertiliser	Wheat	Maize/ Corn	Soybean	Total	Cement	Paddy	Fertiliser	Wheat	Maize / Corn	Soybean	Total	Cement	Paddy
Base Case	2019-20	0.258	0	0	0	0	0.346	0	0.237	0.118	0	0	0.118	0.958	0.040
	2024-25	0.277	0.224	0.044	0.021	0.288	1.01	0	0.255	0.224	0.044	0.021	0.288	2.055	0.050
	2029-30	0.299	0.512	0.069	0.034	0.614	3.237	0	0.275	0.512	0.069	0.034	0.614	2.055	0.060
	2034-35	0.322	0.921	0.084	0.041	1.046	2.946	0	0.296	0.921	0.084	0.041	1.046	2.055	0.090
	2039-40	0.347	1.648	0.101	0.05	1.798	3.811	0	0.319	1.648	0.101	0.050	1.798	3.878	0.100
High Case	2019-20	0.285	0	0	0	0	0.691	0	0.244	0.118	0	0	0.118	1.407	0.050
	2024-25	0.307	0.268	0.052	0.029	0.349	2.02	0	0.283	0.268	0.052	0.029	0.349	2.740	0.060
	2029-30	0.356	0.614	0.082	0.045	0.741	4.046	0	0.328	0.614	0.082	0.045	0.741	2.740	0.080
	2034-35	0.413	1.105	0.101	0.055	1.261	3.683	0	0.380	1.105	0.101	0.055	1.261	2.740	0.100
	2039-40	0.479	1.977	0.121	0.066	2.164	4.573	0	0.441	1.977	0.121	0.066	2.164	4.655	0.150
Low Case	2019-20	0.250	0	0	0	0	0	0	0.230	0.118	0	0	0.118	0.469	0.030
	2024-25	0.250	0.179	0.035	0.014	0.228	0.505	0	0.230	0.179	0.035	0.014	0.228	1.370	0.035
	2029-30	0.250	0.409	0.055	0.023	0.487	1.619	0	0.230	0.409	0.055	0.023	0.487	1.370	0.055
	2034-35	0.250	0.736	0.067	0.028	0.831	1.473	0	0.230	0.736	0.067	0.028	0.831	1.370	0.067
	2039-40	0.250	1.318	0.081	0.035	1.432	2.667	0	0.230	1.318	0.081	0.000	1.399	2.792	0.081

3.6. DESCRIPTION OF EXISTING AND PROPOSED FACILITIES OF CARGO TERMINALS

Description of the existing and the proposed facilities at the Panagaon and Ashuganj cargo terminal sites, are provided in Table 46:

Table 46. Description of the existing and the proposed facilities at the Cargo terminal sites

Pangaon Cargo Terminal	Existing Facilities	Proposed Facilities
Located next to existing Pangaon Container terminal on Buriganga River, near Dhaka	Greenfieldsite. No existing facilities but used as landing station for small river crossing boats.	The proposed facilities include: ▪ Two berths, constructed on RCC piles with a suspended deck – total length 190m with expansion joint.; ▪ An apron area of approximately 2,750 square meters ▪ An open storage area of 2,220 square meters; ▪ A transit Shed of 1,500 square meters; ▪ Vehicle parking areas of 5000 square meters; ▪ Office building (1500m2) ▪ Bank Protection (375m) ▪ Boundary wall (700m) ▪ A new port road of 400m length together with a gate house. ▪ Electrical work (sub station, flood light) ▪ Firefighting system ▪ Provision of crane, fork lift and other handling equipment.
Ashuganj Cargo Terminal	**Existing Facilities**	**Proposed Facilities**
Located on Upper Meghna River	Established in 2004. Existing facilities include: ▪ office (150 m2), ▪ RCC Jetty (425 m2), ▪ steel jetty (90 m2) ▪ pontoons – 2nos. ▪ gangway, ▪ warehouse (225 m2) parking area (1000 m2)	Proposed facilities include: ▪ Office building (1000m2), ▪ RCC Jetty (2x425m2=850m2), ▪ steel jetty – (2x45m), ▪ Apron area 2750m2 ▪ Open storage area=2220m2 ▪ Steel Gangway (02 nos) ▪ Terminal pontoon- 2nos., ▪ gangway – 2nos., ▪ bank protection (400m), ▪ warehouse (225 m2), and ▪ parking area (2000 m2) ▪ Port road (1600 m) ▪ Boundary wall (500m) ▪ RCC ramp (02nos) ▪ SPUD ▪ Electrical work (substation, flood light) ▪ Firefighting system ▪ provision of crane, forklift and other handling equipment.

The main differences between both terminals are the dimension of the terminal areas and the length of berthing facility. Berthing facility is designed similar: berth constructed on RCC (reinforced cement concrete) piles with a suspended deck. Land side infrastructures are also similar. Facilities required for both terminals are listed in Table 47.

Table 47. Water side and Land side development proposed for cargo terminals

Facilities proposed for both Terminals
Jetty (RCC piles, suspended deck)
Provision of crane, forklift and other handling equipment.
Covered Storage and Open stake yard
Parking+ circulation
Terminal road
Service building
workshop
Welfare office & canteen
Gate
bank protection,
Electrical work (substation, flood light)
Firefighting system
Utility (septic tank, soak well)
Walkway, median verge, etc.

3.7. PANGAON CARGO TERMINAL

3.7.1. Project location

Proposed terminal is located adjacent to the Pangaon inland container port (ICT) at Keraniganj, on the bank of river Buriganga, located at Keraniganj Upazila of Dhaka district (Figure 53). The area is surrounded by industrial establishments, banks, shops, markets and educational institutions.

The Inland Container Terminal (ICT) exists since 2013 on the western bank of Buriganga River, about 20 km from the Dhaka Metropolitan Area, in an industrial suburb of Keraniganj Upazila. This Terminal was developed by BIWTA and is now operated by CPA. Proposed Terminal site has been planned to be located towards the upstream of the existing ICT (Figure 54).

Area identified for the proposed Terminal facility is vacant land presently. Within this area, presently, one landing station with pontoon facilities for river crossing of passengers exists.

The draft of the river is around 4.5 Meter. At high tide, vessel ranging from 4 to 5-meter draft can move easily. River bank is generally quasi steep (expected to be 1:5).

Existing ICT is located about 4.50 km from the Dhaka - Mawa Highway. Junction at Dhaka- Mawa Highway is congested and cumbersome. Pangaon Terminal Road is 2 Lane Road with roadside establishment. Strengthening and widening of this road is necessary for the efficient dispersal of the Traffic from/ to Terminal. Location is not connected with Rail connection.

Figure 53. Index Plan of the Proposed New Cargo Terminal at Pangaon

Source: FFR Pangaon IWT terminal, June 2019. Package S4 Consultant

Figure 54. Existing ICT Jetty - Water Side View

Source: FFR Pangaon IWT terminal, June 2019. Package S4 Consultant

Figure 55. Pangaon cargo terminal proposed area and access road

Source: TYPSA

3.7.2. Pangaon Master Plan

All data and tables and figures have been sourced from FFR Cargo Terminals, June 2019, Package S4 Consultant.

3.7.2.1. Terminal capacity and main features

Berth capacity is the main bottleneck of the terminal. The length of the quay and available storage area however are very compatible, and the area shape good for port operations. The proposed terminal layout is estimated to have a capacity of approx.2.4 million tonnes/year which is expected to be distributed between cargoes as presented in Table 48.

Table 48. Estimated Maximum Terminal Capacity in Pangaon, for the expected combination of vessel calls and cargo by 2026-2028.

Particulars	Cargo						
	Wheat	Fertilizer	Corn	Soya	Cement– Fixed berth	Cement– Pontoon berth	All cargo
Throughput (Tonnes/yr)	1,173,000	165,000	49,500	24,200	253,000	690,000	2,354,700

The design principle is to have a quay without fixed structures and with warehouses next to the quay, aiming for a versatile and flexible solution. The suggested quay structure is a 362 m long pile supported concrete deck with a width of 25 m. It will yield space for 3 berths for LOA = 82.5 m ships, and 2 pontoon berths in the northern part of the quay for smaller vessels transporting bagged cargo. The 2 large berths closest to existing ICT (Quay 1 and 2) will handle food grain arriving as bulk, while Quay 3 will serve fertilizer and cement vessels.

The 2 pontoons for smaller vessels will be in shallower waters and less maintenance dredging can be expected.

Two pneumatic unloaders will be used for unloading food grains from ships. There will be two bagging equipment on the quay, each with a productivity of approx. 100 tonnes/hr. and containing two bagging lines. Fertilizer will be unloaded by a material handler supplying two hoppers and bagging units on the quay. Cement will be unloaded by a crane or bag conveyors. Cargo will be loaded directly on trucks or stored in warehouses as bags.

The terminal will contain 7 warehouses of 1,800 m2 (total 12,600 m2) where 2 are dedicated to cement, 1 is dedicated to fertilizer and 4 to food grains. An area of approx. 485 m2 is left undeveloped in front of each warehouse (total 3,395 m2) and can potentially serve as open storage yards for dry and break bulk in the future. Required cargo storage capacity depends on the dwell time estimated from the traffic study and should be adapted when in operation. Warehouses are planned now for bags, but can be used for other cargoes as well, also for bulk.

Figure 56 shows the proposed Master Plan for Pangaon Cargo Terminal.

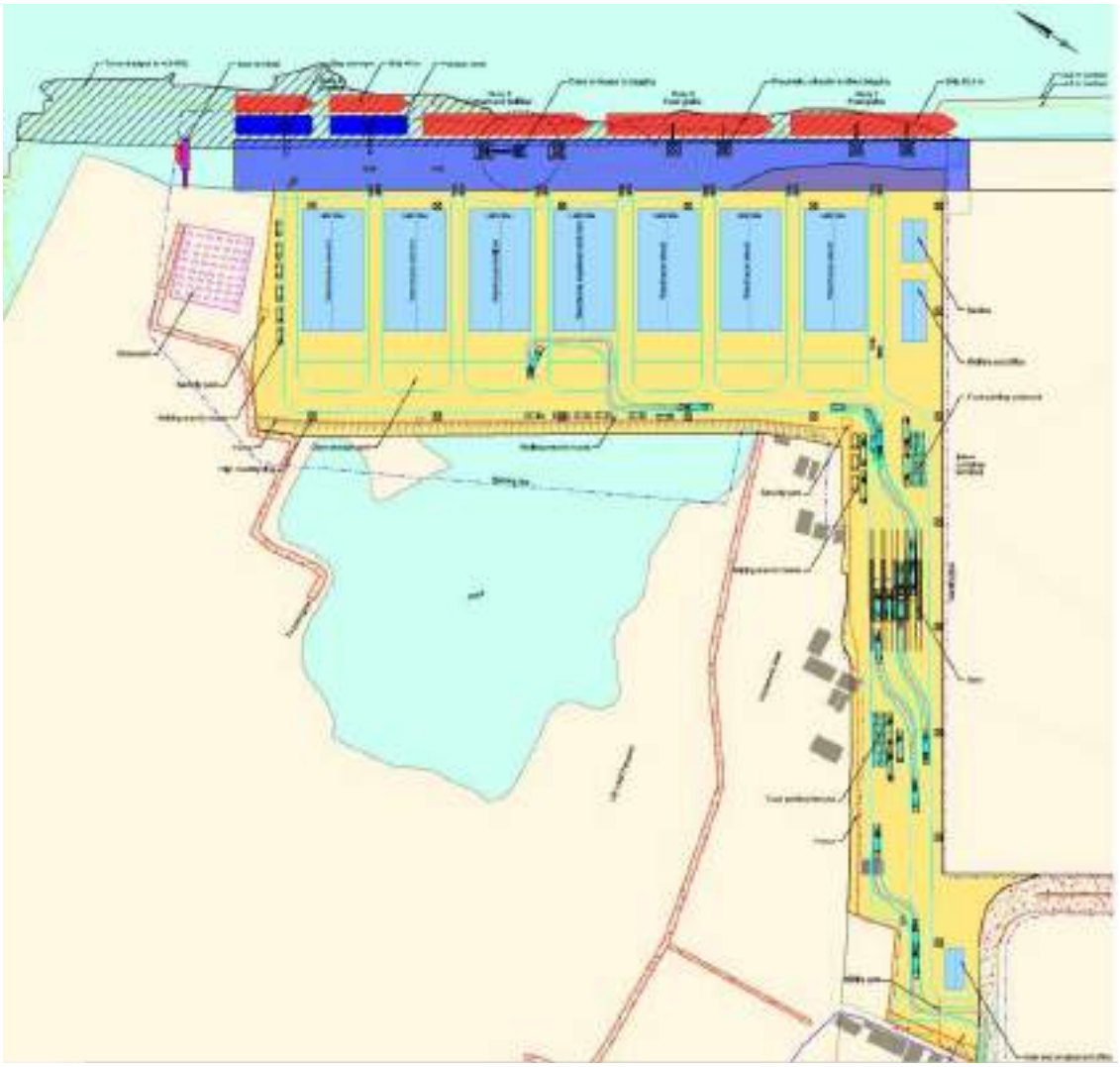


Figure 56. Proposed MasterPlan Layout of Pangaon Cargo Terminal.

Source: Feasibility Report. June 2019. Package S4 Consultant

3.7.2.2. Water side development: Pile Deck and Cargo Handling System and Equipment

Water side development: Pile Deck

As stated above a pile-supported concrete platform (suspended deck) is the most feasible alternative for a fixed quay structure and at the same time only practical solution for the location. Being founded on piles, such structure overcomes poor soil conditions directly, by carrying the loads down to the firm strata.

Pile deck (Figure 57) is 362m long and divided in 8 equal segments, separated by dilatation joints.

The deck is supported by the concrete beams going along the length of the quay. Beams are in turn supported by bored piles, D=1000mm, placed in a 5.5 X 6.8 m matrix. The suspended deck (Figure 58) is designed to withstand a range of quay specific loads, such as mobile crane, trucks with trailers and distributed live load of 30 kN/m2.

Figure 59 shows cross section of pontoon berths for smaller vessels.

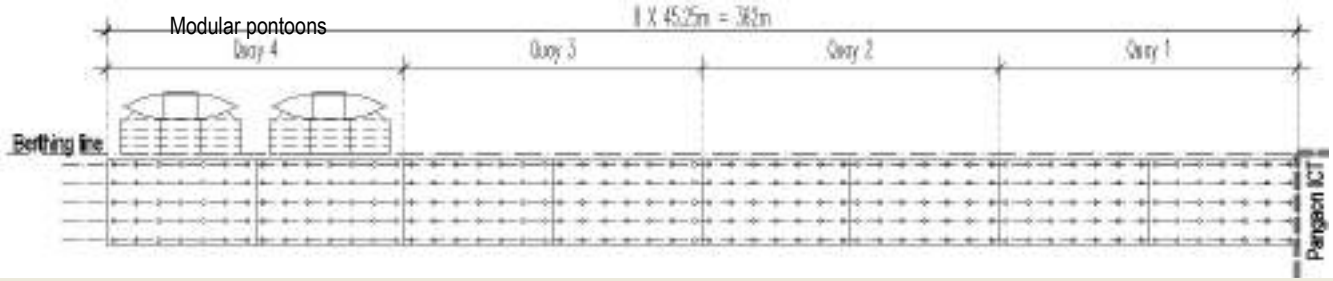


Figure 57. General Arrangement of Pangaon Terminal Jetty

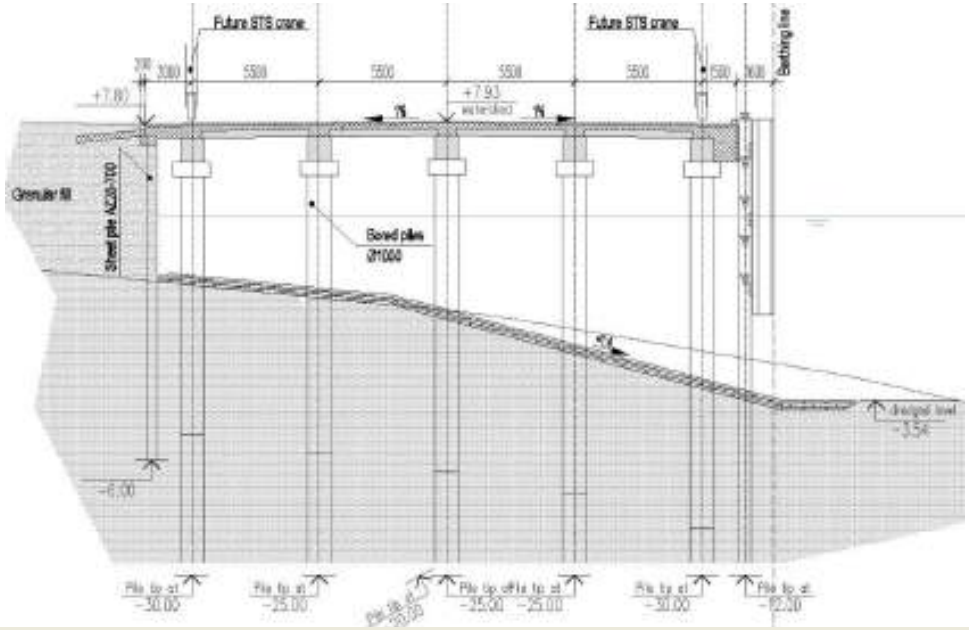


Figure 58. Typical Cross Section of Pangaon Suspended Deck Structure

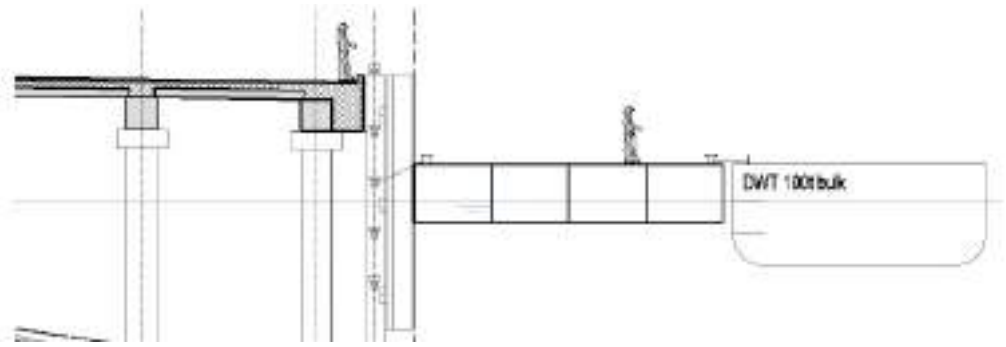


Figure 59. Example of Modular Pontoons at the Berths for Cement Bag Handling

Cargo Handling System and Equipment

- Cement bags

For small vessels, cement bags will be unloaded by using pontoons to berth the vessels. The recommended method to unload bags from the vessel on to the pontoon is manual handling. Bag conveyor could be possible, but a proven existing equipment was not found. Transporting bags from the pontoon up to the fixed quay platform will be done by a conveyor system or a material handler.
It is recommended that the chosen operator selects and develops appropriate transport system according to their operational practices.

- Fertilizer

Fertilizer will be unloaded by a material handling and a grab attached to it. The material handler will supply two bagging units on the quay.

- Food grains

Food grains will be unloaded by two pneumatic unloaders. Unloaders will supply two bagging units on the quay.

3.7.2.3. Land side development

- Cargo Storage

Bag cargo will be stored in warehouses. Warehouses are PVC coated relocatable buildings. The size of the buildings will be 1,800m^2, 30 m wide and 60 m long. The warehouse will be equipped with lighting and a simple fan. There will be large doors (roller) in both ends of the buildings as well as normal pedestrian doors.

- Gate

There is enough space for a modern gate system. The gate consists of two lanes in and two lanes out with a small post for gate operators. Lanes are equipped with remotely operated boom gates.

- Gate Office (security and administrative)

A gate office is located outside the security are. The location provides good capability to establish employment office so that potential employees don't have to go inside the security area.

- Office (operational) and welfare building

The main office building has three floors. Operational offices and welfare functions are located on the ground floor. Canteen and support functions (IT, cleaning, etc.) are located on the second floor and administration on the third floor.

- Service

The service building consists of a high service and spare part room as well as maintenance office and welfare spaces. Additionally, ship welfare functions could be in this building, if required.

- Basic Infrastructure

Development proposal includes Land Development, Boundary Wall & Gate, Internal Road & Yard Paving, Water Supply and Sewerage System, Drainage System, Fire Fighting System, Power Supply, Bank Protection, Environmental Mitigation Measures enough to cater the demand.

3.7.2.4. Existing passenger jetty

The existing passenger jetty has been relocated and placed behind the quay structure on the upstream side such that transportation of passengers across the river can continue without interfering with cargo operations. As indicated on the master plan layout, an existing road along the pond and graveyard ensures that passengers can walk to and from the jetty.

3.7.2.5. Pangaon cargo terminals alternatives

Plan layout alternatives studied and assess during feasibility study are shown in Annex 2.

3.7.3. **Pangaon Terminal final Design**

Figure 60 shows Pangaon Cargo Terminal Detail design general layout. The layout design shows Phase 1 and Phase 2 under the selected layout after Feasibility Study.

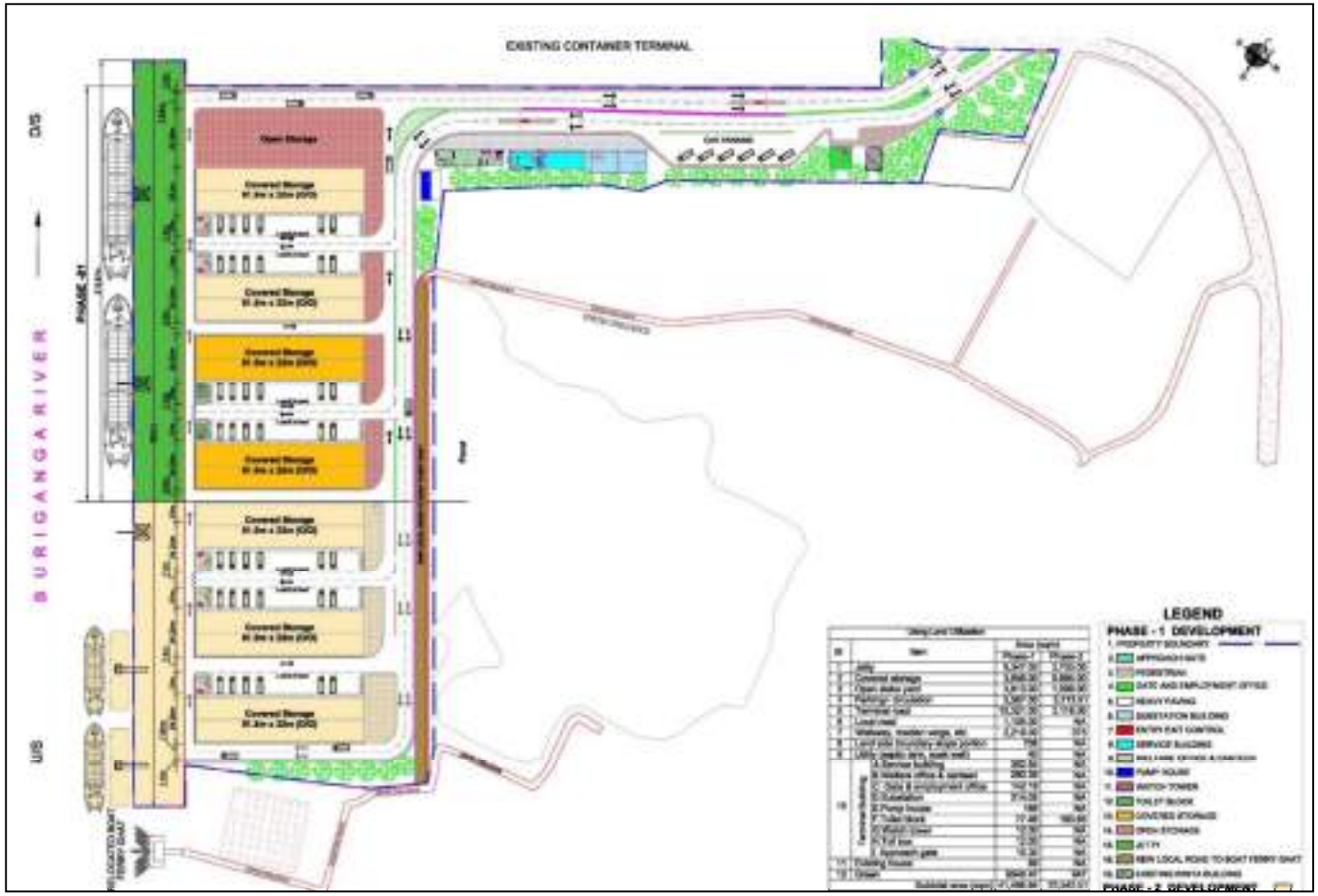


Figure 60. Pangaon Terminal final Design

Source: Draft Detailed report. October 2019. Package S4 Consultant

3.7.3.1. Final layout

Land use requirements for Pangaon Cargo Terminal are listed in Table 49.

Table 49. Land use areas for Pangaon cargo terminal

Using Land Utilization				
SI	Item		Area (sqm)	
			Phase-1	Phase-2
1	Jetty		5.347,00	3.703,00
2	Covered storage		3.958,00	9.895,00
3	Open stake yard		3.813,00	1.099,00
4	Parking+ circulation		5.567,00	3.213,51
5	Terminal road		10.321,00	3.118,00
6	Local road		1.105,00	NA
7	Walkway, median verge, etc.		2.219,00	373,00
8	Land side boundary slope portion		706,00	NA
9	Utility (septic tank, soak well)		40,00	NA
10	Terminal Building	A. Service building	352,54	NA
		B. Welfare office & canteen	280,39	NA
		C. Gate & employment office	142,18	NA
		D.Substation	314,05	NA
		E. Pump house	168,00	NA
		F. Toilet block	77,46	193,65
		G. Watch tower	12,00	NA
		H. Toll box	12,00	NA
		I. Approach gate	15,30	NA
11	Existing house		89,00	NA
12	Green		6.949,47	947,00
Subtotal area (sqm)			41.488,84	22.542,51
Total area (sqm)			64.031,00	

Ground Surface of the Terminal will be filled to reach the upper design elevation. From contour map of pre-work vis-a-vis the Pangaon target top level of 7.93m PWD, the maximum value of filling height is about 8.00m and minimum value of about 3.00m. Terminal ground soils will need improvement. The soil needs to be improved to avoid excessive settlement and prevent stability failure that affecting the safety of the infrastructure.

To accelerate the process of consolidation settlement for the construction of any structure, the useful technique of Vertical Sand Drains (VSD)/sand compaction pile can be used.

Dredged sand from the riverbed with FM > 0.80 has been considered for filling. Clayey soil from borrow area or outside may be used for cover layer of slopes. Embankment shall be prepared in layers not exceeding 300 mm.

Estimate filling of Terminal ground is about 150.000 m3.

Figure 61 shows terrain development, filling and excavations and dredging requirements for Pangaon Cargo Terminal detailed Design and vertical sand drains (VSD) / sand compaction.

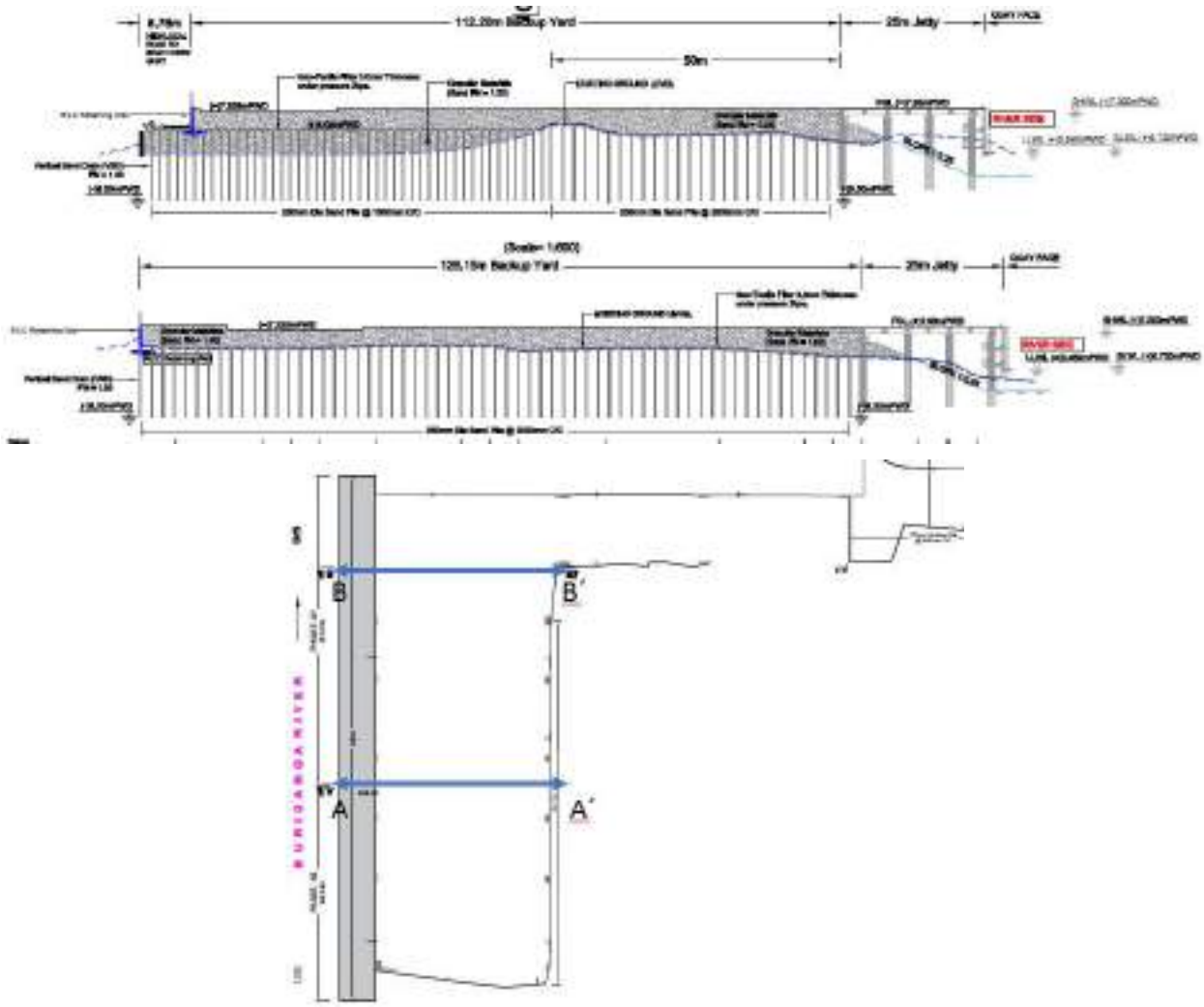


Figure 61. Ground terminal filling and vertical sand drains. Sections A- A´ and section B-B´

3.7.3.2. Water side development

Figure 62 shows the final pile deck arrangement and jetty cross section:

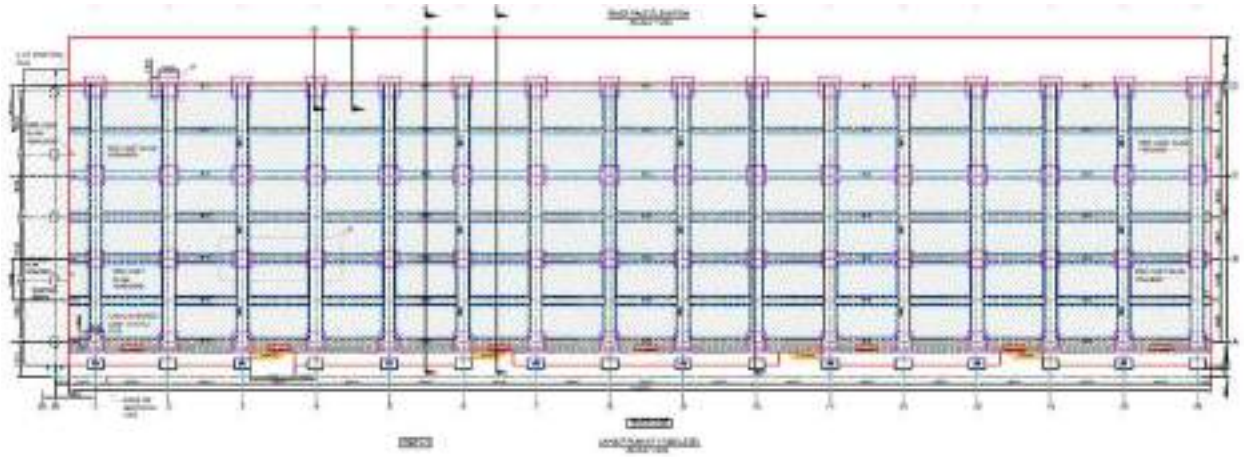


Figure 62. General Arrangement of Pangaon Terminal Jetty. Final Design

Deck is supported by concrete beams running along the length of the quay. Beams are in turn supported by bored piles, D=1000mm, placed in a 5.5 X 6.8m matrix. Piles reach to approximate level of 25m (30m below STS crane rails), with tip in dense sand layer. Protective casing is extracted as the piles are concreted but remains in place in the top 5-6m below surface and above surface. This is to prevent concrete bleeding into the loose top soil and to allow easy concreting in the water / above the waterline.

Suspended deck Nº of piles:

- Phase 1: 64 (16x4 grid)
- Phase 2: 64 (16x4 gris)

For jetty development earth movement and dredging is shown in Figure 63, (estimated volumes is an approach based on S4 DD report).

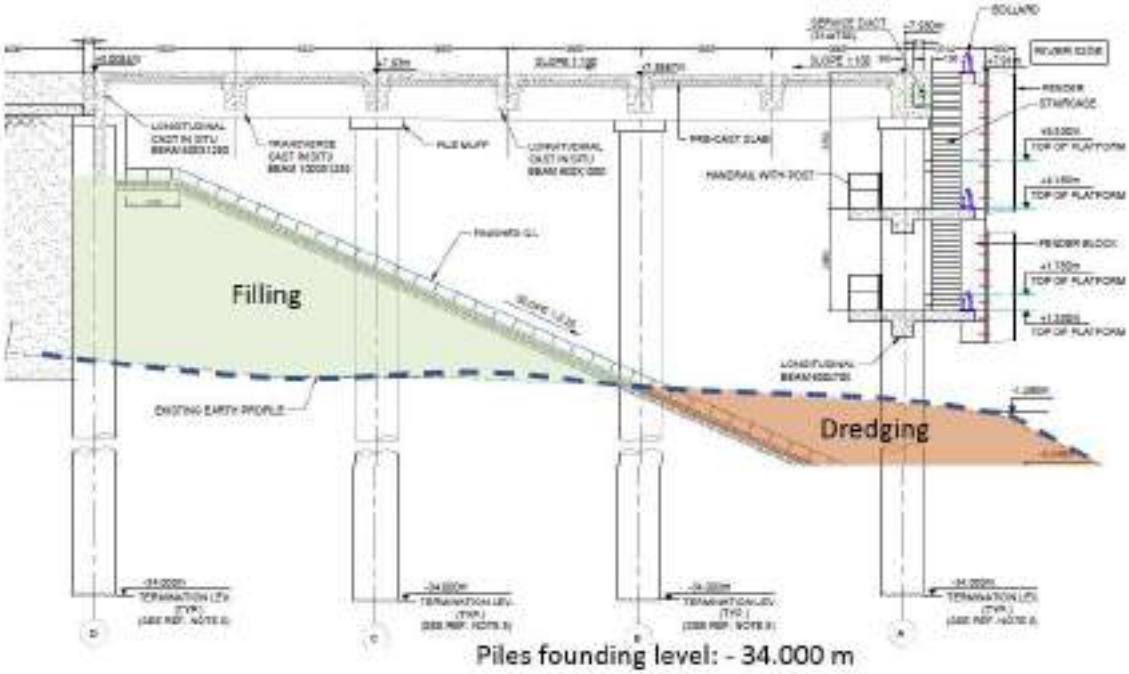


Figure 63. Pangaon jetty design Cross section

To reach Finished ground level under the suspended deck to a slope 1: 2.25, some filling should be needed. Dredging is also needed. North side of jetty will need more dredging since ground water level shows higher elevation (that's way deck 4 and 3 will be use by lesser vessels).

Dredging volumes, features approximate (estimated by ESIA Consultant based on S4 DD report)

- Phase 1 Dredging: 3.150 m3
- Phase 2 Dredging: 6.300 m3

Based on Feasibility Study carried out by S4 Consultant the dredged material is suitable for filling, thus it will be used for filling ground level under the suspended deck, where more volume is need for filling than the one dredged, and therefore no dumping site is required.

3.7.3.3. Utilities, water supply and wastewater

Water supply system of Pangaon (applicable to Ashuganj cargo terminal since water supply system will be the same).

Underground water reservoir. One central underground water reservoir (Figure 64) is adequate to store a single day's water demand plus water required for fire protection (high rise building) of each building and port facilities.

Roof water reservoir (Figure 65) has been selected to meet a half day daily water demand as determined according to the calculation considering economy and structural advantage for Welfare office and canteen, service builder, gate and employment and Toilet block.

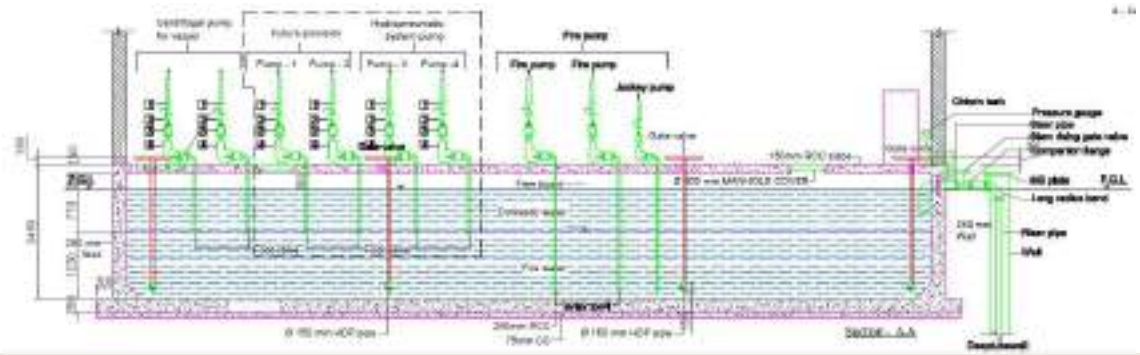


Figure 64. Plan of underground water reservoir

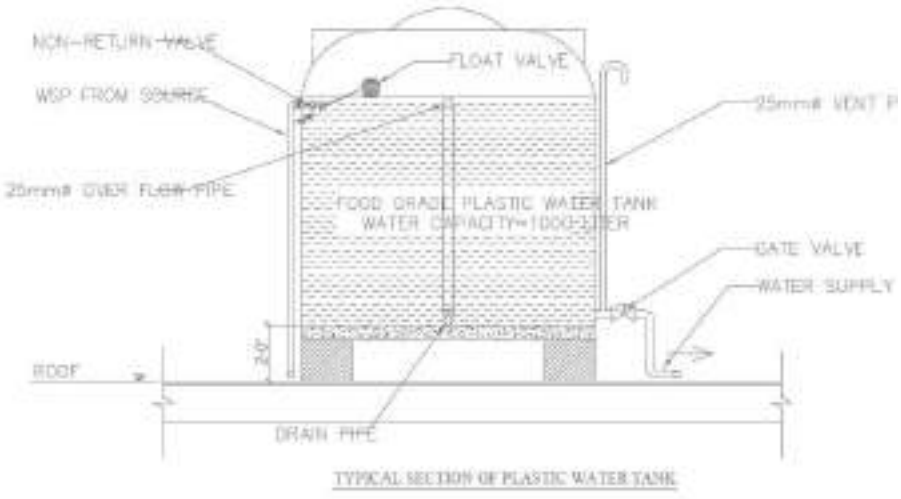


Figure 65. Typical cross section of Plastic tank

Sewerage System of Pangaon (the same design as for Ashuganj cargo terminal). The proposed sewerage system is illustrated in Figure 66.

For septic tank design, BNBC, 2015 rule has been followed. The system will be a pipeline network around the building and the sewerage water will come in the septic tank and soak well. The soak well will filter the liquid part of the sewerage and finally will be discharge into the river.

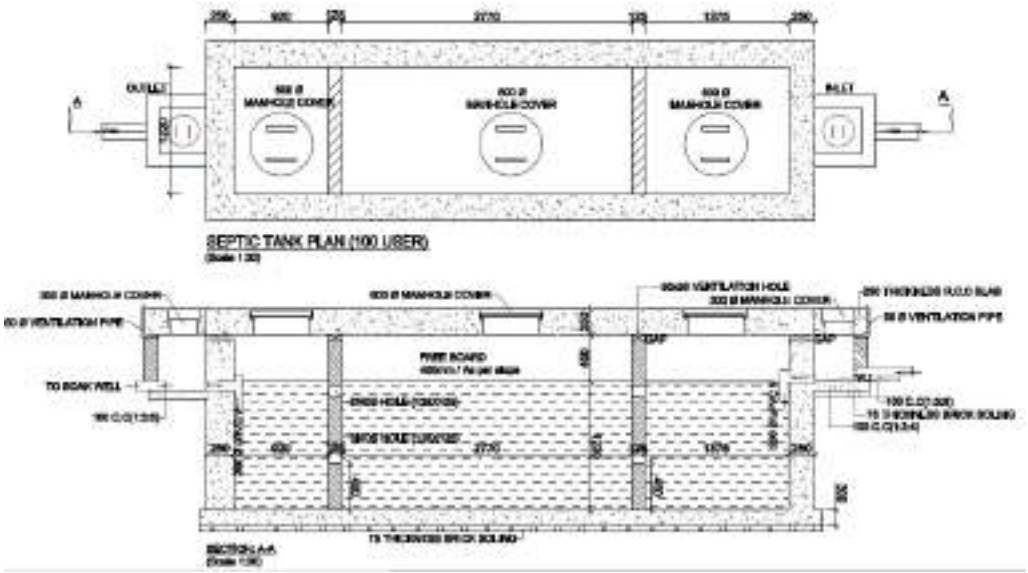


Figure 66. Septic tank plan

3.8. ASHUGANJ CARGO TERMINAL

3.8.1. Project location

This is an existing port under operation since long as one of the important among other Cargo Terminals in Bangladesh (Figure 67). Ashuganj is a BIWTA owned river port established in 2004, located on the east bank of Meghna River. The river port of Ashuganj is located about 60 km away from Dhaka city and 28 km and 43 km respectively from Brahmanbaria town and the Akhaura land border between Bangladesh and India.

The port is located in an industrial area in the vicinity of the Ashuganj fertilizer factory, silo and Power Station, a 1,777-megawatt thermal power plant which is one of the largest in Bangladesh.

Figure 67. Index Plan of the Existing Terminal at Ashuganj

Source: FFR Ashunganj IWT terminal, June 2019. Package S4 Consultant

Figure 68. Ashunganj Cargo Terminal location. A: phase 1 location, B: Phase 2 location

Source: FFR Ashunganj IWT terminal, June 2019. Package S4 Consultant

3.8.2. Ashunganj Master Plan

Ashuganj was declared as “Port of Call” under the Protocol on Inland Waterways Transit & Trade (PIWTT) in May 2010 for transhipment of bulk and break-bulk cargo to Tripura and other North-Eastern States namely Manipur, Mizoram and lower Assam.

Existing installation on the Ashuganj riverbank vis-à-vis the proposed development plan is presented in Figure 67.

Figure 69. Ashuganj Riverbank vis-a-vis Proposed Development Plan

Source: FFR Ashunganj IWT terminal, June 2019. Package S4 Consultant

Dedicated port facilities are in place / has been planned for handling of Food Grain, Fertilizer Plant and the Transhipped Traffic From / To India apart from the BIWTA Port facility.

BIWTA port facility is being used for Unloading of the following Commodities:

- Imported Fertilizer [receive bulk but unload after bagging];
- Imported Food Grain [receive bulk but unload after bagging];
- Cement [in bags];
- Stone Chips [bulk];
- Sand [Bulk].

Generally, BIWTA jetties receives maximum of 1500 T vessels.

Temporary facilities have been made to attend the ships due to limited number of jetty facilities and manual handling of commodity, this situation abused the entire bank. Proposed development has to consider this condition and either consider development site at the present location or to a new location in a green field situation as shown in Following figure or a combination of the two considering the demand.

BIWTA facilities includes RCC Jetty (425 m2), Office (150 m2), Pontoons (01 Nos)., Gangway (2 Nos), Warehouse (225 m2), Parking Area (1000 m2).

Plan showing the BIWTA Ex facility is presented in Figure 70.

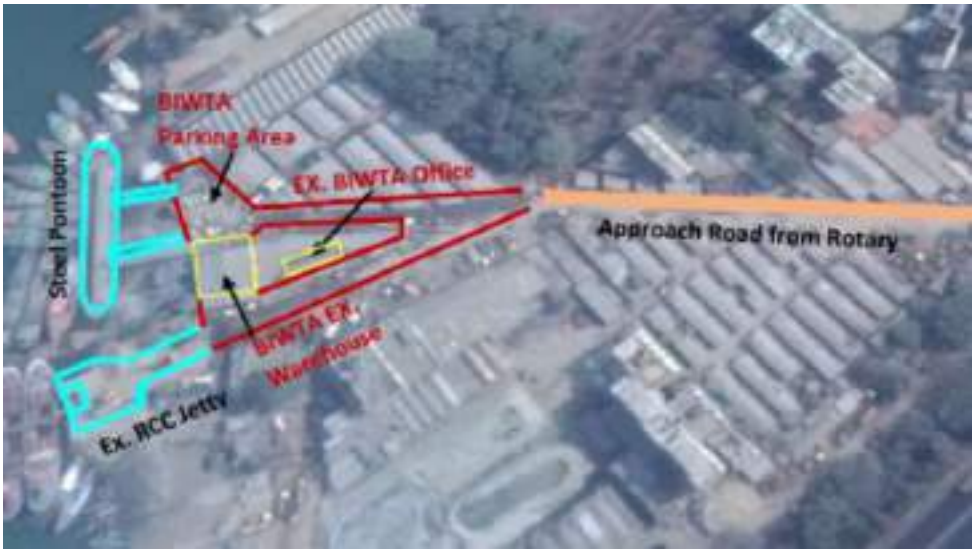


Figure 70. Existing BIWTA Facility Plan at Ashuganj

Source: FFR Ashunganj IWT Terminal, June 2019. Package S4 Consultant

Road connection to the present BIWTA operation is from a rotary and necessitate sharp turn for entry from Bhairab Bridge end. Entire route from the rotary to the terminal area is congested with truck parking and unplanned turns.

From the above, a major attention is necessary for the approach road in case the proposed development is considered at the existing location or around. As understood, New road alignment is being developed up to the proposed ICT including the reconstruction of underpass.

Ashuganj is an existing cargo terminal where current cargo handling operations are manual. The site is partly owned by the Government and partly by private Stakeholders as seen in Figure 71.

Figure 71. Land Ownership in Ashuganj

3.8.2.1. Terminal capacity and main features

Number of berths is the limiting factor for throughput and capacity. Nine berths would eventually be needed by the end of the forecast period in 2040 to handle all cargo estimated in the Traffic Study. However, only two large berths for 82.5 m vessels and three pontoon berths for smaller vessels are available. It is clearly illustrated that the number of berths will be the limiting factor for the terminal throughput.

To reduce costs and to provide more flexibility it has been chosen that the cargo handling principle is to unload cargo and bag the cargo on the quay with mechanized and modern equipment (however with somewhat lower capacity, than if bagged at the storage facility).

It is recommended to use pneumatic unloaders for unloading of food grains, and hydraulic material handler cranes for fertilizers. Bagging equipment will be installed on the quay. Bags are then transported to the warehouse by a conveyor or by forklift. Bags can also be loaded directly on trucks by conveyors.

There is not enough space to store fertilizer and cement bags in three warehouses, and only 69 % of the food grains can be stored. It is recommended not to store food grains in the same warehouses as cement and fertilizer.

Naturally, the share of different cargoes can be changed in practice and most notably some cargo will be transported directly with trucks without storage. It is assumed that the current operation with direct loading to the trucks will be practiced during the early years of the terminal. However, areas should be reserved for potential future warehouses and modern ship unloading methods.

The terminal is built as a pile deck and open quay structure expected to have a minimum impact on the free river flow. The natural sediment transport will therefore not be disturbed significantly so that dredging requirements are kept at a minimum.

To provide best possible road transport conditions and avoid traffic congestions, the existing road leading up to the future terminal entrance will have to be expanded outwards. The road should consist of two lanes and wide shoulders on each side, enabling trucks to park and pedestrians to walk without blocking the traffic. This is expected to provide adequate flow of trucks to and from the terminal.

To prevent fluvial erosion, revetments for the land reclamation will be constructed below the concrete deck. A significant area between the concrete deck and the existing terminal area will be reclaimed and is necessary to obtain the proposed terminal layout.

The proposed terminal layout is estimated to have a capacity of approx. 2.1 million tonnes/year which is expected to be distributed between cargoes as presented in Table 50.

Table 50. Estimated maximum terminal capacity in Ashuganj.

Particulars	Cargo						
	Wheat	Fertilizer	Corn	Soya	Cement – Fixed berth	Cement – Pontoon berth	All cargo
Throughput (Tonnes/yr)	550,000	165,000	49,500	24,200	253,000	1,038,000	2,079,700

For the expected throughput for the given combination of vessel calls and cargo in Ashuganj by 2026-2028. The port terminal is designed with the purpose of obtaining a great level of flexibility (Figure 70). There are no infrastructure or equipment on the quay which could limit usage for different cargoes and the planned warehouses can be used for different purposes. The quay structure is designed as a 323 m

long pile supported concrete deck with a width of 25 m and will yield space for 2 berths for LOA = 82.5 m ships and 3 pontoon berths for smaller vessels,

The layout is based on 2 berths for 82.5 meters long vessels and three berths for 40 meters long vessels. Cement bags are mainly unloaded from pontoon berths and it is expected that the selected operator will choose an appropriate mechanized method to transport bags from the vessel hold to the fixed quay platform. Cement bags are either loaded directly on trucks or stored in the warehouse.

The terminal will contain 7 warehouses (total 8,100 m^2) where 3 are dedicated to cement, 1 is dedicated to fertilizer and 3 to food grains. An area of approx. 6,000 m^2 is left undeveloped in the south-eastern part of the terminal to potentially serve as open storage yards for dry and break bulk in the future. Two warehouses of 900 m^2 each are indicated in this area to show that this can also be accommodated in the future if desired. The storage capacity is not adequate for volumes created by the berth capacity, such that some or even the majority of cargo could be transported directly by trucks to limit the need for storage.

Bulk cargo, fertilizer and food grains will be bagged next to the quay. Fertilizer will be unloaded by a material handler to an integrated hopper and bagging equipment. One material handler can supply two bagging units. The pneumatic unloader will be used for unloading cargo from vessels, and the bagging equipment will be similar the one used for fertilizer bagging. Two bagging units will be needed for fertilizer and food grain vessel to provide adequate productivity.

There will be access control at the project boundary for allow inbound trucks in for waiting free loading position. This arrangement is likely to cause congestion to the access road and there should therefore be sufficiently parking place along the access road to minimize this. It is proposed to expand the access road such that it will have two lanes and a shoulder on each side for pedestrians and truck parking, resulting in a total width of approx.12-13 m.

Figure 72. Proposed Master Plan Layout of Ashuganj Cargo Terminal.

Phase 2 development

The storage capacity and number of berths are inadequate at the existing site in Ashuganj to meet the forecasted cargo volumes in the Traffic Study on a longer perspective (2040). It has therefore been investigated how port facilities can be configured at the alternative location in Ashuganj once the maximum capacities are reached at the existing site. This is termed “phase 2” of the development of Ashuganj.

The configuration of berths in phase 2 is proposed to be similar to the terminal development at the existing terminal, with 2 large and 3 small vessels (Figure 73).

Figure 73. Proposed Master Plan Layout of Ashuganj Cargo Terminal –Phase 2.

3.8.2.2. Water side development: Pile Deck and Cargo Handling System and Equipment

Pile deck is 362m long and divided in 8 equal segments, separated by dilatation joints (Figure 72).

The deck is supported by the concrete beams going along the length of the quay. Beams are in turn supported by bored piles, D=1000mm, placed in a 5.5 X 6.8 m matrix (Figure 74). The suspended deck is designed to withstand a range of quay specific loads, such as mobile crane, trucks with trailers and distributed live load of 30 kN/m2.

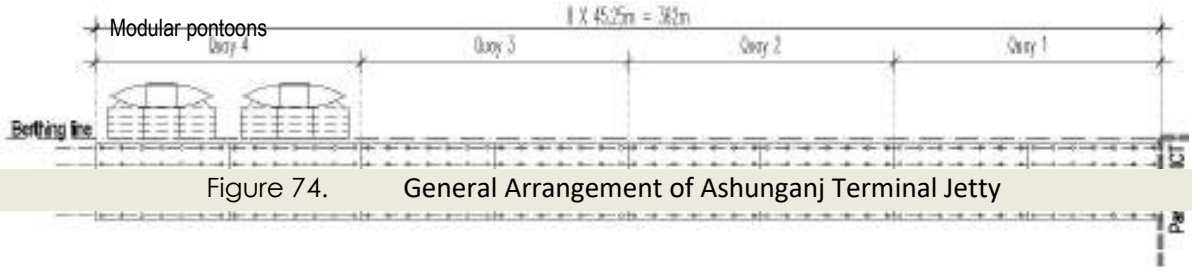


Figure 74. General Arrangement of Ashunganj Terminal Jetty

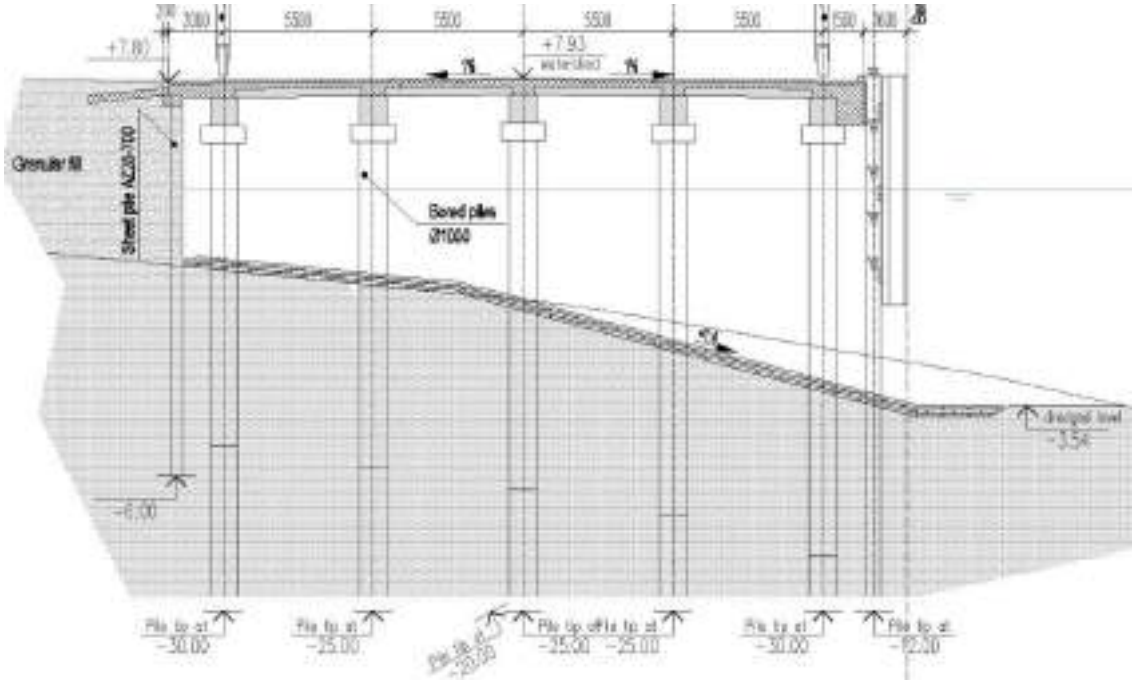


Figure 75. Typical Cross Section of Ashunganj Suspended Deck Structure

- Cargo Handling System and Equipment
  - Cement bags

For small vessels, cement bags will be unloaded by using pontoons to berth the vessels. The recommended method to unload bags from the vessel on to the pontoon is manual handling. Bag conveyor could be possible, but a proven existing equipment was not found. Transporting bags from the pontoon up to the fixed quay platform will be done by a conveyor system or a material handler.
It is recommended that the chosen operator selects and develops appropriate transport system according to their operational practices.

  - Fertilizer

Fertilizer will be unloaded by a material handling and a grab attached to it. The material handler will supply two bagging units on the quay.

  - Food grains

Food grains will be unloaded by two pneumatic unloaders. Unloaders will supply two bagging units on the quay.

3.8.2.3. Land side development

- Cargo Storage

Bag cargo will be stored in warehouses. Warehouses are PVC coated relocatable buildings. The size of the buildings will be 1,200 m^2, 30 m wide and 40 m long smaller one 800 m^2, 30 m wide and 30 m long. The warehouse will be equipped with lighting and a simple fan. There will be large doors in both ends of the buildings, as well as normal pedestrian doors.

- Gate

There is not enough space for a modern gate system and related waiting area before the gate. There are waiting areas inside the gate for trucks. This solution is likely to create congestion to the access road and therefore appropriate parking alongside the road is required. The gate consists of one lane in and one lane out. Lanes are equipped with remotely operated boom gates.

- Gate Office (security and administrative)

A gate office is integrated with other buildings inside the security area next to the gate. Employment office functions could be located here as well.

- Office (operational) and welfare building

The required offices are smaller than in Pangaon due to the available area and its shape. The office buildings have two floors. Administration is in one building and operations and welfare are split into two buildings. Basic Infrastructure

- Services and basic infrastructure

Same as Pangaon Cargo Terminal

3.8.2.4. Ashunganj cargo terminals alternatives

Plan layout alternatives studied and assess during feasibility study are shown in Annex 2.

3.8.3. **Ashunganj Terminal final Design**

Figure 76 shows Ashunganj Cargo Terminal Detail design general layout. The layout design shows Phase 1 and Phase 2 under the selected layout after feasibility study.

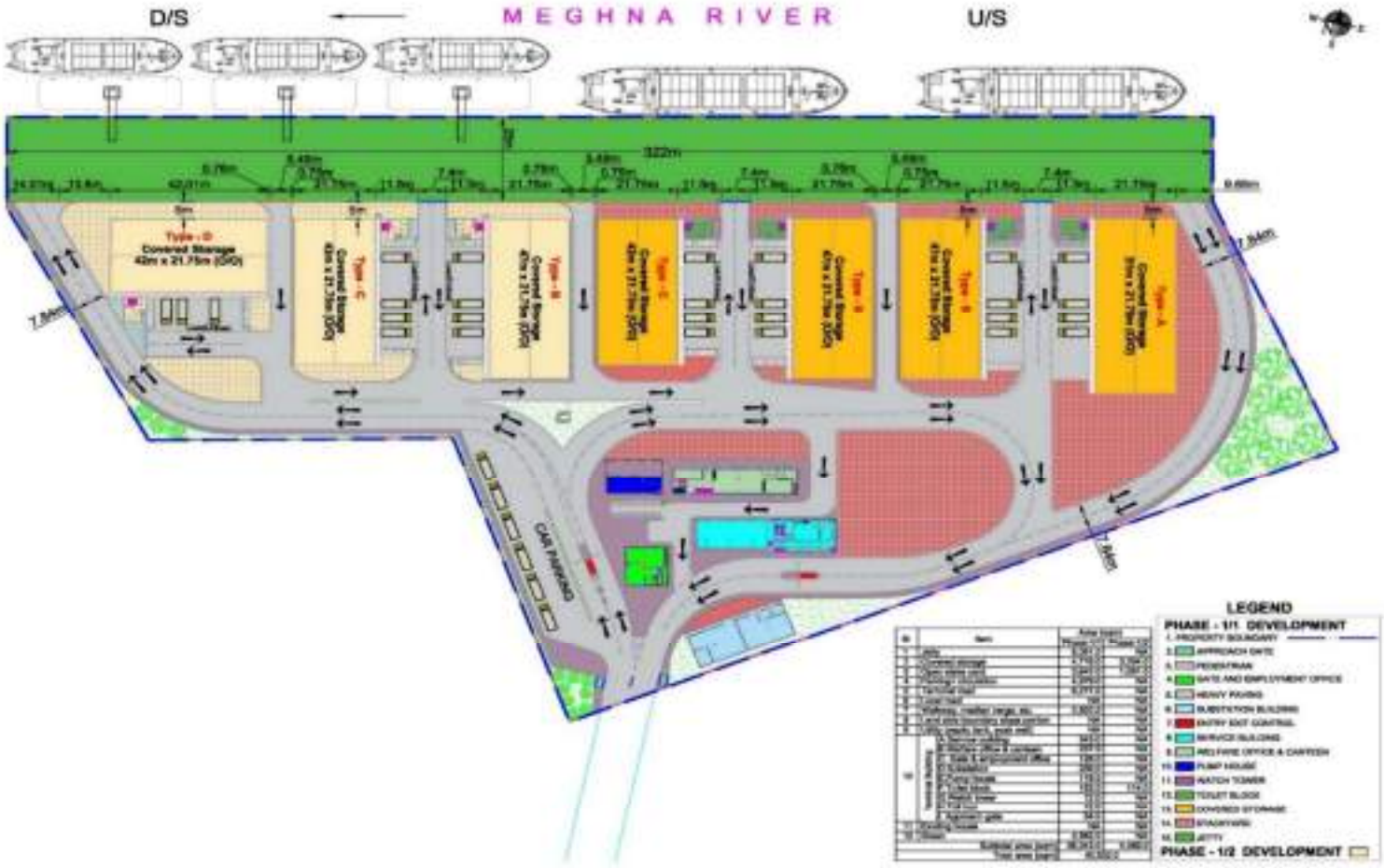


Figure 76. Ashunganj Terminal final Design

Source: Draft Detailed report. October 2019. Package S4 Consultant

3.8.3.1. Final layout

Table 51 lists the land requirements for Ashunganj Cargo Terminal.

Table 51. Land use areas for Ashunganj Cargo Terminal

Using Land Utilization				
SI	Item		Area (sqm)	
			Phase-1/1	Phase-1/2
1	Jetty		8.051,00	NA
2	Covered storage		4.716,00	3.294,00
3	Open stake yard		3.642,00	1.081,00
4	Parking+ circulation		4.979,00	NA
5	Terminal road		8.277,00	NA
6	Local road		NA	NA
7	Walkway, median verge, etc.		2.502,00	NA
8	Land side boundary slope portion		NA	NA
9	Utility (septic tank, soak well)		NA	NA
10	Terminal Building	A. Service building	343,00	NA
		B. Welfare office & canteen	237,00	NA
		C. Gate & employment office	126,00	NA
		D. Substation	239,00	NA
		E. Pump house	119,00	NA
		F. Toilet block	152,00	114,00
		G. Watch tower	12,00	NA
		H. Toll box	12,00	NA
		I. Approach gate	54,00	NA
11	Existing house		NA	NA
12	Green		2.582,00	NA
Subtotal area (sqm)			36.043,00	4.489,00
Total area (sqm)			40.532,00	

Terminal ground soils will need improvement. The soil needs to be improved to avoid excessive settlement and prevent stability failure that affecting the safety of the infrastructure.

To accelerate the process of consolidation settlement for the construction of any structure, the useful technique of Vertical Sand Drains (VSD)/sand compaction pile can be used.

Dredged sand from the riverbed with FM > 0.80 has been considered for filling. Clayey soil from borrow area or outside may be used for cover layer of slopes. Embankment shall be prepared in layers not exceeding 300 mm.

Estimate filling of Terminal ground is about 50.000 m3.

Figure 77 shows terrain development, filling and excavations + dredging of Ashunganj cargo terminal detailed Design and vertical sand drains (VSD) / sand compaction.

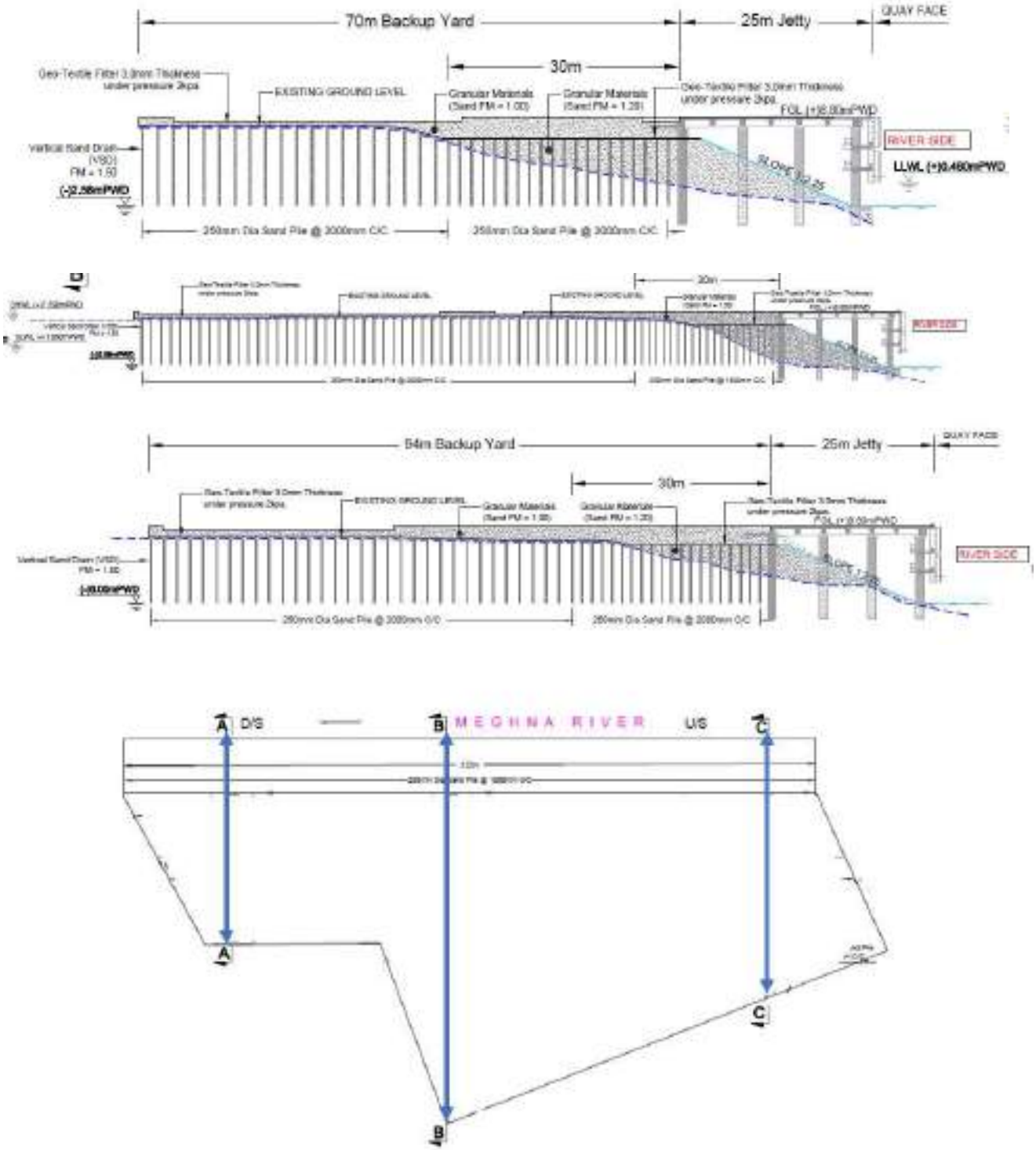


Figure 77. Ashunganj Ground terminal filling and vertical sand drains. Sections A- A´, B-B´ and section C – C´

3.8.3.2. Water side development

Figure 78 shows final pile deck arrangement and jetty cross section

Figure 78. General Arrangement of Ashunganj Terminal Jetty. Final Design

Deck is supported by concrete beams running along the length of the quay. Beams are in turn supported by bored piles, D=1000mm, placed in a 5.5 X 6.8m matrix. Piles reach to approximate level of 25m (30m below STS crane rails), with tip in dense sand layer. Protective casing is extracted as the piles are concreted but remains in place in the top 5-6m below surface and above surface. This is to prevent concrete bleeding into the loose top soil and to allow easy concreting in the water / above the waterline.

Suspended deck Nº of piles: 52 (13x4 grid)

For jetty development cross section is shown in Figure 79. As shown on the figure, cope line is chosen in such a way to eliminate need for dredging, except to remove man-made reef at chainage 0+200, volume of material to remove is about 500 m3 only. On the other hand, slope raises only to the level of 3-4m PWD in the long stretch of the quay. To limit retaining height of the sheet pile wall at the back, slope is partially filled. Slope is kept with mild grading of 1:4 to minimize erosion and obstruction to the flow.

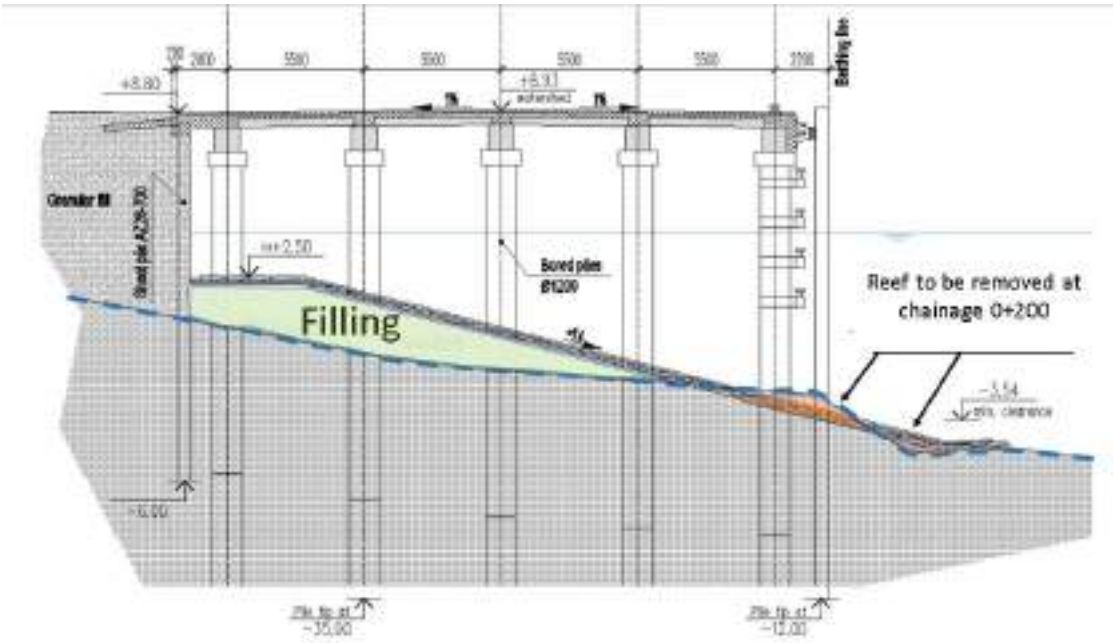


Figure 79. Ashunganj jetty design Cross section

3.8.3.3. Utilities, water supply and wastewater

Utilities, water supply and wastewater sections described for Pangaon is applicable for Ashunganj, design are the same.

3.9. AREA OF INFLUENCE

According to IFC Performance Standard N° 1, where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence. This area of influence encompasses:

- The area likely to be affected by:

  (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project;

  (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or

  (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.

- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.

- Cumulative impacts that result from the incremental impact.

The Areas of Influence include the physical and biological components that are affected by the project footprint and areas closed or far from the project that may be disturbed by the project:

- Total area of the Terminal for both land side and water side.

- The area closed to the terminal layout disturbed directly by the Project, during construction and operation. Surrounding areas disturbed by machinery noise, personnel movement, vehicle noise and related air pollutant emission, soils and water systems directly connected to the terminal who exports wastes; liquids or solids, wildlife community disturbed and repelled affected by terminal construction or operation, aquatic biota affected by construction activities on the waterside and operation of vessels, etc.

- The area not directly connected to the Project which some Valued environmental components that can be impacted; dolphin population far from the terminal disturbed by construction on water side and operation of the terminal.

For social and community health impacts, it is useful to consider Area(s) of Influence for direct impacts and Area(s) of Influence for indirect impacts. The Areas of Influence for direct impacts will include the households and communities that will be affected by the Project Footprint due to:

- their location within the Project footprint

- their location within the Area(s) of Influence for environmental resources, such as air or water quality, noise and vibration, visual and landscape, etc.;

- impacts on livelihood resources that will be affected by the Project (fisheries, forest resources)

- their connection to cultural, social or health resources that will be impacted by the Project.

- The Area(s) of Influence will also typically consider populations that will experience indirect or induced impacts that may not be within the direct control of the Project, such as:

- economic opportunities associated with employment and economic spend;
- interaction with the workforce and use of services by the workforce

The Area of Influence for indirect impacts will be far more geographically extensive regarding the country cargo transportation in the case of Cargo Terminals and inland water Passenger traffic and movement throughout the country.

A set of selected environmental component can establish the area of influence of likely impacts covering the wide range of Project impacts and useful to impact monitoring:

- Air environment; noise and air quality
- Biological environment, terrestrial flora and fauna
- Aquatic ecosystem

Noise is a good parameter to establish impact are of influence. The sound intensity decreases inversely proportional to the squared distance, that is, with $1/r^2$ from the measuring point to the sound source, so that doubling of the distance deceases the sound intensity to a quarter of its initial value, that means that at a measuring point located 200 m away from a 100 dB sound source, sound level measure shall be around 25 dB.

For biological environment a range between 200 and 350 m from the site perimeter could be established for monitoring impacts, nevertheless this area varies for each project sites depending on the existence of valuable biological component.

Effects on aquatic ecosystem, rivers at the terminal sites, could travel a large distance downstream the source point, considering that the receiving sections of the river in most of the sites are currently under a large variety of impacts, the area of influence has been established to a more restricted distance, including also upstream section. For dolphins, although these species are capable of detecting variations in water quality from remote sources, a more practicable area should be established, from 1 km to 2 km, even more if we consider that multiple sources of pollutants and noise currently exist along the river section at all sites.

3.9.1. Area of influence by terminals sites

Area of influence may be far to terminal sites specially for socioeconomic environment; however, the following area of influence shall be applied in terms of environmental monitoring and management within which environmental and social parameters or requirements shall be implemented.

3.9.1.1. Passenger terminals

Sashangaht terminal area of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	100 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 350 m length
	1000 m length, up to Badamtoli boat terminal

Sashangaht terminal area of influence	
<u>During operation:</u>	
Air environment; noise and air quality	100 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	There is no area of terrestrial vegetation or habitat of interest, 350 m outside the terminal perimeter for urban trees and wildlife.
Aquatic ecosystem	upstream 150 m length
	downstream700 m length

Chandpur terminal are of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	100 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 350 m length
	Downstream 700 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream
<u>During operation:</u>	
The layout of the terminal	
Air environment; noise and air quality	100 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 350 m length
	downstream700 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream

Narayanganj terminal are of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	100 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	There is no area of terrestrial vegetation or habitat of interest, 350 m outside the terminal perimeter for urban trees and wildlife.
Aquatic ecosystem	upstream 350 m length

Narayanganj terminal are of influence	
	Downstream 1000 m length, up to Badamtoli boat terminal
Dolphin and other protected aquatic species	2000 m downstream and upstream
<u>During operation:</u>	
The layout of the terminal	
Air environment; noise and air quality	100 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	There is no area of terrestrial vegetation or habitat of interest, 200 m outside the terminal perimeter for urban trees and wildlife.
Aquatic ecosystem	upstream 350 m length
	downstream700 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream

DEPTC area of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	50 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	There is no area of terrestrial vegetation or habitat of interest
<u>During operation:</u>	
The layout of the terminal Air environment; noise and air quality 50 m outside the terminal perimeter	
For any parameter: 100 m outside the terminal perimeter	

Barishal terminal area of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	150 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 350 m length
	Downstream 700 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream
<u>During operation:</u>	
The layout of the terminal	

Barishal terminal area of influence	
Air environment; noise and air quality	150 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 150 m length
	downstream700 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream

3.9.1.2. Cargo terminals

Pangaon terminal area of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	150 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	500 m outside the terminal perimeter for urban trees and wildlife.
Aquatic ecosystem	upstream 350 m length
	Downstream 1000 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream
<u>During operation:</u>	
The layout of the terminal	
Air environment; noise and air quality	150 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 350 m length
	Downstream 1000 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream

Ashunganj area of influence	
<u>During construction:</u>	
The layout of the terminal	
Air environment; noise and air quality	150 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	There is no area of terrestrial vegetation or habitat of interest, 200 m outside the terminal perimeter for urban trees and wildlife.
Aquatic ecosystem	upstream 350 m length
	Downstream 1000 m length

Ashunganj area of influence	
Dolphin and other protected aquatic species	2000 m downstream and upstream
<u>During operation:</u>	
The layout of the terminal	
Air environment; noise and air quality	150 m outside the terminal perimeter
Biological environment, terrestrial flora and fauna	350 m outside the terminal perimeter
Aquatic ecosystem	upstream 350 m length
	Downstream 1000 m length
Dolphin and other protected aquatic species	2000 m downstream and upstream

4. DESCRIPTION OF THE ENVIRONMENT

This section provides information on the physical and biological characteristics of the environment as it relates to the proposed works of the BIWTA Project, which shall be the baseline data set used as benchmarks for future monitoring. Baseline environmental monitoring forms the backbone for any Environmental Impact Study and it gives scope for the impact prediction and for designing and formulating the management plan to be adopted at the site during the implementation stage.

A baseline study is an inventory of environmental, social, and historical features in and around the proposed project area. The baseline environmental parameters are monitored to assess the prevailing site conditions. The concentration of the environmental parameters would focus on how the natural resources are being impacted due to the rapid urbanization and industrialization of the surrounding areas. Generally, the ground conditions are assessed by monitoring the environmental parameters and are further strengthened by gathering the secondary information from the environmental studies conducted in the adjacent area for different projects. The baseline parameters would indicate the present environmental status of the project area. The primary data, such as the existing air quality, ground and surface water quality, sediment and soil quality and the noise levels form the primary parameters, which should be generated at the site by monitoring and collecting samples and analyzing the same at a well-recognized laboratory. The questionnaire surveys require the collection of data through the observations, discussions, and personal interviews and last, but by no means least, secondary data should be gathered from the published information.

4.1. STUDY AREA

Figure 80. Maps of Dhaka and Narayanganj distrcits

The study area of this project is mainly restricted to the Meghna River (upper and lower), its estuary and tributaries-distributaries. Main rivers within the Project boundary beside Meghna are: Buriganga, Dhaleshwari and Sitalakhya. The projects are located in the following districts: Dhaka, Narayanganj, Chandpur, Brahman Baria and Barishal Districts. The location of Dhaka and Narayanganj districts are shown in the following figure and Brahman Baria, Chandpur and Barishal are shown below. Of these districts, Chandpur and Barishal are located along the banks of Meghna River.

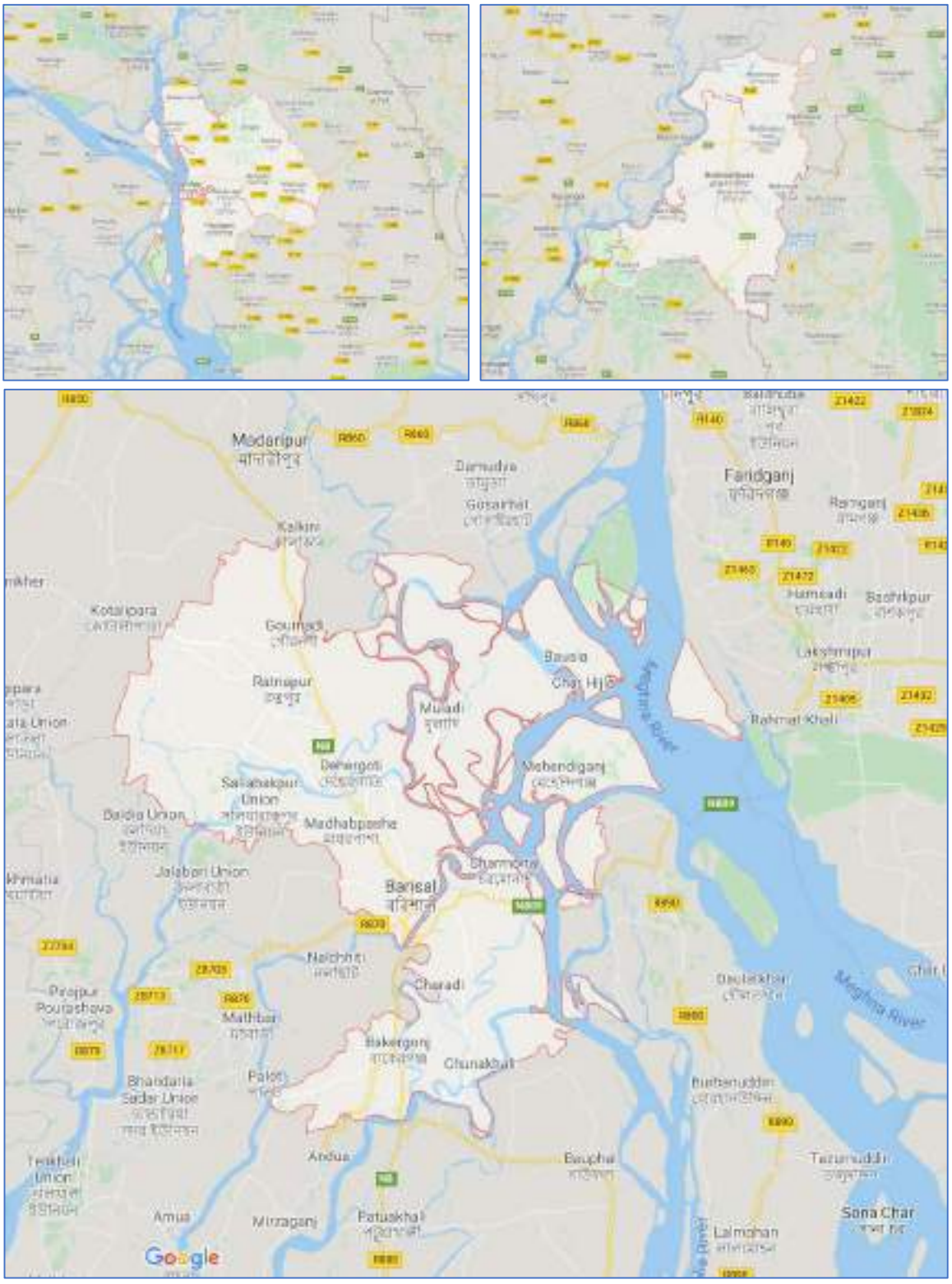


Figure 81. Maps of Chandpur, Brahman Baria and Barishal districts

4.2. PHYSICAL ENVIRONMENT

4.2.1. Climate

Bangladesh, a small country with generally low-lying area, is located in the central part of the Asiatic monsoon region where the climate is tropical. The climate peculiarity of this country happens between June and September. This period is known as monsoon period and during those months the climate conditions change dramatically due to alterations in atmospheric circulation and precipitation mainly associated with the asymmetric heating of land and sea. As a result of this type of climate, the country has moderately warm temperatures, high humidity and heavy rainfall.

The climate of Bangladesh ranges from subtropical to tropical, with a pleasantly warm and sunny winter from November to February, a short hot spring between March and May, and a long rainy season from June to October due to the summer monsoons.

4.2.1.1. Climate sub-regions

The climate of Bangladesh is divided in 7 sub-regions shown in the following figure whereby temperature, wind, cloud cover, rainfall and humidity are specifics of each sub-region, according to the Bangladesh Meteorological Department. With regard to the climatic sub-regions, all the sub-project locations fall in the **South-Central Zone (Zone G).** See next figure for details.

South-central zone (zone G). In this zone rainfall is abundant, being above 1,900 mm. The range of temperature is, as can be expected, much less than to the west, but somewhat more than in South-eastern zone. This is a transitory zone between the South-eastern, North-western and South-western zones and most of the severe hailstorms, or 'westers' and tornadoes are recorded in this area.

Figure 82. Climatic sub-regions of Bangladesh. All the sub-projects fall in sub-region G (source: BMD)

- Monsoons in Bangladesh

The rainy season, which coincides with the summer monsoons, is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall, and long consecutive days of rainfall which are separated by short dry spells. Rainfall in this season is caused by the tropical depressions that enter the country from the Bay of Bengal. During the winter season, a center of high pressure lies over the north western part of India. A stream of cold air flows eastward from this high pressure and enters the country through its northeast corner by changing its course clockwise, almost at a right-angle. This wind is the part of the winter monsoon circulation of the South Asian subcontinent. During this season, winds in the

country generally have a northerly component (flowing from north or northwest). See next figure for details.

During the early part of this sub-season, the winds are neither strong nor persistent. However, with the progression of this season wind speed increases, and the wind direction becomes more persistent. During the pre-monsoon season, a narrow zone of air mass discontinuity lies across the country that extends from the south-western part to the north-eastern part. This narrow zone of discontinuity lies between the hot dry air coming from the upper Gangetic plain and the warm moist air coming from the Bay of Bengal. As this season progresses, this discontinuity weakens and retreats toward northwest, until it finally disappears by the end of the season, making room for the onset of the summer monsoon. (Source: Banglapedia[6])

On the other hand, during the summer season, a center of low pressure develops over the west-central part of India due to intense surface heat. As a result, a stream of warm and moist air from the Bay of Bengal flows toward the above-mentioned low pressure through Bangladesh (similar flow prevails from the Arabian Sea toward India). This wind is the part of the summer monsoon circulation of the sub-continent. So, the prevailing wind direction in Bangladesh during the summer season has generally a southerly component (flowing from the south, southwest or southeast). However, wind directions during the transition seasons (in spring and autumn) are variable. Generally, winds are stronger in summer (8-16 km/h) than in winter (3-6 km/h). The mean pressure is 1,020 millibars in January and 1,005 millibars from March to September.

Figure 83. Climatic elements of Bangladesh

Source: Banglapedia

- Hydro-metrological conditions

Shasanghat, Narayanganj, Ashuganj and Pangaon sites are close to Dhaka city, furthermore, the nearest meteorological station into this area is located in Dhaka. Chandpur and Barishal are also included in the same area, the South Central zone, but those locations have their own meteorological stations and meteorological data from their stations will be used. Meteorological data for Dhaka, Chandpur and Barishal stations are collected to analyze climatic variation for the Passenger and Cargo Terminals. Ashunganj lacks its own meteorological station and the nearest is located in Dhaka, so we can

[6] Banglapedia (undated) Banglapedia. The National Encyclopedia of Bangladesh. Website: www.en.banglapedia.org

approximate its value range from the station of Dhaka. Moreover, Ashuganj belongs to the same climatic sub-region as Dhaka and for that reason we use the same data to describe their climate.

4.2.1.2. Temperature

Dhaka and the rest of the locations experience a hot, wet and humid tropical climate. Under the Köppen climate classification, the locations have a tropical wet and dry climate. The capital city has a distinct monsoon season, with an annual average temperature of 25 °C (77 °F) and monthly mean varying between 18 °C (64 °F) and 33 °C (91.4 °F). Chandpur has an annual average of 26 °C (78.8 °F) and Barishal has an annual average of 25.6 °C (78 °F). Temperature data shown below has been obtained from the website: Climate Information Management System (BARC)[7]. This website is under control of Ministry of Agriculture of Bangladesh.

- Dhaka Meteorological Station

Monthly average maximum temperature data has been analyzed from January 1953 to December 2018 and it can be observed that the highest temperature was 40.8 °C in the month of June 1987 and the lowest was 23.6 °C in the month of January 2018. The highest average maximum temperature is 37°C in the month of April and the lowest is 28.4 °C in the month of January. Monthly average minimum temperature data has also been analyzed from January 1953 to December 2018 and it can be observed that the highest temperature was 27.1 °C in the month of August 2018 and the lowest was 4.3 °C in the month of January 1983. The highest average minimum temperature is 24.1 °C in the months of July and August and the lowest is 9 °C in the month of January. See Table 52 for detail.

Table 52. Monthly average min. and max. temperatures (°C) of 2018 and over the period of 1953 – 2018 at Dhaka

(Source: BMD).

	MINIMUM TEMP		MAXIMUM TEMP	
MONTH	Monthly avg. Minimum Temp. (2018)	Normal Avg. Minimum Temp. (1953 – 2018)	Monthly avg. Maximum Temp. (2018)	Normal Avg. Maximum Temp. (1953 – 2018)
JAN	12.8	9.0	23.6	28.4
FEB	18.1	11.2	29.2	32.1
MAR	22.3	15.2	33.3	36.2
APR	22.5	19.0	33	37.0
MAY	24.1	20.4	32	36.3
JUN	26.2	22.8	33.5	35.2
JUL	26.7	24.1	32.6	33.9
AUG	27.1	24.1	33.8	34.2
SEP	27	23.7	34.1	34.6
OCT	23.6	20.0	32	34.0
NOV	19.8	15.0	30.3	31.9
DEC	16.2	10.9	26.1	28.9

[7] BARC (undated). Bangladesh Agricultural Research Council (BARC) Climate Information Management System Portal. Web: http://climate.barcapps.gov.bd/ Date accessed: 21 March 2020

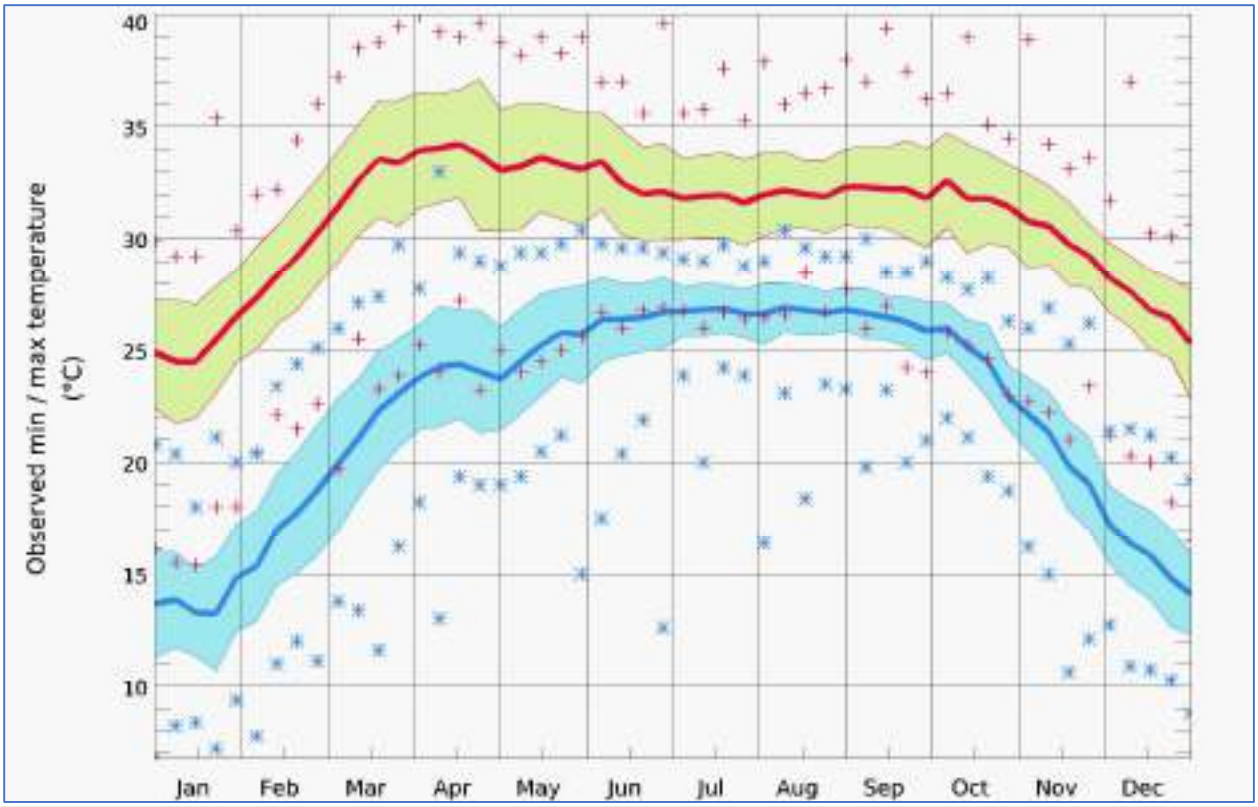


Figure 84. Monthly average min. and max. temperatures (°C) of 2018 and over the period of 1953 – 2018 at Dhaka

(*Data Source: BMD)*

- Chandpur Meteorological Station

Monthly average **maximum** temperature data was analyzed from January 1953 to December 2018 and it can be observed that the highest temperature was 40 °C in the month of April 2014 and the lowest was 24.3 °C in the month of January 2018. The highest average maximum temperature is 35.6 °C in the month of May and the lowest is 27.8 °C in the month of January.

Monthly average **minimum** temperature data has also been analyzed from January 1953 to December 2018 and it can be observed that the highest temperature was 26.8 °C in the month of September 2018 and the lowest was 7.2 °C in the month of January 2013. The highest average minimum temperature is 24.4 °C in the months of August and the lowest is 10.7 °C in the month of January.

See Table 53 for details.

Table 53. Monthly average min. and max. temperatures (°C) of 2018 and over the period of 1953 – 2018 at Chandpur

(Data Source: BMD)

	MINIMUM TEMP		MAXIMUM TEMP	
MONTH	Monthly avg. Minimum Temp. (2018)	Normal Avg. Minimum Temp. (1953 – 2018)	Monthly avg. Maximum Temp. (2018)	Normal Avg. Maximum Temp. (1953 – 2018)
JAN	12.4	10.7	24.3	27.8
FEB	17.3	12.4	28	31.5
MAR	21.1	16.1	31.4	34.8
APR	22.9	19.8	33.5	35.4
MAY	24.1	21.1	32.6	35.6
JUN	25.7	23.4	31.9	35.1
JUL	26.4	24.2	31.7	33.9
AUG	26.6	24.4	31.1	33.9
SEP	26.8	23.9	33.9	34.4
OCT	23.7	21.0	32	34.0
NOV	19.8	16.5	30.6	32.2
DEC	16.2	12.4	26	28.6

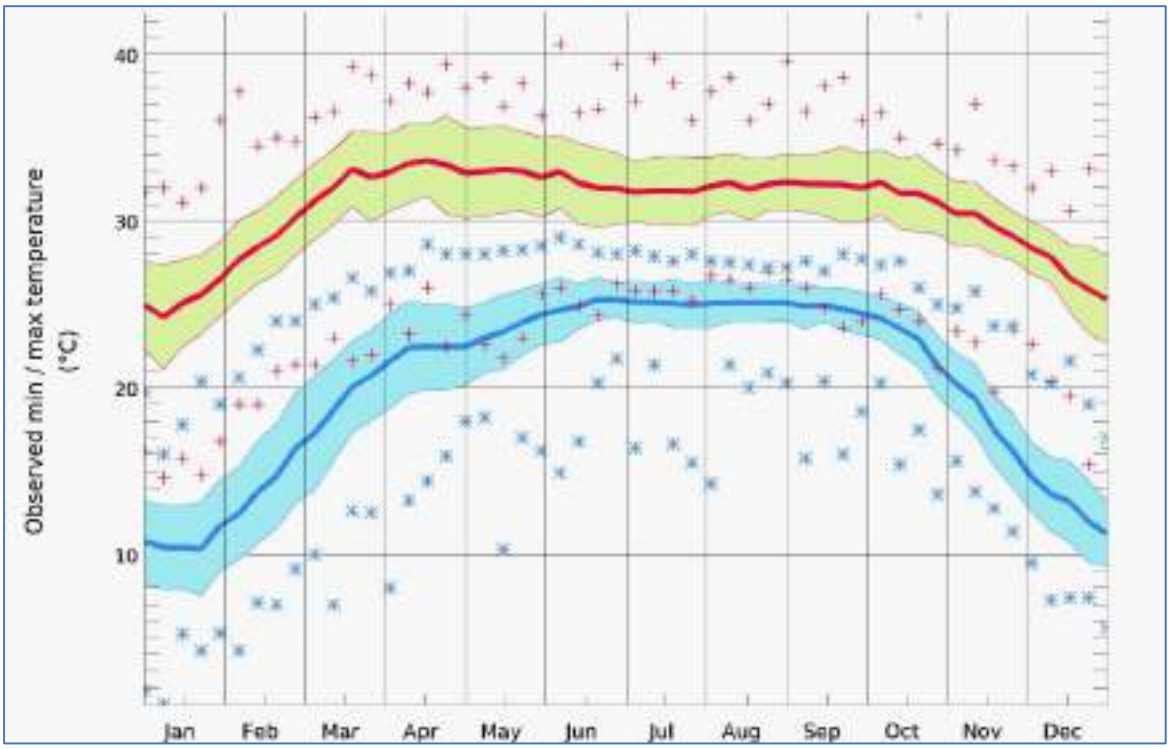


Figure 85. Monthly average min. and max. temperatures (°C) of 2018 and over the period of 1953 – 2018 at Chandpur

(Data Source: BMD)

- Barishal Meteorological Station

Monthly average **maximum** temperature data has been analyzed from January 1953 to December 2018 and it can be observed that the highest temperature was 39.6 °C in the month of June 1987 and the lowest was 24.9 °C in the month of January 2018. The highest average maximum temperature is 36 °C in the month of April and the lowest is 28.7 °C in the month of January.

