

Environmental Impact Assessment (EIA) for Barisal 350 MW Coal-fired Power Plant Project at Taltoli, Barguna, Bangladesh

Final Report



Volume-I: Main Report



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Final EIA Report

Barisal Electric Power Company Limited (BEPCL)

**Environmental Impact Assessment (EIA) for Barisal 350 MW
Coal-fired Power Plant Project at Taltoli, Barguna,
Bangladesh**

Volume-I: Main Report

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Reviewed & Approved by:

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Executive Director

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List of Abbreviation

ADB	Asian Development Bank
AIDS	Acquired Immunodeficiency Syndrome
AP	Affected Person
As	Arsenic
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BDT	Bangladeshi Taka
Be	Beryllium
BEPCL	Barisal Electric Power Company Limited
BFIDC	Bangladesh Forest Industries Development Corporation
BFRI	Bangladesh Forest Research Institute
BIWTA	Bangladesh Inland Water Transport Authority
BMCR	Boiler Maximum Continuous Rating
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BNH	Bangladesh National Herbarium

BOD	Biological Oxygen Demand
BPDB	Bangladesh Power Development Board
BRTA	Bangladesh Road Transport Authority
BTG	Boiler Turbine Generator
Ca	Calcium
Cd	Cadmium
CEO	Chief Executive Officer
CFB	Circulating Fluidized Bed
CFC	Chlorofluorocarbon
Cl	Chlorine
CMB	Centralized Mass Basin
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
COD	Chemical Oxygen Demand
COLREG	Convention on International Regulations for Preventing Collisions at Sea
COP	Conference of Parties
Cr	Chromium
CSR	Corporate Social Responsibility
Cu	Copper
dB	Decibel
DC	The Deputy Commissioner
DDM	Department of Disaster Management
DEM	Digital Elevation Model
DG	Diesel Generator
DMB	Disaster Management Bureau
DO	Dissolved Oxygen
DoE	Department of Environment
DPHE	Department of Public Health Engineering
EC	Electrical Conductivity
EC	Environmental Clearance
ECA	Environment Conservation Act
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rules
EHS	Environment, Health and Safety
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EMP	Environmental Management Plan
ENT	Ear, Nose and Throat
EP	Eco-Park
EPC	Engineering, Procurement and Construction
EQS	Environmental Quality Standards
ESP	Electrostatic Precipitator
ETP	Effluent Treatment Plant
FAO	Food and Agriculture Organization
FC	Fecal Coliform
FCPS	Fellow of College of Physicians and Surgeons
FD	Forced Draft

FD	Forest Department
Fe	Ferrous (Iron)
FGD	Flue Gas Desulfurization
FGD	Focus Group Discussion
GIS	Geographic Information System
GoB	Government of Bangladesh
GPP	Guidelines for People's Participation
GPS	Global Positioning System
GSB	Geological Survey of Bangladesh
HCFC	Hydro chlorofluorocarbon
HCO ₃	Hydrogen Carbonate (Bicarbonate)
Hg	Hydrargyrum (Mercury)
HH	Households
HP	High-Pressure
HSD	High Speed Diesel
HVAC	Heating, ventilation, and air conditioning
IBAs	Important Bird and Biodiversity Areas
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICTPs	International Conventions, Treaties and Protocols
IEE	Initial Environmental Examination
IEEE	Institute of Electrical and Electronics Engineers
IFC	International Finance Corporation
IMO	International Maritime Organization
INDC	Intended National Determined Contribution
INMARSAT	International Maritime Satellite
ITG	Iso Tech Group
IUCN	International Union for Conservation of Nature
IWM	Institute of Water Modelling
JICA	Japan International Cooperation Agency
KII	Key Informant Interview
km	Kilometer
kV	Kilovolt
kWH	Kilowatt Hour
LAP	Livelihood Action Plan
LDO	Light Diesel Oil
Leq	Level Equivalent
LFL	Lower Flammable Limit
LGED	Local Government Engineering Department
LMF	Licentiate of Medical Faculty
m	Meter
m ³	Cubic Meter
MBBS	Bachelor of Medicine, Bachelor of Surgery
Mn	Manganese
MoFL	Ministry of Fisheries and Livestock
MOSTI	Manually Operated Shallow tube well for irrigation
MoU	Memorandum of Understanding
MPEMR	Ministry of Power Energy and Mineral Resources

MSC	Maritime Safety Committee
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MW	Megawatt
NBSAP	National Biodiversity Strategy Action Plan
NEMA	National Environment Management Authority
NEMAP	National Environment Management Action Plan
NFPA	National Fire Protection Association
NGOs	Non-Governmental Organization
NH ₃	Ammonia
Ni	Nickel
NLTP	National Land Transport Policy
NLUP	National Land Use Policy
NO ₃	Nitrate
NOC	No Objection Certificate
NO _x	Oxides of Nitrogen
NP	National Forest
O&G	Oil and Grease
O&M	Operation and Maintenance
O ₃	Ozone
OEM	Original Equipment Manufacturers
OSHA	Occupational Safety and Health Act
OWTP	Oily Water Treatment Plant
PA	Primary Air
PAP	Project Affected People
Pb	Plumbum (Lead)
PCR	Power China Resources Limited
PD	Project Director
PGCB	Power Grid Company Bangladesh
PIU	Project Implementation Unit
PM	Particulate Matter
PM ₁₀	Particulate Matter of 10 Microns in diameter or smaller
PM _{2.5}	Particulate Matter of 2.5 Microns in diameter or smaller
PPA	Power Purchase Agreement
PPE	Personal Protection Equipment
PPM	Parts Per Million
PRSP	Poverty Reduction Strategy Plan
RAP	Resettlement Action Plan
RHD	Roads and Highways Department
RO	Reverse Osmosis
RV	Replacement Value
S&H	Safety and Health
SC	Selective Catalytic Reduction
SCC	Site Clearance Certificate
SCR	Selective Catalytic Reduction
SDS	Safety Data Sheet
SEP	Stakeholder Engagement Plan

SO ₂	Sulfur Dioxide
SO ₄	Sulphate
SPARRSO	Space Research and Remote Sensing Organization
SPL	Sound Pressure Level
SPM	Suspended Particulate Matter
SRDI	Soil Resource Development Institute
STD	Sexually Transmitted Disease
STP	Sewage Treatment Plant
TC	Total Coliform
TDS	Total Dissolve Solids
TMCR	Turbine Maximum Continuous Rating
TMP	Traffic Management Plan
ToR	Terms of Reference
TPP	Thermal Power Plant
TSS	Total Suspended Solids
UNDP	United Nation Development Program
UNFCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WB	World Bank
WCS	Wildlife Conservation Society
WS	Wildlife Sanctuary
WTP	Water Treatment Plant
Zn	Zinc

Executive Summary

E 1.0 Introduction

In order to contribute toward meeting the growing electricity demand in Bangladesh, the Barisal Electric Power Company Limited (or the “BEPCL”) has taken an initiative for developing a coal-fired power plant. The BEPCL is planning to install 350 MW (1 x 350 MW) power generation unit in Taltoli Upazila under Barguna District of Bangladesh. The proposed power plant will be Build Own Operate (BOO) based Independent Power Producer (IPP), operated by the BEPCL and will be based on 100% imported coal.

E 1.1 Screening Category

As per the Environment Conservation Rules, 1997 and subsequent amendments (Schedule-1: Classification of industrial units or projects based on its location and impact on the environment) proposed coal-based power plant falls under the “Red” category project and needs Site Clearance and Environmental Clearance from the Department of Environment (DoE), Bangladesh. The proposed project get the site clearance and approved ToR for EIA study from DoE on 14th June 2018 vide memo no. 22.02.0000.18.72.74.18-378.

E 1.2 Objective of the EIA Study

The purpose of this Environmental Impact Assessment (EIA) study is to provide information on the surroundings and the extent of environmental impact likely to arise on account of the proposed power project for 1 x 350 MW.

E 1.3 Project Location

The proposed power plant project site is located at Village: Bara Ankujan Para and Joyalbhanga, Mouza: Chhota Nishanbaria Chak, Union: Nishanbaria, Upazila: Taltoli, District: Barguna, Division: Barisal, Bangladesh. The proposed power plant project site is located between 21°51 '58.632"N to 22°3'41 .049"N Latitude and between 89°57'35.011"E to 90°10'18.461 "E Longitude. The location map of the proposed project area is given in following Figure-1.

E 1.4 Project Description

The proposed project involves the installation of a stream of machinery and equipment's to generate 1 X 350 MW of power. During the installation of proposed power plant one boiler unit of supercritical type, steam turbine and generator. Salient features of the project are given below in Table-1.

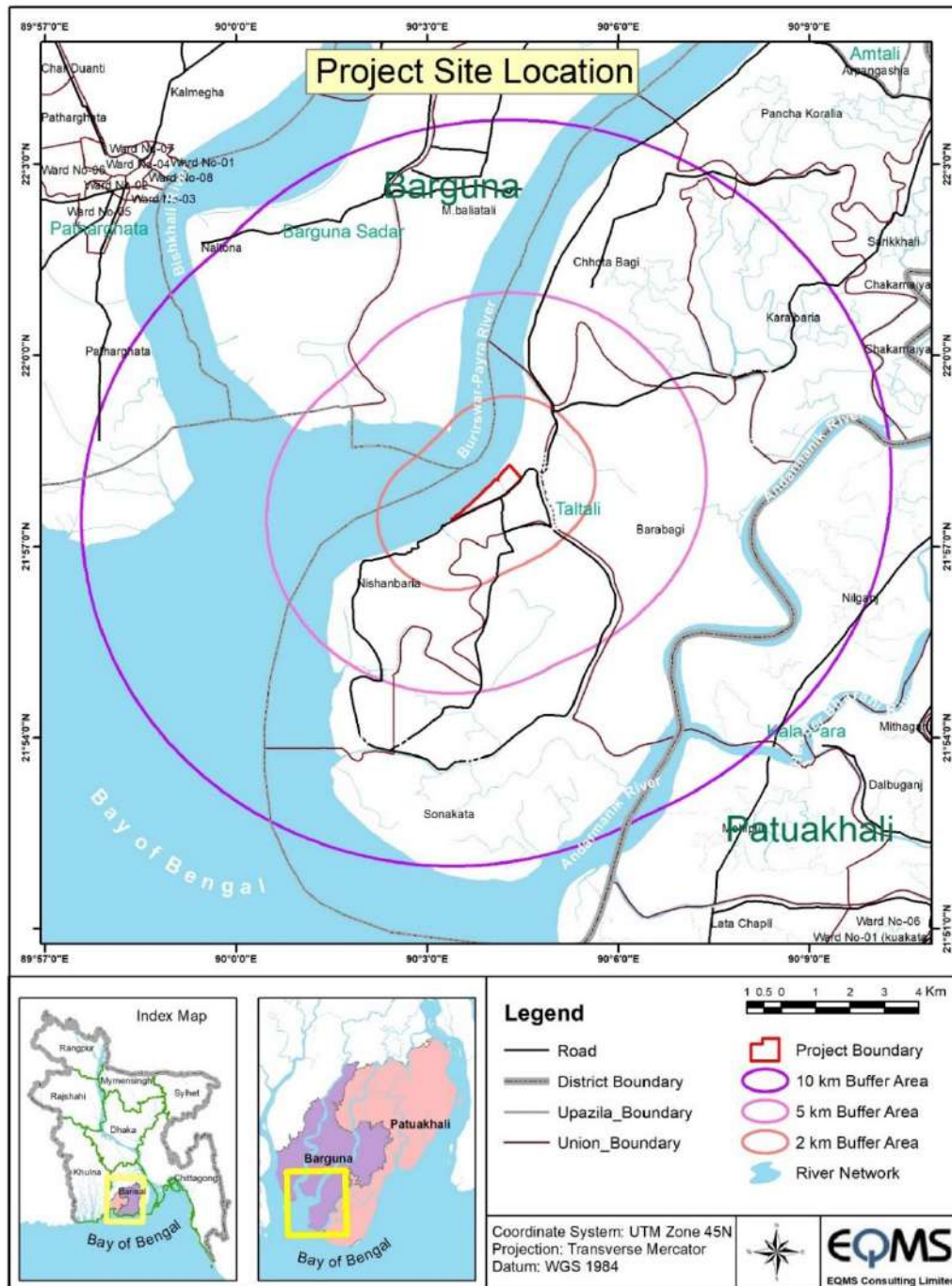
Table-1: Salient Features for Proposed Power Project

SL#	Features	Description
1	Capacity	350 MW
2	Configuration	1x350 MW
3	Type of Boilers	Supercritical, single reheat, single furnace, balanced ventilation, dry-ash furnace, outdoor layout, “Π” type, once-through boiler
4	Power Evacuation	GIS will be provided in the plant and connected through 400kV single-circuit outgoing line to the 400kV substation about 26 km away in the north-east
5	Fuel	Coal and oil
6	Source of Oil	Light fuel oil from the international market
7	Source of Coal	Import from Indonesia, South Africa or Australia
8	Coal Requirement	1.1185 million tons per year
9	Sulphur content	0.3% to 0.9%
10	Ash content in Coal	4% to 18%

SL#	Features	Description
11	Ash Generation	Total 237,875.820 tons/year; 35,679.15 t/a (Bottom Ash), 2,02,196.67 t/a (Fly Ash)
12	ESP	Twin-chamber five-electric-field ESP will be equipped with dust collection efficiency of not lower than 99.72%
13	Stack height	220 meter
14	Water requirement	48,115 m ³ /hour will be intake from the Buriswar-Payra River
15	Land requirement	174 Acres
16	Project Cost	629 million USD (approximately more than 5,000 crores in BDT)

Source: Feasibility Report, 2018

Figure-1: Location Map of the Proposed Project Site



Source: EQMS, 2018

E 1.5 Environmental Settings of the Site

The proposed site is about 9.90 km away (west side) from the nearest Dhaka-Patuakhali (N-8) national highway. An asphalt pavement road in good traffic condition for small vehicles connects the proposed project site with the Taltoli and Amtoli Upazila. There is no existing railway transportation system in the whole of the Barisal division. The capital city Dhaka is about 200 km away from the project site. The nearest airport is located at Barisal is about 95 km. away. The Environmental setting of the proposed project area is given below in Table-2.

Table-2: Environmental Setting of the Project Area

SL	Particulars	Details
1	Plant Location	Village: Bara Ankujan Para and Joyalbhanga, Mouza: Chhota Nishanbaria Chak, Union: Nishanbaria, Upazila: Taltoli, District: Barguna, Division: Barisal
2	Plant site coordinates	Latitude: 21°51'58.632"N to 22°3'41.049"N Longitude: 89°57'35.011"E to 90°10'18.461"E
3	Climatic condition	Temperature: 40°C (Highest in April 2014) and 7.7°C (lowest in January 2013); Rainfall: average 2,861.0 mm/year; Humidity: 75.5% to 88.3%; Wind speed: average 2.72 m/s and Wind direction: SSE to NNW
4	Plant site elevation above MSL	Average 0~3.41m
5	Plant site topography	Floodplain and no hilly area
6	Present land use at the site	Single cropland, settlement, ponds, canal, barren land consists of shrubs and bushes
7	Nearest Highway	Dhaka-Patuakhali (N-8) on the east side from the project site and 9.90 km away
8	Nearest Railway Station	No railway in Barisal Division
9	Nearest Airport	Barisal Airport 95 km on the north side
10	Nearest major water bodies	Bay of Bengal and Buriswar-Payra River on west and north side close to the project boundary
11	Water source of the project	Surface water from Buriswar-Payra River
12	Nearest Town/City	Barguna 20 km on the North
13	Nearest Sea Port	Payra Sea Port, 25 km East
14	Nearest Village	Bara Ankujan Para on the south and west side
15	Hills/valleys	None within 10 km radius
16	Archaeological important places	None within 10 km radius
17	Protected Area (National Park, Wildlife Sanctuary etc.)	Tengragiri WS on the south @ 6.16 to 8.30 km; Sundarbans East WS on the west @ 15.14 km; Kuakata NP on the south @ 10.96 km from the project site
18	Reserve forests	Laldia Reserve Forest on the north-east & Sundarbans Reserve Forest on the west side @ 19.22 km
19	Seismicity	Seismic zone-3 (GSB)
20	Defense installation	None within project site
21	Major industries in 5 km radius	None
22	Socio-economic factors	Approximately 112 number of households

Note: All distances mentioned are aerial distances

Source: Field Survey by EQMS, 2018

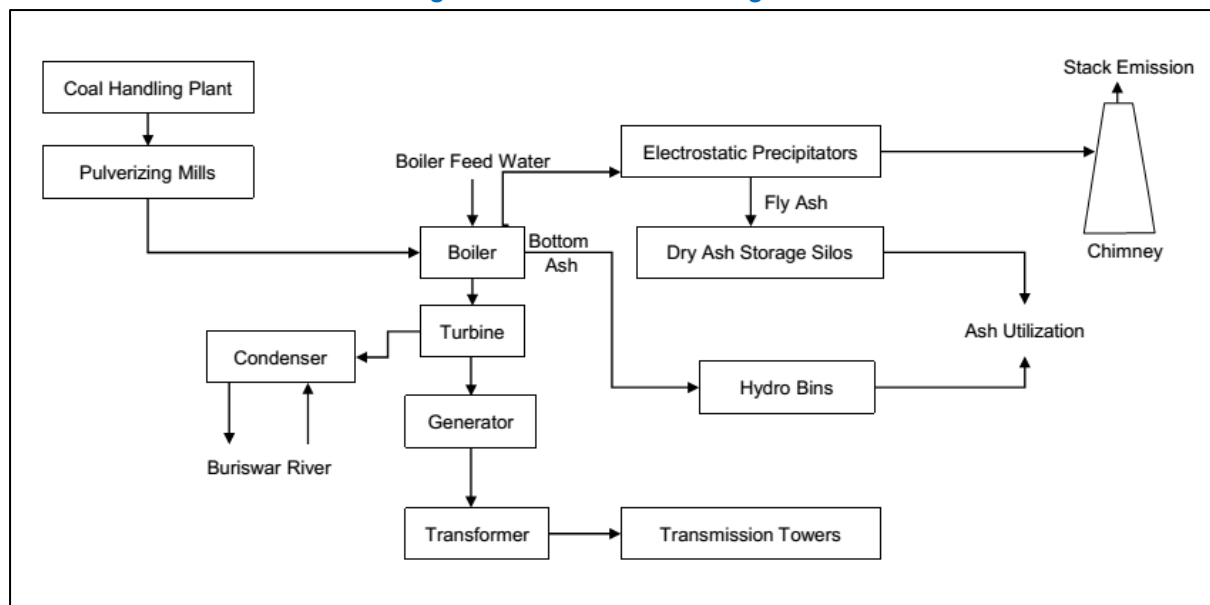
E 2.0 Process Description

In a thermal power plant, the chemical energy of the fuel (coal) is first converted into thermal energy (during combustion), which is then converted into mechanical energy (through a turbine) and finally into electrical energy (through a generator).

The coal is transferred from the coal handling plant by conveyor belt to the coal bunkers, from where it is fed to the pulverizing mills, which grind it to a fine powder. The finely powdered coal, mixed with air is then blown into the boiler by a fan where it burns.

The process of combustion releases thermal energy from coal. The boiler walls are lined with boiler tubes containing high-quality demineralized water (known as boiler feed water). The combustion heat is absorbed by the boiler tubes and the heat converts the boiler feed water into steam at high pressure and temperature. The steam, discharged through nozzles on the turbine blades, makes the turbine to rotate, which in turn rotates the generator coupled to the end of the turbine. Rotation of the generator produces electricity, which is passed to the step up transformer to increase its voltage so that it can be transmitted efficiently. The power is evacuated via switchyard through a Transmission System. The process flow diagram of the proposed project is given in following Figure-2.

Figure-2: Process Flow Diagram



Source: BEPCL, 2018

E 3.0 Resource Requirement

E 3.1 Land Requirement

The proposed project will be set up within the premises of the leased privately owned land from Iso Tech Electrification Company Limited and lease of government (Khas) land. However, all the lease land will be transferred to the project company in future except the government (Khas) land. The total land required for the proposed power plant is 174 acres comprising single cropland, settlement area, homestead vegetation, ponds, canal and barren land consists of shrubs and bushes.

E 3.2 Water Requirement and Supply

The total water requirement for the proposed project will be around 48,115 m³/hour during its operational phase. The required raw water for the proposed project will be withdrawn from the nearest Buriswar-Payra River.

E 3.3 Manpower Requirements

During the operation of the proposed 350 MW power plant, about 172 personnel will be required for operation, maintenance and administration purposes.

E 3.4 Chemical Requirement

During the operation of the proposed power plant, different types of chemicals will be required in different units. Chemicals will be required in the ETP, WTP and STP units for raw water processing, effluent treatment.

E 3.5 Fuel Requirements

The main fuel to be used for generating electricity will be the imported coal. Based on the estimations of the Feasibility Report, the daily coal requirement for the generation of 350 MW power by operating 1 x 350 MW power plant shall be 3304.84 tons and 1.1185 million tons per year. Secondary fuel oil will also be used cold start up with initial warm up. A detailed EIA study for coal transportation will be done separately after getting EIA approval for the main power plant from DoE.

E 4.0 Detail Description of the Land Cover/Land Use

The land use/cover inventories are an essential component in land resource evaluation and environmental studies due to the changing nature of land use patterns. The existing land use study for the proposed project and its 10 km radius is given below in Table-3.

Table-3: Existing Land Use in the Project Area

SL#	Land Use/Cover Classes	10 km Study Area	
		Area (Acres)	Area (%)
1	Agricultural land	3,7574.55	41.59
2	River and Khal/Canal	2,7816.94	30.79
3	Settlement with Homestead Vegetation	1,3946.04	15.44
4	Mangrove Forest	5,432.64	6.01
5	Mangrove Plantation	3,629.54	4.02
6	Mud Flat	3,629.54	4.02
7	Pond	293.84	0.33
8	Sand Beach	203.75	0.23
9	Aquaculture	184.22	0.20
10	Vegetation Cover	127.54	0.14
11	Built-up Area	107.19	0.12
12	Brick Field	53.85	0.06
13	River Bank	48.48	0.05
14	Salt Pan	11.56	0.01
Total		90337.92	100.00

Source: Physical feature survey by EQMS, 2018 and interpret from Google Earth

E 5.0 Baselines Environmental Condition

E 5.1 Methodology of the Study

Keeping in view the nature of activities, the process of power plant and various environmental guidelines, the area covering a radial distance of 10 Km from the boundary of the plant site was selected as study area for the purpose of EIA study. To establish baseline status of air, water, noise, land, biological and socio-economic environment in the study area, extensive field studies were undertaken in and around power plant during the pre-monsoon and monsoon season in 2018.

E 5.2 Meteorology

E 5.2.1 Temperature

The variation of maximum, minimum and average temperature recorded at the Khepupara weather station. The data analysis of 30 years (1987-2016) shows that monthly maximum temperature varies from 30.5°C to 40°C whereas the monthly minimum temperature varies from 7.7°C to 23.0°C. The lowest average temperature recorded in the past 30 years was in January 2013 (7.7°C). The highest temperature reached 40°C in April 2014. Throughout the year, the highest temperatures are generally in March through October and the lowest temperatures are from December to January.

E 5.2.2 Rainfall

About 80% of the rainfall occurs over six months (May to October) with June to August getting the maximum rainfall. The last 30 years data of the Khepupara meteorological station shows that the annual average of total rainfall is recorded as 2861.0 mm/year.

E 5.2.3 Humidity

The monthly average relative humidity varies from 75.6% to 88.3% in the project area. Humidity remains high in monsoon (June to September) and post-monsoon (October and November) season and comparatively low in winter (December to February) season. Relative humidity in the project area is generally above 80% during June to December. The month of February is the driest with the relative humidity around 75%.

E 5.2.4 Wind Speed

Wind direction and speed exhibits seasonal variation. Winds are generally moderate during non-monsoon season whereas during the monsoon season, these are moderate to strong. The average wind speed in the project area is 2.72 m/s. Pre dominant wind speed varies from 1.50-3.50 m/s which is almost 60.1% of the year.

E 5.3 Topography

The terrain of the proposed study area is fairly flat gently sloping from west to east. According to the feasibility report, the proposed project site is on the wide and open terrain with an average elevation of 0~3.41m (based on Mean Sea Level).

E 5.4 Physiography

According to the physiography of Bangladesh, the proposed project area falls under the physiographic unit of "Ganges Tidal Floodplain".

E 5.5 Geology

According to the Geological Survey of Bangladesh (GSB), the proposed project area falls in the two geological units "Tidal deltaic deposits and Mangrove swamp deposit".

E 5.6 Soils

The study area can be classified as "Non-calcareous Grey Floodplain Soils (Non-saline)",

E 5.7 Hydrology and Drainage

The proposed plant site is located at the confluence of the Buriswar-Payra River, Bishkhali River and the Bay of Bengal.

E 5.8 Agro-ecology

The major types of agro-ecological unit is reported from the study area is include "Ganges Tidal Floodplain"

E 5.9 Environmental Qualities

E 5.9.1 Ambient Air Quality

Ambient air quality was monitored at four numbers of air quality stations (2 seasons and 4 weeks duration) and its was observed that the level of SPM, PM₁₀, PM_{2.5}, SO₂, NO_x and CO are well within the standards prescribed by the DoE, Bangladesh.

E 5.9.2 Ambient Noise Quality

To understand the noise environment in the study area, a noise survey was conducted using a sound level meter. Noise measurements were carried out at eight locations (Industrial, Silent, Commercial, Residential and Mixed category) at different environmental conditions as per the DoE, Bangladesh guideline. All the measured noise level was within the DoE, Bangladesh permissible limit.

E 5.9.3 Water Quality

To understand the water quality in the study area, four surface water samples were collected during the baseline survey from the proposed project area. Two samples were collected from the Buriswar-Payra River (one from upstream of the project and another one from downstream of the project site). The two surface water samples were also collected from the Joyalbhanga Canal and pond near the project site. These samples were taken as grab samples and were analyzed for various parameters to compare with the national standards. The surface water samples analyzed and compliance to the use in different purposes as per the standards of ECR, 1997 (Schedule 3: Standards for water). From the result, it is found that, pH level of all the surface water samples are over the standard limit of the ECR, 1997, BOD level at SWQ-2 and SWQ-4 is not suitable for “source of drinking water for supply only after disinfecting” and DO level at SWQ-3 indicates that it is not suitable for any kind of use.

Four groundwater (deep tube well) samples were collected from the study area. After collection, the groundwater samples were sent to the DPHE and BCSIR laboratory at Dhaka for further examination of the ground water parameters. Water samples were collected in pre-washed one-liter plastic bottles and 250 ml sterilized clean PET bottle for complete physio-chemical and bacteriological tests respectively. The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. According to the test result, mercury, pH, potassium and sodium was exceed the permissible limit of the ECR, 1997. However, total coliform and fecal coliform was absent in the groundwater.

E 5.10 Biological Environments

The study area for ecological survey includes an area within 10 km radius of the proposed project site. The study area covers Tengragiri Wildlife Sanctuary, which is the second largest mangrove forest of Bangladesh and Laldia Reserve Forest, which is a delta of the Sundarbans Reserve Forest. Land use of buffer area includes agricultural land, ocean, river, canal, homestead forest, mangrove forest etc. As the proposed project location is situated adjacent to the planted mangrove patches and confluent of the Buriswar-Payra River and the Bay of Bengal, it covers a rich biodiversity.

E 5.10.1 Bio-ecological Zone

The study area has fallen under two bio-ecological zones: i) Saline Tidal Floodplain; and ii) Coastal and marine waters.

E 5.10.2 Protected Areas

According to the Bangladesh Forest Department list of the protected areas, the closest protected area (Tengragiri Wildlife Sanctuary) is located within the 10 km buffer of the project area.

E 5.10.3 Ecological Critical Areas

The nearest ECA area from the proposed project boundary is the “Sundarbans (10 km landward periphery)”. The description of ECA areas are discussed in following subsequent sections.

E 5.10.4 Migratory Bird Staging Area

The proposed project area does not fall in any Important Bird and Biodiversity Areas (IBAs).

E 5.12 Socio-economic Environment

The socio-economic features of the study area are discussed in this section:

- **Population and Demography:** In the proposed study area, there are about 25,321 households (HHs) including squatters with a total population of 104,439;

- **Sex Ratio:** average sex ratio is 98 and the average household size is 4.0, whereas average population density is 358 per sq. km;
- **Religion:** dominated by the Muslim community constituting almost 95.2% of the total population. The remaining 3.78% is Hindu, whereas, Buddhist (1%), Christian (0.01%) and others (0.05%) are very negligible in percentage;
- **Ethnic Composition:** about 1,058 people (Rakhain-1,057 and others-1) of the ethnic community has been found in the proposed project study area.;
- **Cropping Pattern:** cropping intensity of the union is 121%, which is low compared to national average;
- **Education:** According to the population and housing census (2011), it shows that the concentration of literate people in three and two unions of Taltali and Barguna Upazila. The literacy rate in the study area is 54.6%, which is higher than the national average of 47.68%
- **Settlement and Housing:** predominant structure of this study area is Kutcha (52%) followed by Jhupri (15%), Semi-pukka (43%) and Pukka (0);
- **Housing tenancy:** Housing tenancy of the study area is owned by (94.6%), rented (4.3%) and rent free (1.1%);
- **Water Supply:** major source of drinking water is tube-well where about 90.78% population use tube-wells water. About 0.20% people have access to tap water. Other 9.03% people have access neither tube-well nor tap water;
- **Electricity:** almost 20.0% of the households have grid electricity connection;
- **Sanitation:** about 56.7% and 26.4% of households use water-sealed and non-water-sealed sanitary latrine facility, respectively, whereas about 14.9% households use non-sanitary facilities. Around 3.6% households defecate in open places with no access to hygienic latrine facilities.

E 6.0 Environmental Impacts Assessment and Evaluation

A matrix method (Table-4) has been adopted for identifying the possible environmental and social impacts.

Table-4: Impact Identification Matrix for the Proposed Project

Potential Impacts/Risks Activity	Environmental, Ecological and Social component																								
	Aesthetic & Visual Impact	Landscape	Land use	Soil Quality	Sediment Quality	Surface Water Quality	Surface Water Quantity	Ground Water Quality	Ground Water Quantity	Air Quality	GHG Emission	Noise Level	Vibration level	Drainage Pattern	Traffic (Road & River)	Terrestrial Ecology	Aquatic Ecology	Occupational Health & Safety	Economy and Livelihood	Employment	Population Displacement	Social and Cultural Structure	Infrastructure & Services	Community Health & Safety	Social Conflict
Pre-construction and Development Phase																									
Land Acquisition, Requisition and Lease																									
Removal of vegetation/trees																									
Soil collection (dredging) and transportation to the project site																									
Land filling, levelling, excavation and compaction																									
Equipment & machinery operation in the project site																									
Maintenance, replacement of vehicles & equipment																									
Establishment of temporary labor camp & employment opportunities																									
Construction Phase																									
Establishment and maintenance of Labor camp																									
Generation of solid waste from labor camp and disposal																									

Potential Impacts/Risks Activity	Environmental, Ecological and Social component																								
	Aesthetic & Visual Impact	Landscape	Land use	Soil Quality	Sediment Quality	Surface Water Quality	Surface Water Quantity	Ground Water Quality	Ground Water Quantity	Air Quality	GHG Emission	Noise Level	Vibration level	Drainage Pattern	Traffic (Road & River)	Terrestrial Ecology	Aquatic Ecology	Occupational Health & Safety	Economy and Livelihood	Employment	Population Displacement	Social and Cultural Structure	Infrastructure & Services	Community Health & Safety	Social Conflict
Abstraction of water for construction activities and labor camp																									
Construction of Jetty (river side)																									
Transportation and storage of construction materials																									
Storage and handling of chemicals																									
Machineries and equipment’s operation and maintenance in the construction site																									
Civil construction																									
Mechanical and Electrical Erection Activities																									
Influx of labor																									
Removal of labor camp																									
Operation Phase																									
Imported coal from abroad and transport through vessels to coal handling jetty																									
Unloading, Crushing and Storage of Coal																									
Emission generated from stack																									

Potential Impacts/Risks Activity	Environmental, Ecological and Social component																								
	Aesthetic & Visual Impact	Landscape	Land use	Soil Quality	Sediment Quality	Surface Water Quality	Surface Water Quantity	Ground Water Quality	Ground Water Quantity	Air Quality	GHG Emission	Noise Level	Vibration level	Drainage Pattern	Traffic (Road & River)	Terrestrial Ecology	Aquatic Ecology	Occupational Health & Safety	Economy and Livelihood	Employment	Population Displacement	Social and Cultural Structure	Infrastructure & Services	Community Health & Safety	Social Conflict
Fugitive emissions are envisaged from handling and storage of coal in the stock yard, fly ash handling systems and transfer operations																									
Generation of noise from boiler sections areas, loading and unloading area, machineries and vehicles movement																									
Utilization of surface water from Buriswar-Payra river for the power plant operation																									
Generation, treatment and disposal of effluent																									
Domestic and other non-hazardous wastes handling, storage and disposal																									
Hazardous material and waste storage																									
Maintenance and replacement of equipment																									
Greenbelt development																									

E 6.1 Pre-construction and Development Phase

During the pre-construction stage of the proposed project, the major impacts will be found due to land acquisition, resettlement and compensation. According to the preliminary RAP survey, approximately 112 number of households will be directly affected due to land acquisition for the proposed project. Another major impact on terrestrial ecology during the pre-construction phase will be from the removal of trees and vegetation. According to the RAP preliminary survey, approximately 14,526 trees will be affected due to the project implementation consisting 6,315 big size (≥ 90 cm), 3,382 medium size ($=60-89$ cm), 2,520 small size (<60 cm) and 2,309 sapling trees. In addition that, approximately 2,346 number of annual plants including Banana, Bamboo and Papaya will be affected. Soil extraction from the sea area for land development will impacts on aquatic ecology. Noise level will be increased during the land filling, levelling and movement of workers. Top soil inside of the project boundary will be impacted by the pre-construction phase activities. Inappropriate waste management can have consequences on soil quality. Due to the land filling in the existing project site and closing the existing canal, drainage system in the project site and surrounding area will be impacted. During the pre-construction phase, temporary employment opportunities for the skilled, semi-skilled and unskilled persons will be generated.

E 6.2 Construction Phase

During the construction stage major impacts on the fisheries resources, water bodies and soil. Ambient air quality will also be impacted from the exhaust emission from the construction vehicles, vessels, machineries and equipment's. During the construction period, major noise generation will be from the transportation facilities, civil construction including concrete mixing plant, brick and stone crushing machine etc. Vibration will be generated from the piling activities and movement of heavy vehicles, instruments and machineries. Construction wastes, such as metal cutting, debris, packaging materials, which may contaminate soil at the site of construction. Liquid and solid wastes will be generated from the construction labor camp facilities and improper disposal during the construction phase can pollute soil quality as well as the water quality. Accidental spillage or inappropriate management of fuels, engine oil and hazardous chemicals during the maintenance and replacement of vehicles and equipment's can pollute the surface soil. The proposed project sites do not cover any ecologically sensitive area. Noise, vibration, dust and wastes from heavy machineries and equipment operation, piling, excavation, concrete work, construction of the internal road network, physical presence of workers, improper storage and management of wastes may impacts upon the ecosystem. During the construction of jetty, approximately 100 to 200 number of planted mangrove trees will be required to remove from the proposed jetty location. The construction phase of the proposed power plant will be created employment opportunities for the skilled, semi-skilled and unskilled workers. The project construction phase will also be able to generate indirect employment opportunities (small shops like tea stalls, hotels, supply of intermediate raw materials, repair outlets, hardware stores, etc.) apart from direct employment. This will be a positive socio-economic development for the region. The population influx in the project area can lead to unwarranted pressure on key local infrastructures such as water, healthcare, electricity and road etc. This could lead to increase in sexually transmissible diseases (HIV/AIDS, syphilis among others), injuries and loss of life or properties.

E 6.3 Operation Phase

During operation of the proposed power plant, the main source of air pollution comes from the combustion of coal in the boilers. In order to estimate ground level concentrations for each study pollutant, an atmospheric dispersion modelling study was undertaken using the USEPA preferred AERMOD dispersion models. According to the model result, highest concentration of NO_x is found as 29.95 $\mu\text{g}/\text{m}^3$ (24 hours), SO₂ is 26.60 $\mu\text{g}/\text{m}^3$ (24 hours) and 24.44 $\mu\text{g}/\text{m}^3$ (annual) and SPM is 112.88 $\mu\text{g}/\text{m}^3$ (8 hours) at AAQ-4: Taltoli Bazar. The total CO₂ production due to coal combustion during boiler operation in the proposed project, has been estimated using the guidance document 'Calculation Tool for Direct Emissions from Stationary Combustion, GHG protocol' and will be about 1.85 million tones/year. The environmental noise prediction model SoundPLAN 7.4 was used for modeling noise emissions from the power plant operation. According to the model result, noise level will be increased inside of the power plant operation site and surroundings of the project site. In few

places may experience 2-3 dB (A) excess noise than the present noise level during operation of the proposed 350 MW coal-fired power plant.

The proposed coal-fired power plant will utilize a once-through cooling system for the condenser. A once-through cooling system carries off waste heat from the power plant by means of water flowing through the condenser and discharges it to the natural water body, which will impacts on the availability, breeding, migration of fish resources and aquatic ecosystem in the Buriswar-Payra River. The following two models were used for the plume water modelling study: Initial mixing zone model (CORMIX) and three-dimensional hydrodynamic model (Delft3D). According to the CORMIX model result, “maximum distance of contours of temperature rise of 3°C away from the outlet is about 10.6 m (less than 100 m)” and Delft3D model “maximum distance of temperature rise contours of 3°C away from the outlet will be less than 20 m for the neap tide during the wet and dry seasons”.

Ash yard management will be the major concern during the operation of the power plant. Plant operation and its associated activities will increase the ambient noise level in the project surrounding area. Improper management of waste from the plant will impacts on the surrounding aquatic and terrestrial environment. During the operation of the proposed project, major solid waste will be the ash. Improper management of ash yard will impacts on groundwater quality, soil quality, terrestrial flora, dust emission, surface water pollution etc. Direct and indirect employment opportunities will be generated. However, the fishing activities, income and livelihoods of the fisherman community may be impacted. However, detail impacts assessment and evaluations are described in Chapter-8 in this EIA report.

E 7.0 Mitigation Measures

The impact significance was evaluated based on nature of impacts, extent, duration, intensity/severity, irreplaceable, probability and magnitude of impact. Based on the significance of impacts, mitigation of negative impacts has been proposed in Chapter-9 in this report. Aftermath, this study suggests necessary mitigation measures to the project with the objective of limiting negative impacts as minimum as possible in compliance with ECA, 1995 and enhancing ecological and societal benefit.

E 8.0 Environmental Management Plan

As per the scope of EIA study, a detail EMP has been developed that shall be duly implemented in project pre-construction, construction and operation phase in order to minimize the negative impacts. The environmental and social management plan has been described elaborately in Chapter-10 in this report. The capital cost for environmental management of the proposed plant is estimated to be BDT 44.5 million. Budget allocation of BDT 17 million will be required every year to meet the recurring expenditure for implementing the EMP excluding the monitoring.

E 9.0 Risk Assessment

Assessment of risk of the environment and occupational safety is important for this power plant project. The hazards and risk of the proposed power plant has been identified precisely in this EIA study by using ALOHA. This study has been carried out to identify the potential hazard associated with or inherent in the design process and to identify the possible measures to avoid any hazard along with the safety plan for minimizing the risk. Attempt has been made to identify the point of hazards, chemical sources, and zone of influences, associated risk, emergency and safety plan sequentially.

E 10.0 Environmental Monitoring Plans

Successful implementation of the EMP depends on regular monitoring with the selected indicators at specified locations in and around the project area. The automatic inbuilt monitoring devices regularly update every potential source of hazards and the project personnel will submit the performance report, particularly quality of the environmental parameters like air, water, noise, soil, sediment, ecology etc. compliance to ECR, 1997 and subsequent amendments. The EHS personnel of BEPCL will monitor the effectiveness of the EMP implementation. Quarterly Progress Reports that can be submitted to the regional office and head office of the DoE required as a part of environmental

clearance process shall also be prepared and submitted based on the necessary monitoring and reporting formats. The EHS officer of the contractor should monitor the EMP implementation during preconstruction and construction phase and submit report to the concerned department. The monitoring cost has been incorporated in the report as 1.07 million for pre-construction phase, 24.4 million for construction phase and 14.8 million for per year operation phase of the proposed power plant project. A details monitoring plan for the proposed project is also depicted in Chapter-12 in this report.

E 11.0 Work Plan

The pre-construction phase will be 4 to 6 months duration and construction phase will be 30 months duration. The expected commercial operation will be started in June 2021.

E 12.0 Project Benefits

The proposed 350 MW coal-fired power plant will be established at Taltoli Upazila of Barguna District. The proposed project by BEPCL would enable to meet part of the electricity demand in the national grid. The proposed project will create direct and indirect employment opportunities for the local community. Small and medium scale industries may be further developed as a consequence. The proposed power plant will result in improvement of infrastructure as well upliftment of social structure in the area. It is anticipated that the plant will provide benefits for the locals in three phases i.e. pre-construction, construction and operation phase. Details are given in Chapter-14 in this report.

E 13.0 Stakeholder Consultation

The public consultation meeting was held on 27th October 2017 (Friday) at the premises of the Kadamtola Jame Mosques, Bara Ankujanpara village, Nishanbaria Union in Taltoli Upazila, Barguna. The proceedings were commenced at 10:00 AM. The meeting was attended by a total of 60 people, which represent local people, businessman, farmer, fisherman, service, imam, social workers, student, senior citizen, housewife and officials from project proponent. Detail description of the public consultation meeting is discussed in Chapter-15 in this report. A range of stakeholder engagement and consultation methods have been used to identify concerns, issues and suggestions for the project. This included any suggested management and mitigation measures. This involved consultation, KII and FGD. This EIA has addressed each stakeholder concern with the development of specific mitigation and management measures.

E 14.0 Conclusions

The EIA study team members observed that the site of the proposed project is situated near the confluence of the Bay of Bengal and Buriswar-Payra River and the land is a single cropped land, settlement, pond, canal, vegetation or trees and barren land. From the EIA study, it is found that major impacts on environment in the area due to implementation of the power plant project would be resettlement, compensation, vegetation/tree removal, closing of existing canal, air pollution, noise pollution, surface water pollution, ground water pollution, soil pollution, sediment pollution and impacts on aquatic ecology in pre-construction phase and construction phase. Gaseous emission burning of coal, wastewater from workers camp and industrial process units, impacts on aquatic ecology due to the heated cooling water disposal, accidental spillage of hazardous materials and noise from power plant etc. These problems would be overcome by taking proper mitigation measures as stated in the EMP. There are also very significant positive impacts during pre-construction, construction and operation like local people job opportunities and increase business opportunities.

E 14.1 Recommendations

The following recommendations are made based on EIA study that should be considered for achieving the goal of optimum minimum environmental and social impact and optimum benefits:

- Proper resettlement and rehabilitation plan is necessary for proper compensation to project affected people;
- People those who are not owner but dependent on the land to be acquired should be compensated and create scope for alternative livelihoods;

- The project proponent must excavate alternative canal before starting the land development activities and site cleaning activities in the project site. It must be considered the width, length, depth and use of existing canal;
- A drainage study including detailed survey must be conducted by the project proponent to avoid the waterlogging in the proposed project surrounding area;
- Income and employment opportunities for the local community and strengthen the CSR activities for the local community;
- No disturbance of fishing in the Buriswar-Payra River near the project site;
- Green belt development in and around the project site;
- No disturbance of fish migration and reduce the activities during Hilsa Breeding season;
- Conduct fish survey and dolphins in the Buriswar-Payra River during construction and operation phase of the proposed project;
- All types of waste should be collected, storage and recycle/ treatment properly for further reuse;
- Findings and suggestion of EIA study in project planning, design and operation should be considered and implement with strong monitoring;
- All activities (pre-construction, construction and operation stage) should be implemented according to the proposed EMP;
- Environmental Management Plan, Emergency/Disaster Management Plan should be implement at every suggested steps of proposed power plant pre-construction, construction and operation;
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety during pre-construction, construction and operation phases of the project;
- EMP has been formulated considering anticipated impacts. However, further updating of impact management procedure must be made with respect to spatial and temporal regularly based on monitoring of impacts during pre-construction, construction and operation of the project;
- The plant should be operated ensuring all pollution abatement measures; and
- The present EIA report finds that though there are certain adverse environmental impacts associated with the project unit, those are however manageable. In light of the above, the project proponent, BEPCL may be allowed to go ahead with the implementation of the Project.

CHAPTER ONE: INTRODUCTION

1. Introduction

1.1 Background

In order to contribute toward meeting the growing electricity demand in Bangladesh, the Barisal Electric Power Company Limited (or the “BEPCL”) has taken an initiative for developing a coal-fired power plant. The BEPCL had identified a site near village Bara Ankujan Para and Joyalbhangra in Chhota Nishanbaria Chak Mouza, Nishanbaria Union, Taltoli Upazila under Barguna District of Barisal Division, Bangladesh. The geographical location map of the proposed project is shown in following Figure 1-1. The proposed project will be set up within the premises of the leased privately owned land from Iso Tech Electrification Company Limited and lease of government (Khas) land. However, all the lease land will be transferred to the project company in future except the government (Khas) land. The proposed project will have a gross generation capacity of 350 megawatts (MW). This project is being set up as a part of the power generation augmentation program of the Government of Bangladesh (GoB).

The proposed project has been prepared to take into consideration of the requirement of land, water and other basic infrastructure accordingly. The proposed power plant will be operated by the Barisal Electric Power Company Limited (BEPCL) and will be based on 100% imported coal.

1.2 Purpose of the Study

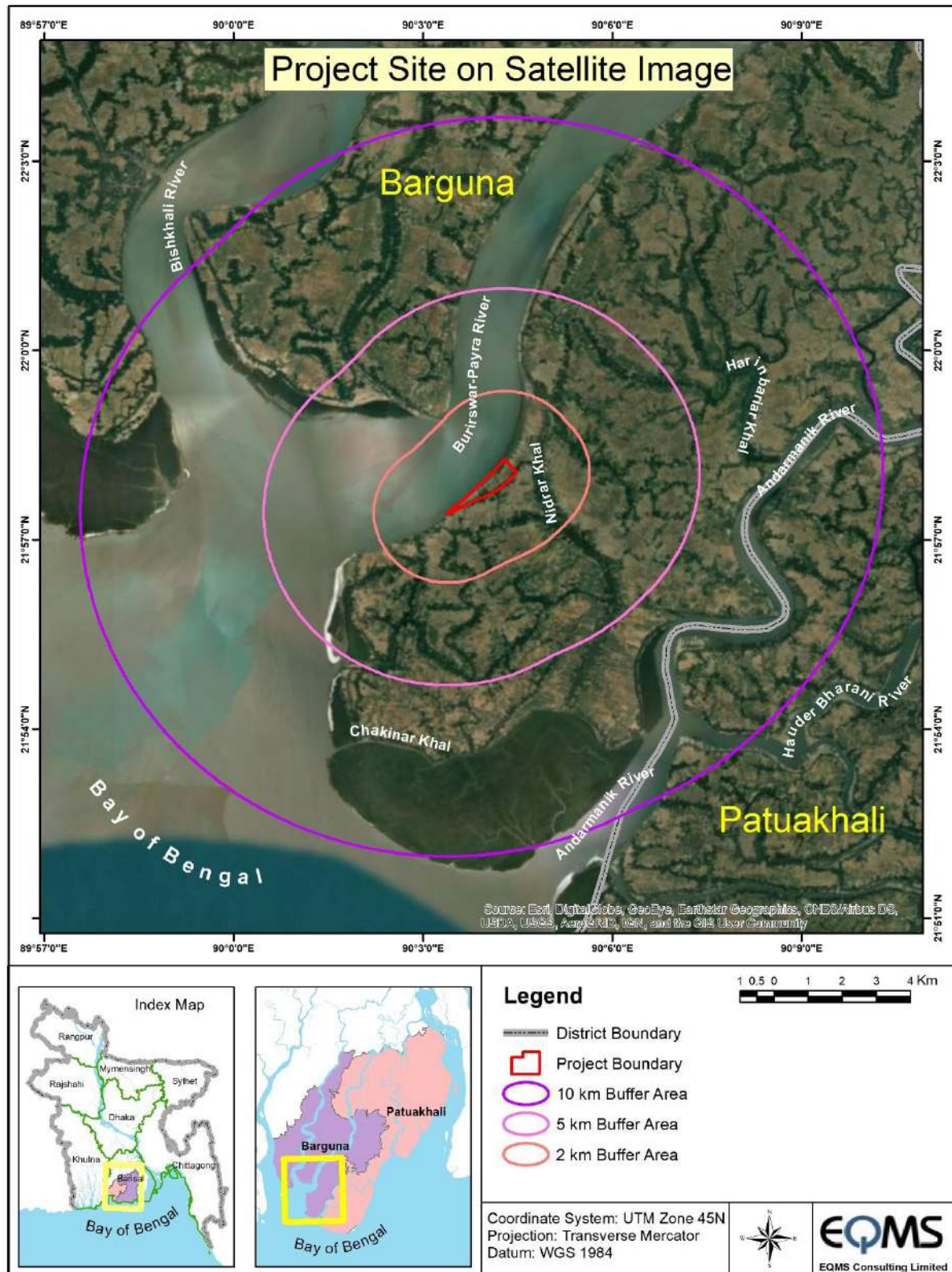
As per the Environment Conservation Rules, 1997 and subsequent amendments (Schedule-1: Classification of industrial units or projects based on its location and impact on environment) proposed coal-based power plant falls under the “Red” category project and needs Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from the Department of Environment (DoE), Bangladesh. As per the ECR 1997 and subsequent amendments, project proponent conducted the Initial Environmental Examination (IEE) study and get site clearance in 428th meeting of the DoE dated 06/06/2018.

The Environmental Impacts Assessment (EIA) report has been prepared for the proposed power plant to get prior environmental clearance (EC) from the DoE. The present EIA report has been prepared based on the Terms of Reference (ToR) approved by DoE, vide Memo No: 22.02.0000.18.72.74.18-378; Dated: 14th June 2018 and based on the primary data collected during April to September 2018.

The overall objective of the present study is to conduct an EIA study of the proposed 350 MW coal-fired power plant at Taltoli Upazila in Barguna District with the purpose of obtaining ECC from the DoE. The specific objectives of the study are:

- Identification of national and international legal environmental requirements;
- Establishment of the Environmental and socio-economic baseline condition of the proposed project area and the surrounding area;
- Delineate the anticipated significant environmental and socio-economic issues found and believed to be involved;
- Identification of the environmentally preferred process and technology alternatives;
- Identify the environmental impacts of the project and quantify them to the extent possible;
- Assessment of occupational risk and hazard;
- Identification of possible mitigation and abatement measures to reduce the significance of potential impacts;
- Development of Environmental Management Plan (EMP).

Figure 1-1: Project Site at Taltoli Upazila in Barguna District



Source: EQMS, 2018

1.3 Need of the Project

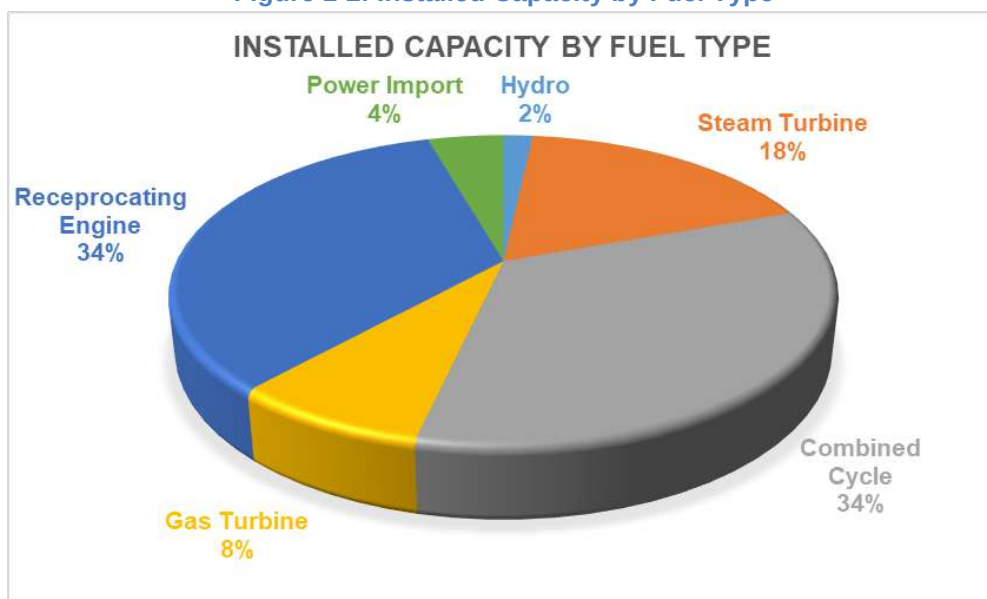
Electric energy is known as the vital utility and prerequisite for simulating the industrial and commercial activities in the economic development of any country. In recent time, the country has witnessed significant growth in the power sector especially the power generation. However, there has been a sustained deficit in the power supply and it is expected to increase further in the future.

Bangladesh is also considered one of the most arousing energy growth nations. About 76% of the total population of the country has access to electricity (including renewable energy) up to June 2016. The Government has taken necessary initiatives to reform and restructure the power sector to make electricity available to all by 2021.

Electric power also has an important role to play in alleviating poverty and enhance social and economic development in Bangladesh. Therefore, the demand for electric power in Bangladesh especially in the sectors of industry, agriculture, utility service, households, etc. is increasing day by day. The demand, over the years, has attained an overwhelming dimension as the supply positions continue to fail gradually and ever-increasingly to meet all the more ever-increasing demand. Coming-in of various industrial activities in a previously not-so-much industrialized country like Bangladesh, cropping up high-rise industrial as well as residential complexes, manifold diversification of power consumption, etc., compared to the limited and insufficient growth of the power sector till date, have been the reason behind the present-day power crisis in the country. Government sponsored conventional power generation and distribution system alone is incapable of overcoming the prevailing trend of power crisis within a short period, while the demand position warrants immediate action. A public-private partnership is, hence, adopted toward meeting the power crisis and, hence, keeping the pace of economic development unhindered. The Bangladesh Power Development Board (BPDB) has been the only agency in the government sector for the production of power and its sale and distribution to household, office, agriculture, industrial and various other purposes. The situation pertaining to the power sector under BPDB is as follows:

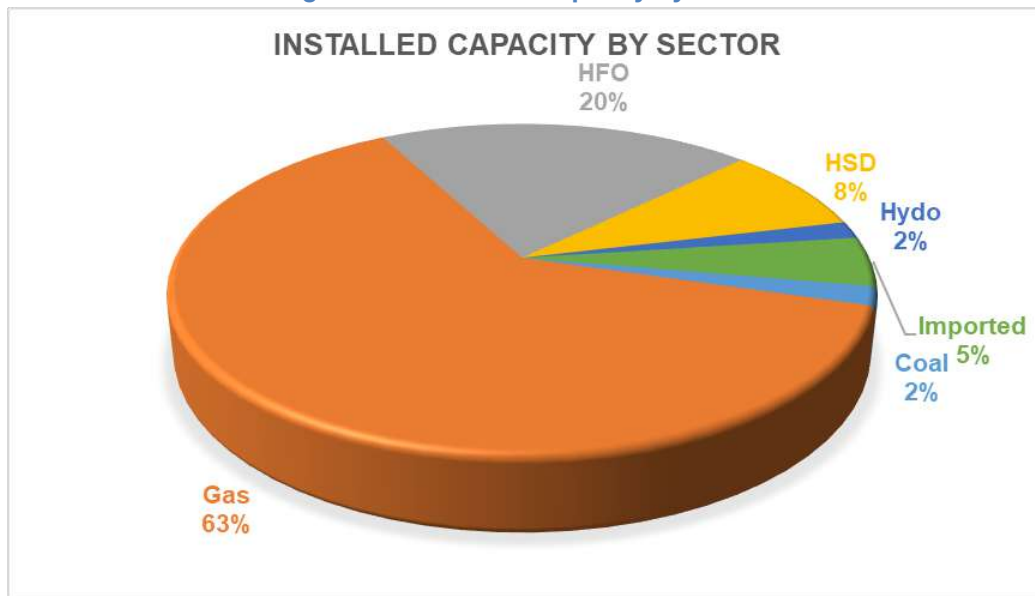
According to the BPDB in July 2017, the installed generation capacity in the power sector was 13,555 MW. On average 77.9% population have access to the electricity in Bangladesh and per capita generation was 348 kWh, which is very low compared to other developing countries. The net capacity of the installed power plant was 13,555 MW of which 34.12% came from Combined Cycle 33.87% from Reciprocating Engine type, 8.15% from Gas Tribune. However, Hydropower plant with a capacity of 230 MW contributed least (1.70%) in the total power sector (Figure 1-2). Of the total generation in June 2017, public sector power plants contributed 55.12% while private sector contributed 40.44% and rest 4.40% were imported. The share of gas, hydro, coal and oil-based energy generation was 62.62%, 1.69%, 1.84% and 20.51% in power generation respectively (Figure 1-3). The net electricity generated in FY 2012-13 was 38,230.27 MWh, in FY 2013-14 was 42,195.71, FY 2014 -15 was 45,835 and FY 2015-16, 52,193 MWh i.e. net energy generation growth in FY 2015-16 was 13.87% more than the FY 2014-15. The installed capacity by fuel type and the capacity shared by public and private sectors as of June 2017 are shown in the following Figure 1-2 and Figure 1-3 respectively.

Figure 1-2: Installed Capacity by Fuel Type



Source: BPDB, 2017

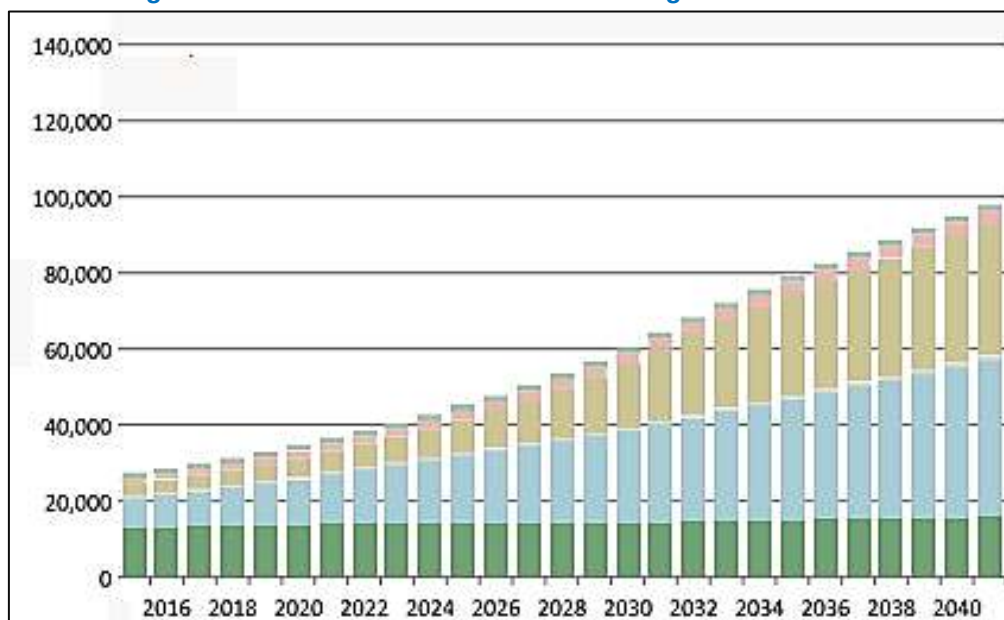
Figure 1-3: Installed Capacity by Sector



Source: BPDB, 2017

Currently, thirty-one (31) power plants with a total generation of 9,631 MW are under construction at this moment countrywide and the plants would go into operation in the phase during 2017-2019. Sixteen power plants with 5,625 MW capacity are in the public sector and 15 with 3,716 MW are in the private sector. Still, there is a shortage of electricity demand and production. According to the forecast by JICA Study Team, according to the government policy of Bangladesh, in 2030 the power demand would increase to around 33,000 MW. The power demand forecast in Bangladesh (2010 to 2030) is given in the following Figure 1-4.

Figure 1-4: Power Demand Forecast in Bangladesh 2010-2030



Source: JICA Study Team

To achieve the goal, different coal-based power plants are planned for the period from 2017 to 2021. Still, the power supply tension in Bangladesh will keep escalating along with load growth. The PGCB and ministry of MPEMR draw up plans to increase the capacity of power plants and meet load growth demand. In order to cope up with the increasing gap in power demand and supply, GoB has widened the scope of private sector investment/participation in the electricity generation by allowing them to set up power plants. With a view to harvesting the current opportunity, BEPCL initiated proceedings for setting up of a power plant in the Barguna District of Bangladesh.

1.4 Importance of the Project

The proposed power plant will add 350 MW electricity to the national grid that will improve the country's present electricity generation significantly and as well as trigger our national economic development. Not only that, industrial development will be initiated after implementation. Additionally, it will be created employment opportunity for the local people and improve the transportation system in the project area, which will ultimately play an important role in poverty reduction and develop social safety net condition. Moreover, this coal-based power plant will thereby play an important role in fuel diversification in electricity generation and reduce pressure on natural gas reserve.

1.5 Scope of EIA Study

The EIA report is prepared based on the guidelines and requirement of DoE, Bangladesh. The study area for the EIA is 10 km radius area around the periphery of the proposed power plant. Environmental and social baseline monitoring has been carried out during pre-monsoon season (March to May 2018) and monsoon season (June to September 2018) and used to identify potential significant impacts. Modelling exercises have been carried out to predict and evaluate impacts due to the proposed coal-fired power plant. An Environmental Management Plan is included in the report.

1.6 Approach and Methodology

The approach and methodology are outlined based on information available about the proposed project and our previous experience of understanding of coal-based power plant projects and regulatory requirement in Bangladesh and the requirements to meet EIA as DoE standards.

In terms of the study implementation for the project, EQMS primarily review all the project documents and feasibility report. The main focus of the EIA study was to anticipate environmental and social effects, both positive and negative that may result from the project or its alternatives as well as their potential magnitude, reversibility, period of occurrence, nature etc. predictions were considered all aspects and phases of the project and any indirect environmental and social effects and any environmental effects that may result from accidents or malfunctions. The EIA study of the proposed project was followed a systematic process of:

- **Screening Study:** The proposed project falls under Item Red category as per Schedule–1 of ECR, 1997 for power plants, therefore, would require EC from the DoE based on IEE and EIA, carried out as per the approved terms of reference for the EIA study;
- **Scoping** of the likely potential significant impacts and the geographical temporal scope of these impacts and set out an appropriate methodology for the EIA to assess these impacts;
- **Environmental and Social baseline** conditions against which the assessment will be undertaken;
- **Consult with stakeholders and the local community** to integrate their views into the project design and mitigation;
- Systematically **predict and evaluate** the positive and negative changes in these baseline conditions;
- **All impacts and benefits** of the project should be documented and fully explained within the EIA report;
- Identify the **mitigation measures** that BEPCL will take to avoid, reduce, remedy offset or compensate for adverse impacts and to provide or enhance benefits from the project;
- Develop an Environmental Management Plan (EMP); and
- The timeframe for the EIA discussed and agreed with BEPCL subsequent to the initiation of the work.

1.6.1 Reference Framework for the EIA Study

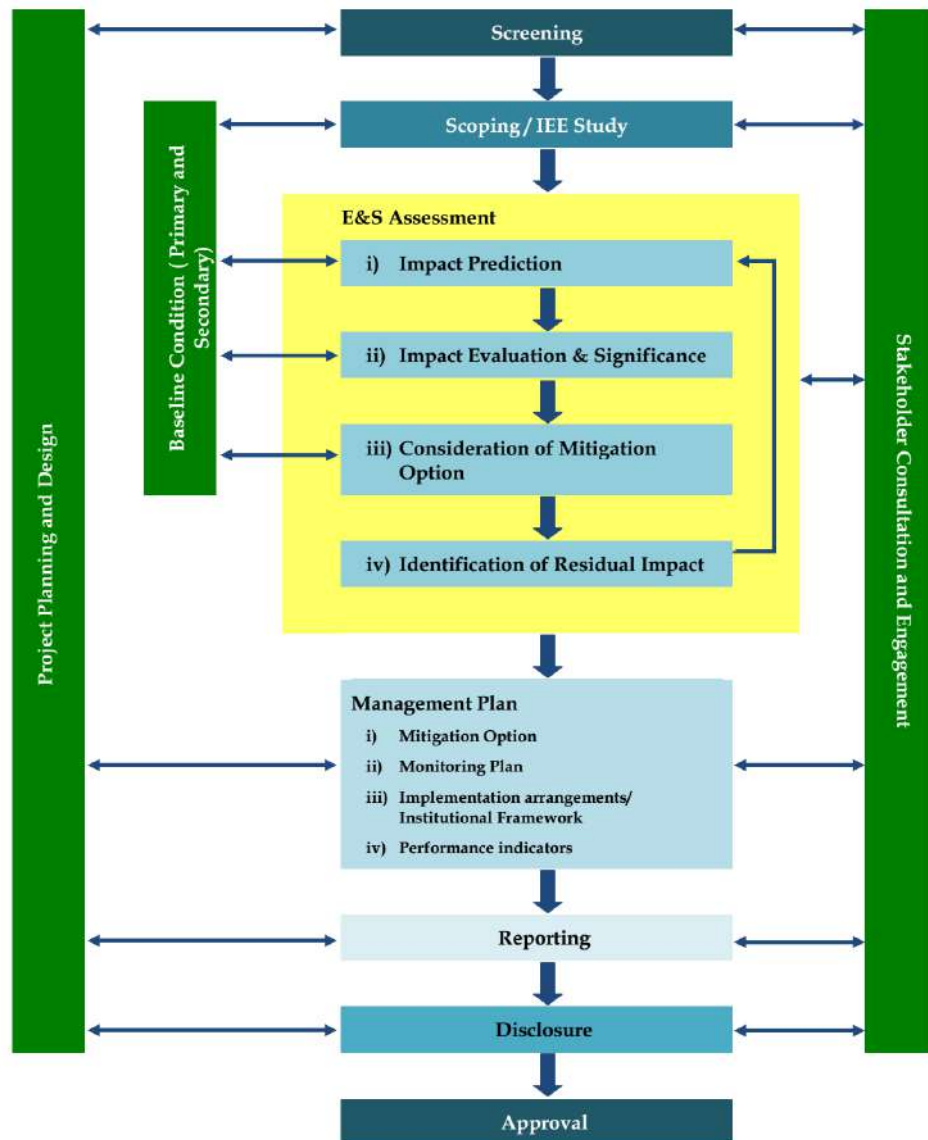
As per discussion for the project, the reference framework will include:

- Environmental Conservation Rules (ECR), 1997 and subsequent amendments; and
- Environmental Conservation Act (ECA), 1995 and subsequent amendments.

1.6.2 Approach for the EIA Study

The approach followed for the EIA study is presented in the following Figure 1-5.

Figure 1-5: Approaches for the EIA Study



Source: EQMS, 2018

1.6.3 Methodology for the EIA Study

In order to attain the earlier mentioned scope of work, the EIA study based on a collection of primary and secondary baseline environmental information, impact assessment and delineation of EMP. The methodology proposed to complete the EIA study was divided into the following tasks as presented in following Table 1-1 and elaborated in subsequent sections.

Table 1-1: Tasks are undertaken for the EIA Study

Task Number	Task
Task-1	Kick-off Meeting and Mobilization
Task-2	Scoping for EIA Study
Task-3	Project Description
Task-4	Environmental and Social Baseline Conditions
Task-5	Environmental & Social Impact Assessment

Task Number	Task
Task-6	Development of EMP
Task-7	Preparation of Draft EIA Report
Task-8	Preparation of Final EIA Report

1.1.1.1 Task-1: Kick-off Meeting

Immediately following the completion of the contract negotiations, the Project Director, together with the Project Manager completed all logistical arrangements. In accordance with EQMS quality requirements, the Project Manager formalizes team-briefing notes outlining the scope of work and outputs required from each of the team members. Shortly after this, a kick-off meeting was held at the BEPCL office with the officials of the client. The main purpose of this meeting was to:

- Clarify our understanding and major objectives of the project;
- Finalize local logistical arrangements and identify continuous points of contact;
- Present key elements of EQMS's approach to fulfill all aspects of the project; and
- During the kick-off meeting, project relevant information was requested to the client.

1.1.1.2 Task-2: Scoping for EIA Study

EQMS was submitted an RFI to the client and upon its receipt, EQMS review it for scoping for the EIA study. The review of Project related information followed the assessment of environment-related regulatory requirements for the Project. Any gaps in the Project information, which is essential for determining impacts/risks and also as a requirement to comply with the applicable environment-related regulations would be sought from the client. Relevant Project related information that was collected from the client includes the following:

- Geographical Co-ordinates of the Project site/Boundary;
- Maps at appropriate scales to illustrate the proposed Project components;
- Brief Project component description - their location etc. on Layout plan; and
- Other Project related information including Project cost, land details, surrounding features, details of construction activities, project duration, implementation schedule, water requirement and source, water balance, manpower, fuel requirement, energy requirement and source, sewage treatment plant, water treatment plant, effluent treatment plant, wastes and other proposed pollution control measures.