Monthly average **minimum** temperature data has also been analyzed since January 1953 to December 2018 and it can be observed that the highest temperature was 26.5 °C in the month of July 2018 and the lowest was 3.7 °C in the month of January 1998. The highest average minimum temperature is 23.9 °C in the months of August and the lowest is 8.9 °C in the month of January. See Table 54 for details.

Table 54. Monthly average min. and max. temperatures (°C) of 2018 and over the period of 1953 – 2018 at Barishal

(Source: BMD)

	MINIMUM TEMP		MAXIMUM TEMP	
MONTH	Monthly avg. Minimum Temp. (2018)	Normal Avg. Minimum Temp. (1953 – 2018)	Monthly avg. Maximum Temp. (2018)	Normal Avg. Maximum Temp. (1953 – 2018)
JAN	10.1	8.9	24.9	28.7
FEB	16.1	10.8	29	32.0
MAR	20.8	15.2	34	35.5
APR	22.6	19.6	33.6	36.0
MAY	24.4	21.0	32.6	35.7
JUN	26.1	23.1	33.9	35.1
JUL	26.5	23.8	33.3	33.6
AUG	26.5	23.9	32.4	33.9
SEP	26.5	23.3	33.4	34.4
OCT	22.8	20.3	31.6	33.9
NOV	18.1	14.7	30.3	31.9
DEC	12.8	10.5	26.1	29.0

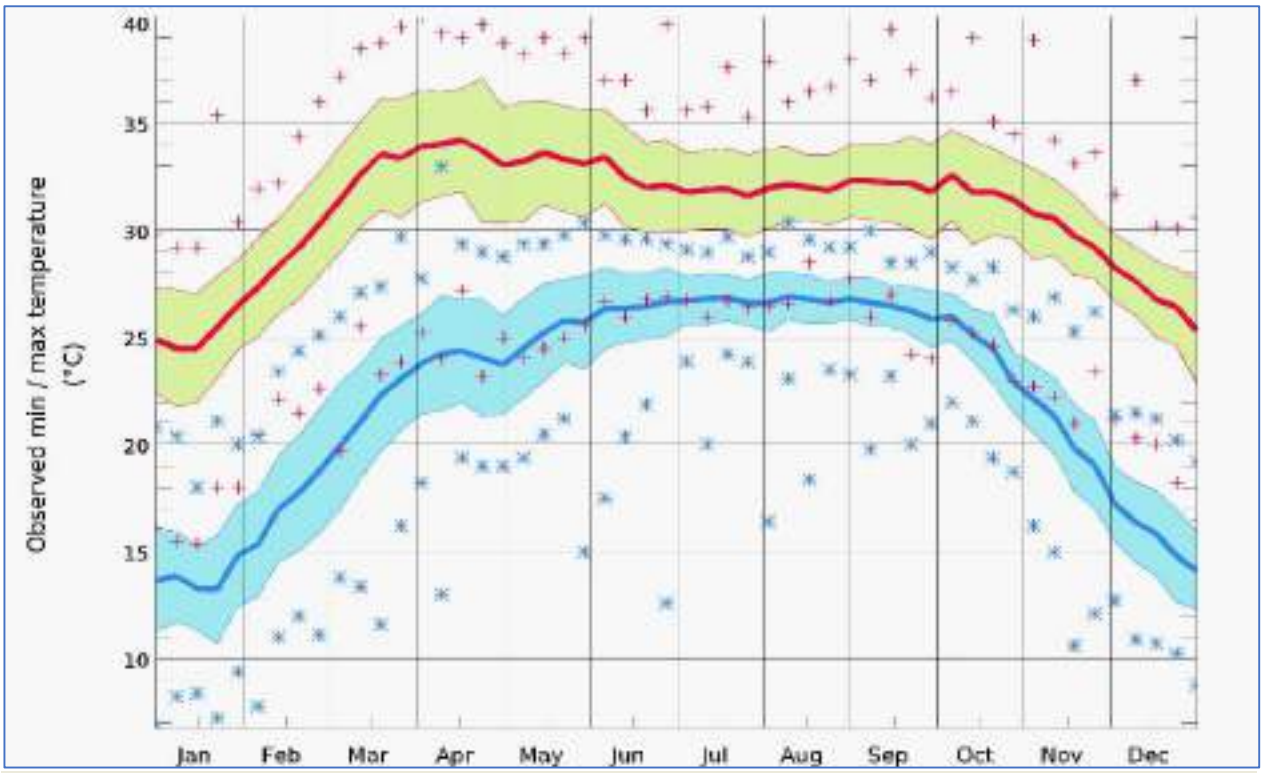


Figure 86. Monthly average min. and max. temperatures (°C) of 2018, 1953 – 2018 at Barishal *(Source: BMD)*

4.2.1.3. Rainfall

The single most dominant element of the climate of Bangladesh is the rainfall. Due to the country's location in the tropical monsoon region, the amount of rainfall is very high. However, there is a distinct seasonal pattern in the annual cycle of rainfall, which is much more pronounced than the annual cycle of temperature. As the winter season progresses into the pre-monsoon hot season, rainfall increases due to intense surface heat and the influx of moisture from the Bay of Bengal. Average monthly rainfall during monsoon period (June-September) varies between 177.54 mm to 751.1 mm.

The rainfall follows the general weather pattern with the highest rainfall in the wet season (June to September) and minimum rainfall in the cooler and drier months (December to February). It is evident that extreme rainfall events occurred during the monsoon, but it is highest in July. The normal rainfall is lower during the winter months and it is the lowest in January. Nearly 80% of the annual average rainfall occurs during the monsoon season. Monthly average accumulated rainfall at different locations is shown in the following tables. Rainfall data has been obtained from Bangladesh Meteorological Department (BMD).

Monthly average rainfall data has also been analyzed since January 1949 to December 2013 from the website: Climate Information Management System (BARC) to obtain more information.

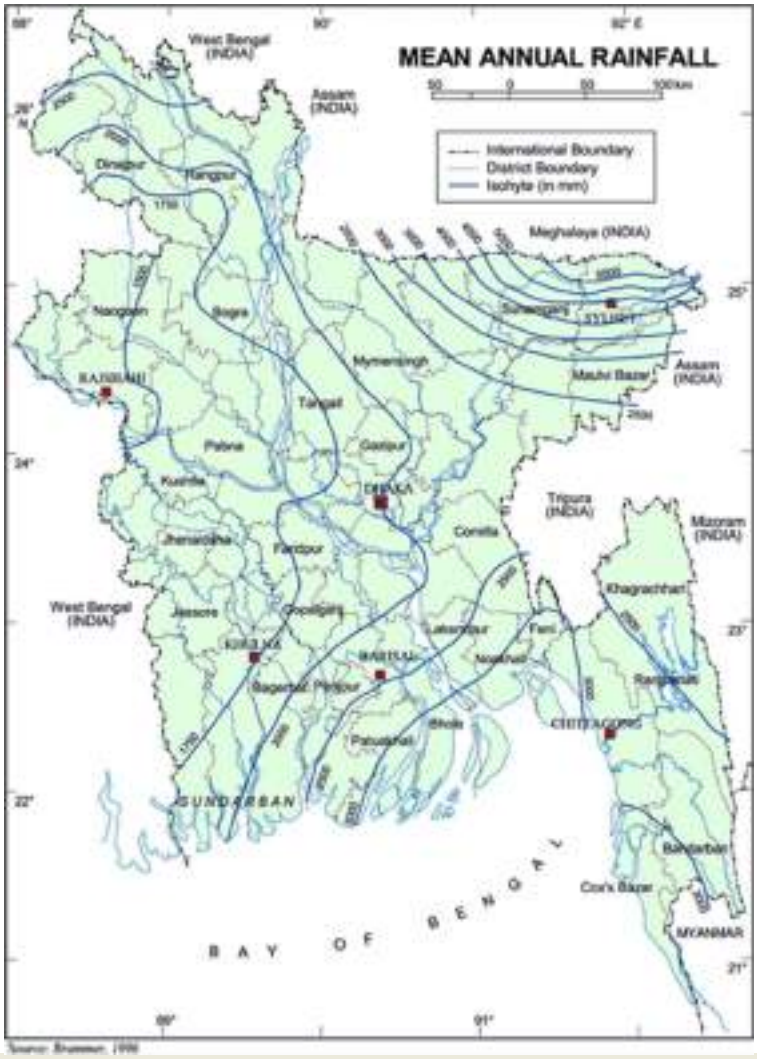


Figure 87. Mean annual rainfall distribution over Bangladesh (Adapted from Hasan et al. 2014)[8]

- Dhaka Meteorological Station

Rainfall data has been analyzed from January 1953 to December 2017 and it can be observed that the highest rainfall was 856mm in the month of June 1961. Annual average rainfall is around 2040 mm over the period of 1953-2017 at Dhaka Station. See Table 55 for details.

Table 55. Average Monthly total Rainfall Data from 2013-2017 at Dhaka

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monthly Average Normal Rainfall (mm)	1.2	10.4	39	112.2	222	333.6	425.2	342.6	231.8	143.8	6.2	7.6

Source: BMD, further processed by BARC

[8] Hasan, G M J., Chowdhury, M., Ahmed, S. Analysis of the statistical behavior of daily maximum and monthly average rainfall along with rainy days variation in Sylhet, Bangladesh. Journal of Environment Science and Technology, 9(5):559-573

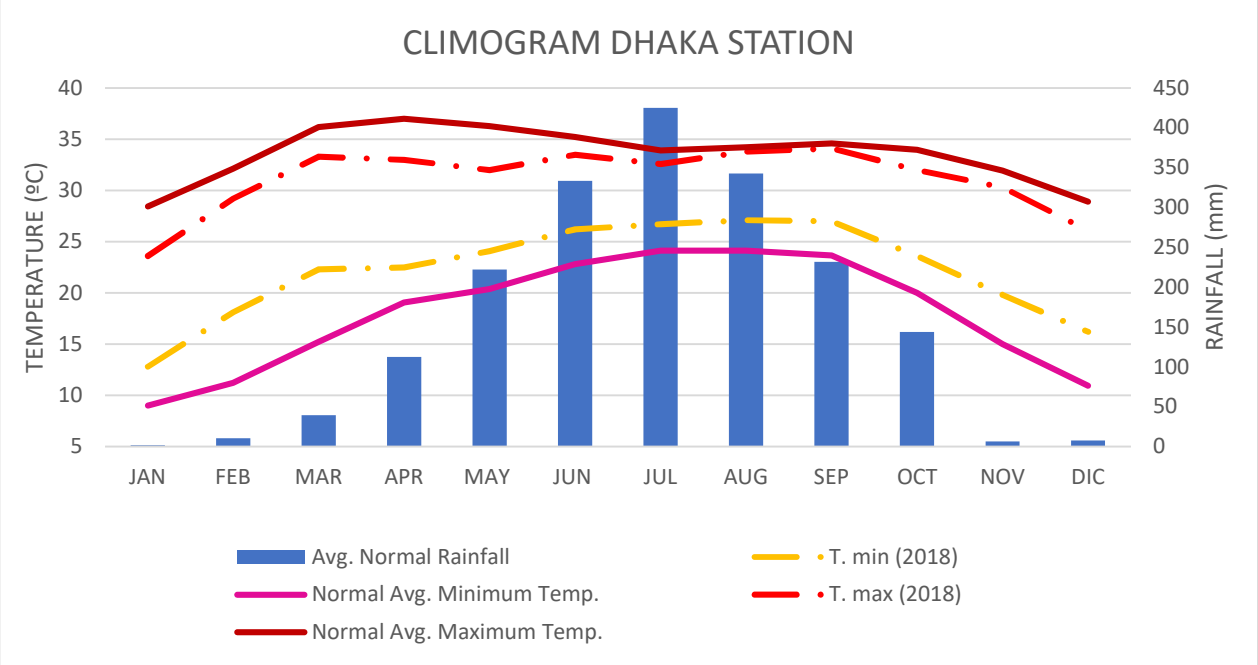


Figure 88. Climogram from Dhaka Station

(Source: BMD, further processed by BARC)

- Chandpur Meteorological Station

Rainfall data has been analyzed from January 1966 to December 2017 and it can be observed that the highest rainfall was 1151mm in the month of June 1984. Annual average rainfall is around 2025 mm over the period of 1966-2017 at Chandpur Station. See Table 56 for details.

Table 56. Average Monthly total Rainfall Data from 2013-2017 at Chandpur

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monthly Average Normal Rainfall (mm)	0.6	17.2	37.8	119.8	345.2	482.4	520.4	431.2	325.4	160.4	30	25.4

Source: BMD, further processed by BARC

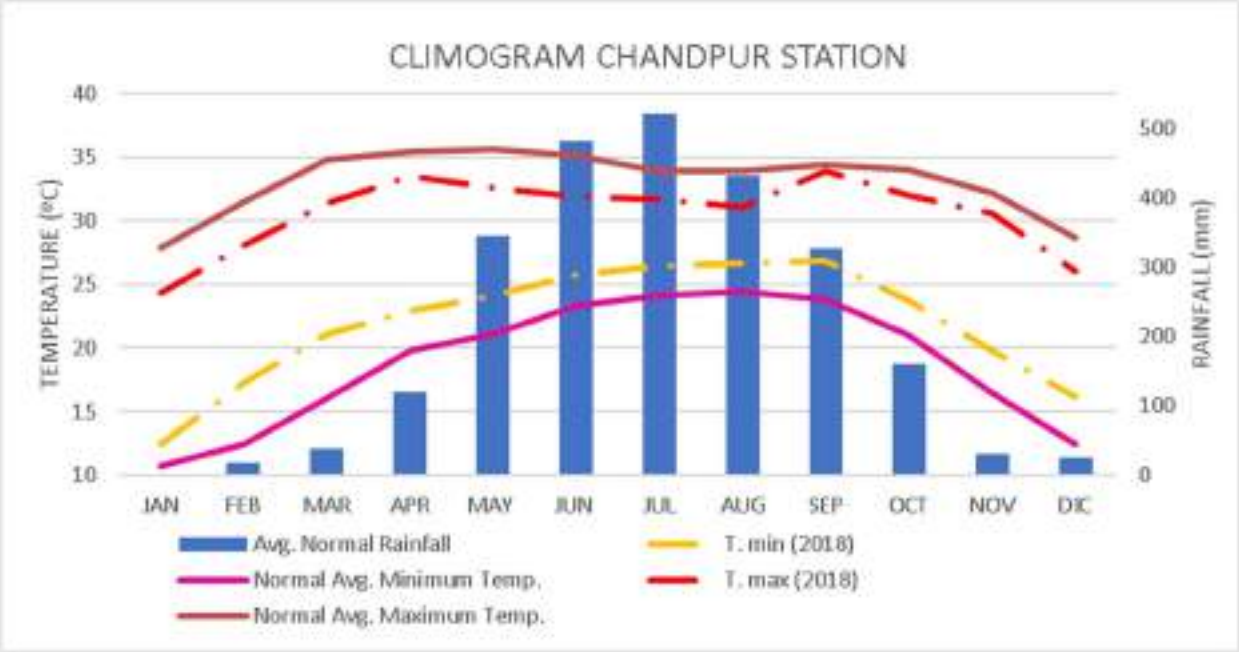


Figure 89. Climogram from Chandpur Station

(Source: BMD, further processed by BARC).

- Barishal Meteorological Station

Rainfall data has been analyzed from January 1949 to December 2017 and it can be observed that the highest rainfall was 1067mm in the month of September 2004. Annual average rainfall is around 2105 mm over the period of 1949-2017 at Barishal Station.

See Table 57for details.

Table 57. Average Monthly total Rainfall Data from 2013-2017 at Barishal.

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monthly Average Normal Rainfall (mm)	0.8	15.2	20.6	122.8	312.8	416.4	497.2	364.2	286.4	163.4	25	12

Source: BMD, further processed by BARC

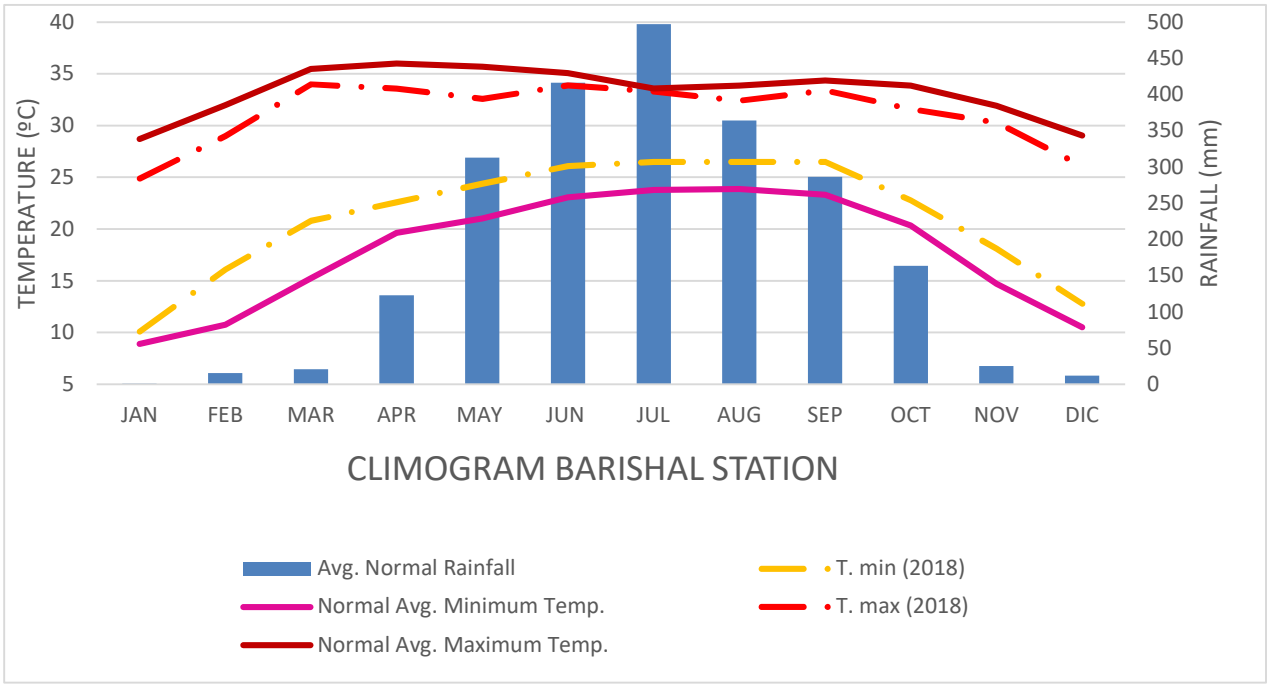


Figure 90. Climogram of Barishal Station

(Source: BMD, further processed by BARC)

4.2.1.4. Relative Humidity

Regarding humidity, no big differences have been found between dry and monsoon season in the study area. However, relative humidity during the wet season (June-September) is slightly higher than those occurring at other periods of the year. The humidity remains high all year round, producing thick fog in winter. The least humid months in the eastern areas are January to March. Here the lowest monthly average of 58.5% has been recorded at Brahmanbaria in March. The relative humidity is over 80% everywhere from June to September (Source: Banglapedia).

March is the least humid month over the study areas of the country. The average lowest relative humidity (61%) has been recorded at Dhaka and the average highest relative humidity was 89% recorded from Barishal station in the months of July and August. Relative Humidity data was obtained from BMD which is further processed by BARC.

- Dhaka Meteorological Station

Relative Humidity data has been analyzed from January 1953 to December 2017 and it can be observed that the highest relative humidity was 90% in the month of June (1954), and the lowest 49% in the month of March (1962). Average relative humidity was highest, 85% in the month of July, and lowest, 61% in the month of March in the Dhaka area. The following Table shows relative humidity data and the following figure shows the relative humidity pattern of Dhaka District.

From the graph it can be observed that average relative humidity fluctuates, and variation occur among the months of the year. Similar results have been observed in the other stations. Annual average relative humidity was 75% in the period of 1953-2017 at Dhaka Station. See Table 58 and figure for details.

Table 58. Monthly average relative humidity (%) at Dhaka (1953-2017)

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average monthly relative humidity (%) at Dhaka. (1953-2017)	70	63	61	70	77	84	85	84	84	79	73	73

Source: BMD, further processed by BARC

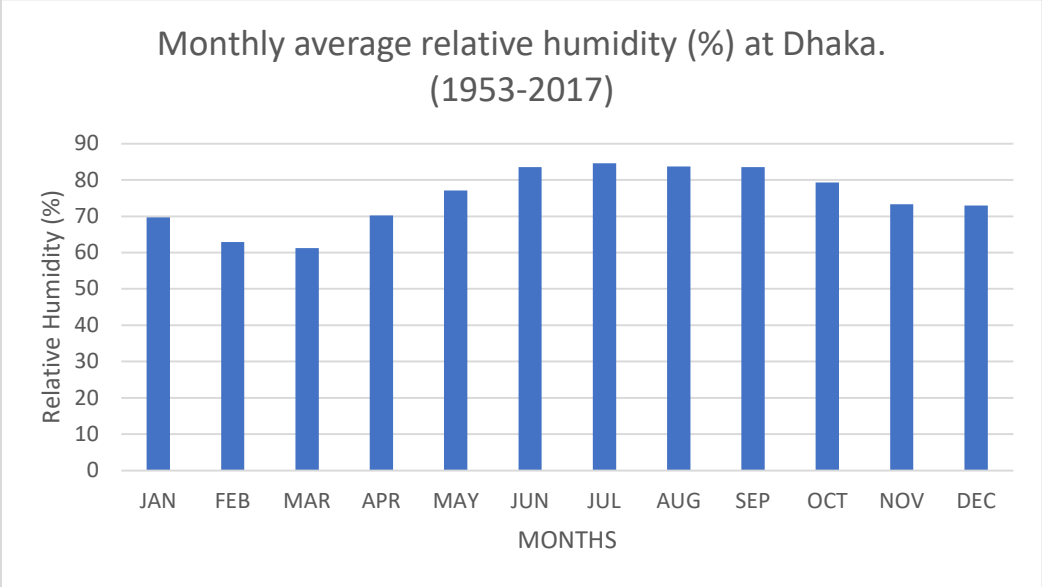


Figure 91. Monthly average Relative Humidity (%) pattern (Dhaka, 1953-2017)

Source: BMD further processed by BARC

- Chandpur Meteorological Station

Relative Humidity data has been analyzed from January 1966 to December 2017 and it can be observed that the highest relative humidity was 91% in the month of July (1969), and the lowest, 62% in the month of February (1974). Average relative humidity was highest 86% in the months of July and August, the lowest was 72% in the month of March at Chandpur station. The following Table shows relative humidity data and the following figure shows the relative humidity pattern of Dhaka District. From the graph it can be observed that average relative humidity fluctuates, and variations occur among the months of the year. Annual average relative humidity was 80% in the period of 1966-2017 at Chandpur Station. See Table 59 and figure 92 for details.

Table 59. Monthly average relative humidity (%) at Chandpur station (1966-2017).

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average monthly relative humidity (%) at Chandpur. (1966-2017)	77	73	72	76	79	85	86	86	85	82	78	78

Source: BMD, further processed by BARC

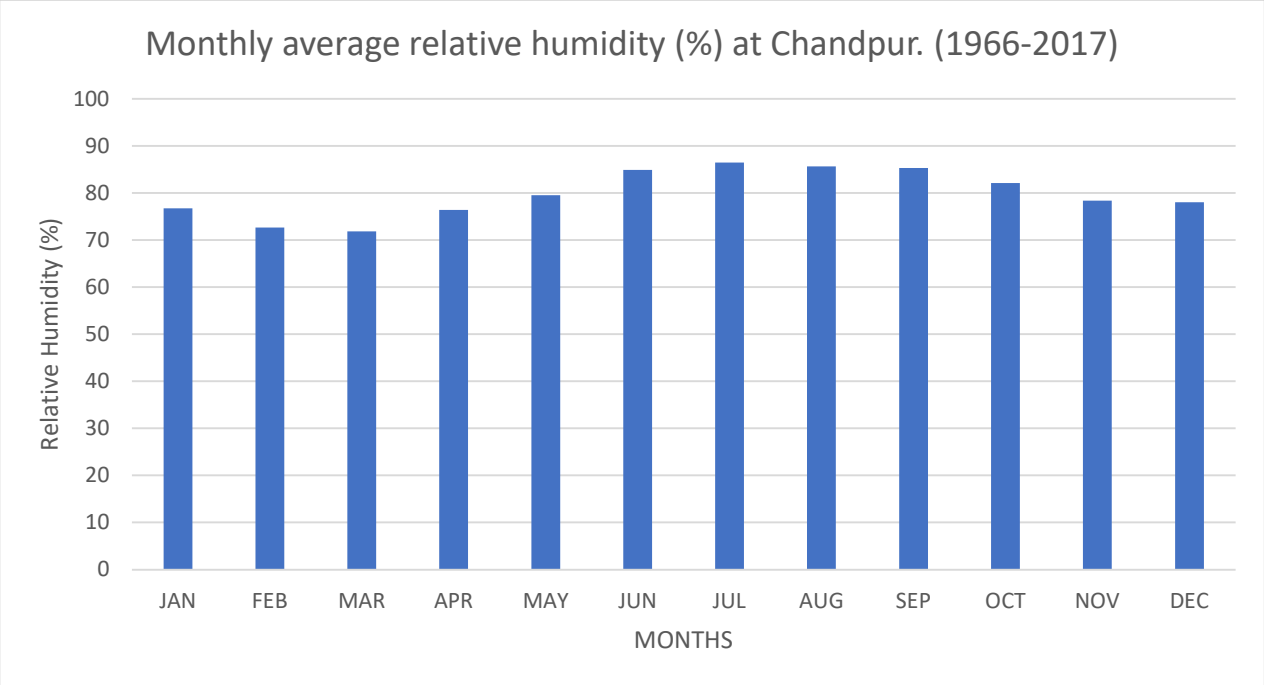


Figure 92. Monthly average Relative Humidity (%) pattern (Chandpur, 1966-2017)

Source: BMD, further processed by BARC

- Barishal Meteorological Station

Relative Humidity data has been analyzed from January 1949 to December 2017 and it can be observed that the highest relative humidity was 94% in the month of July (1987), and the lowest 58% in the month of March (1962). Highest average relative humidity was 85% in the month of July and the lowest was 61% in the month of March at Barishal station. The following Table shows relative humidity data and the following figure shows the relative humidity pattern of Barishal District.

From the graph observed that average relative humidity fluctuates, and variations occur among the months of the year. Similar result has been observed in the other stations. Annual average relative humidity was 75% in the period of 1953-2017 at Barishal Station.

Table 60. Monthly average relative humidity (%) at Barishal station (1949-2017).

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average monthly relative humidity (%) at Barishal. (1949-2017)	79	76	74	79	82	87	89	89	88	86	82	79

Source: BMD, further processed by BARC

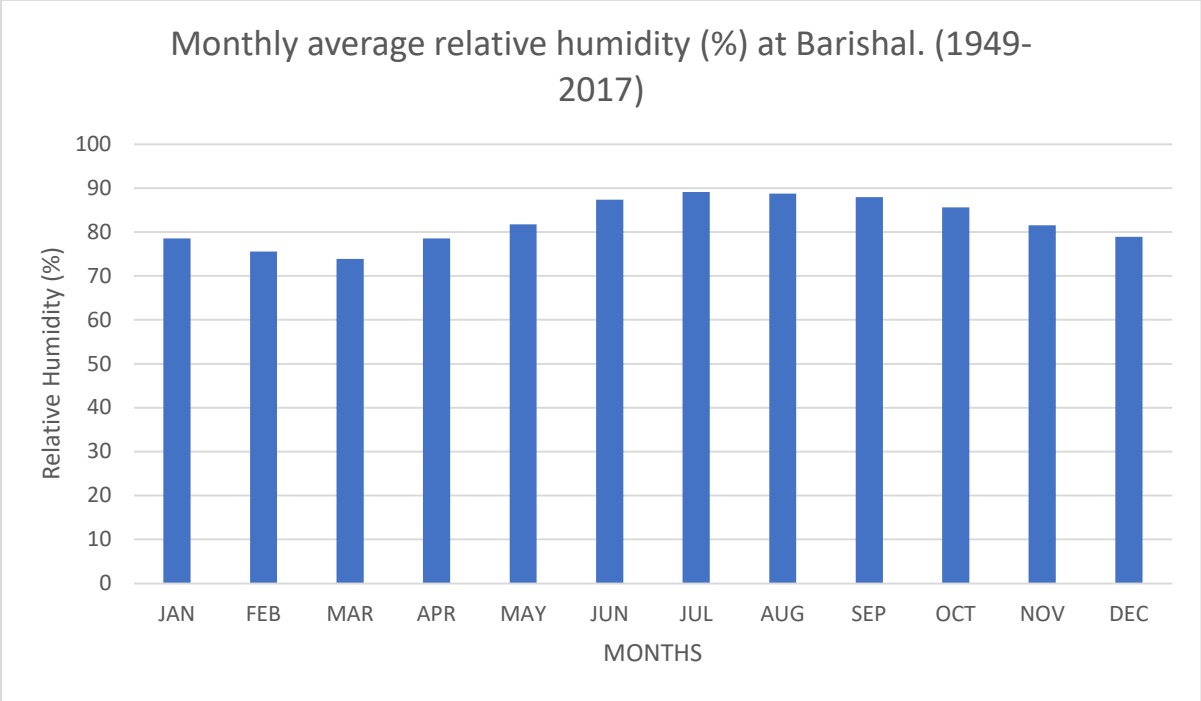


Figure 93. Monthly average Relative Humidity (%) pattern (Barishal, 1949-2017).

Source: BMD, further processed by BARC

4.2.1.5. Wind

The direction of wind varies depending on the seasons. Therefore, the whole year has been categorized into four clusters of months and these are: Cluster-1: December-March, Cluster 2: April-June, Cluster 3: July to September, and Cluster 4: October to December. Wind speed data and direction have been collected from the Dhaka, Chandpur and Barishal BMD station at a height of 10 m above ground level.

- Dhaka Meteorological station

From 1987-2017, clusters 1 and 4 wind direction are predominantly in a northwest to southeast direction, inclined towards east and for clusters 2 and 3 it is predominantly from south and southeast to north and northwest. In cluster 1 calm wind prevails for 27.2% of total period; similarly it is 11.0% for cluster 2; 12.5% for cluster 3; and 56.9% for cluster 4; respectively.

Figure 94 presents wind speed and direction graphically round the year. Table 61 is followed by figure 95 which presents the wind roses, followed by a Table showing the wind speed and direction data over the period 1987-2017.

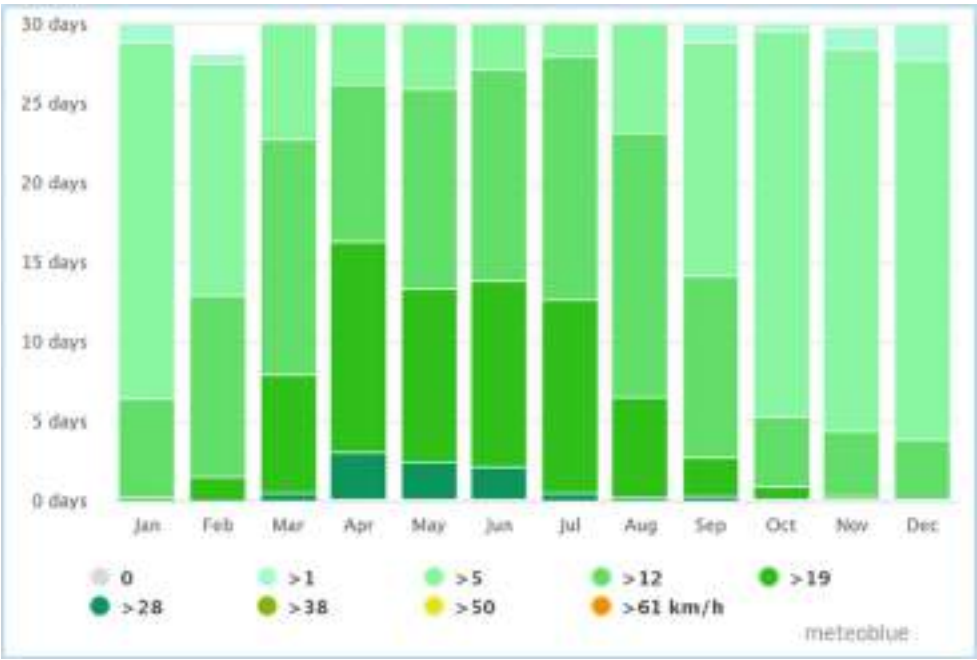


Figure 94. Monthly wind speed distribution at Dhaka.

Source: URL: www.meteoblue.com[9]

[9] Meteoblue (undated) Website: *www.meteoblue.org* date accessed: 20 January 2020.

Table 61. Wind speed and direction data of Dhaka Meteorological Station over the period of 1987-2017 (Source: BMD)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir
1987	3.2	NW	3.3	NW	4.4	S	5.3	S	4.9	S	4.4	S	4.2	S	4	S	3.6	S	3.4	E	2.7	E	2.4	N
1988	2.5	N	3	NW	4.9	S	5.3	S	6.2	S	4.2	S	4.4	S	4.4	S	3.8	SW	3.6	N	2.4	N	2.8	N
1989	3.5	N	4.5	SW	3.5	W	6.4	S	6.1	S	4.9	S	4.2	S	3.7	S	4.3	SE	3.6	SE	2.6	N	2.9	N
1990	2.6	NW	3.5	NE	6.3	S	6.5	S	3.8	S	4.8	S	4.4	S	4.2	S	4.7	S	7.5	SE	2.6	E	3	N
1991	3.2	N	4	N	3.3	SW	4.6	S	6.2	S	3.9	S	4.5	S	4	S	4.3	S	3.1	S	2.3	N	4.2	N
1992	3.7	N	4.2	E	4.7	W	5.8	S	4.4	S	4.1	S	3.9	S	5.2	SE	3.6	S	3.8	E	2.5	N	2.8	N
1993	3	W	3.7	S	4.6	S	3.5	S	3.7	S	3.9	S	3.4	S	3.4	SE	3.1	SE	3.6	SE	2.5	NE	2.7	N
1994	3.2	NW	3	NW	4.4	S	3.9	S	4	S	4.2	SE	3.8	SE	3.8	SE	3.7	SE	2.6	SW	2.1	N	2.2	N
1995	2.8	NW	2.6	W	2.9	NW	3.1	S	3.4	S	3.7	S	3.8	SE	3.9	SE	3.7	SE	2.4	NE	2.3	NE	2.2	W
1996	2.3	NW	2.7	W	3	SW	2.9	S	2.7	S	2.6	SE	2	S	1.8	S	1.5	S	3.3	E	1.4	N	1.4	NW
1997	1.5	NW	1.8	W	2.4	W	2.3	S	2.2	S	2.4	S	2.2	SE	2.9	SE	2	S	1.4	NW	2	N	1.7	N
1998	1.5	NW	1.7	NW	2.7	W	2.5	S	3.1	S	2.8	S	2	S	1.9	S	2.1	SE	2.7	SE	3.6	NE	2	NW
1999	2.1	NW	2.2	NW	2.2	S	2.5	S	2.5	S	2.5	S	2.6	SE	2.3	SE	1.9	SE	2.4	SE	1.6	N	1.7	N
2000	1.6	N	2	N	2.3	S	3.3	S	2.6	S	2.5	S	2.4	S	2.4	S	2.2	S	3.3	NE	1.5	N	1.6	N
2001	2.2	NW	1.8	NE	3.6	S	4.1	S	3.4	S	3.2	S	3.9	S	2.5	S	3	S	2.6	S	1.7	N	2	N
2002	2.5	N	2.5	NW	3.9	S	4.1	S	3.5	S	2.8	S	2.7	S	2.8	S	3	SE	2	N	6.5	NE	2.4	N
2003	3.1	NW	3.5	N	3.8	S	5.1	S	4.9	S	4.1	SE	4.1	S	4.3	SE	4.3	SE	3.3	NE	2.8	N	3.1	W
2004	3.5	W	3.9	W	5.6	S	5.9	S	5.5	S	3.6	S	4.3	SE	4.1	SE	6.3	E	4.2	SE	3.2	W	3.3	NW
2005	4.1	NNW	4.3	W	4.6	S	4.5	S	4.4	S	4.4	SE	4.6	SE	3.5	S	4.6	SE	4.8	SE	3.4	NW	3.7	NW
2006	3	N	3.6	S	5	NNW	3.8	S	3.8	S	2.1	S	2.2	SE	4.5	SE	5.4	SE	2.3	N	2.1	NW	2.4	NW
2007	2.9	NW	3.1	NW	4.2	NW	3.8	S	3.5	S	3.1	S	3.1	S	3.1	S	3.2	S	4.1	NE	5.5	NE	2.9	NW

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
2008	3.6	N	3.2	N	3.8	S	3.4	S	3.4	S	3.3	S	3.4	S	2.8	S	2.8	S	9.6	NE	2.5	NE	3.3	W
2009	3.3	W	4.1	W	4	W	4.1	S	3.8	S	3.1	S	4.3	SE	2.8	S	4.2	SE	2.3	E	2.8	N	2.4	NW
2010	2.9	NW	3.3	W	3.8	S	4.1	S	3.7	S	3	S	2.4	S	2.2	S	2.6	SE	2	NE	2.9	N	2.4	N
2011	2.2	W	2.4	W	3.8	S	2.4	S	3	S	2.7	SE	2.4	SE	2.4	SE	2.6	SE	2	NW	2.3	W	2.1	NW
2012	2.4	W	3	W	2.5	S	2.6	S	2.5	S	3	S	2.7	SE	2.5	SE	2.2	E	2	S	2.2	W	2.3	W
2013	2.3	W	2.2	W	2.6	W	2.8	S	3.2	E	2.3	S	2.7	SE	2.7	SE	2.2	S	2.9	SE	2.1	N	2.3	W
2014	2.5	W	2.5	W	2.4	NW	2.2	S	2.8	S	2.1	S	2.4	SE	2.4	SE	2.1	SE	2.1	W	2.1	W	2.2	W
2015	2.2	W	2.4	W	2.2	W	2.5	S	2.3	S	2.6	S	2.4	E	2.7	S	3	SE	1.9	S	2.5	N	2.1	W
2016	2.7	W	2.6	W	2.3	S	3	S	3.6	S	2.4	S	2.3	S	2.8	E	2.1	S	2	W	2.5	NE	2	W
2017	2.2	NW	2.3	S	2.5	S	3.1	S	2.5	S	2.4	S	2	S	2.2	S	2.2	S	3.3	E	2.4	E	2	NW

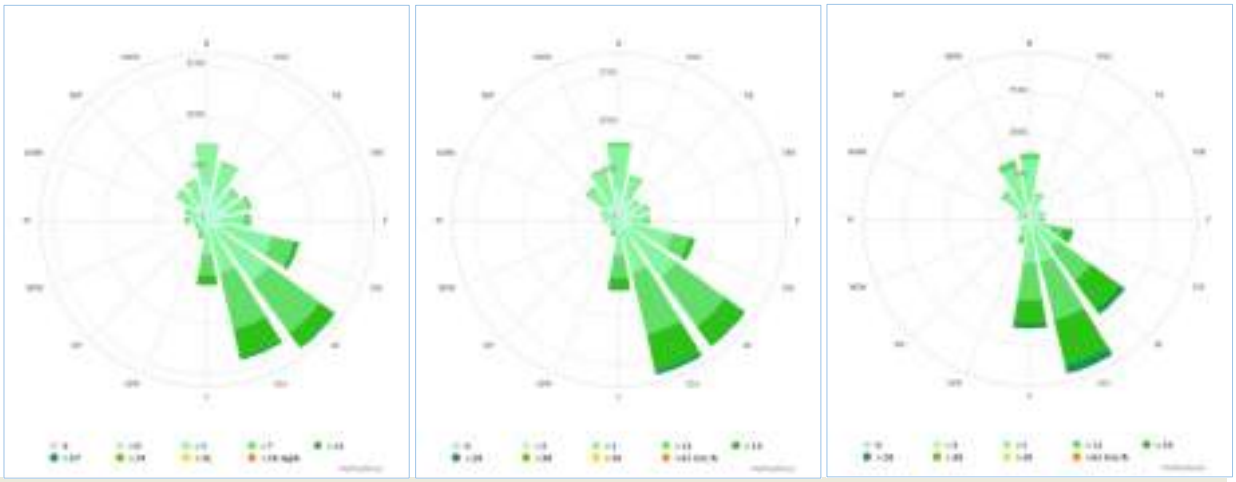


Figure 95. Modelled wind rose from wind speed and direction for Dhaka (Left), Chandpur (middle) and Barishal (Right).

Source: Data and model by URL: www.meteoblue.com

- Chandpur Meteorological station

From 1987-2017 the wind blew predominantly towards south-southeast and southeast from northwest. From September to February wind generally remained calm (<1km/hr). During the period of April-June wind speed was variably high (>28km/hr) for about 5 days a month. The next figure presents wind speed and direction graphically throughout the year. Table 62 shows the wind speed and direction data over the period 1987-2017.

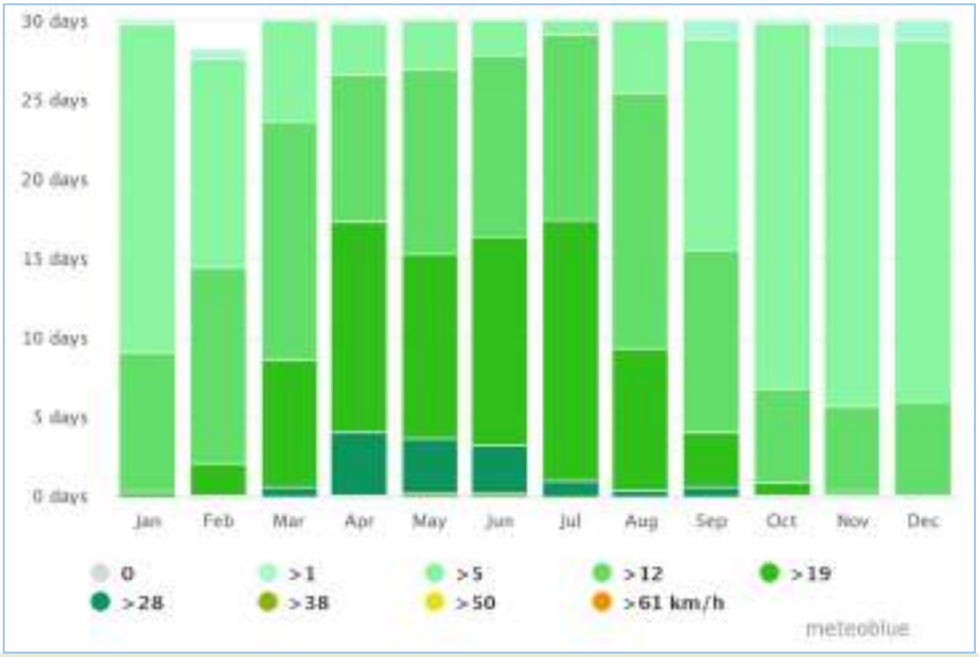


Figure 96. Monthly wind speed distribution at Chandpur.

Source. URL: www.meteoblue.com

Table 62. Wind speed and direction data of Chandpur Meteorological Station over the period of 1987-2017

(Source: BMD)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir
1987	2	NW	1.7	NW	2.3	S	4.1	S	2.9	S	2.8	S	2.7	S	2.3	S	2.3	S	1.8	N	1.8	N	1.9	NW
1988	1.9	NW	1.8	NW	1.8	SW	2.4	S	4.5	S	3	SE	2.2	S	1.9	S	1.7	S	1.5	N	1.5	N	1.3	NW
1989	1.6	N	2.6	S	1.7	SW	3.4	S	2.3	S	2.5	S	2.4	S	2.1	SE	2	SE	1.8	SE	1.3	N	1.7	NW
1990	1.5	NW	1.5	N	1.4	N	3.4	S	1.8	SW	2.1	SE	1.7	SE	1.7	SE	1.9	SE	2	SE	1.4	N	1.2	N
1991	1.6	NW	1.6	NW	1.5	SW	2.6	S	2.4	SE	2	SE	2.3	SE	1.9	SE	1.1	SE	1.7	SE	1.5	NNW	1.7	NW
1992	2	NW	2	NW	3.4	S	4.2	S	4.3	S	2.5	S	2.7	SE	2.7	SE	2.4	SE	1.8	NW	2.2	NW	2.3	NW
1993	2.2	NW	4.1	S	2.7	S	3.5	S	3.5	S	3	SE	2.7	SE	2.7	SE	2.1	SE	1.5	SE	1.7	NW	1.1	NW
1994	2.1	NNW	1.2	NW	3.2	S	2.7	S	2.5	S	2.6	SE	3.3	SE	3.1	SE	2.7	SE	1.7	NW	2.1	N	1.5	NNW
1995	4.5	NW	2.6	NW	3	NW	2.9	S	3.1	S	3	S	3.4	S	2.9	S	2.7	SE	2.3	SE	2.7	NW	1.8	NW
1996	2.1	N	2.6	NW	3.1	S	2.3	S	4.1	S	3.1	SE	2.3	SE	2.3	SE	1.9	NW	2.8	NW	2	NW	2.3	NW
1997	2.2	NW	2.2	NW	2.5	SW	2.2	S	3.4	S	2.7	S	3.3	SE	3.3	SE	2.8	SE	2.2	N	3.4	NW	2.9	NW
1998	2.9	NW	2.3	N	2.3	N	4	S	4.4	S	4	S	2.7	S	2.8	S	3.8	S	2.2	SE	3.4	N	2.5	N
1999	2.5	NW	2.9	NW	2.9	S	2.5	S	2.6	S	3.6	S	2	S	2.1	S	2.5	S	2.3	SE	2.2	N	1.8	NW
2000	2.5	N	2.3	N	2.3	S	2.7	S	6.6	S	2.6	S	2.1	S	2.5	S	1.5	SE	1	N	1.5	N	1.7	N
2001	2.5	NW	2.3	N	1.9	S	2.9	S	3.9	NW	2	S	2.7	S	2.2	S	1.6	S	1.8	S	1.2	N	1.9	NW
2002	2.3	NW	2.3	NW	2.1	NW	3.5	S	3.3	S	2.4	SE	2.4	S	2.3	SE	2.7	SE	2.2	NW	2.1	NW	2.3	NW
2003	2.5	NW	3	N	2.5	S	3.5	S	2.1	SE	2.9	S	3.1	S	2.4	SE	2.1	SE	2.2	W	2	N	2	NW
2004	2.4	N	1.9	NW	1.5	S	2.4	S	2.2	S	2.1	SE	2.4	SE	2.5	SE	3.7	SE	3	SE	2.2	N	1.5	NW
2005	2	N	2.7	NW	3.1	S	2.4	S	2.1	S	2.3	S	2.4	SE	2	SE	2.1	SE	1.7	NW	2.1	NW	2.2	NW

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
2006	1.9	NW	2.2	S	2	N	2.5	S	2.4	S	2.3	S	2.4	SE	3.6	SE	3.4	SE	2.1	NW	2.5	N	2.1	N
2007	2.3	N	2.4	NW	2.3	NW	3.4	S	2.9	S	2.7	S	2.5	S	3	S	2.8	SE	2.5	SE	1.7	NW	2.2	N
2008	2	N	1.9	N	2	S	2.2	S	2.4	S	2.4	S	2.2	S	2	S	2.7	SE	2.1	NW	2.1	N	1.7	NW
2009	2	NE	2.2	N	2.4	NW	3.2	S	2.5	S	2.3	S	2.5	S	2.1	S	2.7	S	2.4	S	2.2	N	2.4	N
2010	3	N	2.8	N	4	S	3.7	S	2.8	S	2.6	S	2.6	S	2.5	S	2.4	S	2.2	NW	2.6	N	2.4	N
2011	2.2	N	2.5	N	4.3	S	2.5	S	2.3	S	2.4	S	2.2	S	2.2	S	2.2	S	2.1	N	2.1	N	2.4	N
2012	2.4	N	2.5	N	2.5	S	2.8	S	2.8	S	3.1	S	2.6	S	2.4	S	2.4	S	2.2	N	2.3	N	2.7	N
2013	2.8	N	2.8	N	2.1	S	2.9	S	3.1	S	2.3	S	2.3	S	2.4	S	2.3	S	2.3	S	2.5	N	2.4	N
2014	2.9	N	2.6	N	2.7	N	3	S	3.1	S	2.2	S	2.4	S	2.3	S	2.5	S	2.5	N	2.4	N	2.4	N
2015	2.6	N	2.6	N	2.9	N	2.8	S	2.4	S	2.5	S	2.4	S	2.1	S	2.3	S	2.6	N	2.3	N	2.1	N
2016	2.2	N	3	N	2	S	3.6	S	2.7	S	2.3	S	2.3	S	3.4	S	2.5	S	2.7	N	3.4	N	2.8	N
2017	2.6	N	2.4	N	3.2	S	3.6	S	2.8	S	2.7	S	2.5	S	2.6	S	2.5	S	3.8	S	2.9	N	2.7	N

- Barishal Meteorological station

From 1987-2017 the wind blew predominantly towards south-southeast and southeast from northwest. From October to December wind generally stayed calm (<1km/hr.). During the period April-July wind speed remained variably high (>28km/hr.) for about 5 days a month. Figure 97 presents wind speed and direction graphically throughout the year. This is followed by the figure containing the wind roses, with Table 63 showing the wind speed and direction data over the period 1987-2017.

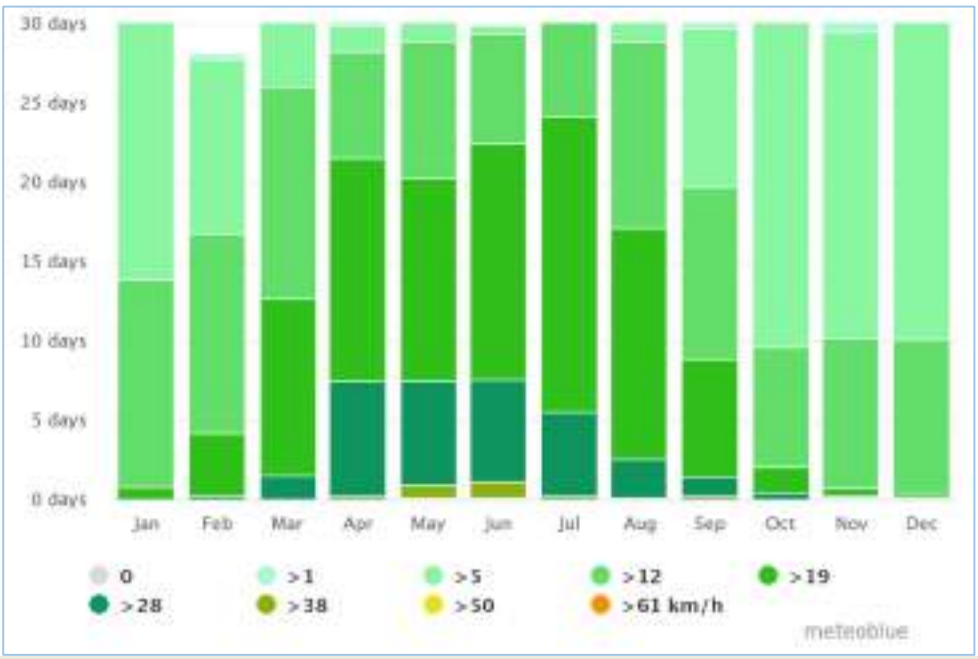


Figure 97. Monthly wind speed distribution at Barishal.

Source: URL: www.meteoblue.com

Table 63. Wind speed and direction data of Barishal Meteorological Station over the period of 1987-2017

(Source: BMD)

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir
1987	3.2	NW	3.3	N	3.9	S	4.7	S	3.8	S	3.9	S	3.6	S	3.1	S	3.7	S	3.2	NW	3.2	N	3.4	N
1988	3.9	N	3.2	S	3.4	S	4	S	4.9	S	5	SE	3.9	S	3.6	S	3.3	S	2.8	NW	2.5	N	3.2	N
1989	3.7	N	3.9	NW	3.6	SW	5	S	4.3	S	4.2	S	3.9	S	4.1	SE	3.9	S	4.1	SE	2.9	N	4.5	N
1990	3.7	NW	3.4	SW	6	S	5.3	S	4	S	4.4	S	3.7	S	5	SE	3.7	S	4.1	SE	3.6	N	2.9	N
1991	3.6	N	4.2	SW	3.3	SW	4.5	S	6.1	S	3.7	S	3.6	S	4.3	SE	3.6	S	4.8	SE	4.1	NW	5.2	NW
1992	4	NW	4.4	S	4.1	S	4.8	S	5	S	4.1	S	4.6	S	4.8	SE	4.3	S	4.3	SE	2.7	E	4.4	NW
1993	4.4	NW	5.6	S	4.7	S	4.8	S	6.2	S	5.1	S	4.9	SE	4	S	4.5	SE	3.2	S	2	NW	3.4	N
1994	3.9	NW	4	N	4.3	S	3.9	S	4.4	S	3.8	S	4.3	SE	3.8	SE	4.8	SE	3.2	S	2.4	NW	2.8	N
1995	3.3	N	3.8	S	3.4	S	4.1	S	4.3	S	4.3	S	6.1	SE	4.3	S	4.7	S	4	N	3.5	NW	4	NW
1996	3.9	NW	4.3	NW	5.6	S	4.5	S	7.5	S	7.3	S	5.6	S	4.9	S	4.8	S	11.3	E	5	N	5.7	N
1997	5.8	N	4.2	S	5.5	SW	5.5	S	6.5	S	5.9	S	5.9	SE	7.8	SE	5.7	S	5.1	N	4.3	N	5.6	N
1998	5.7	N	5.2	SW	6.9	SW	6.7	S	7.5	S	7.7	S	5.8	S	5.4	S	6	SE	6.1	SE	4.9	N	4.5	N
1999	4.6	NNW	6.1	N	5.8	S	6.7	S	7.2	S	6	S	5.3	SE	4.7	SE	4.9	SE	4.4	SE	2.8	N	5.3	NW
2000	5.8	N	5.7	N	6.1	S	6.1	S	6.1	S	5.3	S	5.6	S	5	S	4.6	S	8	E	4	N	4.2	N
2001	3.4	N	5.9	S	5.1	S	7.7	S	6.1	S	5	S	5.4	S	5.3	SE	4.8	S	3.8	E	4.5	E	5	NW
2002	4.4	N	4.7	N	5.7	S	6.6	S	6.5	S	5.5	S	5.1	S	6.1	S	4.7	S	3.7	E	8.3	E	5.2	NW
2003	4.6	N	4.2	N	6	S	7.5	S	7.1	S	6.2	S	5.4	S	5.6	S	5.3	S	5.6	S	2.5	N	3	N
2004	4.4	N	4.5	S	6.1	S	8.9	S	7.4	S	5.1	S	5.6	S	6.2	SE	5.2	SE	6.2	SE	4	NW	0	CLM
2005	4.9	N	4.3	S	5.7	S	5.3	S	5.6	S	5.1	S	5.3	S	4.2	S	5.2	SE	3.8	S	2.8	N	3.7	N
2006	4	N	4.3	S	3.8	S	4.9	S	4.9	S	5.3	S	3.6	S	3.7	S	3.6	S	2.4	NW	2.8	NW	3	NW

Year	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
2007	3.3	NW	3.7	NW	3.1	W	5	S	5	S	4.3	S	3.8	S	3.8	S	3.9	S	5.8	E	4	NW	4	N
2008	3.4	N	5	N	4.1	S	4.8	S	4.3	S	4.2	S	4.3	S	4	S	4.2	S	4.8	N	3.7	N	3	N
2009	4.2	N	3.4	NW	3.6	S	5	S	4.5	S	4	S	3.1	S	2.8	S	4.8	SE	2.8	S	2	NE	2	N
2010	3.1	N	2.7	NW	4.9	S	5.7	S	4.9	S	4.2	S	3.1	S	2.8	S	4	SSE	4.8	E	0	CLM	1.8	N
2011	3.1	N	4.7	N	5.8	S	2.9	S	3.5	S	3.2	S	3.7	S	3.4	S	3.9	S	3.5	SSW	3	NW	2.4	NW
2012	2.8	N	2.8	NW	2.9	S	3.2	S	3	S	3.1	S	2.3	S	2.4	SE	2.3	SE	2	NW	1.5	NW	2.1	N
2013	2.4	NW	2.1	NW	2.8	S	3.2	S	4.2	S	3	S	3.1	S	2.9	S	3	S	4.5	SE	1.8	NW	2.7	NW
2014	2.2	N	2.4	N	2.4	S	2.8	S	2.4	S	2.2	S	2.4	S	2.2	S	1.9	SE	2	NNW	2	NW	2	NW
2015	1.9	NW	2.9	NW	3	NW	3	S	2.6	S	3	S	2.9	S	4.4	S	3	S	3.5	SSE	3	ESE	2.3	NW
2016	2.2	NW	2	SSW	2.6	S	3.9	S	3.4	S	2.9	S	2.8	S	4.9	SE	2.9	S	3.6	SE	4.9	N	1.7	NW
2017	3.1	N	4.8	S	3.7	S	4.2	S	3	S	3.5	S	3	S	3	S	2.8	S	3.4	SE	2	NW	2	NW

4.2.2. Air Quality

The air quality monitoring was carried out at 6 locations for the project sites to verify the current quality of air. The aim was to collect the existing air quality data and to compare the data with the air quality data during future 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. Dispersal of pollutants depends upon factors such as prevailing wind direction and other weather conditions, atmospheric stability, height of the source. The air quality monitoring was performed from 22 October 2019 to 29 October 2019 (see figure 98). The filter and each chemical were measured before testing. The Electro-Chemical Sensor devices were calibrated before testing certain other parameters.

Figure 98. Air quality monitoring at various sites

Prevailing weather conditions during air quality sampling are given in Table 64

Table 64. Prevailing weather condition during air quality sampling

Sample ID	Location	GPS Location	Humidity (%)	Temperature (^{0}C)	Wind Speed & Wind Direction (knot)
BIWTA_AAQ_01	Shasanghat, Dhaka New Terminal near Postagola	23°41'24.55"N, 90°25'34.72"E	62	33	2.7 knots from Southwest to West
BIWTA_AAQ_02	Narayanganj Passenger Terminal	23°36'58.86"N, 90°30'20.53"E	69	30	3.8 knots from Northeast to East
BIWTA_AAQ_03	Ashuganj Cargo Terminal	24° 2'32.78"N, 91° 0'1.37"E	81	26.4	6.48 knots from Northeast
BIWTA_AAQ_04	Pangaon Cargo Terminal	23°39´30.79"N, 90°27´14.68"E	84	23	7.02 knots from East to West
BIWTA_AAQ_05	Barishal Passenger Terminal	22°41'59.44"N, 90°22'31.39"E	79	27	8.64 knots from North south to East
BIWTA_AAQ_06	Chandpur Passenger Terminal	23°13'59.61"N, 90°38'54.65"E	75	26	1.62 knots from North to East

Description of the surroundings during air quality sampling period is given in Table 65.

Table 65. Description of surroundings during air quality sampling

Location and Sample ID	Sample Site Description
Shasanghat, Dhaka New Terminal near Postagola (BIWTA_AAQ_01)	The weather was sunny Beside the Buriganga River and no. of vessels were high Road traffic volume was moderate, pedestrian movement was low Moderate amount of dust particles was present
Narayanganj Passenger Terminal (BIWTA_AAQ_02)	The weather was sunny Beside Shitalakshya River Commercial and busy area, Traffic volume was high Higher amount of dust particles was present People movement was high, overcrowded area
Ashuganj Cargo Terminal (BIWTA_AAQ_03)	The weather was mostly cloudy Lower amount of dust particles was present People movement was moderate Beside the Bhairab Bridge and the Meghna River Traffic volume was moderate
Pangaon Cargo Terminal (BIWTA_AAQ_04)	The weather was cloudy Lower amount of dust particles was present People movement was high Traffic volume moderate Beside the Buriganga River
Barishal Passenger Terminal (BIWTA_AAQ_05)	The weather was sunny Traffic volume was high People movement was high Commercial area (Launch Ghat) Moderate amount of dust particles was present Beside the Kirtankhola River Crowded Area.
Chandpur Passenger Terminal (BIWTA_AAQ_06)	The weather was sunny Traffic volume was high People movement was high Commercial area (Launch Ghat) Beside the Meghna River

Air quality sampling results are given in next Table 66.

Table 66. Test Results of Ambient Air Quality Monitoring

Parameter	Unit	BIWTA_AAQ_01 Shasanghat, Dhaka New Terminal near Postagola 23°41'24.55"N, 90°25'34.72"E	BIWTA_AAQ_02 Narayanganj Passenger Terminal 23°36'58.86"N, 90°30'20.53"E	BIWTA_AAQ_03 Ashuganj Cargo Terminal 24° 2'32.78"N, 91° 0'1.37"E	BIWTA_AAQ_04 Pangaon Cargo Terminal 23°39´30.79"N, 90°27´14.68"E	BIWTA_AAQ_05 Barishal Passenger Terminal 22°41'59.44"N, 90°22'31.39"E	BIWTA_AAQ_06 Chandpur Passenger Terminal 23°13'59.61"N, 90°38'54.65"E	Bangladesh Standard	Duration (hours)	Weather Condition	Method of Analysis
$PM_{2.5}$	µg/m³	26.2	27.8	30.3	29.2	29.7	34.5	65	24	Partly Cloudy and Partial Sunny	Gravimetric
PM_{10}	µg/m³	39.1	52.3	33.7	30.3	37.4	64.2	150	24		Gravimetric
SO_2	µg/m³	1.85	2.12	1.18	1.10	2.17	2.28	365	24		West-Geake
NO_x	µg/m³	8.74	9.02	5.23	5.17	10.14	10.22	100	Annual		Jacob and Hochheiser
O_3	µg/m³	12.23	14.67	10.45	11.35	13.39	15.01	NYS	24		Photometric
CO*	PPM	1	2	1	<1	2	3	9	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 19 July 2005 - S.R.O. No. 220-Law/2005.
*NYS: Not Yet Standardized

1. **PM_{10}**: Particle pollution, also called particulate matter or PM, is a mixture of solids and liquid droplets floating in the air. Some particles are released directly from a specific source, while others form complicated chemical reactions in the atmosphere. PM10 are 2.5 to 10 micrometers in diameter. Sources include crushing or grinding operations and dust stirred up by vehicles on roads. From the above Table of test results, it can be seen that, for all the locations, the values were within the national standard.

2. **$PM_{2.5}$:** $PM_{2.5}$ are 2.5 micrometers in diameter or smaller and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes. The test results show that for the locations the values of $PM_{2.5}$ was within the national standards.

3. **SO_x**: Sulphur oxides (SO_x) are compounds of sulphur and oxygen molecules. Sulphur dioxide (SO_2) is the pre-dominant form found in the lower atmosphere. It is a colorless gas that can be detected by taste and smell in the range of 1,000 to 3,000 micrograms per cubic meter ($\mu g/m^3$). From the test results it can be said that, for all the locations, the value was within the national standard.

4. NO_x: In atmospheric chemistry, NO_x is a generic term for the nitrogen oxides that are most relevant for air pollution, namely nitric oxide (NO) and nitrogen dioxide (NO_2). These gases contribute to the formation of smog and acid rain, as well as tropospheric ozone. The test results above show that, for all the location the values of NO_x are within the national standard.

5. CO: Carbon monoxide is a gas and is found in the air. High levels of carbon monoxide are poisonous to humans and, unfortunately, cannot be detected by humans as it has no taste or smell and cannot be seen. The main sources of additional carbon monoxide are motor vehicle exhaust and some industrial activities, such as making steel. Tobacco smoke is one of the main indoor sources of carbon monoxide. The above Table shows that, for all the sampling locations, CO was within the national standard.

6. **O_3**: Ozone (O_3) is a highly reactive gas composed of three oxygen atoms. It is both a natural and a man-made product that occurs in the Earth's upper atmosphere, (the stratosphere) and lower atmosphere (the troposphere). Depending on where it is in the atmosphere, ozone affects life on Earth in either positive or negative ways. There is no air quality standard for ozone in Bangladesh. However, according to the Environmental Protection Agency (EPA), in USA air quality standard for ozone is set as 240 μ/m^3 which has not been exceeded in the sites.

4.2.3. Noise

Noise Level Measurements were analyzed at 6 locations, being the same as air quality monitoring locations. The monitoring was performed from 22 October 2019 to 29 October 2019 for both day and nighttime. Noise measurement at each location was carried out continuously for 1hour both at day and nighttime. The results of the noise level monitored along with details of the sampling locations have been shown in Table 68.


Figure 99. Noise quality monitoring at various sites

Description of the prevailing conditions during noise sampling is given in Table 67.

Table 67. Prevailing condition during noise sampling

Sample Location and ID	Sample Site Description
Shasanghat, Dhaka New Terminal near Postagola (BIWTA_NM_01)	Ship breaking yard nearby People movement was moderate Traffic volume was moderate Generator was running.
Narayanganj Passenger Terminal (BIWTA_NM_02)	Traffic volume was high. Beside crowded area. People movement was high. Generator was running. Bus Stand Area.
Ashuganj Cargo Terminal (BIWTA_NM_03)	People movement was high Loading-unloading was going on The place is in commercial zone. Traffic volume was moderate
Pangaon Cargo Terminal (BIWTA_NM_04)	People movement was high Water vessels were running Beside a CNG stand Traffic volume was high
Barishal Passenger Terminal (BIWTA_NM_05)	The place is in a commercial zone. People movement was high. Traffic volume was high. Generator was running Launch vessels were running. Some people are chatting near the sampling site.
Chandpur Passenger Terminal (BIWTA_NM_06)	Crowded Area. People movement was high Traffic volume was high Beside a tempo stand. Sudden horn blasts from launches and local transport affect sampling quality.

Table 68. Test results of noise sampling at sites. Noise levels exceeding Bangladesh Standards are highlighted.

Sample ID	Sample Location	GPS Location	Land Use Category	Time		Noise Level (dBA) (LAeq)		Bangladesh Standard (dBA) **	
				Day	Night	Day	Night	Day	Night
BIWTA_NM_01	Shasanghat, Dhaka New Terminal near Postagola	23°41'24.55"N, 90°25'34.72"E	Commercial	10:27	20:09	61.13	52.21	65	55
BIWTA_NM_02	Narayanganj Passenger Terminal	23°36'58.86"N, 90°30'20.53"E	Commercial	11:27	20:50	71.25	67.56	65	55
BIWTA_NM_03	Ashuganj Cargo Terminal	24° 2'32.78"N, 91° 0'1.37"E	Commercial	11:52	20:05	72.35	66.87	65	55
BIWTA_NM_04	Pangaon Cargo Terminal	23°39´30.79"N, 90°27´14.68"E	Commercial	13:58	20:50	70.84	65.63	65	55
BIWTA_NM_05	Barishal Passenger Terminal	22°41'59.44"N, 90°22'31.39"E	Commercial	10:52	21:45	73.14	64.23	65	55
BIWTA_NM_06	Chandpur Passenger Terminal	23°13'59.61"N, 90°38'54.65"E	Commercial	11:58	22:00	76.06	62.47	65	55

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

4.2.4. Topography, Geomorphology, Geology

Topography configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flash rivers. To the south, a highly irregular deltaic coastline of about 600 km fissured by many estuarine rivers and channels flowing into the Bay of Bengal. The alluvial plain is part of the larger plain of Bengal, which is sometimes called the Lower Gangetic Plain. Elevations of the plains are less than 10m above the sea level.

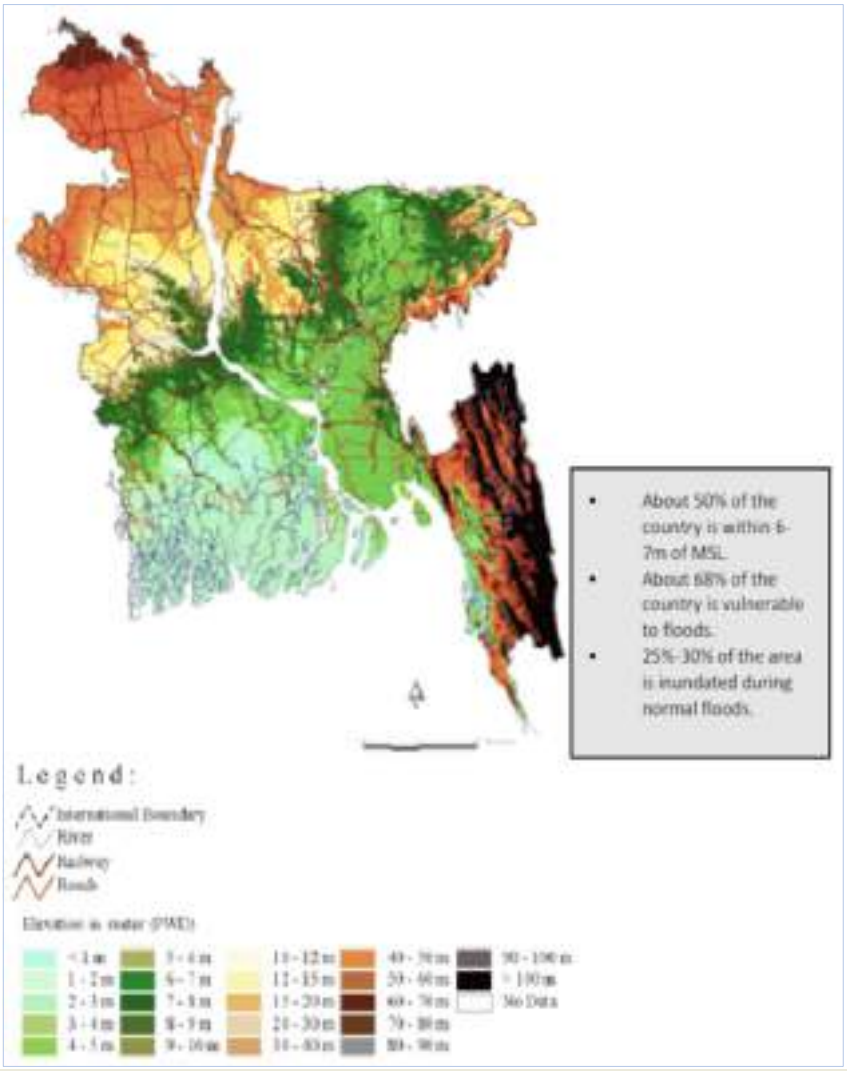


Figure 100. Topographic map of Bangladesh

Source: DMB (2010)[10]

Bangladesh is a tropical country, situated mainly on the deltas of large rivers flowing from the Himalayas. The Brahmaputra River, known locally as the Jamuna, unites with part of the Ganges to form the Padma,

[10] DMB (2010). Disaster Management Bureau, Disaster Management & Relief Division, National Plan for Disaster Management 2010-2015, April 2010

which, after its juncture with a third large river, the Meghna, flows into the Bay of Bengal. Offshoots of the Ganges-Padma, including the Burishwar, Garai, Kobadak, and Madhumati, also flow south to the Bay of Bengal. No part of the delta area is more than 150 m (500 ft) above sea level, and most of it is barely a meter or two above sea level. Its soil consists mostly of fertile alluvium, which is intensively farmed; mineral deposits are negligible. During the rainy season floodwater covers most of the land surface, damaging crops and harming the economy. The north-western section of the country, drained by the Tista (Teesta) River, is somewhat higher and less flat, but the only really hilly regions are in the east, notably in the Chittagong Hill Tracts to the southeast and the Sylhet District to the northeast. Near the Myanmar border, in the extreme southeast, is the Keokradong, which at 1,230 m (4,034 ft) is the highest peak in Bangladesh.

Bangladesh is in the low-lying Ganges–Brahmaputra River Delta or Ganges Delta. This delta is formed by the confluence of the Ganges (local name Padma or Pôdda), Brahmaputra (Jamuna or Jomuna also known as "Yamuna"), and Meghna rivers and their respective tributaries. The Ganges unites with the Jamuna (main channel of the Brahmaputra) and later joins the Meghna to eventually empty into the Bay of Bengal. The alluvial soil deposited by these rivers has created some of the most fertile plains in the world. Bangladesh has 57 trans-boundary rivers, making water issues politically complicated to resolve – in most cases as the lower riparian state to India. Most parts of Bangladesh are less than 12 m (39.4 ft) above the sea level, and it is believed that about 10% of the land would be flooded if the sea level were to rise by 1 m (3.28 ft) (Source: URL: *https://www.nationsencyclopedia.com/knowledge/Bangladesh.html*).

The highest point in Bangladesh is in the Mowdok range at 1,052 m (3,451 ft) in the Chittagong Hill Tracts to the southeast of the country. Cox's Bazar, south of the city of Chittagong, has a beach that stretches uninterruptedly over 120 km (75 miles).

Geologically almost 85% of entire Bangladesh is underlain by alluvial and deltaic deposits borne by the river systems of the Ganges, the Brahmaputra and the Meghna. Coastal deposits are limited to narrow-strip zone along the western age of Chittagong and Cox's Bazar districts (Alam et al, 1990)[11]. The study regions geologically fall broadly in the Dhaka and Barishal area.

- Geology of Dhaka

Dhaka is situated at the southern tip of a Pleistocene terrace, the Madhupur tract. Two characteristic geological units cover the city and surroundings, viz Madhupur Clay of the Pleistocene age and alluvial deposits of recent times. The Madhupur Clay is the oldest sediment exposed in and around the city area having characteristic topography and drainage. The major geomorphic units of the city are the high land or the Dhaka terrace, the low lands or floodplains, depressions and abandoned channels. Low lying swamps and marshes located in and around the city are other major topographic features.

The sub-surface sedimentary sequence, up to the explored depth of 300m, shows three distinct entities: one is the Madhupur Clay of the Pleistocene age, characterized by reddish plastic clay with silt and very fine sand particles. This Madhupur Clay unconformably overlies the Dupitila formation of the Plio-Pleistocene age, composed of medium to coarse yellowish-brown sand and occasional gravel. The incised channels and depressions within the city are surfaced by recent alluvial floodplain deposits and are further

[11] Alam, M.S.; Shamsuddin, S.D. and Sikdar, S., 1990. Application of remote sensing for monitoring shrimp culture development in coastal mangrove ecosystem in Bangladesh. Proc. Annual Congress on Surveying and Mapping (American Society for Photogram and Remote Sensing, Colorado, USA).

sub-divided into Lowland Alluvium and Highland Alluvium (Source: Banglapedia).

Structure and Lineaments the Dhaka city area does not reveal any surface folding. However, a large number of faults and lineaments have N-S, E-W. NE-SW, NW-SE trends recognized from aerial photo interpretation and the nature of the stream courses. All four sides of the city are bounded by major faults.

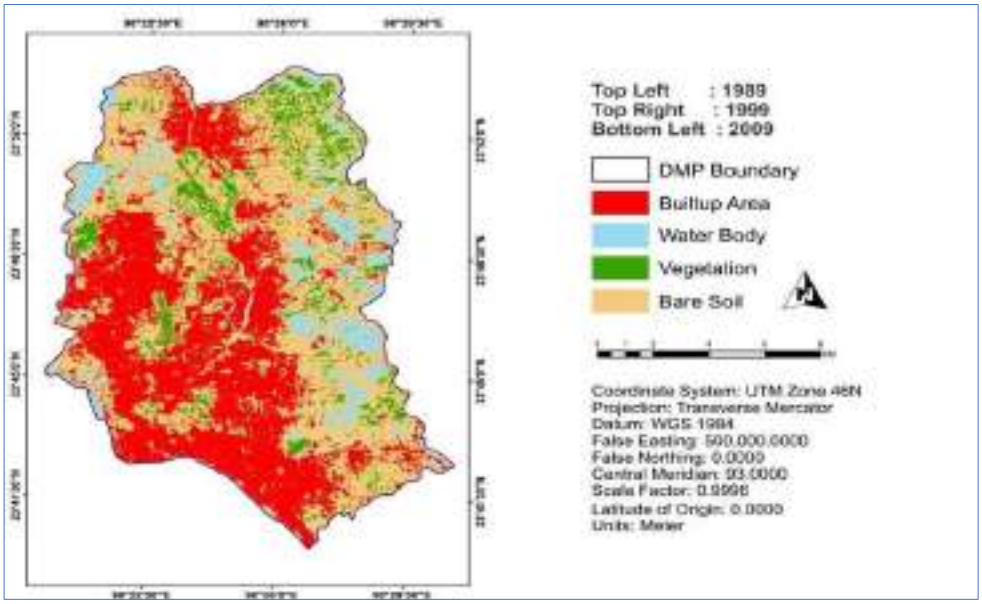


Figure 101. Landcover of Dhaka city.

Source: Rahman (2018)[12]

- Geology of Barishal and Chandpur

Barishal-Chandpur High is interpreted as a gravity and magnetic anomaly caused by a magmatic body at great depth. This zone is located between Faridpur trough and Hatiya trough of the Bengal Foredeep. The width of the zone is about 60 km and apparently corresponds to an uplift of the sedimentary cover.

A number of gravity anomalies are spread over this zone. A paleo-height stretching from Barishal-Chandpur High in the NE direction has been presumed and the ridge was interpreted to turn south of Barishal-Chandpur High in a north-south direction merging with the Ninety East Ridge. There is no definite evidence for existence of such a ridge dividing the Bengal Foredeep into two parts, Patharghata, Muladi, Chandpur, Lakshmipur, Munshiganj, Kamta and Daudkandi are the main anticline structures of this zone. Muladi wells failed to yield positive result in respect of commercial accumulation of hydrocarbons due to lack of northern closure. This zone has not been sufficiently investigated by seismic surveys.

- Geology of Ashuganj

Ashuganj is situated at the start of the Middle Meghna floodplain, according to the next figure. Silt loams occupy relatively higher areas and silty clay loams occupy the depressions. Topsoils are strongly acidic and subsoils slightly acidic to slightly alkaline. The general fertility level is medium with medium to low organic matter, and N and K-bearing minerals.

[12] Rahman, KM. (2018). Analyzing the Level of Accessibility of Public Urban Green Spaces to Different Socially Vulnerable Groups of People. Sustainability. 10. 3917

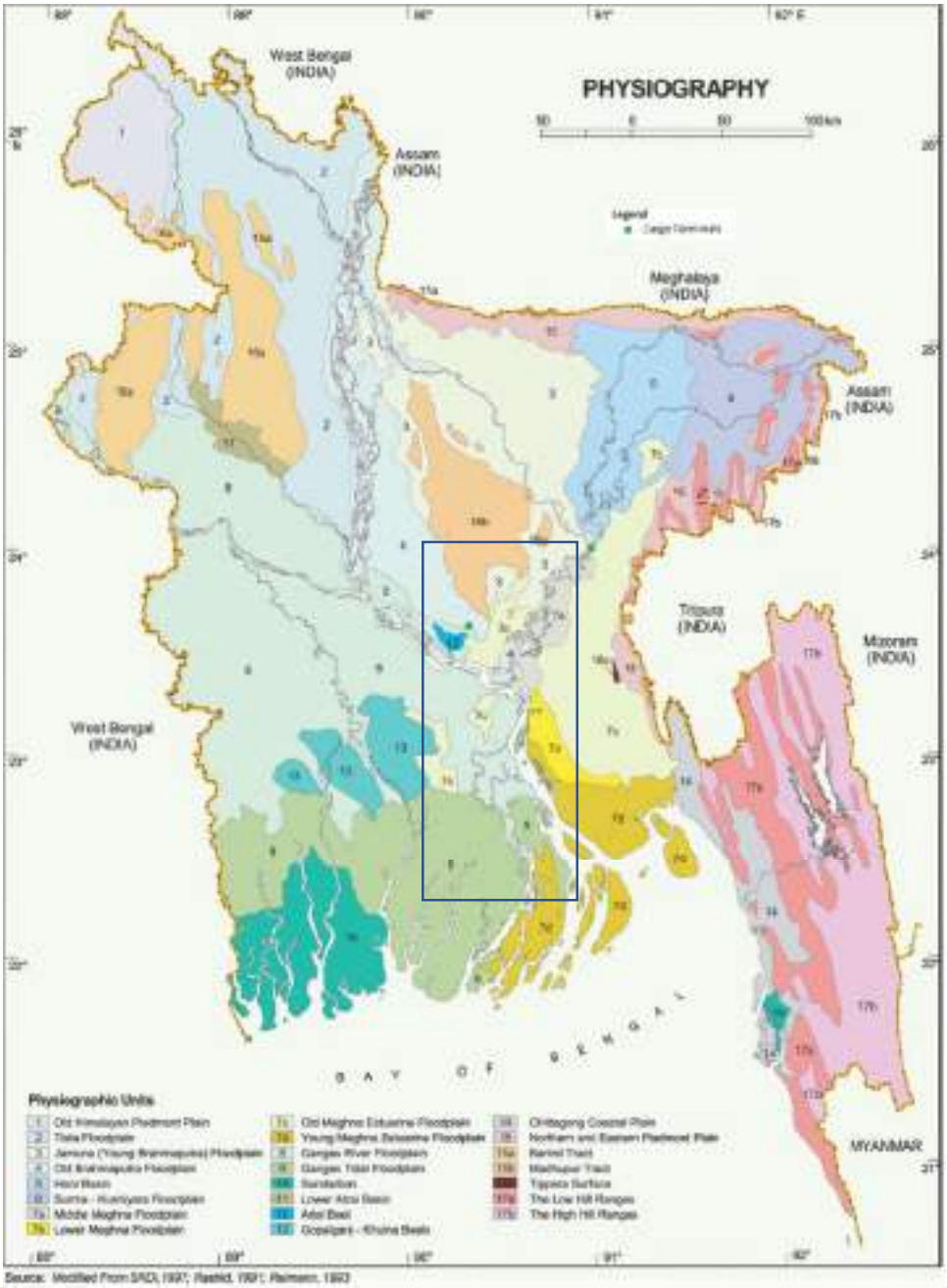


Figure 102. Physiographic map of Bangladesh. Study area is demarcated with blue box

Source: Face of Bangla (2013). Physiographic map of Bangladesh.

4.2.4.1. Hydrogeology of the study regions

Over the last 150 years there were no major avulsions of the main rivers of Bangladesh. But declining and enlarging of the main rivers occur on a large-scale. At the beginning of the 16th century, the Mughals, in fact the first, established Dhaka city, the central part of the basin. The expansion of Dhaka city was mainly in and around the river Burigunga. The canals within the mega city Dhaka and the rivers surrounding the city act as natural drainage system, water reservoir and river route. These canals are Begunbari khal,

Segunbagicha khal, kallayanpur khal, Dholai khal etc. The surrounding rivers are the Buriganga, the Shitolakhya, the Balu, the Turag and the Dhaleshari. Although the total basin area consists of the Rivers: Balu, Bongshi, Buriganga, Dhaleswari, Sitalakhya, Tongi Khal and Turag.

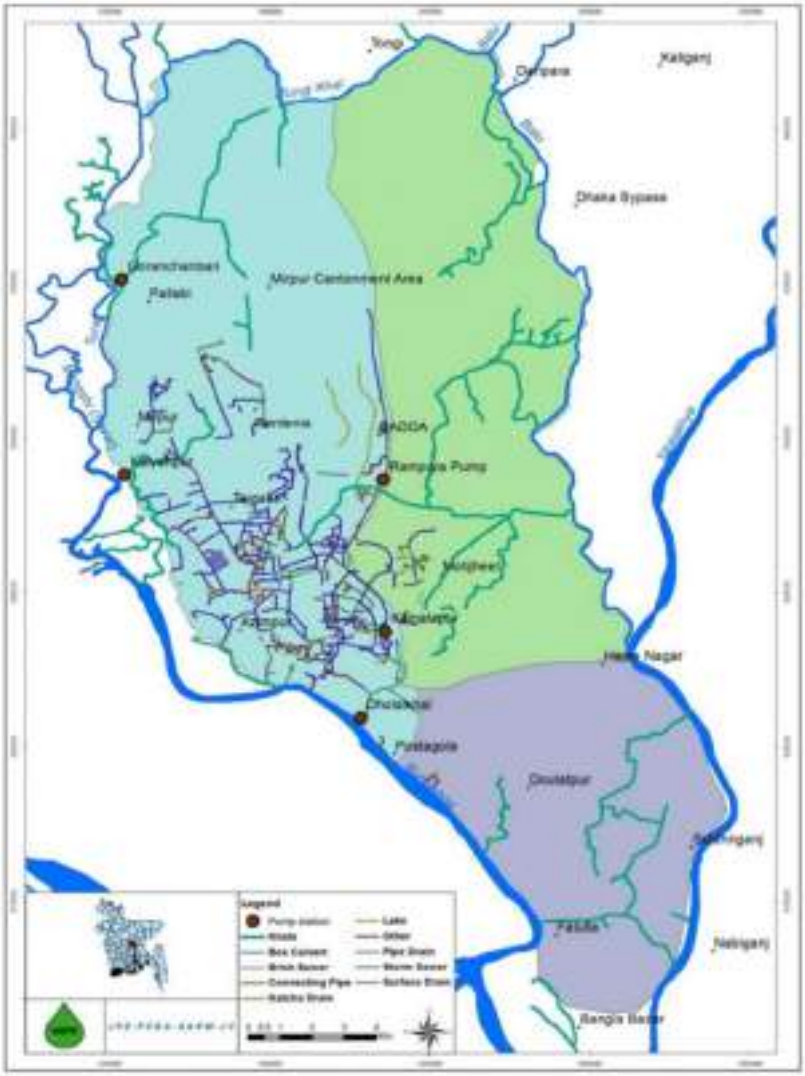


Figure 103. Existing Drainage Network of DWASA.

Source: DWASA, 2014[13]

The basin is completely dependent on the ground water resources while all other surface water sources are almost extinguished or unusable. Climate change increases variability in precipitation, soil moisture rate of evaporation and surface water in developing countries such as Bangladesh. Recently Bangladesh has major concerns over sustainably managing its ground water, as it tends to become scarce.

In Dhaka river basin area, surface water withdrawal from adjacent rivers is not a proven feasible option because of high levels of industrial and domestic pollution from unregulated waste disposal. Dhaka city is dependent primarily on groundwater for the urban water supply.

Chandnighat plant supply potable water for city dwellers. The water works plant now lies hidden amid buildings in old Dhaka halfway between Lalbagh Fort and Chawkbazar. It draws water from Buriganga river at Chandnighat, the place where the Royal boat "Chandni" of Mughal Subahder Islam Khan moored.

[13] DWASA (2014) Annual Report 2012-2013. Dhaka Water Supply and Sewerage Authority, Dhaka, Bangladesh.

The plant, with its subsequent improvement, supplies 39 million litrs of filtered water daily which meets 1.8% of the total water supply of Dhaka now. Pouring of millions of liters of untreated, highly toxic liquid wastes directly into river by the tanneries and industrial units of Rayerbazar and Hazaribagh have polluted river water so much that it is hardly possible to treat polluted river water any more to make it fit for human consumption. 82% of potable water of Dhaka is now drawn from underground source by over 400 production wells.

Presently Dhaka Water and Sanitation Authority (DWASA, 2014) obtains 83 % of the drinking water from groundwater sources via 627 deep tube-wells in the metropolis of Dhaka City and Narayangonj, and 17 % is supplied by three major surface water treatment plants. Ground water of Dhaka city has been drawn down significantly because of overexploitation and also the pressing demand from urbanization, while it is also evident that the rate of water-level drop in the city area is about 2.5 m/year over recent years.

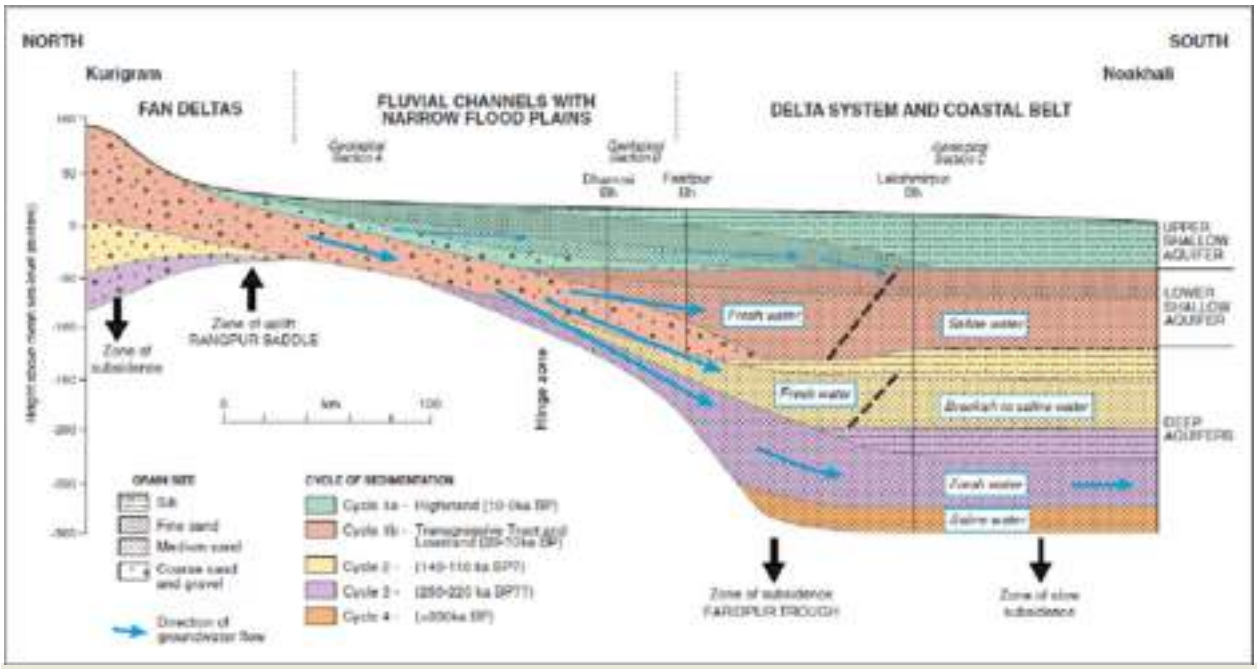


Figure 104. Hydro-geological framework of Bengal basin

Source: (DPHE-BGS 2001)[14]

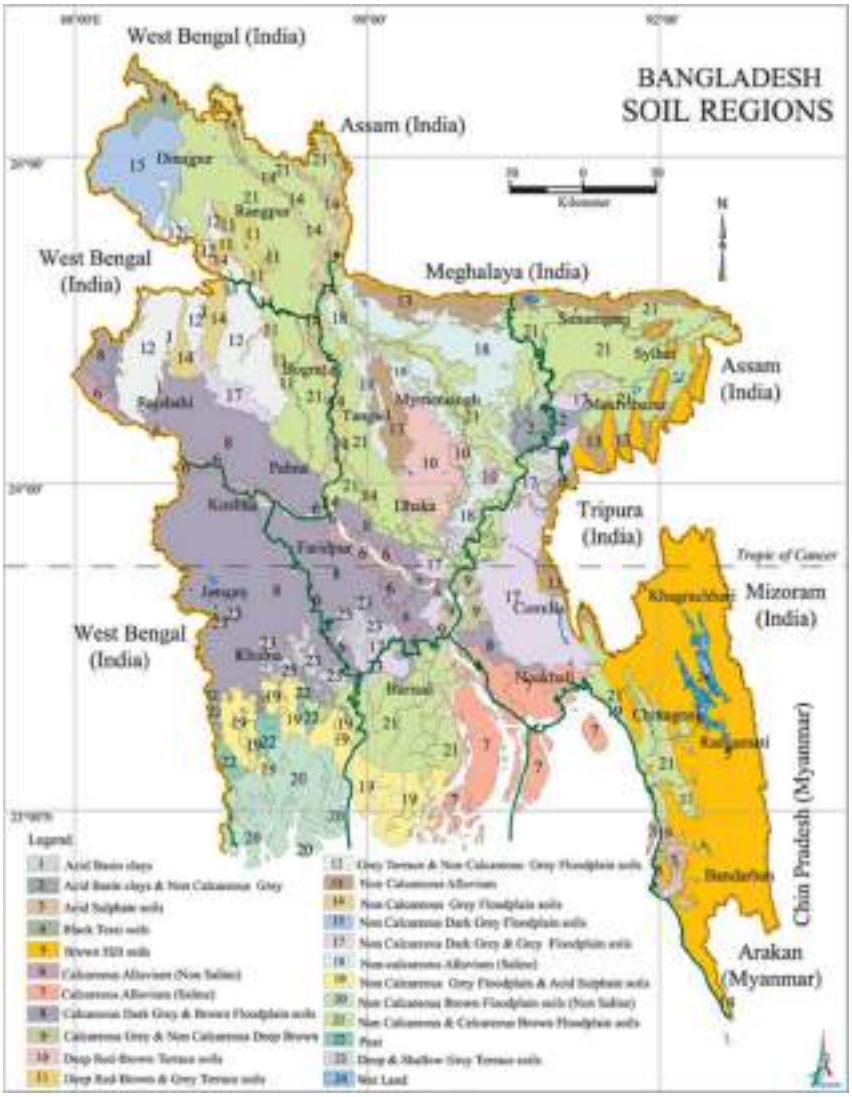
4.2.5. Soils, Sediment and Soil Quality

4.2.5.1. Soils

The types of soil on which the passenger and cargo terminals defined in this project are located are classified into three types. The different soil types are shown in the figure below where they are marked in different colors on the map of Bangladesh.