1.1.1.3 Task-3: Project Description

A section on project description was prepared. This was developed to a level of detail needed to adequately understand potentially significant project impacts. This was cover project location, size, life, schedule, implementation arrangements and discharge information inventories and maps using appropriate scales. Also, identify components of key environmental indicators on physical, ecological and social environments.

1.1.1.4 Task-4: Environmental and Social Baseline Conditions

The environmental and social baseline data for the assignment was defined as part of the scoping exercise undertaken under task proposed to be collected for 10 km radius from the project site during pre-monsoon season (March to May 2018) and monsoon season (June to September 2018) immediately available dry season. Environmental and social baselines study the following:

- Meteorological data at the project area;
- Ambient Air Quality;
- Ambient Noise Level;
- Water resources and quality - both surface and groundwater;
- Soil and Sediment quality;

- Ecology - covering terrestrial and aquatic flora and fauna (detailed fish survey, Phytoplankton, Zooplankton and Benthos), habitats and ecologically sensitive spots within the project site and surrounding area;
- Road network and Traffic factor;
- Prevailing land use; and
- Socio-economics, Health and Aesthetics.

A. Primary Baseline Data Collection

With the assistance of the client, EQMS has identified an accredited environmental laboratory of repute which was engaged for the collection of baseline information on micro-meteorology, ambient air quality, ambient noise quality, surface and groundwater quality, soil quality and sediment quality as per aspects detailed in the following Table 1-2:

Table 1-2: Primary Baseline Data for the EIA Study

SL#	Environmental Attribute	No. of Locations	Frequency	Remarks
1	Ambient Air Quality	4	24 hours (2 seasons monitoring)	AAQ monitoring covering upwind, downwind and crosswind directions and at Project site
2	Groundwater Quality	4	Once during the baseline survey	Ground Water samples from the nearest deep tube-well
3	Surface Water Quality	4	Once during the baseline survey	Surface water from the Burishwar-Payra river and pond inside of the project site
4	Ambient Noise Quality	8	Once during baseline survey	Noise levels monitored on BD standard
5	Soil Quality	2	Once during baseline survey	Soil samples from the project site and surrounding area
6	Sediment Quality	2	Once during baseline survey	Sediment samples from the project Burishwar-Payra River (upstream and downstream from project site)
7	Flora and Fauna (Ecology and Fish survey)	Study Area	Once during baseline survey	An ecological survey was undertaken to assess the biodiversity aspects
8	Socio-economics	Project area & within 2 km radius	One time survey	Mostly assessed through questionnaire, FGDs and available secondary information

B. Secondary Baseline Data Collection

Secondary baseline data were collected from the following organizations like Barisal Electric Power Company Limited (BEPCL), Bangladesh Meteorological Department (BMD), Forest Department (FD), Bangladesh Bureau of Statistics (BBS), Bangladesh Agricultural Research Council (BARC), Geological Survey of Bangladesh (GSB), International Union for Conservation of Nature (IUCN), Space Research and Remote Sensing Organization (SPARRSO), Department of Disaster Management (DDM), published Journals and Books for the following aspects.

A. Physical Environment

- **Regional Setting:** Physiography, Geomorphology, Land use, Geology, River system, Hydrology and Soil etc.;
- **Climate and meteorology:** Temperature, Rainfall, Humidity, Wind patterns (wind speed and direction);
- **Hazard and Risks:** Natural Hazards, Seismic activities, Seasonal storms & cyclones, Tidal surges, Landslide, Riverbank erosion etc.

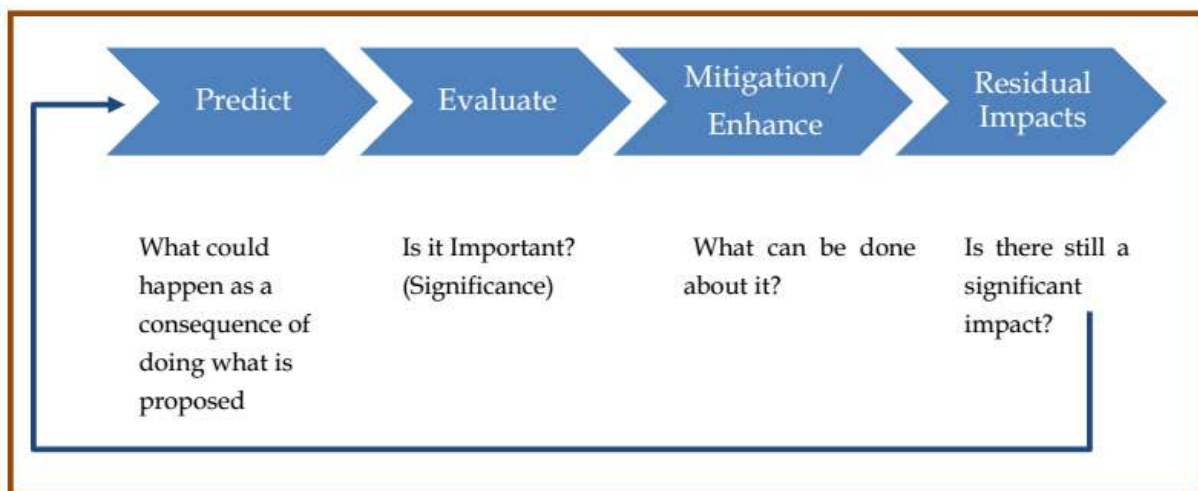
- B. Socio-economic Environment**
- Demographic profile;
 - Education & Literacy;
 - Economic activities & livelihood pattern;
 - Socio-economic Infrastructure & Indicators: Healthcare facilities, Education facilities, Drinking water & sanitation, Transportation facilities and Sites of cultural/archaeological importance.
- C. Ecology & Biodiversity**
- IUCN Red list status 2015;
 - Flora and fauna;
 - Biodiversity condition;
 - Existing terrestrial ecosystem;
 - Aquatic fauna and vegetation.

1.1.1.5 Task-5: Environmental & Social Impact Assessment

The EIA was evaluated potential impacts using a methodology based on the evaluation of the “significance” of identified issues and impacts on baseline parameters. Analysis of the baseline results and the incremental impacts of the project were assessed in accordance with the national guidelines for air, water and noise emissions; standards mentioned in the ECR, 1997.

The impact assessment was covered in the full project lifecycle, including pre-construction, construction, operations and decommissioning activities. The impact assessment has involved the prediction, evaluation and mitigation of impacts and report on impacts including residual impacts and cumulative impacts. Impact prediction was taken into account control measures that are part of the project design. Additional mitigation measures aimed at further reducing predicted impacts were proposed where necessary or appropriate.

Figure 1-6: Impact Assessment Process for the EIA Study



The impacts were identified and quantified for the intensity using modelling and/or matrix techniques and evaluated as a major, medium, minor or insignificant impacts on the environment and communities in the study area. Aspects which was considered in the impact assessment, for the pre-construction, construction and operation phase of the project, air quality, surface water quality, groundwater quality, noise level, soil quality, sediment quality, ecology, waste, landscape and visual, traffic and natural disaster risk, socio-economic and health. The environmental, socio-economic and project information are collected to assess the potential impacts of the proposed activities. The issues among others are studied included potential project impacts.

The principal aim of this task was to identify and assess potential impacts on various environmental and social components due to the proposed project. Based on baseline data collected from the study area, information on type and quantity of emission of pollutants (provided by client) and surveys of the

study area, EQMS' EIA team identify and predict potential impacts due to the proposed project on the surrounding environment during pre-construction, construction and operation stages of the project.

The key issues identified after collecting the baseline information. Each issue consists of components that on their own or in combination with each other give rise to potential impacts, either positive or negative, from the project onto the environment or from the environment onto the project. In the EIA, the significance of the potential impacts was considered before and after identified mitigation is implemented, for direct, indirect and cumulative impacts, in the short and long term.

Methods of Impacts Significance:

A description of the nature of the impact, any specific legal requirements and the stage are given. The following criteria are used to evaluate **significance**:

A. Nature:

This is an assessment of the type of effect the activity is likely to have on the surrounding affected environment. The description includes what is being affected and its magnitude. The nature of the impact was classified as positive or negative and direct, indirect and induced.

Direct	Potential/possible impacts will be generated directly from the project activities and its associated facilities, which are directly linked with the project. (e.g. loss of land due to power plant project development)
Indirect	Potential/possible impacts will be generated from secondary sources, which are induced by the project activities. (e.g. loss of any species habitat due to the project activities)
Induced	Potential/possible impacts will be generated due to effect/consequence/outcome of the project (e.g., the influx of camp followers resulting from the importation of a large project workforce)

B. Extent and Location:

This indicates the spatial area that may be affected by the project activities or its associated facilities (Table-A).

Table-A: Geographical Extent of Impact

Extent	Description
Project Site	Potential/possible impacts area only at or within the project site/project boundary
Local	Potential/possible impacts area is not only limited to the site but also its immediate surrounding areas/receptors
Regional	Potential/possible impacts area extends to the immediate surrounding areas along with adjacent areas
National	Potential/possible impacts area considered of national level.
Transboundary	- Impact considered of not only within national level but also the neighboring country. - Impact considered global level.

C. Duration:

This measures the lifetime/existence/continuation of the impact (Table-B).

Table-B: Duration of Impact

Duration	Description
Short term	Potential/possible impact duration is very limited time or length of construction/decommissioning period
Medium term	Potential/possible impact duration will continue after the construction period but

Duration	Description
	stop/ discontinue/cease within a tenure of 10 years
Long-term	Potential/possible impact duration will continue more than 10 years or the entire operational life of the project
Permanent – Mitigated	Potential/possible impact will remain after operational life of the project but appropriate mitigation measures reduce the impact
Permanent – no mitigation	- Potential/possible impact will remain after operational life of project. - No mitigation measures will reduce impact after implementation.

D. Intensity/Severity:

This is the degree to which the project affects or changes the environment; it includes a measure of the reversibility of impacts (**Table-C**).

Table-C: Intensity of Impact

Intensity	Description
Insignificant	Changes due to Potential/possible impact are minor, not visible/ noticeable, natural functioning of the environment not affected
Low	Natural functioning of the environment is minimally affected. Natural, cultural and social functions and processes can be reversed to their original state if mitigation measure is taken.
Medium	Environment remarkably distorted/disturbed/impacted, still functions, if in modified way. Negative impacts cannot be fully reversed.
High	Cultural and social functions and processes distorted/ disturbed/ impacted. Potentially ceasing to Environmental function temporarily. Negative impacts cannot be fully reversed.
Very High	Natural, cultural and social functions and processes permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. Negative impacts cannot be reversed.

E. Potential for Irreplaceable Loss of Resources:

This is the degree to which the project will cause loss of resources that are irreplaceable (**Table-D**).

Table-D: Potential for irreplaceable loss of resources

Potential for irreplaceable loss of resources	Description
Low	No Irreplaceable/ unique resources will be impacted.
Medium	Irreplaceable/ unique resources can be replaced, with mitigation measure/ effort and will be replaced after a certain period of time.
High	Potential/ possible Impact replaces a particular/ vulnerable resource.

- **Probability:** This is the likelihood or the chances that the impact will occur (**Table-E**).

Table-E: Probability of Impact

Probability	Description
Unlikely	Under normal conditions, no Potential/ possible Impact expected
Low	The probability of the impact to occur is low due to its design or historic experience

Medium	There is a distinct probability of the impact occurring
High	It is most likely that the impact will occur
Definite	The impact will occur regardless of any prevention measures

- **Magnitude:** This is calculated as extent + duration + intensity + potential impact on irreplaceable resources.

Magnitude essentially describes the intensity of the change that has the potential to occur in the resource/receptor as a result, of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor. The universal magnitude designations are positive, Insignificant, Low, Medium-Low, Medium – High, High and Very High.

In the case of a potential positive impact, no magnitude designation (aside from ‘positive’) is assigned. It is considered sufficient for the purpose of the EIA to indicate that the project has the potential to result in a potential positive impact, without characterizing the exact degree of positive change that may occur.

- **Significance:** The significance will be rated by combining the consequence of the impact and the probability of occurrence (i.e. Magnitude probability = significance).

Table-F: Probability of Impact

		Probability of Impact				
		Unlikely	Low	Medium	High	Definite
Magnitude of Impact	Insignificant	Very Low	Very Low	Very Low	Low	Low
	Low	Very Low	Very Low	Low	Low	Medium-Low
	Medium – Low	Very Low	Low	Low	Medium-Low	Medium-high
	Medium – High	Very Low	Low	Medium-Low	Medium-high	High
	High	Low	Medium	Medium-high	High	High
	Very High	Low	Medium	High	High	Very High

Table-G: Significance of issues (based on Environmental Parameters)

Significance	Description
Positive Impact	Potential/possible impacts that have a beneficial impact on affected media
Very low	No action required.
Low	Impacts are within the acceptable range. Potential/possible impacts such as localized or short-term effects on habitat, species, or environmental media.
Medium-Low	Impacts are within the acceptable range but should be mitigated to lower significance levels wherever possible. Potential/possible impacts such as localized, long-term degradation of sensitive habitat or widespread, short-term impacts to habitat, species, or environmental media.
Medium-High	Potential/possible impacts are significant and require attention; Mitigation is required to reduce the negative impacts to acceptable levels; Potential/possible impacts such as localized but irreversible habitat loss or widespread, long-term effects on habitat, species, or environmental media.
High	Impacts are of great importance, mitigation is crucial. Potential impacts such as significant, widespread, and persistent changes in habitat, species, or environmental media.

Significance	Description
	Potential impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Very High	Impacts are unacceptable. Potential impacts such as loss of a significant portion of a valued species or loss of effective ecosystem function on a landscape scale.

Potential social impacts are inherently variable because community response to a potential impact, perceptions of existing and changing conditions, and the degrees of vulnerability are all heavily dependent on local conditions and the human factor. The significance designations for potential social impacts take into consideration social science expertise and previous experience in Bangladesh regarding the relationships between individuals, communities, government agencies, NGOs and special interest groups, and the oil and gas industry.

Table-H: Potential Social Impact Significance

Significance	Definition
Positive Impact	Potential/possible impacts that have a beneficial impact on affected stakeholders
Very low	Potential/possible impacts that are practically indistinguishable from the social baseline, with little to no potential impacts to or concerns from affected external stakeholders.
Low	Potential/possible impacts that are short-term nuisance or inconvenience; potentially affected external stakeholders concerned but likely able to adapt with relative ease.
Medium-Low	Potential/possible impacts such as localized or short-term effects; potentially affected stakeholders concerned but likely able to adapt with relative ease.
Medium-high	Potential/possible impacts such as local-to-regional (sub-national) or medium term effects; potentially affected stakeholders concerned and raise the issue as a high priority, but may be able to adapt with some targeted support or assistance.
High	Potential/possible impacts such as local-to-national or long-term effects; potentially affected stakeholders concerned and raised as a high priority; may not be able to adapt without targeted support or assistance in order to maintain pre-impact livelihood.
Very High	Potential/possible impacts such as local-to-global or irreversible long-term effects; potentially affected stakeholders concerned raise the issue as a high priority and are likely not able to adapt without targeted support or assistance.

To determine potential public health impacts, the assessment team considers the public, which has the potential to be exposed to various aspects and potential impacts of the project, whether it is a permanent resident with continuous exposure or a periodic exposure to a fisherman transiting through the project area. The significance determinations for potential public health impacts take into consideration local and regional public health expertise and previous experience in Bangladesh regarding the relationships between individuals, communities, health care providers, government agencies, NGOs and the power industry.

Table-I: Potential Public Health Impact Significance

Significance	Definition
Positive Impact	Potential/possible impacts that have a beneficial impact on affected stakeholder
Very low	No impact on the public
Low	Potential/possible illness or adverse effect with limited or no impacts on the ability to function and medical treatment is limited or not necessary.

Significance	Definition
Medium-Low	Potential/possible illness or adverse effects with mild to moderate functional impairment requiring medical treatment or management.
Medium-high	Potential/possible serious illness or severe adverse health effect requiring a high level of medical treatment or management.
High	Potential/possible serious illness or chronic exposure of a few resulting in life-shortening effects.
Very High	Potential/possible serious illness or chronic exposure of many resulting in life-shortening effects.

1.1.1.6 Task-6: Environmental Management Plan (EMP)

Requirement and details of the mitigation measures for minimizing identified negative impacts and enhancement measures for increasing the benefit of positive impacts are suggested in the EMP for implementation by the client during pre-construction, construction and operation phases of the project. The EMP comprise of the following aspects based on the impacts assessed for the Project:

- Introduction to the purpose of the EMP;
- Institutional mechanism - roles and responsibilities for EMP implementation;
- Summary of significant adverse impacts and potential hazards;
- Mitigation measures and control technologies, safeguards etc. to minimize adverse impacts on air, noise, water, soil, sediment, ecology and socio-economic environment, measures to minimize associated hazards and control the emergency situation; and
- Project monitoring programme for effective implementation of the mitigation measures and ascertain the efficacy of the environmental management and hazard control systems in place.

This sets out the mitigation and management measures required during project implementation to avoid or reduce the environmental and/or social impacts, including developing the action plan in accordance with DoE requirements. A monitoring plan included here, covering the type of monitoring to be done, responsible parties, schedule, standards to be used and resources. Plans that can be developed at a later stage (e.g. construction waste management plan, emergency response plan) identified and provided as initial documents, which will be updated prior to the start of construction activities by the contractor.

1.1.1.7 Tasks-7 & 8: Reporting - Draft & Final EIA Report

Draft EIA report is prepared upon completion of the above tasks as per the approved Terms of Reference (ToR) for EIA study by the Department of Environment (DoE).

Based on one set of consolidated comments of the client, Draft EIA was finalized for submission to the DoE to get Environmental Clearance Certificate (ECC).

1.7 Limitations

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

The EIA study team has prepared this report based on the available information provided by the project proponent (BEPCL), Feasibility Report and detailed field investigation. Certain provisions in this report assume reliance on conceptual design and technical information. If the design of the project changes from that assessed due to design development, inclusion of new information, changing motivations or any other reason, the results of any impact assessment or mitigation measures provided in this report may be inconsistent. The project proponent has been provided all NOCs, boundary of the proposed project, land documents including mouza map and lease document. The study team only followed the provided documents and incorporated in the report. The EIA study

team has conducted no due diligence on land information and NOCs. If any kind of issue raised related to land document and NOCs in future, it will be the responsibility of the BEPCL. This EIA process is limited to the assessment of the proposed power plant and associated infrastructure, as defined in Chapter-3 and Chapter-4 of this report. This EIA report excludes the coal mining activities, coal transportation, coal handling in the deep sea, transmission lines from the power station to the national grid and dredging activities for the navigation of coal transportation vessels and dredge materials required for land filling. The other limitations of this study is the unavailability of historical air quality data in and around the study area. However, attempts were made to overcome these limitations.

1.8 The EIA Team

EQMS Consulting Limited, Bangladesh (EQMS) is a specialized consultancy firm appointed by the BEPCL to conduct the EIA study for the proposed Barisal 350 MW coal-fired Power Plant at Taltoli, Barguna. Before conducting the study, it is very important to set up an expert team at the right time in order to assess the significant impacts of the project on the environment. EQMS formed a professional team consist of qualified and experienced from various discipline in order to address the critical aspects. The composition of the EIA team is shown in following Table 1-3.

Table 1-3: EIA Team Composition

SL#	Name of Expert	Position
1	Kazi Farhed Iqbal	Project Director/EIA Expert
2	Md. Zahidul Islam	Environmental Expert/Project Manager
3	Shah Monirul Kabir	Sociologist
4	Mirza SA Habib	Ecologist
5	Rofiul Karim	Community Development Expert
6	Abu Mohammed Nasiruddin	Sociologist
7	Tauhidul Hasan	Environment Monitoring Expert/Air Quality Modelling
8	Sk. Salahuddin Ahammad	Risk Assessment Expert/Noise Modelling
9	Md. Faisal Imran	Biodiversity Expert
10	Dr. Md. Nazim Uddin	Hydrologist
11	Md. Wahidur Rahman Khan	Disaster Management Expert
12	Md. Zohir Uddin Omor	GIS Specialist
13	Ashis Dhar	Social Monitoring
14	Md. Mustafizur Rahman	Environmental Monitoring
15	Irteja Hasan	Environmental Monitoring

1.9 Structure of EIA Report

The overall contents of the EIA report have been prepared as per the generic structure prescribed in the approved ToR issued by the DoE, Memo No: 22.02.0000.18.72.74.18-378, Dated: 14th June 2018. The report consists of 16 (sixteen) chapters and the content is briefly described in this section.

Chapter-1: Introduction: This chapter gives the basic information about the project and project area. It also discusses the justification of the project and the purpose of the EIA study including the scope of the study, approach and methodology of the EIA study and EIA study team.

Chapter-2: Legal and legislative framework, regulations and policy considerations: This chapter discusses the policy, legal and administrative framework describing the relevant policy and legal frameworks for the EIA process.

Chapter-3: Project Data Sheet: This chapter discuss the project proponent, location the project, nature and size of the project, project components, activities, schedule, resources and utilities requirement, source of primary fuel and transportation of fuel for the proposed power plant.

Chapter-4: Process Description: This chapter provides information related to the proposed project site, layout, land requirement, fuel requirement, water availability and requirement, manpower requirement, chemical requirement, technology and power generation process, description of major systems and different pollution control measures in the power plant.

Chapter-5: Analysis of Suitability of Different Alternatives: This chapter describes systematic comparisons of feasible alternatives for the proposed project site, technology and operational alternatives. Alternatives have been compared in terms of their potential environmental impacts, capital and recurrent costs and suitability under local conditions.

Chapter-6: Detail Description of the Land cover/Land use: This chapter emphasize on the details description of land use of the project area and surrounding area.

Chapter-7: Baseline Environmental Condition: This chapter describes the details environmental and social baseline conditions with detail on physical, ecological and socio-economic condition.

Chapter-8: Environmental Impacts Assessment and Evaluation: This chapter identifies the possible environmental impacts and assess the significance of the possible or potential impacts considering pre-construction, construction and operation phase activities.

Chapter-9: Mitigation of Impacts: This chapter identifies the potential mitigation measures based on significance of impacts including responsibility and cost.

Chapter-10: Environmental Management Plan: This chapter describes the Environmental Management Plan for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.

Chapter-11: Risk Assessment: This chapter outlines the possible hazards and risks associated with the proposed power plant project and provide necessary safety measures.

Chapter-12: Environmental Monitoring Plan: This chapter describes the environmental monitoring plan that will be followed to mitigate the impacts during pre-construction, construction and operation of the proposed power plant.

Chapter-13: Work Plan: This chapter depicted the tentative work plan for the proposed power plant project.

Chapter-14: Project Benefits with benefit-cost analysis the covers among others, environmental and social cost: The benefits that will be accrued from the project in the locality in particular and society in general as well as development will be identified and described in this chapter.

Chapter-15: Public Consultation: This chapter gives an overview of the public consultations held in the project sites as well as disclosure and results including methodology, public opinions and suggestions derived from the consultations.

Chapter-16: Conclusions and Recommendations: Conclusions and recommendations summarize the key findings of the EIA study.

CHAPTER TWO: LEGAL AND LEGISLATIVE FRAMEWORK, REGULATION AND POLICY CONSIDERATION

2. Legal and Legislative Framework, Regulation and Policy Consideration

2.1 Introduction

Environmental issues in Bangladesh are legislated by different sectoral policies and law, such as those relating to land use, water and air pollution, toxic chemicals, noise, solid wastes, wildlife protection, forest conservation, environmental health and sanitation and industry. The sectoral laws dealing with different environmental issues in Bangladesh were enacted at different periods, with many now being outdated and not able to control and manage present development needs. Moreover, the environmental concerns and priorities of the country have changed considerably in recent years. For environmental management, in particular, the need for updating of legislative requirements has been identified and is currently being undertaken by the DoE.

To address the environmental and social risks of any proposed project and its associated components; to protect and conserve the environment from any adverse impacts, the GoB has specified regulations, policy and guidelines.

2.2 Applicable Policies and Legal Provision

All legal provisions relevant to environmental protection applicable to the planning, construction and operation of the coal-fired power plant were identified under the scope of the EIA. The following Table 2-1 summarizes all relevant legal provisions:

Table 2-1: National Legal Provisions applicable to the proposed Power Plant Project for ensuring Environmental Protection

Issues	Legislation or regulation
Governance of Power Generation and Management System	- Bangladesh Energy Regulatory Commission Act, 2003 - Power System Master Plan, 2010 - National Energy Policy, 2004
Coal Sourcing	- Bangladesh Coal Policy (Draft) - Power System Master Plan 2016 - Master Plan on Coal Power Development, 2010 - Import and Export Control Act, 1950
Coal Transportation	- Terrestrial Water and Maritime Zones Act 1974 & Rules 1977 - The Ferries Act, 1885 - Ports Act, 1908 - Bangladesh Merchant Shipping Ordinance, 1983 - The Prevention of the Interference with Aid to Navigable - Waterways Ordinance, 1962
Prevention of pollution and Protection of Environment	- Ports Act, 1908 - The Forests Act, 1927 - ECA, 1995 and the Amendments thereafter - Environment Conservation Rules, 1997 - The Environment Court Act, 2000
Health and Safety	- Fatal Accidents Act, 1855 - Dock Laborers Act, 1934 - Dangerous Cargoes Act, 1953 - Imports and Exports (Control) Act, 1950 - Public Safety Ordinance, 1953

Issues	Legislation or regulation
	• The Explosives Act, 1884 • Fire prevention and Extinguish Act, 2003
Procurement in Bangladesh	• The Public Procurement Regulations, 2003 and revisions there after
Transport, Handling and Storage of Dangerous Goods	• Environment Conservation Act, 1995 (Amendments thereafter) • Ports Act, 1908 • Petroleum Act, 1934 • Dangerous Cargoes Act, 1953

2.3 Legislative Approvals Requirements

2.3.1 Bangladesh Environmental Conservation Act, 1995 and Amendments

The provisions of the act authorize the Director General of the DoE to undertake any activity that is deemed 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 (ECAs);
- Obtaining Environmental Clearance Certificate (ECC);
- 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; and
- Formulation of environmental guidelines relating to control and mitigation of environmental pollution, conservation and improvement of environment.

2.3.2 Environment Conservation Rules, 1997 and Amendments

The ECR, 1997 are the first set of rules promulgated under the ECA, 1995. These rules provide for, inter alia, the following:

- The NEQS for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/ development projects/activities) pollution load;
- Procedure for obtaining ECC;
- Requirements for undertaking IEE and EIA's as well as formulating EMP according to categories of industries/development projects/activities; and
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

2.3.3 The Environment Court Act, 2000 and Amendments

The Environment Court Act, 2000 provides for the establishment of environment courts and matters incidental thereto. This act also provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of environment appeal court.

2.3.4 Noise Pollution (Control) Rules, 2006

The Noise Pollution Control Rules have been established in order to manage noise-generating activities, which have the potential to impact the health and wellbeing of workers and the surrounding communities. Under this legislation, control zones are listed as:

- **Quiet Area** – for example school or hospital;
- **Residential Area** – an area primarily occupied by dwellings;
- **Mixed Area** – area with a mix of residential, commercial and industrial land uses;
- **Commercial Area** – an area primarily occupied by businesses and officers; and
- **Industrial Area** – and area used for industry or manufacturing.

Daytime and nighttime noise level restrictions are provided for these areas. Additionally, limits are provided for noise emissions from motor vehicles and boats.

2.3.5 National Water Act, 2013

The National Water Act, 2013 is based on the NWP and provides the legal framework for integrated development, management, abstraction, distribution, usage, protection and conservation of water resources in Bangladesh. The Act provides for the formation of a high-powered National Water Resources Council headed by the Prime Minister. An Executive Committee under the MoWR will implement the decisions taken by the council.

As per this Act, all forms of water (e.g., surface water, ground water, seawater, rain water and atmospheric water) within the territory of Bangladesh belong to the government on behalf of the people. Private landowners will be able to use the surface water inside their property for all purposes in accordance with the Act.

The management of water resources within the territory of the country in rivers, creeks, reservoirs, flood flow zone, and wetlands has been assigned to the Executive Committee under the MoWR. Draining of wetlands that support migratory birds has been prohibited by the Act. Consequently, without prior permission from the Executive Committee, building of any structure that can impede the natural flow of water has been prohibited. A few activities like dredging of rivers for maintaining navigability, land reclamation projects by filling wetlands, and flood control and erosion control structures will be exempted pending prior permission.

The Act provides provisions for punishment and financial penalty for non-compliance, including negligence to abide by government policy, ordinance, and non-cooperation with government officials, refusal to present necessary documents, providing false information, affiliation with perpetrators, and protection measures for water resources management. The maximum penalty for violations is set to five years of imprisonment and/or a monetary penalty of Taka10,000.00.

2.3.6 Ground Water Management Ordinance, 1985 (Ordinance No. xxvii of 1985)

This is an ordinance to manage ground water resources for agricultural production. This Act authorizes the Thana/Upazila Parishad to grant license for installing tube wells under its jurisdiction. The Thana/Upazila Parishad may grant the license if the parishad is satisfied that the installation of the tube well applied for:

- a) Will be beneficial to the areas where it is to be installed, or
- b) Will not have any adverse effect upon the surrounding areas, or
- c) Is otherwise feasible.

2.3.7 Bangladesh Labor Act, 2006

This Act pertains to the occupational rights and safety of workers and the provision of a comfortable work environment and reasonable working conditions. In the chapter VI of this law safety precaution regarding explosive or inflammable dust/gas, protection of eyes, protection against fire, works with cranes and other lifting machinery, lifting of excessive weights are described. And in the Chapter VIII

provision safety measure like as appliances of first aid, maintenance of safety record book, rooms for children, housing facilities, medical care, group insurance etc. are illustrated.

2.3.8 The Penal Code, 1860

The Penal Code of 1860 has some valid provisions related to pollution management, environment protection and protection of health and safety. Chapter XIV of the Penal Code provides offences affective public health, safety, convenience, decency and morals: Section 277: Falling Water or Public Spring or Reservoir; Section 278: Making Atmosphere Noxious to Health.

Section 284: Negligent Conduct with Respect to Poisonous Substance; Section 285: Negligent Conduct with Respect to Fire or Combustible Matter; and Section 286: Negligent Conduct with Respect to Explosive Substance.

According to the Section 277, whoever voluntarily corrupts or fouls the water of any public spring or reservoir, to render it less fit for the purpose for which it is ordinarily used will be punished under the law.

According to the Section 278, whoever voluntarily vitiates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighborhood or passing along a public way will get punishment.

2.3.9 The Fatal Accidents Act, 1855

An Act to provide compensation to families for loss occasioned by the death of a person caused by actionable wrong. It is mentioned in s.1, whenever the death of a person shall be caused by wrongful act, neglect or default, and the act, neglect or default is such as would (if death had not ensued) have entitled the party injured to maintain an action and recover damages in respect thereof, the party who would have been liable if death had not ensued shall be liable to an action or suit for damages, notwithstanding the death of the person injured, and although the death shall have been caused under such circumstances as amount in law to felony or other crime.

2.3.10 The Dock Laborers Act, 1934

An Act to give effect in Bangladesh to the Convention concerning the protection against accidents of workers employed in loading and unloading ships. It is stated in S.5 (1), the Government may make regulations providing for the safety of working places on shore and of any regular approaches over a dock, wharf, quay or similar premises which workers have to use for going to or from a working place at which the processes are carried on, and for the lighting and fencing of such places and approaches, prescribing the measures to be taken in order to prevent dangerous methods of working in the stacking, unshackling, stowing and unstaring of cargo, or handling in connection therewith, prescribing the precautions to be observed when the workers have to work where dangerous or noxious goods are, or have bee, stowed or have to deal with or work in proximity to such goods.

It is mentioned in S.9, any person who unless duly authorized, or in case of necessity, removes any fencing, gangway, gear, ladder, life-saving means or appliance, light, mark, stage or other thing required to be provided by or under the regulations made under this act; or having in case of necessity removed any such fencing, gangway, gear, ladder, lifesaving means or appliance, light, mark, stage or other thing, omits to restore it at the end of the period for which its removal was necessary; shall be punishable with fine which may extend to five hundred taka.

2.3.11 Wildlife Conservation (Protection and Safety) Act, 2012

The act has been formulated for the conservation and safety of wildlife to manage the protected areas. The act depicts 10 new types of protected areas. The bill with many other provisions proposed stern action for violation of the law. It proposed one-year imprisonment and Taka 50,000 fine for such a violation. The law also proposed at least two years and highest seven years of imprisonment and minimum Taka one lakh and maximum Taka 10 lakh fine for killing a tiger or elephant. According to the Act, 2012, in Chapter-4, Section-16, Sub-section 2(e), there is a restriction for the detrimental activities to environment within the 2 km from the border of the sanctuary area.

2.3.12 The Protection and Conservation of Fish Act 1950

The act was enacted to provide for the protection and conservation of fish. The law defines 'Fish' as all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, mollusks, echinoderms and frogs at all stages in their life history. Under the Act the Protection and Conservation of Fish Rules was adopted in 1985. This is a set of rules in line with the overall objectives of the Act. The Rule 5 of the Rules provides that no person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters. During the Project intervention, it should be noted that if waste effluent is not treated then it may cause significant damage to the local fishery and thus violate the provision of the law.

Rule 6 states that no person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters.

2.3.13 The Forest Act, 1927 and the Forest (Amendment) Act, 2000

The Forest Act, 1927 is the first and omnibus law of the land on forestry. It provides for reserving forests over which the Government has an acquired property right. According to the Act the Government (Forest Department) can prohibit certain activities in the declared Reserved Forest area such as any intervention kindles, keeps or carries any fire; trespasses or pastures cattle, or permits cattle to trespass; causes any damage by negligence in felling any tree or cutting or dragging any timber; etc.

"26. Acts prohibited in such forests-Any person who, in a reserved forest a) Kindles, keeps or carries any fire except at such seasons as the Forest-Officer May notify in this behalf; b) Trespasses or pastures cattle, or permits cattle to trespass; c) Causes any damage by negligence in felling any tree or cutting or dragging any timber; d) Quarries stone, burns lime or charcoal, or collects, subjects to any manufacturing process, or removes any forest produce other than timber; or who enters a reserved forest with firearms without prior permission from the Divisional Forest Officer concerned, shall be punishable with imprisonment for a term which may extend to six months and shall also be liable to fine which may extend to two thousand taka, in addition to such compensation for damage done to the forest as the convicting Court may direct to be paid".

2.3.14 The Private Forests Ordinance Act, 1959

Conservation of private forests and for the afforestation on wastelands.