- *Calcareous Dark Grey and Brown Floodplain soils (8).* Occur extensively on the Ganges floodplain and locally on the soils that comprise cambic B-horizon and lime in part or throughout the solum

[14] DPHE-BGS (2001) Arsenic contamination of groundwater in Bangladesh. British Geological Survey and Department of Public Health Engineering, Govt. of Bangladesh; rapid investigation phase, Final Report.



Source: Banglapedia

and with a dark grey topsoil and/or upper subsoil. There are continuous dark grey gleans as well in the Ganges tidal floodplain. They are Calcaric Gleysols. Within this category of soil is the terminal of Chandpur.

- *Non-calcareous Dark Grey and Grey Floodplain soils (17).* They have a cambic B-horizon, non-calcareous dark grey topsoil and subsoil. They occur extensively on the Old Brahmaputra and Old Meghna estuarine floodplain. Silt loam and silty clay loam are predominant on the Meghna estuarine floodplain and in the Tista meander floodplain, whereas silty clays and heavy clays are extensive on the Old Brahmaputra floodplain. The majority of these soils are Eutric Gleysols. Within this category of soil are the terminals of Ashuganj and Narayanganj.

Table 69. Soils of the study area belongs to 8, 17 and 21

Non-calcareous and Calcareous Brown Floodplain soils (21). Generally, comprise grey topsoil and a cambic B-horizon in the subsoil with a grey matrix or grey gleans. They extensively occupy Tista, Karatoya-Bangali, Jamuna, middle Meghna and eastern Surma-Kushiyara floodplains. However, there are considerable regional differences in the proportions occupied by individual *soil textures*. Silt loam texture is dominant in the Tista meander floodplain whereas silty clays are predominant in the Ganges tidal floodplain and in the Surma-Kushiyara floodplain. But the Jamuna floodplain has a more even distribution of silt loam, silty clay loam and silty clays. Most of these soils have been included in Eutric Gleysols. Within this category of soil are the terminals of Barishal, Pangaon and Shasanghat.

The soils of the terminals proposed in this project are practically the same. The current soils are composed of garbage and waste from the activities of the citizens in the vicinity. In addition, some of these soils are in continuous change due to sediments deposited by rivers and by sand loads deposited in the ports.

4.2.5.2. Sediment Characteristics

In the Meghna Estuary median diameter of riverbed samples varies between 0.016 mm to 0.2 mm, and about 50% of the samples have a median diameter of less than 0.063 mm (silt) (BWDB 2001, Meghna Estuary Study). The major part of bed sediment consists of a mixture of (very) fine sand, silt and mud. The particles of silt and clay are carried by the current, mainly as suspended material (BIWTA 2016: ESIA report of BRWTP1)[15]. The riverbed and banks consist mainly of clayey-silt which is often loosely packed and is susceptible to liquefaction in some places. Of the three major rivers, the Upper Meghna carries relatively less sediment. The characteristic particle size D50 varies from upstream to downstream of the Upper-Meghna River. The average value of D50 is about 0.14mm in the Upper- Meghna River. The sediment concentration measurements conducted by BWDB under Meghna Estuary Study (MES) and Land reclamation project (LRP) indicated a variation of the sediment concentration during a fortnightly cycle of the spring and the neap tide. The variation of sediment concentration showed a tendency to increase towards the spring tide. The maximum depth averaged sediment concentration at spring tide was about 2-5 times higher than that at neap tide. About 70% of the sediment discharge, in the estuary, consisted of fine sediment (BIWTA 2016: ESIA report of BRWTP1).

4.2.5.3. Sediment Transport

The averages total annual sediment discharge of the Brahmaputra and Ganges are highly variable, ranging from 402 to 710 × 106 tonnes/year for the Brahmaputra River and from 403 to 660 × 106 tonnes/year for the Ganges River. Both these rivers carry predominantly coarse silt to sand-size particles. This sediment discharge increases due to impact of climate change

The sediment discharge of the Upper Meghna River is negligible compared to the discharge of the Brahmaputra and Ganges. It is assumed that the net deposition of sediment in the southern part of Bangladesh is related to the amount of river borne sediment discharge: during periods of high river borne sediment discharge (monsoon season), the net gain of land and intertidal areas is higher than during low periods of river borne sediment discharge. It is also estimated that from May to October its daily load of sediments is nearly four million tonnes. The annual load of sediments carried is about 1,500 million tonnes and annual water discharge about 875 million acre-feet (MAF) (BIWTA 2016: ESIA report of BRWTP1).

The hydrodynamic factors that shape the Lower Meghna Estuary area are tides, upstream river inflow, sediment transport, estuarine circulation, waves and atmospheric forcing. The resulting temporal and spatial changes in the channel and char systems in the estuary are primarily a consequence of the interaction of these factors acting all over the estuary. The tidal influence reaches about as far as the Bhairab Bazar in the Upper Meghna and at Mawa in the Padma River during the dry season. The velocities in the Lower Meghna River usually decrease in downstream direction as flow expands into the estuarine section of greater cross-sectional area near the river mouth. In the transition zone of the Lower Meghna Estuary area fresh water is mixed with saltwater; sediment transport capacity diminishes, and sediments are deposited.

The periodic rise and fall of tide results in the temporary storage of large volumes of sea water in the estuary during high tide, followed by drainage at low tide. The volume of water exchanged by tide -the tidal prism or “salt wedge”- during pre-monsoon and post-monsoon is at least an order of magnitude greater than the river discharge (BIWTA 2016: ESIA report of BRWTP1).

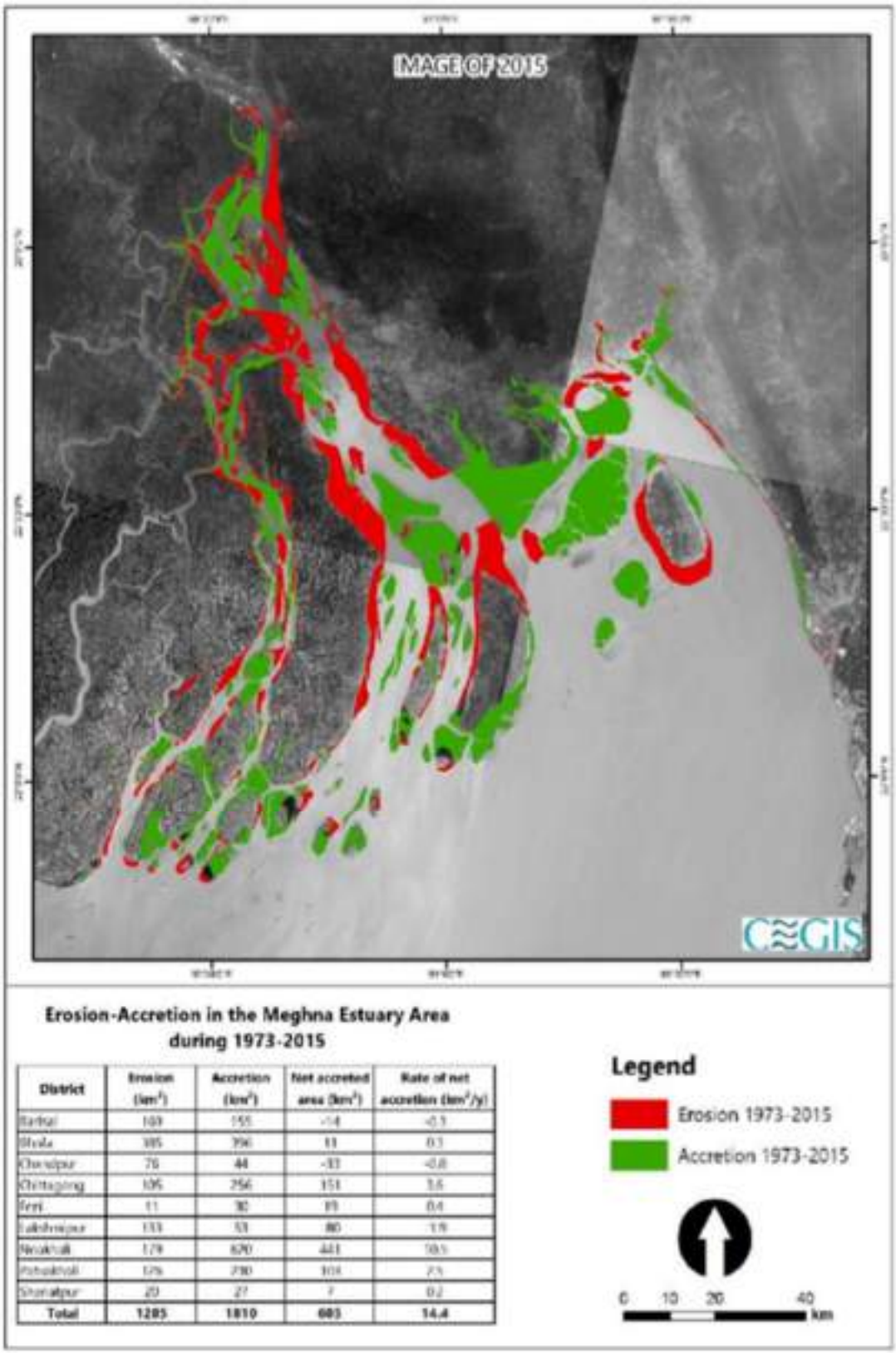
[15] BRWTP-1 (2016) Environmental Impact Assessment Report of the Bangladesh Regional Waterway Transport Project 1 aided by the World Bank, Government of The People’s Republic of Bangladesh Ministry of Shipping, Dhaka, Bangladesh.

- Accretion and erosion

Deltas and estuaries are generally known as areas of a net deposition of sediments either transported by the river systems from the upstream or supplied from the sea. The growth of the delta and the accretion of land in the estuaries is a continuous and generally a very gradual natural process interfered by the dynamics of the ever- changing courses of their channels.

Approximately overall sediment budget in the study area over the period indicates that the deposition processes exceed the erosion processes. Erosion dominates in the northern part of the river system while high rate of sediment deposition is found in the north-east of the estuary, between Noakhali mainland, Urir Char and Sandwip (BIWTA 2016: ESIA report of BRWTP1). In the Bangladesh Delta Plan 2100 (BDP 2100)[16], a time series of digitized satellite images from the period 1973 to 2015 was used to examine the extent of land for each date and to assess the changes in plan-form and channel system due to accretion and erosion in the estuary. The accretion and erosion pattern, as seen in the following figure, demonstrates the dynamic behavior the estuary.

[16] BDP 2100 (2017) Bangladesh Delta Plan 2100. General Economics Division, Bangladesh Planning Commission, Ministry of Planning, Government of the People's Republic of Bangladesh.



District	Erosion (km^2)	Accretion (km^2)	Net accreted area (km^2)	Rate of net accretion (km^2/y)
Barisal	169	155	-14	-0.5
Bhola	185	196	11	0.3
Chandpur	76	44	-33	-0.8
Chittagong	105	256	151	3.6
Feni	11	30	19	0.4
Lakshmipur	133	53	80	1.9
Noakhali	179	620	441	10.5
Patuakhali	176	280	104	2.5
Shariatpur	20	27	7	0.2
Total	**1285**	**1810**	**605**	**14.4**

Figure 105. Erosion accretion in the Meghna Estuary during 1973-2015.

Source: BDP 2100

These phenomena can also be clearly seen in passenger and cargo terminals in periods of less than 5 years. Two examples presented in the figure 106 are Ashuganj and Chandpur. For the comparison between both images an interval of 5 years (2014 - 2019) has been taken from the same place. In the first case we can see a case of erosion and in the second a case of accretion.

Figure 106. Changes in terrain morphology in terminal adjacent areas over 5 years.

4.2.5.4. Riverbed sediment (soil) quality

The quality of the riverbed sediment was identified to characterize the baseline status. The riverbed sediment samples were collected from around the 6) project locations from 22 October to 29 October 2019. Test results of sediment analysis are given in next Table. Photos are given in figure 107.

Figure 107. Riverbed sediment quality sampling at sites

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 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines – Soil and Groundwater Standards'[17] to assess sediment quality and to determine the need, if any, for remedial action. **Parameters analyzed in baseline quality of sediment were observed to be well below the threshold limits for Intervention** as per the Dutch Standards.

[17] Dutch VROM (2000), The Circular on Target Values and Intervention Values for Soil Remediation, Ministry of Housing, Spatial Planning and the Environment, the Netherlands, February 4th, 2000

Table 70. Results of riverbed sediment quality analysis

Parameters	Unit	Concentration Present						OSPAR Standards for Riverbed Materials, 2004	Method of analysis
		Shasanghat, Dhaka New Terminal near Postagola	Narayanganj Passenger Terminal	Ashuganj Cargo Terminal	Pangaon Cargo Terminal	Barishal Passenger Terminal	Chandpur Passenger Terminal		
		Buriganga River	Shitalakshya River	Meghna River	Buriganga River	Kirtankhola River	Meghna River		
		BIWTA_RBM _01	BIWTA_ RBM _02	BIWTA_ RBM _03	BIWTA_ RBM _04	BIWTA_ RBM _05	BIWTA_ RBM _06		
		23°41'24.00"N 90°25'33.74"E	23°37'0.80"N 90°30'22.21"E	24° 2'32.78"N 91° 0'1.37"E	23°39'31.36"N 90°27'13.68"E	22°41'57.26"N 90°22'33.60"E	23°13'59.05"N 90°38'56.94"E		
Total Organic Carbon	%	0.42	0.33	0.11	0.41	0.52	0.40	NYS	**Wet Oxidation**
Total Phosphate	mg/kg	1195.65	763.56	649.78	1230.56	1487.78	1243.65	NYS	**Aquaregia & Yellow color**
Water Soluble Phosphate	mg/kg	21.52	11.33	6.13	22.75	27.59	26.14	NYS	**Olsen Method**
Total Arsenic	mg/kg	2.497	1.743	1.850	2.379	2.362	3.158	9	**APHA 3114**
Total Cadmium	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	25	**Aquaregia & AAS**
Total Mercury	(ppb) (µg/kg)	0.35	0.27	0.22	0.32	0.26	0.19	0.5	**EPA/SW-846/7000A/7040A /7071A**
Total Lead	mg/kg	8.87	7.70	5.88	8.82	18.75	9.25	300	**Aquaregia & AAS**
Total Chromium	mg/kg	12.60	15.31	21.30	11.66	1.88	1.68	87	**Aquaregia & AAS**
Total Nickel	mg/kg	23.15	10.51	8.22	23.45	25.75	29.80	560	**Aquaregia & AAS**
Total Zinc	**mg/kg**	**47.75**	**35.73**	**57.50**	**46.68**	**53.75**	**55.50**	**8700**	**Aquaregia & AAS**

- **Total Organic Carbon:** From the test results, the TOC concentration in the project influenced areas ranged from 0.11% to 0.52%. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_05 (Barishal Passenger Terminal, Kirtankhola River).
- **Total Phosphate (PO_4^{3-}):** From the test results, the total phosphate concentration in the project influenced areas ranged from 649.78 mg/kg to 1487.78 mg/kg. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_05 (Barishal Passenger Terminal, Kirtankhola River).
- **Water Soluble Phosphate (PO_4^{3-}):** From the test results, the soluble phosphate concentration in the project influenced areas ranged from 6.13 mg/kg to 26.14 mg/kg. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River).
- **Total Arsenic (As):** From the test results, the As concentration in the project influenced areas ranged from 1.743 mg/kg to 3.158 mg/kg. The minimum value was in BIWTA_RBM_02 (Narayanganj Passenger Terminal, Shitalakshya River) and BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River).
- **Total Mercury (Hg):** From the test results, Lowest Hg concentration was found to be 0.19 µg/kg in BIWTA_RBM_05 (Chandpur Passenger Terminal, Meghna River) and highest Hg concentration was found to be 0.35 µg/kg in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River).
- **Total Nickel (Ni):** From the test results, Lowest Ni concentration was found to be 8.22 mg/kg in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and highest Ni concentration was 29.80 mg/kg in BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River).
- **Total Zinc (Zn):** From the test results, Lowest Zinc (Zn) concentration was found to be 35.73 mg/kg in BIWTA_RBM_02 (Narayanganj Passenger Terminal, Shitalakshya River) and highest Zinc (Zn) concentration was 57.50 mg/kg in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River).
- **Total Lead (Pb):** From the test results, Lead (Pb) concentration ranges from 5.88 mg/kg to 18.75 mg/kg. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_05 (Barishal Passenger Terminal, Kirtankhola River).
- **Total Cadmium (Cd):** From the test results, all the samples have shown concentration below the detection level.
- **Total Chromium (Cr):** From the test results, Chromium concentration ranges from 1.68 mg/kg to 21.30 mg/kg. The minimum value was in BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River) and maximum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River).

4.2.6. Hydrology, River systems, Drainage and Surface Water Quality

4.2.6.1. Hydrology and river systems

Bangladesh is a riverine country, composed of a total 700 rivers and including 57 transboundary rivers (Bangladesh Water Development Board, 2011). In 2004 the NWMP divided the country into 8 hydrological regions. The river system of Bangladesh is shown, and the main rivers are shown in figure 108.

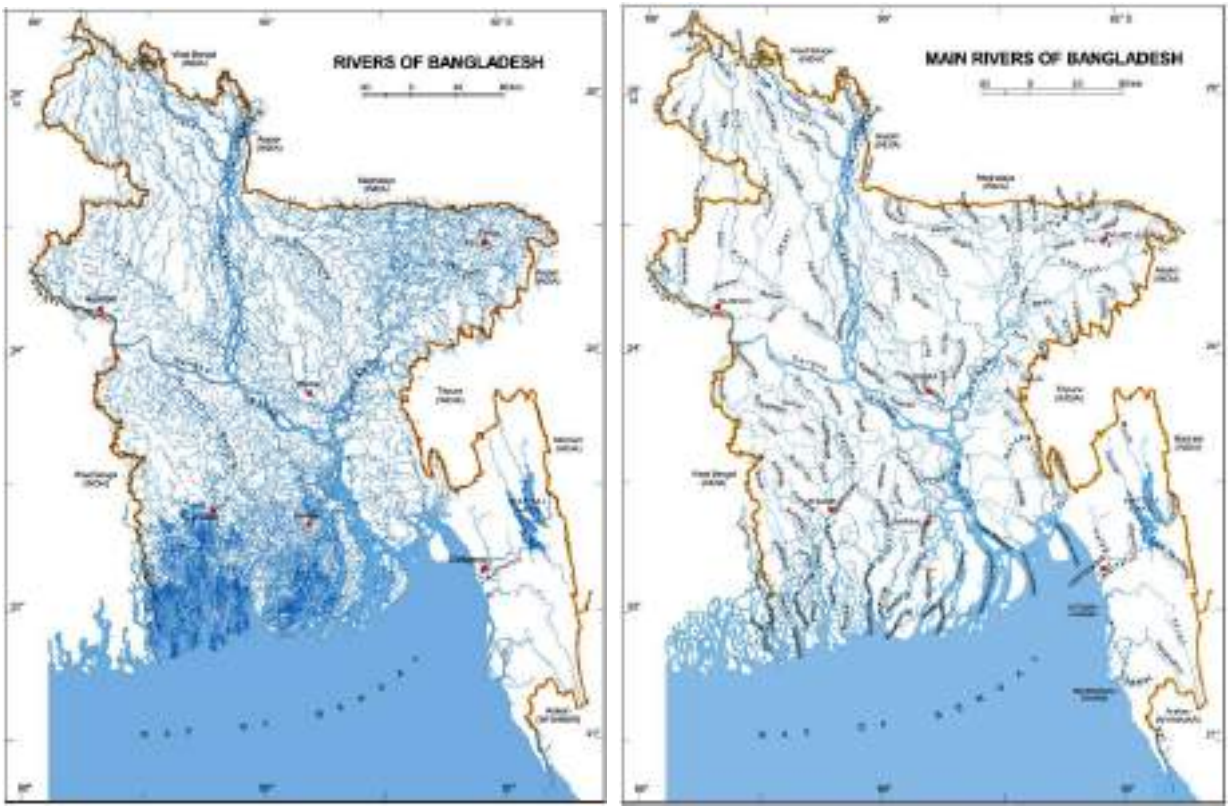


Figure 108. (Left) River system in Bangladesh; (Right) Major rivers of Bangladesh.

Source: Prime Minister´s Office Library, Dhaka

River valleys have been important centers of civilization, they afford travel routes, and their alluvial soils form good agricultural lands. Navigable rivers are important in commerce and have influenced the location of cities. In Bangladesh, almost all the major cities/towns and commercial centers are located on the banks of rivers, e.g., Dhaka on the bank of Buriganga, Narayanganj by the side of Shitalakshya, Chittagong by the side of Karnafuli, and Mymensingh by the side of Brahmaputra. Rivers with sufficient water volume, velocity and gradient can be used to produce hydroelectric power. At Kaptai the river Karnafuli of Chittagong region is being utilized for producing hydroelectricity (Banglapedia 2020, URL: *http://en.banglapedia.org/index.php?title=River*).

4.2.6.2. Hydrological regions

National Water Management Plan (NWMP) divided Bangladesh into 8 hydrological regions: North West, North Central, North East, Eastern Hills, South West, South Central, South East and Rivers & Estuary. The BWDB divided the rivers of Bangladesh into 6 hydrological regions: North West, North Central, North East, Eastern Hills, South East and South West. BWDB combine the South Central and South West region South West and South Central are very different hydrological regions, South Central has fluvio dominated coastal rivers.

All the rivers of the country are covered within these 6 regions. The regions are bounded by the major rivers: the Jamuna, the Padma, the Meghna, the Old Brahmaputra and the Ganges. All the river systems ultimately flow into the Bay of Bengal.

The Hydrological regions involved into S3 and S4 package are briefly described below:

- North Central: The North Central Region is bounded by the Brahmaputra-Jamuna in the west, the Padma in the south, the Old Brahmaputra in the north-east and the Meghna Upper River in the south-east. The region consists of 8 districts including the Capital Dhaka. The region has 61 rivers including 1 transboundary river. Among these rivers, the important rivers are Padma, Old Brahmaputra, Sitalakhya, Dhaleswari, Buriganga, Kaliganga, Bangshi, Turag and Balu.
- South East: There are 24 rivers including 9 transboundary rivers in the region. The transboundary Rivers originating in India enters Bangladesh and discharges into the Meghna River. Along with the Meghna, the Shalda, Titas, Feni, Gomti etc. are some of the important rivers of this region.
- South West: There are 102 rivers including 5 transboundary rivers in this region. The region is bounded by the Padma in the north, the Meghna Lower River in the east and the Bay of Bengal in the south. The rivers Arial Khan, Bhairab, Garai, Kumar, Rupsa etc. are some of the important rivers of this region.

4.2.6.3. Rivers related to Passenger and Cargo Terminals

- The **Buriganga River** rises in Dhaka city, border the city and ends in the junction with Dhaleshwari River. Shasanghat and Pangaon are in the section of this river (North Central Region).
- Narayanganj is located on final course of **Shitalakhya River** (North Central Region).
- Ashunganj belongs to **Meghna (Upper) River** and Chandpur is at the junction between **Padma River** and upper part of Meghna River (South East Region).
- Barishal belongs to **Kirtankhola River,** but it is considered to be within the **Meghna (Lower) River** estuary area when considering its hydrology (South Central Region).

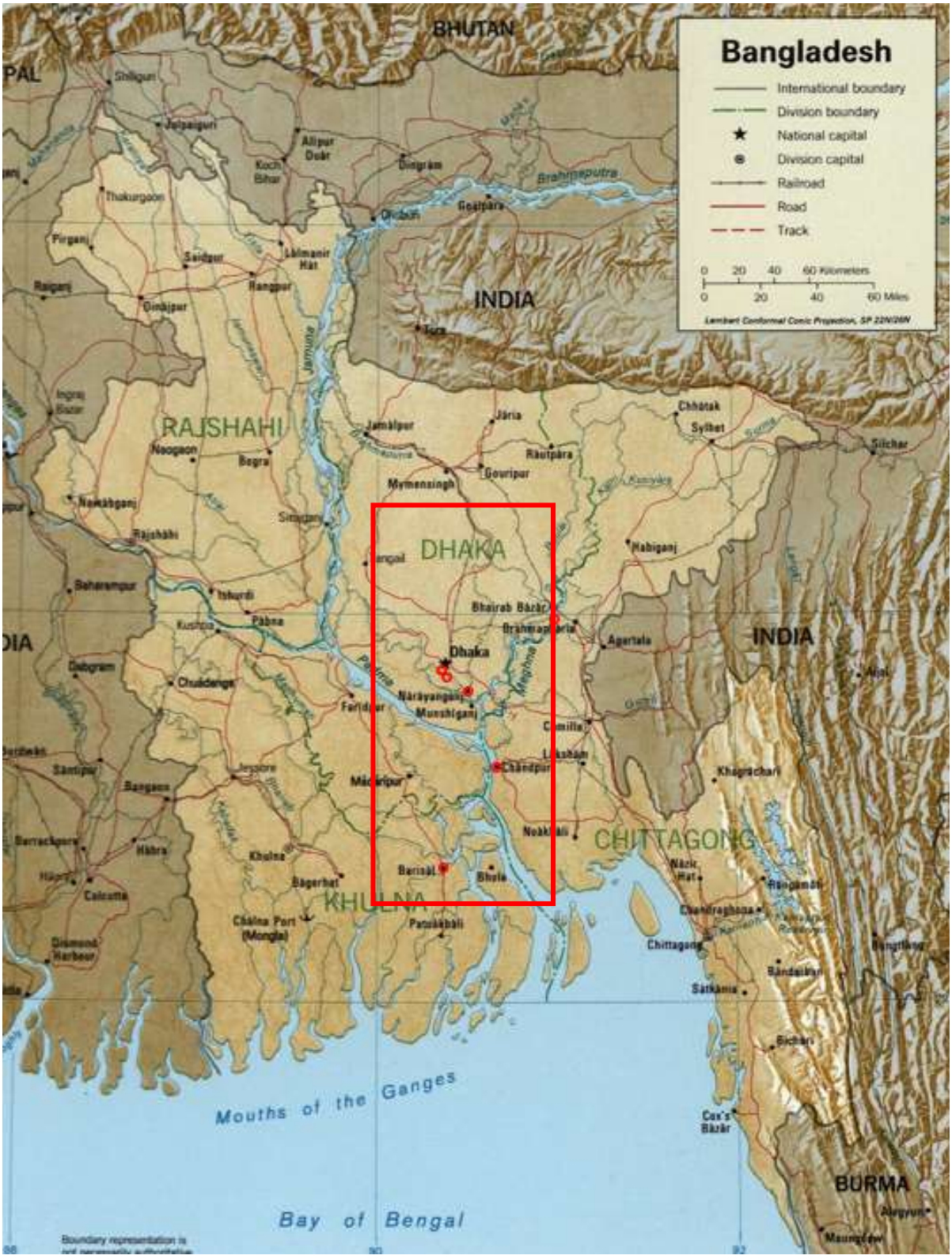


Figure 109. Locations of terminal and main rivers involved.

Source: Wikipedia

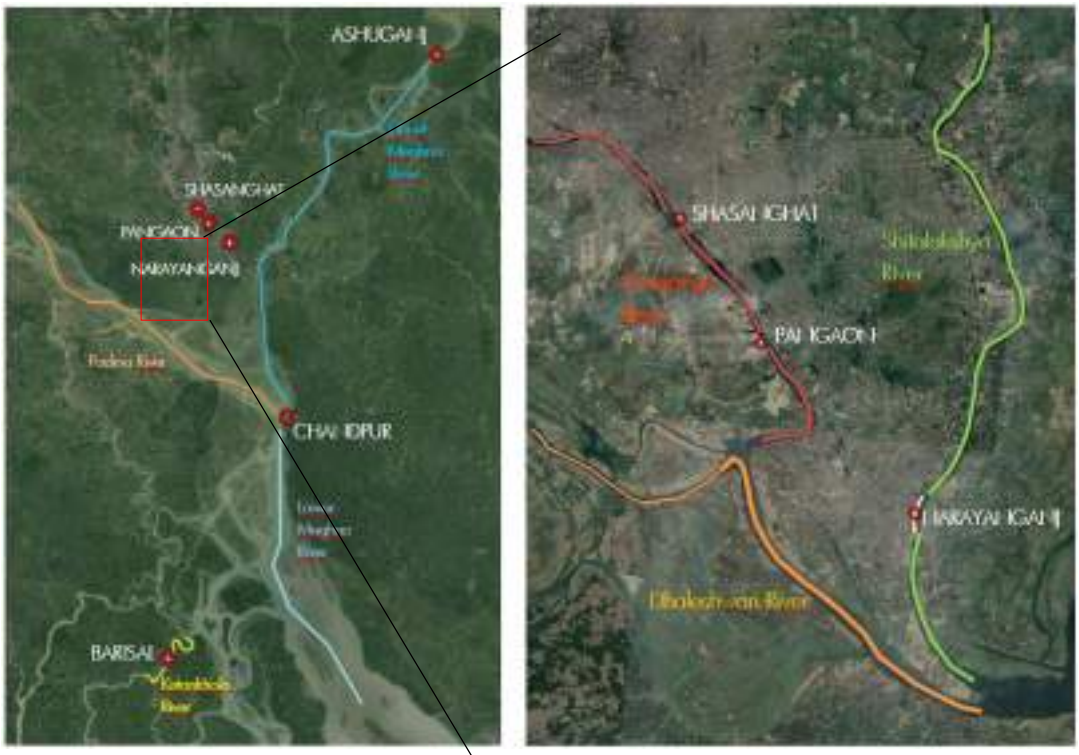


Figure 110. Locations of terminal and main rivers involved.

- Meghna River

The Meghna is one of the major rivers in Bangladesh, especially famous for its great estuary that discharges the flows of the Ganges-Padma, the Brahmaputra-Jamuna and the Meghna itself.

Figure 111. South East Hydrological Region and course of Meghna River.

Source: MWR (2016)[18]

[18] MWR (2016) Classification of Wetlands of Bangladesh, Ministry of Water resources, Government of the Peoples' Republic of Bangladesh.

- Upper Meghna

The Upper Meghna River rises in the north-eastern part of Bangladesh and flows throughout the southeast. The Upper Meghna carries the combined flow of the Surma and the Kusiyara Rivers which originate in the Indian hills' northeast of Bangladesh.

Heading downstream, the Upper Meghna River is joined by the Old Brahmaputra at Bhairab Bazar. The Dhaleshwari is another tributary (and another distributary from the Jamuna system) and it joins the Upper Meghna River at Munshiganj on the right bank. The Dhaleshwari River comes down in a brown stream and meets the clear blue-green Meghna. For many kilometers the waters do not seem to mix, for half the river water remains brown and the other half blue-green. The boatmen are fond of pointing out this peculiarity.

Sixteen kilometers from Shatnol, the combined flow of the Ganges and Brahmaputra-Jamuna, known as the Padma River, meets the Meghna at an 11 km wide confluence in the rainy season near Chandpur. From this point southwards the Meghna is marked as the Lower Meghna, becoming one of the broadest rivers and largest estuaries in the world. Although having some reaches with a system of various channels, the Upper Meghna River can be characterized as a river mainly meandering within a well-defined high waterbed and having flood discharges up to some 16,000 m3/s. (ESIA report of BRWTP-1, 2016)

The major contributors to the river upstream of Bhairab Bazar are from the Baulai, the Surma and the Kushiyara rivers, covering an area of 62,960 km2. The river stretch from Bhairab Bazar to Chandpur is about 125 km in length, but the total length is 156 km (Rivers of Bangladesh, 2016). Average width of the river is around 3,400 meters and varies from 1 km to more than 10 km. The river channel is more or less well defined upstream of its confluence to the Padma. Figure112 shows the minimum, maximum and monthly mean discharge of the river at Bhairab Bazar and also shows the small slope along the river during lowest discharges, affecting the navigation depth along the river length. (ESIA report for Component 1 of BRWTP-1, 2016)

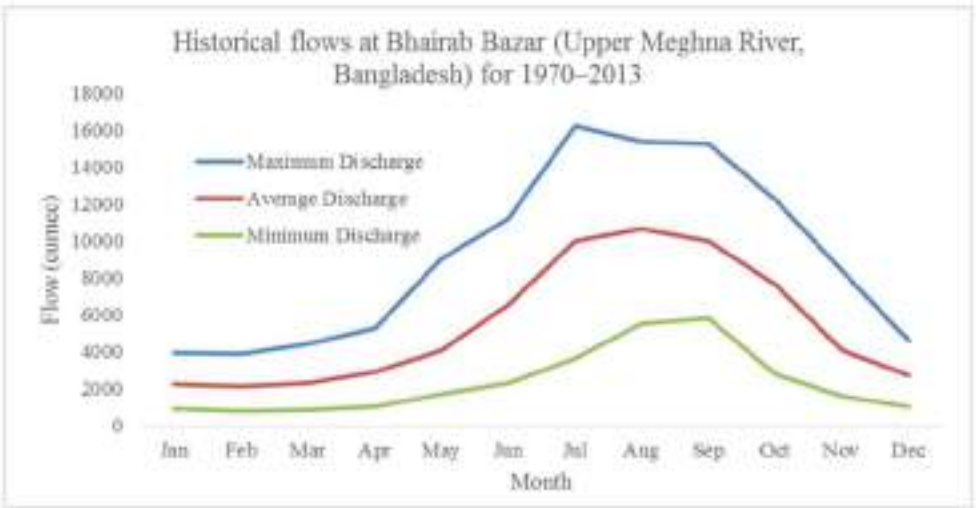


Figure 112. Discharge of Meghna River at Bhairab Bazar.

Source: ESIA report for Component 1 of BRWTP-1, 2016

The river discharge falls significantly during dry season and becomes about 800 m3/s (1970-2013) resulting in very low water level as well as navigation depth. The average daily water flow at Bhairab Bazar varies between 0.74m and 7.78 m over a year (next Table). (ESIA report for Component 1 of BRWTP-1,

2016)

Table 71. Water level statistics of Upper Meghna River at Bhairab Bazar.

Historical water level at Bhairab Bazar (Upper Meghna River, Bangladesh) for 1970–2013			
Month	Maximum WL (mPWD)	Average WL (mPWD)	Minimum WL (mPWD)
Jan	2.22	1.59	0.89
Feb	2.29	1.48	0.74
Mar	2.94	1.64	0.90
Apr	3.43	2.16	1.09
May	5.23	2.89	1.63
Jun	6.14	4.21	2.06
Jul	7.78	5.73	3.51
Aug	7.65	6.00	4.29
Sep	7.66	5.74	4.19
Oct	6.55	4.71	2.31
Nov	4.91	2.89	1.51
Dec	3.14	2.01	1.06

Source: S4 consultants

The water levels along the Upper Meghna are subjected to tidal influence. During low flows in the Upper Meghna River the tidal range near the confluence with the Padma River is about 1m and under those conditions still a vertical variation in tide of some 0.2 m is noticeable in Bhairab Bazar. (ESIA Report for Component 1 of BRWTP-1, 2016) The minimum water level can fall below 1m from January to March as seen in the monthly statistics of water level and there is every likelihood of experiencing inadequate navigation depth in this Class 1 route during this period. The above Table 71 presents the water level statistics. The seasonal variation is quite significant and seasonality index i.e. ratio between maximum and minimum water level over a year is about 9 which implies higher navigation depth from June to October. (ESIA Report for Component 1 of BRWTP-1, 2016)

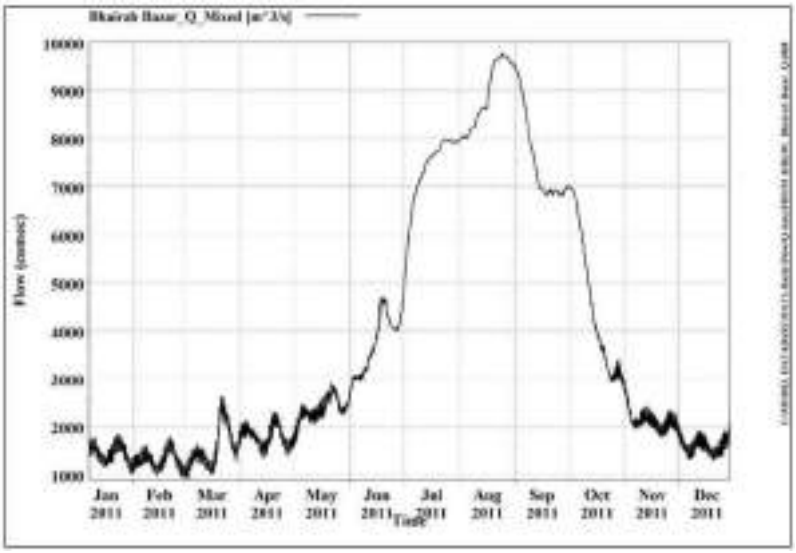


Figure 113. Observed water level hydrograph of the Upper Meghna River at Bhairab bazaar.

Source: ESIA Report for Component 1 of BRWTP-1, 2016

- Lower Meghna

Lower Meghna is the combined stream of the Padma River (confluence of Ganges and Brahmaputra-Jamuna) and Upper Meghna, reinforced by the Dhaleshwari River. The Dhaleshwari-Meghna and the Padma are each 5 km wide at the confluence where both flows at Chandpur. The Lower Meghna has several small chars (braid-bars) in it, which create two main channels, of which the large eastern one is 5 to 8 km wide. The western channel is about 2 km in width. Near Muladi the 1.5 km wide Safipur River is an offshoot from the right-bank. Further south, the Lower Meghna shifts into three channels: west to east flowing tentulia (Ilsha) river, the Shahbazpur and the Bamni. The Ilsha is a 5 to 6.5 km wide channel separating Bhola Island from the Barishal mainland.

The river stretch from Chandpur to Bhola District is about 65 km in length. Average width of the river is around 11,000 meters. The monthly mean discharge of the Padma river varies from 5800 m3/s in the month of February to 72,000 m3/s in August (Source: BWDB time series discharge data 1970-2013) at Baruria. The average monthly minimum flow in the Padma River is 3,700 m3/s in February and 33,400 m3/s in August. The water flow/discharge, in the West Shahbazpur Channel between Bhola and Manpura Island, present a peak discharge close to reaching a flow of 100,000 m3/s. (ESIA Report for Component 1 of BRWTP-1, 2016)

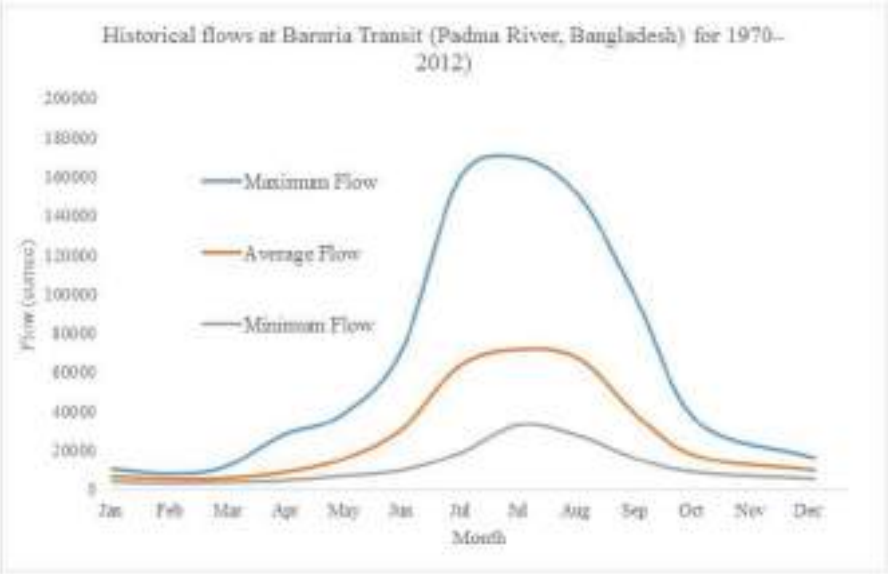


Figure 114. Monthly flow hydrograph of Lower Meghna (measured at Padma near Baruria).

Source: ESIA Report for Component 1 of BRWTP-1, 2016

- The estuary

The estuary of the Lower Meghna is usually considered to stretch from the Rabnabad islands to the Kumira coast, a distance of 153 km. The water is, however, saline for half of the year as far north as a line could be drawn from the middle of Bhola to the north of Sandwip. The estuary of the Lower Meghna may be considered as extending between the Ilsha (Tentulia) and Shahbazpur rivers which together have a width of about 40 km at the sea-face. The volume of the estuarine discharge is not known, but at Chandpur the mean discharge from June to October is around 2.5 million cusecs. The mean maximum in this period of the year is about four million cusecs.

In maximum flood, the Lower Meghna's flow is no less than five million cusecs. The Lower Meghna, as the

major outlet of the combined Ganges, Brahmaputra and Meghna has therefore somewhat less outflow than the Congo, which is second only to the Amazon.

The winter flow is about one-eighth of this although the river is even then several kilometers wide. The low flow is due to the stream's sluggishness During dry season the sea dominates, the tide in the coastal area of Bangladesh is semi-diurnal in nature and it arrives approximately from the south reaching the coast of Hiron Point (south of Khulna) and Cox's Bazar at the same time (de Wilde, 2012). The extensive shallow area in front of the large delta causes refraction and distortion of tidal waves. According to Azam et al., (2000), the incoming tides from the southern part of the Bay of Bengal are important for the flow features in the Meghna Estuary and they contribute to the residual circulation significantly.

Sediment distribution of both coarse and fine fractions in the Meghna estuary is largely influenced by residual current which is primarily dictated by the tidal currents. Also, the other important factor which can influence sediment distribution especially in the Meghna estuary is salinity because a major fraction of the sediments in the estuary are fine graded. The salinity distribution again is largely affected by the interaction between highly varying fresh water inflow from the rivers, wind stress and tidal fluctuations. So the investigation of tidal characteristics which is essentially influenced by the morphologic changes of the Meghna Estuary is very important.

Here, at the northern end of the Bay of Bengal, erosion and accretion rates are high and the area is periodically subject to severe storms and cyclones, these latter accompanied by tidal bores and storm surges.

- Tide

The Lower-Meghna, Tertulia, Kirtankhola rivers and Meghna Estuary serve as important navigation routes for Inland Water Transport, which are characterized by tidal and wave actions. Tides in the Bay of Bengal are semi-diurnal in nature, exhibiting two high waters and two low waters per day. The amplitudes of the two cycles differ slightly. Over a longer term, a fortnightly variation in amplitude between spring and neap tides is also evident, with spring tide amplitudes approximately 2.5 to 3 times higher than the neap tide. The duration of one tidal cycle is 12 hours 25 minutes.

The water level variation is dominated by a semi-diurnal tide with a considerable variation from neap to spring tides. In the western part of the coastal area of Bangladesh the average tidal range is approximately 1.5 m. In the area around Sandwip, the tidal range is significantly higher. It can be observed that the maximum tidal range is about 6.6m. The area around Sandwip Island is macro-tidal with variation in tidal range of 3 to 8 m. The area between Bhola and Hatia (Shabhazpur Channel) is meso-tidal, with tidal range of 2 to 4 m. (ESIA Report for Component 1 of BRWTP-1, 2016).

- Water level

There is a considerable seasonal variation of water level in the Meghna Estuary due to huge onrush of upstream flow and wind setup in the Bay of Bengal during monsoon. This seasonal variation influences the navigability in the river and difference of navigation depth is more than a meter between dry and monsoon period.

Moving average considering 56 tidal cycles, taken half hourly, observed water level data was carried out to find the seasonal variation of water level in the Lower Meghna River. Next figure shows the seasonal variation of the water level in the Lower-Meghna River at Chitalkhali in the Lakshmipur district (Source: IWM). It can be seen that seasonal variation is about 1.4m, which also varies year to year depending on upstream flood flow during monsoon. The seasonal variation of the mean high-water level (from dry to

the wet season) decreases significantly along the Lower Meghna Estuary in a southwards directions. The seasonal variation of the mean high-water level at Chandpur is about 3 m. The variation in the southern part of the Bangladesh coast is about 0.8 to 2.1 m. (ESIA Report for Component 1 of BRWTP-1, 2016)

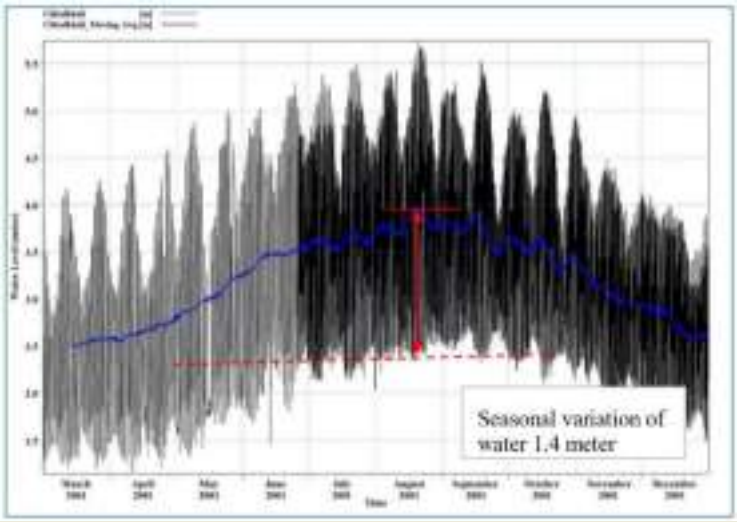


Figure 115. Monthly flow hydrograph of Lower Meghna (measured at Padma near Baruria).

Source: ESIA Report for Component 1 of BRWTP-1, 2016

It is evident from the next graph that the water level variation shows high seasonal and monthly variation (0.18 m to 5.52 m). However, the navigation depth at and around Chandpur is adequate throughout the year. The next figure shows the monthly variation of water level in the Lower Meghna River at Chandpur.

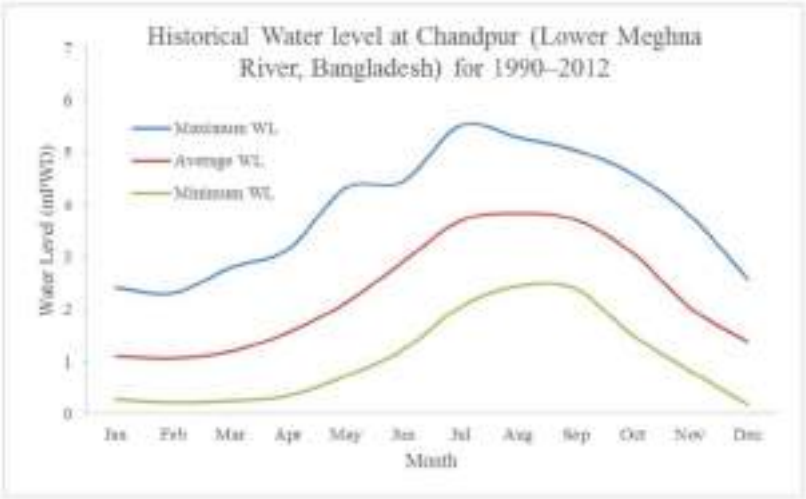


Figure 116. Monthly flow hydrograph of Lower Meghna (measured at Padma near Baruria).

Source: ESIA Report for Component 1 of BRWTP-1, 2016

Average monthly water level during dry season (December to May) varies from 1.06 m to 2.12 m; the seasonal variation of average water level is about 2.78 m over a year. However, the Lower Meghna River at and around Chandpur is very deep and usually there is no navigation problem, of which there is evidence in the recent bathymetric survey carried out by BIWTA. Water level statistics at different locations of the Meghna estuary are presented in the following table72. (ESIA Report for Component 1 of BRWTP-1, 2016)

Table 72. Water level statistics of Upper Meghna River at Bhairab Bazar.

Station	River Name	Dry Season (November-April)			Monsoon (May - October)		
		Maximum WL (mPWD)	Mean WL (mPWD)	Minimum WL (mPWD)	Maximum WL (mPWD)	Mean WL (mPWD)	Minimum WL (mPWD)
Chandpur	Lower Meghna	2.65	1.26	0.18	4.98	3.45	1.22
Chitalkhali/Laxmipur	Lower Meghna	3.15	1.05	-0.95	4.15	2.05	-0.35
Char Ramdaspur	Tentulia	3.16	1.21	-0.06	4.38	2.35	0.66

Source: S4 consultants

The critical period for navigation is the dry season and the minimum water level drops considerably downstream of the Lower Meghna River. The minimum water level is quite low in the East Shahbazpur channel and in the Tentulia River. If sedimentation occurs along the navigation channel at these locations, then adequate draft for cargo traffic might not be available.

- Flow distribution in the different channels of the Lower Meghna Estuary

To estimate the overall water flow distribution in the various channels of the lower Meghna estuary the hydrodynamic conditions has been simulated for one month for both dry (February-March) and wet (August) periods for the available flow conditions of 2009.

Hatiya channel is influenced by tide which results in northward net flow in the channel during the dry season. The north tip of Hatiya is experiencing erosion and the flow in Hatiya channel has increased at present time with respect to 2000. Most of the Lower Meghna river flow is conveyed along the west part of the estuary through the West Shahbazpur Channel. Therefore net flow is high in this channel compared to the other channels of the river system. The model results showed that continuous erosion is taking place at the east bank of Char Gazaria and west bank of Ramgati. The net flow through the Lower Meghna River at the east of Char Bhairabi has increased significantly compared with its west branch. At present the flow through the east branch is much greater than the western branch. Comparison of the two bathymetries in the sediment budget analysis shows erosion in the east branch and deposition in the west branch, which supports this finding. (ESIA Report for Component 1 of BRWTP-1, 2016)

- Buriganga River

The Buriganga River is one of the most important rivers in Bangladesh. This river is economically very important to Dhaka. Launches and rural boats provide connection between the capital city and other parts of Bangladesh using this river. It provides important services to the residents, including water supply, navigation, recreation, sanitation, and flood control.

However, this river has become extremely polluted and is close to biological death due to the tremendous increase in population over the last three decades. This situation has created enormous environmental problems, including among others the disposal of solid waste, sewage, and drainage problems. River depth is decreasing due to sludge deposition, hence affecting the navigation. Proper dredging of the existing river and removing non degradable matters from the riverbed are essential for restoring the river for its multi-purpose services.

The Buriganga River rises from the junction of Turag and Karnatali rivers, immediately adjacent to the Amin Bazar Bridge. The river surrounds the west part of Dhaka city in a southward direction. The course of the river passes through the main port of Dhaka, Sadarghat, located in the southern part of Dhaka.

Sadarghat Launch Terminal is one of the largest river ports in the world. About 200 large and small passenger launches depart and arrive at the terminal every day. According to the officials at the terminal, 30,000 people, on average, use the terminal for departure and arrival every day. A new cargo terminal and a new passenger terminal proposed for the Bangladesh Regional Waterway Transport Project - 1 are located along the course of Buriganga River. The river ends in the junction with Dhaleshwari River. The Buriganga River has a total length of 29 Km. An average width of 302 m, with a greatest width of 538 m and the lowest around 89 m (Rivers of Bangladesh).

The maximum flow occurs during monsoon, which is 2630 m3/s. The minimum flow over the period of 1996 to 2012 is 110 m3/s. The river exhibits high seasonality of water flow triggering a critical condition for navigability during the dry season. The figure 117 shows the monthly variation of water flow/discharge of Buriganga River at Mill Barrake.

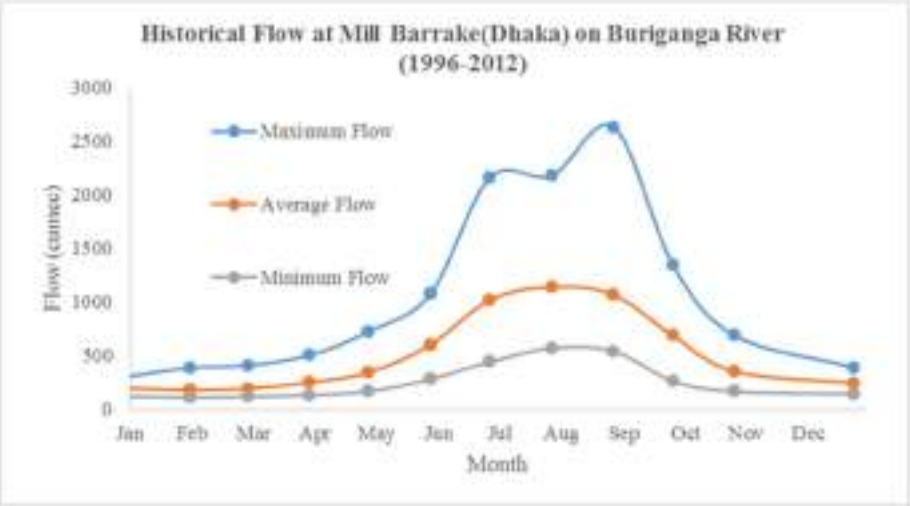


Figure 117. Monthly minimum, maximum and average discharge hydrograph of Buriganga River at Mill Barrake.

Source: ESIA Report for Component 1 of BRWTP-1, 2016

Over the period of 1996 to 2012, the minimum water level can fall to 0.52 mPWD, which can rise to 7.2 mPWD. The minimum daily water level from December to April is below 1 mPWD. However, average monthly water level varies from 1.24 mPWD to 1.79 mPWD for the same period indicating higher navigation depth for a considerable period even in the dry season. (ESIA Report for Component 1 of BRWTP-1, 2016)

- Dhaleshwari River

The Dhaleshwari River is the main left-bank distributary of the Jamuna/Brahmaputra River and is the main channel of a complex river system. Off-take morphology of this river from the Brahmaputra/Jamuna comprises a system of watercourses subject to continuous morphological changes thereby influencing the flow entrance as well as location at which it takes place. This river contributes with a reverse flow to lower Buriganga River during the dry season, which can affect the river quality and the new cargo terminal in Pangaon.

Dhaleswari is flowing full/partly in the monsoon starting from June to October and other months remaining dry in a year. The downstream part (near Rekabibazar) of the Dhaleswari River has certain tidal influence with a fluctuation of around 0.5 m. The percentage historical changes of annual flow volume of the Dhaleswari River with respect to the Bramaputra/ Jamuna flow. The maximum flow in the river is around 1,400 m3/s and 430 m3/s during monsoon period at Off-take.

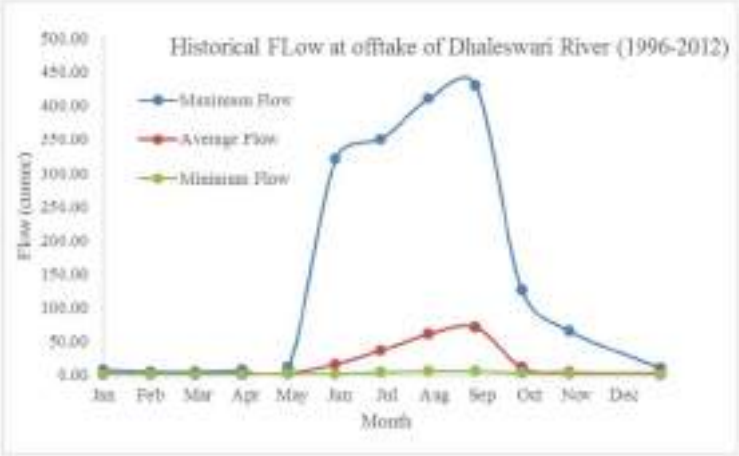


Figure 118. Monthly water flow hydrographs of Dhaleshwari River at Off-take.

Source: ESIA Report for Component 1 of BRWTP-1, 2016

- Shitalakhya River

The Shitalakhya River flows along the eastern side of Dhaka and Narayanganj districts and flows into the Dhaleswari River near Madanganj of Narayanganj. The Shitalakhya River was once an important center for the industry. Even today, there are centers of artisan weaving on its banks. There also are a number of industrial units on its banks, including the thermal power plants. Industrial affluent dumped into the river resulting in high levels of pollution is a cause for concern. There is a river port in Narayanganj included in the S3 package of BRWTP-1 where numerous launches move out along the river to different parts of Bangladesh. The Old Brahmaputra River, which flows through Mymensingh Division, crosses the division going into Dhaka Division and just at this point the name of the river changes to Shitalakhya River. The river, finally flows into the Dhaleswari River and comes together with the Meghna River.

The river is 110 km long and his average width is 228 m. The narrowest width is 151 m and the widest is 392 m, having a water area of 375 hectares. The water flow varies from 40 m3/s to 540m3/s over a year. During the dry season the water flow/discharge is very low, so the monthly average flow varies from 65m3/s to 75m3/s from January to March causing low river water levels that result in inadequate navigation depth.

The water level variation over the years is very high and during dry season the river is influenced by the tide. Daily water level variation is from 0.72 m PWD to 6.92 m PWD, which implies extremely significant seasonal variation of available navigation depth. Water levels start to rise from the month of April and reach a peak in the month of August.

- Kirtankhola River

This small river located in Barishal District rises from the Arial Khan River, flowing south-westward and traversing the city of Barishal, finally flowing into the Sugandha River. Kirtankhola River is about 16 km long and 15 meters deep. Its average width is about 500 m, the lowest width is 321 m and the highest is 674 m. The catchment area is 307.00 km2. The river normally flows throughout the year and is influenced by the tide.

4.2.7. Surface water quality

Surface Water samples were collected from 6 project locations from 22 October 2019 to 29 October 2019. An EZDO 8200 Multimeter was used to conduct the on-site test of pH, TDS, EC, Salinity and Temperature. For measuring Iron (Fe), water samples were collected from 6 project influenced locations from 13 January 2020 to 15 January 2020. Lutron DO-5509 was used to conduct the on-site test of Dissolved Oxygen (DO). The samples were sent to Department of Public Health Engineering (DPHE) and Department of Soil, Water and Environment, Dhaka University Laboratories for physicochemical parameters testing within 24 hours of being collected. Before collecting water sample, bottles were washed with distilled water. Only the samples for oil and grease were collected in glass bottles. Results of the surface water quality at the project locations have been shown in the next Table. The following figure represents the photos of sampling at sites.

Figure 119. Figure 1 Surface water quality sampling at sites

The surrounding environment is important while interpreting the results of the surface water quality test. The following Table gives the description of the surrounding environment during sampling campaign.

Table 73. Description of surrounding environment during surface water quality campaign

Sample Location and ID	Sample Site Description
Shasanghat, Dhaka New Terminal near Postagola (Buriganga River) ***(BIWTA_SW_01)***	The water is polluted. Some water hyacinth is covering part of the water. A launch was being dismantled and workers throwing waste into the water. Loading – unloading was going on. Some boats were moving.
Narayanganj Passenger Terminal (Shitalakshya River) ***(BIWTA_SW_02)***	A large part of the terminal was covered by waste materials. A launch crew was bathing using the river water. A large part of the water is covered by water hyacinth. Continuous movement of launch and boats.
Ashuganj Cargo Terminal (Meghna River) ***(BIWTA_SW_03)***	Loading and unloading was going on. Continuous movement of ships and boats. People throw food waste and also dump generator oil in the water. The water is being polluted.
Pangaon Cargo Terminal (Buriganga River) ***(BIWTA_SW_04)***	Several boats and launches were moving. The water is covered by water hyacinth. People movement was much higher in waterways.
Barishal Passenger Terminal (Kirtankhola River) ***(BIWTA_SW_05)***	Several launches were parked in the terminal. A large part is covered by waste near the terminal. A small part is covered by water hyacinth. Launch crews use the water for bathing and washing purposes. Several types of waste have been thrown in the water.
Chandpur Passenger Terminal (Meghna River) ***(BIWTA_SW_06)***	The terminal is surrounded by water hyacinth. People have thrown all types of waste in the water. The water is used for bathing and washing purposes mainly for launch crews. Several launches were parked in the terminal People movement was high in the terminal area.

The surface water quality standard is still not developed in the ECR 1997 except for a few parameters. Among the tested parameters the DO and BOD values for most of the **tested locations were below the standard value set by ECR 1997.**

Table 74. Surface water quality test results

Parameters	Unit	Concentration Present						Standards for Inland Surface Water*	Analysis Method
		Shasanghat, Dhaka New Terminal near Postagola	Narayanganj Passenger Terminal	Ashuganj Cargo Terminal	Pangaon Cargo Terminal	Barishal Passenger Terminal	Chandpur Passenger Terminal		
		Buriganga River	Shitalakshya River	Meghna River	Buriganga River	Kirtankhola River	Meghna River		
		BIWTA_SW_01	BIWTA_SW_02	BIWTA_SW_03	BIWTA_SW_04	BIWTA_SW_05	BIWTA_SW_06		
		23°41'24.00"N 90°25'33.74"E	23°37'0.80"N 90°30'22.21"E	24° 2'32.78"N 91° 0'1.37"E	23°39'31.36"N 90°27'13.68"E	22°41'57.26"N 90°22'33.60"E	23°13'59.05"N 90°38'56.94"E		
Temperature*	0C	33.1	32.3	26.4	26.2	29.0	31.4	NYS	**Multimeter**
pH*	-	9.12	8.87	8.29	8.51	8.94	8.55	6.5-8.5	**Multimeter**
Salinity*	ppt	0.093	0.133	0.105	0.095	0.133	0.137	NYS	**Multimeter**
Electrical Conductivity (EC)*	µs/cm	426	466	205	535	329	287	NYS	**Multimeter**
Dissolved Oxygen (DO)*	mg/L	3.1	3.3	4.8	3.3	4.9	5.2	5 or more	**DO Meter**
Total Dissolve Solid (TDS)*	mg/L	2077	2666	133	262	2214	189	NYS	**Multimeter**
Biochemical Oxygen Demand (BOD5)	mg/L	3	2	1	2	1	3	6 or less	**5 days Incubation**
Total Suspended Solids (TSS)	mg/L	12	11	17	10	13	8	NYS	**Gravimetric**
Turbidity	NTU	2.5	3.1	35.6	2.9	85.5	33.1	NYS	**Turbidity Meter**
Sulphate	mg/L	38	11	5	35	4	6	NYS	**UVS**
Oil and Grease	mg/L	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5	NYS	**TOC Analyzer**
Total Organic Carbon	mg/L	2.258	1.758	1.556	2.217	1.314	1.582	NYS	**APHA (5520.B)**
Iron (Fe)	**mg/L**	**0.61**	**0.27**	**0.48**	**0.25**	**0.31**	**0.25**	**NYS**	**AAS**

- **Temperature:** Differences in water temperature and density cause stratification. A property that is unique to water versus other substances is that it is most dense at 4 degrees Celsius, or 39 degrees Fahrenheit, and is less dense at either higher or lower temperatures. The standard for inland surface water is undefined. The test result shows that the highest temperature was found to be 33.1°C in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River) and lowest temperature was found to be 26.2°C in BIWTA_SW_04 (Pangaon Cargo Terminal, Buriganga River).
- **pH:** The "desirable" range of pH prescribed by the DOE is between 6.5 and 8.5. This is the range, which provides adequate protection to the life of freshwater fish and bottom dwelling invertebrates. The test result revealed that the amount of pH for all of the sampling location are exceed within the national limit because the water is polluted and people through their waste in the water body. The test result also shows that the highest pH was found to be 9.12 in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River) and lowest pH was found to be 8.29 in BIWTA_SW_04 (Ashuganj Cargo terminal, Meghna River).
- **Electrical Conductivity (EC):** EC stands for electrical conductivity, which measures the potential for a material to conduct electricity. The test result shows that the highest temperature was found to be 535 µs/cm in BIWTA_SW_04 (Pangaon Cargo Terminal, Buriganga River) and lowest temperature was found to be 205 µs/cm in BIWTA_SW_03 (Ashuganj Cargo Terminal, Meghna River).
- **Dissolved Oxygen (DO):** Dissolved oxygen is necessary for many forms of life including fish, invertebrates, bacteria and plants. Decrease in DO values below the critical level of 3 mg/L causes death of most fishes and other aerobic aquatic organisms. The test result shows that the highest DO was found to be 5.2 mg/L in BIWTA_SW_06 (Chandpur Passenger Terminal, Meghna River) and lowest DO was found to be 3.1 mg/L in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River).
- **Total Dissolve Solids (TDS):** Dissolved solids refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulphates) and some small amounts of organic matter that are dissolved in water. The standard of TDS for inland surface water is undefined. The test results show that, TDS value was highest in BIWTA_SW_02 (Narayanganj Passenger Terminal, Shitalakshya River) and it was 2666 mg/L and lowest in BIWTA_SW_03 (Ashuganj Cargo Terminal, Meghna River) and it was 189 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. BOD concentration was below the national standard limit for all the sampling locations.
- **Total Suspended Solids (TSS):** Total suspended solids (TSS) are the dry weight of particles trapped by a filter. The test result shows that the highest TSS was found to be 17 mg/L in BIWTA_SW_03 (Ashuganj Cargo Terminal, Meghna River) and lowest TSS was found to be 8 mg/L in BIWTA_SW_06 (Chandpur Passenger Terminal, Meghna River).
- **Sulphate:** Sulphate is second to bicarbonate as the major anion in hard water reservoirs. Sulphates (SO_4^{2-}) can be naturally occurring or the result of municipal or industrial discharges. When naturally occurring, they are often the result of the breakdown of leaves that fall into a stream, of water

passing through rock or soil containing gypsum and other common minerals, or of atmospheric deposition. The test result shows that the highest Sulphate concentration was found to be 38 mg/L in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River) and lowest Sulphate concentration was found to be 4 mg/L in BIWTA_SW_05 (Barishal Passenger Terminal, Kirtankhola River).

- **Iron:** 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. It is easily oxidized to ferric iron [Fe^{+++}] or insoluble iron upon exposure to air. The concentration of iron was higher in downstream than Upstream. The test result shows that the highest Iron concentration was found to be 0.61 mg/L in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River) and lowest Iron concentration was found to be 0.25mg/L in both BIWTA_SW_04 (Pangaon Cargo Terminal, Buriganga River) and BIWTA_SW_06 (Chandpur Passenger Terminal, Meghna River).
- **Turbidity:** Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity. Turbidity is considered as a good measure of the quality of water. The test result shows that the highest turbidity was found to be 85.5 NTU in BIWTA_SW_05 (Barishal Passenger Terminal, Kirtankhola River) and lowest turbidity was found to be 2.5 NTU in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River).
- **Total organic carbon (TOC):** Total organic carbon (TOC) is the amount of carbon found in an organic compound and is often used as a non-specific indicator of water quality or cleanliness of pharmaceutical manufacturing equipment. The test result shows that the highest TOC was found to be 2.258 mg/L in BIWTA_SW_01 (Shasanghat, Dhaka New Terminal near Postagola, Buriganga River) and lowest turbidity was found to be 1.314 mg/L in BIWTA_SW_05 (Barishal Passenger Terminal, Kirtankhola River).
- **Oil and Grease:** Oil and grease has the natural tendency to float on the water surface under quiescent conditions, as the density of oil and grease is usually less than one. Not all the oil and grease are in liquid or solid form. Appreciable amounts remain in a finely divided emulsified form. From the test result it is found that, all the samples contain concentration of less than 5 mg/L.

4.2.7.1. Ground Water Quality

Ground water quality has not been assessed by the ESIA consultants. Since ground water quality assessment has been carried out during 2015 and 2016 by Component 1 Consultants , the results are used for the study as baseline. The groundwater samples were collected twice, during dry season (January- February 2016) and wet season (September – October 2015). Results are given in the following Table. It is seen from the results that the amount of Mn and Fe exceeds the DoE standard in Ashuganj site. The most common sources of iron and manganese in groundwater are naturally occurring, for example from weathering of iron and manganese bearing minerals and rocks. Industrial effluent, acid-mine drainage, sewage and landfill leachate may also contribute iron and manganese to local groundwater.

At concentrations approaching 0.3 mg/L Fe and 0.05 mg/L Mn, the usefulness of the water may become seriously impacted, e.g., there may be a metallic taste to the water and staining of plumbing fixtures may become common. At these concentrations, however, the health risk of dissolved Fe and Mn in drinking water is insignificant.

Table 75. Ground water quality at sites.

Parameter	Unit	Ashuganj		Sadarghat, Dhaka		DOE Standard for Drinking Water
		Dry season	Wet season	Dry season	Wet season	
pH		6.76	6.55	6.85	6.65	6.5- 8.5
Temp	°C	26	25.3	29	24.8	20 - 30
EC	µS/cm	462.1	324.0	986	987.0	-
TDS	mg/L	231.1	198.0	562	622.0	1000
Ca	mg/L	42.96	19.8	94.3	101.0	75
Mg	mg/L	26.71	16.5	31.3	28.8	30-35
Na	mg/L	1.19	19.9	31.4	53.1	200
K	mg/L	4.01	3.71	4.04	5.49	12
Cl-	mg/L	-	15.1	-	116.0	150-600
F	mg/L	-	<0.5	-	<0.5	1
Br	mg/L	-	<1.0	-	<1.0	-
SO_4	mg/L	-	<4.0	-	<4.0	400
As	mg/L	0.011	0.03	<0.005	<0.005	0.05
Fe	mg/L	1.17	24.7	0.36	0.35	0.3-1.0
Mn	mg/L	5.67	1.73	0.38	0.50	0.1

Source: S4 Package consultants

Parameters exceeding DoE Standard are flagged up

4.2.8. Agroecological Zones in Study Area

Agroecological Zone land areas recognized on the basis of hydrology, soil types, tidal activity, cropping patterns, and seasons. In fact, an agroecological zone indicates an area characterized by homogeneous agricultural and ecological characteristics. This homogeneity is more prominent in the sub-region and unit levels. The agroecological zones of Bangladesh have been identified based on four elements such as physiography, soils, land levels in relation to flooding and agroclimatology.

- *Physiography:* forms the primary element in defining and delineating the agroecological regions in Bangladesh.
- *Soils*: form the second element in defining and differentiating agroecological zones as soil conditions determine important properties for plant growth, moisture supply, root aeration and nutrient supply.
- *Land level* in relation to flooding: The country has been classified into the following types of land level:
  - Highland (land which is above normal flood-level).
  - Medium highland (land which normally is flooded up to a depth of about 90 cm during the flood season).
  - Medium lowland (land which normally is flooded up to a depth of between 90 cm and 180 cm during the flood season).
  - Lowland (land which normally is flooded up to a depth of between 180 cm and 300 cm during the flood season).
  - Very lowland (land which normally is flooded to a depth of more than 300 cm during the flood season).

- Bottomland is recognized for depression sites for any land level class which remains wet throughout the year.

These classes actually indicate the level of flooding which farmers expect when they decide which crops to grow in the *kharif* season on their different kinds of land, based on their long experience of cultivation on particular sites.

- *Agroclimatology.* The fourth element considered in identifying agroecological zones in Bangladesh comprises the four climatic zones of the country. The combined agroclimatic zones could be superimposed on the zones and sub-regions to create unique agroecological units.

Bangladesh has been tentatively divided into 30 agroecological zones BARC (1988)[19] as shown in the figure 120.

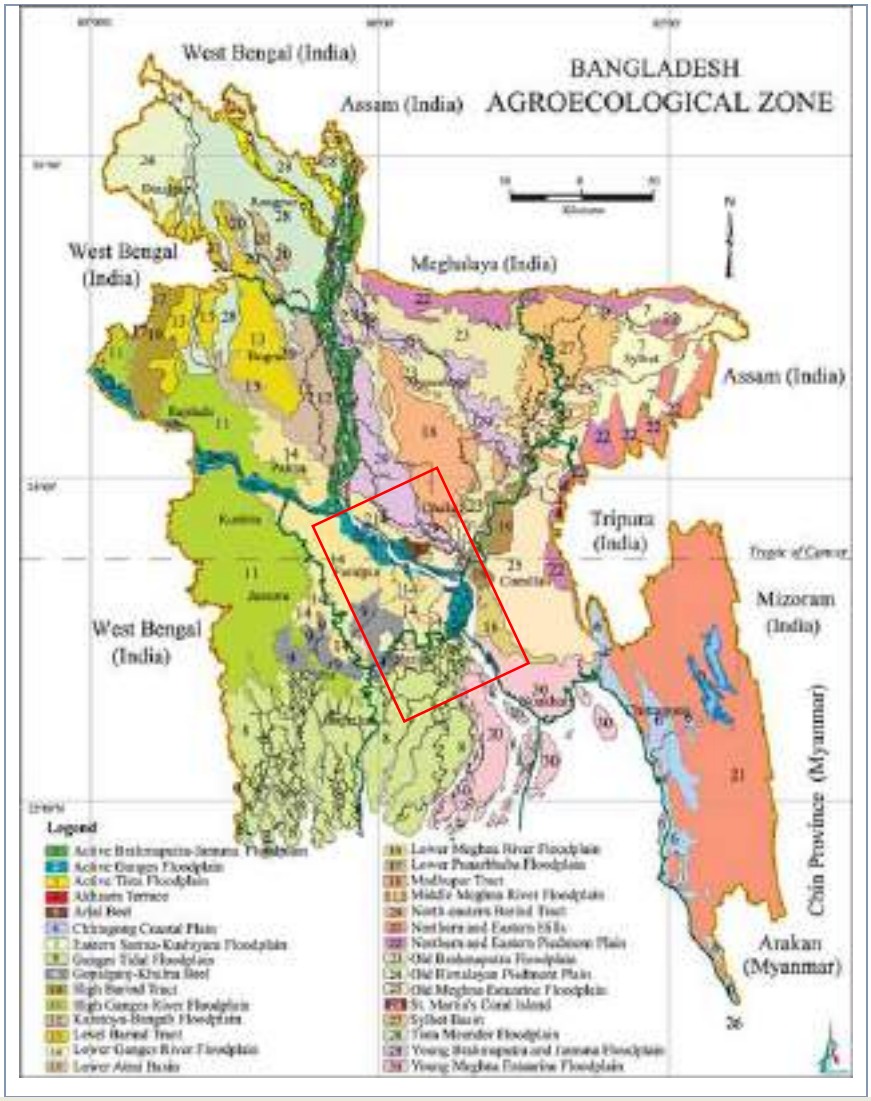


Figure 120. Agroecological zones of Bangladesh.

Source: Banglapedia

The project terminals belong to zone 13 and 19.

[19] BARC (Bangladesh Agriculture Research Council) (1988) Land resources appraisal of Bangladesh for agricultural development. BARC, Dhaka

- **Barishal Terminal. Zone 13: Ganges Tidal Floodplain**. (17,066 sq. km) this region occupies an extensive area of tidal floodplain land in the southwest of the country. The greater part of this region has smooth relief having large areas of salinity. Riverbanks generally stand about a meter or less above the level of adjoining basins. Non-calcareous grey floodplain soil is the major component of general soil types. *Acid sulphate soil* also occupies a significant part of the area, where it is extremely acidic during the dry season. Most of the topsoils are acidic and subsoils are neutral to mildly alkaline. Soils of the *sundarbans* area are alkaline. General fertility level is high, with medium to high organic matter content.
- **Narayanganj, Chandpur and Ashuganj Terminals, Pangaon and Shasanghat terminal Zone 19: Old Meghna Estuarine Floodplain:** (7,740 sq km) this region occupies a large area, mainly low-lying land between the south of the Surma-Kushiyara floodplain and the northern edge of the young Meghna estuarine floodplain. Silt loam soils predominate on highlands and silty clay to clay on lowlands. Organic matter content of the soils is moderate. Topsoil are moderately acidic, but subsoils test neutral. General fertility level is medium.

Table 76. Physiographic Unit for Passenger Terminal AEZ Zones.

Name of the AEZ	Location	Extent	Land type	Organic Matter Content	Fertility level	Suitable crops
13. Ganges Tidal Floodplain	All or most of Barishal, Jhalkati, Pirojpur, Patuakhali, Bagerhat, Barhuna, Khulna and Satkhira districts. It includes the Khulna and Bagerhat Sundarbans Reserve Forests.	17,066 km^2	Medium high: 78% Others: 22%	Medium to high	High	**Kharif:** B. Aus, T. Aman, Green manures **Rabi:** Boro rice, Wheat, Mungbean, Grasspea, Cowpea, Chilli
19. Old Meghna Estuarine Floodplain	Kishoreganj, Habiganj, Brahmanbaria, Comilla, Chandpur, Feni, Noakhali, Laksmipur, Narsingdi, Narayanganj, Dhaka, Shariatpur, Madaripur, Gopalganj and Barishal.	7,740 km^2	Medium high: 24% Medium low: 33% Low: 21% Others: 27%	Medium	Medium	**Kharif:** B. Aus+B. Aman, T. Aman, Jute **Rabi:** Boro rice, Wheat, Potato, Mustard, Grasspea, Chickpea, Winter vegetables

Source: UNDP-FAO (1988)[20]

[20] UNDP-FAO (1988) Land Resources Appraisal of Bangladesh for Agricultural Development, BGD/81/35, Technical Report No. 3 Land Resources database, Volume II: Soil, landform and Hydrological database. UNDP, FAO, Rome 1988.

4.3. BIOLOGICAL ENVIRONMENT

4.3.1. General

Bangladesh is a land of water and wetlands. Situated between the Indo-Himalayas and Indo-Chinese subregions, the country has a total area of 147,570 km, of which about 80 percent comprises one of the largest deltaic plains in the world, formed in the confluence of the Ganges, the Brahmaputra (Jamuna), and the Meghna rivers. Two-thirds of the delta lies in Bangladesh while the rest of the delta is part of the state of West Bengal, India. The delta is the largest in the world and one of the most fertile regions. The wetlands in Bangladesh encompass a wide variety of ecosystems including the main rivers (the Ganges, the Brahmaputra and the Meghna) and their 700-plus tributaries and distributaries; about 6,300 beels (permanent and seasonal shallow lakes in floodplain depressions); at least 47 major haors (deeply flooded depressions in the north-east), baors (oxbow lakes); vast areas of seasonally flooded land; and fishponds and tanks (Nishat 1993, Khan 2001). The floodplain in Bangladesh occupies a greater part of the landscape and offers important habitats of a wide variety of wild flora and fauna. A total of 200-300 plant species in Bangladesh are wetland species for all or part of their life spans (Nishat 1993).

Bangladesh possesses a rich species diversity of flora and fauna. The tropical semi-evergreen forests in the country are botanically amongst the richest in the Indian subcontinent, and they also support a considerable diversity of mammals and great diversity of birds. Bangladesh possesses rich species diversity particularly for angiosperms. It has been reported from previous studies that there is a total of 3,611 species of angiosperm. Although endemism is relatively low for the country, the records suggest the existence of at least 16 endemic species of flowering plants in Bangladesh (Encyclopedia of Flora and Fauna of Bangladesh (2007) and Indian Forth National Report to CBD).

Rivers, Floodplains, wetlands and estuaries of Bangladesh support a myriad of species comprising biological diversity. Aquatic biodiversity of the country are also a basis of renewable resources-based economic growth and millions of people enjoy their day-to day livelihoods from these important resources. Biodiversity has a very close relationship between ecosystem services and livelihoods when allocating land and natural resources. Healthy ecosystems ensure human well-being by providing food, materials (e.g. wood, crops, fiber, fruits and vegetables) and clean water, while also breaking down waste materials. Diversity of ecosystems and its rich floral and faunal resources have made Bangladesh and its ecosystems resilient to natural calamities. The rich biodiversity of this land with moderate tropical climate makes it comfortable for the human habitation. As an agrarian society, Bangladesh and its population heavily depend on the genetic resources of crop varieties. The history of its rich agricultural practices goes back many centuries and farmers were highly innovative to create many cultivars using wild genetic resources. The presence of 10,000 plus rice varieties is a clear example of our vast wealth of genetic resources. Bangladesh is also one of the oldest producers of cotton and its rich and diverse collection of medicinal plants has attracted attention throughout history.

4.3.2. Bioecological Zones and Land Cover

4.3.2.1. Bioecological Zones

Apart from the floodplains and water surfaces around 20% of rural area comprises of undulating hillocks, and forested hill tracts. Distinct physiographic characteristics, variations in hydrological and climatological conditions, and difference in the soil properties in Bangladesh contribute in developing diverse forms of ecosystems enriched with great diversity of flora and fauna. The floodplains of Bangladesh have long been subject to cultivation, the most dominant land use in the country and within the project area, where only scattered patches of native trees, wetlands and associated fauna habitat remains in isolated locations.

Based on Bio-ecological zones of Bangladesh (IUCN, 2002) a first approach can be made to natural ecosystem zones, defined as ecologically and geographically defined area with distinctive natural communities and species within an acceptable range of variation. Following IUCN classification for Bangladesh bio-ecological zones Project sites lies within the following: 4c: Brahmaputra-Jamuna Floodplain and 11: Major Rivers (see figure 121).

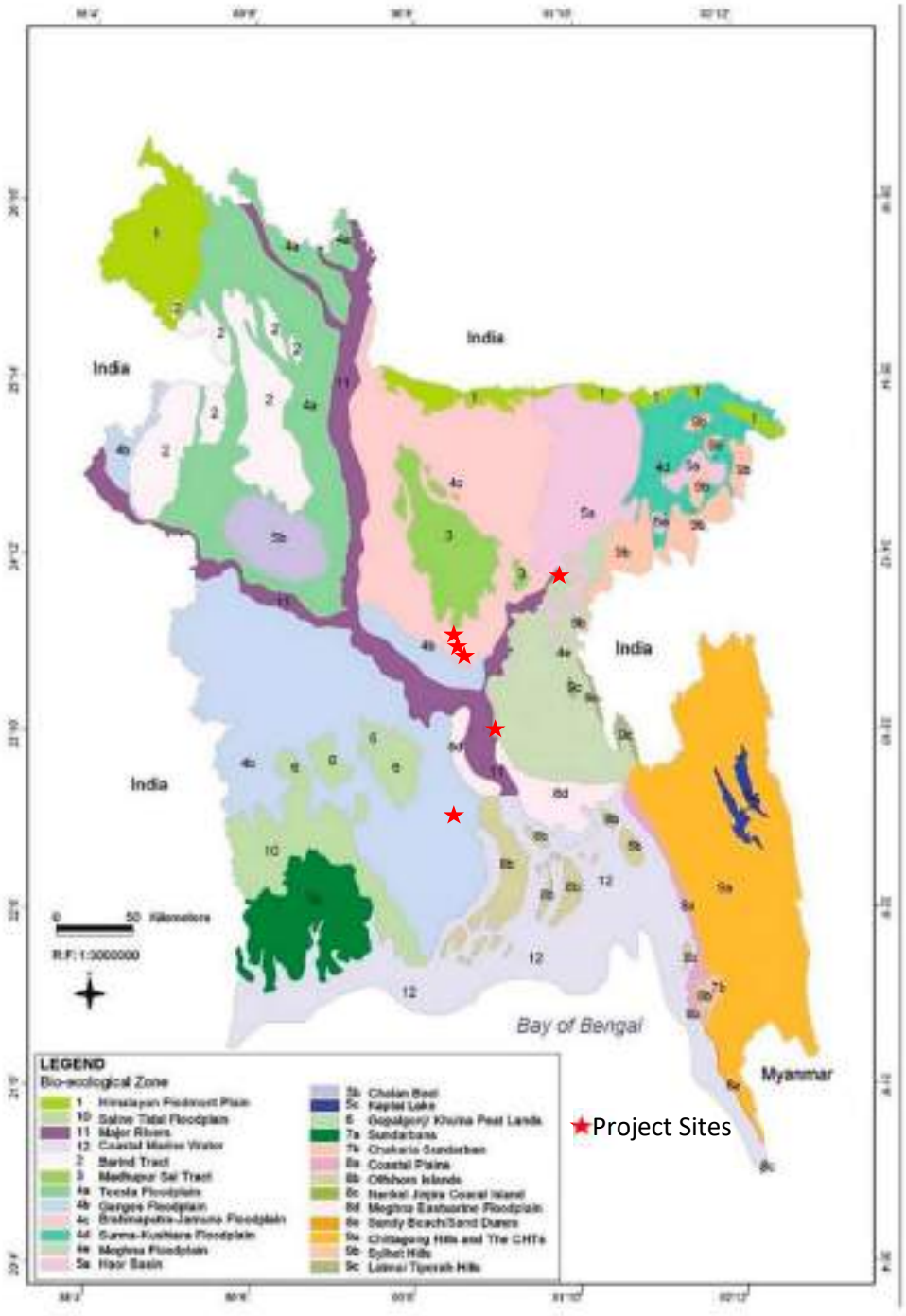


Figure 121. Bio-ecological zones of Bangladesh. The project terminals belong to 4c and 11 zones. *(Source IUCN, 2002).*

4b: Ganges floodplain

The Ganges Floodplain basically consists of the active floodplain of the Ganges River and the adjoining meandering floodplains and is mostly situated in the administrative districts of greater Jesore, Kusthis Faridpur, and Barishal. The adjoining meander floodplains mainly comprise a smooth landscape of ridges, basins and old channels. A noteworthy aspect here is that the Gangetic alluvium is readily distinguishable from the old Brahmaputra, Jamuna and Meghna sediments due to its high line content. Besides, the relief is locally irregular alongside the present and former river courses, especially in the west, comprising a rapidly alternating series of linear low ridges and depressions. The Ganges channel is constantly shifting within its active floodplain, eroding and depositing large areas of new char lands in each flooding season, but it is less braided than that of the Brahmaputra-Jamuna. Interestingly enough, both plants and animals move and adapt with the pattern of flooding (Brammer, 1996).

The floodplain is characterized by mixed vegetation. A lot of stagnant waterbodies and channels, rivers and tributaries are present in this zone, which, to a certain extent, supports a habitat of rich biodiversity. In the rivers and other waterbodies, free-floating aquatic vegetation is prominent. Homestead forest, on the other hand, include both cultivated and wild plant species. The dominant flora types are: Panimorich (*Polygonum orientale*), Jhanji *(Hydrilla verticillata*), Helencha (*Alternanthera Philoxeroides*), Topana (*Pistia strateotes*), Chechra (*Schenoplectus articulates*), Shada shapla (*Nymphacea nouchali*), Kolmi (*Ipomea aquatica*), Tamarind (*Tamarindus indica*), etc. Moreover, grasses are abundant in the Ganges floodplain and begin to grow as soon as the floodplain begins to recede. The notable grass species are *Cyperus rotundus, C. diformis, Eleocharis sp., Hemarthria sp. etc*. (GoB-IUCN, 1992).

Nearly all the major groups of the oriental birds are represented on the zone by one or more species. In addition, a large number of migratory birds are found here during the winter. Besides, different species of freshwater tortoise and turtles are also found in the rivers and ponds, most of which are a popular delicacy among the non-Muslim locals. The amphibian species found in this zone include a few species of toads, frogs, and tree frogs. Among the mammalian fauna, foxes, jackals, rats, mice, squirrels, bats, *etc*. are seen in all parts (GoB-IUCN, 1992).

4c: Brahmaputra-Jamuna Floodplain: The mighty Brahmaputra River, which is often referred to Jamuna, although the latter´s channel is comparatively new, and its course is clearly distinguishable from that of the older Brahmaputra. The Brahmaputra floodplain (situated in greater Mymensignh and Dhaka districts) comprises the active channel of the Brahmaputra River and the adjoining areas of the young floodplain lands formed, back around 1780, when the river shifted to its present course to the south of Dewanganj in the Jamalpur district. The main river course is strongly braided. It consists of several interconnecting channels, which erode and form new lands on a large scale during each flooding season.

The Brahmaputra-Jamuna floodplain possesses a unique variety of plants, medicinal herbs, fruit bearing tress, hundreds of jungle shrubs, creepers and climbers, flowering trees, etc. many of which yield valuable products. Some of the flora species, which are valued by timber producers include: The Banyan (*Fycus begalensis*) Tamarind (*Tamarindus indica*), Sada koroi (*Albizia procedera*), Simul (*Bombax ceibal*) and Ashwath (*Ficus religiosa*). The prominent fruit-bearing tress of this zone are: Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*) and Litchi (Litchi chinensis). Bushes of reeds and canes are also found here.

Like the flora diversity, this zone equally enjoys riches of faunal variety. According to Hunters (1875), leopards were frequently sited in this zone. A few species of deer, such as the Sambe (*Cervus unicolor*), Hog deer (*Axis porcinus*), Swamp Deer (*Cervus duvauceli*) and Barking Deer (*Muntiacus muntjak*) were also once found in abundance everywhere in the forest of this zone. Among the bird species, small game birds such as the Common peafowl (*Pavo cristatus*), Red junglefowl (*Gallus gallus*), Partridges, and several varieties of

Pheasant were commonly found. The Bengan florican (*Houbaropsis begalensis*) and snipes are plentiful in the sandbanks and chars of this zone. On the other hand, the most common poisonous snake is the Bankded krait (*Bungarus fasciatus*) in this zone, which could easily be identified by its broad black and yellow bands.

Most of this bio-ecological zone is currently under cultivation, and has been for centuries.

11: Major Rivers: The Project terminals lie directly in the Buriganga, Meghna (Upper and Lower), Padma, Kirtankhola and Shitalakshya Rivers.

4.3.2.2. Land cover

Apart from the above described Ecological zones, land cover shows the current status of the land. Biological community, which is expected to be found in such a zone, has been replaced by cultivated land, grasslands, or modified anthropogenic landscape in most of the areas. In continuation a brief introduction of current land cover is described.

The land cover in Bangladesh has been described in a classified map, consisting of forest (mixed evergreen forest, deciduous forest and mangrove forest), scrub, grassland, agriculture, plantations, water bodies, barren land and settlements. The predominance of agricultural land is evident, constituting 62.2% of the total geographical area followed by plantation (including orchards). The third largest land cover in the country is forest (9.5%), (see figure 122 below).

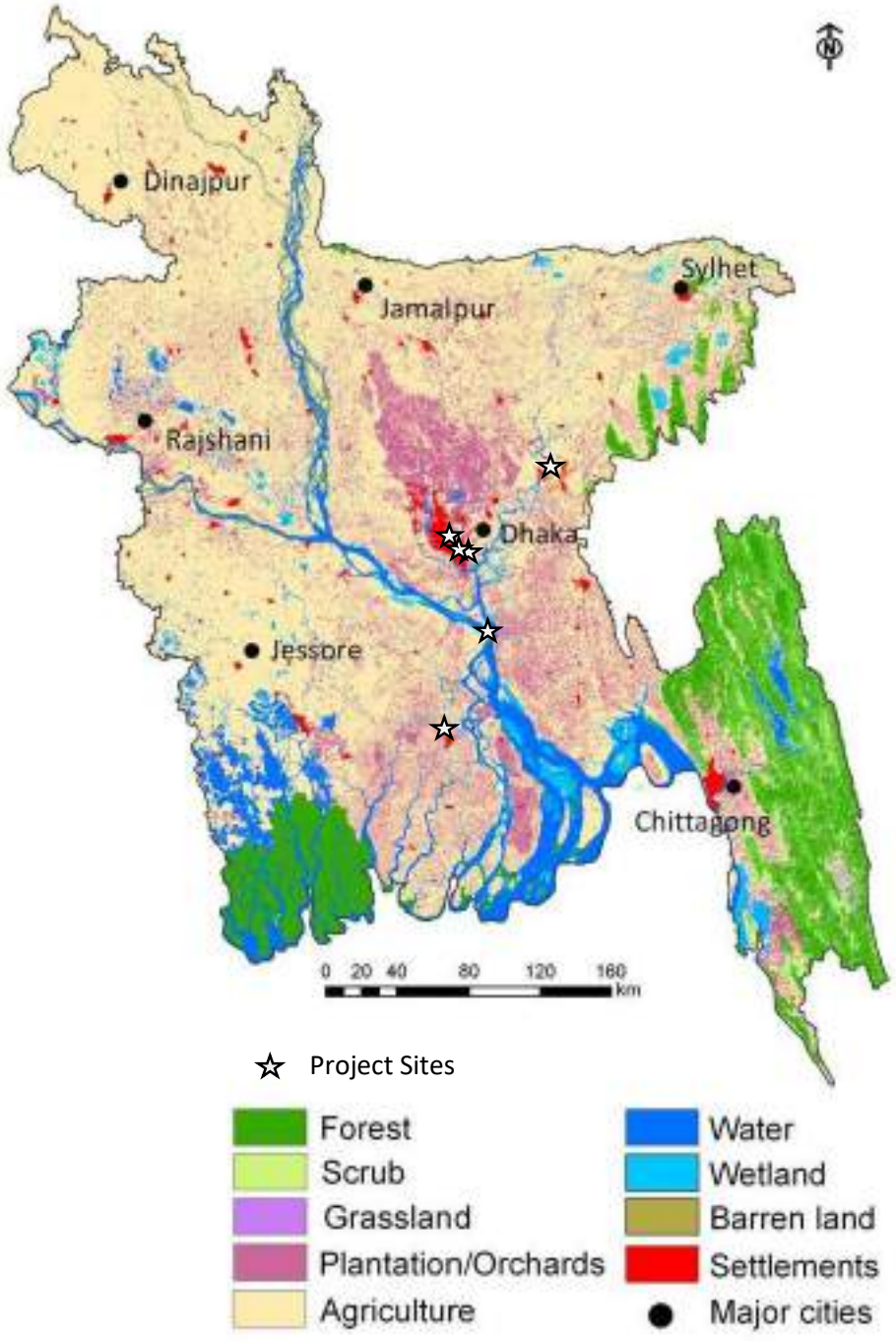


Figure 122. Land Cover Map (2014) from Bangladesh.

Source: Global and Planetary Change, February 2016

Table 77. Areal extent of land use/land cover in Bangladesh: 2014

Land cover class	Area (Km2)	% of the Total Geographical Area
Forest	14.086	9.5
Scrub	4.745	3.2
Grassland	556	0.4
Plantation	18.059	12.2
Agriculture	91.716	62.2
Wetlands	2.441	1.7
Water	13.136	8.9
Barren land	1.188	0.8
Settlements	1.643	1.1
Grand Total	147.570	100

(*Source: Global and Planetary Change, February 2016)*

As a summary of the Land cover map and bio-ecological map, Bangladesh has four main areas of vegetation and ecological areas. The eastern zone, consisting of parts of the Sylhet and Chittagong areas, has many low hills covered with jungles of bamboo and rattan (a species of climbing palm). The most common plant is a large type of bamboo that forms the basis of the country's paper industry.

The central zone, covering parts of the country to the north of Dhaka, contains many lakes and supports swampy vegetation; the soil of part of this zone produces the Madhupur jungles. The area lying to the northwest of the Jamuna and to the southwest of the Padma forms a flat plain, the vegetation of which consists mostly of cultivated plants and orchards. Babul (Acacia arabica) is the most conspicuous tree.

As is clearly shown in the above land cover map, plantation, agriculture, orchards, wetlands and water are the most common land cover in the country, moreover riverbank and homestead vegetation (a combined landscape of the above predominant land cover units) is a very important plant community, albeit a synthetic one. A description of agriculture and homestead, riverbanks and water bodies and urban-periurban areas are presented below. Project sites are located within these three main vegetation and ecological zones.

4.3.3. Main Ecosystems in Project sites

4.3.3.1. Agriculture and homestead areas

Agriculture is the largest employment sector in Bangladesh. Rice and jute are the primary crops and wheat is assuming greater importance. Tea is grown in the northeast. Because of Bangladesh's fertile soil and normally ample water supply, rice can be grown and harvested three times a year in many areas.

In Bangladesh, only nine crops- rice (73.94%), wheat (4.45%), jute (3.91%), rape and mustard (3.08%), lentil (1.54%), chickling vetch (1.25%), potato (1.13%), sugarcane (1.12%), and chilly (1.05%) are grown on 90 percent of the crop acreage (14.61 million ha) and may be considered as major crops.

Rice, wheat, maize, potato, pulses, and oil seeds are major food crops in Bangladesh. While rice is the primary staple food and the most important crop, wheat and maize are of second and third importance.

Pulses and oilseeds are important crops in the context of supplying plant-based proteins for rural people. Jute and sugarcane are important cash crops. Average yields, cultivated area, and production of major food crops over the last six years (2006-2012) are shown Table 78

Table 78. Average (2006-2012) yield, harvested area and yield of major food crops in Bangladesh

Crop	Average yield (t ha-1)	Harvested area (Mha)	Total production (Mt)
Rice	2.80	11.14	31.16
Wheat	2.32	0.38	0.88
Potato	16.68	0.42	6.94
Maize	4.97	0.17	0.82
Pulses	0.89	0.25	0.22
Oil seeds	1.69	0.35	0.60

Source: BBS (2012)

Agriculture in Bangladesh is predominantly based on smallholders with about 80% of the farmers cultivating less than one hectare. Agriculture is characterized by traditional farming methods using draft animals for ploughing and hand hoe for land preparation and sowing.

Small-scale mechanization is increasing through use of double-wheeled tractors for tillage and power threshers for paddy rice and wheat. Irrigated area has expanded in recent years.

Cotton is one of the important cash crops in Bangladesh. It is the main raw materials of textile industry. Annual requirement of raw cotton for the textile industry of Bangladesh is estimated around 2.5 million bales. Local production is only about 0.1 million bales.

Rice dominates the cropping pattern throughout Bangladesh. It has been broadly divided into three classes viz, aman (transplanted and broadcast varieties), boro and aush according to the season in which they are harvested, namely, in December-January, March-May and July-August respectively. Again, of these varieties transplanted aman is the most important and covers about 46.30% of the paddy area, followed by boro (26.85%), aus (17.59%) and broadcast aman (9.26%). Transplanted aman is grown almost everywhere in Bangladesh, while broadcast aman is mostly grown in the low-lying areas of the south and northeast. Boro is grown to a certain extent in every district, especially in the irrigated part, while aus is a well scattered crop.

Next to rice, wheat is the most important crop in Bangladesh. It is grown mainly in the drier parts of the north and is cultivated only as a winter crop. Jute leads the country's list of export crops but is ranked third in terms of area cultivated. It is confined mainly to the low-lying areas of the Brahmaputra-Jamuna and Padma floodplains.

Mustard (including rape) is the fourth most important crop. It is also grown mainly in the low-lying areas of Brahmaputra-Jamuna and Meghna floodplains.

Masur (lentil) and khesari (chickling vetch) are two important varieties of pulses produced in Bangladesh. Masur is mainly grown in the Gangetic delta while khesari is a well-scattered crop in the islands and chars (any accretion in the riverbed, usually sandy islands).

Potato is the most important of the winter vegetables and is widely grown. At present potato is an important crop for Munshiganj, Comilla, Rajshahi, Rangpur, Dinajpur, Bogra, Joypurhat and Nilphamari districts. Sugarcane is the eighth most important crop in the country. It grows best in the Rajshahi, Natore, and Chuadanga districts.

Although chilli is produced to a certain extent in every district of the country, the cultivation is mainly concentrated in the southern districts including Bogra, Sirajganj and Pabna.

Figure 123. Bangladesh Mayor Cultivation Area Map

Source: BBS (2012)

In Bangladesh gram (0.78%), millets and maize (0.60%), onion (0.58%), black gram (0.51%), sweet potato (0.45%), groundnut (0.40%), green pea (0.36%), sesame (0.33%), linseed (0.30%), garlic (0.20%), pea (0.12%), barley (0.10%), etc., are usually considered as minor crops (grown on less than one percent of the gross cropped area (GCA) of a country). In addition, some crops, including vegetables, spices, etc., occupy a very insignificant proportion of the GCA (i.e. less than 0.10% for each crop), accounting for 1% in total.

Tea, is mainly grown in the hills of Maulvi Bazar district and small areas of Habiganj, Sylhet, Chittagong, and Cox's Bazar districts. Three other minor cash crops are tobacco, betel nut, and betel vine. Lalmonirhat, Nilphamari, Rangpur and Kushtia have the maximum share in tobacco cultivation. Betel nut cultivation is generally concentrated in the seaward districts, while betel vine is an important crop in certain areas of Barishal, Cox's Bazar, Rajshahi, Maulvi Bazar, and Satkhira.

Among minor cereals maize, barley and different varieties of millet are grown in certain localities. Groundnut, sesame and linseed are grown to some extent in most districts. Gram, black gram, green pea, and pea are also produced to a certain extent in every district. Nawabganj has the largest share in maskalai (black gram) cultivation. Among vegetables and spices, onion, garlic and brinjal are mostly grown in kitchen gardens in every district, while Patuakhali and Bhola are generally leading in sweet potato cultivation.

Among fruits, banana, mango, coconut, and jackfruit are generally grown around homesteads almost throughout Bangladesh, while pineapple is the most common around Maulvi Bazar, Rangamati, Tangail, Khagrachhari and Bandarban districts.

Homestead cultivated plants. The community includes two types of plant: those cultivated for their economic value, and those that are self-propagating. Plants of the first category can be found all along the riverbanks and adjacent rivers, and composition within this type is largely uniform. The composition within the second type is more interesting, in that it reflects the composition of nearby natural communities, including communities and species that have otherwise vanished locally, and contains some strong clues as to local vegetation composition in times past.

The dominant homestead trees comprise rain tree (*Samanea saman*), koroi (*Albizzia procera*), some *A. richardiana*, some Hizal (*Barringtonia racemosa*), koroch (*Pongamia pinnata*), and Borun (*Trewia nudflora*). Added to these are fruit trees such as mango (*Mangifera indica*), custard apple (*Annona reticulata*), guava (*Psidium guajava*), and jackfruit (*Artocarpus heterophyllus*).

Among the less common species are Dillenia indica (elephant apple; chalta), Alstonia scholaris (Indian Blackboard Tree, chatim). The backyards contain herbs and shrubs of various species and saplings of fruit trees and other naturally grown species providing a refuge for some of the wildlife such as monitor lizards, fishing cats, etc.

Dillenia indica (Chalta, Elephant apple)

Pongamia pinnata (Koronja)

Alstonia scholaris (Indian Blackboard Tree, chatim)

Figure 124. Riverbank and Homestead Vegetation

(@ Photos Flora of Bangladesh)

The trees which are most common are: *Albizia odoratissima, Albizia saman, Artocarpus heterophyllus, Cocos nucifera, Litsea monopetala, Mangifera indica, Phoenix sylvestris, Pongamia pinnata, Thespesia*

populnea and *Terminalia catappa*. Dominant herbaceous plants of the area include: *Cynodon dactylon, Oenanthe javanica, Phyla nodiflora* and *Scoparia dulcis* respectively. Most commonly cultivated crops are *Arachis hypogaea, Citrullus lanatus, Solanum tuberosum, Solanum melongena, Solanum lycopersicum, Oryza sativa, Piper betle, Cucurbita maxima, Ipomoea batatus* and *Lathyrus sativus*.

The plant diversity in some of the off-shore islands and chars in the Lower Meghna estuary include mangrove plants like Acanthus illicifolius, Excoecaria agallocha, Sonneratia apetala, Derris scandens and Tamarix indica. Mangrove plantation started during 1967-68 in newly accreted land in the Meghna estuary. Under the Green Belt Social Forestry Program (funded by the World Bank), the Noakhali Coastal Forest Division planted both indigenous and exotic species such as *Phyllanthus emblica, Dalbergia sissoo, Casuarina equisetifolia, Acacia auriculiformis, Azadirachta indica* and *Acacia mangium*, etc., from 1981-82.

The characteristic vegetation along the riverbank homestead is evergreen in nature. Few plants like *Terminalia spp, Albizia spp, Zizyphus mauritiana, Erythrina fusca, Bombax ceiba, Cassia fistula* and *Crateva magna* are deciduous, seasonally changing the landscape color.

Figure 125. Artocarpus heterophyllus (Jackfruit)

(@ Photos Flora of Bangladesh)

The dominant homestead trees comprise rain tree *Samanea saman, Koroi Albizzia procera, some A. richardiana, some Hizal Barringtonia racemosa, koroch Pongamia pinnata,* and *Borun Trewia nudflora*. Apart from these are the fruit trees such as Mango (*Mangifera indica),* Custard Apple *(Annona reticulata),* Guava *(Psidium guajava)* and Jackfruit *(Artocarpus heterophyllus).* Among the less common species are *Dillenia indica* (Elephant apple); chalta, (*Alstonia scholaris*) Indian Blackboard Tree, Chatim.

Samanea saman (rain tree)

Mangifera indica (mango tree)

Psidium guajava (Guava)

Artocarpus heterophyllus (Jackfruit)

Dillenia indica (elephant apple)

Alstonia scholaris (Indian Blackboard Tree)

Figure 126. **Dominant homestead trees found in the Project Area**

The backyards contain herbs and shrubs of various species and saplings of fruit trees and other naturally grown species providing a refuge for some of the wildlife like monitor lizards, fishing cats, etc.

Acanthus ilicifolius

Tamarix indica

Excoecaria agallocha

Phyllanthus emblica

Azadirachta indica

Acacia mangium

Figure 127. **Dominant Vegetation among the Lower Meghna Statuary**

4.3.3.2. Aquatic & Riverbank (Terrestrial) flora

Aquatic plants are plants that have adapted to living in aquatic environments (saltwater or freshwater). They are also referred to as hydrophytes or macrophytes. These plants require special adaptations for living submerged in water, or at the water's surface. The most common adaptation is aerenchyma, but floating leaves and finely dissected leaves are also common. Aquatic plants can only grow in water or in soil that is permanently saturated with water. They are therefore a common component of wetlands. The principal factor controlling the distribution of aquatic plants is the depth and duration of flooding. However, other factors may also control their distribution, abundance, and growth form, including nutrients, disturbance from waves, grazing, and salinity.

Aquatic vegetation can be broken down into several communities or types. Each type is an aggregated assemblage of plant species and is characteristic of a particular set of environmental conditions (hydroperiod, flow regime, water quality, soil, etc.) and likewise the distribution of wetland species is influenced by the fluctuating hydrological regime. Different plant communities occupy different habitats along the gradient of flooding and moisture. Elements of the sequence of plant communities, or sometimes the entire sequence, may be absent from particular landscapes due to disruption from human activities.

In the Project Influence Area, eight communities of aquatic vegetation were identified:

- 1. Submerged plants
- 2. Free floating plants
- 3. Rooted floating plants
- 4. Sedges and meadows
- 5. Floodplain grassland (transitional; includes sedge/meadow and reed swamp species, and grass species)
- 6. Reed swamp
- 7. Crop field vegetation
- 8. Homestead vegetation

Submerged plants remain fully submerged for their entire life cycle, except for the flower which occurs above the water surface. Some are rooted to the bottom and some are freely suspended. All of these plants are monocotyledons, from ten fairly closely related families including *Aponogetonaceae, Hydrocharitaceae*, and *Potamogetonaceae.*

These plants are, for obvious reasons, highly susceptible to seasonal water level fluctuations and can be found in the floodplains; the community expands in area during the monsoon and contracts with the coming of the dry season. The plants start growing when water levels start rising at the very beginning of the monsoon, persisting throughout the wet season for as long as ample water is present. When the water starts receding, most of these plants flower and fruit very quickly, thereby assuring offspring in the next year; though most of these species have rhizomes and can also reproduce vegetatively. Where the water recedes further, the plants become desiccated and decompose; in permanent water bodies, they can survive for a much longer period.

Figure 128. Submerged Plants

Source: @ Photos Flora of Bangladesh

Free floating vegetation consists of plants that are most found floating freely on and collecting nutrients from the water; most of them can also survive for a certain period with their roots out of or in moist soil. This community is common but not dominant and comprised plant species from the classes Angiosperm and Pteridophytes. The most dominant family in this community is Lemnaceae. Other common families are Salviniaceae, Lentibulariaceae and Pontederiaceae.

This community is also affected by water level fluctuations, though they are in general less dependent on water and more adaptable than the submerged plants. Before the monsoon begins, they are found growing luxuriantly in the stagnant water. They persist as the water rises, but as flooding becomes general, they tend to move out into the rivers. Their main mode of propagation is vegetative, though many members of this community can produce seeds.

Figure 129. *Eichhornia crassipes* (Water hyacinth).

@ Photos S6

Rooted floating plants root deeply in the soil and float leaves and flower on the water surface. To accomplish this, most plants have very long stalks for both leaf and flower, and a stem that remains under water, sometimes beneath the soil; a few plants have long stems rather than long stalks. The most dominant families in this community are Nymphaeaceae and Menyanthaceae.

These plants are also susceptible to seasonal water level fluctuations. In the permanent beels they can survive and regenerate for the whole year. But in seasonally flooded areas, the rhizomes or seeds remain buried under the soil during the dry season and then start sprouting with the arrival of water. As water levels increases, they then elongate their stems or leaf and floral stalks. They typically start flowering on a large scale when the water starts receding just after the peak flood. Almost all the plants of this community can propagate vegetatively as well as sexually.

Figure 130. *Nelumbo nucifera* (Padma)

(@ Photos Flora of Bangladesh

Sedges and meadows comprise the ecotone (transition area between two communities, such as floodplain and grassland, and as such usually exhibiting competition between species common to both) consisting of amphibian plants (plants that can tolerate wet or dry conditions). Usually, the leaves of these plants are exposed to the air and the roots remain under water, though inundation and desiccation are tolerated to some degree. This community has the highest species diversity of all.

The most dominant families in this community are Cyperaceae and Polygonaceae, followed by Gramineae and others. At the species level Polygonum (kukra, bishkatakali, and others), and various species of Cyperus

(mutha), Phragmites (nol khagra) are more or less common. Some other species like Ipomoea fistulosa (dhol kalmi), Monochoria hastate (baranukha, kechur) and Typha (hogla) are common. Most of the plants of this type are rhizomatous and can propagate vegetatively, but all of them produce seed. Generally, this vegetation type occupies the water margin and is also dominant in the charlands.

Figure 131. *Monochoria hastata* (Boronukha)

@ Photos Flora of Bangladesh

Floodplain grassland prefers reasonably well-drained land affected by flooding of fairly short duration, typically found in plain lands between riverbanks and homesteads. The community consists of various medium to high grasses. Species like Vetiveria zizanioides (binna) and other associated species like *Phragmites karka* (khagra, nol), *Saccharum spontaneum* (khag), *Sclerostachya fusca* (khuri), and *Arundo donax* (baranol). Small annual grasses, herbs, Polygonum and Cyperus are common in the dry season. In the newly formed chars there is a presence of a mixture of plant species, grasses, tree seedlings that suggest that the grassland community may not be a climax type, though the succession process seems to be very slow. Water birds, particularly the waders may fully utilize such grasslands.

Figure 132. *Saccharum spontaneum* (khag/ kaash)

@ Photos Flora of Bangladesh

Reedlands were found mostly in the chars and in some cases riverbanks that were low and affected by tide and dominated by *Typha sp*. The peripheral areas of the chars are fairly deeply flooded during the flood season and dry out during the dry season. The grasses *Phragmites karka* (khagra, nol) and *Saccharum spontaneum* (khag, aisha) predominate. Some sedge/meadow grasses are also found here, in lesser amounts, such as *Vetiveria zizanioides* (binna, gandhabena), *Sclerostachya fusca* (khuri), and *Arundo donax* (baranal, gobanal). Other than the grasses, woody shrubs such as *Ficus heterophylla* (bonolat, baladumur), and *Lippia javanica* (bhuiokra) are also found. Another prominent species is *Asclepias sp*., a climber from the Asclepidiaceae family. Mature reeds attain heights of three to four meters.

The community is composed principally of perennials, making it particularly vulnerable to utilization pressure. The reed lands are under threat and sustainable harvesting is possible if a rotation of at least

three years is allowed, but indiscriminate reed cutting for converting to agricultural land, industrial raw material, and fuel is common.

4.3.3.3. Urban Vegetation

The sum of all vegetation present in an urban ecosystem like trees, shrubs, ornamental plants, small plants, etc. is called urban vegetation.

The term 'urban vegetation' describes the total assemblage of plants (including urban forests) within and on the perimeter of cities and towns. This includes a diversity of plants in a wide range of habitats.

They are established and managed for a variety of reasons, and exhibit economic, social, aesthetic and ecological value. The ecological value of urban vegetation plays a role in the protection of biodiversity and maintenance of ecological processes and life-support systems. As for social value, urban vegetation contributes to quality of life through its influence on the psychological and physiological well-being of individuals. Improvements in the quality of life are also exhibited at the community level. Overall, vegetation is shown to be a significant, if not essential, component of the urban environment. The rationale for the inclusion of vegetation planning and management as an integral part of the urban planning process is thereby established.

Urban vegetation is a living contribution within the urban landscape. It includes not only man-grown plants introduced from other countries of the world that exist in parks, gardens, yards, streets, avenues and squares, but also a wide variety of herbaceous species that reproduce and evolve without any control. They constitute spontaneous vegetation, which withstands human pressure very well due to its short life and rapid growth. In spite of the hostile environment that the city supposes for many living beings there are countless recesses that are quickly and frequently occupied by many wild species. They have a great capacity to proliferate in different habitats such as cracks, roofs, asphalt and cement, debris, garbage, in places abandoned by humans; wastelands and abandoned buildings.

Figure 133. Urban Vegetation in Narayanganj and Barishal Terminals

4.3.3.4. Natural Vegetation-Endemic

Endemic species are confined to a certain place, not found anywhere else, probably after extiction in other places. Conservation of these species is a priority. Therefore, conservation of these species needs to be ensured at the dvelopment stes.

Basically, natural vegetation in Bangladesh has been substituted by agricultural uses and urban areas, with just limited residual natural vegetation remaining. Out of 3,611 plant species of Bangladesh, 28 are endemic at or below species level which is about 0.78% of the total species. No endemics at generic or supra-generic level could be recognized from Bangladesh. Among these, 4 are tree species, 2 shrubs, 1 undershrub, 2 parasites, 2 woody climbers and 17 herbs. By district, the endemics were recorded from Greater Sylhet (5 species), Chittagong (7 species), Cox's Bazar (2 species), Hill Tracts (10 species), Tangail (2 species), Dhaka-Jamalpur-Pabna (1 species) and Mymensing (1 species).

Table 79. List of Endemic Plants in Bangladesh

Name	Bangla Name	Potential Value	Occurrence	Status
Ampelygonum salarkhanii	Bangla name: Girishobhansak	Potential value: Used as leafy vegetable by the tribal people.	Found only in Bandarban district	Least Concern (lc).
Boesenbergia islamii	Not Available	Medicinal and ornamental (as pot plant).	Chittagong (Chunati, Sitakundu).	Endangered (EN).
Croton chittagongensis	Not Available	Wild life supporting plant.	Rangamati (Mainamukh)	Extinct (EX)
Curcuma bakerii	Ban-halud.	Rhizome used as spice mixed with turmeric.	Tangail (Madhupursal forest).	Endangered (EN).
Curcuma hookerii	Janglihalud.	Substitute of turmeric.	Chittagong (Bariadhala hill).	Rare (R).
Curcuma roxburghii, Curcuma wilcockii, Curcuma wallichii	Janglihalud.	Substitute of turmeric.	Chittagong (Rangunia) and Rangamati (Rangapani).	Rare (R).
Cuscuta chittagongensis	Pahari swarnalata.	Medicinal	Bandarban (Chimbuk hill), Rangamati (Myanimukh) and Sylhet (Beyani Bazar).	Least concern (lc).
Cyperus pilosus	Not Available	Not known	Mymensingh (loc. non cit.).	Extinct (EX)
Dalbergia confertiflora	Not Available	Not known	Chittagong (loc. non cit.).	Extinct (EX)
Globba rahmanii	Not Available	Ornamental (could be grown as pot plant).	Chittagong (Bariadhala, Sitakundu), Khagrachari (Dheghinala),	Rare (R).

Name	Bangla Name	Potential Value	Occurrence	Status
			Rangamati (Barkal).	
Gomphostemma salarkhaniana	Not Available	Medicinal	Sylhet (Tamabil, Jaintapur, Jafflong).	Rare (R).
Hedyotis thomsonii	Not Available	Not known	Bank of the river Meghna and Mahanudde (Hook.f., 1880), Sylhet (Jafflong, Tamabil) and Bandarban (Jiban nagar)	Rare (R).
*Iodes thomsoniana**	Not Available	Not known	Chittagong (loc. non cit.).	Extinct (EX)
Knema bengalensis W	Khude Barala	Wild life supporting plant, fire wood.	Cox's Bazar (Dulahazra, Ramu Upper Rezu).	Rare (R)/Endangered (EN).
*Lagenandra gomezii**	Ban-kachu.	Not known	Greater Sylhet (Panchara).	Extinct (EX)
*Limnophila cana**	Not Available	Not known	Dhaka (loc. non cit.), Jamalpur (loc. non cit.) and Pabna (loc. non cit.).	Extinct (EX)
*Litsea clarki**	Not Available	Not known	Chittagong (Sitakundu)	Extinct (EX)
Mantisia salarkhanii	Pathari-ada, Kew-kheya (Marma).	medicinal	Bandarban (Guishap Jiri, Ali Kadam).	Endangered (EN).
*Nothopegia acuminata**	Not Available	Not known	Cox's Bazar (Kelatulichara).	Extinct (EX)
Periploca acuminata	Bish-lata.	Medicinal/Poisonous.	Sylhet (Tamabil-Jafflong)	Rare (R)/Endangered (EN)
Persicaria eciliata H	Bishkatali.	Not known	Rangamati (Kaptai).	Rare (R)/Endangered (EN)
Rotala simpliciuscula	Agasa.	Not known	Chittagong (loc. non cit.).	Extinct (EX)
Tarenna scandens	Gujer-kota	Fire wood.	Sylhet (loc. non cit.) and Rangamati (Kaptai Rampahar).	Endangered (EN)
Taxillus thelocarpus	Not Available	Not known	Chittagong (Kazike hat,	Endangered (EN)

Name	Bangla Name	Potential Value	Occurrence	Status
			Baraiadhala-Hazarikhil).	
Trigonostemon praetervisus	Not Available	Wild life supporting plant, fire wood.	Occurrence: Sylhet (loc. non cit.).	Extinct (EX)
Zingiber salarkhanii	Jangliada.	Rhizome used spice with zinger.	Chittagong (Sitakundu).	Endangered (EN)

4.3.4. Cover Vegetation on Project Sites

In general, all the Terminal sites and its area of influence are poor in floral diversity and abundance. The ground vegetation cover is very scarce and limited to some localized spots. Most recorded species are common and abundant throughout the country and considered weeds. The observed tree species represent the planted commercial species and limited to few species only.

In general, all S3 and S4 project sites are poor in floral diversity and abundance. A total of 151 flora species, represented by 50 species of herb, 47 species of shrub, 7 species of climber, 45 species of tree and two species of Pteridophyte, were recorded from the project sites. Of these, 129 species are terrestrial, seven aquatic species and the remaining 15 species are both aquatic and terrestrial. Except, Pangaon, ground vegetation cover is very scarce and limited to some localized spots within the project boundary. However, there are wide differences in the occurrence and abundance of recorded flora species among the study sites.

An inventory of the recorded species is given in Annex3.6 while summarized information on the floral diversity by sites and by flora groups are shown in Figure 134 below.

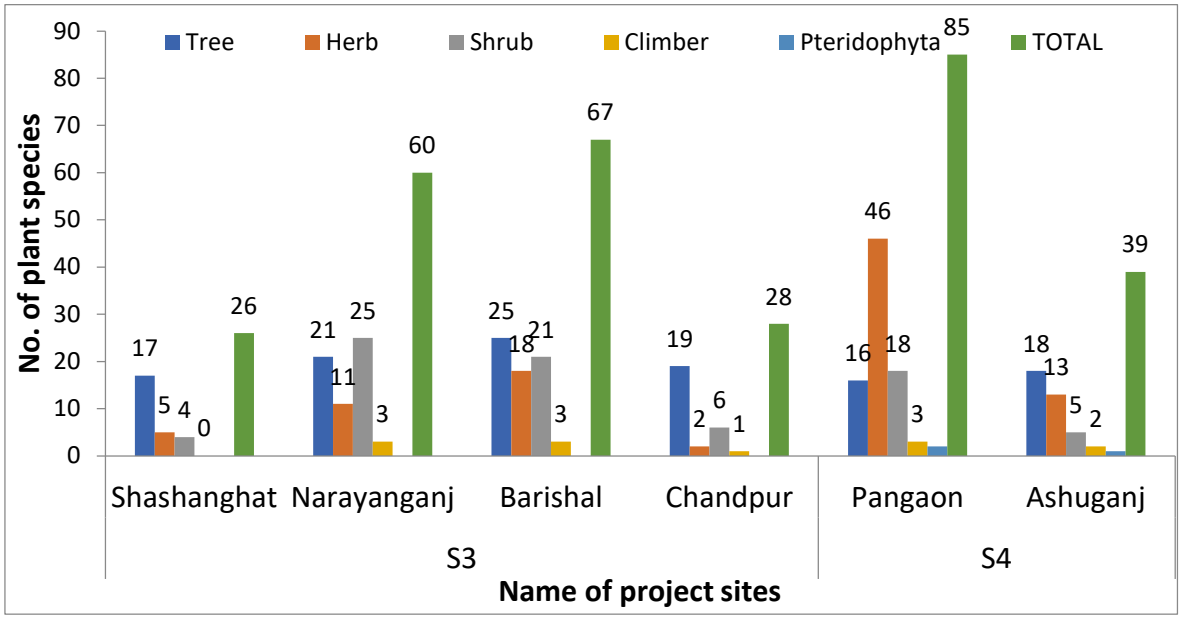


Figure 134. Flora diversity in S3 and S4 Terminal Sites

A brief floral description of the terminal sites is given below:

4.3.4.1. Shasanghat PT Site

Although Shasanghat PT will be new construction, the site represents a highly modified and built up area. of influence comprise business, industrial and residential infrastructures. The construction site proper is almost devoid of any vegetation (Figure 135), while aquatic environment comprises the highly polluted Buriganga River..

Figure 135. Passenger IWT site at Shasanghat

In the Terminal Site, there are no crops, the use of the land is urban with dispersed vegetation, without continuous areas of trees, forests, or bushes. There is no natural vegetation, nor riverside. The vegetation predominates in isolated arboreal form and on the banks, there is a presence of invading plants *Eichhornia crassipes* (Water hyacinth) but aggregated at the site.


Figure 136. Riverside of Shasanghat IWT Terminal

However, the adjacent areas have some commercial planted tree species with good canopy coverage that provides refuge to many bird species. Some floating water hyacinths aggregate the riverbank areas. Some sparsely distributed herbaceous species are found in some small localized areas.

A total of 26 flora species, none of thenm endemic or red-listed. comprising 17 tree species, five herb and four shrub species occur within and immediately around the site. Some noted herbaceous plants are Dolkolmi (*Ipomoea fistulosa)*, Sensitive plant (*Mimosa pudica*), katanotey/spiny amaranth (*Amaranthus spinosus*), Bermuda grass (*Cynodon dactylon*), Swamp cabbage (*Ipomoea aquatica*), Prickly Chaff-flower (*Achyranthes aspera*), but found in negligible quantities. The major trees are Banyan (*Ficus benghalensis*), Neem (*Azadirachta indica*), Jackfruit (*Artocarpus heterophyllus*), Coconut (*Cocos nucifera*), Raintree (*Samanea saman*), Yellow fig (*Ficus comosa*), Blackberry (*Syzygium cuminii*), Mehgoni (*Swietenia mahagoni*), Chambol (*Artocarpus chaplasha,* which all represent planted trees.


Figure 137. Adjacent area of Shasanghat IWT Terminal

4.3.4.2. Narayganj PT Site

Narayanganj IWT Passenger Terminal is situated on right bank of Shitalakshya River. Shitalakshya River goes further and meets the Dhaleshwari River and further Dhaleshwari meets Meghna River and runs downstream.

Figure 138. Passenger IWT site at Narayanganj

With Narayanganjan Terminal already in existence, the use of the land is totally urban with disperse vegetation focused on gardening use, without large trees or natural bushes. There is no natural riverside vegetation but a huge presence of invasive plants *Eichhornia crassipes* (Water hyacinth).

The adjacent areas of the Narayangonj PT include business area, characterized by numerous buildings, metaled roads and a bus station. However, the Terminal Building area has a garden planted with a large number of ornamental species (about 27) and has a good coverage of understory vegetation. In total, 60 flora species, including 21 types of trees, 11 species of herb, 25 species of shrub and three species of climber, were found within the terminal area. The major tree species of the study site are Banyan tree (*Ficus benghalensis*), Moringa (*Moringa oleifera*), Mehghoni (*Swietenia mahagoni*), Arjun (*Terminalia arjuna*), Krishnochura/Flame tree (*Delonix regia*), Jackfruit (*Artocarpus heterophyllus*). The common and major herbaceous plants observed are Bermuda grass (*Cynodon dactylon*), Carpet grass (*Axonopus compressus*), Assamlata (*Eupatorium odoratum*). Some water hyacinth (*Eichhornia crassipes*) aggregate around the terminal jetty. A rare plant, *Cycas* sp, has been recorded in the Terminal Building Garden.

Figure 139. Riverside of Narayanganj IWT Terminal

Figure 140. Adjacent area of Narayanganj IWT Terminal

4.3.4.3. Barishal PT Site

The Barishal PT Site is also a highly modified and built-up area, and its immediate vicinity also has buildings, markets, and other infrastructures, and therefore, the site supports little vegetation.

Figure 141. Passenger IWT site at Barishal

With Barishal Terminal already in existence, the use of the land is totally urban with disperse vegetation focused on gardening use, without large trees or natural bushes. There is no natural riverside vegetation but a huge presence of invading plants *Eichhornia crassipes* (Water hyacinth). However, there is a strip of herbaceous plants between the Jetty and terminal building.

The survey found 67 flora species, of these 25 species are trees, 18 species are herbs, 21 species are shrubs and three species are climbers, within the site and its adjacent areas.

The major herbaceous vegetation includes Bermuda grass (*Cynodon dactylon*), Sachishak,/Sessile joyweed (*Alternanthera sesilis*), Spiny amaranth (*Amaranthus spinosus*), Assamlata (*Eupatorium odoratum*), Kachu/Taro (*Colocacia esculenta*), Apang/Prickly Chaff-flower (*Achyranthes aspera*), Bontamak/Fex-Mex tobacco (*Nicotiana plumbaginifolia*),), Helencha/ Aligator weed (*Alternanthera philoxeroides*).

Figure 142. Riverside of Barishal IWT Terminal

The adjacent BIWTA land has some planted tree species, mainly including Krishnachura/Flame tree (*Delonix regia*), Mehghoni / (*Swietenia mahagoni*), Betelnut (*Areca atechu*), Koro/White sirisi (*Albizia procera*), Coconut (*Cocos mucifera*), Kadam/Burt flower tree /(*Anthocephalus chinensis*), Jackfruit (*Artocarpus heterophyllus*), etc., providing habitat for some bird species.

Figure 143. Adjacent area and access roads to Barishal IWT Terminal

4.3.4.4. Chandpur PT Site

The Chandpur PT site represents the existing terminal areas and nearby built up areas. The proposed construction site is barren and devoid of ground vegetation. However, some floating water hyacinth temporarily aggregate around the terminal pontoons

Figure 144. Passenger IWT site at Chandpur

In the Terminal Site, there are no crops, the use of the land is urban with disperse vegetation. There is no natural vegetation, nor riverside. The vegetation predominates in isolated arboreal form except in the surroundings where there are several spots with groups of vegetation, mainly trees. On the banks, there is a huge presence of invasive plants *Eichhornia crassipes* (Water hyacinth).

Figure 145. Riverside of Chandpur IWT Terminal

Figure 146. Adjacent area and access roads to Chandpur IWT Terminal

A total of 27 flora species was recorded from the site, including 19 tree species, two herb, six shrub and one climber. The trees mainly include Chambol/Monkey jack (*Artocarpus chaplasha*) Eucalyptus (*Eucalyptus citrodora*), Krishnachura/Fame tree (*Delonix regia*), Mehghoni (*Swietenia mahagoni*), Betelnut tree (*Areca atechu*), Koroi/white siris (*Albizia procera*), Coconut (*Cocos mucifera*), Mango (*Mangifera indica*), Kadam/Burtflower (*Anthocephalus chinensis*),, Jackfruit (*Artocarpus heterophyllus*), Wood apple (*Aejle marmelos*), with all species representing planted trees.

4.3.4.5. Pangaon Site

The terminal is planned to be built in a green field location. The proposed Pangaon CT is a green field area and represents a peri urban environment, affected by adjacent settlements, industrial and ICT development adjacent to the site and its operational activities. An extremely busy ferry ghat/station is located within the project site. This aquatic habitat, the Buriganga River, is also highly utilized for navigation.

The project site and its adjoining areas have good ground vegetation cover of herbaceous plants. The riverbank, upon which the terminal facilities will be developed, is a gently sloping/flat area containing creeping vegetation, most of which becomes inundated during monsoon periods.

A pond, part of which is located within the project boundary, contains some aquatic vegetation including, among others, Water hyacinth (*Eichhornia crassipes*), Keshordam/Creeping Water primrose (*Jussiaea repens*), Topapana/Water lettuce (*Pistia stratiotes*), Khudepana/Duckweed (*Lemna minor*) which are considered invasive species in Bangladesh, but not particularly established at the site. The upper part of the bank has some planted trees.

Figure 147. Cargo IWT site at Pangaon

Figure 148. Riverside of Pangaon IWT Terminal

A total of 85 flora species, represented by 16 tree species, 46 herb species, 18 shrub species, 3 climber species and 2 Bryophyte species were recorded from the site during a limited survey. The adjoining settlement areas also have some herbaceous vegetation and planted fruit and timber tree species. The terrestrial herbaceous plants are dominated by Durabagash/Bermuda grass (*Cynodon dactylon*), Carpet grass (*Axonopus compressus*), Assamlata (*Eupatorium odoratum*), Telakucha (Coccinea cordifolia. The major tree species are Sajna/Moringa (*Moringa oleifera*), Pakur/Yellow fig (*Ficus benjammina*), Raintree

(*Samanea saman*), Narikel (*Cocos nucifera*), Jagaadumur/Fig tree (*Ficus racemosa*), Mehghoni (*Swietenia mahagoni*). The vegetation at the site provides shelter to some wildlife.

Figure 149. Adjacent area and access roads to Pangaon IWT Terminal

Just as in Pangaon Terminal, we need to take into account, that the new Terminal will be placed on and next to a water pond. An unpaved road (embankment) acts as the eastern limit of the major pond and its owned by the local mosque, with several lines of planted trees.

Figure 150. Design Master Plan for Pangaon Terminal

For the new construction of the Terminal, we will have a reduction of the main pond of almost the 55% of the total actual water area, being activated by an increment of thickness in the bank of 200m more. It is

worth mentioning that this area, is subject to several morphological changes, due to the River hydro-system and human activity as shown in Figure bellow.

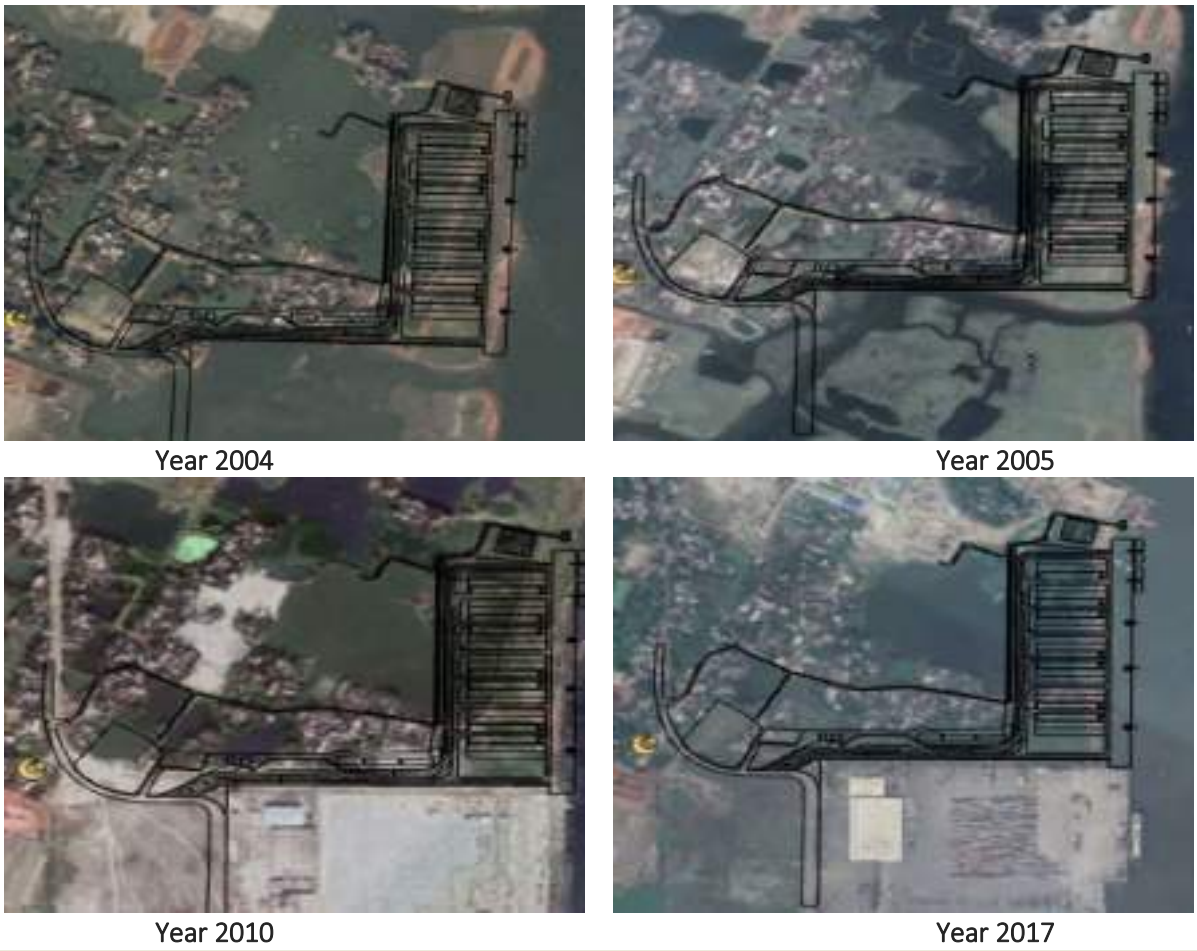


Figure 151. Evolutionary change over recent years in Pangaon Terminal Site

Flora in this area is rather poor, just represented by creeping vegetation, most of which becomes inundated during monsoons. The upper part of the bank has some planted trees. These ree lines placed on the unpaved road will be removed during clearance as they are planted in the same area where platform will be constructed.

This tree line has an approx. number of 20 units with a cup between 15-20m of diameter. These species are not indigenous to this region, although very common and representative in the country.

Figure 152. Tree line planted in the unpaved road in Pangaon site

On this same riverbank, there is also some terrestrial herbaceous plants such as Durabagash (*Cynodon dactylon*), Carpet grass (*Axonopus compressus*), Assamlata (*Eupatorium odoratum)*, Telakucha (*Coccinea cordifolia)* that will also be removed in the clearance and filling of the new riverbank. This species does not represent any significant importance as they are a natural representation from the region, with a high recovery capacity, when the Terminal construction is completed, they will become reestablished in the same area. For the rest of the represented vegetation, consisting of just a few individual species, there will similarly be very limited impact.

4.3.4.6. Ashuganj CT Site

The project site, located on the east bank of Meghna River, includes the existing Cargo Terminal, which represent a built-up area, comprising business units, terminal facilities, residential areas and road traffic routes. The Cargo Terminal site development area is almost devoid of vegetation, except some herbs in some pocket areas and a few planted trees in and around the proposed development site. The adjoining residential areas have some plants in courtyard areas. Also, nearby there is a small plantation of exotic trees.

Only, 39 plant species were recorded during a limited field survey, of these 18 species are trees, 13 herb species, 5 shrub species and 2 climber species. The herbaceous plants mainly include Durba (*Cynodon dactylon)*, Kata Notey (*Amaranthus spinosus*), Carpet grass (*Axonopus compressus)*. The major tree species are Krishnachura (*Delonix regia*), Raintree (*Samanea saman*). Mehgony (*Swietenia mahagoni*), Sajna (*Moringa oleifera)*, Mango (*Mangifera indica*), Kathal (*Atrocarpus* sp.). However, most of these are in the adjoining areas of the project development site.

The herbaceous and shrub species observed in the study sites are common and abundant throughout the country, and most of them are considered weeds. No species recorded are known to contain genetic resources of any domesticated variety. Except *Cycas sp*., none of the species recorded is threatened in the country according to the Redlist of threatened plant species in the country (Khan 2001). Most tree species recorded are planted and many of these are exotic. No species recorded in the study sites is endemic to the country or to the region. Therefore, conservation significance of the recorded herbaceous plants is negligible.

Figure 153. Adjacent area and access roads to Ashuganj IWT Terminal

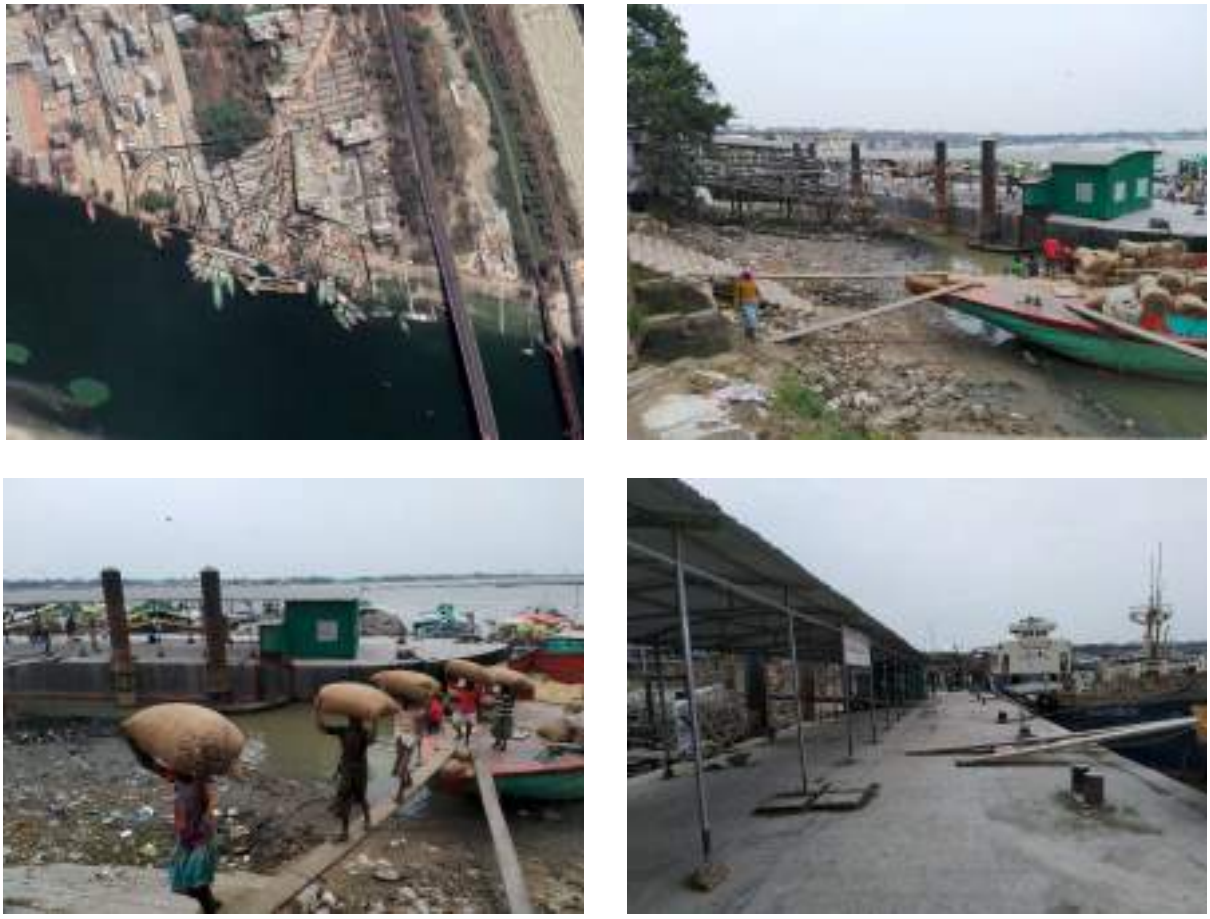


Figure 154. Cargo IWT site at Ashuganj

Figure 155. Riverside of Ashuganj IWT Terminal

4.3.5. Fauna: Terrestrial and Aquatic Habitats

Considering a huge human population cramped into a small landmass, Bangladesh is generally not expected to support a vast assemblage of Biodiversity. But its location in the Indomalaya Realm makes this a country to be home to a wide diversity in wildlife.

The ***Red Listing*** in 2015 (IUCN 2015) has arrived at a consensus list that covered a total of 1,619 species that included 138 mammals, 566 birds, 167 reptiles, 49 amphibians, 253 freshwater fishes, 141 crustaceans and 305 species of butterflies when vast majority of the invertebrates and estuarine and marine fishes are omitted. The invertebrate fauna of the country, inclusive of butterflies and crustaceans both of which are under the Phylum Arthropoda, said to be around 6, 225 species that is just 0.5% of the world species (DoE 2015). In this comparison there is no doubt that Bangladesh has far more vertebrate species than invertebrates. The Mammals, Birds, Reptiles, Amphibians, Fishes, Crustaceans and Butterflies live in all available natural habitats in the country. In addition to natural habitats, many fauna species are found in modified habitats, like urban, settlement areas and and the crop fields.

Information on the observed fauna species by individiual project site is provided in Sectioins 4.3.5.6-4.3.5.7 .Also detail inventory on the observed fauna species by sites is provided in Annex 3.7

4.3.5.1. Mammals

The country supports roughly 26% of the South Asian mammals and 2.4% of all the mammalian species of the world.

At present a total of 127 species of mammals belong to 35 families under 9 orders, are found in Bangladesh. Information on population of different species of mammals is scant. Most of the studies over the last four decades are focused on the status of mammals of Bangladesh depending on the presence or absence of certain taxa rather than estimating population (*Khan* 1982, 1987a, 1996, 2015). As a result, population trend enumeration is very difficult for most of the mammalian species in the country. However, from several studies, population data on some of the best-known species are available: Bengal Tiger, Asian Elephant, Hoolock Gibbon, Rhesus Macaque, Capped Langur, Common Langur, Spotted Deer, few species of bats and some cetaceans. Chiropterans constitute the largest mammalian community in the country where the largest fruit bat colony (±3000) is recorded in Birampur in the Dinazpur district.

Depending on the geographic location, climatic condition and floral composition five different habitats are found in the country, which are used by the mammalian communities:

- **Forest.** Natural forests cover 5.9% of the country's area. Based on the vegetation characteristics three types of natural forests are found in Bangladesh: mixed evergreen forest, deciduous forest and mangrove forest.
    - Mixed evergreen forest; found in the northeast and southeast regions of Bangladesh. Mixed evergreen forests provide fruits throughout the year, supporting a large mammalian community of frugivorous, folivorous and seed eaters or granivorous. Dense undergrowth of this forest also supports herbivorous, carnivorous and burrowing mammals. Principle mammalian fauna of mixed evergreen forests in Chittagong Hill Tracts of southeast region are Asian Elephant, Leopard, Asiatic Black Bear, Malayan Sun Bear, Barking Deer, Hog Deer, Hoolock Gibbon, Serow, Bengal Slow Loris, Phayre's Leaf Monkey, Capped Langur, Wild Boar, Indian Crested Porcupine, Chinese Pangolin, Blyth's Horseshoe Bat, Crab-eating Mongoose.

- Deciduous forest. The deciduous forests are distributed in the central, northern and north-western parts of the country. These are generally known as Sal or Shal forests. The Madhupur Tract (in the central part of the country) is the largest single mass of moist deciduous Sal forest in Bangladesh, with an area of 340 km2 (NFA 2007). The most dominant mammalian species of such forests are Capped Langur, Rhesus Macaque, Barking Deer, Jackal, Hoary-bellied Squirrel, Jungle Cat, Civets, Mongooses, Bats and so on. Most of these do not occur in man-made Sal forests in the Revenue Divisions of Rangpur and Rajshahi, the north region of the country.
- Mangrove forest. The largest continuous mangrove forest of the world is the Sundarbans, which itself covers an area of 0.6 million hectares. Generally, this forest includes fairly dense evergreen plant species of about 10-15 m height, which are adapted for life under saline conditions and frequent inundation by the tides. The Sundarbans is the home of the Bengal Tiger along with many other mammalian faunae of the country. Leopard Cat, Spotted Deer, Wild Boar, Oriental Small-clawed Otter, Smooth-coated Otter are found in these mangrove forests.

- **Wetlands.** Wetlands of Bangladesh also support a large number of aquatic mammals of the country. Nearly 50% (eight million hectares) of the total land surface of the country are considered as wetlands, which includes rivers, natural lakes, freshwater marshes, baors (oxbow lakes), beels (floodplain depressions), ponds, one large water reservoir (Kaptai Lake), and extensive seasonally inundated floodplains (Feeroz 2014, Khan 1982, 1987, 1996, 2015). Wetlands of the country are significant for Gangetic River Dolphin, which forage in the project area during wet season, and 3 species of otters, small cats and other small mammals.

    - Estuarine areas, coasts and the Bay of Bengal provide habitats for 10 species of marine cetaceans. Spinner Dolphin is the most protected mammal of this habitat.

Grey mongoose

Small-clawed Otter

Fruit bat

Wild Boar

Spinner Dolphin

Golden jackal

Figure 156. Mammalian species found in Bangladesh

- **Scrub and Grassland Areas.** In the administrative Divisions of Sylhet and Chittagong, especially the hilly areas, wild bamboo and tall grass grow where the forests are degraded or lost. Both bamboo and tall grass are collected by people living nearby and the commercial harvesters. Small patches of

bamboo and grass also exist in the vast tea-estates in Sylhet Division. These areas are good habitats for small mammals including 3 species of mongooses, several species of rats, civets, small cats, Wild Boar, Hog Badger etc.

- **Plantation and Homestead Vegetation**. Historically the villagers of Bangladesh grow fruit yielding plants around their homes and hence, flourishing vegetation in the backyards of village homes often create a perfect habitat for small mammals. Homestead vegetation and surrounding crop fields are good habitats for many small mammalian species including small cats, bats, civets, mongooses, rats and other small mammals.

4.3.5.2. Birds

Birds live in every continent and are found in every ocean of the world today. The checklist of birds of the world has about 10,500 species and the number is continually growing. The checklists of the birds of Bangladesh made by the biologists over the past 40 years have cited the species numbers from 578 to 718 (Khan 2015). Any of these numbers, even the lowest, can be termed very large considering the small size of the country (less than 0.15 km2). The bird biodiversity of Bangladesh is astonishing, especially because the birds have to share this small country with over 160 million people.

Birds are found everywhere in Bangladesh. Even the densely populated cities and towns have long lists of birds of wide-ranging species. Many of these birds are scavengers and thrive on the offal and gather around dumps. More birds are found in the villages with farmland, orchard and good deal of homestead plants. Most birds, however, live in places where human activities are not intense such as: mixed-evergreen forests, bamboo-forests and grasslands, deciduous forests, mangrove forests, rivers and flooded fields, large lakes called haors, estuarine inter-tidal areas and the Bay of Bengal.

- **Forests:**
  - **Mixed-evergreen** Dense undergrowth is a feature of these forests most attractive to the birds. The birds seen in the tree cover of the forest are pigeons, doves, cuckoos, owls, hawks, bazas, buzzards, trogon, hornbills, bee-eaters, barbets, woodpeckers, parakeets and many passerines. The undergrowth of the forests supports pheasants, partridges, pittas, nightjars, babblers, thrushes, robins etc. The iconic birds of these forests are Red-headed Trogon (*Harpactes erythrocephalus*), Great Hornbill (*Buceros bicornis*), Great Barbet (*Megalaima virens*), Great Slaty Woodpecker (*Mulleripicus pulverulentus*), Mountain Imperial Pigeon (*Ducula badia*), Spot-bellied Eagle Owl (*Bubo nipalensis*), Crested Kingfisher (*Megaceryle lugubris*), Oriental Dwarf Kingfisher (*Ceyx erithaca*) and Long-tailed Broadbill (*Psarisomus dalhousiae*). Two globally Critical species, namely White-rumped Vulture (*Gyps bengalensis*) and Slender-billed Vulture (*Gyps tenuirostris*) are known to roost and nest in Rema-Kalenga Wildlife Sanctuary and neighborhood areas.
  - **Deciduous Forests**. The undergrowth in most of these forests are cleared or trampled by people and cattle. In many forests even the leaf-litters are vigorously harvested. These degraded forests still support a few species of woodpeckers, bee-eaters, doves, owls, nightjars, pittas, cuckooshrikes, drongos, minivets, shrikes, orioles, flowerpeckers, sunbirds etc. The most notable species of these habitats are Indian Roller (*Coracias bengalensis*), Indian Pitta (*Pitta brachyura*), Eurasian Wryneck (*Jynx torquilla*), Greater Flameback (*Chrysocolaptes guttacristatus*), Orange-headed Thrush (*Zoothera citrina*) and Brown Boobook (*Ninox scutulata*).

- **Mangrove Forests.** Sundarbans is a good habitat for the birds and over 300 species of birds have been recorded there (Khan 2013). Of all the forests of Bangladesh, Sundarbans has the greatest diversity of birds. Two species of birds, namely Mangrove Pitta (*Pitta megarhyncha*) and Ruddy Kingfisher (*Halcyon coromanda*) have been sighted in Bangladesh only in the Sundarbans and mangrove of Kuakata. Another species, namely Masked Finfoot (*Heliopais personata*), has been sighted nowhere in Bangladesh outside the Sundarbans. A few other iconic birds of the Sundarbans are Lesser Adjutant Leptoptilos javanicus, Brown-winged Kingfisher (Pelargopsis amauroptera), Buffy Fish Owl (*Ketupa ketupu*), Great Thick-knee (*Esacus recurvirostris*), Streak-breasted Woodpecker (*Picus viridanus*), White-browed Scimitar Babbler (*Pomatorhinus schisticeps*) and Whitebellied Sea Eagle (*Haliaetus leucogaster*). Several islands along the coast with mangrove are considered good habitats for the ducks and the shorebirds. A few iconic species of this area are Spoon-billed Sandpiper (*Calidris pygmaea*), Nordmann's Greenshank (*Tringa guttifer*), Indian Skimmer (Rynchops albicollis), Eurasian Spoonbill (*Platalea leucorodia*), Eurasian Oystercatcher (*Haematopus ostralegus*), River Tern (*Sterna aurant*ia) etc. A few of other islands with extensive mangrove, namely Manpura, Char Shahjalal, Char Pial, Char Montaz, Char Kachhopia and Char Biswas are also good habitats for the birds.

- **Scrub and Grossland Areas**. Land under wild bamboo, scrub and tall grass is roughly estimated to be 0.8 million hectares or 5% of the country's whole forest area. Although the intensity of human activities is continually growing, the areas with bamboo and grass still support buttonquails, doves, nightjars, bee-eaters, swifts, coucals, kites, hawks, harriers, falcons, roller, dollarbird, babblers, grassbirds, larks, prinias, munias, pipits, buntings etc. The iconic species of this habitat are Black-winged Kite (*Elanus caeruleus*), Pied Harrier (*Circus melanoleucos*), Red-headed Falcon (*Falco chicquera*), Common Kestrel (*Falco tinnunculus*), Indian Roller (*Coracias bengalensis*) and Dollarbird (*Eurystomus orientalis*).
- **Wetlands.** A lot of water from the Himalayan glaciers and monsoon rain flow to the Bay of Bengal through hundreds of rivers and rivulets in Bangladesh. The rivers, rivulets and beels support a wide variety of birds. These wetlands are the permanent home of many species and the seasonal residence of many other species of birds. Birds of as many as eight Orders are found here. The major users of this habitat are ducks, grebes, rails, crakes, storks, herons, cormorants, kingfishers and many passerine species. Of the passerines the notable species are starlings, mynas, stonechats, martins, munias, pipits, wagtails, grassbirds, warblers etc. The iconic species of this habitat are Ferruginous Pochard (*Aythya nyroca*), River Tern (*Sterna aurantia*), Black-bellied Tern (Sterna acuticauda), Black-necked Stork (*Ephippiorhynchus asiaticus*), Painted Stork (*Mycteria leucocephala*), Asian Wooly-neck (*Ciconia episcopus*), Black Stork (*Ciconia nigra*) and Bristled Grassbird (*Chaetornis striata*).

    - **Haors**. Heavy rain over the Garo hills in monsoon inundates six northern Districts of Bangladesh bordering Meghalaya of India. Before the water can slowly flow through the rivers to the Bay of Bengal the deluge makes the entire region look like an inland sea. The region is locally called the Haor Basin. When the water level falls in the dry season the Basin becomes a mosaic of lakes called beels varying in size from a few hectares to several thousand hectares Haor basin is the prime habitat of the migratory waterbirds and several families of small passerines in Bangladesh. Bird species of as many as 10 Orders are found here. The commonly seen birds are ducks, geese, grebes, rails, crakes, coot, storks, herons,

ibises, cormorants, darter, osprey, eagles, harriers, plovers, sandpipers, jacanas, snipes, gulls, terns, kingfishers and many small passerines. Of the passerines the notable birds are grassbirds, warblers, thrushes, chats, robins, flycatchers and wagtails. The iconic birds of the Haor Basin are Baer's Pochard (*Aythya baeri*), Falcated Duck (*Mareca falcata*), Ferruginous Pochard (*Aythya nyroca*), Pallas's Fish Eagle (*Haliaeetus leucoryphus*), Greater Spotted Eagle (*Aquila clanga*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Bristled Grassbird (*Chaetornis striata*), Firethroat (*Luscinia pectardens*) and White-tailed Rubythroat (*Luscinia pectoralis*).

- **Estuary**. A number of large Himalayan Rivers flow through Bangladesh creating a very active estuary ending at the Bay of Bengal. It is known for massive sedimentation and formation of endless mudflats. The nutrient-rich water and mudflats of the estuary are magnets for the waterbirds and is termed Important Bird Areas of Asia. The intensity of human activities at the estuary is, however, very high because of the lure of easy agriculture on the newly accreted land and fishing in the brackish water. Birds are forced to share the estuary with humans ever more. The estuary is the largest habitat of the resident and the migratory waterbirds of Bangladesh. Bird species of as many as 11 Orders are found here. The commonly seen birds are ducks, geese, grebes, rails, coot, storks, herons, ibises, spoonbill, cormorants, osprey, eagles, harriers, plovers, sandpipers, snipes, thick-knees, pratincoles, gulls, terns, skimmer kingfishers, falcons and many small passerines. Of the passerines the notable birds are grassbirds, warblers, chats, flycatchers, pipits and wagtails. The iconic birds of the estuary are Eurasian Spoonbill (*Platalea leucorodia*), Spoon-billed Sandpiper (*Calidris pygmaea*), Indian Skimmer (*Rynchops albicollis*), Nordmann's Greenshank (*Tringa guttifer*), River Tern (*Sterna aurantia*), Painted Stork (*Mycteria leucocephala*), Greater Spotted Eagle (*Aquila clanga*) and Peregrine Falcon (*Falco peregrinus*).
- **Bay of Bengal**. The vast area of the Bay of Bengal beyond the accretion zone, especially the Swatch of no Ground, is the only important habitat of pelagic birds in Bangladesh. This immense marine ecosystem, however, remains mostly unexplored and receives least protection. The presence of whale and dolphins rather than the pelagic birds has further accentuated the conservation need of this marine eco-system. The diversity of bird species of the high seas is not high. Birds of only two orders, namely Charadriiformes and Phaethontiformes, have been recorded at the Swatch of no Ground. They are gulls, terns, skuas, shearwater and tropicbirds (not considered for threat assessment). The iconic species of that marine habitat are Short-tailed Shearwater (*Puffinus tenuirostris*), Red-billed Tropicbird (*Phaethon aethereus*) and Pomarine Jaeger (*Stercorarius pomarinus*).

- **Plantation and Homestead Vegetation**. Traditionally every household in the villages of Bangladesh had orchard, bamboo-grove, vegetable garden and a small pond. Villages usually have grassland and jungle from where the community collected dead branches and fallen leaves for cooking. Such villages were good habitats for many species of birds. Although with the growth of population and consumerism many villages are transforming into mini township or shanty towns, some villages still retain the traditional look and remain bird friendly.

  The diversity of birds found in the homestead vegetation is astounding. Birds of 13 Orders can still be seen in many villages of Bangladesh. The birds usually seen there are doves, nightjars, swifts, cuckoos, waterhen, watercock, herons, cormorants, buttonquails, owls, vultures, kites, eagles, hoopoe, bee-eaters, rollers, kingfishers, barbets, woodpeckers, falcons, parakeets and many passerines. The herons, egrets, bitterns and cormorants invariably roost and nest in the village

groves. The most seen passerines of the villages are iora, cuckooshrikes, shrikes, orioles, drongos, fantail, crow, treepie, bulbuls, tailorbird, babblers, starlings, mynas, sunbirds, sparrows, weavers, munias, wagtails and pipits. Less obvious but equally abundant species are monarch, tit, larks, prinias, warblers, flycatchers, white-eye, leafbirds and flowerpeckers. The iconic bids of the villages of Bangladesh are White-rumped Vulture (*Gyps bengalensis*), Grey-headed Fish-eagle (*Ichthyophaga ichthyaetus*), Indian Spotted Eagle (*Clanga hastata*), Barn Owl (*Tyto alba*) and Asian Paradise-flycatcher (*Terpsiphone paradise*).

lack-bellied Tern (Sterna acuticauda),

Baer's Pochard (Aythya baeri),

Ferruginous Pochard (*Aythya nyroca)*

Figure 157. Birds species found in Rivers and Flooded Fields

(@ Photos Flora of Bangladesh)

4.3.5.3. Reptiles and Amphibians

Main concentrations of reptiles and amphibians in Bangladesh are in the natural forests and wetlands, although some reptiles are more at home in human habitations than the natural ones. Also, several species live as commensal to human beings.

Reptiles. Reptiles are diversified vertebrates (animals with backbone, having scaly skin that keep their bodies from drying out, their young do not go through a larval stage like the amphibians but instead look like small miniatures of the adults when they hatch out. They include four main groups: turtles and tortoises, lizards and snakes, crocodiles and alligators, and tuatara- the only species left from the ancient group of reptiles that goes back to the era of the dinosaurs. Some reptiles spend most of their time in water, many spend their life on land, some are arboreal and when others are even fully aquatic. They can be found in all types of habitat, except polar ice and the Tundra regions.

They are ectotherms (poikilotherms or cold blooded)- their internal temperature varies according to the surrounding environment, so they must bask in the sun or find warm places to heat up and become active, and they must find shade or fresh spot to cool off. In adverse cold weather they hibernate and in hot surrounding they aestivate.

The modern reptilian groups comprise two of three linkages of amniote vertebrates that arose from amphibian like tetrapods in the late Paleozoic Era. The two reptilian linkages are the anapsid amniotes, represented by turtles and tortoises, and the diapsid amniotes, represented by lizards, snakes and crocodiles, and tuatara.

- **Turtles, tortoises and terrapins** (commonly known as turtles) are reptiles of the Order Testudines and are remarkable for their shells. Generally, the turtles are aquatic and omnivores but come to lay eggs on land when tortoises are terrestrial and herbivores and usually do not go into water and terrapins are both (amphibious), mostly live near water along rivers, ponds and lakes. Being carnivorous turtles eat carcasses and diseased and weakened animals in the aquatic medium and thus play a vital role in cleaning the environment from pollution.
- **Lizards and snakes** belong to the same reptilian Order Squamata but they have many differences. The most important physical difference is that lizards usually have four limbs (except limbless lizards), which are used for movement. Snakes are limbless and use their ventral scales along with body muscles for locomotion. Lizards and snakes are the only reptiles that can climb, many are arboreal, some are aquatic (mostly marine) and some can glide through the air. They are carnivorous except for a few lizards that are purely herbivorous but none of which exists in Bangladesh. Lizards and most of the snakes are oviparous but some snakes are ovoviviparous. As carnivores, lizards and snakes are playing an important role in controlling insect and rodent populations in natural ecosystems. The Order Crocodylia includes alligators, caimans, crocodiles and gharial, of which the last two groups occur in Bangladesh. They are large bodied armored aquatic reptiles and having nearly complete four-chambered heart. They are carnivorous and oviparous and come on land for laying eggs. The crocodilians are carnivorous; hence, they hunt actively and eat weak, sick animals and carcasses in the aquatic medium. Thus, they play an important role in cleaning the environment from pollution and foul smells.

A total of 167 species of reptiles (3 orders and 25 families) have been listed in Bangladesh. There is no endemic species of reptile in Bangladesh so far, although once it was said to be the Bostami or Black Soft-shell Turtle (*Nilssonia nigricans*) is endemic to Bangladesh (Khan 1980, 1982a, b) it had not been reported from anywhere else since Annandale and Shastri (1914).

Figure 158. Black Soft-shell Turtle (*Nilssonia nigricans*).

The geographic distribution of threatened species of reptiles is mostly concentrated in the east and the southeast and along the coast of the Bay of Bengal then to the northeast regions of Bangladesh (Figure below: *Distribution of threatened reptiles in Bangladesh*). In fact, most of the reptile's species are also

distributed in the east, southeast and northeast parts where mixed evergreen forests of the country exist, and human density is very low.

Figure 159. Distribution of threatened reptiles in Bangladesh)

Source IUCN

The most common reptiles in the project area are as follows:

- *Geoclemys hamiltonii (*Black Spotted Pond Turtle), mostly seen in freshwater wetlands, in the Ganges and Brahmaputra river systems.
- *Hardella thurjii (*Crowned River Turtle), found in all the major rivers and tributaries principally in the Brahmaputra, Buriganga, Dakatia, Dholeswari, Gomti, Jamuna, Kirtonkhola, Kushiyara, Meghna, Padma, Sitalakhaya, Surma, and Tista rivers as well as in freshwater wetlands.
- *Nilssonia gangética (*Ganges Soft-shell Turtle), lives in the major river systems (Ganga-Padma, Jamuna-Brahmaputra, Surma-Kushiara-Megna, and so on) and flood-plains.
- *Nilssonia nigricans (*Black Softshell Turtle), found in Bostami Pond in Chittagong, Mohonganj (Netrokona), Feni River, Muhuri Dam (Feni), Manikchari (Rangamati), Boropathar (Thanchi) and Srimangal (Maulavi bazaar).

- *Melanochelys trijuga (*Pond Tortoise), foud in low-lying floodplain freshwater both in slow moving rivers and in the wetlands in the Greater Districts of Barishal, Comilla, Chittagong, Dhaka, Faridpur, Jamalpur, Mymensingh, Noakhali, Pabna, Sylhet and Tangail.
- *Pangshura tentoria (*Indian Tent Turtle), widely distributed in large and small rivers, and lowland areas
- *Nilssonia hurum (*Peacock Softshell Turtle), widely distributed in the freshwater river systems and major wetland habitats, minus the hilly regions of the north-east of the country.
- *Calotes versicolor (*Common Garden Lizard), widely distributed all over the country in suitable habitats.
- *Gekko gecko (*Tokay Gecko), the taxon is widely distributed all over Bangladesh.
- *Hemidactylus frenatus (*Common House Gecko), widely distributed all over Bangladesh.
- *Hemidactylus flaviviridis (*House Lizard), the species is widely distributed in the west of the Jamuna River, but absent in the Sundarbans.
- *Varanus bengalensis (*Bengal Lizard), It is widely distributed throughout Bangladesh including coastal islands.
- *Eutropis carinata (*Common Skink), widely distributed all over the country, including newly accreted islands where there are human habitations as well as in offshore islands such as the Hatiya and Saint Martin's.
- *Naja kaouthia (naja naja),* widely distributed in Bangladesh except major rivers and open water but found in wetlands with some vegetation.
- *Lygosoma albopunctata (*White-spotted Supple Skink), has been reported from Chittagong, Dhaka, Dinajpur, Hobiganj, Nilphamari, and Rangamati districts by various researchers.

Amphibians. Amphibians are the vertebrates that serve as the bridge between the aquatic and terrestrial ecosystems. Amphibians are 'cold-blooded' or poikilothermic vertebrates with smooth or rough skin, rich in glands which keep it moist. Most of the amphibian species live in and around wetlands but many species have adapted themselves to terrestrial and arboreal habitats. No matter where the adult amphibians live, water is essential for the early part of their life cycle. A total of 49 species of amphibian have so far been recorded in Bangladesh.The recent record of globally Vulnerable (IUCN 2015) Khare's Stream Frog (*Pterorana khare*) in the Chittagong Hill Tracts is an example of Bangladesh's potential as the home of diverse amphibian species. This species was considered endemic to Northeast India. Its occurrence in the Chittagong Hill Tracts has increased its known global range and offered a wider scope for its conservation. At least four cryptic species (Asmat's Cricket Frog *Fejervarya asmati*, Coastal Bull Frog *Hoplobatrachus litoralis*, Mymensingh Microhylid Frog *Microhyla mymensinghensis* and Chittagong Microhylid Frog *M. mukhlesuri*) have been spotted and reported from Bangladesh that have not yet been reported from other neighboring countries

As explained before, the four main habitat types available in Bangladesh are:

- forests
- wetlands
- scrub and grassland Areas
- plantation and homestead vegetation

The Skipper Frog (*Euphlyctis cyanophlyctis*) is the commonest and most widely distributed species in Bangladesh that occur in all types of wetlands, including along the shoreline of the Bay of Bengal. In the homestead vegetation no rare frogs are found, but toads, cricket frogs and Common Tree Frog (*Polypedates leucomystax*) prefer the homestead vegetation.

Figure 160. Distribution of threatened amphibious in Bangladesh

(Source IUCN)

The most common amphibious in the project area are as follows:

- *Duttaphrynus melanostictus, (*Asian Common Toad), commonest amphibian and found throughout Bangladesh from mainland to coastal areas, offshore islands and hill country as well as in all terrestrial forest ecosystems.
- *Hoplobatrachus tigerinus (*Indian Bullfrog), possibly the most widely distributed large frog that occurs all over Bangladesh.
- *Euphlyctis cyanophlyctis (*Skipper Frog), has the widest distribution of all the frogs of the country, ranging from the coastal areas to the hilly terrain in Bandarban District.
- *Microhyla ornata* (Ornate Microhylid Frog), is widely distributed in Bangladesh.
- *Euphlyctis hexadactylus* (Green Frog), is widely distributed in the coastal districts and large wetlands in Barishal, Dhaka and Khulna Divisions
- *Fejervarya asmati (*Bangladeshi Cricket Frog), *Fejervarya nepalensis* (Nepal Wart Frog), *Fejervarya pierrei* (Pierre's Cricket Frog), *Fejervarya syhadrensis* (Bombay Wart Frog), and *Fejervarya teraiensis* (Terai Wart Frog), are widely distributed all around Bangladesh.

- *Humerana humeralis* (Bhamo Frog), is found in mixed-evergreen forests of Chittagong and Sylhet (particularly lowlands, swamps, marshes or ponds), Chandpur, Dhaka, Narayanganj and Rangpur areas.

Figure 161. *Duttaphrynus melanostictus*, (Asian Common Toad).

4.3.5.4. Fishes

The diverse aquatic habitats in Bangladesh support a wide variety of fish. The total number of freshwater fish species occurring in Bangladesh compiled as 250 to 266 species. Of the reported species, 104 are considered riverine species, 36 migratory (travelling to rivers and floodplains) and the rest 113 are floodplain resident species. Besides, a total of 20 species of prawns, 4 species of crabs and 26 species of mollusks are known to occur in freshwaters of Bangladesh.

Fish and fisheries play an important role in the nutrition, economy, employment and culture of Bangladesh people. In fact, fish is second staple food after rice in Bangladesh. It is the sixth freshwater fish producing country in the world (FAO 2005) and produces 961,458 mt freshwater fish annually (FRSS 2014). Fish still provides 60%animal protein to our diet and per capita fish intake in the country amounts to 52 g/capita/day (DoF 2014) against a recommended level of 68 g/capita/day. A total of 1.2 million professional fishers in Bangladesh are involved in fishing on a full-time basis for their livelihood, while another 10 million fishers undertake subsistence fishing either for supplementing their incomes or for household consumption. In fact, each household in rural Bangladesh undertakes some sort of fishing (DoF 2014). Any decline in fish production in the country will affect the nutrition, employment and livelihood of many people of the country.

Although most fish species in Bangladesh are widely distributed within the country, many species exhibit localized distribution. Figure below shows the local distribution ranges of the threatened fishes in Bangladesh. The majority (in the range of 30-40 spp) of the threatened fishes are found mainly in the northwestern and northeastern parts of the country, while limited number of threatened species is found in the southern parts of the country (in the range of 10-20 spp). Some parts of northwestern, north central and northeastern and southeastern regions of the country also have moderate number of threatened fishes (in the range of 20-30 spp.). This distribution of Threatened fishes is probably related to the observed widespread habitat loss in the northern parts, compared to the southern parts of the country where rivers are still wider and deeper. The northeastern, northwestern and southeastern hilly areas of the country also support a good number (12 species) of Threatened species. This is again attributable to

the widespread degradation to hill streams caused by siltation, removal of boulders and pebbles and increased fishing pressure.

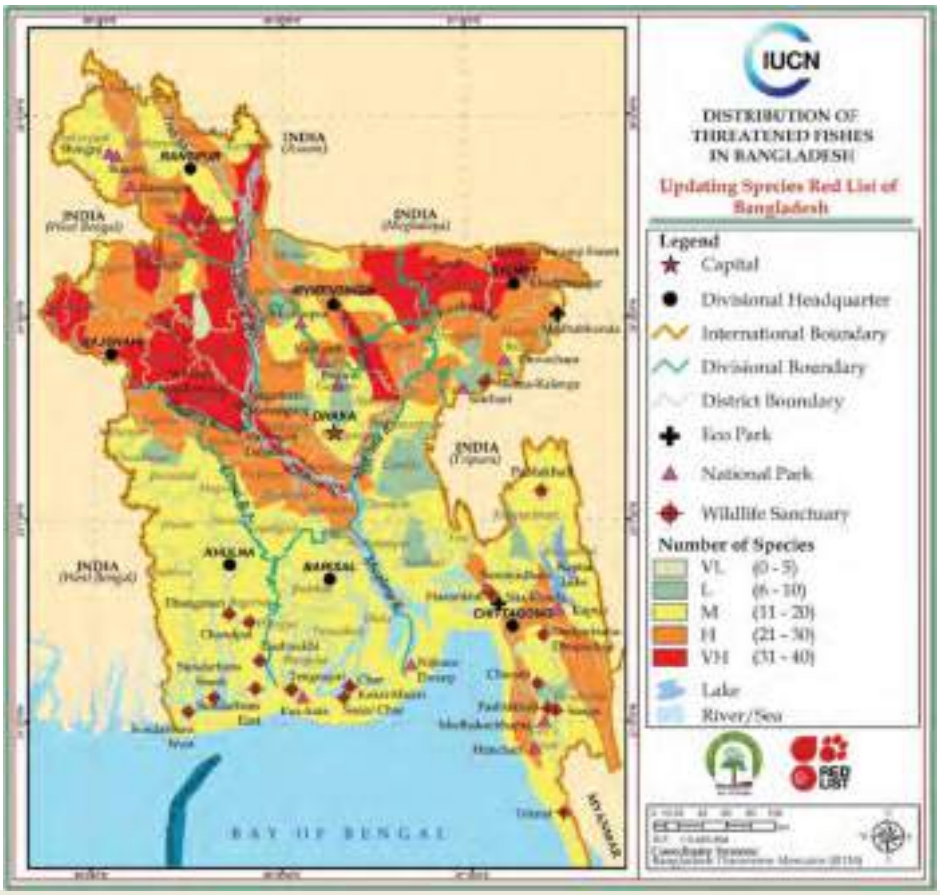


Figure 162. Distribution of threatened fishes in Bangladesh

Source IUCN

The most common fishes in the project area are as follows:

- *Labeo boga (*Boga Labeo), this fish has been recorded from only few locations in Bangladesh, including Padma River.
- *Bagarius bagarius (*Gangetic Goonch), occurs in large river systems of the country and has been reported from Padma, Jamuna, Meghna, Daleswari, Bangali, Baral, Choto Jamuna, Surma, Kushiyara, Manu Baral, Mahananda, Kangsha, Brahmaputra, Titas and Karnafully Rivers and was also reported from Chalan Beel and Kaptai Reservoir.
- *Megarasbora elanga (*Bengala Barb), occurs in rivers throughout Bangladesh
- *Oreichthys cosuatis (*Cosuatis Barb), found in canals, beels and horas.
- *Chitala chitala (*Humped Featherback*),* widely distributed species in rivers, beels, haors, reservoirs, canals and ponds. However, the species is specifically reported from the river Brahmaputra, Jamuna, Padma, Meghna, Someshwari and Kongsho River of Netrokona, Korotoa and Atrai River of Dinajpur, the Surma River of Sylhet, the Kirtonkhola and Shugandha River of Barishal Division.

- *Channa marulius (*Giant Snakehead*), occurs in* The Padma, Padma distributaries, Borulia haor (Nikli, Kishorganj), Mahananda, Choto Jamuna, Ichanoi Beel (Gaibandha), Dogger Beel (Chandpur), Titas, larger haors in Greater Sylhet and Mymensingh Districts, beels and larger water bodies in Dhaka, Manikganj and Tangail Districts.
- *Batasio tengana (*Dwarf Catfish*),* a riverine species particularly reported from the old Brahmaputra River and Tista River drainage and torrential streams in the north-eastern part of Bangladesh.
- *Rita rita (rita),* Padma River, Arial Kha River, Chalan Beel, Barnai River of Rajshahi, Bangali River of Bogra, Baral River of Natore, River Choto Jamuna, Brahmaputra, Turag River, "Ichhanoi Beel" at Palashbari Upzila of Gaibandha (extremely rare), Mahananda River at Chapai Nawabganj District, Medha Beel,Upazilla of Kolmakanda, Netrokona, Someshari and Kangsha River of Netrakona, Kritonkhola, Barishal, Surma River in Sylhet, Surma River, Sunamganj, Surma River, Rupsha River (Khulna), Meghna river Chandpur and Bhairab, Baleswar River.
- *Chaca chaca (chaka),* found in rivers, canals, ponds, inundated paddy fields throughout Bangladesh. In particular, it has been recorded from Tanguar Haor, Myttain Haor (Taherpur, Sunamganj), Patlai River (Taherpur), Hail Haor (Mowlavibazar), Derai Haor (Sylhet), Someshwari River (Durgapur), Dhalai River (Pabna), Chalan Beel (Natore, Sirajganj), Buriganga River, Turag River (Gopinpur, Kaliakoir), Bangshi River.
- *Clupisoma garua (*Garua Bacha*),* widely distributed throughout the country. Tista and Padma-Jamuna-Meghna River systems and their connected beels, baors, lakes, flooded low lands in the north-west to central regions; the Surma, Kushiara, Titas and Kangsha River basins and the connected haors and beels in the north-east region, Sangu River and the inter-tidal estuarine rivers and canals in the south-west to south-east regions in Bangladesh.
- *Ompok bimaculatus (*Butter Catfish*),* distributed throughout the country but particularly reported from the Bangali River of Bogra (De *et al.* 2011), Halda River of Chittagong (Alam *et al.* 2013), Tanguar and Hakaluki Haor, Brahmaputra-Jamuna, Mahanada River and Padma River.
- *Ompok pabda (*Pabda catfish*),* species is widely distributed throughout Bangladesh and reported from Padma, Jamuna, Meghna, Surma, Kushira, Manu Ichamati, Banglali, Turag, Baral, Choto Jamuna, Mahananda, Muhuri, Barnai and Titas Rivers Feni Reserviour, Tanguar Haor, Hakaluki Haor, Chalan Beel and Medha Beel.
- *Mastacembalus armatus (*Tire-track Spinyeel*),* It is distributed in rivers, canals, beels, ponds and inundated fields in the freshwater regimes throughout Bangladesh.
- *Anguilla bengalensis (*Indian Mottled Eel*),* reported from the rivers Padma, Meghna, Jamuna and Brahmaputra.
- *Gudusia chapra (*Indian River Shad*),* distributed widely in the country and known to inhabit all rivers and streams. It is also found in reservoir, haors, baors, ponds and floodplains.
- *Pethia ticto (*Two-spot Barb*),* occurs in rivers, canals, beels, ponds and similar waters in Bangladesh.
- *Pethia gelius (*Golden Dwarf Barb*),* occurs throughout Bangladesh.

- *Notopterus notopterus (*Grey Featherback,*),* found all over Bangladesh in all kinds of water bodies.
- *Sperata aor (*Long-whiskered Catfish*),* widely distributed within Bangladesh.
- *Sperata seenghala (*Giant River-catfish*),* known to occur in Narsunda River, Padma River, Chalan Beel, Barnai River, Bangali River, Baral River, River Choto Jamuna, "Ichhanoi Beel, Mahananda River, Medha Beel, Attrai River, Arialkha, Ichamoti, Kushiara River, Monu River, Pyra River, Kritonkhola River, Bishkhali River, Tetulia River, Baleshwar River, Someshari and Kangsha River, Surma River, Meghna River.
- *Monopterus cuchia (*Gangetic Mud Eel*),* is found throughout Bangladesh.
- *Amblypharyngodon mola (*Mola Carplet*),* widely distributed in the major river systems of the country, including the hill rivers, manmade Kaptai Lake, ponds, ditches, canals and all other freshwater wetlands.
- *Corica soborna (*Ganges River-sprat*),* occurs throughout Bangladesh and has been recorded from the major rivers of the country and also from the Kaptai Lake.
- *Wallago attu (*Freshwater Shark*),* widely distributed in all aquatic habitat systems throughout the country.
- *Chitala chitala (*Humped Featherback*),* described as a widely distributed species in rivers, beels, haors, reservoirs, canals and ponds. However, the species is specifically reported from the river Brahmaputra, Jamuna, Padma, Meghna, Someshwari and Kongsho River of Netrokona, Korotoa and Atrai River of Dinajpur, the Surma River of Sylhet, the Kirtonkhola and Shugandha River of Barishal Division. This species has also been recorded from the Kaptai Lake of Rangamati and the Tanguar Haor of Sunamgonj.

*Bagarius bagarius (*Gangetic Goonch)

*Chitala chitala (*Humped Featherback*),*

*Notopterus notopterus (*Grey Featherback*)*

Figure 163. Fish species found in Project Site Rivers

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4.3.5.5. Crustaceans

Crustaceans form a large group of Arthropods, usually treated under Subphylum - Crustacea that includes important animals such as prawn, shrimp, crab, lobster, crayfish, king crab, zooplankton, krill and barnacle. Crustaceans have an exoskeleton, which they must shed to grow in their life stages.

Most crustaceans are free-living aquatic animals, some are terrestrial (e.g. woodlice). Many crustaceans are parasitic (fish lice, tongue worms, etc.) and some are sessile (barnacles). More than 10 million tons of crustaceans are produced by fishery or farming for human consumption, the majority of it being shrimp.

Krill and copepods are not as extensively fished but have long been the animals with the greatest biomass in the planet earth and form a vital part of the aquatic food chain.

Throughout the world, shrimps, lobsters and portunid crabs are caught extensively for human consumption. Most zooplanktons are cladocerans and copepods that are the major consumers of phytoplankton. Benthic crustaceans are often both scavengers and consumers of plant life found on lake bottoms and the seabed. Collectively, these crustaceans serve as a key food source for fishes, especially during juvenile stages Aside from their role in food webs, the larger species of crustaceans are of considerable economic importance. They are also increasingly important in aquaculture. In fact, the value of crustaceans produced in aquaculture is already as great as that of fish. Bangladesh supports a wide range of crustaceans, including shrimps, prawns, crab, lobsters, zooplanktons, etc. For updating the crustacean red list, a total of 141 crustaceans were enlisted including prawn, shrimp, crab, lobster, king crab, zooplankton, barnacles, etc.

In Bangladesh, crustaceans are available in the floodplains, large and small rivers, beels, haors and baors, manmade and natural ponds, ditches, borrow pits, lakes and enclosures, coastal waterbodies and in the vast Bay of Bengal. There are several hotspots where the diversity and numbers are notably high.

Table 80. Red List Status of Crustaceans in Bangladesh, 2015

IUCN Red List Categories	Number of species assessed (Percentages of total assessed)
Extinct (EX)	0 (0)
Extinct in the Wild (EW)	0 (0)
Regionally Extinct (RE)	0 (0)
Critically Endangered (CR)	0 (0)
Endangered (EN)	2 (1.42)
Vulnerable (VU)	11 (7.80)
Near Threatened (NT)	1 (0.71)
Least Concern (LC)	47 (33.33)
Data Deficient (DD)	79 (56.03)
Not Evaluated (NE)	1 (0.71)
Total number of species assessed	141 (100)

Among the crustaceans listed for the assessment of the biodiversity status, 9.93% are assessed as threatened (i.e., with an elevated risk of extinction) in Bangladesh. Nonetheless, the proportion of threatened crustaceans is indecisive given the extremely high number of Data Deficient (DD) species (56%) and could be 65.96% (if all DD species are considered threatened) in Bangladesh (Table 8).

- **Prawn and Shrimp:** A total of 64 prawns and shrimps, under 8 Families (Class –Malacostraca, Order–Decapoda) are assessed in Bangladesh. The group is dominated by the two Families – Palaemonidae with 20 prawn species mainly of freshwater and estuarine origin and Penaeidae with 24 shrimp species of mainly marine and coastal origin. Key Species in Bangladesh are: Giant freshwater prawn (*Macrobrachium rosenbergii*), Marine tiger shrimp (*Penaeus monodon*), Mantis shrimp and Nymph snapping shrimp *(Alpheus Euphrosyne*),

- **Lobsters**: A total of six lobsters under two Families (Class – Malacostraca, Order – Decapoda were recorded in Bangladesh water and all 6 are included in the red list assessment: Lobsters (6 spc. are most common: spiny lobster - *Panulirus homarus*, ornate spiny lobster - P. *ornatus*, mud spiny lobster - *P. polyphagus* and painted spiny lobster - *P. versicolor* under Palinuridae and two - flathead lobster – *Thenus orientalis* and scaled slipper lobster – *Scyllarus depressus* under Scyllaridae).
- **Crabs:** A total of 38 crabs under 11 Families (Class –Malacostraca, Order–Decapoda) are recorded from Bangladesh and enlisted for the assessment for the biodiversity status. The most common are: Mud crab (Scylla serrata), Horseshoe crab, Red clawed crab, Fiddler crab, Hermit crab and Box crab.
- **Zooplankton**: two Classes, three Orders and six Families are enlisted for the assessment for their biodiversity status. Among the six Families assessed, zooplanktons under two Families – Daphniidae and Diaptomidae were found to include Vulnerable Species. All the zooplanktons under three Families - Bosmoinidae, Macrothricidae and Moinidae are classed under Data Deficient due to lack of proper data on population and distribution.

Figure 164. Distribution of threatened Crustaceans in Bangladesh

Source IUCN

Most common crustaceans in the project area are as follows:

- *Ceriodaphnia reticulata (*Water Flea*),* reported from different ponds of Dhaka city, Buriganga River, Kaptai Lake and Sona Dhigi of Rajshahi.
- *Macrobrachium Spp: M. birmanicum (*Birma River Prawn*), M. dayanus (*Kaira River Prawn), *M. dolichodactylus (*Ghoda River Prawn*), M. lamarrei (*Kuncho River Prawn), *M. malcolmsonii (*Moonsoon River Prawn*), M. mirabile (*Short-leg River Prawn*), M. rosenbergii (*Giant Freshwater Shrimp*),* available in the rivers Meghna, Naaf, Pagla, Halda, Karnaphuli, Sangu

and rivers of Patuakhali as well as in the Muhuri Irrigation project and the countries surrounding Bangladesh.

- *Austrothelphusa transversa (*Inland Freshwater Crab*),* found in all water bodies but only recorded so far is from Manikgonj District.
- *Lobothelphusa woodmasoni,* thinly distributed all over Bangladesh but commonly found in estuaries of the Chakaria Sundarban areas
- *Daphnia lumholtzi (*Water Flea*),* found in the freshwater bodies of Bangladesh.
- *Cyclops nanus (*Zooplankton, Water Flea*),* found in freshwater and brackish water in Bangladesh.
- *Moina macrocopa,* is reported from four freshwater ponds at Shahjalal University of Science and Technology Campus, Sylhet, Beels, Koshba, Naogao district, Trimohni Beel, Rajshahi, Guukshi Beel, Naogaon District, Rivers Halda, Karnaphuli and River Chandkhali, Shikalbaha.

*Ceriodaphnia reticulata (*Water Flea)

Mud crab (Scylla serrata)

Giant freshwater prawn (*Macrobrachium rosenbergii*)

Figure 165. Crustaceous species found in Project site Rivers

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4.3.5.6. Project Site: Terrestrial Survey

Due to of poor vegetation at the sites and huge anthropogenic activities, all Passenger and Cargo Terminal sites are poor in terrestrial fauna diversity and abundances, and mainly represent the non-conspicuous. The majority of the recorded species are common and accustomed to living in disturbed environment. In total 44 species of terrestrial wildlife were recorded from the terminal sites, of them one species is amphibian (toad), eight species reptiles (6 lizards and 2 species of snake), 27 species of bird and eight species of mammal (4 rats, 1 bat, 1 pipistrelle, 1 mongoose, 1 Jackal).

A detailed inventory on the recorded species is provided in Annex 3.

Figure below shows the species diversity of different groups of wildlife recorded from the project sites

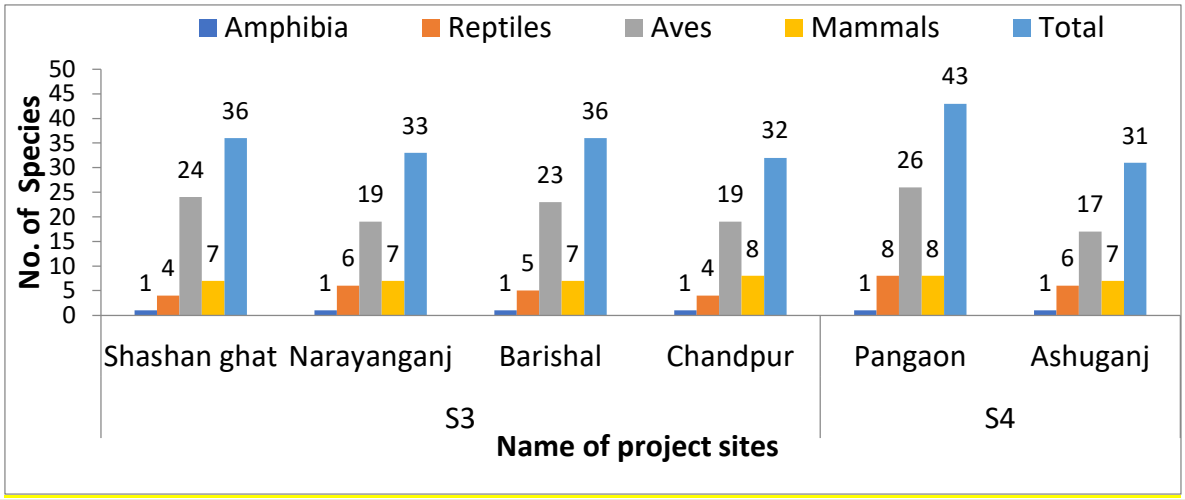


Figure 166. Number of terrestrial wildlife species recorded from different S3 and S4 project sites

The fauna species recorded from the project sites are more or less similar in composition and in abundance across the sites. Of the recorded amphibian species, Common Asian toad (*Duttaphrynus melanostiictus*) is found abundantly in all sites. Among the lizards, wall lizard (*Hemidaaactylus flaviviridis*) is the most abundant species in all sites, while Oriental garden lizard (*Calotes versicolor*), Bengal monitor (*Varanus bengalensis*) and Common skink (*Eutropis carinata*) also recorded from all sites but are less abundant. Yellow monitor (*Varanus flaviscens*) was recorded only from Pangaon and reported to be rare within the site. Cobra*(*Naja naja*) also recorded from the Pangaon site only, represented by a single individual, and sometimes sighted by local people.

The common and abundant bird species in all sites include House sparrow (*Passer domesticus*), Bulbul (*Pycnonotus cafer*), House crow (*Corvus splendens*), Pied starling (*Sturnus contra*) and Pigeon (*Columba livia*) and Crimson sunbird (*Aethopyga tristis*). Two kite species, Brahminy kite (*Halistur Indus*) and Black kite (*Milvus migrans*) often make their appearances in all sites, but not resident to the site. Some common birds reported from most sites, but observed in low abundances are Common sunbird (*Aethopyga siperaja*), Common kingfisher (*Alcedo atthis*), Little egret (*Egretta garzetta*), Jungle crow (*Corvus leivailalantil*), Cattle egret (*Bubulcus ibis*), Indian pond heron (*Ardeola grayii*), Asian koel (*Eudynamys scolopendra*) Rose ringed parakeet (*Psittacula krameri*), Spotted dove (*Spilopelia chinensis*) and Black headed oriole (*Oriolus xanthomus*), a threatened bird, reported only from the Barishal site.

Among the mammals, the most common and abundant species are House mouse (*Mus musculus*), Common house rat (*Rattus rattus*) and House shrew (*Suncus murinus*). Common mongoose (*Herpestes edwardsi)* was reported from all terminal sites, but fairly to less abundant within the sites. Greater short nose fruit bat (*Cynopterus sphinx*) and Indian pipistrelle (*Pipistrellus coromandra*) were recorded from all sites but are relatively low in abundances. The Golden jackal (*Canis aureus*), was reported only from the Pangaon site, but not resident to the site, the species probably visit the site from adjacent areas during night time.

An inventory of wildlife recorded from the Study Areas is presented in Annex 3.7 A summary Table on terrestrial vertebratae fauna, embodying a range important information, is provided hereinafter. .A project site wise discussion on terrestrial vertebrate fauna is made below:

Table 81. Groupwise species diversity of terrestrial vertebrate fauna in S3 and S4 project sites

	Number of species by sites					
Fauna groups	**Shashangat**	**Naraynagonj**	**Barishal**	**Chandpur**	**Pangaon**	**Ashugonj**

Amphibia	1	1	1	1	1	1
Reptiles	4	6	5	4	8	6
Birds	24	19	23	19	26	17
Manmals	7	7	7	8	8	7
TJotal	**36**	**33**	**36**	**32**	**43**	**31**
Redd-listedspecies	0	0	0	0	0	0
Migratory species	0	0	0	0	0	0
Protected species	10	7	8	7	11	9
CITES Appendix 1	0	1	2	1	2	1
Endemic	0	0	0	0	0	0
Critical/significant species	Mongoose	Mongoose	Mongoose	Mongoose	Mongoose	Mongoose Jackal

Sashanghat PT Site: The study found 36 species of terrestrial wildlife in Sashanghat PT site, represented by one amphibians, four reptiles, 24 birds and seven species of mammals. As per local accounts, majority of the recorded species are less to rare/occasional (27 species) and the rest (9 species) are fairly common. None of the species recorded is endemic to the site or the region and also none of them are threatened nationally or globally. However, a total of 11 species are included in the schedule I of the Wildlife (Conservation and Security) Act, 2012 signifying the requirement of their protection., There is no significant or critical terrestrial vertebrate species in this site.