2.3.15 National Biodiversity Strategy and Action Plan, 2004

NBSAP for Bangladesh, 2004 provides a framework for conservation, sustainable use and sharing the benefits of Biodiversity of the country. A major focus of the NBSAP, 2004 is the need for cross-sectoral linkages, reflecting the fact that in Bangladesh, biodiversity conservation is closely interwoven with social and economic development. Thus, the NBSAP also provides a framework for securing the necessary environmental conditions to reduce poverty, ensure sustainable development and respond to the implementation of elements of the country's PRSP.

2.3.16 Ports Act, 1908

The Ports Act 1908 was adopted to consolidate the enactments relating to Ports and port charges. Subject to this Act, a conservator shall be appointed in to the port. Specific environmental management provisions of the Act are given under s.21 (1) which prohibits the discharge of ballast, rubbish and oil into any port or adjacent areas. Under s.31 of the Act, the movement of vessels of 200 tons or more cannot enter, leave or be moved within any port without having a pilot on board. In addition, no vessel of more than 100 tones is to enter, leave or be moved within any port without having a pilot, unless authority to do so has been given in writing. The lawful use of infrastructure such as piers and moorings and ensuring navigable waters are not obstructed is detailed under s.10, whereas s.21 prohibits interference with buoys, beacons and moorings. Unless permission has been granted by the Conservator, any action that causes or may cause injury to the bank or shore is prohibited under s.30 (1).

2.3.17 The Dangerous Cargoes Act, 1953

The Dangerous Cargoes Act, 1953 was enacted to provide provisions related to the safety of ports in respect of the transit, working and storage of dangerous cargoes. Relevant provisions include s.3 (which deals with explosives and fires on vessels), s.6 (safety of vessels imports) and s.9 (enforcement). The concerned authority is the Deputy Conservator of the Port, Board of Trade or the Ministry of Communication and the Chief of Naval Staff.

2.3.18 The Fire Services Ordinance, 1959

The Fire Services Ordinance 1959 also states that the owner needs to obtain a license under the ordinance before using premises as a warehouse. In addition, under this Ordinance the Government by order no. HSLG/SVII/1R-1/60/295 dated 3rd June 1960 declared that any stock of coal exceeding four tones shall be considered to be a fire risk.

2.3.19 The Explosives Act, 1884

The Government may for any part of Bangladesh, make rules consistent with this Act to regulate or prohibit, except under and in accordance with the conditions of a license granted as provided by those rules, the manufacture, possession, use, sale, transport and importation of explosives or any specified class of explosives.

Any person manufacturing, possessing, using, selling, transporting or importing an explosive in contravention of a notification issued shall be punishable with imprisonment for a term which may extend to ten years and shall not be less than two years and also with a fine which may extend to fifty thousand Taka, in default of which with a further imprisonment for a term which may extend to one year, and in the case of importation by water or land, the owner and master of the vessel or carriage in which the explosive is imported shall, in the absence of reasonable excuse, each be punishable with imprisonment for a term which may extend to ten years and shall not be less than two years and also with a fine with a further imprisonment for a term which may extend to one year.

2.3.20 Electricity Act, 1910 and Regulations

The Bangladesh Electricity Act (1910) provides permission to the National Electricity Board (at present BPDB) or any licensee of the Government to lay down or place electricity supply lines within the area of supply. The Act provides the approvals framework within which these works should be undertaken, however this is subject to the payment of appropriate compensation to any persons affected by the removal of structures, standing trees or any other objects for the purposes of building / extending aerial lines. Under the provisions of the Act, GoB permission is required to place any aerial line along or across any street, railway, tramway, canal or waterway. The application requires that the methods of construction are included for approval.

2.3.21 Bangladesh Water Rules, 2018

According to the Clause-16 of Bangladesh Water Rules, 2018, for taking the initiative to establish the following projects by the person or authority, No Objection Certificate (NOC) from anyone of the Water Resources Planning Organizations (WARPO) (Director General), District Committee (Deputy Commissionaire), Upazilla Committee (Upazila Nirbahi Officer) and Union Committee (Chairman) will be required for the specific project. The projects are:

- Flood Control and management project;
- Surface water extraction, supply and use related project and part of the project;
- Irrigation project using surface water;
- Construction of hydraulic structures;
- Water conservation project;
- Flood affected plain land and wetland development project;
- Groundwater for industrial use;
- River bank protection and river control;
- River excavation and dredging project;

- Canal excavation and re-excavation project;
- Fisheries development in surface water project;
- Ground water extraction, supply and use related project and part of the project; and
- Others project.

The proposed 350 MW coal fired power plant will use the surface water from the Buriwar-Payra River for power plant operation. As a result, No Objection Certificate (NOC) will be required from the Union Integrated Water Resources Management Committee for surface water collection, distribution and use in the proposed project.

2.4 Legal framework for Land Acquisition

2.1.1 Acquisition and Requisition of Immovable Property Ordinance, 2017

The principal legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Ordinance II (1982) and subsequent amendments of the Ordinance II (1989, 1993, and 1994). The 1982 Ordinance requires that compensation be paid for (i) land and assets permanently acquired (including houses, trees, and standing crops,); and (ii) any other impacts caused by such acquisition. The Deputy Commissioner (DC) determines (i) market value of acquired assets on the date of notice of acquisition (based on the registered value of similar property bought and/or sold in the area over the preceding 12 months); and (ii) 50% premium on the assessed value (other than crops) due to compulsory acquisition. The value thus paid is invariably less than the “market value” as owners customarily report undervalued land transaction prices in order to pay lower stamp duty and registration fees. As a result, compensation for land paid by DC including premium remains less than the real market price or replacement value (RV).

The GoB promulgated and enacted new acquisition law named Acquisition and Requisition of Immovable Property Act-2017 (Act 21 of 2017) on 21st September 2017. The new law made some amendments in determination of property value fixation. According to the new law, affected person will get additional 200% of assessed value for land and additional 100% for structures, trees, crops and others assets.

The Ordinance II does not deal with social and economic impacts as a consequence of land acquisition. For instance, the Ordinance does not cover project-affected persons without titles such as informal settler (squatters), occupiers, and informal tenants and lease-holders (without registration document). Further, the Ordinance has no provision for resettlement of affected households and businesses or any assistance for restoration of livelihoods of the affected persons. Difference between ARIPO 1982 and ARIPO-2017 in compensation assessment is presented in below Table 2-2.

Table 2-2: Comparison of Additional Compensation between ARIPO-1982 and ARIPO-2017

Acquired Assets	Acquisition and Requisition of Immovable Property Ordinance of 1982	Acquisition and Requisition of Immovable Property Act of 2017
Land	Additional 50% of determined value	Additional 200% of determined value
Structures	Additional 50% of determined value	Additional 100% of determined value
Trees	Additional 50% of determined value	Additional 100% of determined value
Crops ¹	Additional 50% of determined value	Additional 100% of determined value

2.1.2 The East Bengal State Acquisition and Tenancy Act, 1950 (Revised 1994)

The State Acquisition and Tenancy Act (Sections 86 and 87) also define the ownership and use right of alluvium (payostior reformation in situ or original site) and diluvion land (nadi sikosti) in the country. In legal terms, eroded lands (sikosti) inside the alluvion-diluvion (AD) line (i.e. including submerged land or underwater land) are considered Khas land once declared by concerned Deputy Commissioner (DC) demarcating the AD Line.

¹ Tenants, sharecroppers or informal land user will receive compensation for crops from the DC or from Project Company. In that case land user will be identified through Joint Verification or census survey.

2.1.3 Property (Emergency) Acquisition Act, 1989

The Act was formulated to expedite the emergency acquisition of land to enable the Government 'to control inundation, flood and upsurge caused by natural calamity and to prevent river erosion. The 1989 Act was not meant to replace the 1982 Ordinance, but to complement it for special circumstances. Normally, acquisition of land for development purposes would not come under the 1989 Act. Use of this Act to acquire land for development would require extremely compelling reasons.

2.1.4 Framework for leasing of Government (Khas) agricultural land

The rules for managing and leasing Government-owned (Khas) land are notified through two Bangladesh Gazette notifications i.e.: (1) Notification: Bhumo/Sha-8/Kha-jo-bo/46/84/261, Bangladesh Gazette Extra Edition dated May 12, 1997, pp 1527-1536; and (2) Notification: Shuno/Sha-4/Kri-kha-jo-bo-1/98-264, Bangladesh Gazette, September 15, 1998. Under these regulations, the Government leases cultivable agricultural land in the rural areas to landless farming households. The allotments cannot be more than one acre, except in the southern districts where up to 1.5 acres of char land can be allotted. The regulation further defines structure and responsibilities for management and leasing of Khas Lands at the National, District, and Thana levels.

2.5 Applicable Policies in Bangladesh

2.5.1 National Environmental Policy, 1992

The National Environmental Plan, 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, conservation and improvement 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; and
- Promoting active association, as far as possible, with all international initiatives related to the 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 IEE should be conducted before projects are undertaken.

2.5.2 National Environment Management Action Plan, 1995

The NEMAP is a wide-ranging and multifaceted plan, which builds on and extends the statements, set out in the NEP. 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 NCS 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; and
- Improvement of the quality of life of the people.

To this end, it has grouped all the relevant necessary actions under four heads: a) institutional, b) sectoral, c) location-specific, and d) long-term issues. The institutional aspects reflect the need of inter-sectoral 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.

2.5.3 The EIA Guidelines for Industry, 1997

The EIA Guidelines is a handbook for procedures for preparing the EIAs and for reviewing them for the benefit of the development partners, EIA 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.

2.5.4 National Conservation Strategy, 1992

National Conservation Strategy (GoB/IUCN, 1992) was drafted in late 1991 and submitted to the Government in early 1992. Meanwhile, it underwent a number of modifications over the last five years. For sustainable development in the industrial sector, the report offered various recommendations; some of those are as follows:

- Industries based on non-renewable resources should be made to adopt technology which conserves raw materials, and existing industries should be given incentives to install technical fixes to reduce wastage rate;
- All industries, especially those based on imported raw materials, should be subjected to EIA and adoption of pollution prevention/control technologies should be enforced;
- No hazardous or toxic materials/wastes should be imported for use as raw material;
- Import of appropriate and environmentally sound technology should be ensured;
- Complete dependence on imported technology and machinery for industrial development should gradually be reduced, so that industrial development is sustainable with local skills and resources.

2.5.5 Draft Coal Policy, 2010

The Draft Coal Policy (version-1) was published on 1st December 2005 by the Energy and Mineral Resources Division of Ministry of the Power, Energy and Mineral Resources. After that, it was revised several times. The latest one is the Bangladesh Draft Coal Policy, 2010.

The latest Draft Coal Policy (2010) outlines gas shortage, power generation, coal development, investment for coal sector, import coal, environment etc. in Bangladesh. Therefore, this policy will become useful data in relating the domestic coal supply. This policy states that coal will be used for power generation instead of gas as an alternative fuel to maintain national energy stability.

2.5.6 Power System Master Plan, 2010

The main objective of this study is to formulate a Master Plan for the attainment of stable power supply in the People's Republic of Bangladesh up to year 2030 in consideration of the diversification of fuel resources, including an optimum power development plan, power system plan and identification of the potential power plant sites based on the fuel diversification study. Therefore, this study includes a comprehensive power development master plan where the study of the fundamental conditions of the development (demand forecast, procurement of primary energy resources, optimum power development plan, future optimum power supply structure including the positioning of gas-fired power plants, and so on) are added.

The power sector was heavily dependent on gas. Even two/three years back almost 90% of the electricity used to be generated from the natural gas of the country and rest by hydroelectricity and coal. The power sector master plan 2010 has stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel etc. as well as renewable energy sources.

In this Master Plan, the target composition of power supply as of 2030 is set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas and 25% for other sources such as oil, nuclear power and renewable energy.

2.5.7 National Energy Policy, 1995

The National Energy Policy of 1995 provides for utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy sources and environmentally sound sustainable energy development programs. The NEP highlights the importance of protecting the environment by requiring an EIA for any new energy development project and introducing economically viable and environmentally friendly technology. One of the seven objectives (Section 1.2) addresses the environment and states, "(vi) to ensure environmentally sound sustainable energy development programs causing minimum change to the environment". Seven specific policy recommendations are listed under Chapter 1.9. Of those, the following three are relevant to the present Project:

- EIA should be made mandatory and should constitute an integral part of any new energy development project;
- Use of economically viable environment friendly technology is to be promoted; and
- Public awareness is to be promoted regarding environmental conservation.

2.5.8 National Forest Policy, 1994

The National Forest Policy of 1994 is the amended and revised version of the National Forest Policy of 1977 in the light of the National Forestry Master Plan. The major goals of the policy is to conserve the existing forest areas, bring about 20 percent of the country's land area under the Forestation Program and increase reserve forests by 10 percent per year to 2015 through coordinated efforts of GoB-NGOs and through active participation of the people.

Amendments of the existing laws (acts, rules and regulations) relating to the forestry sector and creation of new laws for sectoral activities have been recognized as important conditions for achieving the policy goals and objectives. The Forestry Policy also recognizes the importance of fulfilling the responsibilities and commitments under International Conventions, Treaties and Protocols (ICTPs).

2.5.9 National Land Transport Policy, 2004

The government approved the NLTP in April 2004, which introduced the concept of long-term network planning and integration of transport policy, planning and appraisal across land transport modes. Each sub-sector undertakes physical and institutional improvement in line with its long-term policy provided in the NLTP with each sub-sector master plan. Major issues by subsector include (i) maintenance financing, quality, safety and overloading in major roads; (ii) better planning in rural roads; (iii) restructuring Bangladesh Railways into a commercially oriented organization in conjunction with substantial investment in infrastructure, rolling stocks and wagons, equipment and technical modernization; (iv) efficient dredging and tariff regulation in inland waterways; and (v) operation efficiency improvements in ports. As indicated in the NLTP, environmental adaptation needs to be taken into account in project assessment, which will help mitigate climate change.

2.5.10 National Water Policy, 1999

The NWP promulgated in 1999 with the intension of guiding both public and private actions in the future for ensuring optimal development and management of water that benefit both individuals and the society at large. The policy aims to ensure progress towards fulfilling national goals of economic developments, poverty alleviation, food security, public health and safety, decent standard of living for the people and protection of natural environment. The policy has several clauses related to the protection and prevention of the natural environment for ensuring sustainable development. Some of the relevant clauses are:

- Clause 4.5b: Planning and feasibility studies of all projects will follow the Guidelines for Project Assessment, the Guidelines for People's Participation (GPP), the Guidelines for EIA and all other instructions that may be issued from time to time by the Government.
- Clause 4.9b: Measures will be taken to minimize disruption to the natural aquatic environment in streams and water channels.
- Clause 4.9e: Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding.
- Clause 4.10a: Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken.
- Clause 4.12a: Give full consideration to environmental protection, restoration and enhancement measures consistent with NEMAP and the NWMP.
- Clause 4.12c: Ensure adequate upland flow in water channels to preserve the coastal estuary ecosystem threatened by intrusion of salinity from the sea.

2.5.11 National Land Use Policy, 2001

The National Land Use Policy (NLUP), enacted in 2001, aims at managing land use effectively to support trends in accelerated urbanization, industrialization and diversification of development activities. The NLUP urges that increasing the land area of the country may be not possible through artificial land reclamation process, which is cost-effective only in the long run.

Therefore, land use planning should be based on the existing and available land resources. The policy suggests establishing land data banks where, among others, information on accreted riverine and coastal chars will be maintained. Among the 28 policy statements of NLUP, the following are relevant to coastal area:

- Forests declared by the MoEF will remain as forest lands;
- Reclassification of forest lands will be prevented; and
- Effective green belts will be created all along the coast.

The proposed power plant will be designed in accordance with this strategy and will comply with the above listed requirements.

2.5.12 Draft Wetland Policy, 1998

The wetland policy is relevant to the existing power plant project because it seeks to:

- Conserve wetlands to sustain their ecological and socio-economic functions and further sustainable development;
- Establish key principles for wetland sustainability and unsustainable practices;
- Maintain existing levels of biodiversity;
- Maintain wetland functions and values; and
- Actively promote integration of wetland functions in resources management and economic development decision taking.

2.5.13 National Fisheries Policy, 1999

The National Fisheries Policy, 1999 was formulated following review and intent of the East Bengal Protection and Conservation of Fish Act 1950, which was updated by the Protection and Conservation of Fish (Amendment) Ordinance 1982 and further refined by the Protection and Conservation of Fish (Amendment) Act 1995. These Acts and ordinance provide provisions for the protection and conservation of fish in fresh water and brackish water bodies.

The Fisheries Policy highlights the need to conserve fish breeding grounds and habitats. It intends to promote fisheries development and conservation in all water bodies. The project should consider these policies to protect the habitats, migration and connectivity of fish and fisheries resources around the project area. Measures to reduce any potential negative impacts on local fish populations will be incorporated into all stages of the Project.

2.5.14 The Power Policy, 1995

This is presently an integral part of the national energy policy 1995 like the petroleum policy. This has different policy statements on demand forecast, long-term planning and project implementation, investment and lending terms, fuels and technologies, power supply to the west zone, isolated and remote load centers, tariff, captive and stand by generation, system loss reduction, load management and conservation, reliability of supply, system stability, load dispatching, institutional issues, private sector participation, human resource development. Regional/international cooperation, technology transfer and research program, environment policy and legal issues.

As the proposed project is a power plant project, so all necessary requirement mentioned above will be adopted for the project.

2.5.15 Industrial Pollution Policy, 1991

The Industrial policy of 1991 contains the following clauses in respect of environmental protection:

- To conserve ecological balance and prevent pollution during industrialization;
- To take effective steps for pollution control and conservation of environment during industrialization;
- To ensure embodying of necessary pollution control and preventive measures by industrial investment project endangering environment.

2.5.16 National Water Management Plan, 2001 (approved in 2004)

The National Water Resources Council approved on March 31, 2004 a 25-year National Water Management Plan. The plan provides a framework within which all concerned with the development, management and use of water resources water services in Bangladesh can plan and implement their own activities in a coordinated and integrated manner. The planned activity programs have been presented in the eight sub-sectoral clusters: i) Institutional Development, ii) Enabling Environment, iii) Main River, iv) Towns and Rural Areas, v) Major Cities; vi) Disaster Management; vii) Agriculture and Water Management, and viii) Environment and Aquatic Resources. Each cluster comprises of a number of individual programs. WARPO was assigned to monitor the NWMP.

2.5.17 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 people 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 emphasis on conservation and enhancement of critical ecosystem- necessary measures will be taken to conserve and develop aquatic and terrestrial including all the ecosystems of importance identified by the Bangladesh National Conservation Strategy (Mangrove, coral reef, tidal wetland, sea grass bed, Barrier Island, estuary, closed water body etc.).

2.5.18 Coastal Development Strategy, 2006

Coastal Development Strategy has been approved by the Inter-Ministerial Steering Committee on ICZMP project on February 13, 2006. The strategy is based on the Coastal Zone Policy and takes into account the emerging trends: increasing urbanization, changing pattern of land use, declining land and water resources, unemployment and visible climate change impacts. The strategy has 9 strategic priorities and the following 3 are relevant priorities with proposed type of interventions:

- Safety from man-made and natural hazards;
- Sustainable management of natural resources;
- Environmental conservation.

2.5.19 The Embankment and Drainage Act, 1952

The East Bangle Act No. 1, 1953 was amended in 1953 which has been adapted by the People Republic of Bangladesh, by the Bangladesh Order (adaptation of Existing Laws), 1972 (President's Order No. 48 of 1972). The Act consolidates the laws relating to embankments and drainage providing provision for the construction, maintenance, management, removal and control of embankments and water courses for the better drainage of lands and for their protection from floods, erosion or other damage by water.

The specific Sections and Articles relevant to the project are mentioned below:

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

2.5.20 Bangladesh Climate Change Strategy and Action Plan, 2009

The GOB also prepared the BCCSAP in 2008 and revised in 2009. This is a comprehensive strategy to address CC challenges in Bangladesh. BCCSAP built on and expanded the NAPA. It is built around the following six themes:

- **Food security, social protection and health** to ensure that the poorest and most vulnerable in society, including women and children, are protected from CC and that all programs focus on the needs of this group for food security, safe housing, employment and access to basic services, including health.
- **Comprehensive disaster management** to further strengthen the country's already proven disaster management systems to deal with increasingly frequent and severe natural calamities.
- **Infrastructure** to ensure that existing assets (e.g., coastal and river embankments) are well maintained and fit for purpose and that urgently needed infrastructure (cyclone shelters and urban drainage) is put in place to deal with the likely impacts of climate change.
- **Research and Knowledge management** to predict that the likely scale and timing of CC impacts on different sectors of economy and socio-economic groups; to underpin future investment strategies; and to ensure that Bangladesh is networked into the latest global thinking on climate change.
- **Mitigation and low carbon development** to evolve low carbon development options and implement these as the country's economy grows over the coming decades.
- **Capacity building and Institutional strengthening** to enhance the capacity govt. ministries, civil society and private sector to meet the challenge of CC.

2.5.21 Bangladesh Wildlife (Preservation) Order, 1973

This Order aims to protect and conserve wildlife in Bangladesh. Wildlife preservation, conservation and management fall within the jurisdiction of the Forestry Department. Protection of wildlife is provided with lists of species within three schedules of the Order:

- First Schedule Part I – List of crustaceans, amphibians, reptiles, birds and mammals of Bangladesh which are open to shooting and may be hunted with an ordinary game hunting permit (though since 1988 no hunting permits have been issued by the Government);

- First Schedule Part II – List of mammals, reptiles and birds of Bangladesh where hunting is permissible with a special permit (problem animals and pest species);
- Second Schedule – Wild animals, trophies or meat for which a certificate is required for lawful possession, transfer or import; and
- Third Schedule – Protected animals i.e. those species that are not to be hunted, killed or captured.

The Government of Bangladesh, under the provisions of the Act, has established three categories of protected areas being National Parks, Wildlife Sanctuaries and Game Reserves. In addition to these, the Government of Bangladesh has declared 14 protected areas and is considering declaring more. Further, the Government of Bangladesh has recently declared 7 areas as Ecologically Critical Areas under the Environmental Conservation Act (1995). These are Hakaluki Haor, Sonadia Island, St. Martin's Island, and Teknaf Peninsula (including the Cox's Bazar Sea Beach but not the buffer zones), Tanguar haor, Marjat baor and outside of Sundarbans Reserved Forest to an extent of 10 km.

2.5.22 National Tourism Policy, 1992

One of the aims of the National Tourism Policy of 1992 statement is "Development of tourism resources of the country and their maintenance". Two special sections of the policy focus on 'archaeological and historical sites' and 'conservation of wildlife'.

2.5.23 Seventh Fifth Five Year Plan (2016-2020)

The GoB approved 7th five year plan (2016-20) in October 2015 aiming to empower people by creating employment and skill development opportunities, supplying credit for SME development and many other ways for people to be more productive. Along with growth, the Plan will emphasize social protection, urban transition and a sustainable development pathway resilient to disaster and climate change. The 7th five year plan has also adopted following major policies and policy actions for environment sustainability:

- Increase productive forest coverage to 20 percent;
- Improve air quality in Dhaka and other large cities and enact clean air act;
- Promote Zero Discharge of industrial effluents;
- Urban wetlands are restored and protected in line with wetland conservation act;
- At least 15% of the wetland in peak dry season is protected as aquatic sanctuary;
- 500 meter wide permanent green belt established and protected along the coast;
- Land zoning for sustainable land/water use completed;
- Environmental, Climate Change and disaster risk reduction considerations are integrated into project design, budgetary allocations and implementation process; and
- Canals and natural water flows of Dhaka and other major cities restored.

2.6 Environmental Standards

The appropriate national environmental standards are applied under the ECR, 1997 and subsequent amendments. The standards, commonly known as Environmental Quality Standards (EQS), are legally binding. There is a separate schedule on industry specific standards, other than the general industrial emission and effluent standards. For reference, the Bangladesh standards for ambient air, noise, odor, sewage, industrial effluent, industrial emission and stake height is given in Annex-B (Volume-II).

2.7 Administrative Setup related to Environment in Bangladesh

The Ministry of Environment, Forest and Climate Change is the nodal agency in the administrative structure of the GoB, for overseeing all environmental matters relating to national environmental policy and regulatory issues in the country. The Ministry of Environment, Forest and Climate Change oversees the activities of the following technical/ implementing agencies:

- Department of Environment (DoE);

- Forest Department (FD);
- Bangladesh Forest Industries Development Corporation (BFIDC);
- Bangladesh Forest Research Institute (BFRI);
- Bangladesh National Herbarium (BNH).

2.7.1 Department of Environment (DOE)

The DoE has been placed under the Ministry of Environment, Forest and Climate Change as its technical wing and is statutorily responsible for the implementation of the ECA, 1995. The department was created in 1989, to ensure sustainable development and to conserve and manage the environment of Bangladesh. The principal activities of the DoE are:

- Defining EIA procedures and issuing environmental clearance permits the latter being the legal requirement before the proposed Project can be implemented;
- Providing advice or taking direct action to prevent degradation of the environment;
- Pollution control, including the monitoring of effluent sources and ensuring mitigation of environmental pollution;
- Setting the Quality Standards for environmental parameters;
- Declaring ECAs, where the ecosystem has been degraded to a critical state; and
- Review and evaluation of IEEs and EIAs prepared for projects in Bangladesh.

2.7.2 Procedure for obtaining ECC from DoE, Bangladesh

The applicability of environmental clearance and the process in Bangladesh is described in Figure 2-1. The EIA process consists of three stages, screening, IEE and detailed EIA:

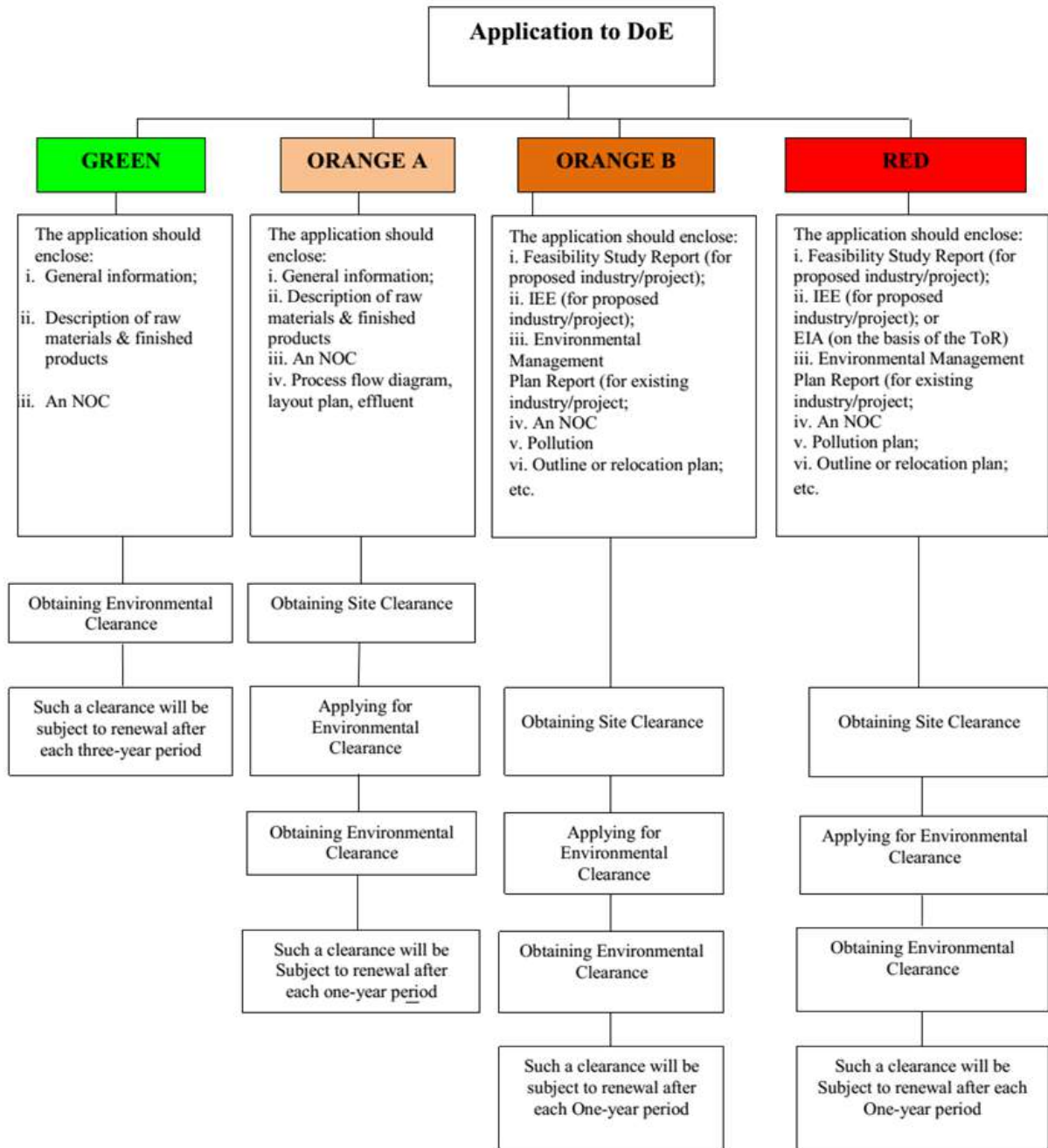
- Projects categorized as Green and Orange-A requires no IEE or EIA for environmental clearance however, the proponent has to submit an application in a prescribed format along with specified documents;
- Projects categorized as Orange-B require an IEE to be submitted to the DoE along with an application in a prescribed format and other specified documents; and
- Red category projects require both IEE and EIA. An IEE is required for the location clearance and an EIA is required for the environmental clearance.

As per the ECR 1997, Power Plant project fall under the “RED” category as referred below:

- Item 6: Power Plant

The process for obtaining an ECC for the proposed project is outlined in the following Figure 2-1.

Figure 2-1: DOE Environmental Clearance Applicability and Procedure



Source: Department of Environment (DoE), Bangladesh

2.8 International Maritime Conventions, Protocols and Agreements applicable for coal transportation

Bangladesh is signatory of the International Maritime Organization (IMO). Therefore, all activities relating to shipment of coal through the Port shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements. The following Conventions/ Protocols of IMO have been agreed by the GoB.

SL	Conventions, Protocols and Agreements	Year	SL	Conventions, Protocols and Agreements	Year
1	IMO Convention	1948	14	IMSO Convention	1976
2	IMO amendments	1991	15	INMARSAT OA	1976
3	IMO amendments	1993	16	FACILITATION Convention	1965

SL	Conventions, Protocols and Agreements	Year	SL	Conventions, Protocols and Agreements	Year
4	SOLAS Convention	1974	17	MARPOL	1973/1978 (Annex I/II)
5	SOLAS Protocol	1988	18	MARPOL	1973/1978 (Annex III)
6	LOAD LINES Convention	1966	19	MARPOL	1973/1978 (Annex IV)
7	LOAD LINES Protocol	1988	20	MARPOL	1973/1978 (Annex V)
8	TONNAGE Convention	1969	21	MARPOL Protocol	1997 (Annex VI)
9	COLREG Convention	1972	22	INTERVENTION Convention	1969
10	STCW Convention	1978	23	SUA Convention	88
11	SAR Convention	1979	24	SUA Protocol	1988
12	STP Agreement	1971	25	OPRC Convention	1990
13	STP Protocol	1973			

Some of the Conventions/Protocols acceded by GoB are highlighted in the following Table 2-3:

Table 2-3: International maritime conventions, protocols and agreements of different issues

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
International Maritime	IMO Convention, 1948	The Convention establishing the IMO was adopted in 1948 but the Organization started life as the Inter-Governmental Maritime Consultative Organization (IMCO) until it was changed to the IMO in 1982. The Aims of the IMO include a range of objectives: - To provide machinery for co-operation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade, and to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation; - To provide for the consideration by the organization of any matters concerning shipping that may be referred to it by any organ or specialized agency of the UN; - To provide for the exchange of information among Governments on matters under consideration by the organization. There have been a series of amendments to the convention, which are 1975 amendments, 1977 amendments, 1991 amendments. This Convention came into force in Bangladesh on May 27, 1976. The amendment 1993 acceded on November 7, 2002.
Maritime safety	SOLAS Convention, 1974	The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant Ships. The 1974 version includes the tacit acceptance procedure-which provides that an amendment shall

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
		enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties. The Convention came into force on May 25, 1980 and acceded by GoB on February 6, 1982. The 1988 Protocol of SOLAS 1974 was acceded by Bangladesh on November 4, 2002.
Measurement of ships	Load Lines Convention, 1966	It has long been recognized that limitations on the draught to which a ship may be loaded make a significant contribution to her safety. These limits are given in the form of freeboards, which constitute, besides external weather tight and watertight integrity, the main objective of the Convention. The Convention acceded by GoB on August 10, 1978. The Protocol of the load Line Convention acceded by GoB on November 4, 2002.
Preventing collisions at sea	Convention on International Regulations for Preventing Collisions at Sea (COLREG), 1972	The 1972 Convention was designed to update and replace the Collision Regulations of 1960, which were adopted at the same time as the 1960 SOLAS Convention. One of the most important innovations in the 1972 COLREGs was the recognition given to traffic separation schemes-Rule 10 gives guidance in determining safe speed, the risk of collision and the conduct of vessels operating in or near traffic separation schemes. The Convention was acceded by Bangladesh on May 10, 1978.
International Maritime Satellite	System Convention on International Maritime Satellite Organization (INMARSAT), 1976	IMO recognized the potential for satellite communications to assist in distress situations at sea soon after the launch of the world's first telecommunications satellite, Telstar, in 1962. In February 1966, IMO's Maritime Safety Committee (MSC) decided to study the operational requirements for a satellite communications system devoted to maritime purposes. In 1973, IMO decided to convene a conference with the object of establishing a new maritime communications System based on satellite technology. The Convention came into force by GoB on July 16, 1979.
Prevention of Pollution from Ships	International Convention for the Prevention of Pollution from Ships (MARPOL)	The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and also includes the protocol of 1997 (Annex VI). It has been updated by amendments through the years. MARPOL 73/78 (Annex-I, II, III, IV, V and VI) was acceded by GoB on November 4, 2002.
	Convention on Facilitation of	The Convention's main objectives are to prevent

Issues	International Maritime Conventions, Protocols and Agreements	Remarks
	International Maritime Traffic (facilitation), London, 1965	unnecessary delays in maritime traffic, to aid cooperation between Governments, and to secure the highest practicable degree of uniformity in formalities and other procedures. In particular, the Convention reduces the number of declarations, which can be required by public authorities. The Convention came into force in Bangladesh on October 28, 2000.
Safety of maritime navigation	Convention for the Suppression of Unlawful Acts of Violence against the Safety of Maritime Navigation (SUA convention), 1988	The main purpose of the convention is to ensure that appropriate action is taken against persons committing unlawful acts against ships. These include: a) The seizure of ships by force; b) Acts of violence against persons on board ships; and c) The placing of devices on board a ship, which are likely to destroy or damage it. The convention obliges Contracting Governments either to extradite or prosecute alleged offenders. The Convention came into force in Bangladesh on September 7, 2005.

2.9 International Legal Obligation

Bangladesh is signatory to a number of MEAs and also some bilateral instruments. Some of them are very important in the context of environmental protection. The legal obligations and provisions of MEAs related to the proposed project interventions will be reviewed; (Convention on Biological Diversity; Convention on Wetlands of International Importance Especially as Waterfowl Habitat; United Nations Convention on the Law of the Sea; Convention Concerning the Protection of the World Cultural and Natural Heritage) Bangladesh has already had accessed to, ratified or signed a number of important MEAs related to environment protection and conservation of natural resources which shall have to be complied with during implementation of the project. The pertinent ones of these are highlighted below:

2.9.1 Rio Declaration, 1992

The 1992 UNCED adopted the global action program for sustainable development called “Rio Declaration” and “Agenda 21”. Principle 4 of the Rio Declaration, 1992, to which Bangladesh is a signatory along with a total of 178 countries, states, “In order to achieve sustainable development, environmental protection should constitute an integral part of the development process and cannot be considered in isolation from it”.

2.9.2 Convention on Biological Diversity, 1992

The Convention on Biological Diversity, Rio de Janeiro, 1992 was adopted on 5th June 1992 and entered into force on 29th December 1993. Bangladesh ratified the Convention on 20th March, 1994. The Contracting Parties of the Convention have committed to:

- Introducing appropriate procedures requiring environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimizing such effects, and where appropriate allow for public participation in such procedures; and

- Introducing appropriate arrangements to ensure that environmental consequences of its programs and policies, that are likely to have significant adverse impacts on biodiversity, are duly taken into account.

Obligation has been placed on State parties to provide for environmental impact assessments of projects that are likely to have significant adverse effects on biological diversity (art. 4).

2.9.3 Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, 1971

This convention is also known as the Ramsar Convention. It was adopted 2nd February, 1971 and entered into force on 21st December, 1975. Bangladesh has ratified the Convention 20th April, 2002. This provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are 127 Parties with 1085 wetland sites designated as Wetlands of International Importance. This is an intergovernmental treaty, which provides the framework for international cooperation for the conservation of wetlands habitats. Obligations for Contracting Parties include the designation of wetlands to the “List of Wetlands of International Importance”, the provision of wetland considerations within their national land use planning, and the creation of Natural Reserves.

2.9.4 United Nations Convention on the Law of the Sea, Montego Bay, 1982

This Convention was adopted on 10th December 1982 at Montego Bay, Jamaica. Bangladesh has ratified this Convention. Main objectives of the convention are:

- To set up a comprehensive new legal regime for the sea and oceans, as far as Environmental provisions are concerned, to establish material rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment; and
- To establish basic environmental protection principles and rules on global and regional cooperation, technical assistance, monitoring, and environmental assessment, and adoption and enforcement of international rules and standards and national legislation with respect to all sources of marine pollution.

2.9.5 UNESCO World Heritage Convention, 1972

Convention concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972: This convention has been ratified by 175 states. This defines and conserves the world's heritage by drawing up a list of natural and cultural sites whose outstanding values should be preserved for all humanity. Of the 730 total sites, there are currently 144 natural, 23 mixed and 563 cultural sites that have been inscribed on the World Heritage List (distributed in 125 State parties). These are the “Jewels in the Crown” of conservation.

2.9.6 The United Nations Framework for Convention on Climate Change, 1992

Also known as the Kyoto Protocol, this convention aims for the “stabilization and reconstruction of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system”. Bangladesh is a signatory to the Protocol and thus the Project is being undertaken in line with the Bangladesh Government's strategies for greenhouse gas planning for the country.

2.9.7 Conference of Parties (COP-21)

The COP (Conference of Parties) is the supreme decision-making body of the UNFCCC. Based on attendance of number of head of states, there are high COPs and Low COPs. Paris COP-21 was a High COP with 150 Heads of states attending. Two major issues of the negotiation were CO₂ emission and finance. In its Intended Nationally Determined Contribution (INDC) Bangladesh pledged an unconditional 5% greenhouse gas emissions cut by 2030, adding that with financing and technology support it will cut emissions by 15%.

CHAPTER THREE: PROJECT DATA SHEET

3. Project Data Sheet

This chapter describes the details of proposed project proponents, project location and area, nature and size of the project, project components, activities, project schedule, resources and utility demand sources and transportation of fuel etc. for the proposed 350 MW coal-fired power plant at Taltoli Upazila of Barguna District, Bangladesh.

3.1 Project Proponent

Electric power plays an important role in alleviating poverty and enhancing social and economic development in Bangladesh. The country has been suffering from severe power shortfall. Fully aware of sufficient and stable power as a precondition to attract domestic and international investment, the GoB has initiated the MDGs program to overcome power supply restriction, improve social and economic conditions, and achieve 100% nationwide electrification by 2021. Besides laying the most favorable foundation for power sector development of electric by installing and upgrading state-owned power plants, GoB has been actively encouraging private investment in the power sector under BOO mode. According to the strategy on the diversity of fuels in PSMP 2010, the government plans to construct large-scale coal fired power projects along the Bay of Bengal.

In view of the above background, Power China Resources Limited (PCR) intends to collaborate with Bangladesh Iso Tech Group (ITG) jointly formed a company named “Barisal Electric Power Company Limited (BEPCL)” to invest and build a coal-fired power plant in Barguna District. After the completion of the proposed project, it will be able to add 350 MW electricity to the national grid. The proposed project is going to be developed in IPP mode, with PCR and ITG as main investors. PCR will take the lead in the project construction and operation. PCR and ITG hold 96% and 4% of project share respectively. The ratio of project capital fund and bank loan from a Chinese financial institution is currently proposed as 30%:70%. The official name and contact details of the project proponent are given in following Table 3-1.

Table 3-1: Contract Detail of the Project Proponent

Items	Detailed Description
Project Name	Barisal 350 MW Coal-fired Power Plant Project at Taltoli, Barguna, Bangladesh
Chief Executive Officer	Mr. ZHAO Zhenqing
Company Name	Barisal Electric Power Company Limited (BEPCL)
Address	GA-99/3/A&B, Badda, Dhaka-1212
Contract No.	+8801709380127
e-mail	lishuqiang-sdht@powerchina.cn

Source: BEPCL, 2018

3.2 Project Location and Area

In line with the MoU signed with the GoB and on the basis of the prerequisites for selecting a site for the proposed 350 MW power plant project, the site selection was carried out through alternative site evaluation. At first, two alternate sites were identified in Barisal and Barguna district respectively and after evaluation, the Barguna site (near village: Bara Ankujan Para and Joyalbhanga, Mouza: Chhota Nishanbaria Chak, Union: Nishanbaria, Upazila: Taltoli, District: Barguna, Division: Barisal, Bangladesh) having major favorable features along with good environmental features, has been identified for the proposed project. The proposed project is located on the bank of the Buriswar-Payra River and the confluence of the Bay of Bengal. The proposed site for the power plant is a single cropland and barren land consists of shrubs and bushes. There are no major industries close to the proposed project site and the area is a rural area. The photographs of the existing condition of the proposed power plant project site are given in following Figure 3-1.

Figure 3-1: Existing Condition of the Proposed Project Site of the BEPCL



Proposed project site



Inside of the proposed project site



Inside of the proposed project site



Planted mangrove along the Buriswar-Payra River bank



Access road near the project site connected with the Taltoli Upazila

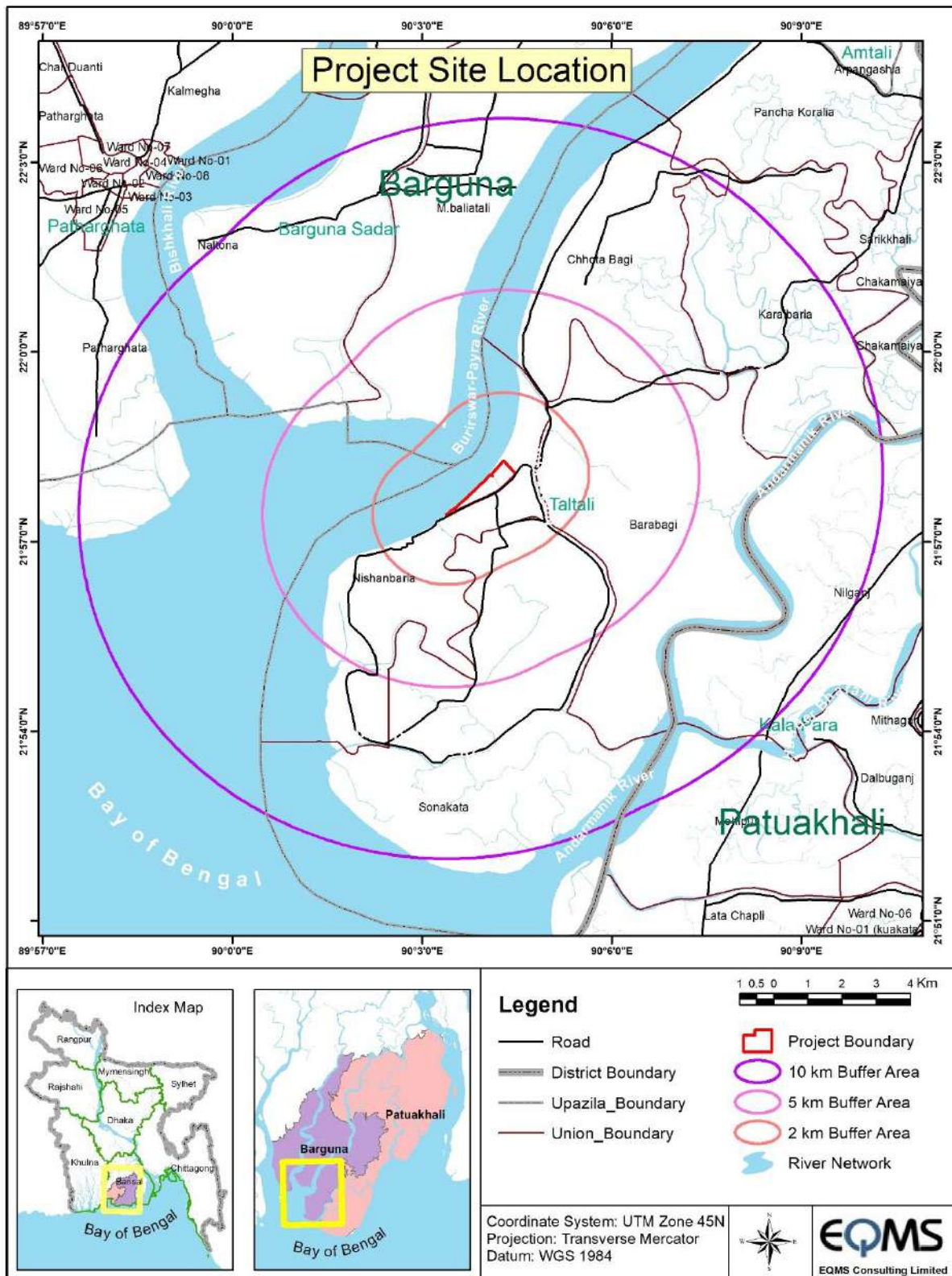


Buriswar-Payra River Channel from the Joyalbhanga Bazar

Source: EQMS field visit during September 2018

The proposed power plant project site is located between 21°51'58.632"N to 22°3'41.049"N Latitude and between 89°57'35.011"E to 90°10'18.461"E Longitude. The tentative area of the proposed project is about 174 acres. The site is surrounded by Buriswar-Payra river and planted mangrove on the north side, Buriswar-Payra river and Joyalbhanga Bazar on the west side, BWDB embankment, settlement including homestead vegetation land on the east side and BWDB embankment, settlement including homestead vegetation, agricultural land on the south side. At the present situation the most of the area of the proposed project site is open and settlement including homestead vegetation are present along the BWDB embankment site. A narrow road is connected the project site with the Taltoli Upazila and other areas on the region. A location map of the proposed power plant project site of the Barisal Electric Power Company Limited is shown in following Figure 3-2.

Figure 3-2: Location Map of the Proposed Project Site



Source: EQMS, 2018

3.3 Nature and Size of the Project

3.3.1 Capacity of the Project

The BEPCL proposes to set up a coal-fired thermal power project of 350 MW capacity near the Bara Ankujan Para village, Nishanbaria Union, Taltoli Upazila in Barguna District. The capacity of the

proposed power plant will be 350 MW. One supercritical boiler will be installed for power generation. The details of the proposed power plant are presented in Table 3-2.

Table 3-2: Details of the Proposed Power Plant

SL#	Features	Description
1	Capacity	350 MW
2	Configuration	1x350 MW
3	Type of Boilers	Supercritical, single reheat, single furnace, balanced ventilation, dry-ash furnace, outdoor layout, all-steel structure, “Π” type, once-through boiler
4	Power Evacuation	GIS will be provided in the plant and connected through 400kV single-circuit outgoing line to the 400kV substation about 26 km away in the north-east
5	Fuel	Coal and oil
6	Source of Oil	Light fuel oil from the international market
7	Source of Coal	Import from Indonesia, South Africa or Australia
8	Coal Requirement	1.1185 million tons per year
9	Sulphur Content	0.3% to 0.9%
10	Ash Content in Coal	4% to 18%
11	Ash Generation	
	Bottom Ash	35,679.15 t/a (design coal) and 49,647.00 t/a (worst coal)
	Fly Ash	2,02,196.67 t/a (design coal) and 2,81,165.04 t/a (worst coal)
12	ESP	Twin-chamber five-electric-field ESP will be equipped with dust collection efficiency of not lower than 99.72%
13	Stack Height	220 meter
14	Water Requirement	48,115 m ³ /hour will be intake from the Buriswar-Payra River

Source: Feasibility Report and PPA between BPBD and BEPCL, April 2018

3.3.2 Project Cost

The capital cost of the project is about 629 million USD (approximately more than 5,000 crores in BDT) for 1x350 MW, which includes about 5.8 million USD (0.45 million for ETP, 0.21 million for STP and 5.23 million for WTP) for environmental management. The project completion schedule is tentatively considered as the 40th month.

3.4 Project Concept

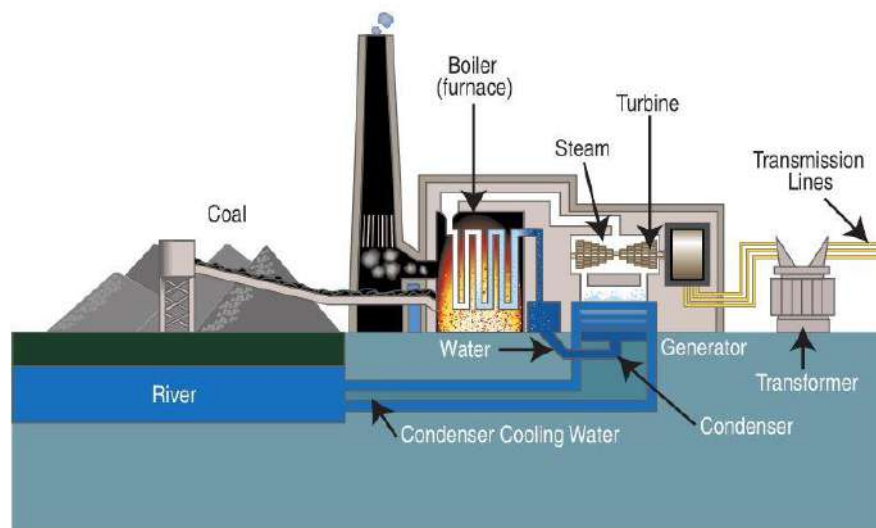
The proposed 350 MW coal-fired power plant project proposed to use supercritical coal-fired boilers, which is a proven technology for power generation. Approximately, 174 acres of land will be required for the establishment of the power plant and auxiliary facilities including main power block, residential township for project staff, chimney, coal handling system, raw water intake pump house, coal yard, ash pond, ash handling and disposal system, space for FGD transmission switchyard, raw water reservoir, FGD, Greenbelt, Jetty, ETP, WTP and STP etc.

The proposed project will use the coal as the primary fuel and it will be imported from the foreign countries like Australia, South Africa and Indonesia. The annual coal requirement for the proposed project is 1.1185 million tons/year. According to the PPA document, the heating value of the imported coal will be 8000-12000 Btu/lb on GaR basis, sulphur content 0.3 to 0.9%, moisture content 15 to 35%, ash content 4% to 18% and carbon content 35% to 45%. A dedicated coal handling Jetty will be constructed in the Buriswar-Payra River on the north side of the proposed project. According to the water balance diagram, the water required for the power plant will be extracted from the Buriswar-

Payra River and groundwater will not be used for this project. As per the feasibility report, once-through circulating cooling system is recommended for the proposed project. The generated electrical power will be evacuated through 26 km long 400kV transmission line (single-circuit) from the plant to regional substation.

According to the project proponent, care should be undertaken concerning the environmental and social impact out of the plant and sufficient protective measures shall be incorporated in the design of the plant for environmental protection especially on air pollution, water pollution, noise level, drainage, soil quality, sediment quality, ecology and biodiversity. A concrete chimney has been proposed for the proposed project and height will be 220 meters considering the guidelines given by the DoE, Bangladesh. The proposed project will ensure the Greenbelt, ESP, FGD and low NO_x burner to ensure the reduction of the environmental pollution during the operation phase of the proposed project. The environment protection measures shall be undertaken in accordance with the environment protection guidelines of WB, IFC, Chinese standard and environmental protection and emission control standards of DoE, Bangladesh. The project proponent have a plan to extent the project capacity by establishing a separate unit in future. A typical diagram of a coal based thermal power plant is shown in Figure 3-3.

Figure 3-3: Typical Diagram of Coal Fired Thermal Power Plant



Source: <http://www.tva.com/news/downloads.htm> tva.com

3.5 Project Components

3.5.1 Boiler

The proposed coal-fired power plant consists of one 350 MW unit. It will be steam-based, pulverized coal-fired boiler unit of supercritical type, steam turbine and generator.

Boiler Parameters:

- **Type:** supercritical, single reheat, single furnace, balanced ventilation, dry-ash furnace, outdoor layout, all-steel structure, “Π” type, once-through boiler;
- **Air preheater:** tri-sectional regenerative air preheater;
- **Combustion mode:** front and back wall opposed firing or corner tangential firing;
- **Boiler ignition mode:** less oil ignition burner-diesel oil-pulverized coal;
- **Oil-fired ignitor atomization:** mechanical;
- **Steam temperature regulation:** superheater: two-stage spray desuperheating reheater: flue gas damper plus emergency spray desuperheating;
- **Minimum stable combustion load:** 30% at BMCR.

The main parameters of the boiler are given in following Table 3-3.

Table 3-3: Parameters of the Boiler

Item	Unit	BMCR Condition
Maximum continuous evaporation	t/h	~1105
Superheated steam rated pressure	MPa(g)	25.4
Superheated steam temperature	°C	571
Reheat steam rated flow	t/h	879.71
Steam temperature at the outlet of the reheater	°C	569
Rated feed water temperature	°C	285
Flue gas temperature at outlet of air preheater	°C	119
Boiler efficiency (calculated by the lower heating value of coal)	%	93.5
Air-preheater type	-	Tri-sectional regenerative
Combustion mode	-	Front & back wall opposed firing or corner tangential firing
Operation mode	-	Constant pressure-sliding

Source: Feasibility Report, 2018

3.5.2 Turbine

The turbine will be supercritical, once intermediate reheat, two-cylinder two-exhaust, single shaft, condensing steam turbine. Others specification of the turbine is given in following Table 3-4.

Table 3-4: Specification of the Turbine

Item	Unit	Capacity
Rated power (TMCR)	MW	350
Main steam pressure (TMCR)	MPa(a)	24.2
Main steam temperature (TMCR)	°C	566
Main steam flow (TMCR)	t/h	984
Reheat steam pressure (TMCR)	MPa(a)	4.828
Reheat steam temperature (TMCR)	°C	566
Reheat steam flow (TMCR)	t/h	785
Feed water temperature (TMCR)	°C	285.2
Turbine speed	r/min	3,000

Source: Feasibility Report, 2018

The thermodynamic system is designed on the basis of the unit system. The regenerative system has eight stages of extraction steam that are supplied to three sets of HP heaters, one deaerator and four sets of LP heaters respectively.

3.5.3 Generator

Under the condition of rated power, rated voltage, rated power factor and rated cooling medium, the continuous rated output power at the generator terminal is 350 MW (deducting the static excitation power). The three-phase two-pole synchronous generator of water-hydrogen-hydrogen cooling mode with proven experience is proposed for the project.

The excitation system is equipped with self-shunt static excitation provisionally, which will be provided by the generator manufacturer. The manufacturer's performance, proven technique and reliable capability shall be the basis for the selection of excitation system. The generator specification is given in following Table 3-5.

Table 3-5: Generator Specification

Item	Unit	Capacity/Description
Type	-	QFSN-350-2
Rated power	MW	350
Rated power factor	-	0.8/0.95 (lagging/leading)
Rated voltage	kV	20
Rated speed	r/min	3,000
Frequency	Hz	50
Number of phases	No.	3
Number of poles	No.	2
Stator winding connection mode	-	YY
Number of outgoing terminals	No.	6
Cooling mode	-	Water-hydrogen-hydrogen
Excitation mode	-	Static excitation
Rated temperature rise	-	Following GB/T7064—2008 Specific Requirements for Cylindrical Rotor Synchronous Machines

Source: Feasibility Report, 2018

3.6 Project Activities

For the establishment of any industrial projects, it requires to conduct various activities in different phases of the project. The activities that will be carried out during pre-construction, construction and operation phases for establishing the BEPCL project are given in the following Table 3-6.

Table 3-6: Activities during Pre-construction, Construction and Operation Phase

Project Phase	Activities
Pre-construction Phase	The following major activities to be undertaken during the pre-construction phase of the proposed project: • Selection of candidate sites; • Land acquisition/requisition/lease; • Resettlement and compensation; • Land survey, geotechnical investigation; • Feasibility study for the power plant and associated facilities; • IEE study for site clearance & EIA study for environmental clearance; • Preparation of layout plan, design and drawings; • Removal of vegetation/Trees; • Dredging, soil collection and transportation to the project site; • Heavy equipment and machinery operation in the project site; • Maintenance and replacement of vehicles and equipment; • Landfilling and levelling; and • Land preparation for the proposed project.
Construction Phase	The following major activities to be undertaken during the construction phase of the proposed project: • Establishment of labor camp; • Temporary sites used for storage of construction goods, materials and machinery for the construction of the power plant and associated facilities; • Construction of Jetty in the river; • Transportation of construction materials by road and waterway;

Project Phase	Activities
	• Heavy equipment and machinery operation in the construction site; • Maintenance and replacement of vehicles and equipment; • Civil construction and technological installation work; • Mechanical and electrical installation; • Development of internal road networks; • Use of utilities like land, power, water, fuel etc.; • Solid and liquid waste generation from the labor camp and construction site and disposal; • Monitoring of mitigation measures for Environmental and social impact; • Overall project construction and management.
Operation Phase	The following major activities to be undertaken during the operation phase of the proposed project: • Manpower requirements for the power plant operation; • Transportation of raw materials (Coal and Oil) from source country; • Distribution of electricity by connecting with national grid; • Use of utilities for the power plant and worker's facilities; • Commercial operation of the power plant; • Generation of solid, liquid and hazardous wastes from the workers camp and power plant operation; • Disposal and management of solid, liquid and hazardous wastes; • Maintenance and replacement of equipments; • Implementation of CSR activity; and • Monitoring of EMP, DMP and HSE.

Source: EQMS, 2018

3.7 Project Schedule

The project authority of BEPCL aims to have the completion of all the works for the power plant in 40th months after signing with the EPC contractor and commissioning date is expected during 40th months. It is expected that the production year will be January 2022. As per the EPC schedule, the overall project schedule for the proposed power plant is shown in Table 3-7.

Table 3-7: Overall project schedule

SL#	Activities	Expected Date
1	Signing PPA and IA	April 2018
2	Signing EPC agreement	October 2018
3	Plant site backfilling	December 2018
4	Financing closing	February 2019
5	Five-accessing-one-leveling & foundation treatment	February 2019
6	350 MW unit commissioning	January 2022

Source: BEPCL, 2018

3.8 Resources and Utilities Demand

The proposed power plant project shall provide employment opportunity for unskilled, semi-skilled and skilled categories during the pre-construction and construction phase. Employment potential shall increase with the start of pre-construction and construction activities. During operation phase, there will also be employment opportunities in the service sector and secondary business.

3.8.1 Soil Requirement

According to the BEPCL, for the land development in the proposed project site, it will be required an approximate amount of 3.2 million cubic meter landfilling material (dredge soil). This landfilling material will be collected from the sea (Bay of Bengal) by dredging. According to the project proponent, the tentative location of the dredging site is about 6.5 km on the west side of the power plant. The Power China Harbour Co. Ltd. will be responsible for landfilling activities in this project. Before starting dredging activity in the Bay of Bengal, the project proponent must ensure the avoidance of the protected area, Wildlife Sanctuary and taken written approval from the concerned authority.

3.8.2 Water Requirement during Pre-construction and Construction

During the pre-construction stage for the land or soil compaction purposes water will be required. This water will be collected from the existing available surface water (Buriswar-Payra River) in the project area. During the construction period water will be collected from the Buriswar-Payra River. During the concreting work during construction phase more water will be required and it is expected that its amount will be approximately 1600m³/day during construction peak and maximum 900m³/day during civil construction. For the domestic purposes approximately 600 m³/day will be required.

3.8.3 Power requirement during pre-construction and construction

During the construction phase of the proposed power plant project, the capacity of the transformer will be 4000KVA and the maximum load will be 3200KW in the peak period.

3.8.4 Gas requirement during pre-construction and construction

Natural gas will be mainly used in the canteen and requirement will be 55m³/h during peak period of the construction phase of the proposed project.

3.8.5 Manpower requirement during pre-construction and construction

During the pre-construction and construction phase skilled, semi-skilled and unskilled laborer and officers will be required to complete the project in time. About 280 operators and labors will be dispatched on site in order to quickly finish the dredging activities. For the landfilling materials transportation, about 100 operators will be needed. During the construction phase, local labors, civil engineers, electrification engineer, machinery engineer and managers will be required. Total 2,200 numbers of people will be required during peak time of the construction phase. Surrounding of the project area there are availability of laborers that can be used for the project.

3.8.6 Vehicles Requirement

There will be 85 numbers of equipment's including dredger(s), bulldozers, dump trucks and loaders will be required for dredger operation. For the land filling materials transportation, 2 vessels will be needed. During the construction period, approximately 27 nos. vehicles (dump truck 15, flatcar 4 and concrete mixer truck 8 nos.) per day will be required. Vehicles will also be required for transportation of construction materials, workers and officer in the construction site.

3.8.7 Construction Materials

Sand, cement, steel bar, brick and materials for decoration will be collected from local market in Bangladesh. For the completion of the power plant, stone will be collected from China or India and steel structure from China.

3.9 Sources of Primary Fuels (Quality and Country of origin)

Coal will be the primary fuel for the proposed power plant. The annual coal consumption for the proposed 1x350 MW unit project is estimated to be about 1.1185 million tons and all the fuel coal will be imported from the foreign countries. Currently, the available options for coal export countries are Australia, South Africa and Indonesia. According to the PPA agreement between BEPCL and BPDB, the coal quality/specification will be as follows (Table 3-8).

Table 3-8: Coal Specification

SL#	Specification	Unit	Value
1	Heating Value	Btu/lb on GaR basis	8,000-12,000
2	Sulphur Content	%	0.3 to 0.9
3	Moisture Content	%	15 to 35
4	Ash Content	%	4 to 18
5	Carbon Content	%	35 to 45

Source: PPA between BPBD and BEPCL, 12th April 2018

According to the feasibility report, the coal analysis result for the proposed project will be as follows (Table 3-9):

Table 3-9: Coal Analysis Data Sheet

SL#	Item	Unit	Design Coal	Worst Coal
1	Sulfur	%	0.85	1.0
2	Ash content	%	20.76	26.2
3	Lower heating value	Kcal/kg	4,945	4,451

Source: Feasibility Report, 2018

3.10 Transportation of Primary Fuel

The proposed project site is located on the bank of the Buriswar-Payra River and the confluence of the river and sea. According to the project proponent, a special coal-unloading jetty will be built at the riverbank on the northern side of the power plant and a NOC from BIWTA will be required prior to start the jetty construction activity. However, the EIA study team yet not received the NOC from the project proponent. The water depth is relatively shallow in the area from the open-sea area to the project area, the water depth is less than 5 m in most of these areas. Due to the limited of water depth in the channel area, large vessel will not be able to directly navigate to the berth, the trans-shipment system in the waters near the project terminal is necessary, the large transport vessels will be transported coal to the coal barges and then will be shipped to the wharf. Considering the barge type used in Bangladesh is mainly 2000~3000t, for the project the coal barge takes 3000t barge. According to the BEPCL, a separate EIA study will be conducted for the jetty construction and coal transportation from outer anchorage point in the sea to the proposed project coal-handling jetty near the project site. A schematic diagram of coal transport is given in the following Figure 3-4.

Figure 3-4: Schematic Diagram of Coal Transport



Source: Feasibility Report, 2018

3.10.1 Dimension of the Channel

The dimension of the channel considers to satisfy the demand of the navigation for 3000t barge.

3.10.1.1 Width of the Channel

The width of the channel is composed of the width of the track belt, width clearance between ships and vessels and width clearance between ships and the bottom line of the channel. Considering the traffic density of the project, the channel considers being a two-way channels, the width of the channel will takes 160m.

3.10.1.2 Depth of the channel and the navigation water level

The channel depth for 3,000t barge takes 6.2 m. According to the bathymetric survey, from August 2016 to October 2017, the nature bottom level of the channel area is between -5.7m ~ -19.5m (Datum: MSL, similarly hereinafter). The area from the proposed power plant project area to the North-East of Pakkhi Char island is approximately 14 km which are mainly in the deep groove and the depth of the channel varies between -9.0m ~ -19.5m. It can satisfy the 3000t barge navigation in it for all tide. In addition, the area from the North-East of Pakkhi Char Island to the deep sea area is approximately 40km is a shallow area of the Bay of Bengal. The depth of the channel varies between -5.7m ~ -8.5m. Water depth is relatively small, which cannot satisfy the 3000t barge navigation in it, in order to satisfy the demand of the 3000t barge navigation, at this stage, temporarily considers the vessel navigating in it by take advantage of the tide.

The navigational speed is considered 6~8 knots, it is needed approximately 3~4 h for the vessel navigation in the 40 km channel mentioned above. According to the analysis of the available tide level data, the tide of the project area belongs to semi-diurnal tides, the total time that the water level greater than 0.5~0.7m in every tide is about 4~5h, which can satisfy the vessel navigating through the channel, so the navigation water level temporarily takes 0.5~0.7m.

3.10.2 Approach Channel

The proposed project is located on the estuary of the Buriswar-Payra River, the natural bottom level of the basin area is -15.0~-21.0m and in the south is the shallow area of the Bay of Bengal, the water depth is relatively shallow in this area, the distance between the -10 isobaths and the coastline is about 35~50 km. At present there is no available channel that can be used for the project, it is needed to build a new channel to establish a connection between the proposed project site and deep-sea area. The length of the new channel is about 54km, the width of the channel takes 160m, the depth of the channel takes 6.2m, the navigation water level temporarily takes 0.5~0.7m.

3.10.3 Navigation Aids

It is necessary to arrange navigation aids to ensure safe navigation of vessels in the channel and turning basin. It is proposed to arrange 33 buoys in both side of the channel and around the turning area and arrange one light beacon in both sides of the proposed jetty respectively.

This is actually the proposed alignment of the navigational channel for the coal transportation for the proposed coal-fired power plant. The environmental sensitive locations, critical area, marine protected areas, fishing zone and other issues will be assessed before finalization of the navigational route and dredging activities in the Bay of Bengal. Separate EIA study will be required for the jetty construction and coal transportation route and dredging in the sea area. The tentative alignment of the navigational channel map is shown in following Figure 3-5.

Figure 3-5: Sketch Map of the Navigation Channel



Source: Feasibility Report, 2018

3.10.4 Marine Structure

3.10.4.1 Coal Unloading Jetty

For coal unloading jetty, steel pipe pile will be used as foundation pile and the bent spacing will be 8.0m. Six piles will be arranged in each bent. The superstructure will be orthogonal beam slab system, which will cast-in-situ transverse beam, precast longitudinal beam and composite slabs. The transverse beam will be inverted T-type. The precast longitudinal beam will be placed on the lower transverse beam.

The approach bridge will join the coal unloading jetty and backland area. It will adopt a mode of high-pile supported and large span structure. The pile foundation will adopt steel pipe pile. Three piles will be arranged for every pier. The hollow slabs and the U-type slab will be arranged for every span.

3.10.4.2 Heavy Lift Jetty

For heavy lift jetty, steel pipe pile will be used as a foundation pile, and the bent spacing will be 8.0m. Eight piles will be arranged in each bent. The superstructure will be orthogonal beam slab system, which will cast-in-situ transverse beam, precast longitudinal beam and composite slabs. The transverse beam will be inverted T-type. The precast longitudinal beam will be placed on the lower transverse beam.

The approach bridge will join the heavy lift jetty and backland area. It will adopt a mode of high-pile supported and large span structure. The pile foundation will adopt steel pipe pile. Three piles will be arranged for every pier. The hollow slabs and U-type slab will be arranged for every span.

There will be two mooring dolphins for heavy lift jetty. The mooring dolphin will adopt a pier structure on piles. One bollard will set up for every dolphin. Steel pipe piles will be arranged for the dolphin. The upper part will be a cast-in-situ pier. Two steel walking ways will join the dolphins and jetty.

CHAPTER FOUR: PROCESS DESCRIPTION

4. Process Description

4.1 Project Site

The land identified for the proposed project (174 acres) is single cropland and barren land consists of shrubs and bushes. According to the feasibility report, the proposed project site is situated on the wide and open terrain with an average elevation of 0~3.41m (based on Mean Sea Level). The proposed plant site is relatively stable and favorable for construction, with general earthquake resistance. According to the GSB, seismically, the site falls under seismic zone-3. The proposed project site is located on the coastal tidal flat without conditions for adverse geologic actions (such as landslide, collapse, mud-rock flow etc.) and karst.

The proposed site is about 9.90 km away (west side) from the nearest Dhaka-Patuakhali (N-8) national highway. An asphalt pavement road in good traffic condition for small vehicles connects the proposed project site with the Taltoli and Amtoli Upazila. According to the feasibility report, existing road is not adequate for the transportation of heavy cargos and recommended that logistics and heavy goods for the proposed project will be transported using the waterway. There is no existing railway transportation system in the whole of the Barisal division. However, the present government has taken a major initiative to set up rail access from Faridpur to Barisal and capital Dhaka through the Padma Multipurpose Bridge. The capital city Dhaka is about 200 km away from the project site. The nearest airport is located at Barisal is about 95 km. away. The details of the environmental setting around the proposed project site are given in following Table 4-1.