Narayangonj PT Site: A total of 33 terrestrial wild species, represented by one amphibian, six reptile species, 20 bird species and seven mammalian species were recorded from the site. As with the Sashanghat study site, majority of the recorded species (23 species) are less to rare within the site, another 19 species are fairly common within the site. No endemic or Red-listed species were observed or reported from the site. Seven species of terrestrial vertebrates are included in Schedule 1 of the Wildlife (Conservation and Security) Act, 2012. There is no significant or critical terrestrial vertebrate species in this site.

Barishal PT Site: A total 36 terrestrial wild fauna potentially occur in Barishal site, including one amphibian species, 5 reptiles, 22 bird and seven mammalian species. As with the other sites, majority of recorded species (24 species) are less to rare in abundance, while 12 species are very common within the project site. As with other project sites, no endemic or threatened species was observed or reported from the site. Only, one migratory bird species, common snipe, was reported, but they are considered aquatic. There is no significant or critical terrestrial vertebrate species in this site. A total of eight terrestrial vertebrate fauna species are included in Schedule 1 of the Wildlife (Conservation and Security) Act, 2012 and three species are included in CITES Appendix I.

Chandpur PT Site: In Chandpur PT site, a total of 32 terrestrial wildlife species were recorded, among them, one species is amphibian (toad), four species reptiles, 19 species birds and seven species are mammals. Most of them are less common to rare within the site. None of the observed species is endemic or threatened nationally or globally. However, seven species are included in Schedule 1 of the Wildlife (Conservation and Security) Act, 2012, while another one species in included in CITES Appendix I. There is no significant or critical terrestrial vertebrate species in this site.

Pangaon Cargo Terminal: Because of industrial and other anthropogenic activities the site is also poor in terrestrial fauna. Nonetheless, the ground vegetation cover and trees around the site provide refuge to some animal species. In total, 43 terrestrial wildlife, represented by one toad (amphibian), eight reptiles, 25 birds and 8 mammalian species. Two significant species Unicellate cobra and Golden Jackal have been

reported from the site. This site contains 11 species protected under Schedule 1 of the Wildlife (Conservation and Security) Act, 2012 and another two species, Bengal monitor and Yellow monitor, are included . None of the recorded species is threatened or endemic to the site.

Ashuganj CT Site: The recorded terrestrial wildlife of the site include one amphibian species, six reptiles (2 turtle, 2 lizards and 2 snakes), 17 birds and 7 species of mammals. Most of the recorded species are less common within the site and represent the common species. No recorded species is threatened or endemic to the site. There is no significant or critical terrestrial vertebrate species in this site.

Protected animals: In total, 11 protected terrestrial vertebrate species (included in Schedule 1 of the Wildlife (Conservation and Security Act, 2012) were recorded from all sites, include Houe sift, Indian pond heron, Spotted owlet, Spotted dove, Greater short nosed fruit bats and Indian pipistrelle, Black hooded oriole was reported only from Chandpur site. Spectacle cobra and Golden jackal were reported only from the site. Bengal grey monitor was reported from all sites, except Sashanghat, while Yellow monitor was reported from Barishal and Pangaon site only. The Schedule 1 of the Wildlife (Conservation and Security) Act, 2012 states that no animal shall be killed, trapped, or captured and it is a punishable crime under the Act. Therefore, it is a requirement of the project to protect these animals and not to to doing any harm to them. .

CITES Appendix I: Of the recorded terrestrial vertrebrate species two species, Bengal monitor (Varanus bengalensis) and yellow monitor (Varanus flavescens) are included in the CITES Appendix I,and thus applies that these aniamls shall not be traded and requires to protect thems from extinction. However, these species are not threatened in the country. Bengal mnitor lzard was reported from all project sites, however, the Yellow monitor was reported only from Barishal PT and Pangaon CT sites only.

4.3.5.7. Project Sites: Aquatic Survey

Aquatic survey focused on aquatic wildlife; fishes, zooplankton, benthic macrofauna, crustaceans and molluscan species on each individual S3 and S4 sites, and a description on these fauna groups are provided below

- Aquatic Wildlife

The informaton on the recorded aquatic vertebrate species on the project sites are provided in Table 82 A total of 13 species of aquatic wildlife, represented by three frog species, three turtle and three bird species and one mammalian species, potentially occur in the project sites (Table 82). Of the aquatic frogs, Skipper frog (*Euphlyctis cynophlyctis*) and Indian bull frog (*Hoplobatrchus tigerinus*) occur in all sites andare less common to rare across the sites. The other frog species, Cricket (*Ferjavena* sp.), was noted only from Narayanganj and Pangaon sites and was reported to be rare within the sites. Of the recorded water snakes, Common smooth water snake (*Enhydris enhydris*) and Checkered keelback (*Xenochrophis piscator*) were reported from all sites and found fairly to less common within the study sites, while Stripped keelback (*Amphiesma stolatum*) was reported only from Narayanganj, Pangaon and Ashuganj sites. All three turtle species (*Lissemys punctata*, *Pangshura tecta* and *Nillosum gangetica*) occur in both Cargo Terminal sites, while Spotted flapshell turtle was also reported from all Passenger terminal sites, except Shasanghat, but are less abundant to rare within the study areas. No turtle species was reported from Shasanghat.

Table 82. Groupwise species diversity of aquatic vertebrate fauna in S3 and S4 project sites

	Number of species by sites					
Fauna groups	**Shashangat**	**Naraynagonj**	**Barishal**	**Chandpur**	**Pangaon**	**Ashugonj**

Amphibia	2	3	2	2	3	2
Reptiles	2	4	4	2	6	5
Birds	2	2	2	2	3	2
Manmals	1	1	0	1	1	1
TJotal	**7**	**10**	**8**	**7**	**13**	**10**
Redd-listed species	1	1	1	1	2	2
Migratory species	1	1	1	0	1	1
Protected species	5	8	5	5	10	8
CITES Appendix 1	1	2	1	2	3	3
Endemic	0	0	0	0	0	0
Critical/significant species	Dolphin**	Flapshell turtle; Dolphin	Softshell turtle;	Flapshell turtle; Dolphin	Softshell and Flapshell turtle Dolphin	Softshell and Flapshell turtle Dolphin

The turtle species were not actually observed during the limited field visits but were authentically reported by the local people. Among the recorded aquatic birds, Common snipe (*Gillanago gillanago*) was reported from all sites except Chandpur, while River tern (*Stema aurantia*) was noted from all sites except Shasanghat. Little cormorant (*Microcarbo niger*) occurs only in Shasanghat, Chandpur and Pangaon sites, but were rare/occasional across the sites.

There is no endemic aquatic vertebrate fauna in any project site. Only one migratory species, the Common snipe, was reported from all sites, except the Chandpur site. This species is found along the riverbanks throught the country, and the species is not threatened.

Two aquatic threatened vertebrates, the Gangetic dolphin, which forage in the project area during the wet seas and the Indian softshell turtle, were noted from the the project sits, of which the later species is found only in Pangaoon and Ashugonj site.

- Out of 13 aquatic vertebrtae species reported from the project sites, 10 of these are included in the Schedule I of the Wildlfe (Conservation and Security) Act, 2012 , and include Indian bull frog, Skipper frog, Cricket frog, Indian softshell turtle, Indian roofed turtle, Spotted flapshell turtle, Checkered keelback snake, ommon smooth water snake, and Gangteic dolphin. The anmals listed in the Schedule 1 shall not be killed and therefore requires to be protected. The highest number of protected species was recorded from Pangaon CT site , followed by Ashugonj CT site (Annex 3.8. & Table 80. The only recorded aquatic mammal, the Gangetic dolphin (*Platnista gangetica*), are found to forage across all sites, except Barishal site, particularly in monsoon months. In Shasanghat dolphin is rarely found, while in Ashuganj the species is relatively a frequent visitor. Zooplankton

Both species diversity and abundance of zooplanktonic community were studied. The zooplanktonic community comprised 6 major groups. A total of 19 zooplankton species, comprising three Protozoan, seven Rotifers, four Copepods, two Cladocerans, two nauplii and one ostracod species, was recorded from the study sites. A site and group wise information on the zooplankton diversity and abundance is given in Figure 167, while species wise information is provided in Annex 3.8

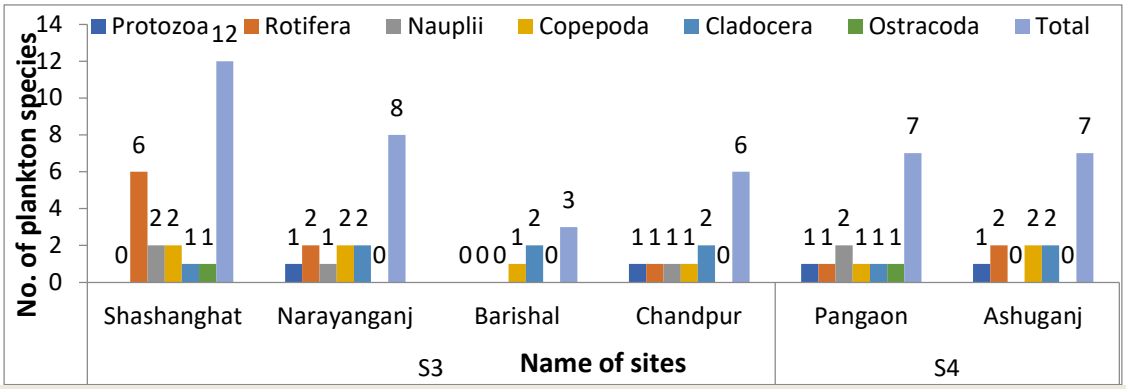


Figure 167. Group wise species number of Zooplankton recorded from the project sites (October 2019)

- **Shasanghat PT Site:** A total of 12 species of zooplankters occurred at the site with a total abundance of 10.67 indiv./l water (Table The abundant species are *Branchionu*s spp. (2.32 indiv./l water) , *Bosmina coregoni* (2.22 indiv./l water) . and *Mesocyclops* sp. (1.33 indiv./l).
- **Narayangonj PT Site** The study found eight species of zooplankters in Narayanganj site with a total density of 12.0 indiv./l water, dominated by copepods (8.45 indiv./l water), followed by cladocerans (1.45 indiv. /L). The most abundant species is *Cyclops nanus* (8.0 indiv./L water, followed by *Diphanosoma* sp. (1.0 indiv./L water) (Annex3.8.). .
- **Barishal PT Site:** The Barishal site was found poor, both in diversity and abundance of zooplankton, represented only by one species of copepod and two species of cladocerans with a total abundance of 6.22 indiv/l water (Table …). The abundant species are *Diaptomus* sp. (2.2 indiv./L) (*Diaphanosoma* sp. (indiv./l) and, *Bosmina coregoni* (2.0 indiv./l.) (Annex3.8). The site is tidally influenced, and regularly flushed away by tidal water and probably results in poor zooplankton diversity.
- **Chandpur PT Site:** The Chandpur site is also poor in zooplankton abundance. Six species of zooplankters occur at the site, representing all observed groups, except ostracods with an abundance of only 2.75 indiv./l water (Table…) The dominant species are *Bosmina coregoni* (0.66 indiv./l water) and *Cyclops nanus* (0.88 indiv./L) (Annex 3.8).
- **Pangaon CT Site:** A total of 7 zooplankton species was recorded from the site, comprising all 6 six observed groups with a density of 12.03 indiv./L water. Protozoa was the most abundant group (7.11 indiv./L) of all zooplankton groups. The dominant species are *Volvox* sp. (7.11 indiv./L) and Cyclops sp. (1.78 indiv./) (Annex 3.8)./L.
- **Ashuganj CT Site:** Ashuganj site also comprises 7 species of zooplankton with a total abundance of 6.25 indiv./L water. The abundant species are *Cyclops nanus* (2.67 indiv./L), *Mesocyclops* sp (0.45 indiv./L) sp*. Diaphanosoma* sp. (1.78 indiv./L) , *Brachionus* spp. (0.889 indiv./L) (Annex3.8)

Table 83. Abundance (indiv./L water) of zooplankton groups recorded from S3 and S4 project sites

Plankton Groups	Plankton density (indiv./L of water) by site					
	S3 Sites				S4 Sites	
	Shasanghat	Narayanganj	Barishal	Chandpur	Pangaon	Ashuganj

Protozoa	0	0.44	0	0.22	7.11	0.44
Rotifera	4.88	0.88	0	0.22	0.44	0.88
Nauplii	0.88	0.44	0	0.22	1.77	0
Copepoda	1.77	8.89	3.56	1.11	1.78	2.66
Cladocera	2.2	1.33	2.67	0.89	0.44	2.22
Ostracoda	0.89	---	---	---	0.44	---
Total (indiv./L water)	10.62	11.98	6.23	2.66	11.98	6.2

- Benthic macrofauna

Both diversity and abundance of benthic fauna were investigated. A total of 21 benthic species, represented by 5 species of oligochaetes, 6 species of mollusks, 4 species of insect larvae and 2 species of polychaetes, were recorded from the study sites. However, the both diversity and abundances varied greatly among the sites. Table below shows the group wise species diversity and abundances, while Annex 3.4.species wise abundances of the recorded organisms.

- **Shasanghat PT Site:** 6 species of macrobenthic organisms were found in Shanshanghat site with a density of 1289.2 indiv/m2 surface area (Table below). The abundant species are Cirratulid polychaete (978.0 indiv./m2 surface area), *Nais* sp. and *Tanypus* larvae (89.0 indiv./m2 surface area, each). The abundance of Cirratulid polychaete is indicative of sewerage pollution.
- **Narayanganj PT Site:** The benthic community at the site comprises 4 species of bentic fauna with a total abundance of 889.0 indiv./m2. The most abundant species include *Dicronata* sp larvae (311.15 indiv. /m2), followed by *Nais* sp (222.5 indiv./m2), *Paranais* sp. and Corbicula sp (177.8 indiv./m2, each).
- **Barishal PT Site**: In Barishal Site, collected sample became decomposed, only one mollusk (44.5 indiv./m2) specimen could be noted
- **Chandpur PT Site:** The benthic community in the site are represented by 4 species of benthic fauna with a total abundance of 533.4 indiv ./m2 surface area (Table …). The most abundant species are *Nepthys*, a polychaete (266.7 indiv./2), followed by *Tubifex* sp. (177.8 indiv./m2).
- **Pangaon CT Site:** 4 species of benthic fauna were recorded from the site, with a total density of 622.3 indiv./m2. The abundant species were *Nais* sp. (311.15 indiv./225 cm2) and *Paranais* ap. (177.8 indiv./m2 .
- **Ashugang CT Site**: In Ashuganj site, a total of 5 species were recorded and the density was found to be 1289.0 indiv. /m2. *Enchytraneus* sp was recorded as the most abundant species (978.0 indiv./m2), followed by larve of *Dicranata* sp. (133.4 indiv./m2). Mollusks accounted for 222.3 indiv. /m2 at the site..

Many of the observed microbenthic fauna abundantly grow in sewerage polluted waters. The higher abundance of benthic fauna observed in Shasanghat, Ashuganj and Narayanganj may be attributed to the presence of sewerage outlet at these sites.

Table 84. Species diversity (No. species) and abundance (indiv./m2 surface area) of benthic macrofauna

	Number of species and density (indiv./m2 surface area)											
	Shasanghat		Narayanganj		Barishal		Chandpur		Pangaon		Ashuganj	
	No.	Density	No	Density	No.	Density	No.	Density	No.	Density	No.	Density
Oligochata	2	133.4	2	400.0	---	---	1	177.8	2	489.0	1	933.5
Polychaeta	1	977.9		---	---	---	1	266.7	---	---	---	---
Insect arvae	2	133.4	1	311.2	---	---	1	---	----	---	1	133.4
Molluca	1	44.5	1	177.8	1	44.5	---	---	2	133.4	3	22217
Decapoda	---	---	---	---	---	---	1	44.5	---	---	---	---
Unidetified	---	---	---	---	---	---	---	---	---	---	---	---
Total density (indiv./m2 area)	6	1289.2	4	889.9	1	44.5	4	533.4	7	622.4	5	1289.0

- Fishes

In total, 78 species of fishes are reported from all terminal sites, however, the diversity of fishes and its abundance varied greatly among the sites. More than 50% recorded fish species can be considered small indigenous species (SIS) (less than 6 inches in length) and these dominate the fisheries. Of the recorded species, 36 are floodplain resident species. The abundant fish species are small and inconspicuous and include Barbs (*Puntius* spp.), Mola carplet (*Amblypharyngodon mola*), Indian potasi (*Eutropicthys atherinoides*), Ganges river sprat (*Corica soborna*), Glassy perchlets (*Chanda* spp.). Among the conspicuous large species Freshwater Shark (*Wallago attu*), Long whiskered catfish and Giant river catfish (*Sperata aor and S. seenghala*), Humped featherback (*Chitala chitala*), Ruhu carp (*Labeo rohita*) and Black rohu (*Labeo calbasus*) were reported from all project sites, however, the abundance of the species vary greatly among the sites. Some important and conspicuous fish threatened fishes like Rita fish (*Rita rita*). Devil catfish (*Bagarias bagariua) and* Pungfish (*Pangasius pangasius*) were reported from some sites, but in very low abundance. The Hilsa shad (*Tenualosa ilisha*), the most important commercial fish in the country, has been recorded from Chandpur, Barishal and Ashuganj sites, predominantly from Barishal and Chandpur. Many of the recorded fish species are considered threatened as per Red list of IUCN Bangladesh IUCN, 2015).

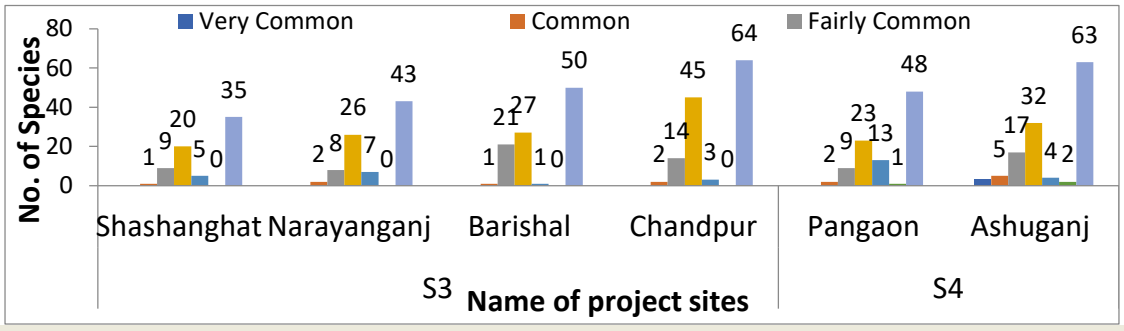


Figure 168. Species diversity and relative abundance of fish recorded from project sites

- **Shasanghat PT Site:** The Buriganga River near Shasanghat is heavily polluted and sometimes causes fish kills during lean flow period in winter. During monsoon, the river is flushed out by huge volume of water resulting in reduced water pollution and at that time the river supports some fish and other aquatic animals, and fishing takes place. In winter, when river waters get pollute, the diversity and abundance of aquatic fauna is also greatly reduced. A total of 35 species of fish was recorded during the early draw down period, majority of them

(25 species) are less common to rare within the site. Only few air breathing species, like Stinging catfish (*Heteropneuestes fossilis*), Walking catfish (*Clarias batrcahus,* spotted snakehead (*Channa punctatus*) are available during lean flow period. The site has now no or little fishery importance.

- **Narayangonj PT Site:** The Shitalakhya River at Narayangonj PT site also gets heavily polluted during winter adversely affecting the aquatic biota. During monsoon, fish and other animal diversity and its abundance increase as the river water is regularly flushed out and results in improved water quality. As with Buriganga River, in winter (lean flow period) the fish and other aquatic biodiversity decreases. Forty-three species of fish were recorded from the study site, majority of which are less common to rare within the site. . However, some conspicuous fish species are found during monsoon and fishing continues during this period.
- **Barishal PT Site:** The river near Barishal PT is comparatively less polluted and supports at least 50 species of fish, of which, about 28 species are less common to rare within the site and abundance of fishes are comparatively more compared to other sites. Some notable conspicuous species including Pungas, Rita, Long-whiskered and Giant river catfish are found at the site. Pungas is an important and critically endangered species in Bangladesh. Hilsa river fishing also dominates in monsoon period. The site is an important area for local fishermen.
- **Chandpur PT Site:** The Meghna River at Chandpur is less polluted and supports a wide variety of fish (at least 64 species) and the abundance of fish at the site is also higher at the site, compared to other S3 and S4 sites. Many of the fish are commercially important and occur in considerable abundance. Some significant species, such as Hilsha sahd, Pangas, Ayre, Major carps, Rita, Boal, etc. are abundant at the site. Fishing is a major economic activity in the area. The conspicuous threatened Pungas and Devil catfish also occur at the site. The site is important for commercial fishing, of which hilsa fishing dominates. Local dependence on fishing is huge. Crocodile Tooth Pipefish, Microphis canculus), a threatened fish, was also reported from the site. Similarly, the only recorded ray, the Short snout stingray (*Dasyatis* sp.) is found at the site.
- **Pangaon Cargo Terminal Site**: The aquatic environment of the Pangaon Site includes a heavily polluted and high traffic Buriganga River, and a perennial fish culture pond of about 5 acres, which is presently under fish culture practice. In total, 48 fish species potentially occur in the Buriganga River, particularly in and around the site, 4 species are common, 9 species fairly common, 23 species less common and another 9 species are rare within this study site. Fishing is no longer an economic activity at the site. In fact, little fishing takes place in dry season in and around the Pangaon area.
- **Ashuganj Cargo Terminal Site**: The aquatic habitat of Ashuganj CT represents a part of Upper Meghna River. Fishes are comparatively more abundant in this project area, represented by at least 64 species, the majority of which are small. The conspicuous species recorded are Boal (*Wallago attu*), Ayre (*Sperata aor* and S *seenghala*), Chitol (*Chitala chitala*), Rita fish (*Rita rita*). Baghair, a critically endangered species is found in Ashuganj site. Many of the recorded fish species are considered threatened as per Red list of IUCN. Fishing at the site is an economic activity.

Endemic fishes: None of the recorded fish species reported is endemic to any of the project sites.

Threatened fishes: A total of 21 threatened fish species are potentially present within the study sites, of which 19 species were recorded from Chandpur and Ashuganj sites, 14 species from Pangaon, 11 species from Barishal, 10 species from Narayangonj and eight species from Shasanghat Of the threatened fishes, one species is Critically endangered (*Pangasius pangasius*) (CR), nine species Endangered (EN) and 11 species are vulnerable (VU) nationally. Table 85. shows species wise threatened categories of the recorded threatened fishes by project sites.

Table 85. List of Threatened fishes recorded from the project sites

Sl. No	Scientific name	English name	Locale name	SG	NG	BS	CP	PG	AG	Threatened Category National
1	*Anguilla bengalensis*	Indian longfin Eel	Bamosh			--	R		R	VU
2	*Bagarius bagarius*	Devil Catfish	Baghair			R	R	R	R	EN
3	*Botia derio*		Bourani	Lc	LC	--	LC	LC	LC	EN
4	*Chaca chaca*	Squarehead Catfish	Chaka, Chaka Veka.			--			LC	EN
5	*Chanda nama*	Elongate Glassperchlet	Nama Chanda	R	R	LC	LC	R	LC	VU
6	*Channa marulius*	Giant Snakehead	Gajar, Gajal		R	---		R	R	EN
7	*Channa orientalis*	Walking Snakehead	Gachua, Raga, Cheng			---			R	VU
8	*Chitala chitala*	Humped Featherback	Chital		LC	LC	LC	R	LC	EN
9	*Cirhinus reba*	Reba	Bhagna, Raik, Tatkini,			--	LC		LC	VU
10	*Clupisoma garua*	Garua Bacha	Ghaura	LC	LC	FC	FC	LC	LC	EN
11	*Gudusia chapra*	Indian river shad	Chapila			--	FC	FC	C	VU
12	*Mastacembelus armatus*	Tire-track spiny Eel	Baim			LC	LC		LC	EN
13	*Monopterus cuchia*	Freshwater mud eel	Kuicha	LC	LC	--	LC	R	LC	VU
14	*Ompok pabda*	Pabdah catfish	Madhu Pabda			--		R	LC	EN
15	*Pungasius pangasius*	Pungas	Pangas			LC				CR
16	*Pethia ticto*	Two-spot Barb	Tit Punti	R	LC	LC		R	LC	VU
17	*Rita rita*	Rita	Rita			FC		R	FC	EN
18	*Sperata aor*	Long whiskered Catfish	Talla Ayre	LC	LC	FC		LC	LC	VU
19	*Sperata seenghala*	Giant River-catfish	Guijja Ayre	R	LC	FC		LC	FC	VU
20	*Wallago attu*	Freshwater Shark	Boal	LC	LC	FC		LC	FC	VU
21	*Microphis cunculus*	*Crocodile toothedpiped fish*	*Kumirer khil*	--	--	--	*LC*	---	--	VU

Source:IUCN, 2015

Note: Relative abundance: VC=Very common; C=Common; FC=Fairly common, LC-Less common; R=Rare

Threatened Category: CR= Critically endangered; EN=Endangered; VU=Vulnerable

- Shrimps, Crabs and Molluscs

5 shrimp species were reported from the project sites, including Giant freshwater prawn (*Macrobrachium rosenbergi*), Monsoon river prawn (M. malcomsoni), Kalna river prawn (*M. dyanus*), River nose cardin (Cardina *gracillostris.*) and *Linder stylifera*, of these *M. rosenvergi* was reported from all sites. All 5 species occur in Ashuganj, Chandpur and Barishal sites, while 3 species in Pangaon and Narayanganj each and 2 species in Shasanghat site. Also 5 species of mollusks, comprising 4 snails and 1 species of mussel, include Common Apple snail (*Pila globosa*), Banded pond/river snail (*Bellamya bengalensis*) Ram's horn snail (*Indoplanorbis exustus*), Horn snail (*Gyraulus convexiusculus*) and Freshwater mussel (*Lamellidens marginalis*) occur in the study sites. All recorded species occur in Ashuganj Site, 4 species in Pangaon, and 3 species in Narayangonj, Barishal and Chandpur site, while 2 species occur in Shasanghat site. Among these, Banded pond/river snail and Ram's horn snails were found in all sites. The 2 crab species recorded are Sartonia crab (*Sartoriana spinnigera*) and *Lebothelphusa woodmason)* are found all sites, but in very low abundance.

Shrimps and molluscs are sensitive to environmental perturbations and reported to disappear from Shasanghat site when river waters get polluted during lean flow period. Almost all recorded species are common and abundantly found in the country and none of the recorded is species threatened locally, or within the country.

4.3.6. Natural Protected Areas

The Buriganga River and Shitalakhya River on which the Shasanghat PT and Narayangonj PT and Pangaon CT will be developed are two government designated Ecologically Critical Area (ECA). Adjacent and connected to these rivers, Balu and Turag Rivers, are also two ECAs within a few kilometers, also another ECA, the Gulshan Lake. These water bodies were declared as ECAs in 2009 under Bangladesh Environment Conservation Act, 1995 and Department of Environment (DoE) is the mandated authority for managing the ECA sites. According to this Act, no conversion or degradation shall be done to the ECA sites and Bangladesh Government has a priority for conserving the ECAs. If any development activities are to be undertaken in the ECA sites, prior permission must be obtained from the DoE. Out of the designated forest protected areas (PA) in the country, none is located within 25 km from the nearest project boundary (Figure below). None of the project sites or its parts are included in any other type of protected area, mega biodiversity or animal hotspots.

Figure 169. Map showing distribution of forest Protected Areas (PAs) in Bangladesh

Source: Mukul et al. 2017

Full citation: Mukul, S.A., Rashid, A.Z.M. and Khan, N.A. 2017. Forest Protected Area and Systems and Bioduversity Conservation in Bangladesh. In: Protected Area Policies, Management and Future Directions: Nova Science Publishers Inc. pp.157-177

Table 86. Name and location of ECAs of Bangladesh.

No.	Name of the ECA	Type of Ecosystem	Location	Areas (ha)	Year of Declaration
1.	Cox's Bazar-Teknaf Peninsula	Coastal-Marine	Cox's Bazar	20,373	1999
2.	Sundarbans (10 km landward periphery)	Coastal-Marine	Bagerhat, Khulna Barguna, Pirojpur and Satkhira	292,926	1999
3.	St. Martin's Island	Marine Island with coral reefs	Teknaf upazila, Cox's Bazar	1,214	1999
4.	Hakaluki Haor	Inland Freshwater Wetland	Sylhet and Moulvibazar	40,466	1999
5.	Sonadia Island	Marine Island	Moheshkhali, Cox's Bazar	10,298	1999
6.	Tanguar Haor	Inland Freshwater Wetland	Tahirpur, Sunamganj	9,727	1999
7.	Marjat Baor	Oxbow Lake	Kaliganj upazila of Jhenaidah and Chaugacha upazila of Jessore	325	1999
8.	Gulshan-Baridhara Lake	Urban Wetland	Dhaka city	101	2001
9.	Buriganga	River	Around Dhaka	1336	2009
10.	Turag	River	Around Dhaka	1184	2009
11.	Sitalakhya	River	Around Dhaka	3771	2009
12.	Balu including Tongi canal	River	Around Dhaka	1315	2009
13.	Jaflong-Dawki	River	Jaflong, Sylhet	1493	2015

Source: Department of Environment (2015)

FULL CITATION: Department of Environment. 2015. Community Based Ecosystem Conservation and Adaptation in Ecologically Critical Areas of Bangladesh: Responding to Nature and Changing Climate. Department of Environment (DoE), Ministry of Environment and Forests, Dhaka, Bangladesh, pp x+122.

4.3.7. Threatened, Protected Fauna and Significant Aquatic Species

No flora species recorded from the study sites are threatened (*Rahman et al.,2001*), However, out of 189 threatened wild animals *(Amphibia through Mammalia*) in Bangladesh, only 2 species are potentially present within the site, include Indian softshell turtle *(Nillosomia gangetica*) and Gangetic dolphin (*Platinista gangetica*).

The Indian softshell turtle is nationally endangered and globally vulnerable, while the Gangetic dolphin is endangered both nationally and globally as per IUCN Red list. A total of 21 threatened fish species are potentially present within the study sites, of which 19 species recorded from Chandpur and Ashuganj sites, 14 species from Pangaon, 11 species from Barishal, 10 species from Narayangonj and 8 species from Shasanghat Of the threatened fishes, 1 species is Critically endangered (Pangasius pangasius) (CR), 9 species Endangered (EN) and 11 species are vulnerable (VU) nationally. Table below shows species wise threatened categories of the recorded threatened fishes. (Table 87)

Table 87. List of Threatened fishes recorded from the project sites

Sl. No	Scientific name	English name	Locale name	SG	NG	BS	CP	PG	AG	Threatened Category National
1	*Anguilla bengalensis*	Indian longfin Eel	Bamosh			--			R	VU
2	*Bagarius bagarius*	Devil Catfish	Baghair			R		R	R	EN
3	*Botia derio*		Bourani	Lc	LC	--		LC	LC	EN
4	*Chaca chaca*	Squarehead Catfish	Chaka, Chaka Veka.			--			LC	EN
5	*Chanda nama*	Elongate Glassperchlet	Nama Chanda	R	R	LC		R	LC	VU
6	*Channa marulius*	Giant Snakehead	Gajar, Gajal		R	---		R	R	EN
7	*Channa orientalis*	Walking Snakehead	Gachua, Raga, Cheng			---			R	VU
8	*Chitala chitala*	Humped Featherback	Chital		LC	LC		R	LC	EN
9	*Cirhinus reba*	Reba	Bhagna, Raik, Tatkini,			--			LC	VU
10	*Clupisoma garua*	Garua Bacha	Ghaura	LC	LC	FC		LC	LC	EN
11	*Gudusia chapra*	Indian river shad	Chapila			--		FC	C	VU
12	*Mastacembelus armatus*	Tire-track spiny Eel	Baim			LC			LC	EN
13	*Monopterus cuchia*	Freshwater mud eel	Kuicha	LC	LC	--		R	LC	VU
14	*Ompok pabda*	Pabdah catfish	Madhu Pabda			--		R	LC	EN
15	*Pungasius pangasius*	Pungas	Pangas			LC				CR
16	*Pethia ticto*	Two-spot Barb	Tit Punti	R	LC	LC		R	LC	VU
17	*Rita rita*	Rita	Rita			FC		R	FC	EN
18	*Sperata aor*	Long whiskered Catfish	Talla Ayre	LC	LC	FC		LC	LC	VU
19	*Sperata seenghala*	Giant River-catfish	Guijja Ayre	R	LC	FC		LC	FC	VU
20	*Wallago attu*	Freshwater Shark	Boal	LC	LC	FC		LC	FC	VU
21	*Microphis cunculus*	*Crocodile toothedpiped fish*	*Kumirer khil*	--	--	--	*LC*	---	--	VU

Source: IUCN Redlist of Bangladesh

Note: Relative abundance: VC=Very common; C=Common; FC=Fairly common, LC-Less common; R=Rare Threatened Category: CR= Critically endangered; EN=Endangered; VU=Vulnerable

IUCN Red list in Bangladesh has no legal standing; however it is used as guidance to biodiversity conservation planning and government agencies respect this document. The threatened species recorded from the site are widely distributed throughout the country as well as in the region and the site is not essential for their survival.

Endemic flora/fauna: Out of 22 recognized endemic flora in the country, two (*Lymnophila cona* and *Hedyotis thomsonii*) were reported from Dhaka District and Meghna River. However, these species were not found and thought to be extinct. None of these two species were observed during the field survey. Similarly, no endemic fauna species were recorded from the project site.

Migratory species: Although, migratory birds stay in the Meghna, Buriganga and other rivers of the country, the S3 and S4 sites are highly disturbed places, so the project sites probably are not the destination of the

migratory species. However, migratory birds could be found in immediately beyond the Ashuganj and Barishal sites. No migratory species was recorded, although several local migrants including River tern, Common River snipe and Asian Koel have been recorded from the sites.

Protected Species: Certain recorded wildlife are included in Schedule 1 of the Bangladesh (Conservation and Protection) Act, 2012), which states that animals listed in the Schedule shall not be killed, trapped or disturbed. It is to be ensured that during the project construction period these animals are protected.

Significant Species

Gangetic Dolphin (*Platinista gangetica*): Gangetic dolphin is an iconic and flagship species in Bangladesh. The species is considered endangered both nationally and globally according to IUCN Red list (IUCN 2015). In the past, they were abundantly found in all river systems in Bangladesh. However, the population has declined over time to an alarming degree. Degradation of river habitat and being caught due to food shortages are the major causes for their decline. Bangladesh Government considers its conservation as a priority.

Turtle Species: A diverse species of turtles are found in Bangladesh. Unfortunately, the populations of most of the turtle species have declined over time, mainly due to over exploitation, habitat degradation, pollution and food shortages. Three species of turtle have been reported from the project site. The Indian soft shell turtle is iconic in Bangladesh. This species is found at the Barishal and Ashuganj sites. This species is also endangered according to IUCN Red list and also protected under Wildlife (Conservation and Security) Act, 2012.

Hilsa shad: Hilsa shad (*Tennualosa ilisha*) is the single most commercial fish species in Bangladesh and contributes mostly to the fish demand in the country. It is also an exportable commodity. A huge workforce is involved with the hilsha fishery. The Bangladesh Government has an elaborate management plan to ensure its sustainable production. In Chadpur and Barishal sites hilsha fishing is a commercial activity. Hislsa fish also available in Ashugonj site. Although, this is not a protected nor a threatened species in Bangladesh, however, the sustenance of hilsa fisheries is a high priority area in Banglaesh fisheries as hundreds thousand of fisherfolk are directly is dependent on this fisheries resource

4.4. SOCIO-ECONOMIC ENVIRONMENT

4.4.1. Population, Demographic Profile and Ethnic Composition

In the 6 project locations, a census and socioeconomic survey has been conducted among the affected people. A total of 618 affected households (residential and commercial) consist of 3,343 individuals have been identified within the proposed boundary of the terminals. This section presents sociodemographic information of the people obtained from the census and socioeconomic survey as a primary source and Bangladesh Bureau of Statistics (BBS) as a secondary source. Population census of the Bangladesh Bureau of Statistics (BBS) 2011 report has been taken into account to calculate the total population in 2020 considering 1% increase rate per year. In the five project districts (Dhaka, Chandpur, Narayanganj, Barishal and Brahman Baria) population in 2020 stands at 24,687,676 including male 12,825,696 and female 11,861,979. Total HHs of these districts are 502,161 and total area is 8,459 square km. Average population density per sq. km is 2,919 persons/sq km with a range from 912 (in Barisal district) to 8993 (in Dhaka district). Average HH size in the project districts is 4.92 which is higher than the national average HH size (4.06 in 2016-HEIS) and lower than the same at the project footprint (5.40 as per census and SES). Table 88 presents demographic data for the project districts.

Table 88. Demographic information of the project districts

Districts	Total Population	Male	Female	Area (Sq. km)	Total HHs	Avg. HH size	Gender ratio	Population Density
Dhaka	13,162,647	7,165,119	5,997,528	1463.6	2,786,133	4.72	119	8,993
Chandpur	2,658,791	1,261,591	1,397,199	1645.28	506,321	5.25	90	1,616
Narayanganj	3,222,106	1,662,797	1,559,309	684.37	675,652	4.77	107	4,708
Barishal	2,539,752	1,242,567	1,297,185	2784.52	513,673	4.94	95.78	912
Brahmanbaria	3,104,380	1,493,622	1,610,758	1881.2	539,837	5.75	93	1,650
Total	24,687,676	12,825,696	11,861,979	8458.97	5,021,616	4.92	100.96	2,919

Source: BBS 2011 (Adopted in 2020)

Among the district population a very small percentage (0.0135%) will be affected by the project interventions at 6 terminals. Out of the total 3,343 affected people in the 6 terminal sites, 1,732 (51.81%) male and 1,611 (48.19%) female which is slightly lower than the national average (49.41% female)[21] . Male/female ratio in the project sites is almost similar in all 6 terminal areas except Barishal (22.97% female and 21.42% male).

Table 89. Affected population by sex

Location	Population					
	Male	%	Female	%	Total	%
Ashuganj	634	36.61	569	35.32	1203	35.99
Barisal	371	21.42	370	22.97	741	22.17
Chandpur	557	32.16	520	32.28	1077	32.22
Narayanganj	100	5.77	93	5.77	193	5.77

[21] World Bank, Tradingeconomics.com 2020

Location	Population					
	Male	%	Female	%	Total	%
Pangaon	69	3.98	57	3.54	126	3.77
Sashanghat	1	0.06	2	0.12	3	0.09
Total	1732	100	1611	100	3343	100
Percentage	51.81		48.19		100	

Source : Social Survey, S-6 Consultants, October-November 2019

In the project districts at least four categories of people i.e. Muslim, Hindu, Christian and Buddhist are found but in the terminal area only Muslim and Hindu people are affected. The Table underneath provides a breakdown of religious affiliation of affected people in the terminal areas. A total of 618 households are effected (3343 people) among which 96.76% are Muslim and remaining 3.24% are Hindu by faith. In the project districts Muslims are 93.58% Hindu 6%, Christian 0.34% and Buddhist and others 0.08%) There are no indigenous people (tribal or ethnic minority) living in the terminals hinterland and, therefore, no indigenous people are affected by the Project interventions under S-3 and S-4 components.

Table 90. Religion of Household Heads in the terminals

Location	Households by Religion		
	Hindu	Muslim	Total
Ashuganj	8	204	212
Barisal	7	147	154
Chandpur	3	179	182
Narayanganj	2	38	40
Pangaon		29	29
Sashanghat		1	1
Grand Total	20	598	618
Percentage	3.24%	96.76%	100

Source : Social Survey S-6 Consultants October-November 2019

Table 91. Religion of the people living in the Project districts

Administrative Unit	Muslims	Hindus	Christians	Buddhists	Others	Total
Dhaka	12,458,949	618,984	67,830	14,500	2,385	13,162,647
Chandpur	2,480,059	177,397	462	120	752	2,658,791
Narayanganj	3,062,925	157,492	1052	413	223	3,222,106
Barishal	2,229,612	296,620	13363	87	70	2,539,752
Brahman Baria	2,871,934	231,584	425	129	308	3,104,380
Total	23,103,479	1,482,077	83133	15,249	3,738	24,687,676
Percentage	93.58	6.00	0.34	0.06	0.02	100

Source: BBS 2011 (Adopted in 2020)

4.4.2. Gender and Women

The gender and development is concerned with the interdependent relations between men and women, the ways in which these relationships produce inequalities between them, for instance in access to resources within the family, community and wider institutions; while absence of discrimination on the basis of a person's sex in opportunities and the allocation of resources or benefits or in access to services confirm gender equality. The principle of "leaving no one behind" guides every goal of the 2030 agenda and the focus on gender equality and women's empowerment is explicit across all the SDGs, both as a stand-alone goal (SDG 5: Gender equality and empowerment of women and girls) on gender equality and as a cross-cutting theme with more than 30 related targets. Gender equality is a right as fundamental as any other in the national and international bills of rights, because in the long run, discrimination against gender consequently breeds violations of discriminated persons' other basic rights such as education, choice of partner, choice of career, decision making power and expression.

However, the constitution and basic laws of Bangladesh provide equal rights to men and women. There is a strong cultural preference for males over females in the male-dominated scenario of Bangladesh which exacerbates an imbalanced society. From fathers to husbands to sons, women are dependent on men throughout their lives. Women are more vulnerable than men because of their lack of control over the means of production, restricted mobility, limited facilities for education and jobs. The concept of gender equity not only recognizes the different needs of women and men, but also acknowledges that women and girls have been disadvantaged due to past discrimination and require additional support to rectify the existing gender imbalance.

According to the census survey result (Table 92), 48.19% of affected population are female in the six terminal area, meaning male –female ratio is 107.51 males vs. 100 females, while it was 102.83 males per 100 females in 2015 and 102.35 male per 100 female in 2019[22]. However, among the affected households, 561 are male headed and 57 are female headed. The female headed households are most vulnerable as per their socio-economic condition. Thus it is essential and highly recommended that any opportunity provided by the project must have equal access to women irrespective of their individual characteristics or differences across the country.Among the affected population in 6 terminals, the majority of them (63.50%) fall within the age group of 15-60 followed by age group 0-14 (28.20%) and age group more than 60 years (8.30%) . The percentage of working population (15-60 years) is considerably higher than the dependent population implying that most of the population belongs to the employable age group, which is vital for fueling the economic growth of the local area.

Table 92. Age group of affected people by gender

Location	Upto 5			5+ to 15			15+ to 30			30+ to 60			More than 60			Total		
	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total
Ashuganj	53	66	119	93	94	187	185	186	371	207	221	428	31	67	98	569	634	**1203**
Barisal	29	36	65	75	79	154	100	91	191	132	135	267	34	30	64	370	371	**741**
Chandpur	56	67	123	105	102	207	153	149	302	152	200	352	54	39	93	520	557	**1077**
Narayanganj	8	8	16	13	24	37	33	25	58	35	37	72	4	6	10	93	100	**193**
Pangaon	4	9	13	10	10	20	13	19	32	25	22	47	5	9	14	57	69	**126**

[22] GOB Web portal

Location	Upto 5			5+ to 15			15+ to 30			30+ to 60			More than 60			Total		
	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total	F	M	Total
Sashanghat							1		1	1	1	2				2	1	**3**
Total	**150**	**186**	**336**	**296**	**309**	**605**	**485**	**470**	**955**	**552**	**616**	**1168**	**128**	**151**	**279**	**1611**	**1732**	**3343**

Source : Social Survey S-6 Consultants October-November 2019

4.4.3. Gender Action Plan

A Gender Action Plan has been developed based on the magnitude of impacts on the women by the Project interventions following the World Bank guiedelines.

Table 93. Gender Action Plan

Component based Gender-related Objectives	Activity/Strategy	Performance/Target Indicators
Preparatory Stage		
Need to ensure due consideration on gender issues and analysis with opening up equal opportunities for male and female stakeholders in program planning, design and implementation procedures.	A full-time Gender Specialist in Bangladesh Regional Inland Waterway Transport Project (BRIWTP) will be recruited and responsible for supervision and reporting against the GAP throughout the Project period. Gather baseline sex-disaggregated data and gender analytical information for preparatory surveys, feasibility studies and assessments. Prepare relevant reports based on GAP and contribute to other project reports to ensure sex-disaggregated data and its implications.	A full-time Gender Specialist is appointed within BRIWTP and implement the programs as per GAP. Organize and facilitate equal participation and consultation of women affected by and involved in the Project during preparatory surveys, studies, FGDs, assessments and other consultative mechanisms. Collected sex-disaggregated data will be analyzed and prepare reports periodically on progress with GAP implementation.
Component 1: Improved Inland Waterway Navigation		
This component includes inland Waterway Maintenance through long-term performance-based contracts for: (i) dredging/river maintenance and provision of visual Aids to Navigation Class 1 route between	Any Civil works or maintenance work designed and constructed considering gender aspects and including features that are important from gender perspective, such as: – Safe lighting, separate toilets and waiting areas for male/ female, child-	Minimum 30% of jobs generated by civil works occupied by women. All construction contracts for project civil works include gender-specific core labor codes, and a code of conduct.

Component based Gender-related Objectives	Activity/Strategy	Performance/Target Indicators
Dhaka and Chittagong Corridor, including Class 1, 2 and 3 branches to Ashuganj, Narayanganj and Barisal; (ii) construction and maintenance of six vessel storm shelters along the aforementioned routes; and (iii) maintenance dredging of the main river ferry crossing routes (Chandpur and Shariatpur; Lakshmipor and Bhola; and Beduria and Laharhat). This component shall include work to maintain advertised depths and mark channel routes through provision of long-term (7-years) performance-based contracts for maintenance dredging and provision of visual aids to navigation including light buoys (lateral marks, cardinal marks, isolated danger and other marks), radar beacons (for navigation during rain and fog), leading lines and other aids to assist day and night navigation.	friendly access and facilities, video surveillance – Station design allows space for market stalls and women-run small businesses as well as female labors get work opportunities and equal wages. All sorts of studies/surveys and reports include reference to gender-disaggregated data and gender analytical information. Female beneficiaries and affected people are equally consulted and participate in meetings on surveys, studies, assessments and other consultative mechanisms. Sex-disaggregated data are reported on the process. Gender-specific physical design features evident in newly constructed infrastructure facilities. – Safe lighting, separate toilets and waiting areas, for male and female, child-friendly access and facilities, video surveillance - Space for market stalls and women-run small businesses in stations.	HIV/AIDS and Trafficking Prevention Program implemented encompassing all Project employees.
Component 2 Improved Services at Priority Inland Waterway Terminals and Landing Ghats/Stations		
This sub-component includes works to improve six common user cargo and passenger terminals with last mile connectivity access infrastructure as well as fifteen river landings on the Dhaka-Chittagong route and connecting routes. The passenger terminals included are: a new terminal at Shasanghat	Establish targets for female employment generation in any project civil works; Regulate adherence to gender-specific core labor codes and a code of conduct in construction company contracts for all civil works. Include information on potential negative impacts through raising awareness and information to all construction labor force.	Each resettlement committee has at least a female representative (revised from 50% of representatives in resettlement committees are women. 100% of affected female including small business and temporary shades/shops have received income restoration and livelihood support.

Component based Gender-related Objectives	Activity/Strategy	Performance/Target Indicators
near Dhaka, and rehabilitation / upgradation of three existing terminals at Narayanganj, Chandpur (reconstruction or completely new construction) and Barisal. The cargo terminals included in the project are: a new terminal at Pangaon near Dhaka and rehabilitation / upgradation of existing Ashuganj cargo terminal.	Ensure that women's needs are equally met through Resettlement Plan, e.g. quotas for women's participation in resettlement committees, specific attention to impacts on (predominantly female) shopkeepers Include responsibility for gender issues and gender analysis in Terms of Reference for all consultants, wherever relevant. Specific issues and gender related facilities for the women, elderly and disabled people in the terminals and vessels; some of the common issues are as follows: a) Separate toilets for male and female passengers as well as laborers b) Separate toilets with facilities for physically challenged people c) Enough lighting and visible location for female toilet considering security and safety d) Space for Breast feeding mother and pregnant women e) Separate prayer space for female with required facilities f) Water supply and useable condition must be ensured by proper maintenance of toilets and other facilities g) Must give priority to recruit local people including women for construction work h) No discrimination of wages for male and female laborers/workers for similar work i) Grievance Redress Mechanism for affected people and construction workers including women who are affected for this work.	100% compensation receipts with female and/or both husband and wife signatures. Separate toilets for male, female and physically challenged people are constructed separately with enough lighting at visible locations. Separate space for breast feeding mother, pregnant women and elderly people

4.4.4. Education

Among the affected people (above 5 years) in the 6 terminals 3.85% (Male 1.39%, Female 2.46%) are illiterate, 8.78% can write their name by virtue of the adult education program of Bangladesh government, 18.19% have dropped out before Primary School Certificate (PSC) examination and 11.07% passed PSC.

It is revealed that, 28.77% of the affected people with almost equal numbers of male and female (Male 14.37%, Female 14.40%) passed Junior School Certificate (JSC) examination while 10.08% (Male 5.52%, Female 5.56%) obtained Secondary School Certificate (SSC). After passing SSC, it is observed that number of female students declines compared to male. A total of 10.31% of affected people obtained graduation or higher degree, 6.22% male and 4.09% female. Table 93 below presents education level of the affected people by location and by gender.

Table 94. Education level of the affected people by location and by gender

Education Level	Ashuganj	Barisal	Chand Pur	Narayan Ganj	Pangaon	Sashan ghat	Total	By gender	
								Male	Female
Illiterate	1.20	3.99	5.98	6.21	7.08	0.00	3.85	1.39	2.46
Only Signature	2.95	14.94	8.81	14.12	18.58	33.33	8.78	4.02	4.76
Upto Primary	11.35	22.78	20.95	24.29	21.24	33.33	18.19	9.58	8.61
Primary School Certificate (PSC)	13.84	17.31	26.10	20.34	17.70	0.00	11.07	5.59	5.49
Junior School Certificate (JSC)	21.13	20.12	20.65	23.73	20.35	33.33	28.77	14.37	14.40
SSC/ Dakhil	14.67	9.02	7.02	5.65	5.31	0.00	10.08	5.52	4.56
HSC/ Alim	13.93	6.51	6.18	4.52	6.19	0.00	8.95	4.72	4.22
Graduate/ Fazil	8.95	2.81	2.83	1.13	1.77	0.00	4.89	3.06	1.83
Masters / Kamil	8.49	1.18	1.26	0.00	1.77	0.00	3.79	2.16	1.63
Higher Education	3.51	1.33	0.21	0.00	0.00	0.00	1.63	1.00	0.63
Total	**100**	**100**	**100**	**100**	**100**	**100**	100	51.41	48.59

Source : Social Survey S-6 Consultants October-November 2019

Physical Disability among the affected people

The social survey sought opinion of the household heads regarding disabled members in their family. According to the census survey about 96% of the affected people were found to be in good physical condition while 3% partially disable (one-eyed, arms broken, etc.) and only 0.96% were found to be totally disabled (Paralyzed, blind, old aged, etc.) who cannot move alone without the help of others.

This is representative of the total district population. Necessary measures for these disabled members would be taken in the terminals and vessels for their easy movement.

Table 95. Disability status of the affected people

Locations	Good		Partially Disable		Fully Disable		Total	
	No.	%	No.	%	No.	%	No.	%
Ashuganj	1166	36.35	32	31.07	5	15.625	1203	35.99
Barisal	711	22.16	26	25.24	4	12.5	741	22.17
Chandpur	1020	31.80	37	35.92	20	62.5	1077	32.22
Narayanganj	189	5.89	3	2.91	1	3.125	193	5.77
Pangaon	119	3.71	5	4.85	2	6.25	126	3.77
Sashanghat	3	0.09	0	0	0	0	3	0.09
Total	3208	95.96%	103	3.08%	32	0.96%	3343	100

Source: Social Survey S-6 Consultants October-November 2019

Source of Lighting

Electricity reached about 93.5 percent people in **Bangladesh** in 2019 as a source of lighting their households, compared to 90.1 percent in 2018, according to a report of the **Bangladesh** Bureau of Statistics (BBS) Jun 30, 2020. This scenario is very much consistent with the project area. It is found that more than 99% of the affected people enjoy electricity facility in the terminal area. Only 0.49% households use solar power/generator/IPS and similar numbers of HHs use Diesel/Kerosine.

Table 96. Source of lighting in the terminal areas

Project Locations	Source of lighting			Total
	Diesel/ Kerosin	Electricity	Solar/Generator /IPS	
Ashuganj	0	211	1	212
Barisal	1	153	0	154
Chandpur	1	179	2	182
Narayanganj	1	39	0	40
Pangaon	0	29	0	29
Sashanghat	0	1	0	1
Total	3	612	3	618
Percentage	0.49	99.03	0.49	100

Source: Social Survey S-6 Consultants October-November 2019

4.4.5. Settlement and Housing

Urban and semi-urban living in Bangladesh is the standard settlement in all the project locations under S3 and S4. Low-income high-density housing areas in spontaneous urban poor settlements (or slums and squatter areas) consists of apartment housing together with some kutcha and semi- pucca structures like rural settlements. It is estimated that 555 entities (111 residence and 444 shops) out of 618 affecetd HHs will be physically displaced due to the project interventions. In the Six terminals under S3 and S4, three community properties and 18 other offices/ institutions have been found affected. The community properties include two Madrasahs and one Mosque at Chandpur and another mosque at Pangaon. Offices/institutions include Government office, government school, Samity (Society), and the labor union. Compensation and special grants for the CPRs will be paid to the Management Committee for the construction of a better one. The mosque will be dislocated since it is fully affected but the Madrasahs

are partially affected and not required displacement. Management committee/authorities may take away salvageable materials free of cost within the BRWTP declared deadlines.

Such offices and CPRs are affected on government land. Table underneath presents affected entities including residential HHs, Commercial enterprises, Offices and CPRs by location. CPRs include two Madrasah and one mosque (operated by community) and offices /institutions include government school, offices, club, labor union, etc.

Table 97 presents the number of households and types of housing structure for each of the project districts. The dominant type of housing by building material is pucca and semi-pucca in the vicinity while most of the affected structures are semi-pucca and tin-made in the foot print of the project locations. Building design and Technology are important components in housing as these reflect the cultural, social and functional needs of the people in this sense. Most areas are experiencing transformation, with adoption of urban housing designs, or construction of two or even multistoried buildings.

Table 97. Distribution of affected entities by location

Affected in Category	Location						
	Ashuganj	Barisal	Chandpur	Narayanganj	Pangaon	Sashanghat	Total
Residential	13	12	87		1		**113**
Commercial	142	137	86	40	15	1	**421**
Both Residential and Commercial	6		5				**11**
Sub-total of Residential and Commercial	161	149	178	40	16	1 ç	**545**
Land	43						**43**
Pond					1		**1**
Tree			1		7		**8**
Secondary Structure	8	5	3		4		**20**
Sub-total of other affected entities	51	5	4	0	12	0	**72**
Total	**212**	**154**	**182**	**40**	**29**	**1**	**618**
Offices	2	3	2	1	1	1	10
CPRs and other institutions	5	2	4	1	01	0	13
Grand Total	**219**	**159**	**188**	**42**	**30**	**2**	**640**

Source : Social Survey S-6 Consultants October-November 2019

Among the affected households, more than 6% are losing pucca (concrete roof with brick wall and floor) structures, 46% are losing semipucca (CI sheet roof with brick wall and brick/earthen floor) structures. Apart from these two types, more than 26% households use Tin-made (CI sheet roof and walls) and 21% use Katcha (CI Sheet roof with bamboo/wooden walls) and only 0.61% use thatched (straw roof with bamboo/straw walls) in the terminal area.

Table 98. Categories of affected structures at the 6 terminals

Type of structures	Area (Sft.) by site						Total	%
	Ashuganj	Barishal	Chandpur	Narayanganj	Pangaon	Shashangh at		
Pucca	6,239	4,237	72	-	418	-	10,966	6.25
Semi-pucca	63,942	1,938	13,690	176	1,125	-	80,871	46.08
Tin-Made	3,424	7,705	32,647	1,228	1,051	-	46,055	26.24
Katcha	33,206	784	256	1,945	324	19	36,534	20.82
Thatched	250	668	156	-	-	-	1,074	0.61
Total	107,061	15,332	46,821	3,349	2,918	19	175,500	100
Percentage	61.00	8.74	26.68	1.91	1.66	0.01	100	

Census and IOL survey , S-6 Consultants, October –November 2019

4.4.6. Land Use

Land use pattern adjacent to the river route has different scenarios for rural and urban sites. Terminals are established in urban or semi urban areas that have developed the Ghat areas as commercial centers of the region with shops and markets. These terminals generate sources of livelihoods for thousands of households. On the contrary, the terminals in rural regions with minimal transportation facilities are mostly surrounded by fallow land, cultivable land, ponds, ditches, and canals. For example, Doulatkhan of Bhola and Sandwip of Chittagong, etc. have fewer shops and commercial entities compared to other terminals. Almost 65% of the private land around the Ferry Ghats and Launch Ghats are found to be used for agricultural production. Most of the titleholders use their land for commercial purposes. Most of the non-titleholders are using government land for business and other purposes. Detailed socio-economic and cultural information has been gathered from the census and socio-economic baseline survey.

4.4.7. Community Safety and Health

The public health system in Bangladesh is hierarchically structured as a five-layer pyramid of health facilities. At the base of the pyramid there are community clinics (**CC**), which are the most proximate facilities to the communities, providing very basic health care. At the next level, are the Union Health and Family Welfare Centers (**UHFWC**) and/or the Union Sub-Centers (**USC**)/rural dispensaries (**RD**), which concentrate on maternal and child health care and provide only limited curative care. At the Upazila (sub-district) level, the Upazila Health Complex (**UzHC**) is responsible for inpatient and outpatient care, maternal and child health services, disease control and emergency care including response to gender-based violence (GBV).

While the bottom three layers provide primary health care, the fourth layer of the pyramid, the District Sadar Hospital (**DSH**), provides secondary care, including some specialized services, and manages cases referred from the lower levels. The highest layer of the pyramid is the tertiary tier, consisting of the teaching hospitals attached to the medical college and post graduate institutes offering a wider range of specialty services.

The current doctor-patient ratio in Bangladesh is only 5.26 to 10,000, that places the country at second position from the bottom, among the South Asian countries, according to the WHO (2019)

The doctor-patient ratio in other South Asian countries are, 7.77 in India, 9.75 in Pakistan, 9.5 in Sri Lanka, 6.5 in Nepal, 8.6 in Myanmar, and 22.3 in Maldives. Only Bhutan is placed behind Bangladesh in maintaining the ratio. Bhutan has 3.7 doctors to every 10,000 population, WHO data states.

The country also falls behind from all of its South Asian neighbors in nurses-patient ratio as it has only 3.06 nurses to provide services to every 10,000 population.

The nurses-patient ratio in other South Asian countries are, 21.07 in India, 21.15 in Sri Lanka, 26.85 in Nepal, 15.09 in Bhutan, 9.79 in Myanmar, 5 in Pakistan and 3.02 in war torn Afghanistan

The Government of Bangladesh has been relentlessly working for development of the public health and reducing maternal and infant mortality rates. Maternal mortality rate is being declined every year by 6%-7%. For instance, the maternal mortality rate for 2017 was 173.00, a 6.99% decline from 2016 which was 186.00 in 2016 (7% decline from 2015) and similarly it was 200 in 2015 (a 6.54% decline from 2014). Regarding the infant mortality rate, it has been falling in Bangladesh in the past decade, from 40.5 deaths per 1,000 live births in 2009 to 25.6 in 2019 (MoHPW October 6, 2020).

According to World Health Organization (WHO), total population in Bangladesh in 2020 was 164,689,383 among them omen of reproductive age (15–49 years) in 2020 was 46,215,591. WHO presents the mortality rate and growth rate[23] and population growth rate in the last three years are as under-

Year	Death Rate	Death growth rate	Population Growth Rate
2020	5.541	-0.070%	1.00%
2019	5.545	-0.050%	1.01%
2018	5.548	-0.200%	1.03%

Bangladesh has made substantial progress in improving sanitation coverage across the country. According to the WHO/UNICEF Joint Monitoring Programme (JMP), in 2000, approximately 18% of the population was practicing open defecation (JMP 2017).

As of 2018, the country had nearly ended open defecation. Bangladesh has made significant progress in reducing open defecation, from 34 percent in 1990 to just one percent of the national population in 2015. However, the current rate of improved sanitation is 61 percent, growing at only 1.1 percent annually.

Still, the quality of sanitation coverage is an emerging area of concern, with more than 40 percent of all latrines classified as “unimproved.” Drinking water access is widespread, but half of the drinking water consumed fails to meet water safety standards. In urban areas of Bangladesh, piped water supply reaches only about one-third of the population, and there is no systematic sewer disposal and treatment system. Only Dhaka, Bangladesh’s capital city, has a sewer system, and it serves just 18 percent of the city.

In the 6 terminal areas affected, people mostly use sanitary toilets (75.40%) followed by slab/water sealed toilets (22.17%). Only 1.94% use Katcha (made of CI sheet/wood, non-water sealed) and only 0.49% practice open defecation which is very much consistent with the national statistics as stated above.

[23] All 2020 and later data are UN projections and DO NOT include any impacts of the COVID-19 virus.

Table 99. Use of toilets by affected people

Location	Type of Toilets				
	None	Open/Katcha	Slab	Sanitary	Total
Ashuganj		1	4	207	212
Barisal		2	54	98	154
Chandpur	2	8	67	105	182
Narayanganj			10	30	40
Pangaon	1	1	2	25	29
Sashanghat				1	1
Grand Total	3	12	137	466	618
Percentage	0.49	1.94	22.17	75.4	100

Source: Census and Socioeconomic Survey, S-6 Consultants October-November 2019

4.4.8. Transport

Sadarghat has connectivity but needs to be upgraded. Shasanghat proposed IWT terminal is located 2.5 km Southeast of Sadarghat terminal which is connected by a 7m wide road owned by BIWTA authorities. The proposed Shasanghat IWT terminal is facing South-West on the Left bank of Buriganga River. Dhaka is, to the North of the Shasanghat terminal location from where a large amount of traffic may be destined to Shasanghat Terminal. There are Multiple National and Regional highways connecting Dhaka to Shasanghat of which the N3 Dhaka- Mymensingh Highway is one of the major routes.

It is observed that, from East and South-East direction National and Regional highways N1 Dhaka-Chittagong Highway, R110 Jatrabari-Demra-Shimrail-Narayanganj (Chasara Road), and R810 Postagola-Narayanganj (Chasara Road) travel to Shasanghat, connecting Shasanghat with the adjoining areas such as Narayanganj, Rupganj, Munshipur, Sonargaon etc. It is observed that from SSW and SWW direction National and Regional Highway N8 Dhaka- Patuakhali Highway, R820 Zinzira-Keraniganj-Nawabganj-Dohar-Srinagar Road connects Shasanghat with the abovementioned directional areas such as Zinzira, Kathuria, Kadamtali, Zhaubari, Chatgaon, Goljarbag, Charkaliganj, Kaliganj, Najirabag, Khejur Bagh etc. N5 Dhaka- Banglabandha/Aricha Highway connects Shasanghat from the North-West, which is one of the major highways, as it has to cover the entire North West region, connecting Gabtoli, Aminganj etc.

Narayanganj has well-established connectivity with roads, railways, and IWT (Passenger & Cargo) but needs to be upgraded. Narayanganj IWT terminal which is connected by about 7m wide port road is owned by BIWTA authorities and is the Sahid Suhrwardi Road. The proposed Narayanganj IWT terminal is facing east on the right bank of Shitalakshya River.

The highways that arrives to Narayanganj are R110 Jatrabari-Demra-Shimrail-Narayanganj (Chasara Road), R111 Dhaka Narayanganj Road and R810 Postagola-Narayanganj (Chasara Road). It can cater for the traffic from the adjoining areas such as Fatullah, Sastapur, Kutubail, Nasdair, BSCIC, Hariharpar, Etimkhana, Norsingpur, Baburail, Pagala, Delpara Sarder Bari, Madani Nagor, Bhuigor etc. The railway line from the Nortwest and Northwest (Syleth Zone) originates and at the Narayanganj Railway Junction.

Chandpur is a very old Port, having multi-modal connections with the steamer, rail and road transport system. The main approach and exit from Chandpur Port site is through Madrasa Road to the Station Road and then on to the town. There is a bottle-neck bridge at the entrance of Madrasa Road. This old bridge needs to be reconstructed with sufficient width and adequate design.

Steamer routes exist from Calcutta (Kolkata) to Narayanganj via Chandpur and vice versa, with railway connections to the big cities of Chittagong and Dhaka. Dhaka, Sadarghat and Narayanganj which are 95km, 60km and 70 km to the NNW of Chandpur and Chittagong is 181km SW of Chandpur. As such Chandpur acts as an intermediate station between Dhaka and Chittagong.

Chandpur is also well connected with National, Regional and Zilla highways and roads. The highway towards Chandpur from Northeast region consists of N1 Dhaka–Chittagong Highway, N102 Comilla-Sylhet Highway, R140 Comilla-Chandpur Highway and the R141 Comilla-Laksam- Chowmohani-Noakhali Highway. The N1 highway has an intersection at Comilla from where one can proceed through R140 to reach Chandpur which is a distance of about 70km, which is feasible for passenger travel in the direction of Dhaka to Chittagong.

Barishal has well-established road connectivity. The main National Highway-8(N8) connecting Dhaka-Patukhauli passes through Barishal city. The two-lane Ring road, of about 12 m width, from Barishal river port directly connects N8 at a distance of 2.5 km in South-West direction and the Ring road also connects the National Highway-809 (N809)- connecting Barishal to Bhola on opposite bank through the cross-ferry service beside the terminal which also provides connectivity with the southern area opposite the Kirthankola river bank.

The Regional Highway R870-Barishal-Pirojpur Highway connects to the N8 near Dapdapia Bridge. Further ahead the N8 crosses the Dapdapia Bridge on the opposite bank of the terminal area which connects the National Highway-809(N809)- connecting Barishal to Bhola

The Ashuganj river port is in Brahmanbaria district under Ashuganj Upazila. This port is located about 60 km from Dhaka city and 28 km and 43 km respectively from Brahmanbaria town and the Akhaura land border between Bangladesh and India. Ashuganj port acts as a port of call for cargo shipments to the nearby Indian state of Tripura. Cargo unloaded in Ashuganj port is transported by road to the Akhaura-Agartala land border; and vice versa.

The transhipment route allows access for several Indian states, including Mizoram, Manipur, Nagaland and Lower Assam. This port plays an important role in the river transport of Bangladesh. This port currently plays an important role in the river transport of Bangladesh.

Pangaon cargo terminal is a part of the Port of Dhaka. The port is located at Keraniganj Upazila of Dhaka district. It is located on the West bank of the river Buriganga and is opposite the Pagla river port. The ghat at proposed terminal area is currently using 60 country boats for carrying passengers to cross the Buriganga River between Pagla and Pangaon.

At present, on an average, roughly 30,000 people travel to and from Dhaka and Narayanganj through Pagla Ghat (on the East bank) and Pangaon Ghat (West bank of Buriganga river) to different destinations of Keraniganj & numbers of Upazilas of Munshiganj districts and also to Mawa ferry Ghat and Padma Bridge, 24 hours a day.

4.4.9. Public Utilities: Water Supply, Sanitation and Solid Waste

Though Bangladesh has for many years enjoyed almost universal access to drinking water, arsenic contamination of 22 percent of the country's tube wells lowered the service coverage to below 80 percent.

Among the affected 618 households, about 57% use their managed deep tubewell water and about 25% use pipe water supply from the municipality. About 17.64% of the affected households depend on hand tube wells for drinking water. Regarding safe water supply to Population, Tables below outlines the scenario at project districts and their terminal areas.

Table 100. Source of drinking in project districts

Administrative Unit	Number of Households	Percentage of Source of Drinking Water		
		Pipe supply %	Tube well %	Others %
Dhaka	2,786,133	62.92	30.25	6.84
Chandpur	506,321	5.99	87.95	6.06
Narayanganj	675,652	17.72	77.39	4.89
Barishal	513,673	1.63	93.31	5.06
B.Baria	538,937	2.17	93.67	4.16

Source: BBS 2011

Table 101. Sources of drinking water in the terminal area

Location	Source of drinking water				Total
	Deep Tubewell	Pipe line	Hand Tube well	Bottled water	
Ashuganj	137	24	47	4	212
Barisal	95	35	24		154
Chandpur	73	85	24		182
Narayanganj	26	7	7		40
Pangaon	21	1	7		29
Sashanghat		1			1
Total	352	153	109	4	618
Percentage	56.96	24.76	17.64	0.65	100

Source : Social Survey S-6 Consultants October-November 2019

As is known, the terminals are located at urban or semi-urban area, therefore water supply and sanitation condition is relatively better. Among the affected people in six terminals, people of Shasanghat and Pangaon under Dhaka district count on piped supply water for domestic use including drinking, dish/cloth washing, bathing, etc. while at Chandpur and Barishal a significant number of people use river/pond water for domestic use.

It is revealed that people of Narayanganj do not use river water, even for domestic use, since the water quality of Shitalakhya River is quite poor. It is good sign that most of the affected people at Shasanghat, Pangaon (under Dhaka), Narayanganj and Ashuganj (Brahman Baria) use sanitary (water sealed) toilet, while about 97% use sanitary water at Chandpur and Barishal. Sustainable Development Goal (SDG) 6.1 and 6.2 ensure safely managed sanitation systems in each of the households.

Tables 100 and 101present water supply for domestic use, drinking and sanitation facilities among the affected people and sources of drinking water in the district level.

Table 102. Sources of water for domestic use among the affected people

Source of Water for domestic use	Pangaon & Shasanghat (Dhaka %)	Chandpur %	Barishal %	Narayanganj %	Ashuganj (B. Baria) %
Deep TW/ Pipe supply/Tap	100.00	60.53	51.61	88.89	72.10
Hand Tube Well	0.00	18.42	6.45	11.11	20.92
Pond/River	0.00	21.05	41.94	0.00	6.98
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source : Social Survey S-6 Consultants October-November 2019

4.4.10. Economy and Employment

The socioeconomic survey revealed that among the affected 618 HHs in six terminals, all of them are identified as businessmen in Dhaka (Shasanghat, & Pangaon) and Narayanganj while it is 87% at Barishal, 80% at Ashuganj (Brahman Baria) and 52% at Chandpur., Other main occupation household heads were found to be fishermen (19.44%) and in service (12.50% at Brahman Baria and 11.12% at Chandpur) (Table 102).

During construction of the project businessmen/traders will be temporarily dislocated but will be paid compensation and resettlement benefits for loss of structures and restoration of business. Suppliers and other large and medium scale businessmen/traders will get the opportunity to perform as sub-contractors or suppliers of necessary goods for the laborers. It is to be noted that at Ashuganj and Chandpur significant numbers of residential households will be affected within the proposed site. Eligible members of the HHs may get preferential employment in the construction process.

Table 103. Occupation of the sampled HH heads

Occupation	Pangaon & Shasanghat (Dhaka %)	Chandpur %	Barishal %	Narayanganj %	Ashuganj (B. Baria) %
Business/trade	100.00	52.78	87.50	100.00	80.00
Service	0.00	11.11	3.13	0.00	12.50
Fisherman	0.00	19.44	3.13	0.00	0.00
Housewife	0.00	5.56	3.13	0.00	2.50
Carpenter	0.00	5.56	0.00	0.00	0.00
Day Laborer	0.00	0.00	0.00	0.00	5.00
Student	0.00	0.00	3.13	0.00	0.00
Mason	0.00	2.78	0.00	0.00	0.00
Boatman	0.00	2.78	0.00	0.00	0.00
Grand Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Source : Social Survey S-6 Consultants October-November 2019

4.4.11. Income and Poverty

It is known that the terminal areas are full of small business units/shops run by poor people for their livelihood. Most of the business units are small or medium scale and a very few are large scale. Incoem level of the small businessmen is quite low. According to the income level of the affected households (618), a total of 276 households are found vulnerable among which 241 HHs have been identified income under poverty line (BDT 21000), 17 HHs are headed by the person with physical disability and 18 HHs are both (income under poverty line cum disable). The households, living under the poverty line[24] and persons with disability have been mostly identified in Chandpur site (118 out of 276 households) followed by Barishal (95 out of 276). It is revealed from the census and socioeconomic survey that very few affected households have fallen under the poverty line at Narayanganj, Ashuganj and Pangaon while no one have been identified at Shashanghat.

Household living below the poverty line are called vulnerable and they will be entitled to additional grants on top of other compensation. They will also be provided skill development training (one from each vulnerable HHs) under the RAP policy on income generating activities with seed grant, market linkage and linkage with financing institutions under income and livelihood restoration program (ILRP). Apart from these, vulnerable people will get preferential employment opportunities in the civil construction of the project according to their eligibility. The table underneath presents income level of the affected households at six terminal locations.

Table 104. Income and poverty level of the HHs

Income range	Ashuganj	Barisal	Chandpur	Narayanganj	Pangaon	Sashanghat	Total
Up to 21000	12	94	113	23	16	1	**259**
21001-30000	27	31	39	15	10		**122**
30001-40000	16	18	7	0	1	0	**42**
40001-50000	24	7	10	1	0	0	**42**
50001-60000	17	0	6	0	0	0	**23**
More than 60000	116	4	7	1	2		**130**
Total	212	154	182	40	29	1	**618**

[24]According to the Household Income and Expenditure Survey (HIES) 2016 of the Bangladesh Bureau of Statistics (BBS) the upper poverty line for HH size of 4.06 in 2016 was BDT 15,988 per HH/month. Acknowledging the average HH size of the project area (5.40) BDT 21000 has been adopted as the 2020 poverty line for the project. Therefore, HHs with average income up to BDT 21,000 per month is considered to be living under the poverty line.

Table 105. HHs under poverty line including HH Heads with physical disability

Location	Under Poverty Line			Disable			Both (under poverty line cum disable)			Total		
	Male Headed	Female Headed	Total	Male Headed	Female Headed	Total	Male Headed	Female Headed	Total	Male Headed	Female Headed	Total
Ashuganj	8	2	10	7	1	8	1	1	2	16	4	20
Barisal	73	16	89	1		1	3	2	5	77	18	95
Chandpur	94	8	102	5		5	9	2	11	108	10	118
Narayanganj	23		23							23	0	23
Pangaon	15	1	16	3		3				18	1	19
Sashanghat	1		1							1	0	1
Grand Total	**214**	**27**	**241**	**16**	**1**	**17**	**13**	**5**	**18**	**243**	**33**	**276**

4.4.11 Loans and Savings of the affected people

Project affected people have taken loan from various agencies i.e. NGOs, Bank, Relatives and Friends, etc. for their livelihood. It is found that about 392 householdls out of 618 households have taken loan from various sources among them 53.32% from NGOs, 28.83% from the Banks and 15.82% relatives. Amomg the loan receivers it is reported that they have loans of minimum BDT 10000 and maximum BDT more than BDT 100,000. Large amount as loan has been taken by the businessmen of Ashugnj for their business. About 91 businessmen have taken loan of BDT more than 100,000. Only one HH is affected at Shashanghat who has reported no loan or savings.

Among the affected HHs, 300 HHs have savings with a minimum of BDT 1000 to maximum more than BDT 100,000. The tables underneath present loan and saving status of the affected HHs in five locations. (except Shashanghat).

Table 106. Source of Loan taken by the PAHs

Location	Source of Loan					
	Bank	Friends	NGO	Relative	Others	Total
Ashuganj	65	1	11	22	3	102
Barisal	28		85	15	1	129
Chandpur	16	1	75	21	2	115
Narayanganj	2		23	3		28
Pangaon	2		15	1		18
Total	**113**	**2**	**209**	**62**	**6**	**392**
Percentage	28.83	0.51	53.32	15.82	1.53	100

Source : Social Survey S-6 Consultants Octoberr 2019 to February 2020

Table 107. Loan Information

Location	Loan Amount (BDT)			
	10000-50000	50001-100000	More than 100000	Total
Ashuganj	4	7	91	102
Barisal	61	33	35	129
Chandpur	46	34	35	115
Narayanganj	17	5	6	28
Pangaon	10	4	4	18
Total	**138**	**83**	**171**	**392**

Source : Social Survey S-6 Consultants Octoberr 2019 to February 2020

Table 108. Savings Information

Location	Range of Savings (BDT)			Total (HHs)
	Up-to BDT 50,000	BDT 50,000-100,000	More than 100,000	
Ashuganj	20	8	27	55
Barisal	111	3	1	115
Chandpur	82	4	2	88
Narayanganj	26			26
Pangaon	15	1		16
Total	**254**	**16**	**30**	**300**
Percentage	84.67	5.33	10.00	100

Source : Social Survey S-6 Consultants Octoberr 2019 to February 2020

4.5. LANDSCAPE AND SCENIC AREAS

The existing landscape and its existing visual context all contribute to the existing "baseline" for landscape and visual assessment studies. The assessment of the potential effect on the landscape is carried out as an effect on an environmental resource, i.e. the landscape features or characteristics.

Landscape effects derive from changes in the physical landscape, which may give rise to changes in its character and how this is experienced. This may in turn affect the perceived value ascribed to the landscape.

The initial step in any landscape or visual impact assessment is to review the existing landscape and visual resource in the vicinity of the proposed development, which are the baseline landscape and visual conditions. The initial assessment of existing landscape will form the basis from which the magnitude and significance of the landscape effects of the development will be identified and assessed.

The purpose of baseline studies is to record and analyze the existing landscape features, characteristics, the way the landscape is experienced, and the condition and the value or importance of the landscape and visual resources in the vicinity of the proposed development.

Any special values that may apply, such as designated landscapes i.e. forested areas, natural areas, water bodies, conservation areas, listed buildings, land use, etc., in the vicinity of the Development Site as well as residents, visitors, travelers through the area and other viewing groups should also be noted.

The sensitivity of the landscape to the development proposed is the major characteristics that should be considered for further impact assessment.

The area of study for the visual assessment may extend to the whole of the area from which the Development Site and its proposed scheme is visible (the visual envelope or zone of visual influence).

Following pictures shows current visual conditions and landscape value for the Project sites:

Figure 170. Landscape. Ashunganj site

Figure 171. Landscape Barishal site

Figure 172. Landscape Chandpur site

Figure 173. Landscape Narayanganj site

Figure 174. Landscape Pangaon site

Figure 175. Landscape Shasanghat site

An evaluation of landscape value and character of each site have been made using the following criteria:

Table 109. Landscape Value criteria

Value	Typical criteria	Typical scale of importance/ Rarity	Typical examples
Exceptional	High importance and Rarity. No or limited potential for substitution	International, National	World Heritage Site, National Park, unique ecosystem
High	High importance and Rarity. Limited potential for substitution.	National, Regional, Local	Conservation area, historical/ cultural site. Non-disturbed area.
Moderate	Moderate importance and Rarity. Limited potential for substitution.	Regional, Local	Undesignated but of value even if some disturbance occurs.
Low	Low importance and Rarity. Considerable potential for substitution.	Local	Areas identified as having some redeeming feature or features and possibly identified for improvement.
Poor	Low importance and Rarity.	Local	Degraded areas, low or poor biodiversity, no visual value, areas identified for recovery.

The condition of the landscape has been assessed using the following criteria:

Table 110. Landscape Condition criteria

Good	Where the landscape and its features are in good repair/quality and have a high contribution to landscape character.
Moderate	Where the landscape and its features are in average repair/quality and make a medium contribution to the landscape character.
Low	Where the landscape and its features are in poor repair/quality and make a low contribution to landscape character.

Landscape valuation and landscape condition for the Project sites are shown in Table 110:

Table 111. Landscape valuation and landscape condition for the Project sites

Project development site	Landscape evaluation	Landscape condition
S3 package		
Shasanghat	poor	Low
Barishal	poor	Low
Narayanganj	poor	Low
Chandpur	poor	Low
S4 package		
Pangaon	low	Low
Ashunganj	poor	Low

5. POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS

The ESIA report is a statement of the likely impacts of a project and how these can be mitigated and managed. It is a planning and decision document, not a compendium of technical information. As such, the ESIA report is both rigorous and easy to understand. It must effectively communicate the findings to the public at large, local people affected by the proposal and interest groups, as well as decision-makers who are the primary users.

The information contained in this report meets the terms of reference established at the scoping stage of the ESIA process, as submitted and approved by to the responsible authority. (DoE, Department of Environment, Government of the People of Bangladesh).

The purpose of the ESIA report is to provide a coherent statement of the potential impacts of a proposal and the measures that can be taken to reduce and remedy them.

This chapter describes the environmental impacts that are likely to result from the project activities during construction and operation. The interaction between various project components and environmental elements are being analyzed to identify and evaluate impacts. A summary of these impacts and interactions has been described in ESIA Identification Matrix and Impact Magnitude tables.

Mitigation measures proposed to be taken to minimize environmental, biological, and social impacts are also discussed. EMF Guideline prepared for the project was referred. Public consultations and observations during field survey of the project sites were important inputs and incorporated in the mitigation measures.

The description of the study area, together with the environmental diagnosis made on it in the above sections, together with the description of project actions, allow identifying and analyzing the potential environmental conditions derived from the planned actions.

5.1. METHODOLOGY

The Assessment identifies, analyzes, and assesses environmental and social impacts of the Project. It distinguishes between positive and negative impacts, major or minor intensity, immediate or long-term impact, its timing, reversibility, and persistence. The significance of impacts of the proposed project will be assessed on its magnitude, and the basis of this assessment will be specified.

5.1.1. Impact Identification & Prediction

The ESIA report focuses on Valued Environmental Components or VECs that could be most affected by the Project and those that are a concern to governments, community members and stakeholders.

VECs are derived from baseline analysis carried out in previous chapters and broken down into environmental and social receptors and in subsequent scoping focus on potential environmental and social disturbance of the projects. Table 112 lists the identified VECs for this Project, and the specific factors that were considered for each in order to undertake the impact assessment.

Table 112. Environmental and Social Receptors (VECs) considered for this ESIA

Environmental and Social Receptor	Factors to be considered
Water Resources	▪ Changes in surface water quality and movement ▪ Changes in groundwater quality ▪ Changes in freshwater/groundwater demand ▪ Changes in groundwater quantity
Geological Resources	▪ Sand availability for filling ▪ Sustainability of construction aggregate quarrying ▪ Changes in soil quality ▪ Changes in siltation pattern
Coastal Hydrodynamics	▪ Changes in wave patterns ▪ Changes in current regime ▪ Changes in littoral drift ▪ Changes in erosion rates ▪ Changes in accretion rates
Atmospheric Environment	▪ Change in air quality ▪ Climate change
Acoustic Environment	▪ Change in sound quality (noise and vibration)
Aquatic Environment	▪ Change in benthic environment ▪ Change in fish and fish habitat area ▪ Change in the usability of fisheries resources ▪ Change in the abundance or distribution of aquatic species of concern (IUCN Red List)
Terrestrial Environment	▪ Change in wildlife populations including migratory birds and their habitat ▪ Change in vegetation, particularly with respect to shoreline vegetation
Community Services and Infrastructure	▪ Change in transportation network (aquatic and terrestrial) ▪ Change in demand on utility networks ▪ Increased demand for solid and septic waste disposal ▪ Change in housing and accommodation
Land and Resource Use	▪ Change in land and resource use (use and enjoyment of land for current purposes – recreation, fishing, subsistence, etc.)
Social Environment	▪ Change in the cultural patterns or activities ▪ Changes in access to opportunities (education, youth, women, disabled persons, etc.) ▪ Change in income levels
Community Health and Safety	▪ Changes to community health (GBV, communicable disease, influx of labor, etc.) ▪ Changes to community safety (accidents, unplanned events, etc.)

5.1.2. Impact Identification: The ESIA matrix

A logical and systematic approach needs to be taken to impact identification. The aim is to take account of all of the important environmental/project impacts and interactions, making sure that indirect and cumulative effects, which may be potentially significant, are not inadvertently omitted. Relatively simple methodologies and tools are applied to impact identification as the first approach; these simple methods are of proven value for undertaking a systematic approach to impact identification.

The most common formal method used for impact identification is the matrix. Matrices are a good method to linking action to impact and for displaying ESIA results.

To have an integrated approach for the impact assessment, a simple matrix is designed. This matrix is based on a concept of rapid Impact Assessment, which is ideally to provide a rapid and clear assessment of the existence of major impacts. This is the first step and simple exercise to identify where potential impact may occur.

That is achieved by preparing a double array, one as a simple breakdown of the environment in elements or factors that may be affected, and a simple breakdown of the various actions or activities of the project under study likely to produce an impact on the said environmental factors.

A matrix is used therefore, as a grid able to identify the interaction between environmental characteristics which are displayed along one axis, and project activities, which are displayed along the other axis.

5.1.3. ESIA Matrix of impacts

For each environmental and social factor main likely impacts are identified for each stage of the project, construction and operation. Environmental factors are placed on rows and actions likely to produce impacts are placed in columns, thereafter, likely impacts are identified and pointed out with corresponding crossings.

Table 112 is the ESIA Identification Matrix for construction phase and the ESIA Identification Matrix for both construction and operation phases are given.

Table 113. ESIA Identification Matrix. Construction Phase. Identified impact highlighted in blue cell.

Impact Identification Matrix		PROJECT´S ACTION DURING CONSTRUCTION PHASE										
		Mobilization of Workers, Heavy Machinery, Equipment and Material.	Camp site operation during construction phase	Land cleaning and topsoil removing	Filling & leveling	Earth movement: Excavations. Land-side develop.	Excavations and dredging Water- side development	Dumping of dredge materials and building materials	Construction of buildings	Construction of paved surfaces, parking, Land-side development	Pilling and Jetty Construction/pile-supported concrete platform (suspended – deck)	Basement and Access Road Construction
AIR QUALITY	Pollutants and Dust	■	■	■		■		■	■	■		■
NOISE AND VIBRATION	Excessive Noise and Vibration	■	■			■	■	■	■		■	■
LANDSCAPE	Change of Landscape			■	■	■		■	■			
TOPOGRAPHY, GEOMORPHOLOGY AND GEOLOGY	Contor alteration and land change			■	■	■		■		■		■
SOIL QUALITY AND EROSION	Change of Soil structure and Erosion effect		■	■	■	■	■	■				■
	Contamination of Soils	■	■	■	■	■	■		■	■		■
	Change of coastline				■		■				■	

Impact Identification Matrix		PROJECT´S ACTION DURING CONSTRUCTION PHASE										
		Mobilization of Workers, Heavy Machinery, Equipment and Material.	Camp site operation during construction phase	Land cleaning and topsoil removing	Filling & leveling	Earth movement: Excavations. Land-side develop.	Excavations and dredging Water- side development	Dumping of dredge materials and building materials	Construction of buildings	Construction of paved surfaces, parking, Land-side development	Pilling and Jetty Construction/pile-supported concrete platform (suspended – deck)	Basement and Access Road Construction
COAST AND SHORELINE	Riverbank erosion						■				■	
WATER QUALITY AND HYDROLOGY	Water quality	■	■	■		■	■	■			■	
	Water regime			■		■		■				
	Sediment quality				■		■				■	
GROUNDWATER QUALITY	Water quality	■	■			■	■					
VEGETATION	Natural ecosystem	■	■	■		■	■					
	Agricultural land and farms		■	■								
WILDLIFE	Natural Habitat			■		■	■					
	Wildlife					■	■					

Impact Identification Matrix		PROJECT´S ACTION DURING CONSTRUCTION PHASE										
		Mobilization of Workers, Heavy Machinery, Equipment and Material.	Camp site operation during construction phase	Land cleaning and topsoil removing	Filling & leveling	Earth movement: Excavations. Land-side develop.	Excavations and dredging Water- side development	Dumping of dredge materials and building materials	Construction of buildings	Construction of paved surfaces, parking, Land-side development	Pilling and Jetty Construction/pile-supported concrete platform (suspended – deck)	Basement and Access Road Construction
AQUATIC ECOSYSTEM	Fish ecology						■					
SOCIOECONOMIC ENVIRONMENT	Settlement				■							■
	Farming				■							
	Effect on boat passenger											■
	Employment	■										■
	Change in land use				■							■
	Incomes	■										■
	Changes in local traffic											■
	Gender Concerns	■										

Table 114. ESIA Identification Matrix. Operational Phase. Identified impact highlighted in blue cell.

Impact Identification Matrix		PROJECT ACTIONS DURING OPERATION				
Environmental components		Cargo handling operations	Vessel traffic	Port road traffic	On shore operation	The port itself
AIR QUALITY	Pollutants and Dust	■	■	■		
NOISE AND VIBRATION	Excess of noise and vibration	■	■	■		■
COAST AND SHORELINE	Riverbank erosion		■			
WATER QUALITY AND HYDROLOGY	Water quality	■	■		■	
	Siltation and siltation pattern	■	■			
GROUNDWATER QUALITY	Water quality	■	■		■	
VEGETATION	Agricultural land and farms			■		
FAUNA	Zooplankton production		■			
AQUATIC ECOSYSTEM	Fish ecology		■			
SOCIOECONOMIC ENVIRONMENT	Effect on boat passenger					■
	Employment		■			■
	Change in land use					■
	Income opportunity		■			■
	Changes in local traffic			■		

5.2.1 Potential Impact Characterization; features and criteria

Impacts should be also predicted semi-quantitatively. Quantification means using numbers to indicate the impact. It is helpful to present information in summary form to give readers an overview of the impact characteristics of the Project.

A logical and systematic approach will to be taken for impact identification. The aim is to consider all the important environmental/project impacts and interactions, making sure that indirect and cumulative effects, which may be potentially significant, are not inadvertently omitted. Individual environmental issues should be viewed in respect of the different facets of the project.

5.1.3.1. Features and criteria for impact characterization

ESIA Identification Matrix used earlier allows us to identify where impacts are likely to happen. At a second stage this identified impact may be in investigated in more depth, identifying which is the particular project action impacting on which environmental or social sub-factor.

Once we got the list of impacts or changes (where “not applicable” or “no change” crossings were dismissed) on the different elements of the environment as a result from the preceding exercise of the ESIA Matrix: impact identification, we proceed to characterize them, for which we use the following features and impact attributes and criteria:

The following describes the meaning of the terms used in Table 114:

- **N** Sign /Nature of the impact: Alludes to the beneficial nature (+) or adverse (-)
- **Ty** Type: Refers to the nature of the impact; direct (3) indirect (2)
- **IN** Intensity: Refers to the degree of impact on the factor, in the specific area in which it operates. Ranked from 1 to 3. The three expressed an almost total impact of the factor in the area in which the effect occurs.
- **EX** Extent/Location: An area of influence covered by the impact in relation to the project environment. In this sense, if the action produces a localized effect within the space, it is considered that the impact of a restricted nature (1). If, however, the effect does not support a precise location within the project environment, having a pervasive influence on all of it or even beyond, the impact will be large (3). Intermediate situations are considered as partial (2).
- **TM** Timing: Refers to the moment of occurrence, the time lag between the onset of action and effect on the appearance of the corresponding factor. We consider three categories according to this time period is; zero, up to 2 years, or more than two years, which are called respectively as immediately (3), medium term (2), and long term (1).
- **RV** Reversibility: Refers to the possibility of reconstructing the initial conditions once the effect. Can be characterized as short-term (1), medium term (2) and impossible (3).
- **RC** Recoverability: Refers to the possibility of providing or not the corrective measures to avoid or minimize impact. For impacts with positive sign no value should be added; from 1 to 3.
- **D** Duration/ Persistence: Refers to the time that the effect supposedly remains, from the onset of the action. Two situations are considered, depending on whether the action produces a temporary effect (1) or permanent (2).

Table 115. Impact Characterization rating attributes

EVALUATION PARAMETER	Attributes	RATING
Sign. Nature of impact (N)	Positive Negative	+ -
Type of Impact (TY)	Direct Indirect	2 1
Intensity (IT)	Major Medium Minor	3 2 1
Extent(EX)	Large Medium Restricted nature	3 2 1
Timing (TM)	Immediate Medium term Delayed, long term	3 2 1
Reversibility (RV)	Not reversible Long term Short term	3 2 1
Recoverability (RC)	Not avoidable Avoidable if mitigated	3 1
Duration/ Persistence (D)	Permanent effect Temporary effect	2 1

A Table is used to characterize the impacts identified, which includes columns of information arranged in the following manner:

- the receiving environment impact (1st column), Factor and environmental component
- operation, task or project action origin of the impact (2nd column)
- brief Impact description; physical action that causes the impact on the factor of the environment; the alteration that led the impact to the factor of environment (3rd column)

Two tables have been prepared: for Construction and for Operation phase.

5.1.3.2. Impact magnitude

The **Significance (or Magnitude) of the impact** represents the entity or significance of the effect, it includes the degree of incidence and the "form" of that effect. This method is based on both Leopold Matrix (Leopold Luna B. 1971) and Ballete-Columbus methodology (Dee, N. 1972 and Conesa V. 1993) quantitative valuation for impact identification (Conesa V. 1993).

Value for Significance is clear from taking the attributes and criteria described above and applying the following formula.

Sg = N (2x TY + 4x IT + 3x EX + TM + RV +2x RC + D) (*)

(*) = We use a modified formula in weightings according to experts' criteria as a result of in-house discussion within TYPSA-KS experts involved, a modification of original formula is a methodological recommendation to accure specific impact assessment.

Where ***Sg***: Significance or Magnitude of the impact generated by the action of the project over the environmental component.

Given the lesser value and higher value of rating of attributes to the above formula the minimum and the maximum possible values of Magnitude are between 14 and 39 respectively. Major adverse impact is the one corresponding to a direct immediate impact with major intensity and wide effect, not reversible even avoidable and with permanent effect to one environmental element. Table 115 presents the significance ratings used.

Table 116. Environmental Significance scoring

SIGNIFICANCE	DESCRIPTION Following Impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment	SCORE
Low	Localized, minor intensity, recoverable, acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved.	14 to 19
Moderate	An impact which requires mitigation, medium intensity and extension. The impact is insufficient by itself to prevent the implementation of the project.	20 to 26
High	An important impact to medium to high environmental or social factor values, major or medium extension in conjunction with medium to major intensity, low recoverability, needs for mitigation.	27 to 34
Very High	A very serious impact. The impact may result in permanent change, loss of environmental and social values; very often these impacts are unmitigable and usually result in severe effects, or very beneficial effects if positive. May be sufficient by itself to prevent implementation of the project if not strongly mitigated or compensated.	**34 to 39**

Tables 116 and 117 show the identified impact characterization matrices for the construction and operation phases, respectively, of passenger terminals. Tables 118 and 119 show the impact characterization matrices for the construction and operation phases, respectively, of cargo terminals. The magnitude for positive impacts has been highlighted in blue color. **Values higher than 27**, high and very high, as major impacts identified, are also highlighted.