Table 4-1: Environmental Setting of the Project Site

SL	Particulars	Details
1	Plant Location	Village: Bara Ankujan Para and Joyalbhanga, Mouza: Chhota Nishanbaria Chak, Union: Nishanbaria, Upazila: Taltoli, District: Barguna, Division: Barisal
2	Plant site coordinates	Latitude: 21°51'58.632"N to 22°3'41.049"N Longitude: 89°57'35.011"E to 90°10'18.461"E
3	Climatic condition	Temperature: 40°C (Highest in April 2014) and 7.7°C (lowest in January 2013); Rainfall: average 2,861.0 mm/year; Humidity: 75.5% to 88.3%; Wind speed: average 2.72 m/s and Wind direction: SSE to NNW
4	Plant site elevation above MSL	Average 0~3.41m
5	Plant site topography	Floodplain and no hilly area
6	Present land use at the site	Single cropland, settlement, ponds, canal, homestead vegetation/tree, barren land consists of shrubs and bushes
7	Nearest Highway	Dhaka-Patuakhali (N-8) on the east side from the project site and 9.90km away
8	Nearest Railway Station	No railway in Barisal Division
9	Nearest Airport	Barisal Airport 95 km on the north side
10	Nearest major water bodies	Bay of Bengal and Buriswar-Payra River on west and north side close to the project boundary
11	Water source of the project	Surface water from Buriswar-Payra River
12	Nearest Town/City	Barguna 20 km on the north
13	Nearest Sea Port	Payra Sea Port, 25 km East
14	Nearest Village	Bara Ankujan Para on the south and west side
15	Hills/valleys	None within 10 km radius

SL	Particulars	Details
16	Archaeological important places	None within 10 km radius
17	Protected Area (National Park, Wildlife Sanctuary etc.)	Tengragiri Wildlife Sanctuary on the south side @ 6.16 to 8.30 km from the project site; Sundarbans East Wildlife Sanctuary on the west side @ 15.14 km from project site, Kuakata National Park on the south side @ 10.96 km from the project site
18	Reserve forests	Laldia Reserve Forest on the north-east & Sundarbans Reserve Forest on the west side @ 19.22 km
19	Seismicity	Seismic zone-3 (GSB)
20	Defense installation	None within project site
21	Major industries in 5 km radius	None
22	Socio-economic factors	Approximately 112 number of households

Note: All distances mentioned are aerial distances

Source: Field Survey by EQMS, 2018

4.2 Project Layout

The layout of the proposed power plant has been optimized considering the space requirements of all the equipment, systems, buildings and structures, coal storage area, ash silos, pump house, water treatment plant, effluent treatment plant, sewage treatment plant, cooling water pump house, 400kV switchyard etc. for the 350 MW power plant. The project proponent will ensure the proper drainage system at the proposed power plant site and surrounding area. Including various facilities, consideration has been given to the following general aspects:

- Provision to install 350 MW power plant;
- Coal storage yard (8 acres) for 60 days requirement at the site for 350 MW;
- Ash silos for fly ash and ash pond area (44.48 acres);
- 400kV switchyard;
- Water treatment facilities;
- Provision of space for FGD unit;
- Raw water supply and storage facilities; and
- Availability of adequate space for fabrication/construction equipment.

All facilities of the plant area will be laid out in close proximity to each other to the extent practicable so as to minimize the land requirement. The layout facilitates movement of men and materials between the various facilities both during construction and operation phase. The general layout plan of the power plant is presented in following Figure 4-1. A large size layout plan is also given in Annex-D (Volume-II) and the break-up of the land use is given in following Table 4-2.

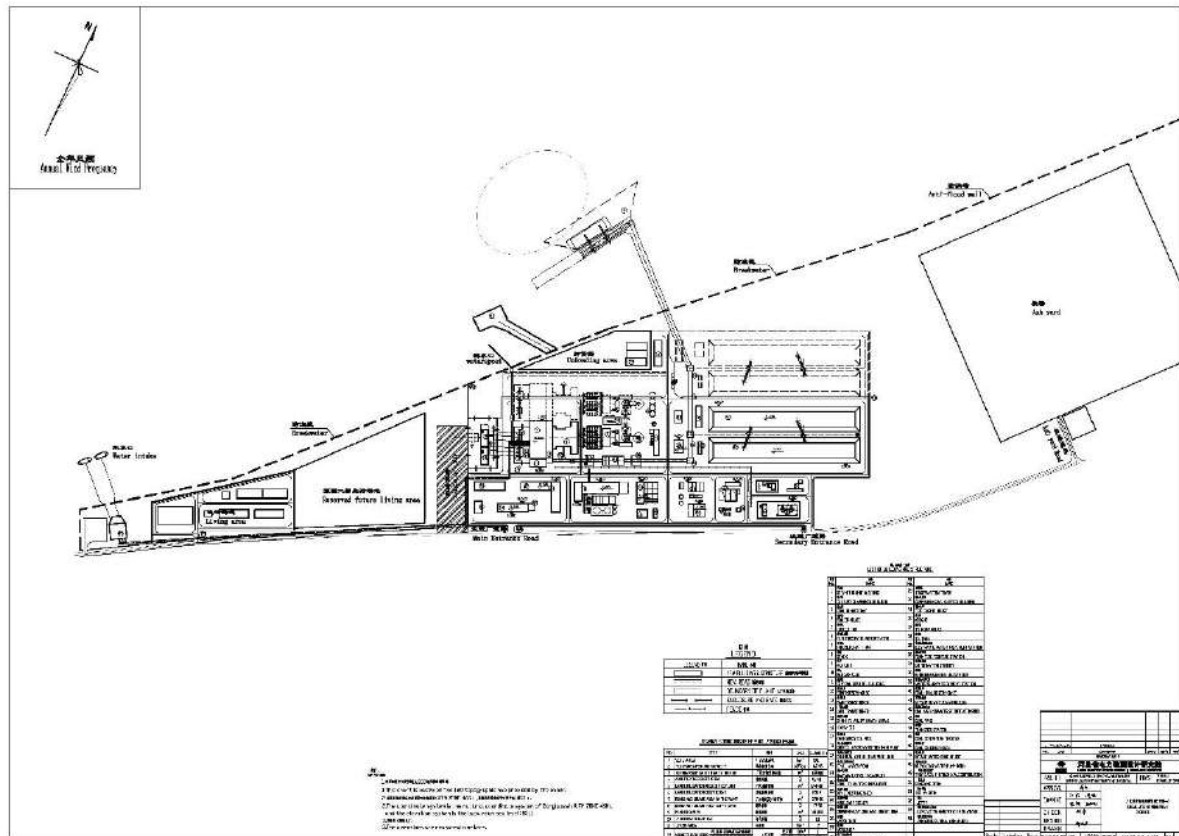
Table 4-2: Break-up of Land use for the Proposed Project

SL	Description	Area (in Acre)	Percentage (%)
1	Main Plant Area	39.20	22.53
2	Coal Stockyard	8	4.60
3	Living Area	7.41	4.26
4	Roads	8.65	4.97
5	Water Intaking Pumps Building	5.19	2.98
6	Transmission Line Corridor	3.21	1.84
7	Unloading Area	3.21	1.84

SL	Description	Area (in Acre)	Percentage (%)
8	Ash Yard	30.65	17.61
9	Jetty	2.97	1.71
10	Intake & Outlet Water Point	2.47	1.472
11	Green Area	62.00	35.63
12	Open Area	1.04	0.60
Total		174.00	100

Source: BEPCL, 2018

Figure 4-1: General Layout Plan of the Proposed Project



Source: BEPCL, 2018

4.3 Land Requirement

The proposed project will be set up within the premises of the leased privately owned land from Iso Tech Electrification Company Limited and lease of government (Khas) land. However, all the lease land will be transferred to the project company in future, except the government (Khas) land. According to the IEE report, the land requirement for the proposed project was 187.83 acres. However, due to the modification of the design and layout of the proposed project the amount of land requirement is reduce. Now the total land requirement for the proposed power plant project is about 174 acres, comprising single cropland, settlement, homestead vegetation/trees, ponds, canal and barren land consists of shrubs and bushes. The land title/lease document of the proposed project is given as Annex-G (Volume-II). According to the consultation with the Executive Engineer, BWDB, Barguna, they have land inside of the proposed project boundary and No Objection Certificate (NOC) or lease document will be required from them. He also said that, the land lease document would be work or act as a NOC and they will impose some condition in the land lease agreement like “no permanent structures on the BWDB land”. However, the EIA study team yet not received the NOC or land lease document from the project proponent.

No Objection Certificate (NOC) from the Deputy Commissionaire (DC) of Barguna will be required for land related issues and establishment of power plant. However, the EIA study team yet not received the NOC from the project proponent. During the selection of the project site and land acquisition, it was considered to avoid the following areas like forest sanctuaries, national parks, game reserves, mangroves, forest areas, wildlife sanctuary, archaeological sites, ancient monument sites, defense installation, biodiversity areas and similar other areas. The proposed plant site has sufficient land for locating the power plant including associated facilities, primary coal storage yard, coal handling system, raw water reservoir, ash yard, green belt and open space. The project proponent already initiated an RAP and LAP study for ensuring proper compensation and resettlement of the affected people. According to the preliminary RAP survey, approximately 112 number of households will be directly affected due to land acquisition for the proposed power plant project. The project proponent already demarcated the land boundary of the proposed project and the photographs of the land demarcation is given in following Figure 4-2.

Figure 4-2: Photographs of the Project Boundary Demarcation



The south side of project site



The south side of project site



The east side of Ash Yard



The west side of the project site



The west side of the project site



The north side of project site

Source: Provided by BEPCL, November 2018

4.4 Fuel Requirement

The main fuel to be used for generating electricity will be the imported coal. Based on the estimations of the Feasibility report, the daily coal requirement for generation of 350 MW power by operating 1 x 350 MW power plant shall be 3304.84 ton and 1.1185 million ton per year. The coal consumption of the proposed project is shown in the following Table 4-3.

Table 4-3: Coal Consumption

Coal consumption/Installed capacity	Unit	1x350 MW	
		Design Coal	Check Coal
Coal consumption (per hour)	t/h	150.22	166.89
Coal consumption (daily)	t/d	3304.84	3671.58
Max. incoming quantity (daily)	t/d	3965.808	4405.896
Coal consumption (yearly)	10 ⁴ t/a	111.85	124.27

Source: Feasibility Report, 2018

During the construction phase, Diesel fuel/oil will be mainly used for the construction machinery. The required fuel will buy from local market by the project authority. The total required amount will be about 900,000 liters. In addition, light diesel fuel oil will also be used for boiler startup, flame stabilization and low-load operation. Annual fuel requirement during operation phase of the proposed project is estimated to be 3,000 ton but it will be depends on the startup time.

One set of light-oil ignition and fuel oil system will be adopted for each boiler in this project. This system is designed as a closed cycle, enabling part of oil to return oil tank during operation. Oil ignitor is of mechanical atomization type. One set of less oil ignition device is designed temporarily for each boiler. 2 x 200 m³ steel oil tanks are designed for the project. Three sets of centrifugal oil feed pumps, two sets of centrifugal oil unloading pumps and dirty oil treatment system will be installed in oil pump house, from which the oil is supplied for oil ignition systems of boiler proper and start-up boiler, as well as emergency diesel oil generator.

4.5 Desulfurization Absorbent Supply

1 x 350 MW supercritical unit and wet limestone-gypsum FGD facility will be constructed synchronously in the plant. The proposed power plant project will be consumed limestone as

desulfurization absorbent and the consumed amount will be about 2.68×10^4 ton/year and 79.20 ton/day. A dry shed (40 m x 46.8 m) will be built in the power plant to reserve the limestone, which can meet the demand of limestone consumption for about 120 days. The limestone will be imported from neighboring countries. The limestone block, as desulfurization reagent, will be transported to the plant's jetty by waterway and then it will be delivered to the dry shed by automobile. The proposed project limestone consumption is given in following Table 4-4.

Table 4-4: Limestone Consumption

Item/Limestone/Capacity	Unit	1x350 MW	
		Design Coal	Check Coal
Hourly consumption	t/h	3.60	4.71
Daily consumption	t/d	79.20	103.62
Daily Max. incoming quantity	t/d	95.04	124.344
Annual consumption	10^4 t/a	2.68	3.51

Note: The daily limestone consumption is calculated as per 22 hours; the daily unbalanced coefficient of incoming limestone quantity is 1.2; the annual operating period is calculated as per 7446 hours.

Source: Feasibility Report, 2018

4.6 Water Requirement

The total water requirement for the proposed project will be around 48,115 m³/hour during its operational phase. The required raw water for the proposed project will be drawn from the Buriswar-Payra River. The river can provide a reliable water source for the power plant and the water is brackish due to the close proximity with the Bay of Bengal. The boiler make-up water, industrial water, domestic water and firewater in this project will be sourced from seawater reverse osmosis system. According to the project's water source, this plant will adopt the once-through circulation cooling system, which can take water from Buriswar-Payra River at the depth of 12 m directly around the site. The freshwater requirement for the power plant is given in the following Table 4-5.

Table 4-5: Freshwater Requirement for the Power Plant

Item	Water demand (m ³ /h)	Recycling water quantity (m ³ /h)	Water consumption (m ³ /h)	Remarks
Boiler makeup water treatment system	23.6	11.3	22.4	Desalinated seawater
Domestic water system	10	4	6	
Domestic sewage treatment system	4	3	1	
Plant landscaping water	3	0	3	
Coal jetty service water	15	0	15	
Miscellaneous	26	26	0	
Truck washing water	3	2	1	
Main building washing water	3	2	1	
Water for oil tank area	5	4	1	
Water for desulfurization	60	10	50	
Desulfurization wastewater treatment system	10	8	2	
Industrial wastewater treatment system	9.2	9	0.2	

Item	Water demand (m ³ /h)	Recycling water quantity (m ³ /h)	Water consumption (m ³ /h)	Remarks
RO-2 drainage	8.4	8.4	0	
Oily wastewater treatment system	4	3	1	
Ash yard spraying water	8	0	8	Desulfurization wastewater
Water for humidifying dry ash	8	0	8	
Bottom ash handling humidification water	7	0	7	
Washing water for coal conveying system	18	15	3	Recycled water
Coal water treatment system	35	34	1	
Coal yard spraying water	8	0	8	
Spray water for bucket wheel reclaiming	8	0	8	
Unexpected quantity	6.4	0	6.4	Desalinated seawater
Total	281.6	129.6	152	

Source: BEPCL, 2018

According to the Clause-16 of Bangladesh Water Rules, 2018, NOC will be required from the Union Integrated Water Resources Management Committee for surface water collection, distribution and use related project and part of the project. However, the EIA study team yet not received the NOC from the project proponent. The amount of seawater consumed for the proposed project considering once-through cooling system is given in Table 4-6.

Table 4-6: Water Consumption for the Proposed Project

Item	Seawater Demand (m ³ /h)	Seawater Drainage Quantity (m ³ /h)	Seawater Consumption (m ³ /h)
Water consumption for once-through cooling system			
Circulating water system (Once-through cooling system)	47,763	47,763	0
Seawater desalination system	352	200	152
Total	48,115	47,963	152

Source: BEPCL, 2018

An overall water balance diagram for the power plant (considering once through cooling system) is shown below in Figure 4-3 and large size diagram is given in Annex-D (Volume-II).

[illegible]

4.6.1 Water Intake Point in Buriswar-Payra River

For the collection of raw water in the proposed project, a water intake point will be established in the Buriswar-Payra River and it will be located west side from the power plant. The tentative location of the proposed water intake point is 1.40 km downstream of the coal-handling jetty of the proposed power plant. Geographical location of the water intake point is 21°57'24.68"N latitude and 90° 3'14.92"E longitude. The tentative location of the proposed river water intake point is shown in following Figure 4-4.

Buniswar-Payya River

Water Intake Point

Legend

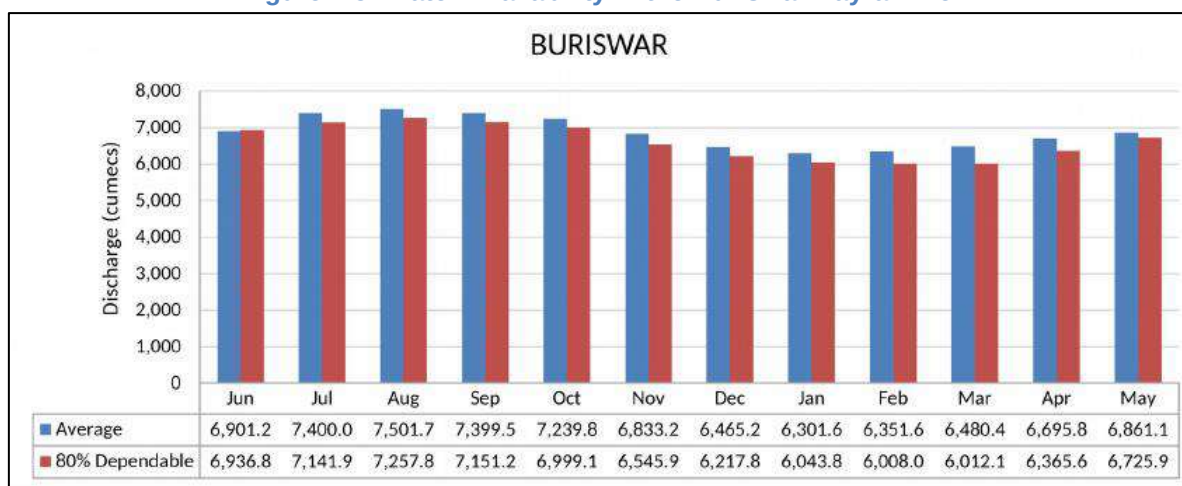
- Project Boundary
- Water Intake Point

BEPCL

4.6.2 Water Availability in Buriswar-Payra River

According to the discharge data of the Buriswar-Payra River source from the simulation result (year 1988~2012) of Institute of Water Modelling (IWM), the water availability of the Buriswar-Payra River is between 6301.6~7501.7 m³/s. The average lowest availability has been found during the months of January and February. If we consider the minimum quantity 6301.6 m³/s or 22,685,760 m³/h. The withdrawal rate (48,115 m³/h) is designed for the proposed power plant project is very insignificant (0.21%) considering the water availability in the Buriswar-Payra River. The water availability in the Buriswar-Payra River is given in Figure 4-5.

Figure 4-5: Water Availability in the Buriswar-Payra River



Source: Institute of Water Modelling (IWM), 2018

4.6.3 Water Users of the Buriswar-Payra River

The availability of water resources is an essential element for the development of any kind of industrial area. The proposed power plant project is going to be established in the coastal region of Bangladesh and inside of the rural settings. The proposed project area is a tidal dominating area, where sea water enters into the coastal zone twice daily and water resources are available round the year. However, during the site visit in the study area no major industry was found within the 10 km radius of the project study area. In the study area, local people depends on groundwater for their daily activities. The water of the Buriswar-Payra River is used for navigation and fishing activities.

4.7 Manpower Requirement

During the operation of the proposed 350 MW power plant, about 172 personnel will be required for operation, maintenance and administration purposes. Among them about 32 numbers of people will be required for the administrative purposes, 134 for the production process and 6 for environmental management. Workers from neighboring districts, if found suitable, shall be employed during construction and operational phases of the proposed project.

4.8 Chemical Requirement

During the operation of the proposed power plant, different types of chemicals will be required in different units. Chemicals will be required in the ETP, WTP, STP units for raw water processing, effluent treatment, oily wastewater treatment etc. The requirement of the chemicals is given in following Table 4-7.

Table 4-7: Chemical Requirement for the Power Plant

SL#	Description/power plant unit	Chemical requirement (t/a)
1	ETP	Acid 60 t/a, Alkali 100 t/a, Salt 900 t/a, Flocculant 180 t/a and Coagulant aids 30 t/a
2	WTP (Boiler make up water treatment)	Acid 170 t/a and Alkali 240 t/a

SL#	Description/power plant unit system)	Chemical requirement (t/a)
3	WTP (Seawater Desalination System)	Anti-sludging agent 60 t/a, Deoxidize 15 t/a, Non-oxidizing fungicides 5 t/a and Acid 5 t/a
4	STP (Sanitary Sewage Treatment System)	N/A
5	STP (Oily waste treatment system)	N/A

Source: BEPCL, 2018

4.9 Technology Selection and Process Description

4.9.1 Technology

The proposed 350 MW coal-fired power plant at Taltoli, Barguna will be used supercritical technology. The thermal efficiency of the power plant can be improved by using the steam at the supercritical condition. The improvement in overall efficiency of the plant compared to subcritical parameters will be at least 2%. The "efficiency" of the thermodynamic process of a coal-fired power describes how much of the energy that is fed into the cycle is converted into electrical energy. The greater the output of electrical energy for a given amount of energy input, the higher the efficiency. A thermal power plant based on supercritical technology is more efficient than a subcritical plant, producing more power from less coal and with lower emissions. The supercritical technology is more popular and stable than ultra-supercritical in the capacity of 350 MW class.

At most elevated condition the steam is supercritical. Thus, if water is at a supercritical pressure and is heated the temperature will increase continuously. At a particular value, the water will flash instantaneously into steam and superheating will commence. There is no change of specific volume from the liquid to the dry steam state. A comparison of the different technology of power plant is given in following Table 4-8.

Table 4-8: Comparison of Different Technology of Power Plant

Parameter	Unit	Subcritical	Supercritical	Ultra-supercritical
Main steam temperature/reheat steam temperature	°C	538/538	538/566	600/600
Press	MPa	17	24.6	25
Heat rate of turbine	KJ/KWh	7800	7600	7320
Boiler efficiency	%	93	93	93
Pipe efficiency	%	98	99	99
Gross Plant Efficiency	%	42.06	43.61	45.28

Source: BEPCL, 2018

Benefits of Supercritical Thermal Cycle Technology:

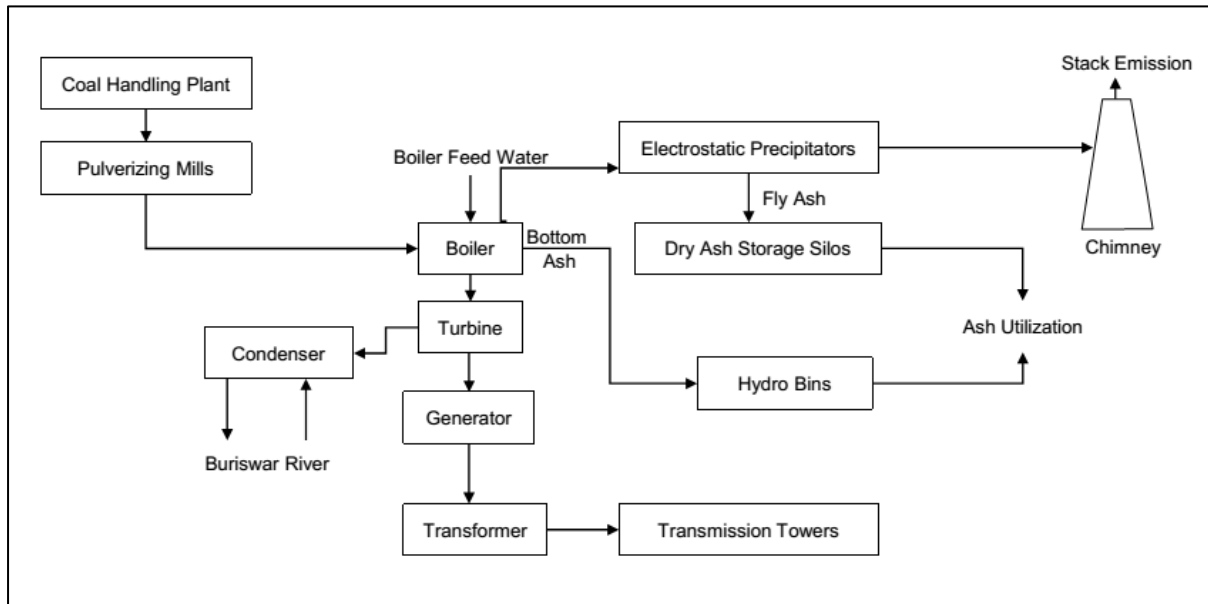
The benefit of supercritical technology is given below:

- Excellent availability, comparable with that of an existing sub-critical plant;
- Reduced fuel consumption due to improved plant efficiency;
- Significant reduction in CO₂ emissions;
- Low coal consumption results to low NO_x, SO₂ and particulate emissions compared to the subcritical power plant;
- The overall reduction in Auxiliary Power Consumption;
- Reduction in requirement of ash dike land and consumptive water;
- Sliding pressure operation due to once-through system;

- Uniform distribution of heat due to spiral wall arrangement leading to less boiler tube failure, thereby improving system continuity and availability of the station;
- Less startup time of the boiler;
- Can be fully integrated with an appropriate CO₂ capture technology.

In summary, highly efficient plant with best available pollution control technology will reduce existing pollution levels by burning less coal per megawatt-hour produced.

Figure 4-6: Process Flow Diagram



Source: BEPCL, 2018

4.9.2 Process Description

In a thermal power plant, the chemical energy of the fuel (coal) is first converted into thermal energy (during combustion), which is then converted into mechanical energy (through a turbine) and finally into electrical energy (through a generator). It has the following steps:

- The coal is transferred from the coal handling plant by conveyor belt to the coal bunkers, from where it is fed to the pulverizing mills, which grind it to a fine powder. The finely powdered coal, mixed with air is then blown into the boiler by a fan where it burns.
- The process of combustion releases thermal energy from coal. The boiler walls are lined with boiler tubes containing high-quality demineralized water (known as boiler feed water). The combustion heat is absorbed by the boiler tubes and the heat converts the boiler feed water into steam at high pressure and temperature. The steam, discharged through nozzles on the turbine blades, makes the turbine to rotate, which in turn rotates the generator coupled to the end of the turbine. Rotation of the generator produces electricity, which is passed to the step-up transformer to increase its voltage so that it can be transmitted efficiently. The power is evacuated via switchyard through a Transmission System.
- During combustion, the non-combustible part of coal is converted into ash. A small part of ash (about 20%) binds together to form lumps, which fall into the ash pits at the bottom of the furnace. This part of ash, known as bottom ash is water quenched ground and then conveyed to pits for subsequent disposal to ash disposal area or sale.
- Major part of the ash (about 80%) is in fine powder form, known as Fly Ash and is carried out of the boiler along with the flue gas. The flue gas, after heat recovery, is passed through the electrostatic precipitators, where the ash is trapped by electrodes charged with high voltage electricity.

- The flue gases exiting from the ESPs are discharged through a tall chimney for a wider dispersal of remaining ash particles and gases. The ash collected in the ESP hoppers is extracted in dry form and conveyed to dry ash storage silos from where it is supplied to user industries. The unused part of fly ash shall be taken to ash ponds for disposal.
- The steam, after passing through the turbines, is condensed back into water in condensers and the same is re-used as a boiler feed water for making steam. The reasons for condensing and reusing the steam are the following:
 - The cost of boiler feed water is very high as it is very pure demineralized water hence reuse is economical.
 - The use of condenser lowers the temperature at the exit end and hence increases the efficiency of the turbine.
- The condenser contains tubes through which cold water is constantly pumped. The steam passing around the tubes of condenser loses heat and condenses as water. During this process, the steam gets cooled while cooling water gets heated up (by about 10°C). In once-through cooling systems take water from nearby sources (e.g., rivers, sea or the ocean), circulate it through pipes to absorb heat from the steam in systems called condensers and discharge the now warmer water to the local source.

4.10 Description of Major Systems

4.10.1 Thermal System

4.10.1.1 Main Steam, Reheat Steam and Turbine Bypass System

For the main steam system, two main steam pipes out of re-heater outlet header will be connected with two main steam valves at both sides of the turbine. For reheat steam system, two cold reheat pipes out of HP cylinder exhaust joint into one single pipe and then separate into two routes in front of the boiler to connect the re-heater inlet header. Two hot reheat pipes out of re-heater outlet header and connect with reheat stop interceptor valves at the left and right side of the turbine. Bypass steam system is designed for better start-up performance, shorter start-up time, longer cycle life, optimized working medium and stable temperature of re-heater. 60% BMCR is designed provisionally as the capacity, which will be finalized after matching with boiler start-up curve.

4.10.1.2 Feedwater System

For the feedwater system, there are 3x100% HP heaters, adopting large bypass system, which consists of an electric inlet, outlet and bypass valves. The system features simple structure and fewer valves. When three HP heaters all disconnect, the unit can still provide rated power, easier for operation and maintenance. Regulating valve station is designed for the bypass feedwater pipe from the outlet of 1# HP heater to the inlet of boiler economizer to control the feedwater flow in start-up and low-load conditions. The total flow at the outlet of feedwater pump (excluding standby feedwater pump) shall satisfy the need of maximum feedwater consumption of boiler connected. Once-through boiler shall be designed with the capacity of 105% of maximum continuous evaporation of boiler.

4.10.1.3 Circulating Water System

The once-through cooling system is designed for the circulating water system with design temperature of 28.5°C provisionally. The circulating water pipe for the unit is connected from the circulating water header outside Row A of the main building, and through the condenser, go out from Row A of the main building, and finally run to the sea to the north of the plant area via circulating water return header. One rubber ball cleaning device designed at each side of the condenser will be used during unit operation periodically.

4.10.1.4 Condenser Vacuum System

Two water ring vacuum pumps each with a capacity of 100% (one for operation, the other for standby) are provided for the condenser vacuum system of each unit. The two pumps can be used at the unit

start-up to shorten the start-up time. Besides, one water chamber vacuum pump with a capacity of 100% is designed for the project in this phase, to reduce the head of the circulating pump based on siphon principle.

4.10.2 Combustion System

4.10.2.1 Pulverizing System

4.10.2.1.1 Pulverizing System

Considering the coal quality, related regulations and operation economy and safety against spontaneous combustion and explosion, a cold primary air direct-blowing pulverizing system with medium speed pulverizer should be adopted in this project.

Primary air will be introduced from outdoors and separates into two routes at PA fan outlet: one flows through air preheater into hot primary air header in front of the boiler and then enters hot primary air inlet of each pulverizer. The other bypass air preheater, directly enters cold primary air header in front of the boiler, mixes with hot primary air at pulverizer inlets to reach the required temperature of drying agent, and then goes into pulverizer.

4.10.2.1.2 Equipment Selection

- A) Primary Air (PA) Fan:** Centrifugal fan (or axial type fan) is designed as PA fan. Its airflow includes the primary airflow required by boiler at BMCR condition and the leakage of air preheater guaranteed by the manufacturer. Two sets of PA fans with inlet silencers will be provided for each other.
- B) Pulverizer:** Five sets of medium speed pulverizers will be provided for each boiler, four in operation and one for standby.
- C) Coal Feeder:** Five sets of pressure mode electronic weighing belt coal feeders will be provided for each boiler. Each pulverizer assort with one set of coal feeder.
- D) Seal Fan:** Two sets of centrifugal seal fans will be provided for each boiler, one in operation and one for standby. Seal fan will be supplied by pulverizer manufacturer.
- E) Raw Coal Bunker:** Five sets of cylinder steel coal bunkers will be provided for boiler, four of which are designed with an effective storage capacity (at fullness coefficient of 0.80) satisfying the design coal consumption of boiler for 9 hours under BMCR condition.

4.10.2.2 Air and Flue Gas System

4.10.2.2.1 Boiler Air and Flue Gas System

Air and flue gas system are designed as balanced draft operation, with system balance (zero pressure) point inside boiler furnace. Thus, all system components in front of this point (airside) operate under positive pressure; the ones behind it (flue gas side) run under negative pressure. From furnace outlet, flue gas runs through tail heating surface, separates into two routes at economizer outlet, entering successively tri-sector regenerative air preheater, ESP and FGD by ID fan and then is discharged from chimney to atmosphere.

4.10.2.2.2 Equipment Selection

- A) FD Fan:** Axial type FD fan with adjustable moving blades are designed for the project. Two sets of FD fan, each with inlet silencer, will be provided for each boiler.
- B) ID Fan:** As the ash amount contained in the flue gas at ID fan inlet under the normal operating condition is low, so the wearing resistance is not the major concern in ID fan selection. Two sets of axial ID fans with adjustable moving blades, each with a capacity of 50%, will be provided for the project. The ID fan will also be used as desulfurization booster fan.

- C) Flame detection cooling fan:** Two sets of centrifugal cooling fans will be provided for each boiler, one in operation and one for standby.

4.10.2.2.3 ESP and Chimney

- A) ESP:** Two sets of dual-chamber five-electric-field ESP will be equipped for the boiler to meet the demand of environment protection.
- B) Chimney:** The proposed project is designed with one 220m high chimney, with outlet inner diameter of 5.0m.

4.10.2.2.4 Boiler Ignition and Fuel Oil System

One set of light-oil ignition and fuel oil system will be adopted for each boiler in this project. This system is designed as a closed cycle, enabling part of oil to return oil tank during operation. Oil ignitor is of mechanical atomization type. One set of less oil ignition device is designed temporarily for each boiler. 2 x 200m³ steel oil tanks are designed for the project. Three sets of centrifugal oil feed pumps, two sets of centrifugal oil unloading pumps and dirty oil treatment system will be installed in oil pump house, from which the oil is supplied for oil ignition systems of boiler proper and start-up boiler, as well as emergency diesel oil generator.

4.10.2.2.5 Steam Source for Unit Start-up

A 1x35 t/h fuel start-up boiler will be provided to supply steam at 1.30Mpa, 350°C for the project.

4.10.3 Electric System

4.10.3.1 Main Transformer

The rated capacity of the main transformer is selected based on following load calculation: the maximum continuous capacity of generator minus capacity of HV unit auxiliary transformer that is unable to be substituted by HV auxiliary start-up/standby transformer. Under standard ambient temperature condition with average temperature rise not exceeding 65°C, the rated capacity of the main transformer is tentatively considered as 460MVA; three-phase oil-immersed two-winding no-load tap changing transformer is adopted with ODAF.

4.10.3.2 Main Electrical Wiring

A 1x350 MW unit will be connected into the power grid adopting 400kV level voltage. A 400kV switchgear will be constructed in the project. One circuit of outgoing line is designed for the project. The 1x350 MW unit will be connected into the switchgear in the form of generator-transformer set. One circuit of 400kV outgoing line from the power plant will be connected into the power grid. 400kV main wiring will adopt single bus configuration method. One circuit of main transformer incoming line and one circuit of outgoing line are connected into the bus of 400kV switchgear. HV start-up/standby power source is led from the bus of 400kV switchgear in the power plant.