Table 117. Construction Phase Impact Characterization Matrix for Passenger Terminals

CONSTRUCTION PHASE. PASSENGER TERMINALS

ENVIRONMENTAL COMPONENT		PROJECT´S ACTION	IMPACTS	N	TY	IT	EX	TM	RV	RC	D	SG
AIR QUALITY	Air quality: Pollutants	Mobilization of Heavy equipment, camp site operation, earthmovements, spoils dumping, land-side devlopment cosntruction and access road	The emission of Smoke, Dust and CO_2	-	2	1	1	3	1	3	1	22
	Air quality: Noise and Vibration	Mobilization of Heavy equipment, camp site operation, earthmovements, spoils dumping, Port construction and access road	Noise and vibration generation	-	2	1	1	3	1	1	1	18
TOPOGRAPHY, LANDSCAPE, SOILS AND EROSION	Landscape	Vegetation clearance/Earth movements/Civil works	Topographic and landscaping changes occasioned by construction	-	2	1	1	1	2	1	2	18
	Soil structure, Erosion	Land cleaning and top-soil removing, vegetation clearance, Earth movements	Soil changes because of spills, material removal and construction work, erosion increasing because of vegetation clearance and earth movements	-	2	1	1	2	1	1	2	18
Coast and shoreline	Change of coastline	Bank protection, Water- side development	Change in river bank morphology	-	1	1	1	1	2	3	2	20
HYDROLOGY AND WATER QUALITY	Water quality	Land cleaning and top-soil removing, camp site operation, earth movement, Land-side develop, Excavations, Water- side development, spils dumping	Likely changes in water chemical quality due to pollution associated with civil works, and spills/wastewater in camp site, Increase in run-off and erosion, and hence water turbidity	-	2	1	1	3	2	1	2	20
	Sediment quality	Earth movement, water- side development	Likely changes in sediment quality due to pllution during construction	-	2	1	1	2	2	1	2	19
GROUND WATER	Water quality	Camp site operation during construction phase,	Likely changes in wground water quality due to construction materials depots	-	1	1	1	1	1	1	1	14
VEGETATION	Natural ecosystem	Land cleaning and top-soil removing, earth movement	Loss of natural vegetation	-	2	1	1	3	1	1	1	18
WILDLIFE	Natural Habitat	Land cleaning and top-soil removing, earth movement	Loss of natural hábitats	-	2	1	1	3	1	1	1	18
	Wildlife	Land cleaning and top-soil removing, earth movement, civil works, noise	Loss of wildlife	-	2	1	1	3	1	1	1	18
AQUATIC ECOSYSTEM	Dolphin	Sounds from underwater construccion activities, increased navigation , water pollution	Disturbances to dolphins foraging. Reduction of local dolphin population	-	2	1	1	2	1	1	1	17
	Fish ecology	Water- side development, spils dumping	Loss of fish biodiversity	-	1	1	1	2	1	1	1	15
SOCIOECONOMIC ENVIRONMENT	Settlement	Land acquisition	Temporarily Acquisition of private lands	-	2	1	1	2	1	1	2	18
	Effect to boat passenger	Diversion to nearby boat ferry ghat	Increase in time and distance	-	2	1	1	2	1	1	1	17
	Employment	Civil Works	Increased job opportunities	+	2	2	2	3	3	1	2	28
	Incomes	Civil Works	Increased income levels	+	2	2	2	2	1	1	1	24
	Changes in local traffic	Construction of Passenger teminal	Diversion and disruption of local traffic	-	2	1	1	2	1	1	1	17
	Gender Concerns	Civil Works	Improved job opportunities for women, Increased family incomes, Women social and economic empowerment	+	2	1	1	2	1	1	1	17

Table 118. Operation Phase Impact Characterization Matrix for Passenger Terminals

OPERATIONAL PHASE. PASSENGER TERMINALS												
ENVIRONMENTAL COMPONENT		PROJECT´S ACTION	IMPACTS	N	TY	IT	EX	TM	RV	RC	D	SG
AIR QUALITY	Air quality: Pollutants	Vessel trafic, Port road traffic, small cargo handling operations,	Noise emission by Port railway operation	-	1	2	2	3	1	1	2	24
	Air quality: Noise and Vibration	Vessel trafic, Port road traffic, small cargo handling operations,	Pollutant emissions by vessel and potrt operation	-	1	2	1	3	1	1	2	21
HYDROLOGY AND WATER QUALITY	River bank erosion	Vessel trafic	Impact on shoreline due to waves	-	1	1	1	3	1	1	2	17
	Water quality	Vessel trafic, On shore operation	Spills and pollutants entering water system	-	1	1	1	3	1	1	2	17
	Sediment quality	Vessel trafic	Spills and pollutants entering water system and therefore sediments	-	2	2	2	1	1	3	2	13
GROUND WATER	Water quality	Vessel trafic, On shore operation	Spills and pollutants entering water system	-	1	2	1	3	1	1	2	21
VEEGETATION	Agricultural land and farms	Port road traffic	Polluntant emission to farms crops and soils	-	1	2	1	1	1	1	2	19
WILDLIFE	Wildlife	Vessel traffic	Increase in water navigation transit disturb wildlife, birds and others,	-	1	1	1	3	1	1	2	17
AQUATIC ENVIRONENT	Dolphins	Vessel traffic	Disturbances to foraging dolphin and occasional physical injuries	-	2	1	2	1	2	1	2	21
FISHERIES	Fish ecology	Vessel traffic	Increase in water navigation transit and pollution of water induce impacts on gfish biodiversity	-	2	2	1	2	2	1	1	22
SOCIOECONOMIC ENVIRONMENT	Employment	New terminal	New cargo terminal and vessel crew increase employment,	+	2	2	3	3	2	3	2	34
	Change in land use	New terminal	New cargo terminal may increase commercial and industrial areas nearby	+	1	1	1	1	3	3	2	21
	Incomes	New terminal	New cargo terminal and vessel crew should increase incomes	+	2	2	3	3	2	3	2	34
	Changes in local traffic	Port road traffic	Local traffic will be affected by trucks	+	2	1	1	2	1	1	2	18

Table 119. Construction Phase Impact Characterization Matrix for Cargo Terminals

CONSTRUCTION PHASE

ENVIRONMENTAL COMPONENT		PROJECT´S ACTION	IMPACTS	N	TY	IT	EX	TM	RV	RC	D	SG
AIR QUALITY	Air quality: Pollutants	Mobilization of Heavy equipment, camp site operation, earthmovements, spoils dumping, land-side devlopment cosntruction and access road	The emission of Smoke, Dust and CO_2	-	2	1	2	3	1	3	1	25
	Air quality: Noise and Vibration	Mobilization of Heavy equipment, camp site operation, earthmovements, spoils dumping, dredging, Port construction and access road	Noise and vibration generation	-	2	1	1	3	1	3	1	22
TOPOGRAPHY, LANDSCAPE, SOILS AND EROSION	Landscape	Vegetation clearance/Earth movements/Civil works	Topographic and landscaping changes occasioned by construction	-	2	1	1	1	2	1	2	18
	Contour alteration	Land cleaning and top-soil removing, Earth movement; excavations & filings, Land-side develop, spoil dumping	Land changes because of levelling and filling	-	2	1	1	1	1	1	2	17
	Soil structure, Erosion	Land cleaning and top-soil removing, vegetation clearance, Earth movements	Soil changes because of spills, material removal and construction work, erosion increasing because of vegetation clearance and earth movements	-	2	1	1	2	1	3	2	22
Coast and shoreline	Change of coastline	Excavations and dredging, Water- side development	Change in river bank morphology	-	1	1	1	1	2	3	2	20
	River bank erosion	Excavations and dredging, Water- side development	increase in erosion/sedimentation of river shore	-	1	1	1	1	2	3	2	20
HYDROLOGY AND WATER QUALITY	Water quality	Land cleaning and top-soil removing, camp site operation, earth movement, Land-side develop, Excavations and dredging, Water- side development, spils dumping	Likely changes in water chemical quality due to pollution associated with civil works, partuicularly deredging, and spills/wastewater in camp site, Increase in run-off and erosion, and hence water turbidity	-	2	2	2	3	2	1	2	27
	Sediment quality	Earth movement, Excavations and dredging, Water- side development	Likely changes in sediment quality due to pllution coming from dredging and jetty construction particularly	-	2	2	1	2	2	1	2	23
GROUND WATER	Water quality	Camp site operation during construction phase,	Likely changes in wground water quality due to construction materials depots	-	1	1	1	1	1	1	1	14
VEGETATION	Natural ecosystem	Land cleaning and top-soil removing, earth movement	Loss of natural vegetation	-	2	1	1	3	1	1	1	18
	Agricultural land and farms	Land cleaning and top-soil removing, access roads	Loss of agricultural land	-	1	1	1	2	1	1	1	15
WILDLIFE	Natural Habitat	Land cleaning and top-soil removing, earth movement	Loss of natural hábitats and fragmentation of ecosystems	-	2	1	1	3	1	1	1	18
	Wildlife	Land cleaning and top-soil removing, earth movement, civil works, noise	Loss of wildlife	-	2	1	1	3	1	1	1	18
AQUATIC ECOSYSTEM	Dolphin	Sounds from underwater construccion activities, increased navigation , water pollution	Disturbances to dolphins foraging. Reduction of local dolphin population	-	2	1	1	2	1	1	1	17
	Fish ecology	Excavations and dredging, Water- side development, spils dumping	Loss of fish biodiversity	-	1	1	1	2	1	1	1	15

CONSTRUCTION PHASE

ENVIRONMENTAL COMPONENT		PROJECT´S ACTION	IMPACTS	N	TY	IT	EX	TM	RV	RC	D	SG
SOCIOECONOMIC ENVIRONMENT	Settlement	Land acquisition	Temporarily Acquisition of private lands	-	2	1	1	2	1	1	1	17
	Farming	Land acquisition	Decrease in farming areas	-	1	1	1	2	1	1	1	15
	Effect to boat passenger	Diversion to nearby boat ferry ghat	Increase in time and distance	-	2	1	1	2	1	1	1	17
	Employment	Civil Works	Increased job opportunities	+	2	2	2	3	3	1	2	28
	Change in land use	Reclamation and levelling	Change from farming to commercial	-	2	1	1	2	1	1	1	17
	Incomes	Civil Works	Increased income levels	+	2	2	2	2	1	1	1	24
	Changes in local traffic	Construction of cargo teminal	Diversion and disruption of local traffic	-	2	1	1	2	1	1	1	17
	Gender Concerns	Civil Works	Improved job opportunities for women, Increased family incomes, Women social and economic empowerment	+	2	1	1	2	1	1	1	17

Table 120. Operation Phase Impact Characterization Matrix for Cargo Terminals

OPERATIONAL PHASE CARGO TERMINALS												
ENVIRONMENTAL COMPONENT		PROJECT´S ACTION	IMPACTS	N	TY	IT	EX	TM	RV	RC	D	SG
AIR QUALITY	Air quality: Pollutants	cargo handling operations, Vessel trafic, Port road traffic	Noise emission by Port railway operation	-	1	2	2	3	1	1	2	24
	Air quality: Noise and Vibration	cargo handling operations, Vessel trafic, Port road traffic	Pollutant emissions by vessel and potrt operation	-	1	2	1	3	1	1	2	21
HYDROLOGY AND WATER QUALITY	River bank erosion	Vessel trafic	Impact on shoreline due to waves	-	1	1	1	3	1	1	2	17
	Water quality	cargo handling operations, Vessel trafic, On shore operation	Spills and pollutants entering water system	-	1	1	1	3	1	1	2	17
	Sediment quality	cargo handling operations, Vessel trafic	Spills and pollutants entering water system and therefore sediments	-	2	2	2	1	1	3	2	13
GROUND WATER	Water quality	cargo handling operations, Vessel trafic, On shore operation	Spills and pollutants entering water system	-	1	2	1	3	1	1	2	21
VEEGETATION	Agricultural land and farms	Port road traffic	Polluntant emission to farms crops and soils	-	1	2	1	1	1	1	2	19
WILDLIFE	Wildlife	Vessel traffic	Increase in water navigation transit disturb wildlife, birds and others,	-	1	1	1	3	1	1	2	17
AQUATIC ENVIRONENT	Dolphins	Vessel traffic	Disturbances to foraging dolphin and occasional physical injuries	-	2	1	2	1	2	1	2	21
FISHERIES	Fish ecology	Vessel traffic	Increase in water navigation transit and pollution of water induce impacts on gfish biodiversity	-	2	2	1	2	2	1	1	22
SOCIOECONOMIC ENVIRONMENT	Effect to boat passenger	New cargo terminal	New cargo terminal displace boat passenger, boat passengers may be impact due to cargo vessel traffic	-	2	1	1	2	1	1	2	18
	Employment	New cargo terminal	New cargo terminal and vessel crew increase employment,	+	2	2	3	3	2	3	2	34
	Change in land use	New cargo terminal	New cargo terminal may increase commercial and industrial areas nearby	+	1	1	1	1	3	3	2	21
	Incomes	New cargo terminal	New cargo terminal and vessel crew should increase incomes	+	2	2	3	3	2	3	2	34
	Changes in local traffic	Port road traffic	Local traffic will be affected by trucks	+	2	1	1	2	1	1	2	18

5.2. ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES DURING CONSTRUCTION PHASE

5.2.1. Impact on Air Quality and Dust

- All sites: Cargo and Passenger terminals

This impact is similar for all sites., since transportation activity will involve many heavy vehicles type dump truck for access road construction, material mobilization and for riverport development material mobilization (e.g., rock, steel, buildings materials etc.). Those vehicles activity involves fuel so it will produce exhaust gases for emissions. The exhaust gas emissions will affect the decrease of air quality as the result of the increase of gas pollutants such as SO_2, NO_2, and CO and the increase of local dust from the windblown soil particles.

The main sensitive receptors of air pollution from project activities are construction workers and residents within the impact area. Local community and sensitive receptors such as settlements, markets, or other infrastructure are closely located to the Project sites.

Although dust and odor generation from works is likely, these are expected to be temporary during the access road and sand filling prior to stabilization. If unmanaged, the waste and sanitation facilities of the proposed temporary field camp are a potential source of unpleasant odors detectable to local people

Material transportation activity will through current access roads and then heading to access road. The material transportation activity potentially increases the burden of air pollutants especially the spread of dusts that can exceed the quality standard and spread to the settlements.

During the construction works such as sand filling construction and reconstruction of berths, etc. the generation of inorganic dust is expected.

Relevant construction infrastructure will be used for construction services. Infrastructure development is planned during construction mobilization phase. Construction infrastructure includes small capacity (e.g.5 m^3/h) concrete unit, belt conveyor, auto transport, excavator, and others.

Sources of ambient air pollution can be 'organized' and 'unorganized' emission sources, namely: organized source – cement silos. Unorganized – belt conveyor and road cars.

Excavated river material/sediment and building materials usually dry into a fine dust, and if not stabilized, this material is easily disturbed either by windy conditions or from the movement of Project vehicles and equipment such as excavators, small vehicles and trucks. These dust particles may become airborne reducing local air quality. Similarly, disturbance of river material from a tidal environment can cause unpleasant odors to be emitted, which can travel and be detected by persons in surrounding community areas. This material can also be mobilized due to heavy rain, causing it to wash away.

According to the achieved baseline data on air quality, included in the environmental quality monitoring report (January 2020) included in Annex 3.2. to this ESIA Report, the current air quality situation in the terminals is generally poor. Chandpur and Barishal stand out as the most polluted locations but none of the parameters exceed the established standards. Considering the Bangladesh National Ambient Air Quality Standards from Environmental Conservation Rules (1997), no measured parameter at the sites during baseline exercise exceeds these limit values. These values will increase during the construction phase but are expected to decrease from the values shown during the operation phase. This is because the traffic in the new area during the following operation phase will be more orderly and the activities will be better distributed.

Cargo terminals: Pangaon and Ashunganj sites, due to their bigger dimension have more capacity to impact physical environment than the passenger terminals, having lower DEPTC development.

Based on the above the impacts coming from the works on air quality will be moderate to low, they will not significantly worsen the current situation of the terminals. The pre-mitigation impacts are temporary, the extent of the work is small, and the intensity is low.

5.2.1.1. Mitigation Measures

- Ashunganj
  - Implement measures in ECoP 6 Air Quality Management.

Dust generation will be restricted as much as possible and water sprinkling carried out as appropriate, especially where earthmoving and excavation are carried out. To help prevent dust generation by heavy machinery and vehicle traffic, irrigation will be applied on access works surfaces and construction pits during works. The procedure to apply irrigation water on access roads work surfaces will be the following:

The construction area surfaces will be continuously irrigated every day during dry periods with no application of water during days of heavy rain. Irrigation will be applied establishing at least the following ratios:

  - Two tanks of at least 7,000 l per day applying water on surfaces.
  - The transit surface irrigations will be applied every 3 hours.
  - The resident Engineer may establish the need to increase the dose of daily watering depending on the generation of dust. He or she may also determine the need for irrigation
- The construction work will use specialized heavy equipment and machinery, such as loaders, haulers, and dump trucks, which transport material to processing facilities using haul roads, and the processed material to the required location for use. This will generate hundreds of trips every single day for the duration of the construction, creating another unique set of environmental impacts, such as emissions of CO2 from fuel combustion, fugitive dust from haulage roads, noise and vibrations which are of concern. Workers shall be trained on dust minimization techniques in the training courses to be given by the Contractor.
- Open stockpiles of construction materials (e.g. aggregates, sand and fill material) of more than 50m3 shall be covered with tarpaulin or similar fabric during rainstorms.
- Suitable 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. Undertake servicing of all equipment regularly to minimize emissions
- Dust generation will be restricted as much as possible and water sprinkling carried out as appropriate, especially where earthmoving and excavation are carried out.
- Provide water spray vehicles to water the unpaved ground, storage piles and other areas where airborne dust may originate. The water spray operation should be carried out at least twice a day (morning and afternoon).

- Pangaon
  - Suitable 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. Undertake servicing of all equipment regularly to minimize emissions
  - Dust generation will be restricted as much as possible and water sprinkling carried out as appropriate, especially where earthmoving, and excavation are carried out.
  - Provide water spray vehicles to water the unpaved ground, storage piles and other areas where airborne dust may originate. The water spray operation should be carried out at least twice a day (morning and afternoon).
  - Open stockpiles of construction materials (e.g. aggregates, sand and fill material) of more than 50m3 shall be covered with tarpaulin or similar fabric during rainstorms.
- Barishal, Chandpur, DEPTC& Narayanganj
  - Suitable 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. Undertake servicing of all equipment regularly to minimize emissions
  - Water the material stockpiles, access roads and bare soils as required to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of high risk (e.g. high winds, high temperature). Stored materials such as gravel and sand shall be covered and confined to avoid wind drift.
  - Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to unloading, collection, aggregate handling, cement dumping, circulation and others, including, if applicable, the concrete batching and mixing plant to control the particle emissions in all its stages.
- Shasanghat

Besides the previous measures, in Shasanghat previous to any project action remove and relocate present wastes, debris, junk, etc., within terminal area including the shoreline and waterside development area . Remove solid wastes, remove polluted first lay of soil, and transport to an approved waste disposal site or recycling depot. Manage this waste and spoils according to waste management regulations.

5.2.2. Impacts on Noise and Vibration

During construction, noise level near the project sites is likely to be increased due to use of vehicles and earth moving equipment in parallel to dust emissions. The main sources of the noise during the construction process are represented by operating construction machinery and vehicles.

List of machines and equipment commonly used during construction, and their corresponding noise features are presented in the Table 120 Data on noise features are published in different sources or are adopted as a result of previously performed measurements.

A continuous exosures of big fishes to a sound leeveel of 150 dB may cause behavioural disturnabces in fish. . However, noise generation during dredging operations is of order of 160-180 dB for CSD category of dredgers. As per U.S. Fish and Wildlife Service (USFWS), sensitivity level for injury in fishes is 186 dB for fish size of >2gm and 183 dB for <2gm. Thus, the dredging operations noise will not cause any injury to

the fishes. Also, it is likely that fishes and aquatic fauna will move away from the source of disturbance. Since, the dredging activity is for a limited period, the aquatic fauna will come back after the disturbance is over.

Table 121. Construction machinery and their output sound

Name of the vehicle (Equipment)	Quantity, piece	Sound level (db)
bulldozer	1	65-70
excavator	1	60-67
mining trucks	4	53-59
mobile crane	1	51-57
concrete pump	2	60
concrete mixer	1	61
dredger	1	67

**Measured from 20 m distance from machineries*

- Shasanghat, Narayanganj and Barishal sites

In Shasanghat, Narayanganj a there are markets and other commercial structures which might be affected by excess noise during construction. Barishat site itself is in a crowded commercial zone

According to baseline data, compiled in Annex 3 , these areas are already noisy, exceeding noise limits set by DoE. Considering the Noise Pollution Control Rules (2006), the sound level standards for commercial area are 65 at daytime and 55 at night-time. Due to the current traffic conditions in the vicinity of the terminals (e.g., passenger traffic, presence of shops and markets in the adjacent areas), noise level in all terminals is high, exceeding standards in all terminals except in Shasanghat, with a more moderate traffic of volume and less people moving. Although those levels are close to dBA Bangladesh standard limits they do not exceed.

Further aggregation of noise level may pose critical treat on the surrounding people including the passengers and shoppers.

- Chandpur site

Chandpur is a rather crowded area, where high daily movement of people is common. The volume of traffic is high, the sudden loud horn use from launches and local transport has also been noted. Further aggregation of noise levels may even increase the threat of impact on the surrounding passengers

However, according to baseline data, compiled in Annex 3, the area is already significantly noisy, exceeding **by far** day and night noise limits set by DoE.

- Ashunganj and Pangaon cargo terminals

Noise during dredging operations may disturb the aquatic life. This impact is discussed in the specific section on this report. In addition, other activities related to the construction of infrastructure and the construction of access roads will increase the noise level for short periods of time.

Short-term temporary increases of noise will occur in the vicinity of the dredging operations and staging/dewatering activities. Sources of noise include the dredging equipment, dewatering equipment, generators, loaders, and the trucks used to transport the dewatered material for placement. Noise levels generated by the dredging operation will vary according to the size and type of the equipment used, and more importantly, the size and type of the engines.

However it is important to remark that no dredging activities are expected in Ashunganj according to the FS, only some dredging, about 3500 m3, is expected in Pangaon so it has no significant consequences.

In Ashunganj for jetty development cross section is shown in the following figure 176. The cope line is chosen in such a way to eliminate need for dredging, except to remove the man-made reef at chainage 0+200, volume of material to remove is about 500 m3 only. On the other hand, the slope rises only to the level of 3-4m PWD in the long stretch of the quay. In order to limit retaining height of the sheet pile wall at the back, the slope is partially filled. Slope is kept with mild grading of 1:4 to minimize erosion and obstruction to the flow.

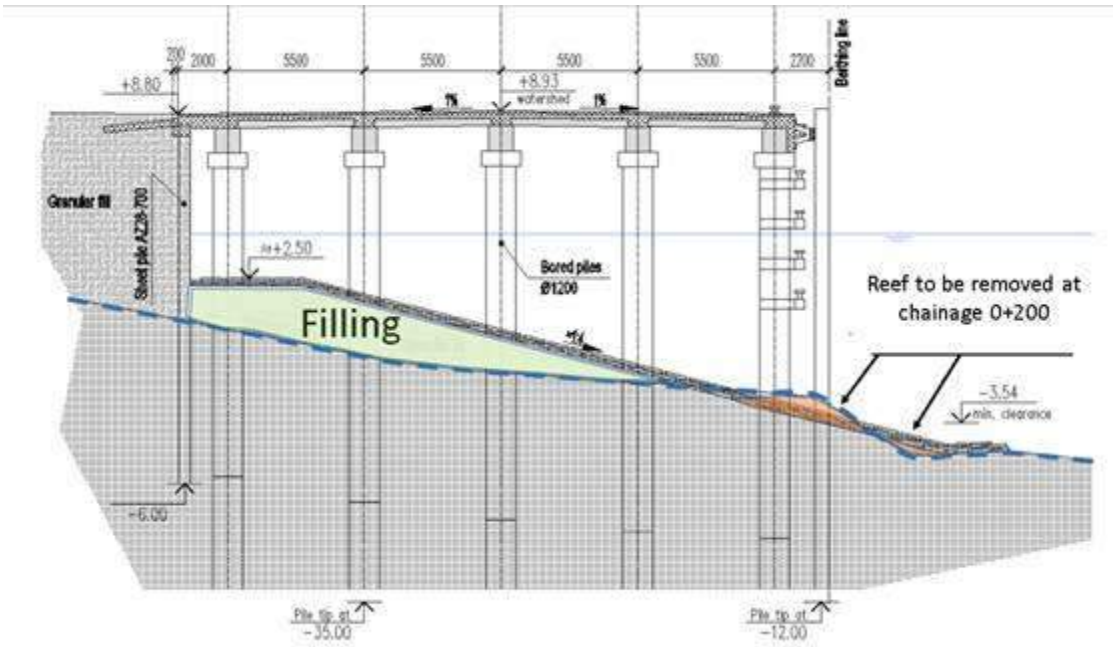


Figure 176. Ashunganj jetty development

As for sensitive marine life, benthic organisms and other animal species are affected by noise and vibration produced by machinery and construction activities.

The Ganges-Brahmaputra-Meghna River system is a favorable river dolphin habitat, especially upper and lower Meghna of the Project area. Potential impacts of noise on dolphins include mortality, hearing damage, masking of communication and other biologically important sounds, and behavioral responses. Mortality only occurs in the immediate vicinity of **very high energy noise sources**, such as blasting, and is unlikely to occur.

Only pile driving operations may represent a significant impact on underwater sound level rates. Anything greater than 3KN of impact driving force can have a serious detrimental impact on fish. However it is again important to remark that underwater sound level currently conditions are bad, and regarding the piles, these are not made with an impact, knock or vibratory pile driver, for precast piles, but with a corkscrew drill with a metallic cover, which is put into the water and then inserted to a depth of 30 m.

Besides, significant vessel traffic at all sites with considerable underwater sound quality, it is not expected that noise and vibrations coming from construction works at all terminals will worsen this condition. Therefore, the noise situation in the terminals is already very bad and the impacts of the work would not make the situation significantly worse.

- DEPTC

The impacts are temporary, the extent of the work is limited, and the intensity is low, therefore the impacts on noise and vibration are estimated as low to moderate. No significant impacts on noise environment are anticipated due to the development of the DEPTC.

5.2.2.1. Mitigation Measures

There is a need for conducting environmental monitoring for road traffic noise, traffic induced ground vibration levels and air quality survey during the implementation of the project, especially during the construction phase. This is because the earth excavators, compacters, trucks and other construction machines will change the present baseline environmental information.

There are number of social services in the vicinity of the terminals, these include health services, water, schools and waste management facility services.

Therefore, it is then essential to maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.

Low noise emission level equipment and operation procedures will have to be observed to safeguard the environment, or a permit obtained for emitting noise in excess of the laid-out standards. Equally important is that the large work expected on site should not make unnecessary noise that could disturb the people

- Shasanghat passenger terminal
  - Prepare site for all noise-generating activities to avoid noise pollution for local residents.
  - Monitor and analyze noise and vibration results and adjust construction practices as required.
  - Maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.

Of the four passenger terminals, Shasanghat has the most moderate traffic volume and less people movements. The presence of industrial facilities, flour mills, junk yards and steel factories are the only remarkable noise generating activities on the site. Although the registered noise levels were close to dBA Bangladesh standard limits they were not above. Thus, the increaser of the noise level with further aggregation of noise level may pose a more critical threat on the surroundings

There are no social services in the vicinity of Sashangat apart from the Cotton Mills Mosque. Due to the presence of the mosque it will be important to observe low noise emission level equipment and operation procedures.

Thus it is also essential to maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.

- Narayanganj passenger terminal

The project site is a crowded, extremely noisy site, In front of the terminal there are other noise generating facilities such as the railway station and bus depot, the road to the terminal and an informal fish market. The registered noise levels already exceed the BD standard limits.

Nevertheless, mitigation measures have to be observed to avoid increasing the levels of noise during construction. There are 3 mosques located in the surroundings (Railway, Thana Pukupar and Bazar Jame Masjid).

  - Prepare site for all noise-generating activities to avoid noise pollution of local residents.
  - The contractor should maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.
  - Low noise emission level equipment and operation procedures will have to be observed to safeguard the environment, or a permit obtained for emitting noise in excess of the established standards. Equally important is that the large work expected on site should not make unnecessary noise that could disturb the people
  - Monitor and analyze noise and vibration results and adjust construction practices as required.

- DEPTC

The noise and vibration impact will be restricted to the phase demolition and building activities. Those activities will no doubt increase the current low noise levels in the area. The activities will not impact on the water ecosystem

  - Therefore it is essential to appropriately site for all noise-generating activities to avoid noise pollution for residents and maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.
  - Low noise emission level equipment and operation procedures will have to be observed to safeguard the environment, or a permit obtained for emitting noise in excess of the established standards. Equally important is that the major work expected on site should not make unnecessary noise that could disturb the people

- Barishal passenger terminal
  - The contractor should maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.

- Low noise emission level equipment and operation procedures will have to be observed to safeguard the environment, or a permit obtained for emitting noise in excess of the established standards. Equally important is that the major work expected on site should not make unnecessary noise that could disturb the people
- Prepare site for all noise-generating activities to avoid noise pollution for local residents.
- Monitor and analyze noise and vibration results and adjust construction practices as required.

- Chandpur passenger terminal

Chandpur is a rather crowded area and further aggregation of noise level may even increase the threat on the surrounding passengers. Low noise emission level equipment and operation procedures will have to be observed to safeguard the environment, or a permit obtained for emitting noise in excess of the established standards. Equally important is that the major work expected on site should not make unnecessary noise that could disturb the people

- Prepare site for all noise-generating activities to avoid noise pollution of local residents.
- Monitor and analyze noise and vibration results and adjust construction practices as required.
- Maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.

- Pangaon and Ashunganj

Despite only some dredging, about 3500 m^3, is expected in Pangaon, it will be important to apply the following mitigation measures

- Select appropriate dredger to minimize the noise as much as possible
- Regularly measure underwater noise level. Underwater noise may not exceed 145dB at 70kHz, which is also the maximum noise level to be used by the pingers to drive the dolphins away. Minimize underwater noise impacts on nearby fauna by slowly ramping up equipment, using pingers etc. to allow fauna to swim away in advance of dredging
- During dry season location of scour holes, river confluences and river bends should be avoided.

As for construction vibrations, since there are number of social services in the vicinity of Pangaon and Ashunganj, including health services, water, schools and waste management facility services it will be important to follow the following measures:

- Prepare site for all noise-generating activities to avoid noise pollution for local residents.
- Monitor and analyze noise and vibration results and adjust construction practices as required.
- Maintain all equipment in good working condition in accordance with manufactures maintenance procedures/protocols. Equipment suppliers and contractors shall present the proof of maintenance register of their equipment.

No dredging activities are expected in Ashunganj according to the FS

5.2.3. Impacts on Topography, Geomorphology, Geology

The main sensitive receptors of changes in topography, geomorphology and geology from project activities are local natural topography, bank geomorphology and local land use. When modifications are made to the terrain of the proposed new terminals or existing terminals, these aspects are modified.

- Pangaon and Ashunganj Cargo terminal

Ashunganj and Pagaon cargo terminals need some excavations before filling and leveling,

According to the result of the screening checklist prepared (included as annex 3.1.) the current situation of drainage and geology in Ashunganj is bad due to the amount of sediment and garbage accumulated.

The areas are degraded, and the impact is low, it could even be positive by rebuilding the existing drains and cleaning the area. The impacts are temporary, the extension of works is limited, and the intensity is low.

These values will increase during the construction phase but are expected to decrease from the values shown below during the operation phase.

In Pangaon the project will involve modification of existing surface morphology requiring excavation and disposal of fill.

However, project activities themselves do not include also open specific quarries needed for rip-rap of river bank protection design. Land and terrain changes will be those related to filling and excavations which can modify the topography and / or local morphology. In principle, all concrete will be provided by external existing concrete plants, so no new borrow sites are expected to be opened.

- DEPTC

No relevant changes in the Topography and geomorphology are expected at DEPTC

- Passenger terminals

The construction of Passenger terminals includes some earth-movement but very limited to the upgrading of existing facilities such as parking area, access or building refurbishment. Also, all Passenger terminals include the construction of riverbank protection which will involve some excavations and riverbank refilling before rip-rap construction.

Due to earth movement on the riverbank and some underwater excavation the riparian area at terminals sites soil will get loose and sticky/clayey. Release of these sediments could cause increase in turbidity of water due to bank protection work and other construction work close to the water area. Such soil has a tendency of sticking over the skin and gills and blocking the pores and is hence harmful.

All these impacts could be characterized as moderate to low for Cargo passengers and low for Passenger terminal due to the total amount of soil and rocks involved, medium magnitude for Cargo and low for Passenger and its likely impact on land, topography or geomorphology.

5.2.3.1. Mitigation measures

The excavation of quarries and borrow pits, used for obtaining rocks, soil and aggregate materials for the construction passenger and cargo terminals and other construction items proposed under this project will be sourced from outside. In any case, should the constructor decide to open new borrows, the mitigation measures included on this ESIA will be applied.

Some soils coming from dredging from Cargo terminals could be used for filling on-shore developments. This will reduce the pressure on importing sand to the works site. In that case, these sources of dredged material would need to be sampled for contaminants and certified as on-shore contaminant free

The quality of the riverbed sediment was identified to characterize the baseline status. The Riverbed sediment samples were collected from around the 6 project locations from 22 October to 29 October 2019. Test results of sediment analysis are given in next Table. Photos are given in next figure.

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 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines – Soil and Groundwater Standards'[25] to assess sediment quality and to determine the need, if any, for remedial action. Parameters analyzed in baseline quality of sediment were observed to be well below the threshold limits for Intervention as per the Dutch Standards

- Ashunganj
  - Use only already opened or authorized borrow pits and dumpsites. Contractor to restore the original conditions of newly opened borrow pits and dumpsites
  - The Contractor is required to reuse the excavated soil as much as possible unless the soil is considered unsuitable for filling.
  - Dredged soil should not be disposed in the river or its banks.
  - Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
  - The Contractor shall plan his works to minimize surface excavation works during the rainy season where practicable.
- Pangaon
  - Implement ECoP 4: Soil Quality Management
  - Use only already opened or authorized borrow pits and dumpsites. Contractor to restore the original conditions of new opened borrow pits and dumpsites
  - The Contractor is required to reuse the excavated soil as much as possible unless the soil is considered unsuitable for filling.
  - Implement sowing of herbaceous species (vetiver) on new green areas as soon as possible to prevent erosion.
  - Dredged soil should not be disposed of in river or on its banks.
  - Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
  - The Contractor shall plan his works to minimize surface excavation works during the rainy season where practicable.

25 Dutch VROM (2000), The Circular on Target Values and Intervention Values for Soil Remediation, Ministry of Housing, Spatial Planning and the Environment, the Netherlands, February 4th, 2000

- Barishal, Chandpur, DEPTC, Narayanganj and Shasanghat
  - Use only already opened or authorized borrow pits and dumpsites. Contractor to restore the original conditions of new opened borrow pits and dumpsites
  - The Contractor is required to reuse the excavated soil as much as possible unless the soil is considered unsuitable for filling.
  - The Contractor shall plan his works to minimize surface excavation works during the rainy season where practicable.
  - To prevent changes in river bank morphology maintain record of all sand or sediment extraction (quantities, location shown on map, timing). No excavated material should be disposed in river or on its banks.

5.2.4. Impacts on Soils and Erosion

- General: Cargo and Passenger terminals

Rocks, soil and aggregate materials for the construction passenger and cargo terminals and other construction items such as sand cement, steel rods and other materials imply a modification in the current composition and quality of the current soils, however the impact is low since these soils are composed of a mixture of river sediments, human waste and garbage, and sands are transported from other places and stored in the proposed area, as is the case of the Shasanghat area.

The main sensitive receptors of changes in soil quality and riverbank erosion from project activities are riverbank soil and benthic sediments. When modifications are made to the terrain of the proposed new terminals or existing terminals, these two aspects are modified.

Regarding soils pollution the construction activities to be undertaken involves storage of raw material, debris, paints etc. and many vehicles types, those vehicles activity use fuel so it could produce accidental leakage of motor oil or hydrocarbons if the necessary preventive measures are not taken, contaminating the soil.. There are likely chances that, the run-off from the site may get contaminated with these materials and when it will enter the water body may also degrade the water quality of the river.

Anyhow, the soil quality in the terminals is very poor due to the presence of sediments and pollution carried by the river, and due to the presence of waste and oils from surrounding industries and businesses. The impacts of the work would not make the situation considerably worse.

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 sediment 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 all the parameters are not yet standards according Dutch Standards.

- **pH:** From the test result it is seen that the pH concentration was ranged from 6.94 to 7.34. The higher concentration was found in BIWTA_SL_02 (Narayanganj Passenger Terminal, Shitalakshya River) and lower concentration was found in BIWTA_SL_03 (Ashuganj Cargo Terminal, Meghna River).

- **Organic Carbon:** From the test result it is seen that the Organic Carbon concentration was ranged from 1.15 to 1.32. The higher concentration was found in BIWTA_SL_02 (Narayanganj Passenger Terminal, Shitalakshya River) and lower concentration was found in BIWTA_SL_03 (Ashuganj Cargo Terminal, Meghna River).
- **Phosphate:** From the test result it is seen that the Phosphate concentration was ranged from 18.78 to 25.66. The higher concentration was found in BIWTA_SL_02 (Narayanganj Passenger Terminal, Shitalakshya River) and lower concentration was found in BIWTA_SL_05 (Barishal Passenger Terminal, Kirtankhola River).
- **Total Bacterial Count:** From the test result it is seen that the Total Bacterial Count concentration was ranged from 4.5×10^3 to 6.5×10^6. The higher concentration was found in BIWTA_SL_02 (Narayanganj Passenger Terminal, Shitalakshya River) and lower concentration was found in BIWTA_SL_06 (Chandpur Passenger Terminal, Meghna River).

- Barishal and Narayanganj site

Commercial spaces functioning for decades at the territory of Barishal and Narayanganj site now allocated for the projected Terminal. Construction of the Terminal within existing commercial zone of the terminals will not cause any significant impact on the landscape or on visual environment.

- Shasanghat site

Shasanghat site is an underdeveloped commercial site currently used as an illegal ship breaking site. The site requires significant amount of sand filling and levelling (Figure 177). Such sand filling activity will impact the local soil quality and may also pose an impact on riverbank erosion since and bridge on Buriganga River is within 100m of the site. Also, it is notable that the site is on the embankment. Therefore, construction activity may destabilize the embankment leading into erosion.

Figure 177. Shasanghat site requires significant amount of land filling. The site also on the embankment

- Chandpur

The main impact on soils should be the included changes because of spills, material removal and construction work, erosion increasing because of vegetation clearance and earth movements

- Ashunganj and Pangaon

Regarding waste from dredging or construction operations has, if not properly managed, a significant impact on soil quality. Their storage and removal must be controlled so that they do not affect the composition of the soil and do not cause erosion problems.

The impacts are temporary, the extent of the work is limited, and the intensity is low.

The impacts on soil quality and riverbank erosion are estimated as low to moderate from Cargo Terminal and low for Passenger Terminal.

Soil quality changes because of spills, material removal and construction work, erosion increasing because of vegetation clearance and earth movements.

This erosion can be avoided in several ways described in the section on mitigating measures.

5.2.4.1. Mitigation Measures for soils and erosion

- Ashunganj and Pangaon Cargo terminals
  - Implement ECoP 4: Soil Quality Management
  - Implement sowing of herbaceous species (vetiver) on new green areas as soon as possible to prevent erosion. Regarding the clearing of the vegetation, only in Pangaon the impact of the clearing of vegetation and surface soil at the beginning of the work and the erosion of the land by removing the natural support produced by trees and shrubs in the area, may induce a low magnitude impact In Pangaon: Removal, stockpiling, conservation of topsoil and reuse for revegetation works

To use the topsoil from the excavation in restoration actions after completion of Works, the topsoil should be stockpiled in advance. At the start of the excavations, the first step of corrective actions in those areas to be altered, will be the removal and stockpiling of the topsoil (first 0.15 m) including competing weeds and scrub vegetation.

The topsoil should also be tested for potential contamination and if the level of contamination is such that the soil does not qualify to be used for the intended purpose, then it should be disposed of in accordance with GoB regulations or, in the absence of these, in accordance with acceptable international standards such as the Dutch standards

The qualified topsoil will be removed and stockpiled in optimal conditions to prevent compacting. The topsoil piles will not be larger than 3 meters high and 5 meters wide. Piles will remain on the terrain until environmental restoration actions start.

This topsoil will be piled and conserved for their further utilization, in the restoration works. To maintain the stockpile in optimal conditions, erosions caused by rain will be restored. The stockpiled topsoil must be extended over the areas to be restored after morphological correction.

This topsoil will be stockpiled parallel to the ROW, within the area delimited by the marking out. The previous piled topsoil should be spread on embankments and over all the area to be restored. A layer of 30 cm of topsoil must be spread. The excess topsoil resulting from excavation and earthworks during construction and not used in environmental restoration activities must be spread on the road reserve areas.

The topsoil will be spread on the affected surfaces where the restoration works will be carried out. The spreading of the topsoil must be done with machinery that causes minimal compaction. The surfaces on which the topsoil will be spread will be scarified slightly beforehand, in order to get a good adherence of

this layer with the lower ones and thus avoid erosive effects. This operation improves the infiltration of the water, avoids the sliding of the extended topsoil and facilitates root penetration. The supply and spread of topsoil will be uniform over the entire affected area.

The spreading of the topsoil will be done with the average thickness of 30 cm, proceeding to the refinement and uniform distribution. The passage of heavy machinery over topsoil will be avoided.

- The Contractor shall plan his works to minimize surface excavation works during the rainy season where practicable.
- Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
- Place the sediments for filling the proposed disposal areas. Prior to filling commencement, the areas being filled will be subdivided into compartments by construction of temporary containment bunds of suitable material (e.g. dredged sand). Filling will be achieved by progressively pumping slurry of sand and water into the bunded areas, allowing the surplus water to drain away to artificial and natural waterways in a controlled manner through the pipeline, without affecting floodplains.
- Dredged soil should not be disposed in the river or its banks (especially during breeding or spawning seasons of aquatic organisms)

- Barishal
  - Stabilize the cleared areas not used for construction activities with appropriate soils and vegetation as soon as possible.
  - Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.
- Chandpur
  - Stabilize the cleared areas not used for construction activities with appropriate soils and vegetation as soon as possible.
  - Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.
  - Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
  - Excavated material should not be disposed in the river or its banks.
- DEPTC
  - 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.
  - Implement sowing of herbaceous species (vetiver) on new slope surfaces to prevent erosion
  - Reinstate and protect cleared areas as soon as possible.
  - Stockpiles will be done in slopes of 2:1
  - Strip the topsoil to a depth of 15 cm and store in stockpiles of height not exceeding 2m.

- Spread the topsoil to maintain the physicochemical and biological activity of the soil. The stored topsoil will be utilized for covering all disturbed area and along the proposed plantation sites
- Cover unused area of disturbed or exposed surfaces immediately with mulch/grass turfing/tree plantations

- Naranyanganj
  - Stabilize the cleared areas not used for construction activities with appropriate soils and vegetation as soon as possible.
  - Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.
  - Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
  - Excavated material should not be disposed in the river or its banks.
- Shasanghat
  - 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. Despite the fact that there is no topsoil found in the project area, it is essential to stabilize the cleared areas not used for construction activities with appropriate soils and vegetation as soon as possible.
  - Cover unused area of disturbed or exposed surfaces immediately with mulch/grass turfing/tree plantations
  - Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
  - Excavated material should not be disposed in the river or its banks.

5.2.5. Impacts on Surface Water Quality and Hydrology

- All sites: Cargo and Passenger terminals

The mobilization of workers and heavy machinery, field operations and especially the movement of earth during construction generate moderate amounts of dust in the environment. This dust generated can end up clouding the river water and producing a decrease in the light in the water column, affecting aquatic life. Also, if the machines are placed near water, they can cause oil and hydrocarbon pollution in the water body.

- Ashunganj and Pangaon

The aquatic ecology is likely to be disturbed due to construction, dredging and piling activities along the bank and riverbed. The suspension of fine sediments in the water column creates turbidity, which scatters and attenuates light levels and potentially affects the growth of plants indirectly by reducing the availability of light and consequently the photosynthetic process in plants. Certain level of localized turbidity can be expected during proposed dredging works.

Similarly, the dredging operations and construction of the breakwaters could all affect the water quality of the rivers adjacent to the terminals and the river mouth both in terms of increased turbidity of the water bodies and increased pollution due to dredged or spilt contaminants.

Water quality effects of dredging activities are variable depending on increases in turbidity, suspended solids, and noise; reduced light transmittance; changes in salinity, temperature and pH; reduced dissolved oxygen (DO); and releases of nutrients, heavy metals and organic contaminants (Connor et al. 2004; US Navy 1990).

During dredging, several changes occur when sedimentary material is dispersed into the water column:

- The particulate organic matter (POM) concentration in the water increases.
- DOM-bound pollutant concentration in the water column increases.
- Total concentration of pollutant in the water increases.
- POM with different pollutant concentrations are mixed.

However, only some dredging, about 3500 m^3, is expected in Pangaon so it has no significant consequences. In Ashunganj for jetty development cope line is chosen in such a way to eliminate need for dredging, except to remove a man-made reef at chainage 0+200, volume of material to remove is about 500 m3 only. Also, due to the weak water currents in this protected part of the terminal, the turbidity is not expected to move very far.

It has to be remarked that in Pangaon, water quality has been found to be the worst in these sites. Therefore, more pollution during construction may be critical for this site

- Shasanghat, and Narayanganj sites

These sites are particularly mentioned because of the river water quality has been found to be the worst in these sites. Therefore, more pollution during construction may be critical for these sites.

In Narayanganj there are some lateral drains which are getting discharged from other parts of the city into Shitalakhya. Potential sensitivity may rise from altercation of drainage channel and blocking of drainage by dumping waste.

Figure 178. Narayanganj site

- Chandpur and Barishal,

In these terminals there are also some lateral drains which are discharged into Lower Meghna River. In Barishal site, many lateral drains were found which are draining to the adjacent river. In Chandpur, some

natural canals were also observed to be running in parallel to the proposed site. Construction operation will impact these parallel sites

These drains will be not be disturbed during the construction. Small drains connected with the houses along the ghats will be connected to interceptor drains and will be taken to other connecting drains to nearby manholes.

Waste from dredging or construction operations has, if not properly managed, a significant impact on surface water quality. Their storage and removal must be controlled so that the waste does not end up mixing and contaminating the river water and affecting the hydrology of the area.

- DEPTC site

The DEPTC site will not pose any impact on surface water quality if common mitigation measures are followed. The impacts on water quality and hydrology are estimated as low to moderate

5.2.5.1. Mitigation Measures

- Ashunganj and Pangaon

The main sensitive receptors of changes in surface water quality and hydrology from project activities are aquatic organisms, aquatic ecology and river water. It should be noted that river Buriganga is an ECA site declared by the Bangladesh government. Therefore, in the Pangaon and Shasanghat sites, extra precaution needs to be adopted. No decline in water quality should be permitted.

Implement measures in ECoPs 2,3 and 5

- Implement EcoP 3: Drainage Management
- Dredging area should be checked every day prior to commencement of dredging work.
- Place silt curtain surrounding work area when piling and dredging to reduce/eliminate suspended materials beyond the confines of the works being carried out. The curtain must be positioned to provide adequate protection to the river water for the area of operations and must allow for any tides or currents present.
- Water samples will be collected near the dredger while in full operation and tested for sediment loads.
- Piling should be stopped for some time, if any dolphin/IUCN red listed species is sighted in activity area. Dolphin (*Platnista gangetica*) is relatively a frequent visitor at the river section of Ashunganj Terminal. To avoid this, pingers will be used to chase away aquatic mammals, dredging equipment will ramp up slowly to minimize noise disturbances and allow for animals to swim away, and that minimum distance will be maintained with sensitive habitats (reedlands, marshlands, etc.)

Installation of concrete slab of at least 10x8 m, with central drain lead rainwater through an appropriate referral, to a final host deposit with a minimum capacity of 7,000 liters.

The machinery to be repaired and pollutants will have to rest upon the concrete slab. The water collected in the reservoir will be managed by specialized companies in the management of hazardous waste. They must become independent of the slab runoff from the rest of the site installations by elevating the slab on the surrounding soil, as detailed in Figure 179.

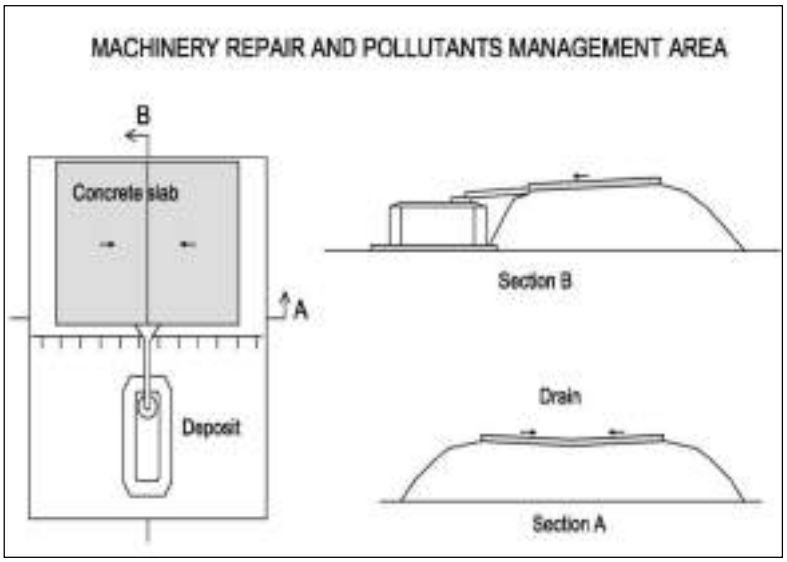


Figure 179. Concrete Slab

Worksites perimeter drainage, Construction and maintenance or network perimeter drainage at worksites

During the rainy season there is a risk of washing of pollutants from the worksite facilities to the adjacent watercourses. To avoid this risk of accidental pollution around singular worksites and in the areas designed for storing and parking machinery and ancillary facilities, a network perimeter drainage, or side ditch, for retaining the surface water runoff around will be built before the start of work operations. This network perimeter drainage will drive the wastewater to a settling pond or basin sand trap type degreaser to avoid reaching the next water course, as detailed in Figure 180.

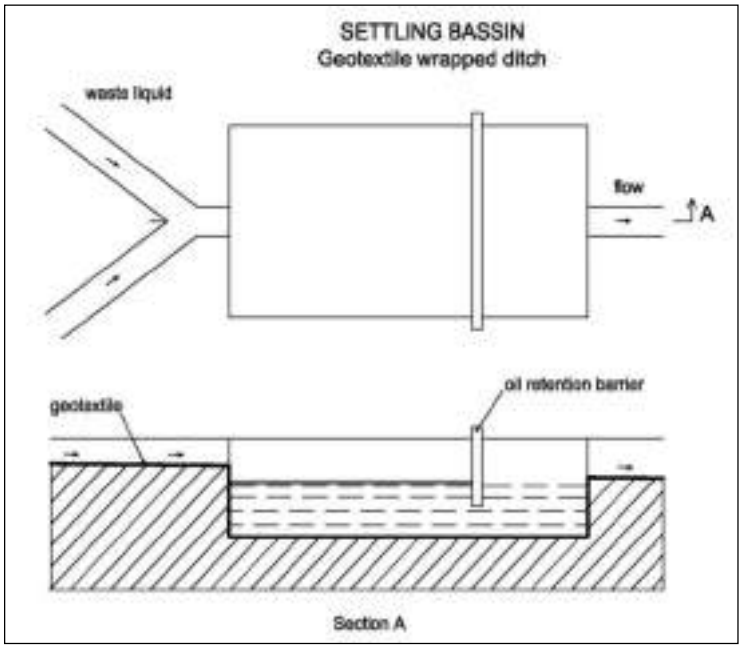


Figure 180. Settling Basin

Considering the amount of rain wash water that these worksites will receive, the side ditches or perimeter drainage trenches will have at least 1,5 m width and 0,5 m depth and will have to be maintained in perfect operating conditions throughout the entire work period.

Trucks delivering concrete shall not wash the chutes on the site or on adjacent properties. All washing operations shall take place off-site at a location where waste water can be disposed of in an acceptable manner. The Contactors and equipment operators should regularly maintain the equipment to avoid oil spillage, avoid using the 75m protection zone along the water course with machinery (pumps and tankers). Contractor will ensure no washing of construction equipment and machinery along the water courses.

- The earthwork sites where exposed land surface is vulnerable to runoff, etc. shall be consolidated and/or covered.
- The material stockpile sites shall be located far away from water bodies and areas prone to surface run-off.
- Storage areas for sand and soil, and all work areas, must be located at least 20 meters away from river. Construction equipment must not be cleaned or washed within 50 meters of the river.
- Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot.

Management of toxic pollutants

The area of auxiliary facilities will be equipped with a remote area of the field, where a temporary deposit of containers, tanks, barrels and any other container and vacuum, taking special care that they are not dumped. These zones are temporary storage having to be removed all these materials in the shortest period of time. The products that may be considered toxic are as follow, among others,

Liquids

- Paints,
- Solvents,
- Detergents, fuels,
- Lubricants, grease and oils,
- Degreasers,
- Fertilizers,
- Tar,
- Aerosols,
- Adhesives,
- Sealants and silicones,
- Any chemical labelled as hazardous waste.

Plastics

- PVC and polyethylene pipes,
- Joints and seams,
- Sealants and resins,
- Geosynthetics and waterproof sheets.

Equipment

- Electronics,
- Computers,
- Light bulbs,
- Fluorescent,
- Batteries of any kind.

The management of these products will be made following the Bangladesh Legislation.

Solid wastes shall not be thrown or spilled over along the route during transportation. Greasy dirt off construction machinery shall be treated collectively, solid wastes with greasy dirt cannot be thrown casually on ground, and rather they shall be treated collectively

- 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.
- The earthwork sites where exposed land surface is vulnerable to runoff, etc. shall be consolidated and/or covered.
- The material stockpile sites shall be located far away from water bodies and areas prone to surface run off.

- Workforce camps will be located away from water resources. All practical measures such as provision of septic tanks, garbage bags and other sanitation facilities will be implemented at the construction camps to prevent the wastewater and solid wastes from contaminating surface water.

For the likely changes in sediment quality due to pollution resulting from dredging and jetty construction: Implement ECoP 9: Dredging Management

- Directly place the sediments for filling the proposed embankment areas. Prior to filling commencing, the areas being filled will be subdivided into compartments by construction of temporary containment bunds of suitable material (e.g. dredged sand). Filling will be achieved by progressively pumping slurry of sand and water into the bunded areas, allowing the surplus water to drain away to the river in a controlled manner.
- Provide alternative drainage for rainwater when construction works interfere with natural or established drainage lines
- Oil/water separators and trapping catch basins should be installed and maintained regularly to keep them operational. Recovered contaminated solids or liquids disposed of as hazardous materials
- Installing filter mechanisms (e.g. draining swabs, filter berms, drainage inlet protection, sediment traps and sediment basins) to prevent sediment and particulates from reaching the surface water;

Finally, there is a need for conducting environmental monitoring for water quality analysis during the implementation of the project, especially during the construction phase, measuring physical parameters of the aquatic habitat such as surface water temperature, pH, turbidity (using Secchi disc) on a monthly basis

- Barishal, Chandpur, DEPTC, Narayanganj and Shasanghat

During construction phase, the following mitigation measures should be followed

- Prepare spill control protocol and submit the plan to PIU for approval.
- Implement measures in ECoPs 2,3 and 5
- Prevent all solid and liquid wastes entering the river, by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot.
- Install protective measures on-site prior to construction, for example, sediment traps
- Spray water on material stockpiles, access roads and bare soils at required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds, high temperature, etc.).

5.2.6. Impacts on Groundwater

The main sensitive receptors of changes in ground water quality and resources from project activities are human population in the surroundings due to decrease of water resources in the vicinity and/or a decrease in its quality.

- Depletion in ground water levels due to water pumping for works

The most severe consequence of excessive groundwater pumping is that the water Table, below which the ground is saturated with water, can be lowered.

Due to the installation of additional boreholes to access water at the project sites near Dhaka and Narayanganj there can be an interaction between the water in rivers and groundwater. Groundwater pumping can alter how water moves between an aquifer and the intercepting rivers, increasing the rate of water movement from the surface-water body into the aquifers.

- Shasanghat, Narayanganj and Pangaon

The sites of Shasanghat, Narayanganj and Pangaon need extra attention since ground water in Dhaka and Narayanganj is depleting fast.

- DEPTC

DEPTC construction will not require as much water as at the terminal sites need. Therefore, small and reversible impact on groundwater is expected which are countered by mitigation measures set out later on. Based on the above, the impacts on groundwater quality are estimated as low.

- Pollution of groundwater sources

Oily wastes from machinery, spillages and leakages of oil and fuels from incoming and outgoing machineries into the site will affect the water quality. This water will have a chance to either drain into the water body or will seep through the land and contaminate the ground water. There will be floating material on the water surrounding the port.All terminal construction includes the use of riverbed sediment as back fill in the assumption that those will be sandy and not clay. The sediment quality which can be used for filling of land in some cases may also lead to ground water contamination due to leaching of that filling material. The quality of the riverbed sediment was identified to characterize the baseline status. The riverbed sediment samples were collected from around the 6 project locations from 22 October to 29 October 2019. Test results of sediment analysis are given in Table 121:

Table 122. Test Result of Riverbed Sediment Quality Analysis

Parameters	Unit	Concentration Present						OSPAR Standards for Riverbed Materials, 2004	Analysis Method
		Shasanghat, Dhaka New Terminal near Postagola	Narayanganj Passenger Terminal	Ashuganj Cargo Terminal	Pangaon Cargo Terminal	Barishal Passenger Terminal	Chandpur Passenger Terminal		
		Buriganga River	Bhitalakshya River	Meghna River	Buriganga River	Kirtankhola River	Meghna River		
		BWTA_RBM 01	BWTA_RBM 02	BWTA_RBM 03	BWTA_RBM 04	BWTA_RBM 05	BWTA_RBM 06		
		23°41'24.86"N 90°25'33.74"E	23°37'8.86"N 90°30'22.21"E	24° 2'32.78"N 91° 8'1.37"E	23°39'31.36"N 90°22'13.68"E	22°41'57.26"N 90°22'33.66"E	23°13'59.05"N 90°38'56.94"E		
Total Organic Carbon	%	0.42	0.33	0.11	0.41	0.52	0.40	NYS	Wet Oxidation
Total Phosphate	mg/kg	1195.65	763.56	649.78	1230.56	1487.78	1043.65	NYS	Aquaregia & Yellow color
Water Soluble Phosphate	mg/kg	21.52	11.33	6.13	22.75	27.59	26.14	NYS	Olsen Method
Total Arsenic	mg/kg	2.497	1.743	1.850	2.379	2.362	3.158	9	APHA 3114
Total Cadmium	mg/kg	BDL	BDL	BDL	BDL	BDL	BDL	25	Aquaregia & AAS
Total Mercury	(ppb) (ug/kg)	0.35	0.27	0.22	0.32	0.26	0.19	0.5	EPA/SW-846/7000A/7040A /7071A
Total Lead	mg/kg	6.87	7.78	5.88	8.82	18.75	9.25	300	Aquaregia & AAS
Total Chromium	mg/kg	12.60	19.31	21.30	11.66	1.88	1.68	87	Aquaregia & AAS
Total Nickel	mg/kg	23.15	16.51	8.22	23.45	25.75	29.88	560	Aquaregia & AAS
Total Zinc	mg/kg	47.75	35.79	57.50	46.68	53.75	55.58	8700	Aquaregia & AAS

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 'Dutch Ministry of Public Housing, Land-use and Environmental Guidelines - Soil and Groundwater Standards' to assess sediment quality and to determine the need, if any, for remedial action.

- Total Organic Carbon: From the test results, the TOC concentration in the project influenced areas ranged from 0.11% to 0.52%. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_05 (Barishal Passenger Terminal, Kirtankhola River).
- Total Phosphate (PO43-): From the test results, the total phosphate concentration in the project influenced areas ranged from 649.78 mg/kg to 1487.78 mg/kg. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_05 (Barishal Passenger Terminal, Kirtankhola River).
- Water Soluble Phosphate (PO43-): From the test results, the soluble phosphate concentration in the project influenced areas ranged from 6.13 mg/kg to 26.14 mg/kg. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River).
- Total Arsenic (As): From the test results, the As concentration in the project influenced areas ranged from 1.743 mg/kg to 3.158 mg/kg. The minimum value was in BIWTA_RBM_02 (Narayanganj Passenger Terminal, Shitalakhya River) and BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River).
- Total Mercury (Hg): From the test results, lowest Hg concentration was found to be 0.19 µg/kg in BIWTA_RBM_05 (Chandpur Passenger Terminal, Meghna River) and highest Hg concentration was found to be 0.35 µg/kg in BIWTA_SW_01 (Shashanghat, Dhaka New Terminal near Postagola, Buriganga River).
- Total Nickel (Ni): From the test results, Lowest Ni concentration was found to be 8.22 mg/kg in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and highest Ni concentration was 29.80 mg/kg in BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River).
- Total Zinc (Zn): From the test results, Lowest Zinc (Zn) concentration was found to be 35.73 mg/kg in BIWTA_RBM_02 (Narayanganj Passenger Terminal, Shitalakshya River) and highest Zinc (Zn) concentration was 57.50 mg/kg in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River).
- Total Lead (Pb): From the test results, Lead (Pb) concentration ranges from 5.88 mg/kg to 18.75 mg/kg. The minimum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River) and maximum value was in BIWTA_RBM_05 (Barishal Passenger Terminal, Kirtankhola River).
- Total Cadmium (Cd): From the test results, all the samples have shown concentrations below the detection level.
- Total Chromium (Cr): From the test results, Chromium concentration ranges from 1.68 mg/kg to 21.30 mg/kg. The minimum value was in BIWTA_RBM_06 (Chandpur Passenger Terminal, Meghna River) and maximum value was in BIWTA_RBM_03 (Ashuganj Cargo Terminal, Meghna River).

- Shasanghat, Narayanganj and Pangaon

In this terminal sites, the main sources of pollution area anthropogenic sources like untreated industrial effluent and municipal wastes. Acute arsenic problem in groundwater around Dhaka city is prominent. Chandpur, Barishal and Ashunganj

- Barishal, Chandpur and Ashunganj

For those terminals, the main sources of current pollution are meant to be agricultural and naturogenic, nevertheless the highest concentrations of Phosphate, Arsenic and heavy metals (as lead) are found in Barishal and Chandpur.

In general, although the parameters analyzed in baseline quality of sediment were observed to be well below the threshold limits. In this context, groundwater pollution will be of utmost concern. Groundwater pollution could increase the current level

5.2.6.1. Mitigation Measures

- Ashunganj
  - Use maximum surface water for construction and labor camp purpose instead of ground water. Use supply water to compensate for local withdrawal of groundwater
  - The contractor will use of water from pipe system instead of extracting water from the river. The contractor is also responsible for liaising with DHAKA WASA in order to be connected with water supply for campsites, workshops, terminals, depots and for construction uses; the contractor will use only authorized boreholes in the campsites
  - Use STP to treat wastewater so that water does not contaminate groundwater Table.
  - For effluents to be discharged from workshops, camps, and offices, treatment arrangements such as retention ponds and septic tanks will be incorporated in the facility designs.
- Pangaon
  - For effluents to be discharged from workshops, camps, and offices, treatment arrangements such as retention ponds and septic tanks will be incorporated in the facility designs.
  - Ensure that no drinking water sources (surface or ground water) are located within 500 m radius of the facility.
  - Use maximum surface water for construction and labor camp purpose instead of ground water.
  - Use supply water to compensate for local withdrawal of groundwater
- Barishal, Chandpur, DEPTC, Narayanganj and Shasanghat

During Construction, the following measures should be observed

- Prepare a program for prevent/avoid standing waters, which PIU will verify in advance and confirm during implementation.
- Do not allow ponding of water especially near the waste storage areas and construction and labor camps. Discard all the storage containers that can store of water, after use or store them in inverted position.
- Follow the waste management guidelines proposed in ECoP 5 and 6.

5.2.7. Impacts on Terrestrial Flora and Fauna

Activities during construction period for the S3 and S4 infrastructures may include river bed dredging at the jetty sites, earth filling, bore hole digging, piling and associated activities construction of buildings, removal of vegetation, transportation of construction materials and machineries, leaching of various chemicals into the environment, noises from the construction activities, influx of huge workforce, etc.

As assessed in the following sections all these activities may have the potentials to negatively affect the local flora and fauna. Such construction activities and degraded habitat quality may kill, destroy, or cause damages to plants and animals, reduce growth and reproduction, disposes animals and plants to diseases and make disturbances to wildlife communities.

Impact analysis was based on some common measurements in order to qualify an impact: its duration, its spatial effect, ability to prevent or reverse negative effects and to mitigate them. In practice, each planned activity under the S3 and S4 development works was checked for its potentials to cause negative and positive impacts on different components, viz, flora, fauna and ecosystems.

Environmental impacts were grouped according the development stage, the predicted impact would take place, namely construction and operation phases of the proposed S3 and S4 development. The significance of impacts was defined according to their severity, extent and duration using the adjectives, low, moderate, high and very high, positive or negative.

The impacts are described according to biological components, viz. flora, fauna and aquatic life.

5.2.7.1. Impact on flora and vegetation

Main project´s action during construction phase likely to impact on vegetation and agricultural land are: mobilization of workers, camp site establishment and operation, land cleaning and vegetation and topsoil removing, earth movement and excavations, piling dredging and dumping of dredge and excavated materials. The impacts are assessed below:

- General Consideration: All sites passenger and cargo terminals
  - Herbaceous Plant:

In general, the S3 and S4 development sites, except the Pangaon site, have little ground vegetation cover, and both species diversity and abundance of herbaceous and shrub vegetation were also found low. Shasanghat, Ashuganj and Chandpur sites virtually have very little ground vegetation and only few species of herbs and shrubs (8-9 species) were noted.

The site clearance process will require to remove the herbaceous and shrub vegetation from the construction sites and its proposed approach road areas, while some creeping herbs, like Bermuda grass, Carpet grass, etc. will be buried permanently under the dredged material used in land filling.

No endemic and conspicuous or economically important herbs and shrub species are present at the sites. Local people consider these shrub and herbaceous vegetation as weeds. In the project sites, this vegetation type probably performs little ecological function, as it provides little shelter and feeding opportunities to animal communities.

On the other hand, herbaceous plants are highly regenerative and is replenished within few months, if suitable land areas become available. The recorded species are mostly common and abundant throughout the ountry. Therefore, conservation of herbaceous plants is not essential at the project construction sites. Based on the above, impact severity, extent and reversibility could be considered low and minor and short-term effect requiring no mitigation measures.

- Trees:

All S3 and S4 development sites are also poor in tree coverage and contain some common planted species, many of which are exotic. A total of 45 species of trees was recorded from all sites and its immediate adjacent areas, depending on the study sites species number varies from 16 to 25 species.

The exotic trees are considered hostile to environment and their conservation is not intended. Removal of these trees is unlikely to pose any extinction risk to any species. Nonetheless, trees perform huge ecological services, particularly in sequestering carbon, and providing nesting, feeding and roosting sites to many animal species, particularly the birds.

Trees are also source for timber, fuel and building materials for the local community people. However, lost trees could be replenished by undertaking ree replantation program. It will take some time to grow intofunctional stage to provide its ecological services. Considering the number of trees likely to be removed and its corresponding ecological function, and potential mitigation measures the impact may be considered low and could be reversed by undertaking mitigative measures. viz. plantation. A site wise impact assessment is done below:

- Shasanghat Terminal:

Shasanghat site represents an urban environment and is almost devoid of trees with some common herbaceous plants in pocket areas within its site boundary (Figure 183). As explained above, the removal of herbaceous plants will have little or no ecological impacts. The trees recorded from he site were mainly from the adjacent areas, and these are mostly common plant\ed and exotic species. Only four nos. trees will be removed from the site in the site clearance process. Considering the diversity and quantity of vegetation to be removed the impact on vegetation is assessed as below:

Significance of impacts: Impact severity: minor; extent and duration: localized and mid-term; Reversibility: not reversible; Potential for mitigation: high; Residual effect: little.

Figure 181. Shasanghat terminal site.

- Chandpur Terminal:

Being Chandpur an existing Passenger Terminal (Figure 184), the site is considered under urban area, therefore the number and variety of terrestrial vegetation and animals is quite low or null. Some trees are found in the surroundings, but with no ecological significance.

The construction process, including earth-filling, drilling, pilling, levelling and building approach roads and parking lot will require to remove some herbaceous plants and604 nos. trees present in pocket areas. This removal is unlikely to cause major impacts. Considering the above, the impacts on vegetation is considered negligible, localized and short-term.

Table 123. Design Master Plan for Chandpur Terminal

- Narayanganj Terminal:

Same as before for other terminals, Narayanganj is an existing Passenger Terminal which will be rebuilt with provision for upgradation and expansion. Green areas are found only as garden zones (Figure 185). These gardens are made by several ornamental herbs, shrubs and trees as: Banyan Tree (*Ficus benghalensis*), Sajna (*Moringa oleifera*), Meghoni (*Swietenia mahogoni*), etc. In the construction process the garden is likely to be damaged with loss of all herbaceous, shrubs and trees. Altogether, a total of 143 nos. tress will be removed. Although, the garden has less ecological importance, however, its aesthetic value and considering the volume of vegetation to be removed the impact to be caused would be less and easily mitigable.

Table 124. Green areas, and gardening in Narayanganj terminal

- Barishal Terminal

Barishal is an existing Passenger Terminal which will be upgraded and modernized. The area occupied is considered an urban environment, with low number and diversity of terrestrial vegetation and animals. Some planted tree species are found in gardens (Figure 186), mainly include Krishnachura (*Delonix regia*), Mehghny (*Swietenia mahagoni*), Supari (*Areca atechu*), Koroi (*Albizia procera*), Coconut (*Cocos mucifera*), Kadam (*Anthocephalus chinensis*), Kathal (*Artocarpus heterophyllus*), etc. and provide habitat for some bird species, offer fruits and protect soil erosion.

There is some herbaceous vegetation within the site boundary and provides refuge to some ground dwelling animals, for example, frogs, skinks, garden lizards, monitor lizards, etc.. However, , most tree species are planted, common and abundant throughout the region. Although not significant, the vegetation at the site provide shade, roosting, nesting and feeding habiitats to some avifauna, in addition to its carbon sequestration functions..

The project development activities, like earth-filling, drilling,piling construction of terminal building, approach roads and parking spaces will destroy herbaceous vegetation and trees will be cut. This will cause some negative impacts on the local ecology affecting the dependent animals and carbon sequestration.

Significance of impacts: Impact severity: minor; extent and duration: localized and midterm; Reversibilty: Little; Potential fpr mitigation: High; Residual impact: Negligible.

Although the anticipated impact is low the Project development should include tree planting and green areas to avoid this little impact.

Table 125. Gardening area in Barishal IWT Terminal

- Pangaon Terminal:

The new Terminal will be placed at a greenfield area in a peri-urban area. The site has wide ground vegetation coverage all around. At the riverbank some terrestrial herbaceous plants as Durabagash (*Cynodon dactylon*), Carpet grass (*Axonopus compressus*), Assamlata (*Eupatorium odoratum*), Telakucha (*Coccinea cordifolia*) will be removed during clearance and filling. Herbaceous vegetation is abundant, particularly along the proposed approach road areas. This herbaceous community thus has got some ecological importance. For the rest of the vegetation, being this some fruit trees planted directly as single specimens, does not signified impact as well.

The upper part of the bank, along an existing unpaved road, has some planted exotic trees (approx. number of 20 units) and two *Ficus sp* (Figure 187). This Tree lines placed on the unpaved road will be off during clearance. This tree species is artificial recreation, not indigenous to this region, but very common and representative in the country. Abuut1045 nos trees will require to be removed from the site for th

site development. The vegetation at the site provide resting, roosting and nesting habitats to some wildlife. As assessed, the impact of project construction on local vegetation would be as follows:

Significance of impacts: Impact severity: moderate; extent and duration: localized and long-term; Reversibility: naturally little, but high by undertaking mitigation measures; Residual impacts: little.

Table 126. Tree line planted in the unpaved road

- Ashuganj Terminal:

This Cargo Terminal site development area is almost devoid of vegetation, except some herbs at some pocket areas and few planted trees in and around the proposed development site represented by some planted single fruit trees and exotic timber yielding trees, most of them in the adjoining areas of the project development (Figure 188).

The site clearance process will require to remove this herbs and about 190 nos. trees, most of which are planted and again exotic, having little conservation and ecological significance. Considering the diversity and abundance of the vegetation it appears that the vegetation at the site perform little ecological functions.

Significance of impacts: Impact severity: negligible; extent and duration: localized and mid-term; Reversibility: net, but high by undertaking mitigation measures: high; Residual impacts: little

Table 127. Poor Vegetation with some individual trees on Ashuganj Terminal

- Agricultural Land and Farms

There is no agricultural fields or production systems within the construction sites or its immediate vicinity.

However, there is a big fish pond of about 2.0 ha adjacent to the Pangaon construction site. The pond is utilized for semi-intensive culture of fish with Indian major caps and some exotic fish species. A part of the pond will be earth filled and this will generate silts and will affect the fish culture activities in the remaining part of the pond, in addition to reduction in viable couture area.

It is anticipated that during the construction period fish culture activity will not be possible. It is suggested that a temporary barricade should be erected in the pond so that filling materials do not accumulate in the remaining part of the pond.

- Mitigation Measures in Flora and Vegetation

- Strictly delimitate the extension of the area to be affected, before the construction works start, the contractor will proceed to mark the outer limit of the work facilities **area by steel rods and plastic tape**. The limits of performance for the trafficking machinery, auxiliary equipment, etc, will be defined and these will necessarily remain within the enclosed area.
- The marking out will consist of steel rods of 30 mm wide and one meter in length, with the lower 30 cm nailed to the ground. These supports will be embedded into the ground and placed every 8 meters and will be joined to each other by a plastic tape.
- Obtain necessary approvals for clearance of vegetation. If the amount of clearance is big (e.g. >10 decimal) obtain permission from DoE. Otherwise, obtain permission from local authorities who own the land.

The detail of this marking out can be observed in figure 182

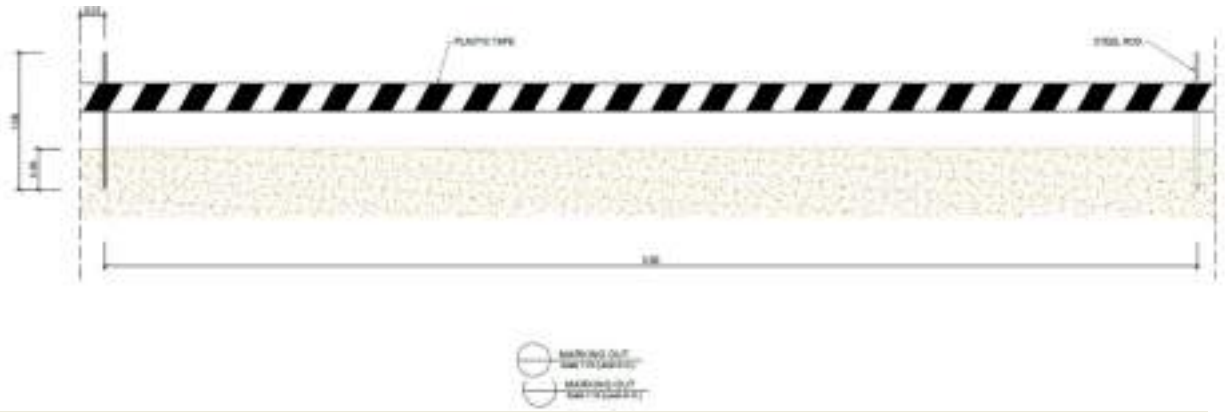


Figure 182. Detail of temporary marking out.

The marking out will be continuously reviewed to ensure its functionality and it will be replaced when it is damaged. The marking out will be temporary, and it will be extended during the period in which the works are carried out. Once the work has been completed, the tape and steel rods will be removed, as well as any other element foreign to the environment related to this work unit.

- Vegetation clearance for temporary infrastructure should be limited to the minimum. Clearance of the vegetation should be limited to the core area of the project. meaning permanent works and the minimum necessary for any temporary works.

Temporary projects infrastructure (borrow pits, access roads, road upgrading camps, stockpiling areas) should avoid woodlands and wetlands. The Contractor shall ensure that only vegetation found within the limits is cleared. It is to be mentioned that these trees are used by some common smaller bird species. They are flexible in nesting and will use nearby available trees for nesting. Vegetation outside the proposed layout of the development must not be removed or disturbed. To avoid unnecessary removal of trees and other vegetation, the Contractor shall make selective and careful pruning of trees where possible to reduce need of tree removal

- Undertake tree replantation program with native species to compensate the lost trees. Tree removes will be replaced, for each one tree remove, five saplings will be planted at the project location, terminal premises and embankment site, etc.
- If trees are removed in nesting period of birds (mid-February to mid May), check the trees for bird nests and if noted wait until the nesting period is over.

Landscaping and planting of vegetation should be done to all disturbed surfaces, including quarries and borrow pits, work road diversions no longer in use, areas along the terminal buildings and depots. The lands should be properly reinstated to allow the landscaping activities and replacement of the vegetation on the affected areas to be restored

In the case where clearing of the vegetation could not be avoided, the areas cleared of vegetation should be re-vegetated using a formula: one tree cut three-five trees planted, to prevent soil erosion and to revuve its ecological functions. However, re-vegetation is only possible given suitable ground conditions (soils, slopes, drainage) moisture, and protection from destruction. The topsoil removed during construction of the pavement of the roads should be stored and be used later to rehabilitate

a. Spread of topsoil will be carry out in areas within the row where the trees have been removed, borrow pits, quarries, new embankments, and some other new surfaces after the completion of works, the vast majority of these places will be environmentally restored by the layout of topsoil that contains indigenous seed species

b. Plants and grasses for re-vegetation should be sourced within the project area to avoid introduction of exotic species. All the trees removed within the row due to the implementation of the project should be replaced. Plants for re-vegetation should be sourced within the project area to avoid introduction of exotic species. The environmental restoration of these temporary work sites will be carried out by the plantation or seeding of indigenous tree and shrubs species, **considering the tree species and their distribution pointed out in the Baseline Report.**

c. Transportation of trees for planting should be done just after the onset of the long rains when the ground will have soaked up adequately. For each seedling a hole of roughly 1 x1 m r and 1 m deep will be dig, returning the excavated topsoil to the hole after planting. A fertilizer addition of NPK (nitrogen, phosphorus, potassium) mixed with small amount of soil will be placed in the bottom of the planting hole, The shrub species will be panted forming edge of 1 m width with a framework of 1 shrub/m. Depending on the tree species the sapling height should be 3 to 6 feet in height and be protected by fencing and providing a support to each individual sapling.

- Slope protection measures.

Plantations of flat growing grass in high-slope embankments to reduce erosion and likely siltation of water courses is designed as erosion prevention measure on embankments with slopes rate of more than 3H2V.

Vetiver Grass *Chrysopogon zizanioides* (Figure 183) is good for reducing Soil Erosion. Vetiver Grass usually grows to one meter in height although it can grow higher. Vetivers' strong, fibrous, binding roots go down between four and six meters. The roots bind with the earth forming an incredibly strong interlocked underground wall, stopping ground movement.

Figure 183. Vetiver Grass

The surfaces on which the topsoil will be spread will be scarified slightly beforehand, in order to get a good adherence of this layer with the lower ones and thus avoid erosive effects. This operation improves the infiltration of the water, avoids the sliding of the extended topsoil and facilitates the penetration of the roots.

The supply and spread of topsoil will be uniform over the entire affected area. When the height of the slopes requires it, the spread of the topsoil will be done progressively, so as to avoid an incorrect execution in the middle layer. The spreading of the topsoil will be done with the average thickness of 30 cm, proceeding to the refinement and uniform distribution.

Vetiver Grass will be planted at 10% of the surface (4 plants/1 m2) at the bottom of the embankment, in order to prevent from erosion (Figure 184). The planting of grass will be done during the first few days of the rainy season at all the identified erosion-prone areas. The areas to be planted will be thoroughly watered before planting to ensure that soil will be uniformly wet over a depth of at least 150 mm when planting takes place. Rooted grass cuttings or seedlings will be evenly planted by hand in lines spaced at 1 m down the slope. Individual plants will be spaced at 0.25 m horizontal intervals. Only fresh plants will be used and grass that has been allowed to dry out shall not be used. Immediately after planting, the grass will be given a copious watering.

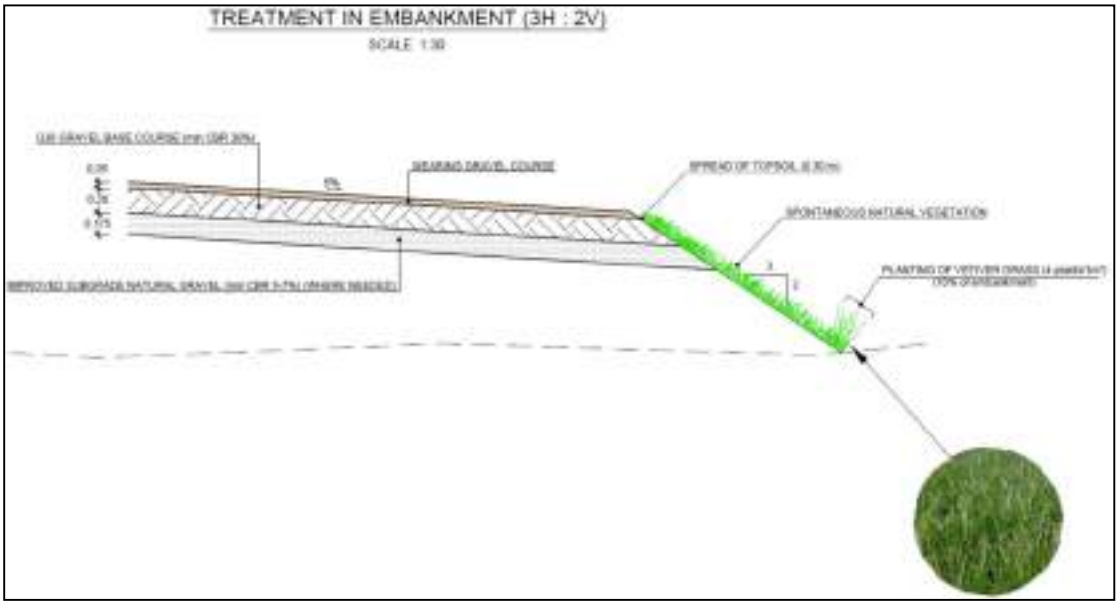


Figure 184. Planting of Vetiver Grass on embankments

- Develop a green area (garden) in waste spaces within each terminal site premise
- Distribute tree saplings among local HHs for planting in courtyard areas.
- The tree cutting debris will be at the disposal of the vicinity at market price or disposed suitable or dumping of in an authorized landfill.
- In the instance of Pangaon Terminal, the removal trees belong to the Vicinity Mosque, so all the cutting debris must be given to its owner directly.

5.2.8. Impacts in Terrestrial Fauna

Main activities during construction phase likely to produce impacts on fauna and habitats are the following: land cleaning and vegetation and topsoil removing, earth movement and excavations, dumping of dredge and excavated materials, noises from construction activities and machneries , night time lighting, night work, .

5.2.8.1. General consideration: All sites passenger and cargo terminals

Total 44 species of terrestrial wildlife species have been recorded from all the project sites, while species diversity among different individual project sites range from 31 to 43 species. Compared to similar landscape elsewhere in the country, the species diversity at the project sites is less. Many of the recorded species are accustomed to living in urban environment and disturbed places.

Removal of vegetation for site clearance is likely to reduce the viable feeding, nesting and roosting sites of many wild species. It may also destroy bird nests if trees are removed duuirng nesting period of birds.It will then be necessary to check the trees for bird nests, if site clearance is done during nesting period of birds. However, considering the number of trees to be removed and amount of herbaceous vegetation to be cleared, the impact is unlikely to be major. Some slow-moving fauna may be buried/ perished under dredged material during earth filling. Similarly, some animals may be perished under vehicle wheels during construction works.

Higher noise levels resulting from construction activities and increased vehicular traffic is also likely to have adverse impact on the birds and other terrestrial fauna. Lights used during night work at the project

sites may affect the aesthetics of the local area and disturb local fauna such as birds and other nocturnal animals at the sites. As a result, the population abundance of terrestrial fauna at the sites may decline in the backdrop of present poor abundances of fauna species at the project sites.

The fauna species recorded from the project sites are mostly common and widespread throughout the country. Some observed species, like rat, mice and shrews are considered vermin and their conservation is not intended. Many of these species are accustomed to, livng in urban and disturbed places, some observed terrestrial species are occasional visitor to the siteunlikely to be affected by project interventions.

None of the recorded terrestrial fauna species is threatened nationally. However, out of 44 recorded terrestrial fauna species, 12 species are included in the Schedule of I of the B(P&S) Act, 2012., which states that these animals shall not be killed, trapped or disturbed. And the project needs to ensure their protection during construction works. The significant species recorded from the project are mostly either rare or occasional at the site. The project sites are not their principal habitat and therefore not essential for their survival. Nonetheless, these species are protected under country's legal regime and therefore requires protecting the species and also not to cause any harm to them. However, most adverse impacts will be of temporary, localized, reversible and some effects could be avoided and reduced through undertaking mitigative measures.

A construction site wise impact assessment on terrestrial fauna is done below:

- Shasanghat Terminal:

Shasanghat Terminal is situated in a barren and urban area, full of industrial waste (Figure 185). The site is very poor in diversity and abundance of fauna species.

A little number of wildlife was reported from the site, but most of them are from surroundings, where many of them are considered vermin and virtually devoid of vegetation coverage, although the adjoining areas have some planted trees. As such, the site does not provide habitat to wildlife. The number of wildlife species recorded for the site is quite low, again not resident to the site, but sometimes appear at the site. The site also does not provide any nesting site for animals within its boundary. Some observed species, (like rats, mice, etc.) are considered vermin, encouraged to control its population. Many of them are again accustomed to living in disturbed places. The species observed are common and found abundant throughout the country. The project activities are unlikely to cause any harm to those, only noises from construction, workers movement and night time light may cause disturbances to the fauna of adjacent areas, but limited to only during construction period. Therefore, overall impact will be negligible, short-term and localised with no residual impacts.

Significance of impacts: Impact severity: negligible; extent and duration: localized and short-term; Reversibility: reversible; Potential for mitigation: high; Residual impacts: negligible. Although, overall impact is negligible, however, precautionary mitigation measure may improve the faunal abundance at the site.

Figure 185. Current status of Shasanghat Terminal.

- Chandpur Terminal:

Given that Chandpur is an existing Passenger Terminal, the site is considered under urban area with a poor vegetation cover, therefore the diversity and abundance of terrestrial fauna species are low and many of the recorded species are recorded from surrounding areas, outside the project boundary.

The project activities have the potentials to cause impacts to terrestrial fauna however, poor occurrence of fauna and presence of common species accustomed to living in disturbed places, the impact would be low. Nonetheless, the project activities like nighttime lighting and sounds from construction works are likely to cause minor level of impact on local fauna at the site.

Significance of impacts: Impact severity: low; extent and duration: localized and short-term; Reversibility: not reversible by natural process; Potential for mitigation: high; Residual impacts: negligible.

- Narayanganj Terminal:

As happen in the previous Terminal, Narayanganj is an existing Passenger Terminal which will be rebuild. Green areas are found only as garden zones, where fauna was mainly observed.

The loss of garden area and adjoining tree coverage will negatively impact the fauna at the site. However, many of the observed species are not resident to the site., while some others are accustomed to living in urban and disturbed places. Many of them are flexible in roosting and may roost in nearby areas. When the garden area is restored, such species will recolonize.

Significance of impacts: Impact severity: moderate; Extent and Duration: localized and short-term; Reversibility: not reversible by natural process; Potential for mitigation: high; Residual impacts: low.

- Barishal Terminal

As because of presence of some tree coverage, ground vegetation and presence of a garden within the site boundary, the site support a number of terrestrial wild fauna, although many of them are common and abundant within the region, while many of them are accustomed to living in urban and disturbed places. Some noted animals are considered vermin, like rats, mice, etc., encouraged to control its population. Sounds from the construction activities and movement of workers within the sites have the potentials to impact local fauna. Some, slow moving animals, toads like lizards, may be buried under filled soil. Also, removal of trees will reduce viable feeding and roosting habitats of fauna, specially the birds. Based on the above, the significance of impacts may be assessed as follows:

Significance of impacts: Impact severity: moderate; Extent and duration: localized and long-term; Reversibility: not reversible by natural process; Potential for mitigation: high; Residual impacts: low.

- Pangaon Terminal

Among the S3 and S4 project sites, Pangaon CT has comparatively more diverse, abundant vegetation cover among the project sites, therefore, Pangaon site has got more diversity and abundance of fauna species, including some significant ones.

Various land-based project activities are likely to cause disturbances to the local fauna species. Loss of considerable vegetation is likely to cause loss of feeding, nesting and roosting habitats of birds and other animal species. Sounds and night time light from the construction areas and workers movement will also cause disturbances to the fauna adjacent to the site. Snakes and lizards will particularly be affected. Some slow-moving lizard, toads are likely to be perished under filled soil. Some common species, such as pied starling, sunbird, and doves utilize the site for nesting and would be affected. Though, these animals flexible in nesting and roosting and will utilize any suitable habitat nearby for the purpose and may recolonize at the site when threats will be withdrawn. As the recorded fauna species are common and wide distributed throughout the country, the site is not essential for their survival.

However, many of recorded species including some lizards, mongoose (Figure 186) have the adaptive capacity to live in disturbed environment. Golden Jackal, which is a significant species, has been reported from the site, but is a occasional visitor , not resident in the site.

Figure 186. Common mongoose observed in Pangaon Cargo Terminal

Following characterization for the Grey Mongoose and the Golden Jackal, we will have the following classification magnitude:

a. Grey Mongoose and Golden Jackal are natural from the Country

b. Exist several individuals in the Project site and surrounding areas.

c. Great Recovery capacity due to its natural origin and numerous representatives.

d. In the project sites exist individuals of mongoose for maturity ages among young.

e. They are not protected by the Red List and Government.

Based on the above, the significance of impacts may be assessed as follows:

Significance of impacts: Impact severity: moderate; Extent and duration: localized and long-term; Reversibility: not reversible by natural process; Potential for mitigation: high; Residual impacts: low.

- Ashuganj Terminal:

Having poor vegetation coverage, the Ashuganj Site (Figure 186) also supports less diversity and poor abundance of wild species. However, adjoining areas support good number of fauna species, particularly

the birds. However, many of these are common, abundant species, while some are accustomed to living disturbed environment. In the site, vermin species dominate. Most project site development activities have the potential to negatively impact the terrestrial fauna. However, the impacts will disappear upon completion of the development. No species recorded at the site are threatened and protected under countries Redlist and Wildlife Act, respectively Based on the above, the significance of impacts may be assessed as follows:

Significance of impacts: Impact severity: negligible; Extent and duration: localized and short--term; Reversibility: reversible; Potential for mitigation: high; Residual impacts: negligible.

Figure 187. Riverbank on Ashunganj Terminal

5.2.8.2. Mitigation Measures in Terrestrial Fauna and Wildlife

- Undertaking tree replantation program as suggested for tree replacement program above; this will have positive impacts on the terrestrial birds and other associated fauna.
- Night time works and use of unnecessary lights within the construction areas should be avoided as far as possible;
- Provide induction training to site level officials and workers on how to avoid causing damage and disturbances to the wildlife.
- Local community awareness should be enhanced on conserving the wildlife in the area.
- Prior to any earth filling and starting construction activity the site should be checked for slow moving fauna, like frogs, lizards, etc., if present drive them out to avoid killing and causing damages to those fauna.
- Creation of a green zone within or nearby will help to restore some lost habitats to provide nesting and roosting habitats to animals. accommodate the affected fauna species.
- Preservation/restoration of the garden will help mitigate /compensate the impacts.

5.2.9. Impact on Aquatic Life

Many of the project activities will be a potential source for degrading aquatic environment and adverse impacts on aquatic biota. The rivers at Shasanghat, Pangaon and Narayanganj are already heavily polluted as reflected in the loss of fish diversity and abundances, and reduction in other aquatic animals. The project development activities in the water areas, like drilling, pilling, dredging of jetty sites, erosion from soil loose soils and materials from land based construction areas, release of liquid wastes (, waste fuels,

greases) from construction machineries and vessels will also affect the aquatic biodiversity including fish, zooplankton, benthic fauna and aquatic wildlife.

These effects may cause impact aquatic ecosystem integrity and aquatic productivity. However, most impacts are likely to be temporary. An assessment of the anticipated impacts is made below.

Impact on fish and fish ecology:

Zooplankton and benthic organisms are the major determinants of fisheries productivity. Riverbed dredging at the jetty sites and drilling activity in river areas at the sites are likely to cause physical damages/ destruction to benthic macrofauna. Similarly, bentonite used for drilling will cause water pollution negatively affecting the aquatic biota.

Release of hazardous wastes from land-based activities and release of lubricant and waste fuels and bentonite into the river environment are likely affect the fish, zooplankton, frogs, turtles, etc. Erosion from the loose soils and materials at the construction areas and silts from dredging and drilling activities will increase water turbidity, negatively affecting fish and zooplanktonic communities and restrict light penetration required for phytoplankton production.

Aquatic pollution may also cause shift in zooplankton and benthic fauna dominance affecting the ecological integrity. The fish and fisheries at the Shasanghat, Pangaon and Narayanganj sites are already highly decline and likely to be further negatively impacted by the project interventions. In other sites, fisheries are still important and local fishers' livelihoods depend on fisheries. The effect of the aquatic pollution may extend to some distant areas from the project boundary.

Suspended sediment due to piling operations in the water column blocks available light for photosynthesis, reducing benthic primary productivity and inhibiting the ability of benthic plants to recover. But the effect of suspended sediments and turbidity in open environment like river are generally short term (<1 week after activity). The impact will be reversible upon withdrawal of threat.

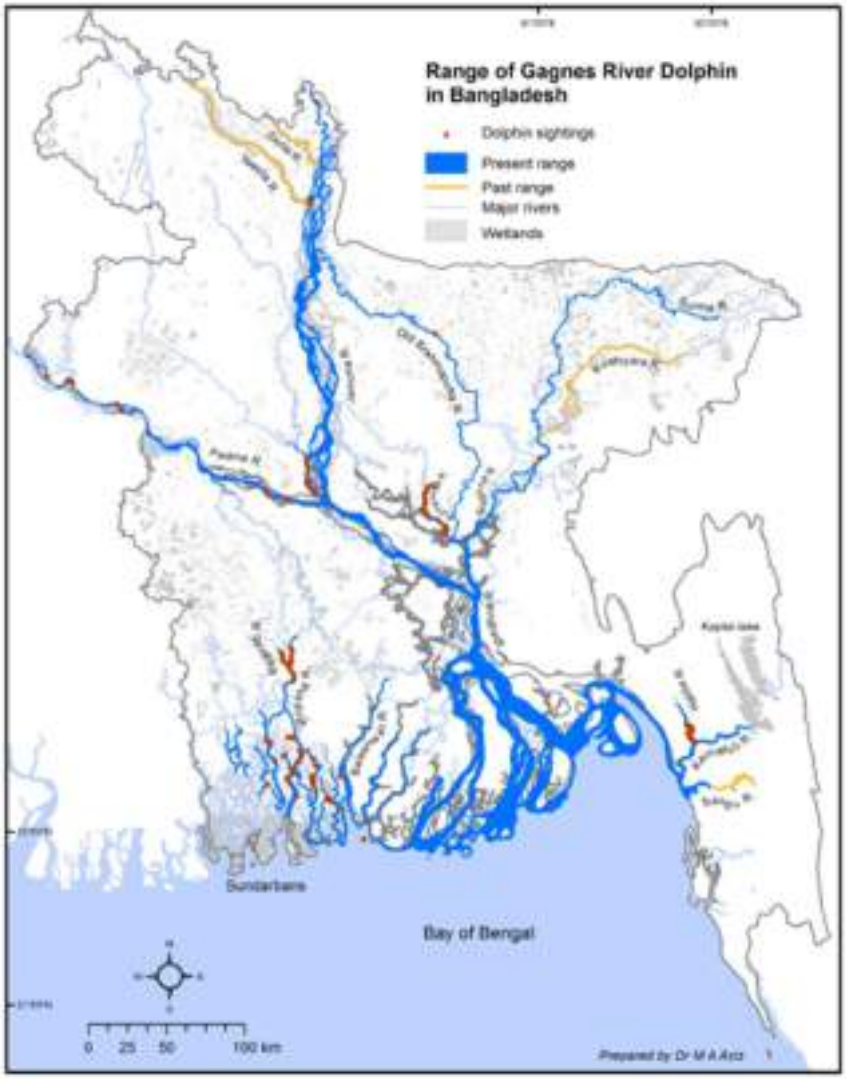
Impact on threatened fish: A total of 21 threatened fish species potentially occur in the project sites, ranging from 14 to 19 species in an individual site. Of these one species is critically endangered, nine endangered and 11 species are vulnerable (Table 87 for full list). The impact risks are likely to be higher in Sashanghat, Pangaon and Naraynagonj sites. However, rivers at these sites, Buriganga and Shitalakhhya, are already highly polluted and support only few non-conspicuous species, stinging catfish, spotted snakesheads, climbing perch, etc. during dry season, However, many fish species reappear in wet seasonwhen water quality improves due huge volume of flushing of waters.

Except few speces, like Pangas, devil catfish , Rita, most fish species are found throughout the country and the noted species also occur in major rivers of the country. The project influce area is unlikely to extensive. It is unlikely that additional pollution caused due to project construction will kill species, rather it will cause avoidance reaction to fish, and these will reappear when threats are withdrawn. In the prevailing pollution scenarios these sites are also not preferred habitat for these species. The major threatened species occur nearby the Chandpur site, where the construction work will be comparatively much less in water areas, the resulting impacts will be in aquatic environment. Stringent control of pollution load from construction work and in the operational period are likely reduce the impact severity., while some monitoring provision should be designed to assess the impacts on these species.

Impact on dolphin and turtles:

Foraging of Gangetic dolphin is observed across rivers at Ashuganj, Pangaon, Chandpur, Barishal and Narayanganj project sites. Fig 188 hows the distribution Ganges river dolphin in Bangladesh river systems.

Figure 188. Distributrion of the Ganges River Dolphin in Bangladesh river system



Source: Aziz (2019)

In Narayanganj and Pangaon sites, the species is found only in wet season, particularly during July to October at a very poor abundance. Construction activities in the river area will produce sound that are likely to affect the foraging species at the site. Dolphin is particularly sensitive to sound. A high sound level causes frightening reaction to the species. Increased pollution due to release of wastes will also negatively affect the species with an avoidance reaction. The animal is also sensitive to aquatic pollution with a result of increased susceptibility to diseases. Perceived increased in navigation in the rivers at the project sites during the construction and operation periods will increase the risk of physical injuries and increased disturbances to the animal. Turtles are also sensitive to sound and pollution. This may cause avoidance reaction in turtle species. According to Aziz (2019) Ganges River dolphin is facing multiple threats leading to its reduced population.

However, as with terrestrial fauna, the scale, type, duration of the threat pollution, sound, etc. will determine the level and extent of impacts on the aquatic biota at different sites

Gangetic dolphin is an iconic and flagship species in the river environment of Bangladesh. The species is endangered nationally and globally, and also protected under Wildlife (Conservation and Security) Act, 2012, of the country. Simlarly, Indian softshell turtle is also an endangered species and included in the ildlife Act.Therefore, conservation of dolphin and Indian softshell turtle is a priority to the country.

Piling activity will generate significant noise. Exposure to low levels of sound for a relatively long period, or exposure to higher levels of sound for shorter periods of time, may result in auditory tissue damage in fish, though recovery is generally possible within 24 hrs (Popper et al. 2005). However, the piling activity in the terminal sites will be for a short duration and the biotic conditions of the area will normalize after the activity is completed. Ganges river dolphins showed mixed responses to approaching vessels, including changing direction to orient away from the boat, prolonging dive times, and displaying attraction toward the boat, and may cause changes in the behavioral responses (Erbe *et al.,* 2019).

Nonetheless, it will be necessary to avoid pile driving and dredging during the period July to October. . A site wise assessment of the impacts is described below:

- Shasanghat Terminal:

In Shasanghat, the most impact project activity will be earth filled where large riverbed areas will be dredged to facilitate berthing of vessels. There will be huge land base construction activities i.e. construction of 6-storied terminal building, approach roads, parking areas and other infrastructures, pilling and drilling, etc. All these will generate huge silts through erosion of loose soils on land and also from dredging of riverbeds. Solid and liquid wastes, like drilling fluid and other hazardous wastes will contaminate water at the site, which will extend up to few kilometers downstream.

The water in Buringanga is already highly polluted from city sewerage and industrial effluents. Recent studies suggest that the water quality is highly degraded and have caused huge decline in fish and other aquatic biota. The pollution caused by the project activities will cause further deterioration to water quality with following impacts:

Impact on fish and fish ecology: The increased pollution may cause complete disappearance of fish fauna, except few species that can survive in polluted water,like air breathing fishes, viz. climbing perch, snakeheads, stinging and walking catfishes. It may be mentioned that presently, most fish species disappear during dry season, when river water gets polluted. Dredging will kill or cause damages to benthic organisms at the river site depleting/ reducing feeding opportunities of fish and some other aquatic biota and may also cause shift in composition, abundance, and dominance benthic and zooplanktonic communities.
Impact on wildlife: One species of turtle still available at the site may avoid the area.
However, these additional impacts caused by the project activities will be limited to dry season, the lean flow period. In monsoon, the pollutant will be flushed away by huge volume of flowing waters. A mentioned in the above general consideration that the foraging dolphin will be affected by water pollution and construction work in auatic environment, particularly during the wet season, the period of foraging by dolphins. However, they will appear after the completion of project wok.

Significance of impacts: Impact severity: moderate; Extent and duration: localized and short-term only during construction period; Reversibility: Reversible; Potential for mitigation: high; Residual impacts: low.

- Chandpur Terminal:

Is situated on the confluence of the River Padma and the River Upper Meghna, and thus has a larger availability of river width. This site of the river is less polluted and supports a wide variety of fishes and abundance of fish at the site is also more here compared to other S3 sites. Many of the fish are commercially important and occur in good abundance. Significant species, like *hilsha shad, Pangas, Ayre,*

major carps, Rita, Boal, etc. are abundant at the site. Fishing is a major economic activity in the area. As reported the site is known for spawning of some important fishes.

The land base activities at the site will include limited earth filling, terminal, and approach road construction activities. In the water area there will be limited dredging at the pontoon site and drilling activities for installing spats for pontoon anchoring.

As indicated above, these activities will contribute to increase water turbidity level, silt loads and cause deterioration in other water qualities with heavy metals and hazardous material contamination, having potentials for impacting the aquatic ecosystem function and biota. The activities will also produce increased sounds from drilling and other water base activities.

However, the river at the site is tidally influenced and water is flushed away regularly daily in the tidal process during dry season with an impact on dilution effects. In wet season, huge flood waters flush away everything as strong current sets in. Therefore, these effects will offset the impacts of project activities. However, the effects may extend to wider areas, although in a very negligible level.

Impact on fish and fish ecology: Although, a number of threatened and significant commercial fish species occur in the river, these are unlikely to be affected much as because of dilution effects of pollutants. However, construction activities in water during mid-April to mid-June may disturb spawning of some fishes. Since, the zooplanktons passively float, they are always carried away by water current and dilution impact will not cause any impact on them. Benthic fauna could be damaged due to dredging and drilling and localized sedimentation process however, these will be short period impact and will be restored immediately after completion of work.

Impact on aquatic wildlife: Gangetic dolphins are often found to forage across the site. The level of sound likely to be generated from drilling and other water-based activities may induce little behavioural change resulting in avoidance reaction, however, this might be only for a short-term of time. The dolphins at the site are bit accustomed to sound and regular disturbances caused by present navigation and other anthropogenic activities. Similarly, drilling in water and construction activities may also cause disturbances to turtles and may induce avoidance reaction. Ther forging dolphins are also likely to affected by construction noises, aquatic pollution and movement of vessels, particularly causing disturbances and even may cause physical injuries to the forging dolphins at the site.

Significance of impacts: Overall Impact severity: moderate; Extent and duration: localized extending over few kilometres and short-term only during construction periodi in water areas; Reversibility: Reversible; Potential for mitigation: high; Residual impacts: low.

- Narayanganj Terminal:

Narayanganj is an existing Passenger Terminal which will be rebuilt. There will be no earth filling at the site and only a small riverbed area will be dredged at the pontoon site. Few drilling holes will be made in water areas that will produce silts only during drilling time. Construction of the terminal building and other land base activities, including drilling, piling, etc. will generate some solid wastes and eroded materials as well as some liquid wastes for example, grease, used fuels, which are likely to finds its way into the river and contribute river pollution. Drilling in the river may produce silts having potentials to release of silts and bentonite. Project activities in water will also produce increased sounds from dredging, drilling activities and vessels/barges used at the site.

The Sitalakhya River is already highly polluted, particularly at the project site. The project activities will add to this. Given the level of pollutant generated, river contamination will be less at the site. The site is

bit tidally influenced during dry season and the pollutant will be diluted and be dispersed. In wet season huge volume of flood water flow will flush out pollutants from the site with improved water quality.

Impact on fish and fish ecology: The river section at the project site support less fish as because of local pollution. The construction may cause further declination in fish abundance during dry season. However, no fish kill is expected to occur, although sublethal level may reduce fish growth and reproduction if continue over longer time. Further, the composition and dominance zooplankton and benthic fauna may also be affected bit due to increased pollution level. This impact would be of low, localised and short-term only during only in elan flow period and reversible as the impact will disappear upon completion of project work

Impact on aquatic wildlife (turtle and dolphin): Only six species of aquatic wildlife are known from the site. Of them, turtles and dolphin are protected under Wildlife Act of the country. Dolphins at the site manly forage during monsoon, although occasionally they also forage across the site during dry season. As both turtle and dolphin are sensitive to sound and pollution, as discussed above, the sound level likely to be produced may distract both turtle and dolphin. These animals are flexible to forage and may avoid the disturbed area during the period of disturbamces and alternatively construction activities during wet season in aquatic environment may be suspended.

Significance of impacts: Impact severity: moderate; Extent and duration: localized and short-term only during construction period; Reversibility: Reversible; Potential for mitigation: high; Residual impacts: negligible.

- Barishal Terminal

Barishal is an existing Passenger Terminal which will be rebuilt, In Barishal site, the major project activities, includes earth filling, construction of terminal building, approach roads on the land and drilling and some dredging in the water areas. As discussed earlier, the activities have potentials to degrade water quality and increase noise pollution in aquatic environment.

This site is highly tidally influenced and as explained earlier this will have dilution impacts in reducing water pollutants build and again as with other sites, in wet season huge volume of flood water will flush out water continuously,

Impact on fish and fish ecology: This site also supports many fish species, some of which are threatened nationally, while some are considered significant species. As a result of dilution of pollutants, the impact on fish will be minimum. However, the increased sound caused by drilling and working vessels is likely to cause impacts. The site is used by many large vessels daily and the local fishes are accustomed to increased sound level and disturbances. Benthic fauna at the dredging site will be destroyed. As explained earlier, benthic and zooplanktonic fauna can regenerate rapidly to replenish abundance. No impact is anticipated because of regular flushing of water.

Impacts on aquatic wildlife: Some frog species have been recorded from areas between the pontoon sand terminal building in good abundance. This area to be earth-filled causing loss of habitat with consequent loss of slow-moving animals, like frogs, water snakes and lizards. These are likely to be buried under filled soils. Three species of turtles are recoded from the site, but unlikely to be affected much by the construction work. Therefore, impact on wildlife will be limited with likely killing of some frog and snake species only and could be avoided by undertaking mitigation measures. Ther forging dolphins are also likely to affected by construction noises, aquatic pollution and movement of vessels, particularly causing disturbances and even may cause physical injuries to the forging dolphins at the site.

Significance of impacts: Based on the above discussion, the impacts from the project implementation could be considered minor, irreversible, short-term, slightly extending beyond the project boundary and without having any future residual effect.

- Pangaon Terminal

This site is a green field development and represents a peri-urban area. The design principle of Pangaon terminal (Figure 188) is to have a quay without fixed structures and with warehouses next to the quay, aiming for a versatile and flexible solution. A huge area will be earth-filled, while another substantial river bed area will be dredged and a large number of drill holes will be made in water areas. In addition, a part of an excavated pond will also be earth-filled.

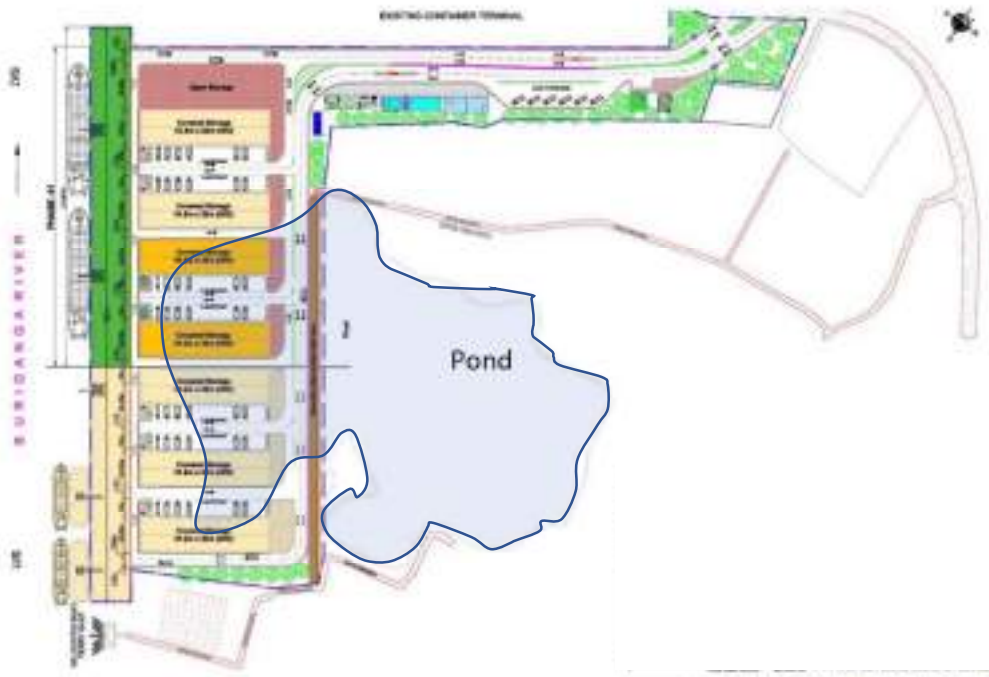


Figure 189. Pangaon Terminal Design.

As outlined elsewhere in this section, the construction activities will create huge silt loads in water as well as degrade water quality to a considerable scale in the backdrop of prevailing huge pollution load in the river from upstream sources. The proposed construction activities will add pollutants contributing to further degradation in water quality to a level that may cause severe impacts on the aquatic ecosystem and its biota. Due to the widening of the Terminal, the pond located in this Terminal, will be affected for the construction activities of excavation, filling, and levelling, will reduce the area occupied by the existing water body up to halfof its dimension.

Impact on fish and fish ecology: The site is already highly declined in fisheries resources due to heavy pollution load from the upstream sources as discussed for Sashanghat site, and the added pollution will worsen the situation, as because of increased water turbidity, silt loads and leached toxic chemicals. The impact of added pollution levels may extend few kilometers downstream, particularly during dry season when the river flow is very lean. Some benthic macrofauna will be killed and damaged in the process of dredging and drilling in the water areas. However, they may recolonize within short period time after completion of work. There will be also changes in the community structure of benthic and zooplankton due to perceived changes in the water quality.

Impact on aquatic wildlife: A total of 9 aquatic wild species have been recorded from the site, include frog species, snakes,turtles, bird species and one mammal species, the Gangetic dolphin. The frogs and snakes may be buried in the process of land filling. The aquatic bird may avoid visiting the area. As discussed earlier, dolphin will be particularly affected due to increase in sound produced from dredging and working vessels. However, in the recent years dolphin is found to forage only during late wet season and are also accustomed to sound from the navigating vessels through the river. Three turtle species were also reported from the site and likely to be impacted with an avoidance reation, however, may reappear after project work is completed. Ther forging dolphins are also likely to affected by construction noises, aquatic pollution and movement of vessels, particularly causing disturbances and even may cause physical injuries to the forging dolphins at the site.

In the earth filling process, some aquatic areas of the river will be permanently lost. The existing pond (Figure 196), part of which is located within the project boundary will be earth-filled and as a result some wildlife will be lost. However, much of the pollution and sound related impacts will disappear with the completion of project work., although some other impacts may continue during operation period.

Significance of impacts: Based on the above, the impacts may be considered as high severity if there is pile driving work proposed during the period when Gangetic dolphin frequent adjacent waters. Most of them will be reversible, although some not, short-term and confined within few kilometers. Except, some habitat loss, there will be no residual impact.

Figure 190. Pond in Pangaon Terminal

Impacts on fish culture production systems

There is no agricultural fields or production systems within the construction sites or its immediate vicinity. However, as explained, there is a big fishpond of about 2.0 ha adjacent to the Pangaon construction site. The pond is utilized for semi-intensive culture of fish with Indian major caps and some exotic fish species. A part of the pond will be earth filled.

Earth filling will generate silts and will affect the fish culture activities in the remaining part of the pond, in addition to reduction of viable couture area. It is anticipated that during the construction period fish culture activity will not be possible. It is suggested that a temporary barricade should be erected in the pond so that filling materials do not accumulate in the remaining part of the pond.

- Ashuganj Terminal:

The river at the terminal site is not much polluted but are heavily used site in the process of cargo handling and the site experiences huge navigation. The construction activities will produce silts and toxic pollutants having potentials for affecting the water quality and turbidity.

The river at the project site supports many fish species, include some significant commercial and threatened species. Commercial fishing takes place at the site and several fishers depends on these fisheries. According to local accounts, some fish species probably breed at the site. The pollution impacts may extend few kilometers downstream of the project site.

Impact on fish and fish ecology: As explained in the preceding sections, high silt loads and leaching of liquid and solid pollutants into the aquatic environment may lead to deterioration in water quality and affect the fish communities present but will again comeback when pollution load decreases. Benthic organisms may be killed and damaged by dredging activities but will replenish and recolonize after the project work is finished. As with other sites, there could be some shift in community structure of benthic communities only. However, this impact will also be of short-term.

Impact on aquatic wildlife: Seven aquatic animals are known to occur in the site, of these, turtle and dolphin are likely to be affected by water pollution and increased sound. As discussed earlier for Sashanghat site, the level of sound expected at the site may cause avoidance reaction to dolphin and the turtles, which may again reappear immediate after the threat is withdrawn. This is based mostly on scientific knowledge. This aspect has been discussed in detail at the begining of the impact section on Aquatic fauna (General consideration-all sites). Impact could be avoided by avoiding piling and drilling activities in wet season. This has been inluded in the mtigation measures for all sites having recrds of dolphins. Ther forging dolphins are also likely to affected by construction noises, aquatic pollution and movement of vessels, particularly causing disturbances and even may cause physical injuries to the forging dolphins at the site.

Significance of impacts: Impact severity: high; Extent and duration: localized and short-term only during construction period; Reversibility: Reversible; Potential for mitigation: high; Residual impacts: low.

- Mitigation Measures in Aquatic Life

Zooplankton and benthos are highly regenerating species, their population are replenished within short period of time. The impacts will thus be temporary and restored as soon as the threat is withdrawn. No mitigation measure is required for the zooplankton and benthic communities. However, their populations need to be monitored as they are good indicator to assess the impact on the aquatic environment. However, some measures may help to reduce or avoid the impacts on river ecology and fisheries.

The following mitigation measures are suggested:

- Ensure that all land-based pollutants are collected and stored in safe place, not allowing to go into aquatic environment.
- Liquid pollutants to be led into pits so that it does not leach into aquatic environment;
- The slurry with bentonite from drilling point should carefully be collected and store it in safe and secured places for subsequent safe disposal;
- Temporary barricade should be made around the land-based construction areas near water bodies to arrest eroded materials going into the water bodies.
- Minimum disturbance to habitat.

- Avoid fish and aquatic animal moving hindrance.
- Movement of barges only within the designated areas in the river.
- Regular monitoring of the worksite and relocate the animal trapped.
- Undertake fish market monitoring at Chandpur and Narayangonj and Ashugonj to monitor adunadnce of few indicator threatened fish species (*Pangasius pnagsius, Bagarias bagarias and Rita rita*) to assess changes in abundances of the species and review the effectiveness of the mitigation measures.
- Implement an awareness program among fishers on the compliances to Fisheries Conservation Act specially relating to catching the juveiles and gravid individuals of these species.
- Collaborate with Department of Fisheries in collecting fisheries data on major threatened fish abundance, particularly relating to major threatened species and review this data to assess the efficacy of mitigation measures.

Gangetic dolphin is an iconic and flagship species in the river environment of Bangladesh. The species is endangered nationally and globally and protected under Wildlife (Conservation and Security) Act, 2012 of the country. Therefore, conservation of dolphin is a priority to the country.

The following mitigation measures are required to avoid and reduce negative impacts on dolphins.

- Avoid construction works in the river during wet season
- Undertake stringent control over the release of pollutants in the aquatic environment
- Provide induction training to BIWTA terminal staff and vessel operators on the conservation of dolphins. The navigating vessels should carefully make sightings of dolphins while operating through rivers to avoid the areas foraging dolphins.
- Undertake dolphin monitoring activities engagiong competent expert on a continual basis

5.2.10. Socioeconomic Aspects

5.2.10.1. Physical and Economic Displacement

The Project will require a considerable manpower during construction and operation stage. This manpower will be within the age of 18-50 years and mostly male population, which will be an unbalanced composition. Most of the skilled worker will come from other areas of Bangladesh and some of them from abroad.

Both residential households (at Chandpur and Ashuganj) and business premises at six terminal sites will be physically or economically displaced due to the project. The relocated families will lose their existing inter-personal relations, social formations etc. that they have built up for years. The displaced shops will need to be relocated in a cluster manner to maintain their livelihood. The residential HHs will be within their kin groups for mutual support and cooperation.

Displaced HHs will be encouraged towards self-relocation by their own arrangements. Project can provide civic amenities in case of cluster relocation by them. Project may provide space for the relocation of the displaced shops in the vicinity of the terminals to ensure livelihood opportunities.

Displaced people will be provided assistance in relocation through PRAC to find alternative land in the icinity. Civic amenities (water supply, sanitation, drain, internal road, etc.) will be provided in case of relocation of houses and shops in a cluster manner.

5.2.10.2. Economic Environment:

Terminals will generate new employment opportunities for the project affected and non-affected people directly or indirectly on permanent and temporary basis. Besides, some backward linkage institutions will be established considering updating of the terminals and new business ventures i.e. suppliers, contractors/subcontractors, new water vessels launches, etc. are opened. The laborers, who will be engaged in construction period, may or may not be deployed in operation phase of the project due to lack of relevant skills. They would be trained on some specific tasks particularly for the cargo terminals, which will help them get jobs in the operation phase which will reduce unemployment.

Opportunities of local goods and services will be sufficient to provide required support to the huge quantity of employees. Local businessmen will make available necessary goods in the local market. Employees and businessmen will benefit more from the project and therefore their economic condition will be improved.

Local people can travel with safety and security in the water vessels and businessmen/traders can develop their business by carrying more goods and enjoy the facilities of improved cargo terminals.

5.2.10.3. Social Services and Infrastructure

It is understood that thousands of people use the passenger terminals for travelling every day and this number is very high during festival particularly in Eid vacation.

The existing infrastructural facilities in the terminals and vessels are not adequate to serve the huge numbers of passengers and handling goods. In the terminal and vessels, they will have to get social services including waiting rooms, enough toilets in hygienic condition, prayer hall, food supply, security, lighting, breast feeding corner and necessary facilities for disabled passengers. A free space for the vehicles terminal nearer to the passenger terminal is to be provisioned and the approach road to the terminals should be wide enough more easy movement of the passengers. The approach road at Chandpur has been considered as part of the BRWTP since the current road is very narrow. In the cargo terminal, cargo handling capacity and storage facility, labor sheds and other infrastructures are not adequately available. Particularly at Pangaon Cargo terminal all the infrastructures are to be newly constructed. To provide adequate facilities for the passengers in the passenger terminals and river crossing, for both the Pangaon and Ashuganj Cargo terminals it will be necessary to construct additional infrastructures as above.

The existing connecting roads are not sufficiently wide to carry huge number of vehicles and passengers particularly at Chandpur, Shasanghat and Pangaon terminals. Therefore, additional road and bridges will need to be constructed simultaneously with other activities for providing adequate facilities to the people. Land acquisition and resettlement issues are to be dealt with well ahead of civil construction. Necessary measures are to be taken by the project authority to comply with World Bank policy on involuntary resettlement.

5.2.10.4. Vulnerable Groups:

In most of the terminal areas, hundreds of shops along with the small businessmen, vendors, wage earners will be economically displaced that may lead vulnerability if they cannot continue their business and employment. In the Chandpur and Ashuganj terminal some residential households will be physically displaced from private and government land. It is evident from the socio-economic survey that in terms of income of the potential affected households/shops, vendors, wage earners including male and female.

About 17% at Pangaon and Shasanghat, 21% at Chandpur and 2.33% at Ashuganj fall into the vulnerable category.

These vulnerable people will need to be given special attention to restore their livelihood by providing compensation and resettlement benefits following World Bank Operational Policy 4.12 and to receive employment opportunities in the civil construction and operation phase of the project.

5.2.10.5. Employment and Labor

There are existing labor laws in the country including standard labor code covering all issues relating to labor deployment, wage, occupational health safety, etc. Following the World Bank guidelines, international labor organization (ILO) convention and GOB laws, laborers are to be deployed and their wages to be paid. Deployment of children in harmful working environment is strictly prohibited by law in Bangladesh. This is to be maintained in the workplace and supply chain. A labor management procedure (LMP) has been developed as a standalone document for the S3 and S4 sites based on which the contractor will prepare a Labor Management Plan. The Labor Management Plan will duly be approved by the PIU.

In the Bangladesh Labor Act, 2006, Section 34, it is mentioned that no child shall be employed to work in any occupation. Section 44 mentions that anyone under age 14 is considered as child and under 18 but over 14 is considered as adolescent. World Bank strictly prohibits child labor and clearly mentioned that the minimum age of 18 years is required for anyone to get employment in such works. Section 37 of the act suggests a fitness certificate required for adolescents to get employed and they can be appointed to do the light works.

According to the World Bank standards and guidelines, the minimum age of employment for this project shall be 18 years (given the potential hazardous situation posed by COVID-19) and to ensure compliance, all employees will be required to produce National Identification Cards as proof of their identity and age which is the national identification document required for employment.

PIU will declare that the forced child labor will be strictly prohibited. If any contractor employs a person under the age of 18 years, measures will be taken by the PIU following the Labor Act and WB guidelines.

Health and safety issues of the laborers are to be given priority. In the workplace laborers do not usually use personal protective equipment (PPE) i.e. helmet, gloves, and other necessary safety measures which prevent accidents. It is to be ensured using PPE at the workplace during construction phase and operation phase where necessary. People will be in competition for getting jobs as unemployment is a major issue in Bangladesh. Preferential employment for the project affected persons is to be considered. An Occupational Health and Safety (OHS) Plan has been developed as part of ESMP (Annex 9) which will be followed by the contractor after necessary modification and approval by the PIU.

5.2.10.6. Social Conflict

Since migrated employees will be working in the terminals during construction phase and in operational activities, therefore social conflict among the host population and migrated workers may take place. This type of conflict will hamper social harmony and affect the local power structures if the necessary measures are not taken by the law enforcement agencies.

5.2.10.7. Lifestyle and Culture:

At present, the passengers and workers of the vessels are accustomed to using the very basic terminals with minimal facilities. After implementation of the project, terminals and vessels will be operated much

more systematically with international standard civic amenities. In the cargo terminals, the capacity of cargo handling along with storage facilities and delivery system will be digitally operated. Therefore, lifestyle and culture of the passenger and other terminal users including vessel workers will experience a positive change.

The injection of a large amount into the local economy through disbursing compensation will promote lifestyle and cost of living of the affected people. After receiving compensation for lost assets the entitled persons will purchase alternative lands and or houses/shops and start better income generating activities if they are paid adequate compensation and resettlement benefits. Other people who are not affected by the project will be impacted by this intervention.

Project will acquire 0.638 acres private land (commercially used) at Ashuganj. Residential HHs (13), commercial premises (142) and offices/institutions (06) have been identified at Ashuganj site. Total 43 private land owners have been identified dueing survey. These land owners will be finally identified by the DC office during LA process based on their records of rights. The commercial premises are mostly affected on the RHD land (relocation site of Bhairab Bridge) at Ashuganj site.

At the Barisal site, 159 entities have been affected on the GOB land (BIWTA) among which 12 HHs are losing residential structures, 142 commercial premises and 6 HHs are losing both residetial and commercial premises, Private land acquisition will not be required for development of Barisal terminal. CPR is not affected here rather five offices/institutions will be dislocated.

At the Chandpur terminal a large number of residential HHs (92=87+5) will be physically displaced due to development of approach road of the terminal. They have been living on the Bangladesh railway land. Apart from the residential HHs, 86 shops, three offices/institutions and three CPRs will be affected at Chandpur. One Mosque (CPR) located at the terminal area will be dismantled and a new one will need to be constructed elsewhere in consultation with the Mosque commitees and local community (terminal users). Two Madrasahs are partially affected at the aproch road but they will not require relocation.

At the Narayanganj site, about 40 HHs are locing commercial premises on the BIWTA land. Besdies, two officies /institutions are also affected here. Residrntial premises are not affected at Narayanganj while at Pangaon cargo terminal, one residential HH and 16 shops will be affected. One office bulding of BIWTA will need to be dismantld for development of the terminal. At the Shashanghat site nothing is affected except one small shop and one office/institution.

The businessmen need a space for continuing their business to maintain their present standard of living. They will be adversely impacted if their business becomes closed for long period. Residential HHs at Chandpur require a space for relocation on GoB land since they do not have alternative land. CPRs (particularly Mosque at Chandpur) will need to be constructed with a better condition. Other offices/instititions including Madrasha will be paid compensation and other assistance as per RAP policy and relocate by themselves. Table 127 presents the magnidue od impacts in six terminals.

Table 128. Magnidue od impacts in six terminals

Category of Loss of the HHs	Ashuganj	Barishal	Chandpur	Narayan Ganj	Pangaon	Sashan ghat	Total
Residential Structures	13	12	87	--	1	--	113
Commercial Structures	142	137	86	40	15	1	421
Both Residential and Commercial	6	--	5	--	--	--	11
Private Land	43	--	--	--	--	--	43
Tree	--	--	1	--	7	--	8
Pond	--	--	--	--	1	--	1
Secondary Structures	8	5	3	--	4	--	20
Sub-Total	**8**	**5**	**3**	**40**	**12**	**1**	**618**
Community Properties	--	--	3	--	--1	--	4
Other Institutions/ Offices	6	**5**	3	**2**	**1**	**1**	**18**
Sub-Total	**6**	**5**	**3**	**2**	**1**	**1**	**21**
Total	**218**	**159**	**185**	**42**	**30**	**2**	**639**

5.2.10.8. Health Hazard

Population influx due to the project, particularly at construction phase, may create health hazards including sexually transmitted diseases (SDTs) of the construction workers and local people if awareness campaign and necessary preventive measures are not taken. Construction workers will have to wear personal protective equipment to protect any incident at work site. Local people and workers will need to be aware of STDs/HIV/AIDS through billboard, posters, media, seminar, symposium, etc. Contractor will have to make the workers and community people aware of the anticipated health hazards during construction phase. Water, sanitation, and hygiene (WASH) is to be ensured at work sites.

Daily OHS briefings will be conducted before the commencement of the works highlighting the hazards and preventive measures from each job, especially those related to COVID-19 outbreak. Contractors will document and report to PIU all accidents and illness, especially symptoms of COVID-19, fatalities or serious injuries that may happen at work site.

PIU will include into the bidding documents specific OHS standard requirements that all contractors will meet under this project. The standards will be consistent with local regulations, WBG EHS guidelines, COVID-19 Protocols and GIIP.

5.2.10.9. Transport and Communication

In some of the terminal sites, existing transport and communication system is not sufficient due to narrow roads and huge density in the surrounding area. During construction phase heavy equipment will move to the construction site and at the same time vehicles for transportation of the passengers and goods will be using the roads. Therefore, existing transport system including road communication will be insufficient which will lead to traffic jams.

This will be mostly happened at Chandpur and Shasanghat sites due to narrow road conditions. Necessary measures including alternative road will need to be in operation to avoid such adverse situations. Construction and development of the terminals will bring remarkable changes in transport and communication system and people will enjoy better facilities in the terminals and vessels.

5.2.10.10. Induced Impacts and Associated Facilities

Implementation of the project will require land acquisition and displacement of the households and shops that have impacts on income and livelihood. The impacts on the affected people and other stakeholders will be both positive and adverse. But such adverse impacts will be very much temporary due to land acquisition and displacement.

The community people and terminal users will also be temporarily impacted during construction. Businessmen will face challenges after displacement until they are relocated and run their businesses again. Adverse impacts on the affected people (landowners, structure and business owners, tenants, vendors, wage earners, vulnerable group) will be mitigated through compensation and resettlement benefits, income and livelihood restoration programs. After implementation of the project people from all cross sections will enjoy better facilities in the passenger and cargo terminals.

5.2.10.11. Gender Issues

Bangladesh government declared “National Women Development Policy 2011” towards women empowerment. Bangladesh government also ratified the “Convention on Elimination of All Forms of Discrimination against Women (CEDAW)” as well as following “Sustainable Development Goals (SDGs)”.

Gender issues including gender-based violence (GBV) more specifically and detailed gender specific facilities will need to be ensured in the terminals and vessels. Gender related facilities for the women in general, will include pregnant women, lactating mothers, elderly and disabled people who will be in the waiting areas or working in the terminals and vessel shelters. Necessary facilities for the women and men including disabled and elderly people will need to be provided as under:

- Separate toilets for male and female passengers as well as laborers
- Separate toilets with facilities for physically challenged people
- Enough lighting and visible location for female toilet considering security and safety
- Water supply and useable condition must be ensured by proper maintenance
- Space for Breast feeding mother and pregnant women
- Separate prayer space for females with required facilities
- No discrimination of wages for male and female laborers/workers for similar work
- Grievance Redress Mechanism for affected people and construction workers including women who are affected for this work
- Phase-2 GRM will particularly deal with the SEA/SH and GBV issues along with other administrative/finance issues of the project.

5.2.10.12. Labour influx management

Labor influx for construction works can lead to a variety of adverse social and environmental risks and impacts. While many of these impacts could have been present already or might occur regardless of the

labor influx, they are likely to be exacerbated by it. The actual type and degree of impact varies significantly depending on the characteristics of the project, community, and incoming workforce.

Gathering of the people from various cross sections may lead to social and environmental adverse imapcts on the community including Risk of social conflict, Increased risk of illicit behavior and crime, Influx of additional population, impacts on community dynamics, increased burden on and competition for public service provision, increased risk of communicable diseases (STDs, HIV/AIDS, COVID) and burden on local health services, Gender-based violence, Child labor and school dropout, local inflation of prices, increased pressure on accommodations and rents, Increase in traffic and related accidents and others. In the operation phase of the project, day laborers (koolee) will be working in the cargo and passenger terminals.

The project will have to take necessary steps to register the laborers with their work attire and identity cards so that passengers can safely deal with them. The mobile vendors selling fruits and other necessary commodities in the vessels would also have identity cards. Selected contractors will have to develop a Workers code of conduct and duly approved by the PIU before deployment of workers at site.

Figure 191 shows the consequence of population influx.

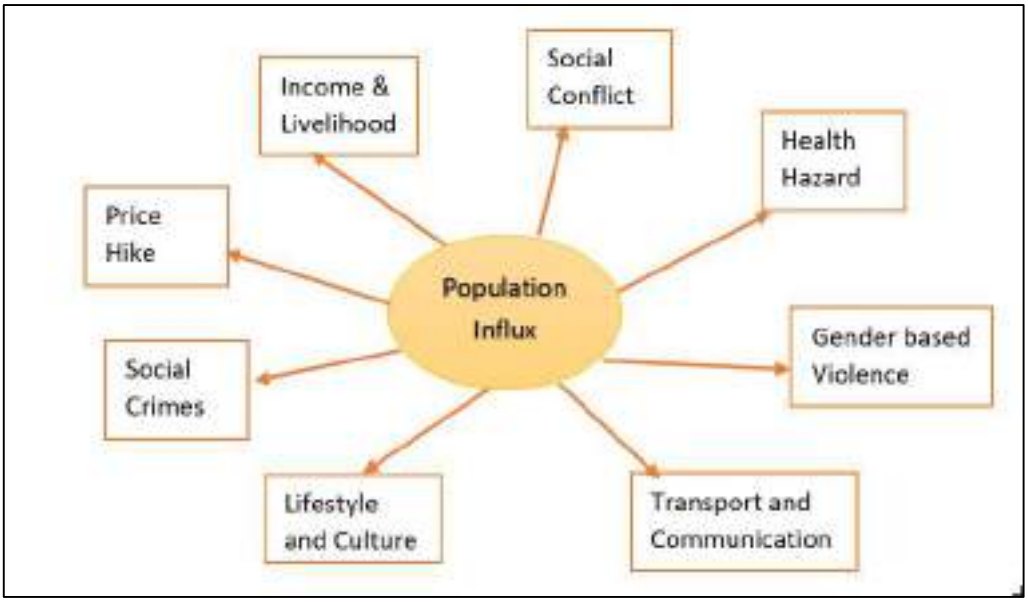


Figure 191. Consequences of population influx

Prior to starting construction, the contractor should prepare and submit the CESMP to the construction supervision consultant and PIU for acceptance. The CESMP should provide a detailed explanation of how the contractor will comply with the project's safeguard documents such as the ESMP, and demonstrate that sufficient funds are budgeted for that purpose. The CESMP must include specific mitigation measures based on the ESMP, the final design, the proposed work method statements, the nature of the project site, etc. It is required to include specific management plans for: (i) work activities; (ii) traffic management; (iii) occupational health and safety; (iv) environmental management; (v) social management; and (vi) labor influx management.

A general guideline to the contractor regarding labor management has been attached as Annex with this ESIA. A Labor Management Procedure has been prepared as a standalone document to guide the contractor for preparation of Labor Management Plan.

Effective assessment and management of the potential impacts of labor influx on communities wll include the following steps-

- Screening and assessment of the type and significance of potential social and environmental impacts that may be generated by labor influx;
- Assessment of the location of the project, contextual factors in the country, and assessment of the policy and legal framework of the Borrower;
- Development of a management plan for social and environmental impacts in consultation with affected communities;
- Implementation of appropriate mitigation and monitoring programs, which includes development and implementation of a stakeholder engagement program;
- Establishment of a grievance redress mechanism (GRM) for workers and host community; and
- Monitoring and supervision, and, as needed, adaptive management actions.

5.2.10.13. Social Mitigation Measures

- Resettlement Plan

As per World Bank terms on involuntary resettlement (OP 4.12), affected landowners are entitled to have the replacement cost for land and other affected properties. Taking into account OP 4.12, the Resettlement Action Plan will have policies to meaningfully consult the affected people, assess replacement cost in consultation with the people, pay compensation to the affected people irrespective of title to the land, regulate monitoring and ensure design and implementation of income and livelihood restoration program (ILRP) for the vulnerable affected people.

- Grievance Redress Mechanism

Two-phased approach GRM has been proposed in this project; The Phase-1 GRM will be established to mitigate resettlement compensation related impacts of the project, a grievance redress mechanism will be established to address social and environmental issues throughout the project period. The Phase -2 GRM is for the remaining issues may encounter during project implementation including procurement, social conflict, gender-based violence, sexual exploitation, and abuse, etc. Three-tier Grievance Redress Committees (GRCs) will be established through BIWTA office order.

Grievance Redress Mechanism (GRM) is a valuable tool which will allow affected people to voice concerns regarding environmental and social impacts for the subproject activities. Committees (site level, port level and PIU level) for phase -1 GRM will be assigned to handle the GRM to be produced under Phase-2. Apart from these two pahses GRM, another GRM has been proposed for the laborers to be deployed by the contractor/sub-contractor for the project. Detailes of the Labor GRM has been provided in the Labor Management Procedure (LMP).

The fundamental objective of GRM will be to resolve any project-related grievances locally, in consultation with the aggrieved party to facilitate smooth implementation of the social and environmental action plans. Another important objective is to democratize the development process at the local level and to establish accountability to the affected people.

The procedures will however not pre-empt a person's right to go to the courts of law. BIWTA would ensure that grievance redress procedures are in place and would monitor those procedures to ensure that grievances are handled properly. The BIWTA office will establish a procedure to answer sub- project -related queries and address complaints, disputes, and grievances about any aspect of the sub-

components, including disagreements regarding the assessment and mitigation of environmental and social impacts.

Generally, the grievance redress committees (GRC) are of two types (i) formal courts of appeal and (ii) a locally constitutes GRC for dispute resolution. The second may not totally avoid but may reduce the problem significantly. Grievance Redress Committee (GRC) will be formed in the RAP as suggested in the Social Management Framework (SMF) of the project. Apart from the formal grievance redress mechanism for the affected people, a separate GRM particularly for the construction workers will be formed at the local level. This GRM will hear and resolve complaints of the workers regarding employment, supply of personal protective equipment, payment of salary, gender-based violence risks, etc. A structured and detailed **GRM** has been prepared and is proposed as part of the Social Management Program included in the Chapter 6 of the present ESIA Report.

5.2.11. Cultural Heritage

Cultural heritage is the legacy of physical artifacts and intangible attributes of a group or society that is inherited from past generations. Not all legacies of past generations are "heritage", rather heritage is a product of selection by society.

Cultural heritage includes tangible culture (such as buildings, monuments, landscapes, books, works of art, and artifacts), intangible culture (such as folklore, traditions, language, and knowledge), and natural heritage (including culturally significant landscapes, and biodiversity). In the terminal sites there is no designated tangible cultural heritage affected by the project interventions but in the project surrounding area there is certain cultural heritage which will not be impacted by the project.

5.2.12. Landscape

The sensitivity of the landscape to change is reflected in the degree to which the landscape can accommodate change (due to a particular development or land use change) without adverse effects on its character. This may be influenced by the extent of changes in buildings, land use, topography and/or existing vegetation.

In the construction phase, sources of landscape and visual effects include:

- Site access and haulage routes.
- Materials stockpiles and construction compounds.
- Construction equipment and plant.
- Utilities, including lighting.

No high or moderate valuable landscapes are present. Berthing, boat launch sites, vessel and boat traffic, congested road traffic, urban noise, are all currently present to a high extent.

Therefore, both passenger and cargo terminals and DEPCT development sites have a high capacity to accommodate changes due to the construction works, while the anticipated impact to the landscape will be very low.

5.3. ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES DURING OPERATIONAL PHASE

This section identifies the potential impacts that the various elements of the proposed Project may have on aspects of the physical, biological, and socio-economic environment during operational stage.

5.3.1. Project elements subject to environmental impacts

In summary, the actions on the operational phase that may have an impact on the natural environment can be broken down into:

- Cargo handling operations
- Vessel traffic
- Port road traffic
- On shore operations
- The port itself

5.3.2. Impacts on Air Quality

During the operational phase the project actions that will affect to the air quality are the cargo handling, vessel traffic and Port road traffic. The main sensitive receptors of changes in air quality during the operational phase are residents close to the area, passengers, and workers in the terminals.

- All sites: Cargo and Passenger terminals

The impact is likely to be localized and confined to a smaller area around the project. Since all sites are located along the river, the pollutants are expected to be dispersed. Emission from Vessels during navigation will not be significant. Major pollutants will be Sulphur dioxide and Nitrogen oxides comming from engines fumes due to the increase of vessel traffic and trucks . The concentration of these air pollutants in ambient air as per the baseline data is well below the limit. Contribution from above sources will be a negligible increase in concentration.

- Vessel traffic

Ships are a possible source of airborne emissions such as gasses, smoke, soot, and fumes. N02 and S02 are typical pollutants generated by ships while both maneuvering and berthing and may affect air pollution in the hinterland.

- Port road traffic

Polluting gases are generated on the access road to the terminal due to the transit of cargo vehicles. No dust should be generated in the environment due to the paving of the access road and its correct maintenance by periodically removing dirt.

- Ashuganj and Pangaon site

Since these sites are cargo terminals, both river vessels and road vehicles are expected to increase in the area exerting pollutants in the air. Besides crane and other heavy vehicles are expected to be operated continuously. All these vehicles will increase local air pollutants, especially PM and NOx, moderately in the air.

- Cargo handling operations

Emissions of dust from bulk cargo handling and gasses from cargo handling equipment can be sources of air pollution. Liquid cargo handling may result in the release of vapor during the cleaning of storage tanks and by the breather systems for ambient temperature changes. Accidental leakage of gasses may cause

problems such as toxic material emission, explosions, fumes, odors and hazardous airborne emissions. Waterfront industries may release various kinds of gasses and can be major sources of air pollution and odor.

- Shasanghat, Narayanganj, Chandpur and Barishal site

Except Chandpur and Barishal site, air quality at the Narayanganj and Shasanghat site was found within acceptable limits due to lower traffic volume. In these two sites, air quality drops only during morning and evening when the river vehicles berth and leave. In contrast, Narayanganj is a busy terminal with not only passengers but also cargo loading-unloading.

Narayanganj is a commercial port where vehicle density is high and air quality is quite low. Shasanghat is not a terminal yet, however there are commercial settlements and shipbreaking industry nearby. All these contribute to high particulate matter in air.

- DEPTC site

No air quality depletion at DEPTC site is envisaged during operation period. Impacts on air quality are estimated as moderate.

5.3.3. Impacts on Noise and Vibration

During the operational phase the project actions that will affect to the noise and vibration are Cargo handling operations, Vessel traffic and Port road traffic. The main sensitive receptors of changes in noise and vibrations from project activities are residents close to the proposed area, passengers and workers in the terminal. Howeverthere will be reduced operating levels during nighttime hours

- All sites: Cargo and Passenger terminals

Noise level will not rise against the present level, as better vessels will be deployed. Noise will be contributed from DG, vessels and vehicles. However, the impact on the surroundings will not be significant.

- DEPTC site

The site will be used as a training center. Therefore, no impact on noise environment in envisaged.

According to the *Environmental Significance Ratings* Table presented in the methodology, at the beginning of this chapter where the magnitude ranges are established to classify the impacts into 4 types according to importance, and seeing the magnitude of the impacts described in the Impact

Magnitude Table, the impacts on noise and vibration are estimated as low

5.3.3.1. Mitigation Measures for air quality and noise

- Maintain all vehicles to keep them in good working order in accordance with manufactures maintenance procedures.
- Use the quietest available machinery and equipment, fit high efficiency mufflers to appropriate railway operation or, modify equipment to reduce noise, i.e., using noise control kits.
- Implementing tank and piping leak detection and repair programs

5.3.4. Impacts on Riverbank erosion

During the operational phase, the project action that will affect to the coast and shoreline is the vessel traffic

The proposed development activities for the project involve development of existing terminals with necessary infrastructures and amenities including riverbank stability. As such there is no such change in drainage pattern of the area. However, a localized change in flow may be observed after completion of the project construction. The main sensitive receptors of changes in the riverbank erosion are the rivers included in the project, where the terminals are located. Rivers are: Buriganga River, Shitalakshya River, Kirtonkhola River and Meghna River.

- Ashuganj and Pangaon site

Although all the sites of concern will require dredging and embankment stabilization, the amount of earthwork, piling and dredging is higher in the cargo terminal sites at Ashuganj and Pangaon. Dredging and piling always affect river erosion in many ways, which even may become unpredictable.

- Shasanghat, Narayanganj, Chandpur and Barishal site

Compared to the cargo sites, dredging and pilling is less, embankment stabilization is required however. Therefore, there is still scope for contributing to river erosion at these sites during operation.

The impacts on riverbank erosion are estimated as low

5.3.4.1. Mitigation Measures

In the zones where the bank less stable, the speed of ships and boats shall be controlled so as to reduce waves. In some regions that need protection, wave fences and/or floating breakwaters should be built.

5.3.5. Impacts on Water Quality, Groundwater Quality and Hydrology

It is envisaged that with the development of the project there would be increases in passenger and cargo transport volume along the terminals and hence the probability of pollution of river water is expected (mainly solid and liquid waste and sanitation issues). Further disposal of waste materials may pollute the water course. In addition, some vessels have sewage holding tanks which are pumped out to shore-based septic systems when berthed, but on the other hand sometimes the sewage is dumped directly into the river systems

Also oil spill and garbage handling are the possible sources of water pollution. Periodical maintenance dredging of channels may also affect the water quality. Maintenance of vessels will also generate wastewater.

The main sensitive receptors of changes in water quality are the rivers, fisheries, aquatic life and groundwater (via spillage).

- Ashuganj and Pangaon site

The followings are the source of impact on water quality and hydrology during operation of cargo terminals:

- Operations on the quay areas
- Cargo storage areas
- Wastewater and sewage
- Runoffs containing oil spills
- Wetland Management
- Ship wastes and bilge water

- Sewage from nearby areas
- Accidental cargo spills
  - Shasanghat, Narayanganj, Chandpur and Barishal site

The followings are the source of impact on water quality and hydrology during operation of passenger terminals:

- Wastewater and sewage
- Runoffs containing oil spills
- Ship wastes and bilge water
- Sewage from nearby areas
  - DEPTC site;

No impacts are envisaged.

The impacts on water quality, groundwater quality and hydrology are estimated as low

5.3.5.1. Mitigation Measures

- Use STP to treat wastewater so that water does not contaminate groundwater Table.
- Prepare and apply spill protocol
- Avoiding installation of storm drainage catch basins that discharge directly into surface waters, using containment basins in areas with a high risk of accidental releases of oil or hazardous materials (e.g. fueling or fuel transfer locations), and oil/grit or oil/water separators in all runoff collection areas.
- Oil/water separators and trapping catch basins should be maintained regularly to keep them operational. Recovered contaminated solids or liquids disposed of as hazardous materials.
- Terminals should include secondary containment for above ground liquid storage tanks and tanker truck loading and unloading areas;

5.3.6. Impact on Terrestrial Flora and Fauna Ecosystems

Project will make a positive change in the Terminal areas, moreover on terrestrial flora and fauna during operation as site will be clean of waste, clear with new green areas, where the present wastelands will be transformed into a green space.

The implementation of the Project will result in the recovery of the area in reference to flora and in most of the terminals as Shasanghat, Narayanganj, etc. a green and clean breathing space. The proposed tree transplanting and revegetation of garden areas will attract fauna species to the study area.

During the operation phase the project actions that will affect to the terrestrial flora and fauna will be related to waste: wastewater and sewage from living activities of the Terminals. The application of specific mitigation measures for terrestrial fauna and flora during operation phase is considered necessary.

The Impact on Terrestrial Flora and Fauna ecosystems is considered positive.

5.3.7. Impact on Aquatic Life

During the operation phase the project actions that will affect to the aquatic flora and fauna will be as follows: Pollution caused by the hull materials; Operation of vessels of large load increasing suspended

solid concentration, turbidity in water; Oil and grease leaking from ships; Spread of infectious disease; Land occupation for periodic maintenance and dredging, etc.

- Impact on fish and fish ecology:

It is anticipated that after completion of the construction works more and, in some cases, larger vessels will operate with increased passenger and cargo carriage. There will have a twofold impact on biological environment during the operation period of the developed facilities: (i) likely increase in the release of waste fuels, greases, mobile, etc. into the aquatic environment from the operating vessels; (ii) there will be more influx of passengers with potential for producing more solid waste, likely be to accumulated on the land as well as some will find their ways into the river with potential for polluting the river and adversely impacting aquatic biota, including zooplankton, benthos, fishes, mollusks and prawns. Therefore, fisheries at the terminal site likely to be affected due to aquatic pollution. There are potentials of releasing hull materials into the water at the cargo terminal sites with potential for polluting the river environment affecting the local fisheries. However, such impacts on fisheries production will be minor and also fishermen fishing at the site are unlikely to be affected.

- Impacts on dolphins:

The increased operation of vessels will produce more sound in the water affecting the dolphin and turtles, sensitive to sounds. It is also likely that some dolphin may be physically injured by the navigating vessels at the site and beyond. It is suggested to make careful sightings of foraging dolphins during navigation of vessel and avoid the foraging areas.

5.3.7.1. Mitigation Measures

The following mitigatory measures can be undertaken during the operational period of the proposed development.

- Implement stringent control over releasing the fuels, used mobiles and greases from the vessels.
- Develop and implement a waste management program for collecting, storing and safe disposing solid wastes for each project site;
- Provide induction and refreshers' training to BIWTA terminal staff and vessel operators and demonstrate how to save dolphin and avoid the dolphin foraging area;
- At the cargo sites loading and unloading of hull materials should be carefully controlled so that hull materials are not released into the aquatic environment
- Implement awareness program on the compliance to Fish Conservation ACT, particularly to not to harvest juvenile and gravid fish of major threatened species among local fishers.
- Collaborate with Department of Fisheries in collecting fisheries data on major threatened fish abundance, particularly relating to major threatened species and review this data to assess the efficacy of mitigation measures.

5.3.8. Socioeconomic Aspects

The BRWTP S3 and S4 will have impact on the people and community due to land acquisition and displacement of households and shops, impact on income and livelihood of the vulnerable people. Population influx, SEA/SH and GBV, nuisance, etc. will take place during operation phase if necessary measures are not adequately taken. Grievance redress mechanism of the BIWTA will be applied during operational phase.

5.3.8.1. Mitigation measures

Land acquisition will be carried out following ARIPA 2017. All of the affected entities (landowners, structure owners, squatters, tenants, vendors and day laborers) have been enlisted through census and inventory of losses survey. Prior to starting the survey, the affected people and other stakeholders were consulted through mass consultation meetings in the terminal sites where they were briefed about the project components and timeline, potential impacts and mitigation measures. The RAP will include socio-economic profile, impact analysis, stakeholder engagement, policy principles, relocation and livelihood restoration strategy, grievance redress mechanism, implementation arrangement, estimated cost and budget and monitoring and evaluation. According to the policy of the World Bank OP 4.12, all the affected people irrespective of title to the land will be entitled to have compensation and other resettlement benefits. Landowners will get replacement cost for land so that they will be able to purchase alternative land with the compensation money.

Land acquisition plans and proposals will be prepared by the PIU, BRWTP and submitted to the concerned Deputy Commissioners offices following the ARIPA 2017. Magnitude and severity of impacts on private land will be ascertained based on the land acquisition proposals. Land price will be paid by Deputy Commissioner (DC) as per ARIPA 2017 including 200% premium on the average price of preceding 12 months from the date of notice under section 4 of the ARIPA 2017. If the price including 200% premium does not represent the current market price, the BRWTP will pay additional compensation on top of DC's payment to reach replacement cost (RC).

Grievance Redress Mechanism will be functional and SEA/SH/GBV risk mitigation mesures are to be taken in proper manner.

5.3.9. Cultural Heritage

As discussed above that no cultural heritage will be affected within the footprint of the passenger and cargo terminals. Therefore, mitigation measures have not been designed. If any of the cultural heritage is affected or adversely impacted by the project interventions necessary measures will be taken following World Bank Operational Policies and GOB laws.

5.3.10. Landscape

The sensitivity of the landscape to be changed is reflected in the degree to which the landscape is able to accommodate change (due to a particular development or land use change) without adverse effects on its character. This may be influenced by the extent of changes in buildings, land use, topography and/or existing vegetation. These and other factors also influence the visibility of the proposed development and therefore influence the extent of its effect on the perceived character and visual amenity of the surrounding landscape.

In this sense, a natural forested landscape shows a high sensitivity to infrastructure development such as highways, airports, etc. while a peripheral degraded urban area shows a low sensitivity or high capacity to accommodate changes to a new infrastructure such as a railway or new urban planning. Landscape effects include the direct and indirect effects of the development on individual landscape elements and features, as well as the effect upon the general landscape character and quality of the surrounding area. Landscape effects are described clearly and objectively, and the extent and duration of any adverse/beneficial effects quantified, using four effect categories, indicating a gradation from high to low (i.e. high, medium, low, negligible i.e.no change). Accordingly, the significance of landscape impacts, shown in the Table 128 below, and effects on landscape due to the Project´s development can be considered low to very low adverse impact.

Table 129. Significance of Landscape Impacts

Significance of Landscape Impacts					
Assessment of significance of landscape impacts. Red cells represent significant adverse impacts. Blue cells represent impacts that are not significant			Landscape receptor sensitivity		
			High	Medium	Low
			Landscape with important components or of a particularly distinctive character, susceptible to relatively small changes of the type proposed.	Landscape with relatively ordinary, moderately valued characteristics reasonably tolerant of changes of the type proposed.	A relatively unimportant landscape with few features of value or interest, potentially tolerant of substantial change of the type proposed.
Magnitude of landscape impact	Major adverse Impact	Significant adverse changes, over a significant area, to key characteristics or features or to the landscape's character.	High adverse significance	High/Medium adverse significance	Medium adverse significance
	Moderate adverse Impact	Noticeable but not significant adverse changes over a significant area, to key characteristics or features or to the landscape's character or distinctiveness.	High/Medium adverse significance	Medium adverse significance	Low adverse significance
	Slight adverse Impact	Noticeable adverse changes or barely discernible adverse changes for any length of time.	Medium adverse significance	Low adverse significance	Very low adverse significance
	Neutral	Any change would be negligible, unnoticeable or there are no predicted changes.	Low adverse significance	Very low adverse significance	Very low adverse significance

For all project sites and their proposed developments, their overall sensitivity is considered to be low. Following landscape impact assessment is described for each one of the developments proposed:

- S3 Package: Passenger Terminals
- Shasanghat

Hard, man-made landscape, commercial, industrial and residential areas of Dhaka City is the surrounding landscape. Dense urbanized areas heavily developed with considerable hard surfaces and limited or not existing landscaped areas. Ship breaking activities and sand handling and depot are at present the activities carried out at the Project site.

No high or moderate valuable landscapes are present. Buriganga River is the only area with visual value.

Berthing, boat launch sites, vessel and boat traffic, congested road traffic, urban noise are present currently in a high magnitude. Therefore, Shasanghat passenger terminal development has a high capacity to accommodate change and the anticipated impact to the landscape will be very low.

- Narayanganj

Like Shasanghat: hard man- made landscape, commercial, industrial and residential areas of Dhaka City is the surrounding landscape. Ship-breaking and ship construction and reparation, commercial and residential, are at present the activities carried out at the Project site.

No high or moderate valuable landscapes are present. Shitalakshya River is the only area with some kind of visual value.

Berthing, boat launch sites, dockyards, vessel and boat traffic, congested road traffic, urban noise are present currently of a high magnitude.

The Project is an upgrade of exiting terminal, no new development is proposed. Therefore, Narayanganj passenger terminal upgrade project has a high capacity to accommodate change and the anticipated impact to the landscape will be very low.

- DEPTC

No significant impact has been identified for DEPTC development

- Barishal

Similar to Shasanghat, hard man made landscape, commercial, industrial and residential areas of Barishal City is the surrounding landscape. No high or moderate valuable landscapes are present. Kirtankhola River is the only area with visual value.

Vessel and boat traffic, boat launch sites and road traffic are present currently of a high magnitude. Therefore, Barishal passenger terminal development has a high capacity to accommodate change and the anticipated impact to the landscape will be very low.

- Chandpur

Man made landscape, commercial, industrial and residential areas with tree and shrub patches is the surrounding landscape. No moderate valuable landscapes are present. Kirtankhola River is the only area with some kind of visual value.

Vessel and boat traffic, boat launch sites and road traffic are present currently of a high magnitude. Therefore, Barishal passenger terminal development has a high capacity to accommodate change and the anticipated impact to the landscape will be very low.

- S4 Cargo Terminals

Although the Cargo terminal development area is somewhat larger than Passenger Terminal, its effects on landscape cannot be considered higher.

- Pangaon

Peripheral landscape to Dhaka City, rural plus man made landscape, rural, commercial, spread industrial and residential areas and water bodies is the surrounding landscape.

No high or moderate valuable landscapes are present. Some green areas and trees give some degree of attractiveness, but loss of value comes from wastes, debris, and anthropogenic impacts. Buriganga River is the only area with some kind of visual value.

Boat launch sites, vessel and boat traffic, cargo terminal operation in the surroundings and urban noise are currently present.

Even if the site is a "green or open area" it has a high ability to accommodate change due to its man-made nature and is considered to have **low** sensitivity. Therefore, Pangaon cargo terminal development site has a high capacity to accommodate change and the anticipated impact to the landscape will be very low.

- Ashunganj

Full percentage of hard landscape, commercial, industrial and water transport and operation are the surrounding landscape. Commercial and port activities are at present the activities carried out at the Project site. Dense urbanized areas heavily developed with considerable hard surfaces and limited or no existing landscaped areas.

No high or moderate valuable landscapes are present.

Berthing, boat launch sites, vessel and boat traffic, congested road traffic, urban noise are present currently in a high magnitude. Therefore, Ashunganj cargo terminal development site has a high capacity to accommodate change and the anticipated impact to the landscape will be very low.

5.4. CUMULATIVE IMPACTS

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities.

Multiple and successive environmental and social impacts from existing developments, combined with the potential incremental impacts resulting from proposed and/or anticipated future developments, may result in significant cumulative impacts that would not be expected in the case of a stand-alone development. Cumulative effects to the environment are the result of multiple activities from different sources whose individual direct impacts may be relatively minor but in combination with others result are significant environmental effects. The multiple impacts of different activities may have an additive, synergistic or antagonistic effect on one another and with natural processes.

Initial appraisal suggests that all S3 or S4 site environments are affected and/ or likely to be affected by other activities /projects sourced nearby. However, cumulative effects can be difficult to predict and manage due to inadequate environmental baseline data, complex ecological processes, and the large

scale at which human development occurs. Nonetheless, still, some sorts of qualitative predictions or approximation of impacts could be made in order to guide development of mitigation measures. Therefore, assessment of cumulative effects might help to design effective mitigation measures and its integration into the environmental management plan

An assessment of cumulative effects for each of the individual S3 and S4 project sites is made below with recommendations on required mitigation measures, in addition to measures identified in the preceding sections.

Main steps in cumulative impacts assessment are as follows:

- Identification of VECs that may be affected by the development under evaluation.
- Identification of other existing and reasonably anticipated and/or planned and potentially induced developments
- Assessment and/or estimation of the future condition of selected VECs, as the result of the cumulative impacts.
- Avoidance and minimization, in accordance with the mitigation hierarchy, of the development's impact on the VECs for the life of the development or for as long as the impacts continue to be present.
- Monitoring and management of risks to VEC viability or sustainability over the life span of either the development or its effects, whichever lasts longer.

5.4.1. Study Boundary

The study boundary of for Cumulative Impact Assessment (CIA), has been considered based on the full lengths of the waterways themselves, the river basins/catchments upstream and downstream of the waterways, floodplain and drainage areas and patterns, areas of potential influence of existing and planned river ports, landings, terminals, vessel shelters, ferry crossings, and dredge spoil dumping locations along the waterways, areas of ecological importance along the waterways such as any parks/reserves/forests, current and planned areas being irrigated by or otherwise using waters from the waterways, roads leading to the spoil disposal sites, etc.

5.4.2. Identification of VECs

Identification of VECs shall focus on the most important VECs, availability of data acquisition of VECs in further monitoring should also be taken into consideration.

Identified VECs are the following:

- Air quality
- Noise
- Water quality
- Aquatic Ecosystem

In addition, BRWTP-1, Environmental and social impact assessment framework identified: Gangetic Dolphin (Platanista gangetica) as VEC.

Effects of Projects terminals and other developments combined should:

- Effects on ambient conditions such as the incremental contribution of pollutant emissions in an airshed.
- Increases in pollutant concentrations in a water body, the rivers where Terminals will be upgrade or constructed..
- Increases in sediment loads on a watershed or increased erosion.
- Interference in Aquatic fauna and ecosystems
- Increases in local transport activity surrounding the Project and in the project's area of influence.
- Changes in river/inland water transport capacity and level of modernization.

5.4.3. Current and Future Development Projects in Context of CIA

5.4.3.1. Bangladesh Regional Inland Water Transport Project

The Project aims to develop the IWT routes and infrastructure between Dhaka – Chittagong – Ashuganj IWT Corridor, including branches to Ghorashal (via Narayanganj) and Barisal. The World Bank is considering financing of this Project. The implementing agency for this project is Bangladesh Inland Water Transport Authority (BIWTA). The key components of this project with potential environmental impacts are the following:

- Component 1: Improved Inland Waterway Navigation
- Component 2 Improved Services at Priority Inland Waterway Terminals and Landing Ghats/Station (Packages 3, 4, 5 and 6 are within this Component)
- Component 3: Institutional Capacity Development and Sustainability

This Project has an in deep presentation in this ESIA Document, so no further explanation is given here.

5.4.3.2. Payra Deep Sea Port.

Development of the Payra Sea Port at the Rabnabad Channel in the Patuakhali District. the government has given up the idea to build a deep seaport in Payra and decided to build a regular seaport there, says State Minister for Shipping Khalid Mahmud Chowdhury.

Accordingly, the port site has been relocated from its original offshore location by 65 kilometres to an onshore location at the mouth of the Rabnabad channel.

Downgrading the project from deep seaport means Payra would not host any mother vessel or very large ships-- but smaller vessels like the ones handled by the Chattogram and Mongla ports.

Economic and social development would be enhanced rapidly in this zone if a sea pot is established. International sea borne trade of Bangladesh has been using two existing seaports, with about 92% passing through Chittagong Port. The objective of the project is to build a seaport in the central coastal zone for economic, business, industrial and social development of the country. With the increasing population, demand of development for seaport in the central coastal zone is crucial for creating employment opportunity and social development of the country.

5.4.3.3. Payra Port Container Terminal

The Payra Port Authority plans to expand the port with the construction of a deep-sea coal and bulk goods terminal, which would make Payra the country's first deep-sea port. This terminal must be able to handle

containers that would be transhipped for onward movement by barge up to Dhaka or Mongla or Chattogram or moved by road or railway inland. Objectives are: To Provide a major gateway for the country's trade with the outside world; Improve the quality of services and develop adequate facilities and decrease the pressure on the existing Ports; Enhance competitiveness of the country's exports as prices of imported and exported commodities decrease as a result of shorter shipping time and lower shipping costs; Exporters would incur lower financial costs for their shipments due to the shorter processing and shipping time for their cargo. It was schedule to be constructed at the end of 2018.

5.4.3.4. Power Plant and LNG Terminal at Payra

A memorandum of understanding between Bangladesh Power Division and Siemens to build the plant was signed in November 2017. Initially expected to start running in 2020, construction has slowed down enough that a steering group was formed with representatives from the North-West Power Generation Company Ltd to speed up the project. In addition, a land-based liquefied natural gas terminal will be built to supply fuel for the power plant. Therefore, Payra is supposed to host an LNG terminal, at Kalapara Upazila - Patuakhali District, in Payra, to facilitate the import of Liquid Natural Gas that would run gas-fired to the power plant other facilities and for national gas supplies.

5.4.3.5. Construction of Embankments, Development of a Road Network on the Embankment and River Training Works along the Bank of Major Rivers:

The future development projects under RMIP, FREMIP, and other development projects includes (i) construction of and rehabilitation of 150 km embankments and development of a two lane highway along the embankment under RMIP Project, which would subsequently be expanded to 4 lanes, (ii) construction of about 32 km of additional new riverbank protection works and rehabilitation of about 13km of existing revetments, six spurs, one hard point and one groyne under RMIP project, (iii) rehabilitation of about 40km length of BRE from downstream of Jamuna Bridge to Chandpur along with necessary river training works.

5.4.3.6. New ICT terminal at Ashunganj.

A new ICT terminal is being developed for Indian ships within 1.5 km downstream of the Ashunganj Cargo Terminal.

5.4.3.7. Projects in the Dhaka-Chittagong IWT Corridor

Development projects are under implementation by BIWTA in the Dhaka-Chittagong corridor and adjoining routes. Table 129 shows the Projects in the Dhaka-Chittagong IWT Corridor and Adjoining Routes.

Table 130. List of Ongoing Projects

List of On-going Projects 2019-20

Projects under Development Budget (ADP): (Taka in Lakh)

SL No	Name of Project	Implementation Period	Estimated Cost	Source of Fund
1.	Procurement of 35 Dredgers with Ancillary Equipment and Accessories.	Oct' 2018- June 2023	448903.42	GoB
2.	Improvement and Restoration of Navigability for Old Brahmaputra, Dharala, Tulai & Punarbhba River.	Sept' 2018- June 2024	437100.00	GoB
3.	Bangladesh Regional Waterway Transport Project-1 (Dredging in Chittagong-Dhaka-Ashuganj IWT Corridor along with associated linked routes and construction of terminal with allied infrastructure).	July 2016- June 2024	320000.00	GoB & World Bank
4.	Procurement of 20 Dredgers with Ancillary Equipment and Accessories.	July 2015- Dec' 2019	204799.87	GoB
5.	Capital Dredging of 53 river routes in inland waterways (1st phase: 24 River Routes).	July 2012- June 2021	192300.00	GoB
6	Establishment of Inland Container River Port at Ashuganj.	July 2018- Dec' 2021	129300.00	GoB & Indian LoC
7	Improvement of navigability from Mongla to Pakshi river route via Chandpur-Mawa-Gualanda.	July 2017- June 2025	95600.00	GoB
8	Construction & Instalation of dimarcation pillar, Walkway, Bank Protection, Jetty with allied work on Evicted Foreshore Land of the River Buriganga, Turag, Balu and Sitalakhya (2nd Phase).	July 2018- June 2022	84855.00	GoB
9	Procurement of 10 dredgers, crane boats, tugs, officer house boats and crew house boats with other accessories (2nd Revised).	July 2011- June 2020	74560.22	GoB
10	Establishment of Port facilities at Nagarbari.	July 2018- June 2021	51390.00	GoB
11	Dredging On 12 important river routes.	Oct' 2011- June 2020	50846.00	GoB
12	Construction and placement of special type terminal pontoons with allied facilities.	July 2018- Dec' 2020	16271.18	GoB
13	Establishment of Ferry Ghat including allied facilities at Balashi and Bahadurabad.	July 2017- Dec' 2019	14260.00	GoB
14	Establishment of Ship Personnel Training Institute, Madaripur (1st Revised).	July 2013- June 2020	5903.32	GoB
15	Re-construction of RCC jetty at Guptachara, Sandwip.	Jan' 2017- June 2020	5264.25	GoB
16	Modernization of three DGPS Beacon Stations including Control Station & Monitoring Station.	July 2016- June 2020	2412.36	GoB
17	Feasibility Study for construction of walkway, Eco-park and other allied infrastructure on the foreshore land of the river Buriganga, Turag, Balu & Sitalakhya (3rd phase) and Waste removal from the river bed along the circular waterways of Dhaka City.	July 2018- Sept' 2019	476.71	GoB
18	Feasibility Study for construction of walkway, Eco-park and other allied infrastructure on the foreshore land of the river Buriganga, Turag, Balu & Sitalakhya (3rd phase) and Waste removal from the river bed along the circular waterways of Dhaka City.	July 2018- Sept' 2019	476.71	GoB
19	Feasibility Study for procurement of 2 (Two) High power Salvage vessel with allied facilities. Different Types of 61 (Sixty One) service vessel including 6(six). River Cleaning vessel & Different Types of 132 (One Hundred Thirty Two) Pontoons for BIWTA.	July 2018- Dec' 2019	435.41	GoB
20.	Feasibilyty Study for Navigation Improvement and Landing facilities at Chittagong Hill Tracts Region.	Dec'2018- Nov' 2019	413.77	GoB

5.4.4. Assessment of future conditions of VECs

Pangaon CT Site: Pangaon site is located on the River Buriganga, within kilometer from the Dhaka Municipal Corporation. The river receives huge quantity of sewerage wastes, industrial effluents, and spills and discharges from the operating vessels and is heavily polluted to an unacceptable level. The existing Sadarghat PT and the proposed Shasanghat PTs are located at only few kilometers upstream of the Pangaon site. Very adjacent to the site is also located Pangaon Container Terminal (ICT), which has recently been commissioned and operationalized. A large flour mill is also located very close to the proposed terminal site.

Sadarghat PT is heavily used site as hundreds of passenger carriage vessels (launches) operate to and from the terminal daily, all of them pass across the Pangaon site before those reach to the Sadarghat PT. Also, many cargo vessels navigate across the proposed CT site daily. The recently constructed Pangaon Inland Container Terminal (ICT) will also receive large number of container vessels for offloading containers that are to be subsequently transported by truckloads to distant places. Although, construction of the Shasanghat PT is intended for diverting many passenger vessels to Shasanghat, instead of using Sadarghat PT, however, it will also intended to expand water transportation across the country implied that more vessels will operate from this terminal site. It is expected that as result of this river traffic will increase by at least by 3 -folds.

Construction of Shasanghat PT and Pangaon CT will be made simultaneously and both will generate wastes with potentials for polluting river water during its construction period. The increased vessel operation during operation period will also increase leaching of waste fuels, oil, and greases into the river. Land base solid waste may also have the potentials to pollute river water.

A huge number of trucks, vans and lorries will be required to transport goods and containers to and from both Pangaon CT and Pangaon ICT sites. The flour mill also uses large number of trucks for transporting raw materials and finished goods. As a result, there will be a huge increase in road traffic. It is therefore obvious that the present road facilities including the approach roads in the area may not be able to cope up with the situation. Overall impacts caused from these sites are summarized below:

- The water pollution will increase much higher than its present level and is likely to further affect the aquatic biota, including fish and other aquatic animals, leading to its likely complete disappearance.
- River traffic level is likely to increase by 3-folds and will affect the aquatic biota and sounds from vessels trucks will affect the adjacent city dwellers and wildlife. Dolphins will be particularly be affected.
- Land traffic will also increase by manifolds resulting in local severe traffic congestion and will also an increase in air pollution.

5.4.5. Condition of selected VECs

5.4.5.1. Air quality and noise

In general, all sites under study show relevant problems in air quality and noise level, as a result of heavily populated surrounding areas, industries, and heavy traffic, among others. Implementation of several new developments, or they upgradation, will results in a probable increase in air quality and noise level problem.

5.4.5.2. Water quality

In general, Buriganga, Sitalakhya, Megnah and Kirtankhola River are heavily polluted as they receives sewage discharges from the populated areas and effluents from industrial units located at the upstream. This degradation in water quality have caused severe depletion in fisheries resources and other aquatic biodiversity, particularly in dry season. However, in monsoon the water quality gets better allowing some fish other biodiversity to reappear. Although, the construction activities at the sites will have little, short-term and reversible impacts, in lean flow season this impact during construction period may additively increase the impacts with greater potentials to negatively affect the aquatic biodiversity. Any other project upstream , even downstream, could multiply the effects on water quality. During Operation the effects from wastes and waste water could have the same cumulative effects.

It has to be pointed out that the upgradation of the terminals and the construction of the new ones could alleviate such a pression on water quality since these facilities will be implemented under a more environmental friendly design and mismanaging replacing the current ones that shows important problems in waste treatment and resources management.

5.4.5.3. Aquatic ecosystem

The Ganges Brahmaputra and Meghna river system and their floodplains are the important source of both capture and culture fresh water fish in Bangladesh. The fish production in these rivers have been continuously decreasing due to changes in river morphology and pollution from the industrial and residential development.

The dredging and inland land construction activities proposed under the Project will negatively affect the aquatic biodiversity in the Project Rivers. Anyhow only Pangaon Cargo Terminal shows relevant amount of dredged materials. Wastes, and waste water should be the main impact on a cumulative basis that can affect biodiversity and general quality of river ecosystems.

The potential developments in the IWT sector can affect the breeding grounds of fishing due to dredging activities. Focused on Terminals developments wastewater discharges should be considered as the more relevant effects.

5.4.5.4. Dolphin

River dolphins are among the world's most threatened mammal species and Hilsa fish species usually migrate between sea and river and are also an important resource in the Project area. They inhabit some of the largest river systems of southern Asia, and their environmental requirements link them to food and water security issues in the world's most densely populated human environments. Populations of river cetaceans have declined dramatically in recent years and much of their range has been lost. River cetaceans are threatened in many ways. Overharvesting of fish and crustaceans reduces the availability of their prey. Deforestation and intensive floodplain farming increase the sediment load of river channels and degrade cetacean habitat. Industrial effluents, human sewage, mining waste, and agricultural runoff contaminate water. Dolphins die from accidental entanglement in gill nets, and mortality rates increase as the use of these nets spreads.

Effects of vessel traffic on river dolphins is identified as the main impact on cumulative or combined effects of plans and projects. Ferry crossings, commercial ports, and primary fishing grounds in rivers are generally located downstream of convergent channels or sharp meanders, which are also the preferred habitat of river dolphins. River dolphins are often observed swimming in areas with high vessel traffic,

that includes small boats, motorized ferries, and in some location's large container ships and oil tankers, with no visible damaging effects. Cumulative effects for Terminals should be focus on collisions and noise and vibration due to increase in river transport. Losing of preys due to dredging is more related to dredging activities of other projects since only Pangaon shows a relevant volume of dredged activity, very little amount of dredging, Ashunganj even more volume of dredged materials, and no dredging planned to passenger terminals.

5.4.6. Mitigation of Cumulative effects

The estimated overall cumulative impact indicates the need for mitigation to be implemented by the various project owners or proponent parties to ensure that their respective contributions to the overall condition of the VECs is coherent and/or compatible as a minimum compliant with ambient quality standards for the desired use.

In general, we need to follow the following measures for all sites:

- BIWTA needs to review the situation and involve all parties, vessel operators, CT, ICT and PT authorities to jointly prepare and implement a pollution control program
- Air quality and noise level monitoring in the areas needs to be implemented.
- Ensure that wastes and waste water management plans are operational and efficient to avoid any kind of pollution of water bodies and terminals surroundings.
- BIWTA should develop a dolphin conservation and monitoring protocol and implement the same and engage competent consultant for the purpose.

The following measures will be more specifically for each site, mitigation measures during construction and operation of a particular Terminal are proposed for each phase in the main mitigation measures section of this report and the following ESMP:

- Pangaon and Shasanghat PT Site

Pangaon and Shasanghat sites are located on the same Buriganga River, very close to each other. The cumulative impacts described for Pangaon site are also entirely apply for Shasanghat site. Therefore, the mitigation measures prescribed for Pangaon site are also be the same for Shasanghat site.

- Narayanganj PT Site:

Sitalakhya River at Narayanganj is also heavily polluted as it receives sewage discharges from the city area and effluents from hundreds of industrial units located at the upstream. This degradation in water quality have caused severe depletion in fisheries resources and other aquatic biodiversity, particularly in dry season. However, in monsoon the water quality gets better allowing some fish other biodiversity to reappear. Although, the construction activities at the site will have little, short-term and reversible impacts, in lean flow season this impact during construction period may additively increase the impacts with greater potentials to negatively affect the aquatic biodiversity'

On the land, the city bus terminal is located just at the immediate vicinity of the launch terminal and has been causing huge local traffic congestion. It is expected that there will be an increase in passengers' movement in future implicating an increase in road vehicular traffic, particularly in access road areas during operation period of the terminal. Controlling of traffic near the terminal area will be required. BIWTA may also hold dialogue with city corporation and other relevant stakeholders for ensuring release of treated effluent into the river.

- Ashuganj CT Site

The impact assessment for the site showed an increase in air, water noise pollution, mainly of short-term, localized and reversible impacts and some river traffic congestion during operation period. In addition, the site receives some waste waters from the local sewerage source. The Indian Cargo Terminal is located very adjacent to the site, which is now in operation, also contribute to water pollution and traffic congestion.

A new ICT terminal is being developed for Indian ships within 1.5 km downstream of the project site with potential increase in air, noise, and navigation traffic activities, both during construction and operation period. Adjacent to it is also located a Petroleum Depot which receives petroleum from ships and contributes to local navigation traffic congestion.

The existing BIWTA launch ghat is also within a kilometre of the site. All these have contributed to and will contribute to increased navigation traffic and river water pollution in the area, particularly during dry season. The traffic situation will further worsen when the proposed cargo terminal and the ICT terminal will be commissioned and operationalized. The increased navigation from all these sources will also have potentials to further degrade the water quality, negatively affecting the aquatic biota, the fish and dolphins. Therefore, there is a need for the implementation of a well-coordinated mitigation measures developed through dialogue among the stakeholders considering the cumulative impacts.

- Barishal PT Site

As assessed, the terminal construction activities at the site will have some noise, water and air impacts pollution during construction and negligible water pollution and increase in navigation during operation period. The site receives sewerage effluents from the city but is regularly flushed out by tidal processes. The existing launch ghat, which is to be upgraded, is highly utilized, and is the major source of local navigation traffic.

There are some development nearby, deep sea port, power plant and LNG Plant that might have the potentials for further degrade the water quality. Therefore, the cumulative impacts at the site will require monitoring measerues.

- Chandpur PT Site

The impact assessment exercise suggests that there will be some air and noise pollution during the construction period with no residual impact for the operation period. Although the construction activities have the potentials to pollute water, however, due to tidal influences this impact will be ameliorated. In addition, the site receives some sewage effluents from the Chandpur township and few adjacent industrial units. As discussed earlier, the water at the site regularly flushed out in the tidal process and thus does not allow build-up of pollutants.

There would be some navigation, traffic at the site. Having the presence of wider river confluence at the site, the anticipated increase in navigation is unlikely to create traffic congestion. As having no other development activities nearby, no cumulative impacts are anticipated.

- General Mitigation measures

Following Mitigation measures should be implemented by BIWTA on a wide spatial basis and not only for the S3 and S4 packages and particularly during operational period.

The main mitigation tasks should be as follows:

  - Regularly check and carry out maintenance work of vessels to reduce air pollution and noise levels.

- Regularly check air noise level in terminals and other riverine BIWTA facilities.
- Do not discharge liquid and solid waste into the river from vessels. Adopt environmentally friendly management plans to avoid discharges of wastes and any pollutant substances into the water.

Mitigation measures proposed in this ESIA report covers the ones that shall be undertaken to prevent cumulative effects derived from the 4 Passenger and the 2 Cargo terminals.

5.4.7. Monitoring

Because cumulative impacts often result from the successive, incremental, and/or combined impacts of multiple developments, responsibility for their prevention and management is shared among the various contributing developments, and for the Terminals development should at first be managed by BIWTA. Because it is usually beyond the capability of any one party to implement all of the measures needed to reduce or eliminate cumulative impacts, collaborative efforts will likely be needed. For the Terminals development and considered the framework of the BRWTP should at first be managed by BIWTA.

5.5. SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

5.5.1. Construction phase key impacts

- Emission of Smoke, Dust and CO2, increased NOx in Air.
- Noise and vibration generation
- Topographic and landscaping changes occasioned by construction
- Land changes because of levelling and filling, top soil removing and earth movements
- Alteration of siltation pattern
- Soil changes because of spills, material removal and construction work, erosion increasing because of vegetation clearance and earth movements.
- Change in riverbank contour and line
- Increase in erosion/sedimentation of river shore
- Likely changes in water quality due to pollution associated with civil works, particularly dredging, and/wastewater in camp site, Increase in run-off and erosion, and hence water turbidity
- Likely changes in flux of water for a specified or unspecified period due to earth movements, dumping of materials or topsoil removing.
- Likely changes in sediment quality due to pollution coming from dredging and jetty construction particularly. Port traffic and use of fuel, wastewater discharge etc. can also cause sediment pollution.
- Likely changes in ground water quality due to construction materials depots
- Loss of natural vegetation
- Loss of natural habitats and fragmentation of ecosystems
- Loss of wildlife
- Loss of fish biodiversity and degradation to fish ecology
- Disturbances to dolphins
- Temporarily Acquisition of private lands

- Decrease in farming areas
- Increase in time and distance
- Loss of income and employment for those who will be temporarily affected directly or indirectly
- Influx of labor in the river port working at the terminals coming from different parts of the Country
- Impact on Women Folk or sexual activities or harassments
- Increased job opportunities
- Change from farming to commercial
- Opportunity for employment, Increased income levels
- Diversion and disruption of local traffic
- Improved job opportunities for women, Increased family incomes, social and economic empowerment of women

5.5.2. Construction phase mitigation measures

Physical envionment

- Air quality

- Implement measures in ECoP 6 Air Quality Management.
- Dust generation will be restricted as much as possible and water sprinkling carried out as appropriate, especially where earthmoving and excavation are carried out.
- Provide water spray vehicles to water the unpaved ground, storage piles and other areas where airborne dust may originate. The water spray operation should be carried out at least twice a day (morning and afternoon).
- Open stockpiles of construction materials (e.g. aggregates, sand and fill material) of more than 50m3 shall be covered with tarpaulin or similar fabric during rainstorms.

- Noise

- Implement ECoP 7: Noise Management
- The Contractor shall abide by the provisions of the Specifications of Contract regarding environmental protection and DOE regulations.
- The Contractor shall at its own expense take all appropriate measures to ensure that work carried out (including works by sub-contractors), whether on or off the site, will not cause any unnecessary or excessive noise.
- All equipment, engines and motors shall be equipped with proper silencers or mufflers during construction.

- Geology & Soils

- Implement ECoP 4: Soil Quality Management
- The Contractor is required to reuse the excavated soil as much as possible unless the soil is considered unsuitable for filling.

- The Contractor shall plan his works to minimize surface excavation works during the rainy season where practicable.
- Maintain record of all sand or sediment extraction (quantities, location shown on map, timing).
- Place the sediments for filling the proposed disposal areas. Prior to filling commencing, the areas being filled will be subdivided into compartments by construction of temporary containment bunds of suitable material (e.g. dredged sand). Filling will be achieved by progressively pumping slurry of sand and water into the bunded areas, allowing the surplus water to drain away to artificial and natural waterways in a controlled manner through the pipeline, without affecting floodplains.
- Dredged soil should not be disposed in river or on its banks (especially during breeding and spawning seasons of aquatic organisms) Soil stockpiles should be covered to protect them from being eroded by heavy rains and from dust during windy dry periods.
    - Water quality
- Implement measures in ECoPs 2,3 and 5
- Workforce camps will be located away from water resources. All practical measures such as provision of septic tanks, garbage bags and other sanitation facilities will be implemented at the construction camps to prevent the wastewater and solid wastes from contaminating surface water.
- Oil/water separators and trapping catch basins should be installed and maintained regularly to keep them operational. Recovered contaminated solids or liquids disposed of as hazardous materials.
- Installing filter mechanisms (e.g. draining swabs, filter berms, drainage inlet protection, sediment traps and sediment basins) to prevent sediment and particulates from reaching the surface water;
- The earthwork sites where exposed land surface is vulnerable to runoff, etc. shall be consolidated and/or covered;
- The material stockpile sites shall be located far away from water bodies and areas prone to surface run-off.
- Storage areas for sand and soil, and all work areas, must be located at least 20 meters from river. Construction equipment must not be cleaned or washed within 50 meters of the river.
- Prevent all solid and liquid wastes entering waterways by collecting solid waste, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot.
    - Ground Water
- Ensure that no drinking water sources (surface or ground water) are located within 500 m radius of the facility.
- Use as much as surface water for construction and labor camp purpose instead of ground water.
- Use supply water to compensate for local withdrawal of groundwater
- Use STP to treat wastewater so that water does not contaminate groundwater Table.

Biological Environment

Baseed foregoing discussions on impacts and proposed mitigation measures this Section summarizes the mitigations measures to be undertaken for different components of Biological Components, viz, vegetation, terrestrial fauna and wildlife, aquatic wildlife and fish ecology, dolphins and by sites.

- Sashaghat PT site
  - Vegetation
  - The Contractor shall provide adequate knowledge to the workers regarding protection of flora and fauna and relevant government regulations and punishing for illegal poaching. The killing of animals discovered on site is considered poaching and is strictly forbidden – inductions for staff anz workers must be carried out on the topic.
  - Develop a green area (garden) in waste spaces within the terminal site premise
  - Undertake plantation of at least 20 trees (plant 5 trees for 1 tree cut) . at the peripheral area of the project site. Plantation should be done with indigenous species. .
  - Strictly delimitate the extension of the area to be affected by the Project, before the construction works start, the contractor will proceed to mark the outer limit of the Project. A perimeter security fence at least 1.5m in height constructed from appropriate materials.
  - Terrestrial Wildlife
  - Check for and drive out the slow moving animals just before eearrth filling of the site.
  - Enhance local community awareness on conserving the wildlife in the area;
  - Aquatic life and dolphins
  - Ensure that all land-based pollutants are collected and stored in safe place, not allowing to go into aquatic environment;
  - Avoid construction works in the river during wet season, when dolphins forage in the area
  - Implement awareness program on the compliance to Fish Conservation ACT, particularly relating to not to harvest juvenile and gravid fish of major threatened species among local fishers.
  - Temporary barricade should be made around the land based construction
  - Confirm that dredge silt booms /or bubble curtains are in place and operating during piling so that pile driving meets threshold limits for shock-wave impactson order to reduce impacts of sounds on dolphin and turtles.egetation.
  - Raise awareness of local fsihers on conservation of thtreatened fish species.
  - Provide induction training to vessel opeartors on conservation of dolphin
- Narayanganj PT Site
  - Vegetation
  - The Contractor shall provide adequate knowledge to the workers regarding protection of flora and fauna and relevant government regulations and punishing for illegal poaching. The

killing of animals discovered on site is considered poaching and is strictly forbidden – inductions for staff and workers must be carried out on the topic.

- Rehabilitate and restore the existing garden after construction work is completed
- Undertake plantation of at least 715 trees (plant 5 trees for 1 tree cut) . at within the site boundary and/ or in available spaces nearby the site. Plantation should be done with indigenous species. .
- Strictly delimitate the extension of the area to be affected by the Project, before the construction works start, the contractor will proceed to mark the outer limit of the Project. A perimeter security fence at least 1.5m in height constructed from appropriate materials.
- <u>Terrestrial fauna and wildlfe</u>
- Check for and drive out the slow moving animals just before earrth filling of the site.
- Enhance local community awareness on conserving the wildlife in the area;
- If tree removal time coincides with period for birdd nesting, cheeck the trees for bird nests, if noted wait until nesting period is, over.
- <u>Aquatic Life, turtles and dolphin</u>
- Ensure that all land-based pollutants are collected and stored in safe place, not allowing to go into aquatic environment;
- Avoid construction works in the river durinwet season when dolphins forage in the area
- Confirm that dredge silt booms /or bubble curtains are in place and operating during piling so that pile driving meets threshold limits for shock-wave impactson order to reduce impacts of sounds on dolphin and turtles.
- Temporary barricade should be made around the land based construction
- Implement awareness program on the compliance to Fish Conservation ACT, particularly relating to not to harvest juvenile and gravid fish of major threatened species among local fishers.
- Provide induction training to vessel opeartors on conservation of dolphin

- Barishal PT Site
  - <u>Vegetation</u>
  - The Contractor shall provide adequate knowledge to the workers regarding protection of flora and fauna and relevant government regulations and punishing for illegal poaching. The killing of animals discovered on site is considered poaching and is strictly forbidden – inductions for staff and workers must be carried out on the topic.
  - Develop a green area (garden) in waste spaces within the terminal site premise and enrich the existing one within the BIWTA Rest House premise.
  - Undertake plantation with trees (plant 5 trees for 1 tree cut) in the suitable available areas within the site and in the rest house garden.. Plantation should be done with indigenous species. .

- Strictly delimitate the extension of the area to be affected by the Project, before the construction works start, the contractor will proceed to mark the outer limit of the Project. A perimeter security fence at least 1.5m in height constructed from appropriate materials
- Terrestrial fauna and wildlife
- Check for and drive out the slow moving animals, like frogs, water snakes, garden lizards, etc. just before earth filling of the site.
- Enhance local community awareness on conserving the wildlife in the area;
- If tree removal time coincides with period of bird nesting, check the trees for bird nests, if noted wait until nesting period is over.

Aquatic life and turtle

- Ensure that all land-based pollutants are collected and stored in safe place, not allowing to go into aquatic environment;
- Temporary barricade should be made around the land based construction
- Conduct awareness programs for the fishers on fish and turtle conservation meeting compliance to fisheries regulation of the country.
- Provide induction training to vessel opeartors on conservation of dolphin
-

- Chandpur PT Site
  - Vegetation
  - The Contractor shall provide adequate knowledge to the workers regarding protection of flora and fauna and relevant government regulations and punishing for illegal poaching. The killing of animals discovered on site is considered poaching and is strictly forbidden – inductions for staff and workers must be carried out on the topic.
  - Develop a green area (garden) in waste spaces within the terminal site premise
  - Undertake plantation of at least 1812 trees (plant 3 trees for 1 tree cut) . within and around at the peripheral area of the project site. Plantation should be done with indigenous species..
  - Strictly delimitate the extension of the area to be affected by the Project, before the construction works start, the contractor will proceed to mark the outer limit of the Project. A perimeter security fence at least 1.5m in height constructed from appropriate materials.
  - Terrestrial fauna and wildlife
  - Check for and drive out the slow moving animals just before eearrth filling of the site.
  - Enhance local community awareness on conserving the wildlife in the area;
  - Aquatic life, turtles and dolphins
  - Ensure that all land-based pollutants are collected and stored in safe place or led in to a pit , not allowing to go into aquatic environment;
  - Avoid construction works in the river during wet season, when dolphins forage in the area

- Confirm that dredge silt booms /or bubble curtains are in place and operating during piling so that pile driving meets threshold limits for shock-wave impactson order to reduce impacts of sounds on dolphin and turtles.
- Raise awareness of local fsihers on conservation of thtreatened fish species.
- Provide induction training to vessel opeartors on conservation of dolphin
- Temporary barricade should be made around the land based construction
- Implement awareness program on the compliance to Fish Conservation ACT, particularly relating to not to harvest juvenile and gravid fish of major threatened species among local fishers.