Generator neutral point is earthed by connecting with single phase resistance earthing transformer via secondary side; neutral point at 400kV HV side of main transformer is designed as direct earthing and also taking unearthed operation into account. So far, access system scheme for this project has not been finalized yet. Main electrical wiring will be subject to final electric access system scheme.

4.10.3.3 Power Supply for HV Auxiliary Start-up/Standby Transformer

One split type on-load tap changing start-up/standby transformer with capacity at 67/43-43MVA will be arranged for the unit of the project as start-up/standby power source. The power for the start-up/standby transformer will led from the bus of 400kV switchgear in the power plant.

4.10.4 Cooling System

4.10.4.1 Cooling Scheme

Considering the water source conditions of the proposed project area in Barguna District, Bangladesh, applicable water supply and cooling schemes include:

Option-1: Once-through Cooling

The water will be directly taken from the Buriswar-Payra River and then boosted and delivered to the condenser of the steam turbine using water intake pump. After heat exchange in the condenser, the water flows into the siphon well and ultimately discharges into the Buriswar-Payra River at the northern side of the power plant.

Option-2: Secondary Circulation with Mechanical Draft Cooling Tower

The circulating water after heat exchange in the condenser flows into the cool tower for cooling rather than directly discharging into the river channel or sea area nearby. Then, the water flows into the condenser of the steam turbine for heat exchange to carry out next cycle.

Comparison between two types of cooling technology is given in Chapter-5 (analysis of suitability of different alternatives chapter) in this report.

4.10.5 Coal Handling System

4.10.5.1 Main Design Parameters

- Annual coal consumption is about 1.1185 million tons.
- Design ship type is 3,000 tons barge.

4.10.5.2 Coal Handling System

4.10.5.2.1 Ship Unloading

For environmental protection, one set of catenary chain bucket type ship unloader (Figure 4-7) will be equipped on the coal unloading Jetty. The main specification of ship unloader will be as follows: rated unloading capacity: 600 t/h, rail gauge: 14m and outreach: 18m. Two skip steer loaders will be assigned for hatch cleaning.

Figure 4-7: Catenary Chain Bucket Type Ship Unloader



Source: Feasibility Report, 2018

4.10.5.2.2 Belt Conveyor Arrangement

There would be two route belt conveyors BC1A and BC1B from the jetty to #1. Transfer Tower and two route belt conveyors BC2A and BC2B from #1 Transfer. Tower to #2 Transfer Tower. The main specification of the belt conveyor system is as follows: rated conveying capacity: 1,200 t/h, belt width:

B=1,400 mm and belt speed: 2.5 m/s. To protect the environment, windshield would be located at both sides of the belt conveyors trestle on the jetty, belt conveyors on the approach bridge are sealed in the gallery.

4.10.5.2.3 Auxiliary Equipment

A. Magnetic Separator

The magnetic separator would be arranged above the head pully of belt conveyor BC1A and BC1B in #1 Transfer Tower. A tramp iron discharge chute and collection bin would be provided to collect tramp iron. The tramp iron would be collected in a bin on the ground level.

B. Belt Scale

The weighing systems would be arranged on the belt conveyor BC2A and BC2B to test and calibrate coal unloaded from barge.

4.10.5.3 Process Flow

Barge → Ship unloader → BC1A/B→BC2A/B → Power Plant

Magnetic separator Electric belt scale

4.10.5.4 Heavy Lift Handling

Heavy lift jetty will be used for heavy lift handling during the construction period. The jetty will also be used for limestone, ash, gypsum and fuel oil handling during the operation period.

4.10.5.5 Offshore Transshipment

The water depth is relatively shallow in the area from the open-sea area to the project area, the water depth is less than 5 m in most of these areas. Due to the limited of water depth in the channel area, large vessel can't directly navigate to the berth, the transshipment system in the waters near the project terminal is necessary, the coal will be transported from the large transport vessels to the coal barges by offshore transshipment equipment and then shipped to the coal unloading jetty. According to the Feasibility Report, the geographical/absolute location (tentative) of the lighterage area is 21°17.208'N and 90°0.654'E. The following Figure 4-8 shows the sample photograph of an offshore transshipment station.

Figure 4-8: Offshore Transshipment for Reference



Source: Feasibility Report, 2018

4.10.6 Bottom Ash and Fly Ash Handling System

4.10.6.1 Volume of Bottom Ash and Fly Ash

About 237,875.82 tons of ash per year will be generated from the proposed power plant among this fly ash amount will be 202196.67 tons and bottom ash will be 35679.15 tons. The volume of bottom ash and fly ash that will be generated by the boiler is given in following Table 4-10.

Table 4-9: Volume of Bottom Ash and Fly Ash

Item	Unit	Design Coal	Worst Coal
Fly Ash Volume	t/h	27.287	37.944
	t/d	600.314	834.768
	t/a	202,196.670	281,165.040
Bottom Ash Volume	t/h	4.815	6.700
	t/d	105.930	147.400
	t/a	35,679.150	49,647.000
Total	t/h	32.102	44.644
	t/d	706.244	982.168
	t/a	237,875.820	330,812.040

Source: Feasibility Report, 2018

4.10.6.2 Bottom Ash Handling System

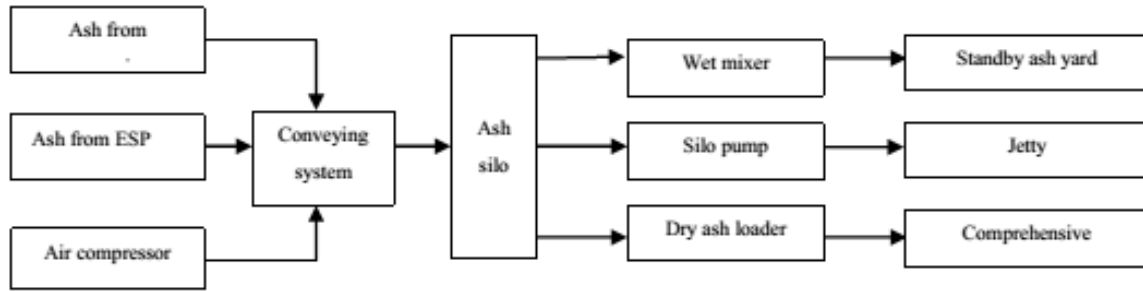
A scraper conveyor will be adopted to directly deliver the bottom ash to bottom ash silo, which will be installed with shaker to prevent blocking. Fly ash handling system plans to adopt positive pressure dense phase pneumatic ash conveying system. Compressed air system will adopts centralized air supply method.

4.10.6.3 Fly Ash Handling System

Fly ash conveying system will adopt pneumatically positive pressure dense phase conveying scheme. Fly ash collected by ESP will be delivered via pipes to fly ash silo. The compressed air and instrument air used for fly ash handling system will be supplied by compressed air station for the whole plant. There will be two concrete ash silos, each with inner diameter of 12m, the total height of about 27m and effective volume of 1500m³, satisfying 24h storage of fly ash generated by one boiler under BMCR condition. One dry ash discharge outlet and one wet ash discharge outlet will be arranged under the ash silo. One dry ash loader with output at 200 t/h will be arranged beneath the dry ash discharge outlet, to load the dry ash into tank car for delivery to comprehensive utilization. One double-shaft mixer with output at 200t/h will be arranged beneath the wet ash discharge outlet. The dry ash is mixed with water to form wet ash with 15-20% water content and then delivered to ash yard or wet ash user. Bag filter with exhaust fan will be equipped at top of the ash silo to ensure qualified emission. Vacuum relief valve will be installed to balance inner pressure. In addition, one set of lifting equipment will also be provided at top of the ash silo.

Fluidizing air system will be comprised of ESP hopper fluidizing air system and ash silo fluidizing air system. In order to prevent condensation, to improve fly ash fluidity and discharge smoothly, ash hopper fluidizing air system will be designed for this project. Two ash hopper fluidizing air blowers and two electric air heaters will be provided below ESP to deliver the fluidizing air through pipeline to fluidizing plate of ESP hopper. In order to prevent fly ash blockage and improve its fluidity, three fluidizing air blowers (two in operation and one for standby) and three electric air heaters (two in operation and one for standby) will be arranged at fly ash silo operating floor. The fly ash handling system of the proposed project is shown in following Figure 4-9.

Figure 4-9: Fly Ash Handling System



Source: Feasibility Report, 2018

4.10.6.4 Compressed Air System

For reducing land occupation and saving investment cost, centralized compressed air supply will be adopted in the proposed project. One compression air station will be constructed to supply compressed air for pneumatic transporting system, thermal system maintenance and instruments of all systems in the plant. The air compressor operates under main piping supply mode and adopts intelligent control module, so as to minimize the quantity of air compressors, to optimize the parameters and operation mode and to reduce equipment initial investment and operation cost.

Three air compressors (two for operation and one for standby) with capacity of 50 nm³/min and three combined dryers (two for operation and one for standby) with capacity of 55 nm³/min will be provided for pneumatic conveying system. Two air compressors (one in operation and one for standby) with capacity of 50 nm³/min and two dryers (one in operation and one for standby) with capacity of 50 nm³/min will be provided for I & C system of the whole plant. There are also five air tanks, of which three for pneumatic conveying and two for I & C system. Final equipment quantity and capacity of compressed air system will be determined after tendering.

4.10.6.5 Pyrites System

Pyrites handling system will be adopted the scheme of pyrite hoppers and electric forklift truck. Fixed pyrite hopper and shutoff gate will be installed below pyrite outlet of each medium speed pulverizer. Moveable pyrite hopper will be installed below shutoff gate. Electric forklift truck will carry the moveable hopper to stacking area; dump truck will transport the pyrites outwards.

4.10.6.6 Off-site Ash Transportation

There are two options for off-site transportation of fly ash: truck transportation and pneumatic conveying. Both options can satisfy operation requirement. Initial investment for truck transportation is low, but vehicle maintenance cost in future is high; ash distribution in ash yard is convenient. Initial investment for pneumatic conveying is high, but maintenance cost in future is low; the impact on environment of the conveying process is low.

Truck transportation is recommended at current stage. Meanwhile, initial investment cost for transporting the fly ash to cargo jetty is calculated and included. Further study will be conducted for fly ash transportation method at next stage according to implementation of fly ash comprehensive utilization.

4.10.7 Chemical System

4.10.7.1 Seawater Desalination System

4.10.7.1.1 Output Calculation

Seawater desalination system supplies water for following systems:

1. Service water: 110 m³/h (1st stage RO product water);
2. Raw water required by boiler makeup water treatment system and domestic water system: 32.4 m³/h (2nd stage RO product water; 40.5 m³/h of 1st stage RO product water is required).

Aggregate amount of above losses: $Q=150.5 \text{ m}^3/\text{h}$. Seawater RO effluent is adopted as power plant service water; combining the output of boiler makeup water treatment system and considering certain self-use water, the design output of seawater desalination system is $152 \text{ m}^3/\text{h}$.

4.10.7.1.2 Seawater Desalination System Description

1. System Flow

The pre-treatment system in seawater desalination system adopts the scheme of ultrafiltration. The process flow of seawater desalination system will be as follows:

Seawater from seawater pre-treatment system ► self-cleaning filter ► ultrafiltration device ► ultrafiltration tank ► ultrafiltration effluent pump ► seawater RO cartridge filter ► seawater RO HP pump ► seawater energy recovery device ► seawater RO device ► fresh water tank (seawater RO effluent tank) ► fresh water pump (seawater RO effluent pump) ► fresh water RO system.

2. Discharge of Wastewater from Seawater Desalination Treatment System

The backwashing water from ultrafiltration system will be discharged to water recovery pond of seawater desalination treatment plant and then discharged to seawater pre-treatment system through backwashing water discharge pump for recovery. Seawater RO concentrated water and circulating cooling effluent water will be mixed before discharge.

4.10.7.1.3 Seawater Desalination System Arrangement

One separate water treatment plant, including water treatment room, water treatment adjacent structure, laboratory building, chemical storage room etc. will be constructed for this project. All water tanks, compressed air system, acid & alkali storage system and wastewater discharge system are arranged outdoors.

4.10.7.2 Boiler Makeup Water Treatment System

4.10.7.2.1 Output for Boiler Makeup Water Treatment System

The boiler makeup water treatment system provides high-purity demineralized water for the following:

1. Main steam loss: $1 \times 1105 \times 1.5\% = 16.6 \text{ m}^3/\text{h}$;
2. Demineralized water for other systems: $4.8 \text{ m}^3/\text{h}$; and
3. Makeup water for hydrogen generation system: $1 \text{ m}^3/\text{h}$.

Aggregate amount of above losses: $Q = 22.4 \text{ m}^3/\text{h}$; combining water demand of boiler makeup water system and $10 \text{ m}^3/\text{h}$ of domestic water, the output of fresh water RO system is designed as $32.4 \text{ m}^3/\text{h}$.

4.10.7.2.2 Boiler Makeup Water Treatment System Description

1. System Flow

The boiler makeup water treatment system will adopt the scheme of one-stage desalination and mixed bed. The process flow of boiler makeup water treatment system will be as follows:

Fresh water RO cartridge filter ► fresh water RO HP pump ► fresh water RO ► fresh water RO product water tank ► fresh water pump ► cation bed ► anion bed ► mixed bed ► demineralized water tank ► demineralized water pump ► main building.

The system effluent quality standard will be as follows:

- Electric conductivity (25°C): $\leq 0.15 \text{ } \mu\text{S}/\text{cm}$
- SiO_2 : $\leq 10 \text{ } \mu\text{g}/\text{l}$
- TOC: $\leq 200 \text{ } \mu\text{g}/\text{l}$

2. Discharge of Wastewater from Boiler Makeup Water Treatment Plant

The regenerated wastewater from cation bed, anion bed and mixed bed will be discharged to neutralizing water tank. The wastewater will be delivered to industrial wastewater treatment station

through neutralizing water pump. Fresh water RO concentrated water will be delivered to ultrafiltration tank.

4.10.7.3 Condensate Polishing System

Medium-pressure condensate polishing system will adopts external regeneration high-speed mixed bed. Each polishing system consists of 2x50% pre-filters, 3x50% mixed beds, 100% filter bypass and 100% mixed bed bypass. One set of external regeneration equipment is designed. Mixed bed resin regenerates externally; complete separation of cation resin and anion resin can be guaranteed by employing high-tower separation system. Regenerated wastewater will be discharged to wastewater pond and then delivered to industrial wastewater treatment system by pumps. Mixed bed equipment of polishing system will be arranged in turbine hall; remaining items of equipment will be arranged in separate room outside turbine hall.

4.10.7.4 Hydrogen Generation Station

Medium pressure water electrolytic hydrogen generation will be adopted with output at 5 nm³/h. As an independent building, hydrogen generation station will be arranged with electrolysis room, auxiliary equipment room, control room and laboratory etc. 3 x 13.9 m³ hydrogen tanks and 1x8 m³ compressed air tank will be arranged outdoors.

4.10.7.5 Cooling Water Treatment System

The scheme of bactericide preparation using electrolytic salt solution will be adopted at current stage. Salt dissolving tank will be arranged. Sodium chloride for industrial use will be adopted as raw material, with the storage capacity designed based on one month of salt consumption.

4.10.7.6 Chemical Dosing Treatment System

Ammonia and oxygen dosing treatment will be adopted for feed water and condensate in thermal system. One set of centralized ammonia dosing device and one set of automatic oxygen dosing device will be provided. In order to protect equipment and pipeline in closed cooling water system from erosion by free oxygen, one set of hydrazine dosing device will be provided.

4.10.7.7 Water & Steam Sampling System

One set of water & steam sampling and analysis system, including temperature and pressure reducing device, thermostat and instrument panel, will be provided for the unit.

4.10.7.8 Industrial Wastewater Centralized Treatment System

4.10.7.8.1 Design Principle for Industrial Wastewater Treatment System

The following design principle will be followed for industrial wastewater treatment system for the proposed power plant project:

1. For industrial wastewater treatment system, the treated water quality will meet Grade I standard in GB/T8978-1996 Integrated Wastewater Discharge Standard.
2. Domestic sewage, coal conveying trestle cleaning drainage water and oily wastewater are excluded from this treatment system.
3. The design output of industrial wastewater treatment system is 60 m³/h.

4.10.7.8.2 Wastewater Treatment System Description

1. Regular Wastewater Treatment

Acid and alkali wastewater discharged from boiler makeup water treatment system and condensate polishing system will be directly delivered to the final neutralization pond of industrial wastewater treatment system and adjusted to pH value of 6~9 by acid & alkali dosing, then flows to clear water pond and finally returns to common water pond after filtration.

Processing flow: Regular wastewater ► final neutralization pond ► clear water pond and clear water pump ► high-efficiency filter ► common water pond.

2. Irregular Wastewater Treatment

Irregular wastewater will be delivered by discharge pump to wastewater pond of industrial wastewater treatment system and then flows to aeration tank by gravity. After air agitation, acid and alkali dosing to adjust pH value and flocculent dosing (in flocculation tank), the water flows into inclined-plate clarifier. The clean water flows into final neutralization pond to mix with acid-alkali wastewater. Then, the water will be treated using acidic-alkaline wastewater treatment method.

Processing flow: Irregular wastewater ► wastewater pond ► aeration tank ► wastewater pump ► flocculation tank ► inclined-plate clarifier ► final neutralization pond ► clear water pond and clear water pump ► high-efficiency filter ► common water pond.

4.10.8 Water Supply and Drainage System

4.10.8.1 Circulating Water System

4.10.8.1.1 Function of Circulating Water System

In this project, once-through water supply system is proposed to be used mainly for cooling Boiler Turbine Generator (BTG) condenser and closed cooling water system. Circulating water after heat exchange will return to Buriswar-Payra River through drainage system.

4.10.8.1.2 Water Intake and Drainage System

Water intake and drainage system will supply circulating water to the plant and discharge thermal drainage to the Bay of Bengal. In order to prevent reverse flow of thermal drainage to the intake, intake structure and drainage structure shall be set with a certain distance.

4.10.8.1.3 Circulating Water Facility

In once-through water supply system, the unit will be designed with 3×50% vertical, wet and mixed-flow circulating water pumps (two for operation and one as standby). All pumps will be installed indoors. The parameters of each circulating water pump will be as follows (tentative):

- Flow: $Q=6.96 \text{ m}^3/\text{s}$
- Head: $H=0.21\text{MPa}$
- Power of motor: $N=1700\text{KW}$
- Voltage: $U=6.6\text{kV}$

The outlet of circulating water pump will be provided with hydraulic control butterfly valve, the opening and closing time of which can be controlled so as to prevent circulating water system from water hammer in the case of pump start-stop or sudden power failure. The outlet of circulating water pump and both inlet and outlet of condenser are designed with expansion joint.

In order to protect circulating water pump and condenser from blocking, grating and rotary screen are set in front of circulating water pump. The screen shall be periodically cleaned based on front and back liquid level drop. The dimension of screen mesh is about $1\text{cm} \times 1\text{cm}$. The screen intercepts sewage in water. Fishes intercepted by screen will be sent back to Buriswar-Payra River. Steel gate for maintenance will be set in front of each circulating water pump. One gantry crane will be set for maintenance of circulating water pump and rotary screen.

4.10.8.1.4 Makeup Water System

Since the power plant site is located at the confluence of Buriswar-Payra River and the Bay of Bengal where the water is naturally brackish, seawater is designed as water source for the project with consideration of sea tide and other factors. The project proposes to set seawater desalination treatment system using reverse osmosis process. After flocculation, clarification, ultrafiltration and desalination, water will be used for boiler makeup water system and as service water and fire water, etc.

4.10.8.1.4.1 Raw Water Pre-treatment System

Raw water pretreatment system is to remove most of suspended matters and sands in seawater to make seawater quality satisfying requirements of seawater desalination treatment system. 2×100% seawater desalination system intake pumps will be set outdoors in seawater circulating water pump station. Raw water will be sent to raw water pretreatment station via in-plant makeup water pipeline, and after coagulation, flocculation and clarification pretreatment, one part flows into industrial and fire fighting reservoir by gravity and one part will be sent to boiler makeup water system.

Raw water pretreatment process flow:

Raw water ► Porous plate type water purification mixer ► Fine mesh flocculation pond ► Small-spacing inclined plate sedimentation pond ► Outlet.

Process flow of sludge treatment system:

Sludge (sludge water from reactive sedimentation pond) ► Sludge collection pond ► Submersible sewage pump ► Concentration pond ► Sludge screw pump ► Sludge dewatering equipment ► Mud cake transport to off-site.

Surface water pretreatment system will be arranged taking land occupation and optimization design into consideration. Dosing system and sludge dewatering equipment will be set in dedicated buildings (structures). Others like flocculation sedimentation pond and sludge condensation pond, etc. will be arranged outdoors. Distribution cabinet and field control cabinet will be arranged in dosing room.

Treatment system mainly adopts mixed flocculation sedimentation process, taking dosing system and sludge discharge system as auxiliary systems. Dosing system adopts coagulant and coagulant aids. Sludge system includes sludge discharge pipe, quick sludge discharge valve, sludge discharge channel, sludge regulating pond, sludge lift pump and sludge dewatering equipment, etc.

4.10.8.1.5 Service Water and Domestic Water Supply System in Plant Area

Service water and firefighting water in plant area will adopt seawater reverse osmosis water from seawater desalination treatment system. Boiler makeup water and domestic water will adopt fresh water reverse osmosis water from seawater desalination treatment system.

4.10.8.1.5.1 Service Water System

Service water will be disinfected desalination water from seawater desalination treatment system. Two sets of industry and firefighting reservoirs with effective capacity of 1,000 m³ and three sets of 50% capacity of service water pumps (two for operation and one as standby) will be designed in this project. Service water system will supply service water for following systems.

- a. Coal Jetty;
- b. Flushing water;
- c. Cooling water for hydrogen production station;
- d. Chemical system dosing;
- e. Miscellaneous.

4.10.8.1.5.2 Domestic Water

Domestic water, sourced from disinfected desalination water from seawater desalination treatment system, will be sent to domestic water reservoir with effective capacity of 200 m³ after filtration and disinfection. Two sets of 100% domestic water pumps (one for operation and one as standby) will be set in comprehensive water pump house.

4.10.8.1.6 Drainage System in Plant Area

This system will includes domestic sewage, coal wastewater, oily wastewater, industrial wastewater, seawater thick-salt drainage and rainwater drainage system etc. All drainage systems will adopt independent drainage pipe network. All the wastewater will be recycled after up-to-standard treatment.

In order to protect environment from rainwater drainage pollution, rainwater in coal yard flows into rainwater sedimentation pond via drainage ditch and then flows into coal wastewater treatment system after sedimentation. Rainwater in transformer area and oil tank area, after oil removal via oil separation tank, will be discharged to oily wastewater treatment system. Drainage from circulating water system, seawater pretreatment system and brine drainage from seawater desalination treatment system will be discharged to open channel and then to the sea. Rainwater in plant area, after being collected by rainwater drainage ditch, will be discharged to Buriswar-Payra River.

4.10.9 Fly Ash and Bottom Slag Storage Yard

4.10.9.1 Ash Yard Primary Dam

A primary ash dam will be built around the ash yard, with height of 5.4m, internal and external side slope of 1:2.5 and top width of 4m, using materials inside the ash yard. The dam slope will be protected using dry masonry block stone. Drainage ditch will be set at dam foot to protect it from rainwater washing. The designed ash stacking height will be 11m and effective storage capacity will be about $144.3 \times 104 \text{ m}^3$, which satisfies storage demand of 1x350 MW unit for about 5 years.

4.10.9.2 Operation and Management of Ash Yard

Ash will be stacked in blocks, minimizing stacking working surface. In order to facilitate comprehensive utilization in the future, ash and slag will be stacked separately. When stacking, the ash will be spread, rolled and compacted from bottom to top layer by layer, with stacking elevation at least 1.0 m lower than ash dam, meeting limits of safety rules requirements in ash storage area. The ash will be rolled with principle of normal operating of machines. The operation slope may be 1:20~1:30. When ash yard will be expected to reach full capacity, the ash surface will be afforested or converted into cultivated land.

To facilitate the operation & management of ash yard and the storage of machines and tools, a management station covering an area of 2500 m^2 , which contains six garages and four offices, will be built near the ash yard. Main equipment for ash spreading, rolling and compaction purpose will be provided as follows:

- Bulldozers (power plant type, plus U-shaped scoop) Two sets;
- Vibratory roller One set;
- Sprinkler (equipped with high-pressure water guns) One set;
- Maintenance tool car One set;
- Hand operated vibrating roller one set.

4.10.10 Fire Fighting System

4.10.10.1 Overview

Firefighting system in this project mainly includes:

- Fire hydrant water supply system;
- Gas firefighting system;
- Automatic water sprinkler system;
- Foam fire extinguishing system in oil tank area;
- Portable and cart type fire extinguisher;
- Fire detection and alarm system (information specialty), etc.;
- Firefighting system will be designed in accordance with NFPA specifications.

Firefighting system is designed and installed for following areas:

- **Major areas:** Boiler house, Turbine hall, GIS, Main transformer and auxiliary transformer, Diesel generator room;
- **Oil tank area:** Oil tank, Fuel oil pump house;
- **Fuel system:** Coal yard, Coal handling trestle and transfer station, Coal crusher room, Coal bulldozer house, Coal handling control building;

- **Water treatment area:** Water supply treatment area, Wastewater treatment area;
- **Auxiliaries:** Administration building, Material warehouse, Maintenance room, Comprehensive pump house.

4.10.10.2 Fire Fighting Pump Station System

Firefighting system is designed and it will be installed to store and supply firefighting water for the indoor and outdoor fire hydrant system, automatic sprinkler system and foam extinguishing system. The system will include firefighting reservoir and firefighting water pump. In this project, electric firefighting water pump, diesel firefighting standby pump and firefighting pressure stabilizer system will be provided. Firefighting water pump will be set in comprehensive pump house and directly suck water from the firefighting reservoir. Independent firefighting water supply pipe network will be provided, of which branch pipes will be arranged in main building, coal yard, oil tank area and other areas. The outdoor offsite fire hydrant water supply network and the automatic sprinkler water supply network will be integrated into one set of fire water supply network. The outdoor offsite water supply network will adopt polyethylene composite pipes with steel frame.

4.10.10.3 Outdoor Fire Hydrant System

Outdoor fire hydrant system mainly will be provided firewater for fire extinguishing and cooling in plant area. The system will include fire hydrant, firewater branch, firefighting equipment, separation valve and firefighting annular pipe network.

4.10.10.4 Indoor Fire Hydrant System

Indoor fire hydrant system, including fire hydrant box, firefighting pipe and piping accessories, will provide firewater for inside of buildings. The pressure and water supply capacity of this system will be designed based on NFPA14 standard.

4.10.10.5 Automatic Water Spray System

Automatic water spray extinguishing system, designed based on NFPA15, is mainly used for oil tank of turbine hall, boiler burner and transformer, etc. Firefighting protection and spray strength shall meet requirements of NFPA850.

4.10.10.6 Automatic Water Sprinkler System

The automatic water sprinkler system will be designed for coal handling system, cable interlayer in control building, coal transfer station and coal conveying trestle, etc. in accordance with NFPA13. The firefighting protection and water spray intensity shall comply with NFPA850.

4.10.10.7 Fixed Foam Fire Extinguishing System

Fixed foam fire extinguishing system will be mainly used for firefighting extinguishing of oil tank and oil pump house. It must provide abundant firefighting extinguishing capability and pressure to satisfy fire-extinguishing requirement of oil tank and oil pump house.

4.10.10.8 Gas Extinguishing System

Gas extinguishing system will be mainly used in electronic equipment room and power distribution room of central control building. Raw coal bunker uses low-pressure carbon dioxide inerting fire extinguishing system.

4.10.10.9 Fire Extinguishers and Fire Engines

Main building and other buildings will be provided with portable and cart type fire extinguishing system. The quantity and position of fire extinguishers shall meet NFPA10 and NFPA850. This project will be designed with one fire engine. Different firefighting extinguishing systems are shown in following Table 4-10.

Table 4-10: Different Firefighting Extinguishing Systems

Buildings and areas	Types of fire detector	Alarm control mode	Fire extinguishing medium and system type
Turbine hall and central control building			
Electronic equipment room	Smoke detector	Automatic alarm, automatic fire extinguishing	FM200 fire extinguishing system
Engineer station	Smoke detector	Automatic alarm, automatic fire extinguishing	
Central control room	Smoke detector	Automatic alarm	
Meeting room, prayer room, shift room, cabinet room, dining room, and kitchenette	Smoke detector	Automatic alarm	Portable dry powder extinguisher
Turbine oil tank and oil purification device	Heat detector or light detector	Automatic alarm, Automatic or Manual fire extinguishing	High-speed water spraying extinguishing system
Hydraulic pressure equipment	Heat detector or light detector	Automatic alarm, Automatic or Manual fire extinguishing	
Oil pipe at middle layer	Heat detector	Automatic alarm, Automatic or Manual fire extinguishing	
Oil tank of boiler feeding pump	Heat detector	Automatic alarm, Automatic or Manual fire extinguishing	-
Switchgear room	Smoke detector	Automatic alarm	Portable dry powder extinguisher
Substation and relay protection room			
Substation and relay protection room	Smoke detector	Automatic alarm, automatic fire extinguishing	FM200 fire extinguishing system
Boiler house and coal bunker bay			
Boiler burner	Heat detector	Automatic alarm, automatic fire extinguishing	High-speed water spraying extinguishing system
Raw coal bunker	Cable type thermal detector (self-checking equipment temperature)	Automatic alarm, CO ₂ activation feedback manual confirmation	LP CO ₂ inert gas fire extinguishing system
Coal conveying belt	Line type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	High-speed water spraying extinguishing system and water curtain
Transformer			
Main transformer	Dual circuit cable type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	High-speed water spraying extinguishing system
Auxiliary transformer	Dual circuit cable	Automatic alarm, Automatic	High-speed water

Buildings and areas	Types of fire detector	Alarm control mode	Fire extinguishing medium and system type
	type heat detector	or Manual fire extinguishing	spraying extinguishing system
Coal handling system			
Coal handling control room	Smoke detector	Automatic alarm	Portable dry powder extinguisher
Trestle	Cable type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	Medium-speed water spraying extinguishing system and water curtain
Coal crusher room and coal handling trestle	Cable type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	Water curtain
Coal yard	Line type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	Fire hydrant
Other buildings and equipment			
Diesel generator and oil tank	Explosion-proof heat detector and explosion-proof cable type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	High-speed water spraying extinguishing system
Diesel fire fighting pump and oil tank	Explosion-proof heat detector and explosion-proof cable type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	
Oil tank area	Explosion-proof heat detector and explosion-proof cable type heat detector	Automatic alarm, Automatic or Manual fire extinguishing	High speed water spray cooling system and foam extinguishing system
Administration building	Smoke detector	Automatic alarm, Automatic or Manual fire extinguishing	Automatic sprinkler system and fire hydrant extinguishing
Living service building	Smoke detector	Automatic alarm, Automatic or Manual fire extinguishing	
Dining room	Smoke detector	Automatic alarm, Automatic or Manual fire extinguishing	
Boiler makeup water workshop	Smoke detector	Automatic alarm	Fire hydrant extinguishing
ESP and ash handling control room	Smoke detector	Automatic alarm	Portable dry powder extinguisher and fire hydrant
Coal bulldozer house	-	-	Portable dry powder extinguisher
Guard room	-	-	Portable dry powder extinguisher

Buildings and areas	Types of fire detector	Alarm control mode	Fire extinguishing medium and system type
Fire engine house	Smoke detector	Automatic alarm	Portable dry powder extinguisher and fire hydrant

Source: Feasibility Report, 2018

4.10.11 Transmission Line

The single-circuit transmission line will be led from 1x350 MW coal-fired power plant GIS and connected to 400kV substation (temporarily referred to as 400kV Kalapara substation) that is about 13 km in the north-east of Kalapara. The power plant is situated on the southwest coastal area of Bangladesh and the proposed 400kV substation is about 26 km to the northeast of the plant. This transmission line is temporarily considered in the length of 32 km. Under the principle of minimizing house demolition, timber cutting and crossing-over. The proposed project proponent will conduct a separate EIA study for the transmission line. The preliminary planning of the line route is given in following Figure 4-10.

Figure 4-10: Tentative route of the Transmission line



Source: Feasibility Report, 2018

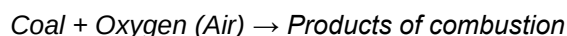
4.11 Material Balance

4.11.1 Heat Balance

The proposed power plant project is based on combustion of pulverized coal with calorific value of 20,689.88 kJ/kg. The emission from coal combustion have been considered based on the coal firing rate at 100% Boiler Maximum Continuous Rating (BMCR) of 150,220 kg/hr. heat balance for 100% load has been depicted in figure below.

4.11.2 Mass Balance

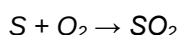
The thermal power generation will involve conversion of chemical energy into electrical energy with intermediary conversions into heat and mechanical energy. The broad process can be presented through the following equation:



The material balance for the two critical parameters, Sulphur and Ash has been presented in the subsequent section.

4.11.2.1 Sulphur

The coal for the proposed power plant will be imported from Australia, Indonesia and South Africa. The coal consumption for the project has been estimated to be 150,220 kg/hour and the design coal have a Sulphur content of about 0.85%.



1276 1276 2552 (values in kg/hr)

The Sulphur dioxide generated will be emitted from the stack, details of which have been presented in section 8.5.4 of EIA report.

4.11.2.2 Ash

The coal consumption per day has been estimated as 3304.84 tons/day. The ash content of the design coal will be about 20.76% and will result in generation of fly ash and bottom ash during combustion. It is estimated that about 85% of the ash will come out as fly ash and 15% will form bottom ash. The details are presented below:

Ash content in Coal → Fly Ash + Bottom Ash

706.244 600.314 105.93 (values in tones/day)

It has been estimated that, approximately 600.34 t/day of fly ash will be produced by the proposed power plant, which can be used in the production of cement, used as concrete admixture and also can be used to build roads.

Water balance for the proposed project has been presented in the section 4.6 (Figure 4.2) of the report.

4.12 Pollution Mitigation Measures (Units and devices)

4.12.1 Air Pollution Control

4.12.1.1 Electrostatic Precipitator

Twin-chamber five-electric-field ESP with dust collection efficiency of not lower than 99.72% will be adopted; meanwhile, desulfurization system with dust collection efficiency of 50% is considered, in order to assure smoke dust concentration at chimney outlet lower than 50 mg/Nm³.

4.12.1.2 Flue Gas Desulfurization

The FGD system will be constructed for the proposed 350 MW coal-fired power plant project. One FGD scrubber will be provided for each boiler. One limestone slurry preparation system will be constructed in the power plant. The limestone-gypsum wet type desulfurization method will be adopted with desulfurization efficiency of not lower than 93%. The sulfur dioxide concentration at the chimney outlet will be lower than 200 mg/Nm³, which can satisfy the requirement of World Bank IFC EHS standard.