- Pangaon CT Site
  - Vegetation
  - The Contractor shall provide adequate knowledge to the workers regarding protection of flora and fauna and relevant government regulations and punishing for illegal poaching. The killing of animals discovered on site is considered poaching and is strictly forbidden – inductions for staff and workers must be carried out on the topic.
  - Avoid unnecessary removal of herbaceous vegetation.
  - Develop a green area (garden) in waste spaces within the site premise
  - Undertake plantation of at least 3145 trees (plant 3 trees for 1 tree cut) . within and around the project site, if adequate space is not available for plantation distribute some saplings among adjacent homesteads for plantation in their premises. . Plantation should be done with indigenous species. .
  - Strictly delimitate the extension of the area to be affected by the Project, before the construction works start, the contractor will proceed to mark the outer limit of the Project. A perimeter security fence at least 1.5m in height constructed from appropriate materials.
  - Terrestrial fauna and wildlife
  - Check for and drive out the slow moving animals just before earth filling of the pocket areas containing herbaceous vegetation.
  - Enhance local community awareness on conserving the wildlife in the area.
  - Aquatic life, turtles and dolphins
  - Ensure that all land-based pollutants are collected and stored in safe place or led in to a pit , not allowing to go into aquatic environment;
  - Avoid construction works in the river during wet season, when dolphins forage in the area
  - Confirm that dredge silt booms /or bubble curtains are in place and operating during piling so that pile driving meets threshold limits for shock-wave impactson order to reduce impacts of sounds on dolphin and turtles.
  - Provide induction training to vessel opeartors on conservation of dolphin
  - Monitor dolphin foraging involving local conservation group o and/or relevant department f local university.
  - The slurry with bentonite from drilling point should carefully be collected and store it in safe and secured places for subsequent safe disposal;
  - Temporary barricade should be made around the land based construction
  - Create a barricade in the pond before earth filling of pond area and remove the aquatic animals, frogs, snakes , turtles, etc. from the pond area by netting,
  - Implement awareness program on the compliance to Fish Conservation ACT, particularly relating to not to harvest juvenile and gravid fish of major threatened species among local fishers.

- Ashugonj CT Site
  - Vegetation
  - The Contractor shall provide adequate knowledge to the workers regarding protection of flora and fauna and relevant government regulations and punishing for illegal poaching. The killing of animals discovered on site is considered poaching and is strictly forbidden – inductions for staff and workers must be carried out on the topic.
  - Develop a green area (garden) in waste spaces within terminal site premise
  - Undertake plantation of at least 570 trees (plant 3 trees for 1 tree cut) . within and around at the peripheral area of the project site,. Plantation should be done with indigenous species.
  - Strictly delimitate the extension of the area to be affected by the Project, before the construction works start, the contractor will proceed to mark the outer limit of the Project. A perimeter security fence at least 1.5m in height constructed from appropriate materials.
  - Terrestrial wfauna and wildlife
  - Check for and drive out the slow moving animals just before eearrth filling of the site.
  - Enhance local community awareness on conserving the wildlife in the area;
  - Aquatic life, urtles and dolphins
  - Ensure that all land-based pollutants are collected and stored in safe place or led in to a pit , not allowing to go into aquatic environment;
  - Avoid construction works in the river during wet season, when dolphins forage in the area
  - Confirm that dredge silt booms /or bubble curtains are in place and operating during piling so that pile driving meets threshold limits for shock-wave impacts
  - Temporary barricade should be made around the land based construction
  - The slurry with bentonite from drilling point should carefully be collected and store it in safe and secured places for subsequent safe disposal;
  - Implement awareness program on the compliance to Fish Conservation ACT, particularly relating to not to harvest juvenile and gravid fish of major threatened species among local fishers.
  - Collaborate with Department of Fisheries in collecting fisheries data on major fish abundance, particularly relating to major threatened species and review this data to assess the efficacy of mitigation measures.
  - Provide induction training to vessel opeartors on conservation of dolphin
  - Monitor dolphin foraging involving local conservation group o and/or relevant department of local university.

Social Environment

- RAP. The private land to be acquired must be paid fair compensation to the owner for the lost lands at market/ replacement value or provided with the replacement of land to the vicinity having same quality of land against the amount of land to be acquired or required for the project.

All the land acquisition process and compensation payments to be done pertinent to GOB and WB prevailing policies/guidelines

- Market value of the trees affected during implementation
- New plantations expecting to bring benefits in connection to natural environment
- In addition to aforesaid compensation, the RAPs may be providing employment in the project construction works
- Different income restoration program may be initiated especially for the affected people to improve their livelihood and living conditions
- Minimum residence facilities with other facilities including food arrangements and fair wages etc. to be provided for labor contractors
- Provisions of time to time mandatory training and awareness buildings for the workforce to as precautionary measures for anti-social activities those includes sexual harassment and gender-based violence, women trafficking communal diseases etc. are punishable offences

5.5.3. Operation phase key impacts

- Noise from river traffic increase, port operation, road traffic
- NOx emission associated with CO2 from fuel burning by vessels and cargo transports
- Spills and pollutants entering water system
- Spills and pollutants entering water system, consequently to sediment
- Spills and pollutants entering water system
- Pollutant emission to farms crops and soils nearby
- Increase in water navigation transit and pollution of water induce impacts on fish biodiversity
- Increase of solid waste if not managed can pollute soils and block drainage
- New cargo terminal displaces boat passenger, boat passengers may be impact due to cargo vessel traffic
- New terminals and vessel crew will create new employment
- New terminals may introduce commercial and industrial areas nearby
- New terminals and possible industries nearby will create new opportunities, thus income generating activities.
- Local traffic will be affected by trucks

5.5.4. Operation phase mitigation measures

- Air Quality & Noise

- Maintain all vehicles to keep them in good working order in accordance with manufactures maintenance procedures.
- Use the quietest available machinery and equipment, fit high efficiency mufflers to appropriate railway operation or, modify equipment to reduce noise, i.e., using noise control kits.
- Implementing tank and piping leak detection and repair programs
  - Water Quality b
- Use STP to treat wastewater so that water does not contaminate groundwater Table.

- Prepare and apply spill protocol
  - -Ground water
- Avoid installation of storm drainage catch basins that discharge directly into surface waters, using containment basins in areas with a high risk of accidental releases of oil or hazardous materials (e.g. fueling or fuel transfer locations), and oil / grit or oil / water separators in all runoff collection areas
- Oil/water separators and trapping catch basins should be maintained regularly to keep them operational. Recovered contaminated solids or liquids disposed of as hazardous materials
- Terminals should include secondary containment for above ground liquid storage tanks and tanker truck loading and unloading areas
  - Fish Ecology
- Implement stringent control over releasing used fuels, and greases from vessels
- Develop and implement a waste management program for collecting, storing and safe disposal of solid wastes
- Prepare and apply spill protocol
- Collaborate with Department of Fisheries in collecting fisheries data on major fish abundance, particularly relating to major threatened species and review this data to assess the efficacy of mitigation measures.
- At the cargo sites loading and unloading of hull materials should be carefully done so that hull materials are not released into the aquatic environment
  - · Gangethic Dolphin
- Orient the vessel operators on how to make careful sightings and avoid the foraging areas of dolphins

5.6. ENVIRONMENTAL BENEFITS AND ENHANCEMENTS

Some benefits and environmental enhancement that the project includes are the following:

- Solar panel

Installation of Solar panel on the roofs of administrative building and roof tops of the terminals might be carried out to reduce the carbon-footprint to a great extent.

- Water harvesting

To control excessive withdrawal of groundwater from the aquifers, a rainwater harvesting device can be installed on the roof of the administrative and passenger sheds. The water collected can be used for all non-potable purposes such as flushing toilets, urinals, washing outdoor surfaces of certain materials and gardening.

Figure 192. Solar Panel system installed on roof top can reduce carbon footprint

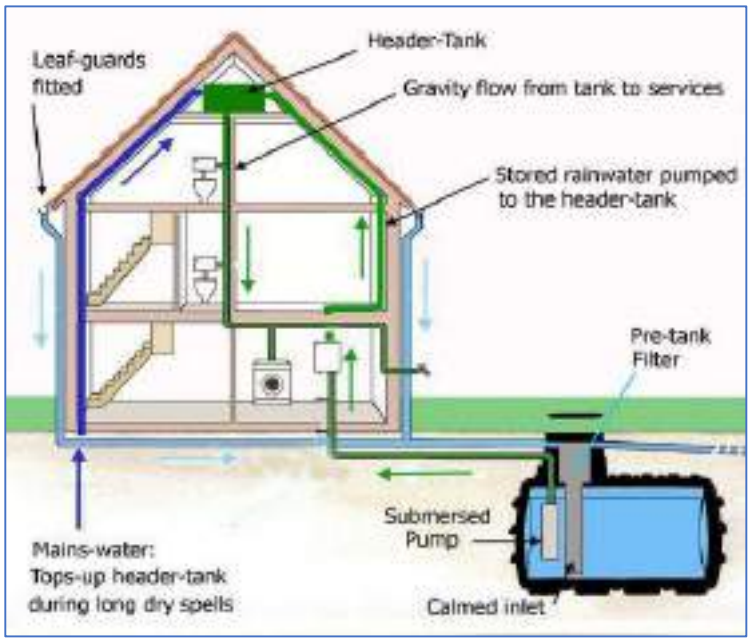


Figure 193. Prototype of Rainwater Harvester

6. CLIMATE CHANGE

6.1. CLIMATE CHANGE PROJECTIONS AND THEIR UTILITY FOR THE PROJECT

It is impossible to "predict" future climate change, especially at local scale, as this change is dependent on global greenhouse gas emissions trends that cannot be known with certainty. Additionally, even if there was certainty in the emissions trends, the science of climate change is limited in the certainty it can provide for different climate variables like temperature and rainfall. As such, it is important to perform project level risk assessments based on uncertainties for the climate outcomes and determine what is the likely range of possible outcomes for climate, and what this means for project investments.

6.1.1. Base climatology projection

The baseline climatology as portrayed in the earlier sections indicates that the rainfall has increased during the past decades. Several attempts were made to develop climate change scenarios for Bangladesh using General Circulation Models (GCM) in the early 1990s which provided more or less similar results [Ahmed et al., 1998, World Bank, 2000; Agarwal et al., 2003[26]]. More recent climate change scenarios have been generated based on a subset of climate models made available through IPCC, 2007, that best simulated the average rainfall during the main monsoon rainy season in Bangladesh (Tanner et al., 2007)[27]. Changes were analyzed based on two established scenarios of future greenhouse gas emissions: A2 (high emissions scenario) and B1 (low emissions scenario).

Table 130 below shows the climate change scenarios of Bangladesh for the future at 10 years interval reference to the year 2000 for temperature and rainfall based on Tanner et al. (2007) reference to A2 and B1 scenarios of the future GHG emission. The climate projections are derived from the GCM model results used for IPCC AR4 studies. A subset of 10 GCMs that best simulate the monsoon rainfall of Bangladesh was used by Tanner et al. (2007)

Table 131. New Scenarios of Temperature of Bangladesh for Future at 10-year interval / 2000 as baseline

GHG Scenario		2010	2020	2030	2040	2050	2060	2065
A2	Annual	0.49	0.95	1.42	1.89	2.35	2.82	3.05
	DJF	0.73	1.40	2.07	2.74	3.41	4.08	4.42
	JJA	0.58	1.08	1.50	1.84	2.10	2.28	2.34
B1	Annual	0.51	0.98	1.38	1.71	1.98	2.18	2.26
	DJF	0.92	1.66	2.23	2.64	2.89	2.98	3.00
	JJA	0.59	1.05	1.41	1.67	1.81	1.85	1.83

Source: Reconstructed from Tanner et al. 2007

26 Agarwala,S., T., Ahmed, A.U., Smith, J., Aalst, M.V., 2003: Development and climate change in Bangladesh: Focus on Coastal Flooding and the Sunderbans. Organization for Economic Co-operation and Development (OECD).

27 Tanner T.M., Hassan A, Islam KMN, Conway, D, Mechler R, Ahmed AU, and Alam, M, 2007. ORCHID: Piloting Climate Risk Screening in DFID Bangladesh. Detail Research Report. Institute of Development Studies, University of Sussex, UK.

Table 132. Scenarios of Future Rainfall (%) over the Study Area at 10-year Intervals with 2000 as the Base Year

GHG Scenario		2010	2020	2030	2040	2050	2060	2065
A2	Winter	3.54	6.87	9.87	12.53	14.86	16.86	17.74
	JJA	19.34	34.91	47.16	56.09	61.70	63.99	63.89
	Annual	4.63	9.05	13.47	17.89	22.32	26.74	28.95
B1	Winter	1.5	4.2	8.0	12.9	19.0	26.2	30.2
	JJA	29.2	47.2	52.0	43.6	22.0	-12.8	-35.2
	Annual	7.4	7.4	18.7	22.4	24.7	25.7	25.7

Source: Reconstructed from Tanner et al. 2007

6.1.2. Projection of sea level rise

For the Bangladesh delta it is necessary to take into account local geological factors such as land subsidence and deposition while assessing the net sea level rise. For the coastal area covering the study towns, the subsidence is around 3mm/year. The study of Khan and Islam (2008) depicted that the subsidence rate is close to the sedimentation rate, which is around 3 mm/year in central coastal zone. However, the sedimentation rate has drastically reduced due to the construction of embankments or polders along the channels. The authors (Khan and Islam.) expressed concern about poor sedimentation within the polders, leading to transgression. Though there is no clear mention of the deposition rate inside the polder in any study, we consider a deposition rate of 1 mm/year over the polderized areas. The sedimentation in the land areas outside polders are considered to be adjusted with subsidence.

From Table 132 below it is seen that the net sea level rise for the Bangladesh coast is 21 cm for 2030 and 39.4 cm in 2050 relative to the lands inside the polders. The sea level rise would reach up to 0.52 m by 2060.

Table 133. Bangladesh Sea Level Rise in 2010, 2030 and 2050, with 1990 as the Reference Year Considering IPCC Prediction with Uncertainties

Projection year	Sea level rise (cm) due to warming	Land Subsidence (cm)	Sediment Deposition (cm) in Side polders	Sediment Deposit inside outside polders	Net sea level rise (cm) relative to lands inside polder	Net sea level rise (cm) relative to lands outside polder
	A	B	C	D	A+B-C	A+B-D
2010	3.5	3	1	3	5.5	3.5
2020	8.5	6	2	6	12.5	8.5
2030	15	9	3	9	21	15
2040	21.5	12	4	12	27.5	21.5
2050	29.4	15	5	15	39.4	29.4
2060	39.6	18	6	18	51.6	39.6
2065	44.4	19.5	6.5	19.5	57.9	53.

Source: TA-8128 BAN: Preparing Coastal Towns Infrastructure Improvement Project – FR Vol. 3: Climate Change

Brown and Nichols (2015)[28] depicted that the evidence for recent changes may also be seen in relative sea-level trends (i.e. land and sea-level changes). Using data extracted from Holgate et al. (2013)[29] and the Permanent Service for Mean Sea Level (2014)[30],

Figure 190 illustrates that relative sea-level rise varied from 4 mm/yr (Hiron Point) to 19 mm/yr (Khepupara). Church et al. (2013)[31] report global mean sea-level trends as 1.7±0.2mm/yr (1901–2010). However, in situ measurements and shorter-term satellite studies in the Indian Ocean indicate sea-level rise is greater than the global mean (Han et al., 2010[32]; Unnikrishnan and Shankar, 2007[33]).

6.2. INCREASE OF STORM

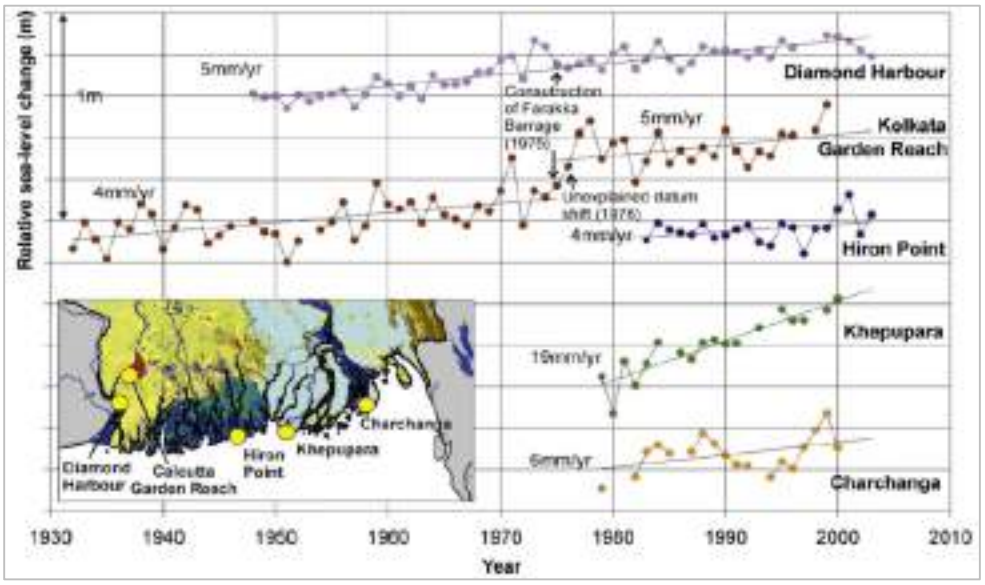


Figure 194. Relative sea-level rise obtained via tide gauge records from Holgate et al. (2013) and Permanent Service for Mean Sea Level (2014).

[28] Brown, S. and Nicholls, RJ (2015) Subsidence and human influences in mega deltas: The case of the Ganges–Brahmaputra–Meghna. Science of the Total Environment 527–528 (2015) 362–374

[29] Holgate, S.J., Matthews, A., Woodworth, P.L., Rickards, L., Tamisiea, M.A., Bradshaw, E., Foden, P.R., Gordon, K.M., Jevrejeva, S., Pugh, J., 2013. New data systems and products at the Permanent Service for Mean Sea Level. J. Coast. Res. 29 (3), 493–504. http://dx. doi.org/10.2112/JCOASTRES-D-12-00175.1.

[30] Permanent Service for Mean Sea Level, 2014. Tide Gauge Data. http://www.psmsl.org/ data/obtaining (Accessed February 2014).

[31] Church, J.A., Clark, P.U., Cazenave, A., Gregory, J.M., Jevrejeva, S., Levermann, A., Merrifield, M.A., Milne, G.A., Nerem, R.S., Nunn, P.D., Payne, A.J., Pfeffer, W.T., Stammer, D., Unnikrishnan, A.S., 2013. Sea level change. In: Stocker, T.F., Qin, D., Plattner, G.-K., Tignor,M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., Midgley, P.M. (Eds.), Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

[32] Han, W., Meehl, G.A., Rajagopalan, B., Fasullo, J.T., Hu, A., Lin, J., Large, E.G., Wang, J.-W., Quan, X.-W., Trenary, L.T., Wallcraft, A., Shinoda, T., Yeager, S., 2010. Patterns of Indian Ocean sea-level change in a warming climate. Nat. Geosci. 3, 546–550. http://dx.doi.org/10.1038/ngeo901.

[33] Unnikrishnan, A.S., Shankar, D., 2007. Are sea-level-rise trends along the coasts of the north Indian Ocean consistent with global estimates? Glob. Planet. Chang. 57 (3–4), 301–307. http://dx.doi.org/10.1016/j.gloplacha.2006.11.029.

6.2.1. Surge height due to sea level rise

Because of the sea level rise the height of the storm surge as well as the tidal level will increase. Here, the future sea level rise for different time levels has been added to the storm surge height related to the intensity is displayed in the Table 133. The table shows that the storm surge may reach up to 9.4 m in the year 2050. However, if this event occurs at high tide the storm surge height may rise by another 2 meters or more depending on the track of the cyclone. Figure 194 shows the risk areas for inundation storms surges by 2050 (Dasgupta, 2011)[34].

Table 134. The Projection of Storm Surges for Future Sea Level rise at Different Storm intensity

	Projection year – Storm surge height (m)							
Vmax (km/year)	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***	***2065***
85	*1.5*	*1.6*	*1.6*	*1.7*	*1.8*	*1.9*	*2.o*	*2.1*
115	*2.5*	*2.6*	*2.6*	*2.7*	*2.8*	*2.9*	*3.o*	*3.1*
135	*3*	*3.1*	*3.1*	*3.2*	*3.3*	*3.4*	*3.5*	*3.6*
165	*3.5*	*3.6*	*3.6*	*3.7*	*3.8*	*3.9*	*4.o*	*4.1*
195	*4.8*	*4.9*	*4.9*	*5.o*	*5.1*	*5.2*	*5.3*	*5.4*
235	*6.5*	*6.6*	*6.6*	*6.7*	*6.8*	*6.9*	*7.o*	*7.1*
26o	*7.8*	*7.9*	*7.9*	*8.o*	*8.1*	*8.2*	*8.3*	*8.4*
28o	*9.o*	*9.1*	*9.1*	*9.2*	*9.3*	*9.4*	*9.5*	*9.6*

Source: Dasgupta, 2011
(Source: Dasgupta 2011)

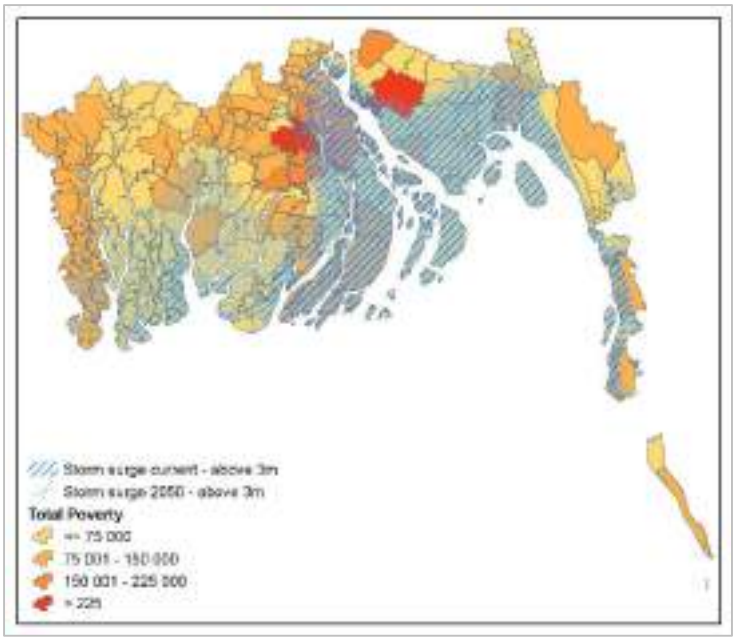


Figure 195. High risk area of storm surge under changing climate by 2050

[34] Dasgupta S. et al. 2011: Cyclones in a Changing Climate: The Case of Bangladesh

6.2.1.1. Projection of tropical cyclones.

There is no GCM-based prediction yet on the future scenario of tropical cyclones for the Bay of Bengal. It is pertinent to consider the observational results which depict that the frequency of cyclonic storms with speeds between 62-87 km/hour forming over the Bay of Bengal are decreasing, while that of severe cyclonic storms with a wind speed higher than 87 km/hr are increasing (Singhvi et al., 2010).

Quadir and Iqbal (2008) have shown that the return period of very severe cyclones with intensity of super cyclonic storms has increased over the Bay of Bengal. The frequency of severe cyclonic storms with hurricane intensity is on the rise, though the frequency of weak cyclonic storms has been found to decrease during the recent decades. Emanuel (2005) has suggested that 1º C rise of sea surface temperature (SST) will cause the increase of wind speed of a cyclone by 4%, 2º C by 10% and 4º C by 22%. The rising trend of SST of the Bay of Bengal thus depicts that in the future a larger number of tropical cyclones will attain higher wind speeds. An analysis of annual mean SST of the Bay of Bengal shows that the SST has an increasing trend of 0.012[1] C/year (Figure195 below).

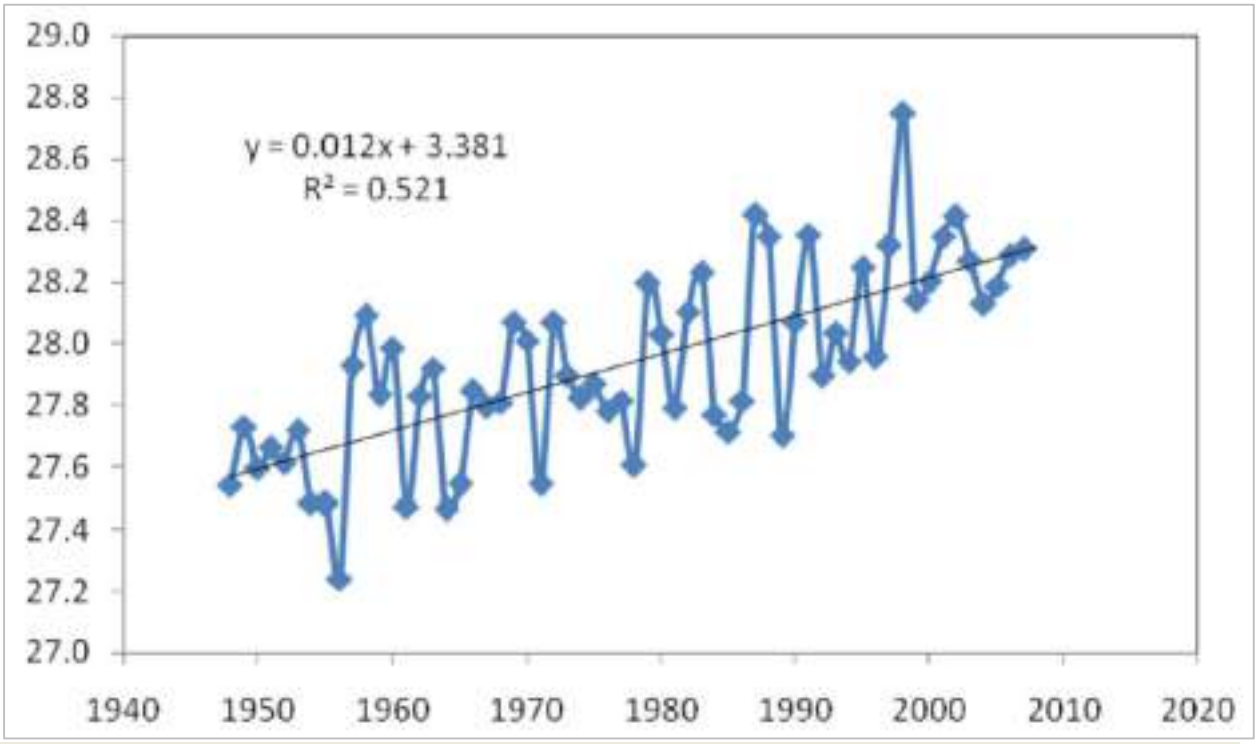


Figure 196. Surface Sea Temperature anomaly over Bay of Bengal from 1942 – 2008 (Source: NOAA)

The probability/year of different categories of tropical cyclones was extrapolated using the future scenarios of tropical cyclone intensity of different categories relative to the statistics of the decade 1991-2000, which was a relatively normal year in terms of the distribution of tropical cyclone intensity. The results of the future cyclone probability estimates are given in Table 134 below.

The results show that the transition occurs from low intensity cyclones to high intensity ones. The probability of category- 4 and 5 cyclones are seen to be high in 2050 when the probability of category-0 cyclone is seen to come down to zero.

Table 135. Projection of Annual Probability of Tropical Cyclone for the Future for Different Intensity Levels for Specified Decades

Categories (wind speed)	2011-2020	2021-2030	2031-2040 2031-2040	2041-2050	2051-2060
Cat-0 (62-117 km/hr)	*0.5*	*0.5*	*0.3*	*0.1*	*0*
Cat-1 (118-153 km/hr)	*0.1*	*0.1*	*0.2*	*0.4*	*0.5*
cat-2 (154-177 km/hr)	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*
Cat-3 (178-207 km/hr)	*0.1*	*0.1*	*0.2*	*0.2*	*0.1*
Cat-4 (208-251 km/hr)	*0.3*	*0.4*	*0.3*	*0.2*	*0.3*
Cat-5 (>250 km/hr)	*0.1*	*0.1*	*0.2*	*0.3*	*0.3*

Source: TA-8128 BAN: Preparing Coastal Towns Infrastructure Improvement Project – FR Vol. 3: Climate Change

6.3. IMPLICATIONS OF CLIMATE CHANGE ON THE PROJECT

6.3.1. Trends of temperature and rainfall

The country average minimum and maximum temperature shows that the minimum temperature increases at the rate of 0.0094º C/year and the maximum temperature increases at the rate of 0.0071º C/year (Singhvi et al., 2011). However, the investigations for individual seasons show that the changes vary over the seasons. The trend for the winter temperature is higher for the minimum temperature. The trend of maximum temperature is positive for monsoon and post-monsoon seasons and negative for winter. The rainfall trends exhibit an increase for all seasons. The percentage trend is higher for winter, pre-monsoon and post-monsoon seasons than for the monsoon season.

6.3.1.1. Trends in Dhaka Station

- General trends

Trends in annual and seasonal temperatures at Dhaka are given in Table 132 below. The numbers in the Table show changes of temperature in ºC/year. Bold numbers in the Table denote change at the 95% level of confidence and italicized-bold numbers denote change at the 99% level of confidence. Average annual maximum and minimum temperature of Dhaka station is shown in Figure 196 .

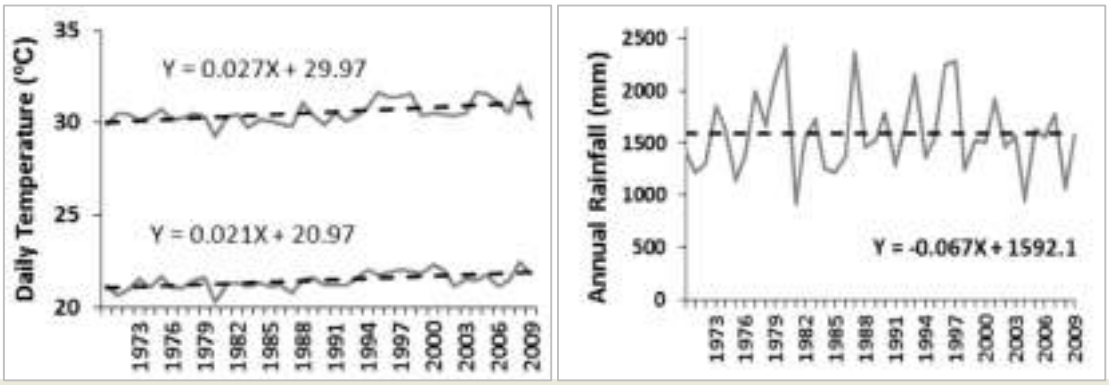


Figure 197. Annual trend of temperature (left) and rainfall (right) at Dhaka station (Source: BMD)

Figure shows that although average annual maximum and minimum temperature had fluctuation during period in Dhaka station, both maximum and minimum temperature increased during period. Trend in average annual maximum and minimum temperature were positive and approximately were 2.7 and 2.1 ^{o}C/century, respectively. Changes in average annual maximum temperature was significant at 99% confidence level, but for average minimum temperature was not significant. Shahid[35] showed that global climate change had an effect on temperature and causing it to rise. Moreover, Table below shows significant increase in daily average minimum temperature, but no change in daily average maximum temperature in Dhaka. Minimum temperature increased more than maximum temperature in Dhaka. Seasonal analysis of temperature trends shows a significant increase of minimum temperature at Dhaka for all seasons.

Maximum temperatures in monsoon and post-monsoon seasons also increased significantly in Dhaka during the study period. Analysis of the changes of annual diurnal temperature range (DTR) shows (Table below) decrease of DTR in Dhaka.

The decrease of DTR at Dhaka is due to the increase of minimum temperature, but no significant change in maximum temperature. It indicates that urban heat island effect due to urbanization has caused an increase in night temperature and decrease in DTR of Dhaka. Seasonal analysis of DTR shows significant increase of monsoon DTR and decrease of winter DTR in Dhaka. Average annual rainfall in Dhaka station is shown in previous Figure. Following figure shows that average rainfall decreases during period time. The trend average rainfall was negative, -0.066 mm/year. Although the trend of average annual rainfall is negative, the decrease of rainfall is not significant.

Seasonal analysis of rainfall trends at Dhaka also showed no significant change in seasonal rainfall at Dhaka. Therefore, it can be remarked that annual and seasonal rainfall at Dhaka city has not changed significantly in the last forty years.

Table 136. Trend of temperature and rainfall at Dhaka station (1958-2012) Climate related extremes

Parameter	Season		Change (per year)
Temperature (in °C)	Winter	Min	***0.055***
		Max	0.002
	Pre-monsoon	Min	***0.022***
		Max	0.009
	Monsoon	Min	***0.009***
		Max	***0.032***
	Post Monsoon	Min	***0.032***
		Max	***0.035***
	Annual	Min	***0.022***
		Max	0.007
Diurnal Temperature Range (in °C)	Winter		***-0.058***
	Pre-monsoon		-0.017
	Monsoon		***0.024***
	Post-Monsoon		0.003
	Annual		***-0.009***
Rainfall (mm)	Winter		0.18
	Pre-Monsoon		-0.32
	Monsoon		-0.93
	Post-Monsoon		0.43
	Annual		-0.81

* Bold numbers denote change at 95% level of confidence; Bold and Italic numbers denote change at 99% level of confidence.

Source: Shourav et al. 2016

[35] Shahid, S. 2010. Recent Trends In The Climate Of Bangladesh. Climate Research. 42(3): 185-193.

Results of a trend analysis of temperature and rainfall related extreme events in Dhaka are presented in Table 136. Numbers in the Table represent changes per decade. Results show that the number of hot days (Maximum Temperature > 32°C) and hot nights (Minimum Temperature > 25°C) have increased in Dhaka. It indicates that an increase in daily minimum and maximum temperatures have changed temperature-related extreme events in Dhaka. Trends in rainfall related extreme events show no changes in any of the extreme rainfall indices in Dhaka.

Table 137. Trends in temperature and rainfall related extremes at Dhaka city over the time period 1958-2012

Index	Change
Max Temp > 32°C	***1.64***
Max Temp >25°C	***0.63***
Days with 95 percentile rainfall	0.00
Days with rainfall > 20 mm	0.00
Continuous dry days	0.16
Continuously wet days	-0.04

* Bold numbers denote change at 95% level of confidence; Bold and Italic numbers denote change at 99% level of confidence.

***Source: Sourav et al. 2016*

6.3.1.2. Trends in Barishal Station

- General trend

Maximum Temperature: From the Table below, it is seen that the max. temperature in Barishal usually reaches its peak in April and its lowest in January; the average max. temperature is also peak in April and its lowest in January. The variability of average temperature in February and April is though relatively large. Some descriptive temperature statistics are listed in Table 137.

Table 138. Descriptive statistics monthly average maximum temperature from 1949 to 2017 (°C)

Max. Temp.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Maximum	31.7	35.6	38.4	43.6	38.6	39.6	35.5	36.7	37.7	35.6	34	31.7
Minimum	26.7	29.2	33.4	32.5	33.5	32.2	31.9	31.4	32.2	32.3	29.4	26.6
Mean	28.98	32.14	35.69	36.36	35.95	35.23	33.75	34.15	34.42	34.06	32.09	29.19
SD*	1.065	1.321	1.075	1.642	0.991	1.368	0.890	1.082	0.929	0.769	1.124	1.049
CV**	3.676	4.111	3.012	4.516	2.758	3.884	2.638	3.168	2.698	2.259	3.501	3.595

**SD = Standard deviation*

***CV = Coefficient of variation Source: BMD*

Minimum Temperature: From the Table 138, it is seen that the min. temperature usually reaches its peak in August and its lowest in January; the average min. temperature is also peak in August and its bottom in January. The variability of average min. temperature in December and January is however relatively large.

Table 139. Descriptive statistics monthly average minimum temperature from 1949 to 2017 (°C)

Min. Temp.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Maximum	12.6	14.4	20	23.5	26	26.2	25.4	25.7	25.6	23.5	18.7	15.6
Minimum	6.4	7.2	12	15.8	17	19.2	17.4	21.6	21.5	12.7	11.9	7.5
Mean	9.388	11.081	15.558	19.734	20.931	23.022	24.036	24.18	23.760	20.620	15.427	11.052
SD	1.606	1.685	1.889	1.445	1.343	1.138	1.227	0.888	0.929	1.661	1.520	1.587
CV	17.117	15.203	12.142	7.322	6.418	4.942	5.104	3.672	3.911	8.056	9.854	14.359

**SD = Standard deviation*
***CV = Coefficient of variation*
Source: BMD

Rainfall: Barishal receives bulk of the annual rainfall during June-August (Table 139). Average annual rainfall at Barishal Station has been found to be 2111mm.

Table 140. Descriptive statistics for monthly average Rainfall from 1949 to 2017 (mm)

Rainfall	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Maximum	148	98	273	412	701	1025	785	823	1067	497	274	197
Minimum	0	0	0	0	22	139	185	138	90	6	0	0
Mean	8.89	19.657	46.01	96.93	208.17	408.64	424.76	356.61	301.50	189.14	42.83	8.77
SD	23.12	24.26	62.419	85.60	123.27	175.81	141.94	142.23	160.34	120.74	63.42	26.75
CV	259.93	123.44	135.64	88.30	59.21	43.02	33.41	39.88	53.18	63.83	148.05	304.85

Source: BMD

Trend analysis of temperature at Barishal station suggests that the annual temperature is slightly increasing (Figure 197) although the gap between maximum and minimum temperature is increasing rapidly, ~0.2^{O}C per decade (see Table 40).

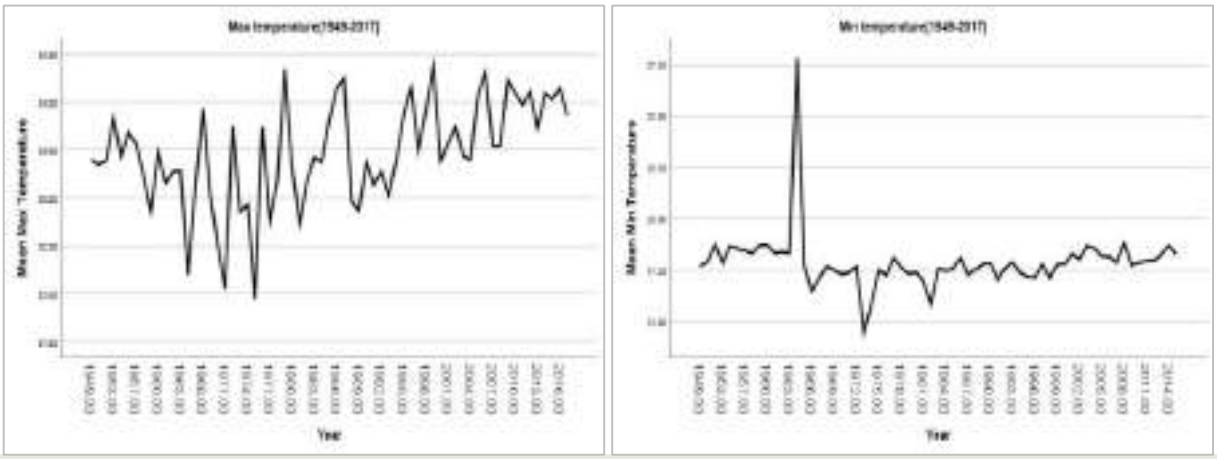


Figure 198. Trend of maximum and minimum temperature (1949-2017) at Barishal station

Table 141. Current Trends of Minimum and Maximum Temperature (0C/decade)

Winter			Pre-monsoon		Monsoon		Post-monsoon		Annual	
Tmin	Tmax		Tmin	Tmax	Tmin	Tmax	Tmin	Tmax	Tmin	Tmax
-0.26	0.03		-0.12	-0.07	-0.08	0.11	-0.09	0.26	-0.13	0.07

Source: Calculated from BMD data

Trend analysis of rainfall over Barishal station over the period of 1949-2017 suggests that winter and pre-monsoon rainfall is increasing at a rate of 4.4 mm/decade and 20.3mm/decade while monsoon and post-monsoon rainfall is decreasing at a rate of 10.5mm/decade and 5.1mm/decade, respectively. However, no significant annual trend has been found (Figure 198).

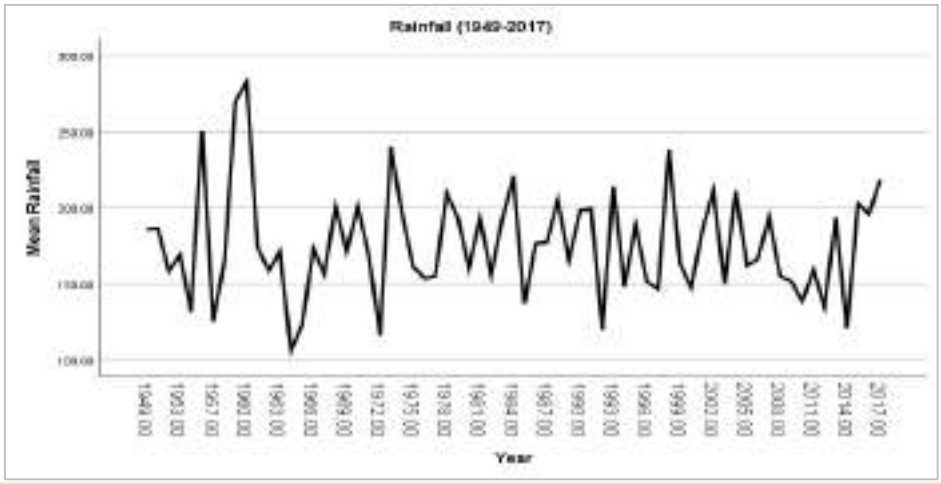


Figure 199. Annual rainfall record for Barishal Station over the period of 1949-2017 (Source: BMD)

6.3.2. Extreme climatic events

The analysis of the observed daily minimum temperature at Dhaka and Barishal station at the 10th percentile show that the number of cold nights has decreased and the 90th percentile shows that the number of warm nights has increased. The observed rainfall analysis indicates that the frequency of extreme rainfall days with daily rainfall more than 10 mm, 20 mm and 50 mm are all increasing. It also shows that rainfall above 95th and 99th percentile exhibits increasing trends.

6.3.3. Sea level rise (SLR)

Sea level rise (SLR) is a secondary effect of global warming caused by the volumetric expansion of sea water and the addition of liquid water to the sea due to the melting of the polar and mountain glaciers. For low-lying countries like Bangladesh, the coastal zones are highly vulnerable to sea level rise.

Studies by Khan et al (1999)[36] and SMRC (2001)[37] have reported increasing trends in SLR using tidal observation data of 1978-1998 (Table 141).

36 Khan, T.M.A, Quadir, D.A., Akter, F., and Sarker, M. A., 1999. Sea Level Changes and Coastal Erosion Problems along Bangladesh Coast. Journal of Remote Sensing and Environment, v-3; 87-103.

37 SMRC, 2003. The vulnerability assessment of the SAARC coastal region due to sea level rise: Bangladesh Case, SMRC-No 3, SMRC publication, Dhaka, Bangladesh.

Table 142. Observed Sea Level Rise during the Period 1978-1998

Station	Latitude	Longitude	Sea Level Rise (mm/year)
Hiron Point	21°48' N	89°28'E	4
Char Changa	22°08' N	91°06'E	6
Cox's Bazar	21°26' N	91°59'E	7.8

Source: SMRC 2001

The implications of climate change on the projects are given in the following Table.142

Table 143. Climate Change Impacts and Adaptation Measures for Project corridor

Climate element	Status of change	Impacts	Recommended Actions
Temperature	Current change: 0.40°C during last 50 years; Future: 1.38-1.42°C by 2030 and 1.98-2.35° C by 2050	Infrastructure damaged by long exposure to heat, new concrete structures weakened due to poor curing.	Materials and design to be selected suitable for resilience of high temperature. Placing and curing of concrete requires more water.
		Surface water is rapidly evaporated affecting household water supplies and garden irrigation. Due to heat, overall per capita water needs will increase. Agriculture and fisheries suffer due to rise of temperature and greater salinity.	Water supply projects should include future increased demands in addition to that due to increase of population and future development. Rainwater harvesting needs to be encouraged and suitable design may be prescribed for this purpose including making arrangements for rainwater preservation and use for domestic application. Reserve ponds may be dug to preserve rainwater for community use. Additional water storage may be required.
Temperature		High temperature affects health due to heat stroke, dehydration and facilitates diseases like diarrhea, asthma and heart and kidney failure.	Building design criteria should consider suitable factors to keep interiors cooler. Green coverage should be developed over suitable areas of the towns, so that there is a shielding against the incoming solar radiations which may to some extent provide comfort the people from heat.

Climate element	Status of change	Impacts	Recommended Actions
Rainfall	Current trend: 25 cm in last 50 years; Wetter monsoon rainfall with future scenarios: Increase of: 13.5-18.7% in 2030 22.3-24.7% in 2050, 27% in 2060	Floods impacting infrastructures	Increased and more intensive rainfall will cause more floods inundating roads and yards, marketplaces and other important areas. It is recommended that the infrastructure is built so that the floods do not damage them, and the water supply plants, reservoirs, pipelines are not affected.
		Reduced drainage channel size causes flooding	Rehabilitating and enlarging existing drains and large capacity new drains will be required to discharge excess storm water. As the regions' topographies, sea level rise and organizational capacities will not allow steeper drains, with complex pumping or water management arrangements larger cross sections, channel lining and detention will be required to the maximum extent possible. Land availability for larger drains and detention capacity are also significant constraints. Drains are to be kept free of waste, siltation and encroachments. Arrangements and capacity for short-term/emergency pumping should be considered when and where appropriate.
Rainfall		Roads damaged due to more flooding and overtopping.	Ensure road is cambered as designed. Use concrete surfaced roads. Better compaction and use of stronger materials for road bases.

7. CONSULTATION WITH STAKEHOLDERS AND PUBLIC CONSULTATION

7.1. GENERAL

Stakeholders are engaged in the project planning process through consultation and disclosure meetings at the community level. All of the project information including background, objective, design, land acquisition requirement, project interventions, timeline, executing agency and their responsibility, role of the affected people and other stakeholders, compensation assessment and payment procedures, relocation requirements, etc. are disseminated to the community level stakeholder at the initial stage of the project planning to make them aware of the project.

The affected people have been individually consulted during conducting census and socioeconomic survey and inventory of losses survey in October 2019 to February 2020. They were again consulted in focus group discussion to ensure their participation in the project planning particularly in social, land acquisition, resettlement and environmental issues.

7.2. STAKEHOLDER ENGAGEMENT DURING IMPLEMENTATION STAGE

Stakeholders will be engaged in the project implementation activities through various committees including grievance redress committee (GRC) and physical relocation assistance committee (PRAC).

Affected people, local government representatives, teacher, influential personalities, etc. will be directly involved in the project through the committees. People will produce grievances on any social and environmental issues to the GRC where local government representative will play a role in resolving the grievance as a member of the GRC. Stakeholders from the local people as nominated by the Mayor of Municipality or Chairman of Union Parishad will play vital role as a member of PRAC in case of physical relocation of the displaced people. Apart from this, people will take part in the valuation process of affected properties. The property assessment and valuation committee (PAVC) will consult five categories of people such as potential seller, potential buyer, religious leader, teacher and deed writer to ascertain current market price of the affected land.

The local government representative will also be involved in compensation payment process to recognize the entitled person as citizen of his/her Union/Municipality. Such involvement will be required during payment of cash compensation under law (CCL) by DC offices and additional compensation/resettlement benefit by the BIWTA. Local people can also put comments/observation/complaints on the quality of civil work as responsible members of the society.

7.2.1. Property Assessment and Valuation Committee

Deputy Commissioners (DC) and BIWTA will conduct joint on-site verification of affected physical properties on private land proposed for acquisition at Ashuganj site for the project. DC office Brahmanbaria will also assess the market price of the affected properties on the proposed land for acquisition with data and assistance from Sub-Registry offices for land, Public Works Department (PWD) for structure, Department of Forest (DoF) for trees, and Agriculture Extension and Agriculture Marketing departments for crops.

The DCs will not compensate the households, shops or any other entities affected on GOB land or having no legal documents/title to the assets affected for project purposes. However, as per World Bank OP 4.12 on involuntary resettlement, the authorized and unauthorized occupants on public land, tenants, wage laborers with no legal papers will also be entitled for compensation and assistance. These non-titled affected persons and their physical and economic losses will be assessed and replacement cost of affected

physical assets and income will be determined by a Property Assessment and Valuation Committee (PAVC) established for each terminal (site) under the project. The PAVC will be a 5-member committee at each Terminal. The members of PAVC will be nominated by the Project Director, BRWTP as per notification (Paripatro) to be issued by the Ministry of Shipping.

Table 144. Membership of PAVC

Executive Engineer, BIWTA	Convener
Traffic Inspector, BIWTA	Member
Representative of concerned DC office	Member
Union Parishad Chairman/Mayor of Municipality (concern Union/Municipality)	Member
Field Coordinator of the RAP Implementing /NGO	Member-Secretary

The PAVC will verify and cross check the field book of the joint verification survey (JVS) conducted jointly by BIWTA and the Deputy Commissioners for the land owners. The PAVC will also conduct joint verification of all affected properties on the GOB land (within the project foot print). They will review and certify the census of affected households (titled and non-titled) and assets by the BIWTA conducted through INGO. If there is major variation between Census and JVS data (more than 10%) in assessing affected properties, PAVC will re-visit and finalize the category and quantity of losses. Replacement cost of the affected physical property will also be determined by the PAVC based on current market price. The PAVC will design and conduct a property valuation survey (PVS) through personal contact with various cross sections of the people in the project sites. They will also consult secondary data to recommend replacement cost of land and structures and market price of trees as well as amount of loss of income at current market price.

7.2.2. Grievance Redress Committee

The proposed GRM will be supported by establishment of Grievance Redress Committees which are expected to be effective in resolving grievances related to compensation and relocation aspects. If aggrieved, it is expected that affected people will first approach the local grievance mechanism before taking the issue to another forum. All affected persons will have full and free access to GRCs.

The Grievance Redress Committee will be established at: site level, port level and project level. to give room for grievances to be fairly reviewed and resolved. Site level and project level GRCs will be established through office order of BIWTA and port level GRC will be established through gazette notification from the ministry of shipping (MOS). The GRM will also be available online so that grievances can be submitted without the need for physical interaction, especially during the time of COVID-19 crisis.

The PAPs can also call upon the support of the implementing NGO (INGO) engaged to implement the RAP to assist them in presenting their grievances or queries to the GRC. Other than disputes relating to ownership right under the court of law, the GRC will review grievances involving all resettlement assistance, relocation and other support.

Structure of the GRM

A three-tier bottom-up Grievance Redress Committee (GRC) system will be established in this project. First, there will be GRC at the site level; second, GRC at the port level; and third, GRC at the project level to give room for grievances to be received and fairly reviewed. The GRCs at all three tiers will be responsible to deal with Phase-1 and Phase-2 GRMs. At each level, the GRC will be composed of 3-5 members, consisting of the followings

A. Structure of the sitelevel GRC

A three-tier bottom-up Grievance Redress Committee (GRC) system will be established in this project. First, there will be GRC at the Site level; second, GRC at the port level; and third, GRC at the project level to give room for grievances to be received and fairly reviewed. The Site level, Port level and Project level GRCs will be established through office order from the BIWTA. At each level, the GRC will be composed of 3-5 members, consisting of the followings:

Table 145. Structure of the Site Level GRC

SL No.	Designation	Representative	Number (in person)	Remarks
01	Convener	BIWTA representative (Not below the rank of Assistant Director/Assistant Engineer or equivalent)	1	Total number of members=5
02	Member	Representative, local government Union Council/Paurashava/City Corporation)	1	
03	Member	2 representatives of PAPs (at least 1 being a woman)	2	
04	Member-Secretary	Representative, Safeguards Implementation NGO	1	

B. Structure of the Port Level GRC

A five-member port level GRC has been proposed to review grievances to be referred by site/ level GRC. This GRC will be formed by BIWTA through Office Order. The members of port level GRC are as under-

Table 146. Structure of the Port Level GRC

SL No.	Designation	Representative	Number (in person)	Remarks
01	Convener	BIWTA representative (Not below the rank of Executive Engineer or equivalent)	1	Total number of members=5
02	Member	Representative from local government (Union Council/Paurashava/City Corporation)	1	
03	Member	BIWTA representative (Not below the rank of Assistant Director/Assistant Engineer or equivalent)	1	
04	Member	Representative from Civil Society	1	
05	Member-Secretary	Representative, Safeguards Implementation NGO	1	

C. Structure of the Project (PIU) Level GRC

A three-member GRC has been proposed in the Project level for review and finalization of decision of the grievances to be referred from port level GRC. This committee will be formed by office Order of the BIWTA.: Structure of the Project (PIU) Level GRC

SL No.	Designation	Representative	Number (in person)	Remarks
01	Convener	Deputy Project Director, BRWTP-1	1	Total number of members=3
02	Member	Head of BIWTA E&S Cell, BRWTP-1, PIU	1	
03	Member-Secretary	Communications/GRM Expert, BRWTP-1 Project, PIU	1	

7.3. PHASE TWO OF GRM

The second phase GRM will be funcitional during construction phase of the project and operationalized simultaneously with the First phase GRM. The Second phase GRM will deal with the social and environmental issues, procurement, quality of work, gender-based violence, etc. Such grievances can be produced before the GRC by individual or group of people anominous or un-anonimous. Affected people, local community, beneficiary groups, etc. can submit their complaints/grievance/observation/ recommendation to the grievance redress committee of the second phase GRM. Grievance Redress Committees (GRCs) of the first phase GRM will act as the GRC of the second phase GRM. Only Gender-based violence issues will be monitored by the Project level GRC. The GBV related grievances will be dealt with by the Contractor's GRM and directly report to PIU and therefore, site level and Port level GRM will not deal with it.

Social NGO and BRWTP-1 field level officials will explain the project interventions including timeline, quality assurance mechanism, etc. to the aggrieved people. If, he/she is not satisfied, he/she can submit their complaints through letter, email and web-application to the site level GRC. The contractor will display detailed Project information in the open place at the site.

The second phase GRM will be functional as under-

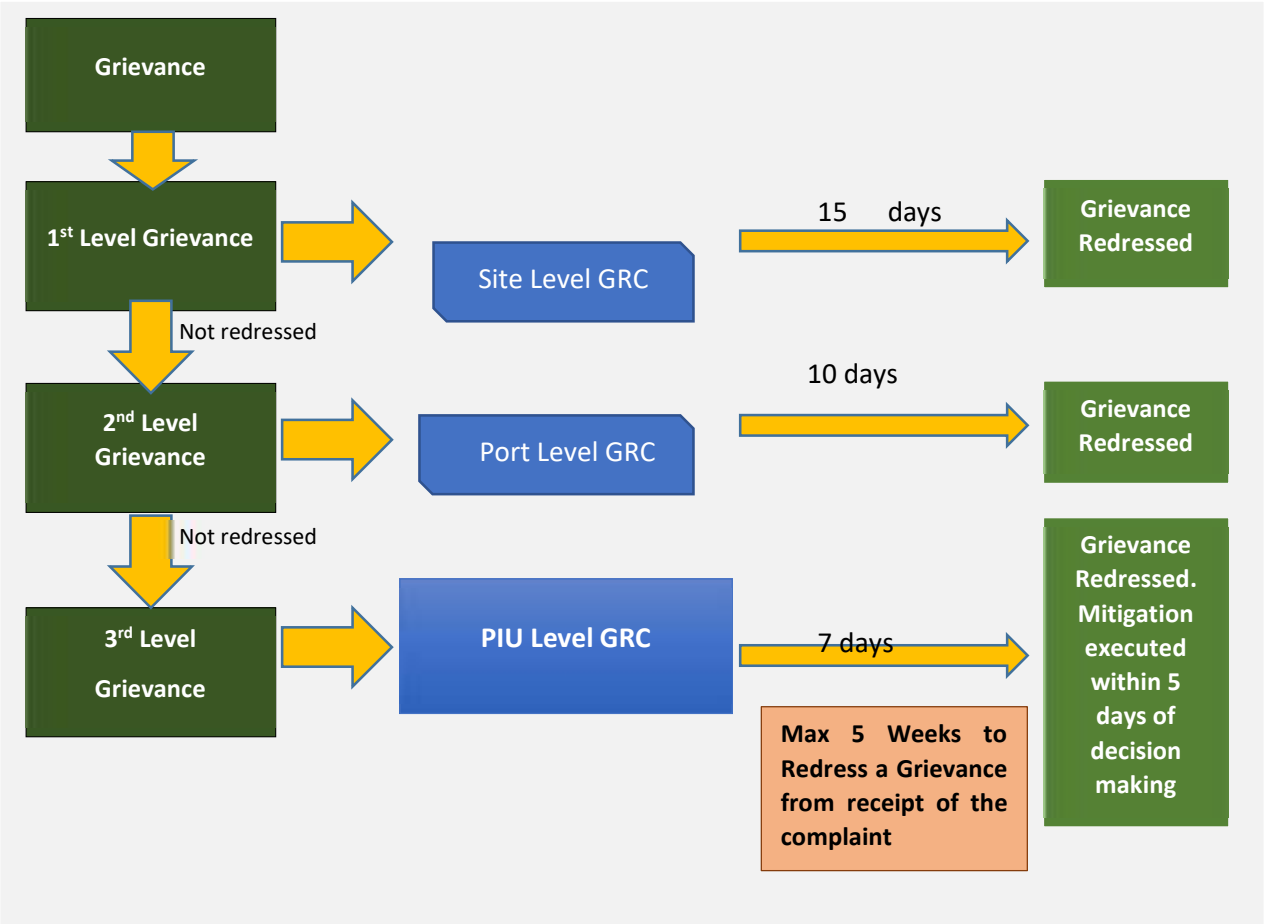


Figure 200. GRM for Phase 2

7.3.1. Griievance Mechanism for the Gender-based Violence

In case of minor GBV (eve teasing, bad touching, etc.) the complaints can be resolved under the Contractor's GRM but in case of major GBV (Rape, Acid throw, etc.) the issue will be brought to OCC/Police Station. A Service Provider (Community Based Organization) will be recruited by the PIU under a particular TOR to facilitate the GBV victim. In case of both minor and major GBV, the Service Provider will provide support to Victim to get justice (compensation, treatment, legal support, etc.) as per laws. The PIU will assign a grievance focal person (Female) at PIU level with whom the victim can communicate for further advices.

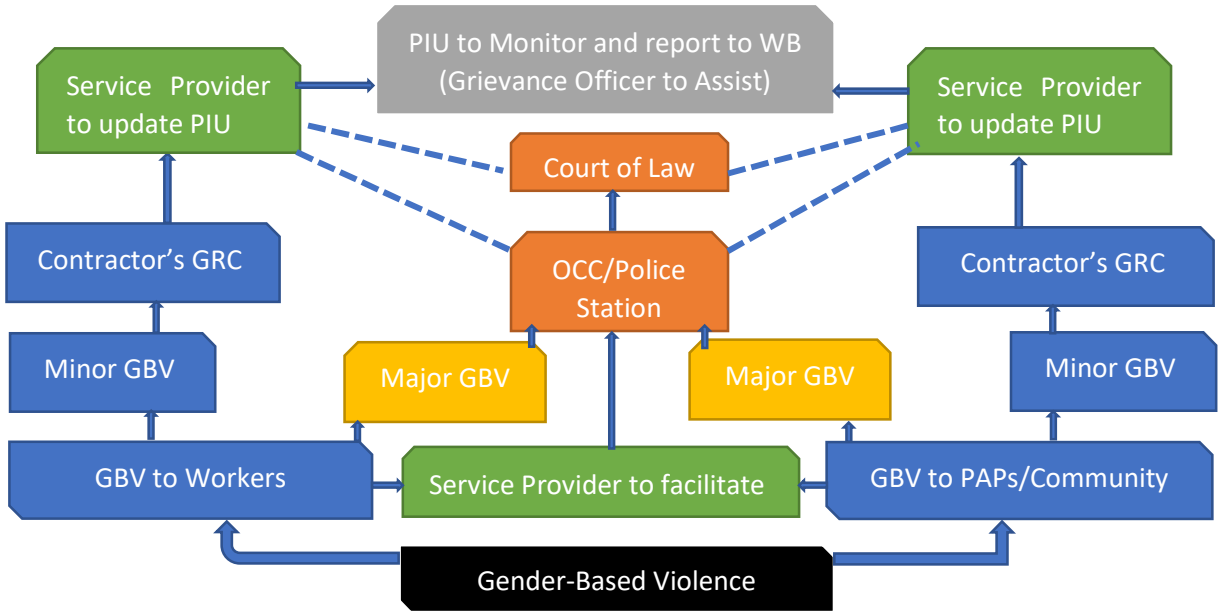


Figure 201. Figure 2GRM for Gender-Based Violence

7.3.2. Physical Relocation Assistance Committee (PRAC)

A Physical Relocation Assistance Committee (PRAC) will be formed for each terminal with elected representatives from concerned Union Parishad/Municipality, representatives from the affected persons, BIWTA local officials and women groups. The PRAC will be headed by the Head of Safeguard Team, BRWTP Head Office and authorized to undertake land search and assist the affected squatters in relocation and resettling on a more permanent site. The PRAC will look into BIWTA's own resources in case of failure in finding out suitable alternative lands for relocation of the vulnerable affected households, owners of affected businesses and other entities including squatters.

Table 147. Membership of PRAC

Cell Head of PIU's Safeguard Cell, BRWTP-1 Project (BIWTA)	Convener
Local UP Member/Ward Councillor (nominated by concerned UP Chairman or Municipal/City Mayor)	Member
Assistant Engineer, BRWTP-1 (BIWTA)	Member
Representative from displaced households/persons	Member
Representative of the RAP Implementing NGO	Member-Secretary

7.4. STAKEHOLDER CONSULTATION

ESIA Stakeholders consultation meetings were held at the proposed 6 terminals (Shasanghat, Pangaon, Narayanganj, Ashuganj, Barishal and Chandpur) with the potentially affected people, vessel owners, laborers, BIWTA local officials and passengers. Meetings were held in easily accessible places with prior notice given to the people. ESIA Social Development & Resettlement Specialist, Ecologist and Environmental specialist facilitated the meetings. BIWTA senior officials including Environmental Specialist, Social Specialist and Executive Engineer attended some of the meetings.

Project information including interventions, potential impacts and mitigation measures, role of the project authority, affected people and other stakeholders were discussed in the meetings. In the discussion ecological, environmental, social and resettlement issues of project implementation have been shared. A total of 393 people, consisting of 373 males and 20 females were present in the six meetings.

They took active part in the discussion and gave opinions for betterment of the project. The Table underneath presents date, location, category and number of participants in all six meetings. The meetings were organized by TYPSA & KS Consultants Ltd and BIWTA supports the activity. The summary of the meeting places and participants listed in Table 146

Table 148. Stakeholder consultation meeting summary

Date	Location	Category of participants	Number of participants	
			Male	Female
22/10/2019	Shasanghat	Businessmen, Ward Councilor, Teacher, Service holder, BIWTA officials, Student, Day Laborer	52	08
22/10/2019	Pangaon	Businessmen, UP Member, Teacher, BIWTA officials, Boatman, Day Laborer	53	04
23/10/2019	Narayanganj	Businessmen, Cargo/ Launch owner, BIWTA local officials, Boatman, DEPTC instructor and trainees, Student, Day Laborer	63	00
24/10/2019	Ashuganj	Businessmen, Doctor, Cargo owner, BIWTA local officials, Boatman, Truck owner, Day Laborer	60	00
27/10/2019	Barishal	Businessmen, Councilor, Service holders, BIWTA local officials, Day Laborer, Boatman	78	06
29/10/2019	Chandpur	Mayor, Councilor, Auto-Rickshaw Driver, Businessmen, Service holders, BIWTA local officials, Day Laborer, Boatman, Student, Labor leader, Rickshaw puller, Expatriate	67	02
Total	**06**		**373**	**20**

Apart from the consultation meetings, a total of 24 focus group discussions (FGDs) were held with various occupational groups at five terminals except Shasanghat under S3 and S4 sites. At the Shasanghat site only one shop is affected within the project footprint. A mass consultation was held at Shasanghat at the beginning of the study with all level stakeholders.

A total of 411 people from various occupational groups including squatters, vendors, tenants, day laborers, landowners, female headed households were present in the 24 FGDs.

The Table 147 below shows the category of affected people brought under FGDs.

Table 149. Category of affected people consulted through FGDs by sites

Terminals		FGD						Total
	Female (HH)	Squatter (Residence& Business)	Tenant (Residence& Business)	Lease Holder	Landowners	Vendor	Day Labor	
Pangaon Cargo Terminal	0	01	0	01	0	0	0	02
Chandpur Passenger Terminal	01	03	01	0	0	0	01	06
Barishal Passenger Terminal	01	01	01	01	0	01	01	06
Narayanganj Passenger Terminal	0	01	01	0	0	03	0	05
Ashuganj Cargo Terminal	0	01	02	0	01	0	01	05
Total	02	06	05	04	01	04	03	24
Total participants of FGDs	26	130	91	21	22	71	50	411

7.5. PUBLIC CONSULTATION PROCESS METHODOLOGY

Consultation meetings were held with prior notice to the people through personal contact, announcement in the mosque and marketplaces and official notice to the people. They were informed as to the date and venue of the meeting and issues to be discussed. Influential local people including representative from the local government, BIWTA local offices, consultants, local NGOs and affected female and vulnerable groups. A checklist was developed for the consultation meetings.

Consultation with the affectd people and other stakeholders is essential for better planning and implementation processes of a project. Affected people in the project footprint and other stakeholders, including local government representatives, have been meaningfully consulted at the cargo and passenger terminals to obtain their knowledge and experience about the baseline information, potential impacts, and feasible mitigation measures. The consultations were conducted to ensure dissemination of adequate and timely information to the project-affected people and communities and to enable stakeholders to voice their opinions in the project planning and implementation processes. The participants took active part in the discussion and provided suggestions about assessing compensation and other benefits taking into account of the magnitude and severity of impacts. Opinions of the people have been taken into account in preparation of the ESIA and Resettlement Action Plan.

Through the public consultations, timely, effective, and multi-directional communications between the Project and the affected persons and communities were ensured to maximize the benefits of the Project. The cut-off date (COD) for the non-titled PAPs, i.e. the date of commencement of the census survey, was declared in the consultation meetings. Cut-off dates for the titled PAPs will be date of serving notice under section-4 of the Acquisition and Requisition of Immovable Property Act 2017 (ARIPA 2017). Cut – off dates for the Non-titled PAPs were declared in the stakeholder consultation meetings prior to starting the census and inventory of losses survey.

Stakeholder Consultation meetings were held at 6 terminals before conducting census and socioeconomic surveys. A total of 393 (male 373 and female 20) were present in the consultation meetings. Female participants in the consultation meetings were far fewer since the meetings were conducted in market/bazaar areas. Women have been contacted personally during census and inventory of losses survey. They were also consulted through focus group discussion. The affected people and other stakeholders including landowners, representatives of local government institutions, squatters, businessman, cargo and passenger vessel owners, tenants, passengers, local influential people, fishermen, day laborers and housewives had information disclosed to them and were made aware of the impacts of the Project. The meetings were held with prior notice provided to the people regarding dates and venue, issues, and necessity of discussion. Consultation meetings will be continued throughout the implementation of the resettlement action plans.

To maximize exposure and participation in meetings, different communication techniques were used, such as: prior communication with the participants; handing over letters of BIWTA to local government offices; and announcing at marketplaces and mosques. Potentially affected people and different levels of stakeholders were informed verbally, and locally influential people were invited at least one day ahead of the meeting. Stakeholders were informed as to the time, location and objectives of the meeting. Senior officials from the PIU (BRWTP-1), TYPSA and KS Consultants facilitated consultation meetings. Each of the participants was given the opportunity to take part in the discussion and provide their opinion about the Project. Consultants drafted minutes of meetings, collected attendance sheets and took photos.

Social safeguard documents for the passenger and cargo terminals have been prepared considering the opinions of the people consistent with the project policy. A banner describing the project name and executing agency was displayed during the consultation meetings and information was disseminated in

the local language (Bangla) to the participants. Methodologies adopted in the consultation meeting are presented in following Figure .200

Figure 202. Methods of Consultation Meeting.

7.5.1. Information Provided

In the consultation meetings the BRWTP officials and S6 Consultants described about the project components, timeline, roles and responsibility of the affected people and project authority and other pertinent issues such as-

- The BIWTA on behalf of the Government of Bangladesh is mandated to develop the existing four terminals (Narayanganj, Chandpur, Barishal, Ashuganj) and construction of two terminals (Shasanghat and Pangaon)
- Out of these six terminals, four are for the passengers (Narayanganj, Chandpur, Barisha and Shasanghat) while the remaining two are for cargo (Ashugan and Pangaon).
- World Bank will provide financial support to implement the Project
- Private land acquisition will be minimum (only 0,638 acres at Ashuganj site) and other terminals will be developed/constructed on BIWTA land
- Affected people irrespective of title to the land will be paid compensation for their lost assets and other resettlement benefits as per policy of the World Bank (OP 4.12)
- Displaced people will ne provided assistance in relocation through PRAC to find alternative land in the icinity. Civic amenities (water supply, sanitation, drain, internal road, etc.) will be provided in case of relocation of houses and shops in a cluster manner.
- In case of purchasing alternative land with compensation money, the landowners will be entitled for stamp duty and registration costs
- Affected business owners including squatters and vendors, tenants, lessees, day laborers will get resettlement benefits
- Displaced people will be allowed to take away salvageable materials free of cost after getting compensation without delaying the Project Works
- Vulnerable people including female headed households will get special assistance

A grievance redress mechanism will be established in the Project with representatives from BIWTA, RAP implementing agency, local government institutions, affected people (male and female) where people will be assisted to present their grievance

The table 150 presents site specific issues raised by the particpants and responses of the consultants/PIU officials

Table 150. Site-specific issues and responses during consultation meetings

Location	Major issues raised by the participants	Response by consultants
Ashuganj	More than 50 river-crossing boats are being operated to carry goods and passenger from Ashuganj to Bhairab. Boat ghat is at the proposed terminal site. About 300 families are fully dependent on the boat operation. Better to build a new cargo terminal at the downstream to avoid displacement of boat ghat.	The project has prioritized improvement of existing terminal in the first phase and new terminal in the second phase at the downstream at any suitable location. If the boat ghat is require displacement due to the project interventions, necessary facilities will be provided including stair.
	Affected shops are to be paid compensation and relocation since these were allotted by RHD during Bhairab Bridge Project under Resettlement Program.	Project will think about compensation and other assistance following the World Bank Environmental and Social Framework (ESF)
	Around 600 business with a large capital investment is being operated at the proposed area. Land value in the adjacent área is very high (per decimal about 10 million takas). People suggested shifting the Project location to the downstream on RHD land where about 28 acres of land is available with free-from-encumbrances.	Project will try to get GOB land if available rather to acquire mass private land. But technical feasibility will be taken into account before selection of site. Project will contact with RHD regarding alternative land since the proposed área is also RHD property.
Barishal	Some businessmen have been operating business at the Barishal terminal area over the decades. They claimed relocation in case of displacement even instead of compensation for structure and business.	Project will pay compensation and other assistance following the World Bank Policy. Relocation issues will be decided in consultation with the business community and the local government institutions as per WB policy and good practices of other development projects.
	There are about 500 shops at the vegetable market and City Market in BIWTA land those require relocation in suitable place	The project will not affect the City market. Only vegetable market will be affected. Necessary measures will be taken by the Project for compensation and relocation.

Location	Major issues raised by the participants	Response by consultants
	A separate location for the speed boat and river-crossing boat is to be identified with independent pontoon and stair	Project will provide separate pontoon and stair for the river-coring boats, speed boat and passenger in safe distance.
Chandpur	Project should try to avoid private land acquisition and ensure payment of compensation for the structures and business on GOB land.	Private land acquisition will not be required for improvement of the terminals. If urgently required, then replacement cost for land will be paid.
	Many of the affected HHs are living on the Bangladesh Railway land over the decades with or without permission. Compensation for structure	Compensation and resettlement benefits for the structures on the GOB land will be paid following World Bank policies and good practices of other projects.
	People are making the river water polluted by throwing garbage. BIWTA should take initiative to prevent such activities by the passenger or terminal users.	Environmental Management Plan will be prepared under this Project and will be strictly monitored during Project
	Approach road will need to be developed along with terminal to enjoy better facility. It will be better to construct approach road from terminal to Bus stand alongside the river	Project will consider development of approach road for better facility to the terminal users.
Narayanganj	Some of the shops will be displaced from the terminal area who would be paid compensation	Affected shop owners will be paid compensation following the World Bank Environmental and Social Framework (ESF)
	River crossing boats along with separate pontoon and stairs would be in safe distance. Adequate planning is required for the women and disabled passenger including separate toilet, prayer hall, breast feeding corner, etc. in the terminal and vessels	Separate pontoon for the river crossing boats and passenger and additional facilities for the women and disabled passenger will be included in the Project design.
	Private land acquisition should be avoided. Relocation of the shops within the terminal or closed to the terminal would be ensured. Drainage system would be uninterrupted to avoid water logging	Private land will not be acquired to improve Narayanganj Passenger terminal Compensation will be paid for the shops but relocation issues will be considered based on necessity and availability of space Drainage system will be developed to avoid water logging

Location	Major issues raised by the participants	Response by consultants
	Employment opportunity would be ensured for the affected people in the project construction and operation phase	Local people particularly affected vulnerable people will be preferentially employed in the civil construction
	Primary treatment facilities for the terminal users would be available with at least 10 beds	A developed medical facility including full-time Doctor and medicine will be in the terminal
Pangaon	Project should avoid private land acquisition if possible. In case of urgency acquire plain land and avoid residential area as well as the pond/fish.	Project will try to avoid private land acquisition and displacement since BIWTA has sufficient land to develop terminal. In case of urgency to acquire, compensation will be paid at replacement cost
	Plan the terminal facilities including construction of a good mosque if the existing mosque is demolished People go to Pagla (business hub) by crossing the river for their daily needs. Construct a separate pontoon, passenger shed and stair in the safe distance for the river crossing people Keep separate place for CNG and Auto-rickshaw and dumping place for garbage as well as need deep drainage system for remission of rainwater from inter area during monsoon	A new mosque will be constructed within the territory of the terminal by the project River crossing boat operation will be uninterrupted. Stair and other facilities will be provided as per policy of the project. BIWTA Management will decide about the space for the CNG and Auto rickshaw stand in the terminal area.
Shashanghat	Alternative location for the terminal is to be selected since Shashanghat is closed to the residential area, Bangladesh Army camp and Postogola Bridge	This site has been selected based on feasibility study. Issue will be conveyed to the BIWTA. They can further review feasibility report
	Some of the people took lease of Bangladesh Railway land for business. Whether they will be paid compensation if their structure is affected on the BR land?	Compensation will be paid for lost assets and business irrespective of title to the land.
	Will BIWTA pay compensation for the Compensation for the structures and business demolished by BIWTA couple of weeks ago	Structures were demolished to clear river bank as per decision of the government. So, compensation for those structures and business will not be paid under this project.

Location	Major issues raised by the participants	Response by consultants
	Hindu community need access to the river from cremation ground for sacrificing Gods (Murti) of Hindu Community and ashes of burnt dead body	Project will keep access to the river for the Hindu Community for sacrificing Gods (Murti) and ashes
	Women and disabled would have all facilities in the improved terminals and vessels shelter.	Project will provide required facilities to women and disabled in the terminals and vessels.
	Adequate compensation and benefits for the affected people is to be paid	Adequate compensation will be paid for lost assets
	Second largest ship breaking yard is located at Shashanghat where thousands of people are involved. How their livelihood will be restored	This project will take care of the people will be affected by this project by losing assets and livelihood.
	Access road to the Shahanghat is very narrow. How the access to the improved Terminal	GOB is planning to implement Subway project connecting the Shashanghat. Other access roads will also be developed to facilitate the improved terminal

Apart from the consultation meetings, 24 focus group discussions (FGDs) were held with various occupational groups (Squatter businessmen, tenants, vendors, female, and wage laborers) at six locations.

A total of 413 participants were present in the meetings and actively raised their voices about potential impacts on their livelihoods due to displacement, supports require from the project and adequate compensation & other assistance for restoration of their livelihoods. Table 151 presents the details of venue, numbers & nature of participants and issues raised.

Table 151. Issues raised by the affected people in the FGDs

SL no	Location	FGD held with	No of participants	Issues raised by the people
1.	Ashuganj	Private owner of land	22	Need to know the compensation rate of land since Ashuganj is a commercial place and land price is so high Drainage system should ne proper and to be connected to the river Access to the main road and river for the businessmen is to be ensured.
2.	Ashuganj	Private (Tenant)	16	• Our business is related to river therefore, we need rehabilitation beside the river.

SL no	Location	FGD held with	No of participants	Issues raised by the people
				• Create godown on river banks for product storage. • Construct a 50 feet road for truck loading • Build a terminal for truck parking
3.	**Ashuganj**	Wage Labor	19	• As we are day laborer, we need financial support from different organization • Need loan for business as we lost our job • Construct restroom for labor
4.	**Ashuganj**	**Resettled business group on RHD land**	21	• Build truck parking with capacity of five hundred truck • Need improve communication system for transporting goods • Provide adequate compensation for all types lossess • Provide space for relocation since we lost our business location • Provide employment opportunity who lost their jobs due to project.
5.	**Ashuganj**	**Tenant businessmen**	25	• Build warehouse to store imported goods • Fair compensation must be ensured • As our business is dependent on the river, so we need access to river and main road as well. • Build a terminal for truck parking
6.	**Barishal**	**Squatter businessmen**	20	• Provide adequate compensation and support from the authority • Provide women employment during and post construction
7.	**Barishal**	**Tenant**	18	• Lease holder must return deposited amount within three months after receiving notice for displacement

SL no	Location	FGD held with	No of participants	Issues raised by the people
				• Provide loan from different organization for the business
8.	**Barishal**	**Lease holder**	10	• We need storage in new terminal • BIWTA should allow to do business within its borders • Notice must be received from the BIWTA at least three months in advance
9.	**Barishal**	**Female group (business)**	09	• We need financial support to run family • Need loan for stating small business
10.	**Barishal**	**Vendor**	16	• Need loan for continuing business • Provide suitable location in the terminal area for running business
11.	**Barishal**	**Wage labor**	11	• Due to project, we lost our job, need financial support to run family
12.	**Narayangonj**	**Vendor: Fish Cutter**	20	• As we process/cut fish to earn our livelihood, we want to stay on the river bank to run our livelihood
13.	**Narayangonj**	**Fish businessmen**	15	• Need compensation for Fish market • Business association and whole-sale market need to stay close
14.	**Narayangonj**	**Vendor: Others**	20	• Need financial support/fair compensation to run our business • Provide space iside the terminal for small business
15.	**Narayangonj**	**Tenant**	12	• Provide alternative employment as we lost our current means of livelihood. • Lease holder must return our deposited amount shortly after issuing notice by the BIWTA
16.	**Narayangonj**	**Squatter businessmen**	21	• Provide space inside the terminal to run business

SL no	Location	FGD held with	No of participants	Issues raised by the people
				• Provide alternative business scope/ adequate compensation & assistance • Need loan for continuing business
17.	**Pangaon**	**Lease holder: Mosque committee, fish & banana cultivator**	11	• Construct a new mosque for prayer • Drainage connection will be provided with river or elsewhere • Authorities should take action on things which is harmful to environment • Need compensation for our lost assets
18.	**Pangaon**	**Squatter**	13	• Beside the main gate of the terminal we should be allowed to do business • Need fair compensation and assistance to run business
19.	**Chandpur**	**Female (HH)**	17	• We need financial help to cope up with the changed situation after displacement • The railway has unused land at madrasa road, this land can be used as relocation site. • Women should engage in social decision making process and get work opportunity in the project
20.	**Chandpur**	**Squatter (residence cum business)**	17	• Need financial help to continue business • Arrange alternative place for accommodation since we are living on Bangladesh Railway (BR) land • Allocate space in the new terminal for running business • It is suggested to fill the BR pond and arrange relocation since we do not have alternative land to live in.
21.	**Chandpur**	**Tenant (business)**	20	• Ensure refund of deposited amount by the structure owners

SL no	Location	FGD held with	No of participants	Issues raised by the people
				• Provide loan for business from banks with easy condition • We demand another place for running business • Provide assistance for transferring business
22.	**Chandpur**	**Squatter: Nishi road**	21	• Equal amounts of land should be taken from both sides of the existing road for widening • We need financial help from the project to run our family • If we get support from government we can build shops and houses on unused pond on BR land.
23.	**Chandpur**	**Squatter businessmen: Launch Ghat**	19	• Allot shop in the new terminal on priority basis • Provide loan for business from banks with easy condition • Notice must be given at least three months in advance • Need fair compensation and financial help from the project
24.	**Chandpur**	**Wage Labor**	20	• Seek financial help from project to run family • Ensure job immediately after displacement • Need work opportunity in the project
	Total		413	

7.5.2. Information Recording and Responsibility

During stakeholder's consultation and focus group discussion, opinions of the participants were recorded and duly reflected in the report. S6 consultants have organized the meetings and disseminated project information to all level stakeholders. PIU, BRWTP senior officials were also present in the meeting and delivered their speech on the project activities. Affected people raised their concerns about avoiding, minimizing and mitigating adverse impacts on them.

They shared their opinion about probable alternatives of the design to avoid mass displacement and private land acquisition. S6 consultants kept a record of discussions at the meetings and conveyed these to the PIU for necessary decisions. After having final decision and demarcation on site, S6 consultants conducted census and inventory of losses survey within the footprint of the proposed sites.

During implementation of the project all level of stakeholders, particularly affected people, will be consulted time to time and their feedback will be recorded by the RAP implementing agency and reported to the PIU, BRWTP.

7.6. SUMMARY OF COMMENTS RECEIVED FROM PARTICIPANTS

During consultation meetings stakeholders at all levels were briefed about the project interventions, components, potential impacts and mitigation measures. Different issues were discussed in different locations.

People raised various pertinent issues relating to land acquisition, compensation and resettlement benefits, relocation and livelihood restoration and employment opportunity during construction and operation phase, equal facilities for male and female in the terminals and vessels.

ESIA consultants responded to all questions and therefore, affected people and other stakeholders by location were well aware of the project. Issues raised by the participants by location are furnished below:

Table 152. People raised concerns in the consultation meetings

Location	Issues raised by the people
Shasanghat	▪ Compensation for the structures and business demolished by BIWTA couple of weeks ago ▪ Search alternative location for the terminal since Shasanghat is closed to the residential area, Bangladesh Army camp and Postogola Bridge ▪ People took land lease from Bangladesh Railway for business. Whether they will be paid compensation for their losses ▪ Need access to the river from cremation ground for sacrificing Gods ***(Murti)*** of Hindu Community and ashes of burnt dead body ▪ Women and disabled would have all facilities in the improved terminals and vessels ▪ Adequate compensation and benefits for the affected people is to be paid ▪ Second largest ship breaking yard is located at Shasanghat where thousands of people are involved. How their livelihood will be restored ▪ Access road to the Shasanghat is very narrow. How the access to the improved Terminal will be developed.
Pangaon	▪ Avoid private land acquisition if possible. In case of urgency please acquire plain land and avoid residential area. ▪ Pay adequate compensation for land, if acquired ▪ Plan the terminal facilities including construction of a suitable mosque ▪ People go to Pagla (business hub) by crossing the river for their daily needs. Construct a separate pontoon and stair for the river crossing people ▪ Pontoon with passenger shed for the river crossing boat would be constructed in safe distance from the cargo terminals
Narayanganj	▪ Avoid private land acquisition ▪ Displaced shops would be paid compensation

Location	Issues raised by the people
	▪ A space for relocation of the shop keepers within the terminal or outside the terminal ▪ Drainage system would be uninterrupted ▪ River crossing boats along with separate pontoon and stairs would be in safe distance ▪ Employment opportunity of the affected people in the project construction and operation phase ▪ Primary treatment facilities for the terminal users would be available with at least 10beds ▪ Necessary facilities for the women and disabled passenger including separate toilet, prayer hall, breast feeding corner, etc. in the terminal and vessels
Ashuganj	▪ Instead of the existing terminal choose free space, preferably RHD land (28 Acre free land) nearer to the Petro Bangla in the down stair, to avoid mass displacement of shops huge compensation ▪ Resettlement of the shops will be required since it is a resettlement site of the Bhairab Bridge Project provided by RHD ▪ Need access to the river since business here is fully dependent on the river ▪ Around 50 river-crossing boats are operated here where about 300 families are dependent on it. Needs separate space along with pontoon and stair for easy access to the boats
Barishal	▪ Avoid private land acquisition ▪ There are about 500 shops at the vegetable market and City Market in BIWTA land those require relocation in suitable place. ▪ Want relocation even instead of compensation for structure and business ▪ Discuss with Honorable Minister and Mayor before finalization of design and relocation plan ▪ Separate location for the river crossing boat and speed boat with independent pontoon and stair
Chandpur	▪ Avoid private land acquisition ▪ Compensation for the structure and business on GOB land ▪ People living on the Bangladesh Railway land want to have compensation and relocation ▪ Environmental issues are to be carefully taken care of ▪ Approach road will need to be developed along with terminal to enjoy better facility. Suggested to construct approach road from terminal to Bus stand alongside the river

7.7. OUTCOMES OF THE FOCUS GROUP DISCUSSION

Table 153. Outcomes of the Focus Group Discussion

Occupational Groups with loss category	Concerns raised
Land Owners	▪ Avoid private land acquisition as much as possible ▪ If not avoidable, assess compensation at replacement cost so that they can purchase alternative land ▪ Land Price would be determined in consultation with the landowners affected by this Project ▪ Compensation to be paid without hassle ▪ Compensation would be paid for structures and other assets on the acquired land at the replacement cost

Occupational Groups with loss category	Concerns raised
Squatters (Residents)	▪ Have been living in the Project site on GOB land for long time since they have no alternative land to live on ▪ Compensation for structures is to be assessed at a rate so that they can reconstruct in new location ▪ Relocation of the houses in a designated site is desired ▪ Allow to take away salvageable materials after payment of compensation ▪ Assist to find alternative land for resettlement
Squatters (Business)	▪ Have been doing business site on GOB land for long time for livelihood ▪ This is only source of livelihood and they have no alternative location to run their business ▪ Compensation for structures and business is to be assessed at a rate so that they can run their business in new location ▪ Relocation of the business in cluster manner is highly required to continue livelihood ▪ Pay compensation and resettlement benefits for business restoration ▪ Work opportunity in the civil Works of the Project
Tenants (Residents)	▪ Have been living as tenant for long time by depositing advance money ▪ Alternative tenancy requires additional money to deposit as advance ▪ It is difficult to find alternative house at short notice within limited income ▪ Resettlement assistance for relocation of household belongings and take rent of alternative houses is desired
Tenants (Business)	▪ Have been dealing in on the GoB land for long time ▪ Deposited a large amount to the structure owner as advance ▪ Alternative tenancy requires to deposit advance money ▪ It is difficult to find alternative location or structure to get rent for the business ▪ This is only income source and closing of business will have adverse impact on their livelihood ▪ Require resettlement assistance for relocation of business and smoothly continue their livelihood ▪ Work opportunity in the civil Works of the Project
Vendors	▪ Running business on the GoB land without structure since they have no money to construct structures ▪ This is only income source and closing of business will have adverse impact on their livelihood ▪ Require resettlement assistance and find alternative location of business and smoothly continue their livelihood ▪ Work opportunity in the civil Works of the Project
Day laborers	▪ Working as day laborer over the years ▪ Resettlement benefits for wage loss for at least 3 months ▪ Work opportunity in the civil Works of the Project
Female groups	▪ Project will have adverse impact on women if displacement takes place ▪ Relocation of the household belongings requires enough time and cost ▪ Allow enough time to relocate household belongings ▪ Additional resettlement benefits for the women headed households ▪ Work opportunity for the women in the civil work

Occupational Groups with loss category	Concerns raised
	▪ Special arrangement for the women in the terminals and vessels

8. CONCLUSIONS AND RECOMMENDATIONS

This ESIA reveals that there will be both negative and positive impacts due to the construction and operation of the proposed S3 and S4 sub-projects.

The main positive environmental impact of the Project are development and improvement of key multi-modal transport networks through waterways, which has always been a natural, environment friendly transportation system. This will certainly reduce the use of other not so sustainable means of transportation in such a congested and saturated environment, especially as it relates to the surroundings of the capital Dhaka.

More locally, the project means a general and substantial improvement of the facilities, accesses, traffic etc. which will achieve a significant improvement in the current levels of pollution, emissions,

and noise, which is in line with the objectives of the different existing master plans for these spaces.

From a social point of view the improvement of the facilities for transportation of passengers and cargo will mean the generation of employment opportunities during construction operation and maintenance stages as well as induced economic growth and activities.

From a gender perspective, gender specific facilities will be ensured in the terminals. Gender related facilities for the women in general, will include pregnant women, lactating mothers, elderly and disabled people who will be in the waiting area or working in the terminals and vessel shelters. Gender and Development issues have been identified as crosscutting priority by both the Government and the development partners to enable women and girls to get the benefit of development and thus reduce the existing gap in their comparative situation with men and boys. It deals with unequal relations of power that prevents equitable development and women's full participation.

The major negative environmental impacts of the project are loss of benthic flora and fauna, obstruction to navigation traffic, loss of land, alteration of habitat, health, hygiene and sanitation of construction workers, public nuisance, blocking of natural drainage, noise, and air.

In summary:

- The water pollution will increase to much higher than its present level and is likely to further affect the aquatic biota, including fish and other aquatic animals, leading to its likely complete disappearance. except few species that can survive in polluted water,like air breathing fishes, viz. climbing perch, snakeheads, stinging and walking catfishes. Dredging will kill or cause damages to benthic organisms at the river site depleting/ reducing feeding opportunities of fish and some other aquatic biota and may also cause shift in composition, abundance and dominance benthic and zooplanktonic communities. In some places like Pangaon and Barishal a total of 9 aquatic wild species have been recorded from the site, include frog species, snakes,turtles, bird species and one mammal species, the Gangetic dolphin.

  The frogs and snakes may be buried in the process of land filling. The aquatic bird may avoid visiting the area. In Sashanghat Dolphin will be particularly affected due to increase in sound

produced from dredging and working vessels. Three turtle species were also reported from the site and likely to be impacted with an avoidance reation,

- River traffic level is likely to increase threefold and will affect the aquatic biota and sounds from vessels trucks will affect the adjacent city dwellers and wildlife. Dolphins will be specially affected. particularly because of noise and vibration impacts from pile driving and dredging, notwithstanding that these may persist for a limited time during construction
- Land traffic will also increase significantly, resulting in local severe traffic congestion and there will also be an increase in air pollution.

The key social impacts are due to project interventions are.

- Land acquisition and subsequent resettlement
- Loss of livelihoods
- Inconvenience and nuisance during construction
- Loss of access
- Likely increase in transport time and costs.

It is important to remark that a RAP Report will be prepared, site specific for each of the S3 and S4 sub-projects, during the planning and design stage.

An ESMP has been prepared to mitigate the negative impacts during various phases (pre- construction, during construction and operation) of the Project to acceptable levels. Also, public consultations, including consultation workshops at regional and national levels have been organized in addition to preparation of resettlement policy framework as per World Bank guidelines to address resettlement and compensation issues.

To ensure that these enhancement and compensation measures are implemented correctly, and negative impacts avoided, the ESMP along with adequate budget is to be included in the contract documents of the Project with a separate line item on environmental management in the BOQ. The main monitoring parameters include monitoring of pollution during works and waste disposal, biological monitoring and enhancement, environmental quality monitoring (air, noise, surface water, riverbed sediment), health and safety, etc.

Most of the potential impacts are short-term and likely to be produced in the construction phase, so that can be avoided or mitigated by **adopting mitigation measures and relevant ECoPs**. As it has been deeply analysed in this report, they would not persist with the adequate application of the proposed mitigation measures.

Cumulative impacts may also appear, Initial appraisal suggests that all S3 or S4 site environments are affected and/or likely to be affected by other activities/projects sourced nearby. However, cumulative effects can be difficult to predict and manage due to inadequate environmental baseline data, complex ecological processes, and the large scale at which human development occurs.

An assessment of cumulative effects for each of the individual S3 and S4 project sites is made in this ESIA with recommendations on required additiontal mitigation measures

The estimated overall cumulative impact indicates the need for mitigation to be implemented by the various project owners or proponent parties to ensure that their respective contributions to the overall

condition of the VECs is coherent and/or compatible as a minimum compliant with ambient quality standards for the desired use.

Residual impacts are those that might remain after measures are taken to avoid and minimize impacts. The risks and impacts identification process should consider direct and indirect project-related impacts and identify any significant residual impacts. According to the mitigation hierarchy where residual impacts remain, compensation/offset, wherever technically and financially feasible should be taken.

After mitigation residual impacts of Cargo Terminals are:

- Increase in Noise level due to Terminal operation
- Impact on air quality due to dust emissions by cargo operation, exhaust gases emission from engines and other machinery and vessel traffic.
- Traffic congestion on local road network due to load vehicles.
- The effects above will persist during terminal operation period.
- Pangaon is a new Cargo Terminal while Ashunganj site is currently under operation. Thus deterioration of ambient noise level and air quality will be worse for Pangaon site.

Regarding passenger terminals, Sashanghat is a new terminal while the rest are upgradation and modernization of existing ones. Anyhow the Sashanghat new terminal has the potential of restore the current bad environmental conditions and to alleviate Sadargaht terminal pressure. No residual impact has been identified for the terminals in such a way that could be compensate within a feasible framework.

In this context compensation measures for residual impacts of Pangaon Cargo Terminal on air quality and nose level and traffic congestion before the implementation of mitigation measures are not, at the moment, technically applicable and not feasible for compensation. Additionally, once mitigation measures have been implemented, no residual impact remain for cargo or passenger Terminals over biodiversity and or ecosystems services.

In general, we need to follow the following measures for all sites:

- BIWTA needs to review the situation and involve all parties, vessel operators, CT, ICT and PT authorities to jointly prepare and implement a pollution control program.
- The present access road in the area needs to be widened to accommodate the increased traffic load with provision for a permanent local traffic control system
- Ensure that all transports, vehicles comply with the GoB set standards, use emission reduction and sound reduction devices.

To keep the project influence area environmentally friendly, BIWTA should ensure that the Contractor prepares site specific EMPs including Emergency response plan, and Mitigation Measures Plan, regular and effective monitoring of environmental quality parameters as indicated in this ESIA report.

Based on the assurance of minimal disturbance to the natural environment and implementation of ESMP in every step of the project activities, the proposed Project could be environmentally feasible. Then DOE may issue necessary environmental clearance to such a nationally important project. BIWTA should follow the guidelines illustrated in the ESMP and other legal and administrative requirements to carry out the activities for improvement of the terminal facilities.

On the other hand, the Project will require a considerable number of manpower during construction and operation stage. The operation of terminals will generate new employment opportunities for the people

directly or indirectly on permanent and temporary basis. Besides, some backward linkage institutions will be established considering updating of the terminals and new business ventures i.e. suppliers, contractors/subcontractors, new water vessels launching, etc. are opened. The laborers, who will be engaged in construction period, may or may not be deployed in operation phase of the project due to lack of relevant skills. They would be trained on some specific tasks particularly for the cargo terminals, that will help them getting job in operation phase which will reduce unemployment.

Opportunities of local goods and services will be enough to provide required support to the huge quantity of employees. Local businessmen will make available necessary goods in the local market. Employees and businessmen will be more benefitted from the project and therefore their economic condition will be improved.

Local people can travel with safety and security in the water vessels and businessmen can develop their business by carrying more goods and enjoy facilities of improved cargo terminals.

8.1. RECOMMENDATIONS

The implementation of the project is suggested to proceed following the recommended mitigation measures as outlined in the ESMP. The ESMP shall be included in the bid document of civil works and need to become part of the civil works contracts.

The timely implementation of ESMP will reduce negative impacts.

The ESMP is a living document and will need to be continuously updated by BI-kv

WTA during the construction and operation to reflect any significant changes in the project scope of work with recommended mitigation measures or to respond to the regular environmental monitoring results, collection and analysis of detailed bio-physical and environmental data.

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