The production process flow to produce limestone slurry for desulfurization will be ship transportation of raw material ► raw material stockyard ► raw material conveying ► primary crushing ► semi-finished product conveying ► wet type ball mill ► finished limestone slurry for desulfurization. Limestone-gypsum wet type FGD has an efficiency of not less than 93%, with the following design data (Table 4-11).

Table 4-11: Specification of FGD system

BMCR	Unit	Design Coal	Check Coal
Flue gas volume (dry basis, 6% O ₂)	m ³ /h	1,090,180	1,108,450
Excess air coefficient	-	1.34	1.34
Flue gas temperature	°C	115.6	115.6

BMC	Unit	Design Coal	Check Coal
Pollutants in flue gas (dry basis, 6% O ₂)	mg/Nm ³	2,000	2,500
SO ₂ concentration at chimney outlet	mg/Nm ³	<200	<200
Desulfurization efficiency	%	93	93

Source: Feasibility Report, 2018

4.12.1.3 Low NOx Burner

The boiler will adopt low NOx burner and staged air distribution combustions to assure NOx emission concentration at boiler outlet lower than 510 mg/Nm³, which will be lower than the limit value required by standards. Space for SCR flue gas DeNOx will be reserved for boilers.

4.12.1.4 Height of Chimney

In this project, one 220m high chimney will be constructed. High chimney emission will conducive to pollutants diffusion.

4.12.1.5 Monitoring

The continuous online monitoring system will be installed to monitor PM, SO₂, NO_x and other pollutants. After considering control measures, the air pollutant emission of the proposed power plant project is shown in following Table 4-12.

Table 4-12: Pollutant Emission Level in the Project

SL#	Item	Unit	Emission value by design coal	Emission value by check coal	Standard limit value
1	Particulate Matter	mg/nm ³	30.89	40.05	50
		t/h	0.035	0.047	
2	SO ₂	mg/nm ³	138.80	178.42	200
		t/h	0.159	0.208	
3	NO _x	mg/nm ³	<510	<510	510
		t/h	0.585	0.595	

Note: 1) Dry flue gas, 1.01325x10⁵Pa, 0°C, 6% oxygen content, Source: Feasibility Report, 2018

4.12.2 Noise Pollution Control

The noise generating sources in the power plant will be mainly from equipment vibration and friction including turbine-generator set, exciter, various pumps and fans and coal pulverizer. The power plant noise will be effectively controlled in three aspects, i.e. reducing the noise of sound source, controlling the route of transmission and strengthening personnel protection. Generally, the following measures will be taken:

- Silencer shall be installed at boiler exhaust vent and fan inlet;
- Acoustic enclosure shall be installed for turbine-generator set;
- Turbine-generator set shall adopt rigid coupling;
- Low noise exciter shall be selected;
- Central control building will be sealed by 250 mm thick aerated concrete blocks. The central control room will be arranged in the middle of the central control building, surrounded by corridors or auxiliary rooms, which will be isolated from the external sound sources; and
- Workers at high noise area shall wear noise protecting earplug.

4.12.3 Effluent Treatment Plant (ETP)

A central ETP will be installed in the proposed project to collect, treat and dispose of wastewater that will be generated from boiler make-up water treatment system, wastewater from condensate polishing system, drains from air pre-heater flushing, etc. and oily wastewater generated from oil pump house,

oil tank area, wash water for the car, main building washing water and transformer area. The amount of the waste water is given in water balance diagram. According to the project proponent, the treating capacity of the ETP will be 60 m³/h and approximately 0.45 million USD has been kept for the ETP. The treated wastewater will be discharged to recycling water system for dry ash humidification, coal handling system flushing, etc. and after separate treatment; desulfurization wastewater will be reused for ash yard sprinkling. Oily wastewater will be collected into the oily water separation pond and then boosted and pumped into the oil-water separator to remove oil. The treated water will be discharged into industrial wastewater drainage pipe network. Oily wastewater treatment system, with treating capacity of 2×5 m³/h (one set for back up, one set for operation), is designed in this project. Detailed specification and process diagram of the ETP is shown in Annex-D (Volume-II).

4.12.4 Sewage Treatment Plant (STP)

The STP will be installed in the proposed power plant to treat the domestic sewage. Two sets of 5 m³/h domestic sewage treatment equipment will be set in this project. It will adopt buried domestic sewage treatment equipment. Mainly this system will be used to collect domestic sewage of whole plant, mainly including drainage from staff shower, flushing, toilet and canteen and discharged to domestic sewage regulating tank via underground pipe and then be pumped to complete set of sewage treatment equipment. The treated water will flow to recycling tank for landscaping of the whole plant. According to the project proponent, approximately 0.21 million USD has been kept for the STP. Detailed specification and process diagram of the STP is shown in Annex-D (Volume-II).

4.12.5 Thermal Pollution Control

The power plant adopts once-through cooling system, with the maximum water consumption at about 47,763 m³/h and the highest temperature increase of water discharge at about 7.5°C. Inlet water temperature is designed as 28.5°C and outlet water temperature is expected to be lower than 36°C, thus meeting the requirement of Waste Water Discharge Standard for Industrial Projects in Bangladesh (ECR, 1997).

4.12.6 Solid Waste Management

All kinds of solid waste to be generated from the proposed project will be disposed on site maintaining DoE's guidelines and standards.

4.12.6.1 Fly & Bottom Ash Pollution Control

This project will adopts positive-pressure dense-phase pneumatic ash handling system for fly ash and wet bottom ash extraction system for boiler bottom ash. Submerged scraper conveyor will delivers the bottom ash directly to bottom ash silo. The fly ash and bottom ash will be collected for comprehensive utilization. Otherwise, they will be transported to ash yard for stacking. In order to avoid underground water contamination caused by wet fly ash & bottom ash in rainy days, anti-seepage geo-membrane will be laid at the bottom of ash silo and the side slope of ash dam to isolate pulverized fuel ash from outside.

Truck sprinkling will be adopted during operation phase, so as to provide water for humidifying and rolling compaction as well as ash surface sprinkling in ash yard. During strong wind season, the exposed ash surface shall be regularly sprinkled. If necessary, the ash pile shall be covered with soil, so as to avoid fly ash pollution. In order to prevent dust from polluting surrounding area, growing trees at exterior area of ash yard to form 13 m width Green belt in order to reduce wind speed and minimize flying dust. Pulverized fuel ash from the power plant can be used in the production of cement, used as concrete admixture, and also can be used to build roads. Otherwise, it will be delivered to ash yard. The water-spray and rolling equipment will be provided to control dust pollution on external environment.

CHAPTER FIVE: ANALYSIS OF SUITABILITY OF DIFFERENT ALTERNATIVES

5. Analysis of Suitability of Different Alternatives

5.1 Introduction

The purpose of the analysis of suitability alternatives as part of the EIA study process is to select the best among all possible project options. This chapter discusses the alternative considerations that have been studied before finally proposing the present project. The alternatives analysis were considered the following major issues:

- Requirement of the proposed project to meet the power demand;
- Selection of the project configurations and technology; and
- Selection of the proposed site.

The assessments and recommendations made by the EQMS team are presented below:

5.2 The No Build Scenario

From a purely physical environmental point of view, the 'do-nothing' is preferable to any project implementation, since it would avoid creation of any of the adverse impacts associated with the project. However, the potential socio-economic benefits to the nation would be foregone; energy security and industrial growth would be hampered by going for this option.

It is concluded that the 'No build' alternative is unacceptable and the potential socio-economic benefits of implementation of such project far outweigh the adverse impacts which are minor and temporary can be controlled and minimized to an acceptable level.

5.3 Analysis of Alternative Technology

The selection of the proper steam generator technology is a critical step in the basic design of a new coal-fired power project. The fuel to be fired and the steam cycle to be adopted dictates the type of steam generator needed to satisfy the requirements of the project.

5.3.1 Alternatives for Boiler Technology

The following are the general options for selection of boiler technology:

For easy to burn fuels, such as bituminous coals - Suspension firing of the pulverized fuel in horizontal, wall-mounted burners is the configuration of choice.

For low volatile, low reactivity fuels, such as anthracite and petroleum cokes, the down-fired arch furnace is the choice adopted worldwide.

Another option for difficult fuels, as well as for waste fuels, which cannot be properly burned with suspension firing, is the circulating fluidized bed (CFB) boiler. Also, the flywheel of circulating solids in the CFB boiler allows a wide range of fuels to be fired in the same unit.

In the proposed project, coal will be the main fuel. Hence, pulverized supercritical boilers are considered.

5.3.2 Alternatives for Boiler Parameters

Three options, sub-critical, supercritical and ultra-supercritical parameters were examined related to power generation of thermal power plants.

Supercritical Boilers having high steam parameters and higher efficiency than the subcritical and is mature experience in manufacture, maintenance, operation and construction. The supercritical technology is more popular and stable than ultra-supercritical in the capacity of 350 MW class. The major benefit of adopting higher steam cycle is reduction in emissions of SPM, CO₂, SO₂, and NO_x.

Hence, in view of the above, supercritical parameters are considered for the proposed boiler configuration.

5.3.3 Alternatives for Cooling System

5.3.3.1 Qualitative Comparison

The qualitative comparison between different types of cooling system is given in following Table 5-1.

- **Option-1: Once-through cooling; and**
- **Option-2: Secondary circulation with mechanical draft cooling tower.**

Table 5-1: Qualitative Comparison of Cooling Schemes

Item/Options	Option-1*	Option-2**	Remark
Capital Investment	Relatively low	Relatively high	-
Operation Cost	Relatively low	Relatively high	For the secondary circulation scheme, the cooling water temperature at outlet of the cooling tower is generally higher than the once-through cooling scheme, causing higher unit operating backpressure and higher coal consumption; hence, the operation cost is relatively high.
Land Occupation	Relatively small	Relatively large	The land area can satisfy the land requirement of both options.
Maintenance Workload	Relatively low	Relatively high	Since mechanical draft equipment is set for the mechanical draft-cooling tower, the maintenance workload is relatively high.
Impact on Environment	Relatively low	Relatively high	For the secondary circulation option, the water discharge volume is low and the discharged water is cooling water. Therefore, the warm water discharge issue doesn't exist. The noise of mechanical draft cooling tower fan has a certain degree of impact on the environment. However, the noise can be minimized by taking proper noise-reduction measures for the equipment. For option-2, since the turbine backpressure is high, the unit coal consumption is relatively high, and corresponding exhaust emission is also high.
Adaptability of circulating water system equipment to high salt and high humidity environment in the sea area	Relatively good	Relatively bad	In option-2, the mechanical ventilation tower will be exposed to high salt and high humidity, which is easy to cause corrosion and affect the normal operation of the unit. There is no cooling tower in option-1, so the corrosion problem does not exist.

* Option-1: Once-through cooling & ** Option-2: secondary circulation with mechanical draft cooling tower

Source: BEPCL, 2018

5.3.3.2 Unit Exhaust Gas Emission Comparison

In option-1, once-through cooling will be adopted, with low cooling water temperature and the unit operating backpressure will be lower than that in option-2. Consequently, option-1 is preferable in unit operating economy.

Compared to the cooling tower pattern in option-2, the once-through cooling in option-1 can save raw coal of 9,000 tons/year, with significant reduction in atmospheric pollutant emissions, e.g. reduction of 1.9t for smoke, 8.5t for SO₂ and 31t for NO_x per year.

5.3.3.3 Tech-economic Comparison

The following are about the preliminary tech-economic comparisons for the two options based on existing design data.

5.3.3.3.1 Initial Investment Comparison

The comparison between two cooling system (once-through and secondary circulation with mechanical draft cooling tower) based on initial investment is given in following Table 5-2.

Table 5-2: Initial Investment for Cooling System (unit: USD 10,000)

SL#	Item	Option-1*	Option-2**
1	Civil works (including foundation treatment)	1,170	1,400
2	Equipment and installation		
A	Water intake facilities and installation	435	96
B	CW piping installation	212	83
C	CW pump house and cooling tower	-	501
D	Water treatment facility installation	72	187
3	Total	1,889	2,267
	Differential	Datum	+378

* Option-1: Once-through cooling & ** Option-2: secondary circulation with mechanical draft cooling tower

Source: BEPCL, 2018

5.3.3.3.2 Annual Cost Comparison

The comparison between two cooling system (once-through and secondary circulation with mechanical draft cooling tower) based on annual cost is given in following Table 5-3.

Table 5-3: Annual Cost for Cooling System (unit: USD 10,000)

SL#	Item	Option-1*	Option-2**
A	Initial investment	1,889	2,267
1	Annual fixed cost	221	265
2	Annual equipment maintenance cost	47	113
	Sub-total	268	378
B	Differential in fuel cost	Datum	85.6
C	Differential in annual operating cost	Datum	118.3
D	All-in annual cost	268	581.9
	Total Annual Cost	Datum	+313.9

* Option-1: Once-through cooling & ** Option-2: secondary circulation with mechanical draft cooling tower

Source: BEPCL, 2018

Both options can meet World Bank standards and DoE, Bangladesh environmental protection requirements. In option-1, the warm discharge water, through model verification, will be qualified for World Bank standard. In option-2, there is no warm discharge water involved, but the concentrated wastewater discharged from the cooling tower still has a certain impact on the sea environment and the cooling equipment, with noise insulation measures taken, can meet the environmental protection requirement, but the noise level is still generally larger than the once-through cooling scheme.

Option-1 is comparatively more economic and energy saving for unit operation and can significantly reduce the atmospheric pollutant emission.

It can be seen from the above comparison that the Option-1: once-through cooling scheme is superior to the Option-2: cooling tower scheme on the such items as: system land occupation, initial investment, operational economy, annual cost, quantity of pollutant discharge, adaptability to the marine environment, maintenance, and noise level. Therefore, this project recommends Option-1: once-through cooling scheme.

5.4 Analysis of Alternative Sites for the proposed Power Plant

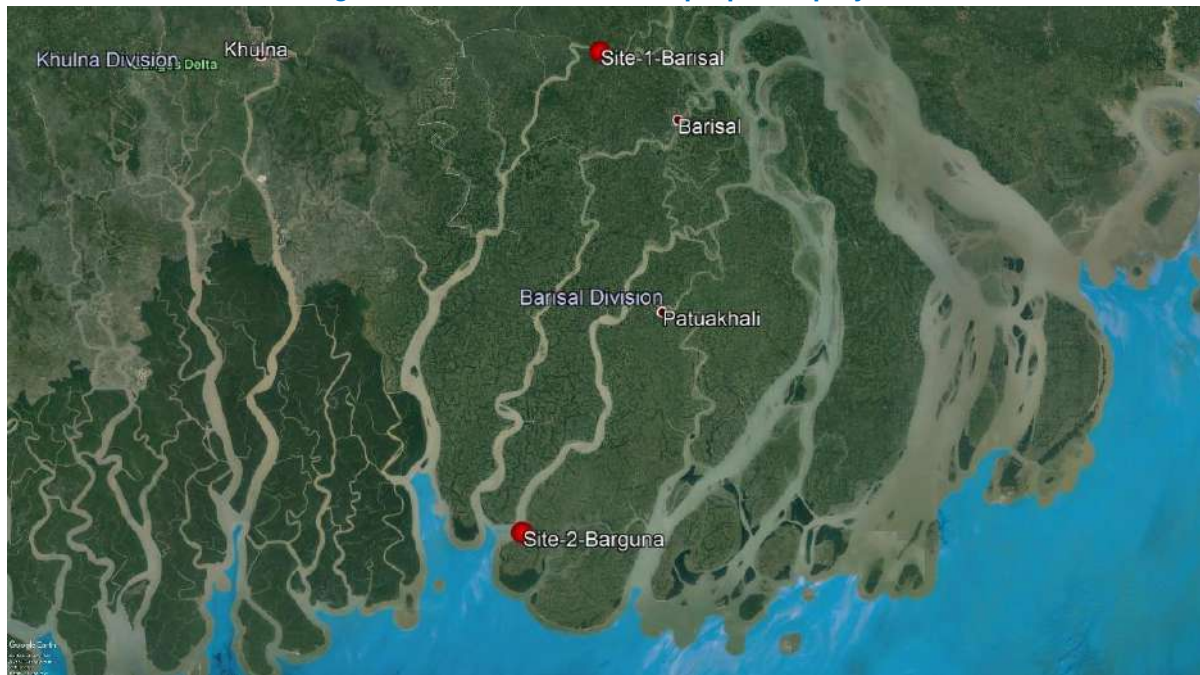
At the primary stage, the project proponent were selected two (2) candidate sites for the establishment of the proposed power plant. The following Figure 5-1 shows the selected two potential sites. The sites are located:

Site-1: Chakhar Union in Barisal District; and

Site-2: Nishanbaria Union of Taltoli Upazila in Barguna District.

After the primary selection, the project proponent conducted different types of survey in different perspectives (Technical, Economical, Environmental and Social) and discussions with the government departments for the finalization of location for the proposed power plant.

Figure 5-1: Potential sites for proposed project



Source: BEPCL, 2018

5.4.1 Site Selection Criteria

Many factors came into play during selecting a proper site for a thermal power plant based on its sustainability and land availability. According to the result of the survey and consultation with different government departments, Site-2 (Taltoli Upazila in Barguna District) have advantages from the following viewpoint:

Indicator	Project site-1 (Barisal)	Score	Project Site-2 (Barguna)	Score
Transmission Line	No available transmission line was present near of the Barisal site. The closest one was more than 75 km away and the capacity was 230 KV	1.5	From the Barguna site, it is required to construct only 25 km transmission line to connect with nearby 400 KV grid (Payra 1320 MW project)	3

Indicator	Project site-1 (Barisal)	Score	Project Site-2 (Barguna)	Score
Coal Transportation	According to the feasibility study of site-1, there were two options for the coal transportation. Both routes were more than 200 KM long comparing site-2 and one of them crosses through the Sundarbans Reserve Forest. More vehicles and logistics were required	2	The distance of coal transportation is 75 KM from site-2, which is more feasible than Site-1 for coal transportation and no Reserve forest/ECA/ Sensitive area is situated in the coal transportation route	4
River bank erosion	Site-1 was vulnerable for river bank erosion	2.5	The river bank erosion is less in site-2 comparing the site-1	3.5
Availability of water resources	Water is available in the Shaynda River round the year at site-1	3	Due to the proximity of the Bay of Bengal water availability is more comparing the site-1	4
Navigation depth	The navigation depth in the Shaynda River is less comparing the site-2	2.5	The navigation depth is higher comparing the site-1 due to the close proximity of the Bay of Bengal	4
Dredging requirement	The river channel was required to dredge for a long distance to maintain the navigability	2	The dredging will be required a short distance and site-2 will get the advantage of the high and low tide	4
Obstacle to frequent use of river channel	The nearest river from the site-1 was the Shaynda River, which is designated waterway under the BIWTA (Hularhat-Dhaka). For the coal transportation and unloading, a jetty was required to construct on the river. There was a possibility to disturb the river traffic	3	A jetty will be required to construct on the Buriswar-Payra river for the unloading of coal. The river traffic is less at the site-2 comparing the site-1	4
Environmentally sensitive area	No sensitive area was found within 5 km radius	5	No sensitive area was found within 5 km radius	5
Total		21.5		31.5

Scoring: From Low-0, High-5

5.4.2 Selection of the Site

After considering the entire above-mentioned indicator, the project proponent for the establishment of the coal-fired power plant finally selected the site-2 (Taltoli Upazila in Barguna District) and finally BPDB approved the final one.

After evaluation, site-2 (Taltoli Upazila in Barguna District), having major favorable features along with good environmental features has been identified for the proposed project. The site-2 (Taltoli Upazila in Barguna District), site has the following advantages:

- Availability of required plain land;
- Selected site is mix of barren land & single crop agricultural land;

- Transmission line length is about 25 km;
- The proposed project site is located on the bank of the Buriswar-Payra river and confluence of the Bay of Bengal;
- Coal transportation route will be short (75 km);
- Availability of surface water;
- Availability of navigation depth and less amount of dredging;
- No forest land within the project site; and
- No National Parks, Wildlife sanctuaries in 5 km radius.

5.5 Consideration of Alternatives

Due to land scarcity in the country, seeking an alternative site for establishing the power plant area is quite difficult. In addition, land acquisition is a lengthy and complex procedure under the existing Land Acquisition Law of Bangladesh (LA Ordinance 1982). Not only that, the project conceptual development over alternative sites is quite difficult because delay in overall land acquisition process might create social conflicts and risks for the project.

To avoid or minimize the impacts resulting from the activities of the project, BEPCL authority is expected to adopt appropriate technological design, improvements or adjustments, policy including good site operational practices and applicable EMP, etc. The overall strategy shall follow the following sequence:

- Impact avoidance or minimization;
- Adequate Compensation where impacts are unavoidable;
- Enhancement Measures-Employment benefits enhancement measures proposed by the consultants.

CHAPTER SIX: DETAIL DESCRIPTION OF THE LAND COVER/LAND USE

6. Detail Description of the Land Cover/Land Use

6.1 Introduction

The land use/cover inventories are an essential component of land resource evaluation and environmental studies due to the changing nature of land use patterns. The land use study for the proposed project and its 10 km radius was undertaken with the following objectives:

- To study the land use/cover in the 10 km radius areas of the proposed project site and provide inputs for environmental planning of the proposed project by analyzing the existing land use/land cover scenario; and
- To establish the existing baseline scenario using a GIS database for incorporation of thematic information on the different physical features including water bodies, settlements, transport networks and administrative boundaries etc.

6.2 Land Use Pattern

The terms 'land use' used in this report means land use and land cover both. The land use of the study area was determined by utilizing two principal resources, namely

- Google Earth imageries; and
- Ground validation by the EQMS study team.

6.2.1 Land Use of Study Area

The land use pattern of the proposed coal fired power plant study area is given in following Table 6-1 and shown in the bar diagram given below (Figure 6-1). The land use/land cover map (Figure 6-2) shows the land use pattern of the area within 10 km radius.

In the study area, within 10 km radius covering about 90,337.92 acres of land, the major share of the land is under agricultural land which is about 37,574.55 acres covering 41.59% of the total land cover. The Sea, Rivers, and Khal including Bay of Bengal, Buriswar-Payra River, Andarmanik River and Biskhali River and settlement and homestead vegetation are also present in the study area, which consists of 27,816.94 acres and 13,946.04 acres respectively and accounts for only 30.47% and 15.44% of the total area respectively. The mangrove forest and plantation area covering 6.01% and 4.02% of the total study area.

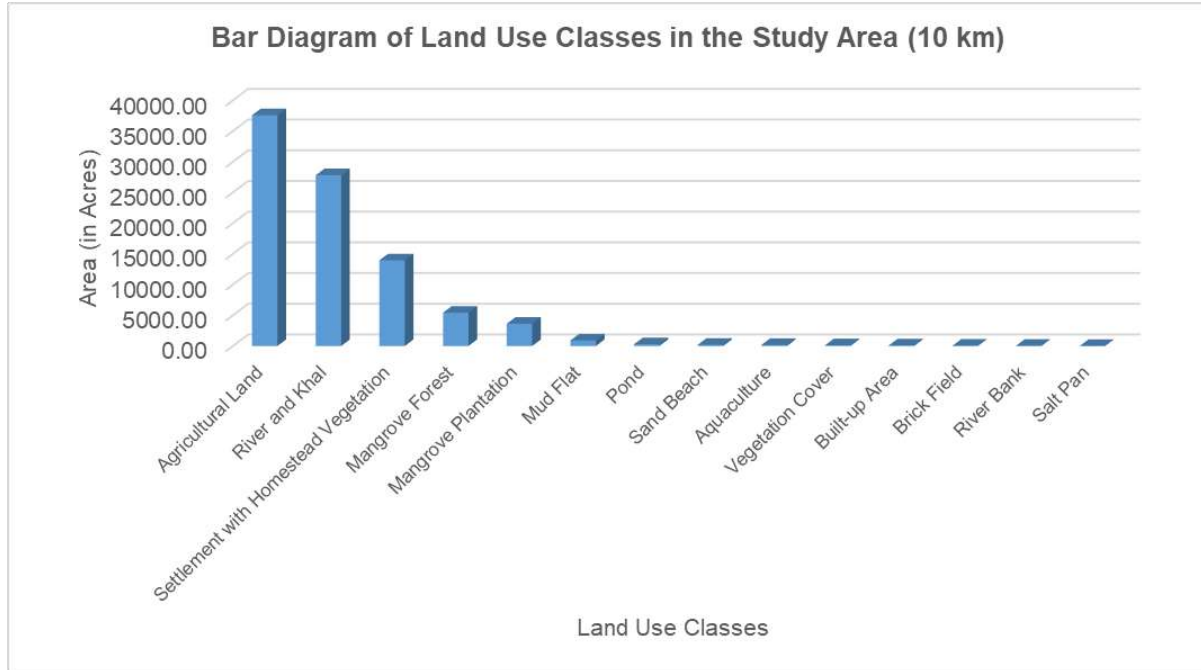
Table 6-1: Existing Land Use Pattern of the Study Area

SL#	Land Use/Cover Classes	10 km Study Area	
		Area (Acres)	Area (%)
1	Agricultural land	3,7574.55	41.59
2	River and Khal/Canal	2,7816.94	30.79
3	Settlement with Homestead Vegetation	1,3946.04	15.44
4	Mangrove Forest	5,432.64	6.01
5	Mangrove Plantation	3,629.54	4.02
6	Mud Flat	3,629.54	4.02
7	Pond	293.84	0.33
8	Sand Beach	203.75	0.23
9	Aquaculture	184.22	0.20
10	Vegetation Cover	127.54	0.14
11	Built-up Area	107.19	0.12
12	Brick Field	53.85	0.06

SL#	Land Use/Cover Classes	10 km Study Area	
		Area (Acres)	Area (%)
13	River Bank	48.48	0.05
14	Salt Pan	11.56	0.01
Total		90337.92	100.00

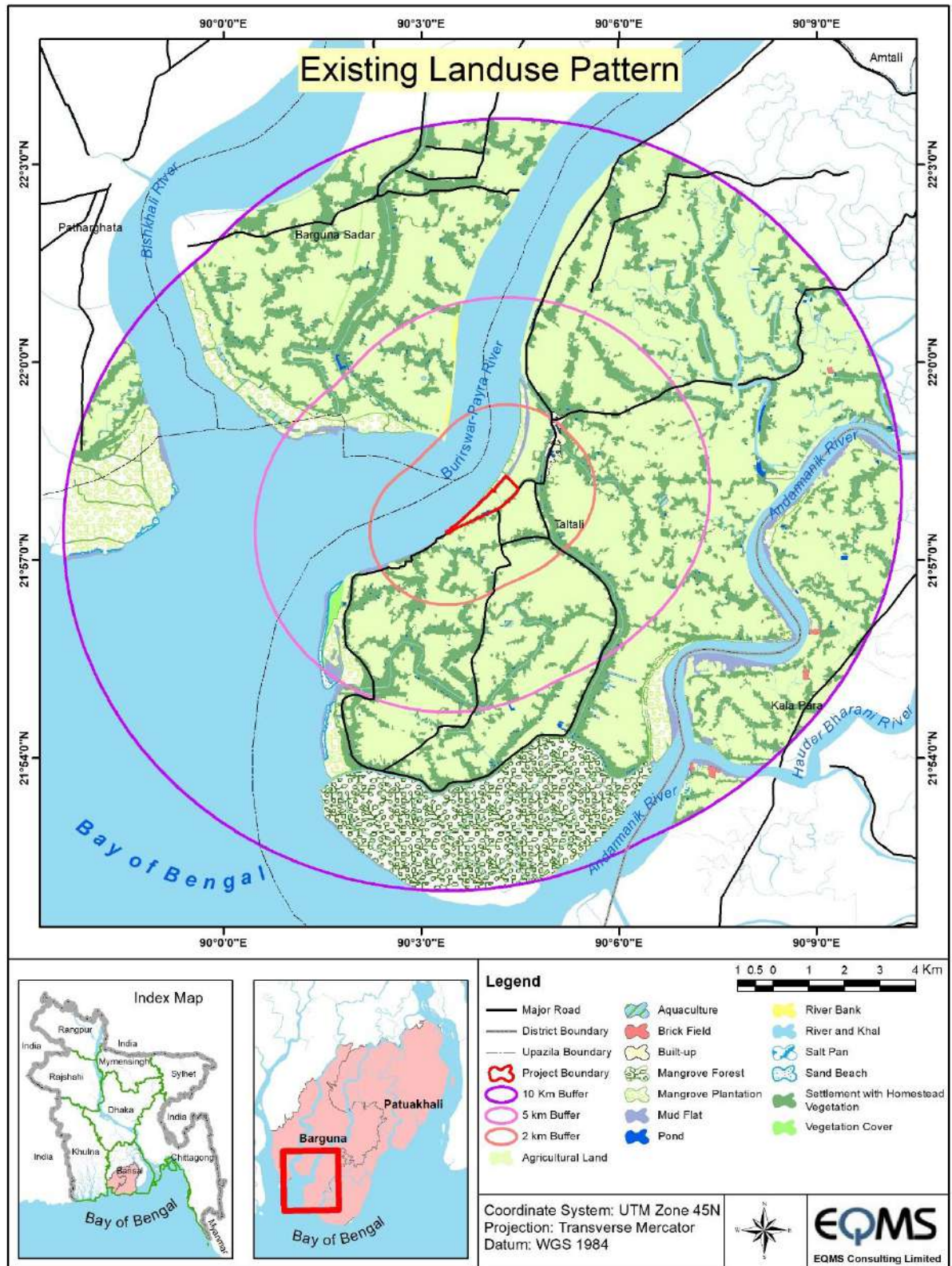
Source: Physical feature survey by EQMS, 2018 and interpret from Google Earth

Figure 6-1: Bar Diagram of Land Use Classes around the 10 km radius



Source: EQMS, 2018

Figure 6-2: Land Use/Land Cover Map of the 10 km Study Area



Source: EQMS, 2018

6.2.2 Land Use of Project Site

The land use of the proposed 350 MW coal-fired power plant project site is mainly covered by agricultural land (64.37%), settlement with homestead vegetation (15.43%), mud flat (11.22%), pond (4.89), river and khal (2.19%) and mangrove plantation area (1.89%). No designated forestland is present within the project site. The proposed proponent already get the NOC from the forest

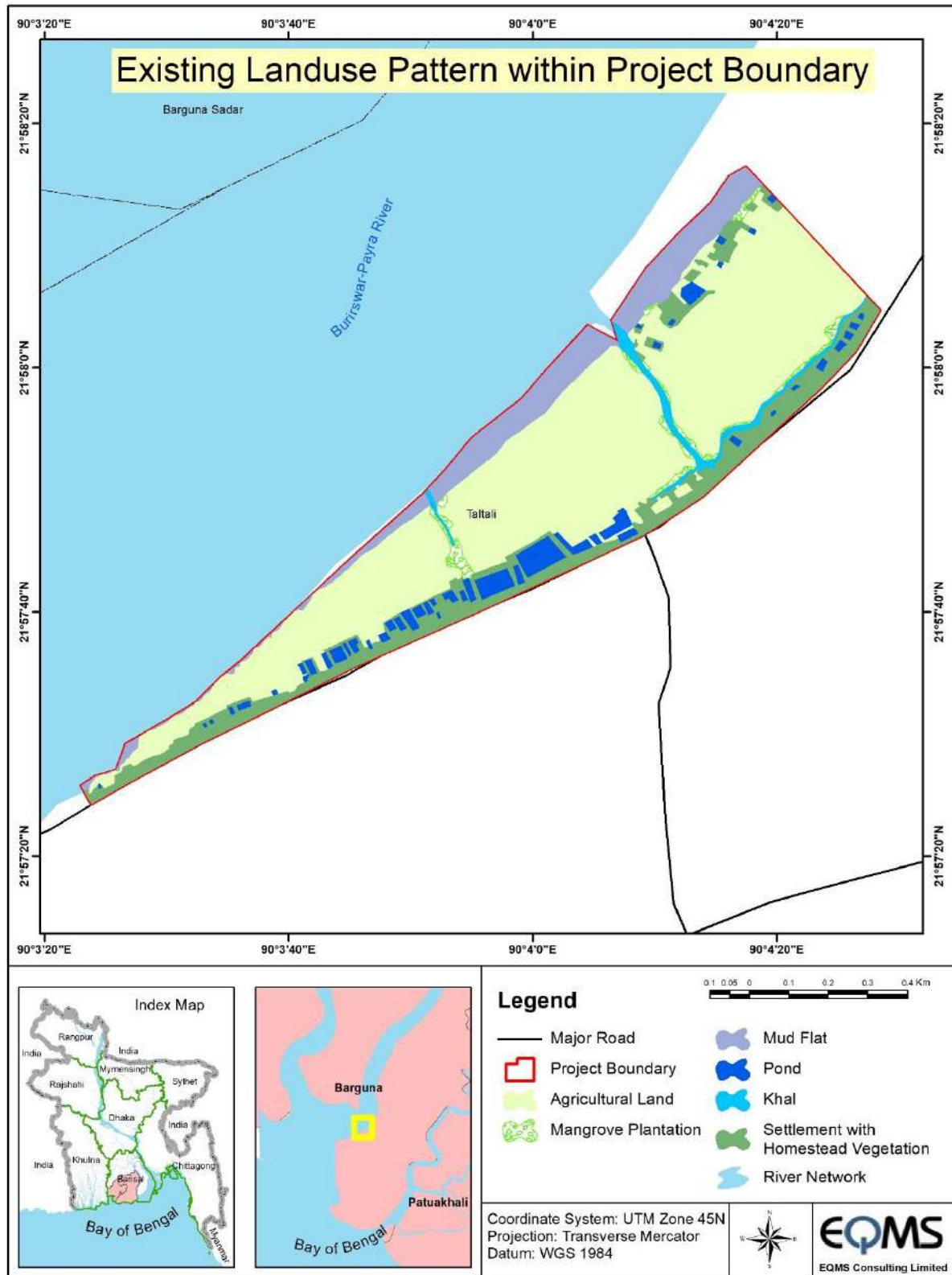
department declaring that the forest department have no land inside of the proposed project boundary, given in Annex-F (Volume-II). According to the preliminary RAP survey, approximately 112 number of households are living in the project site. There is a canal within the proposed project boundary, which will be suitably diverted as ensured by the project proponent. The following Table 6-2 shows the existing land use pattern of the project site.

Table 6-2: Existing Land Use of Project Site

SL#	Land Use/Cover Categories	Area (Acres)	Area (%)
1	Agricultural land	112.01	64.37
2	Settlement with Homestead Vegetation	26.85	15.43
3	Mud flat	19.53	11.22
4	Pond	8.51	4.89
5	River and Khal/Canal	3.81	2.19
6	Mangrove Plantation	3.29	1.89
Total		174	100

Source: Physical feature survey by EQMS, 2018 and interpret from Google Earth

Figure 6-3: Land Use/Land Cover Map of the Project Site



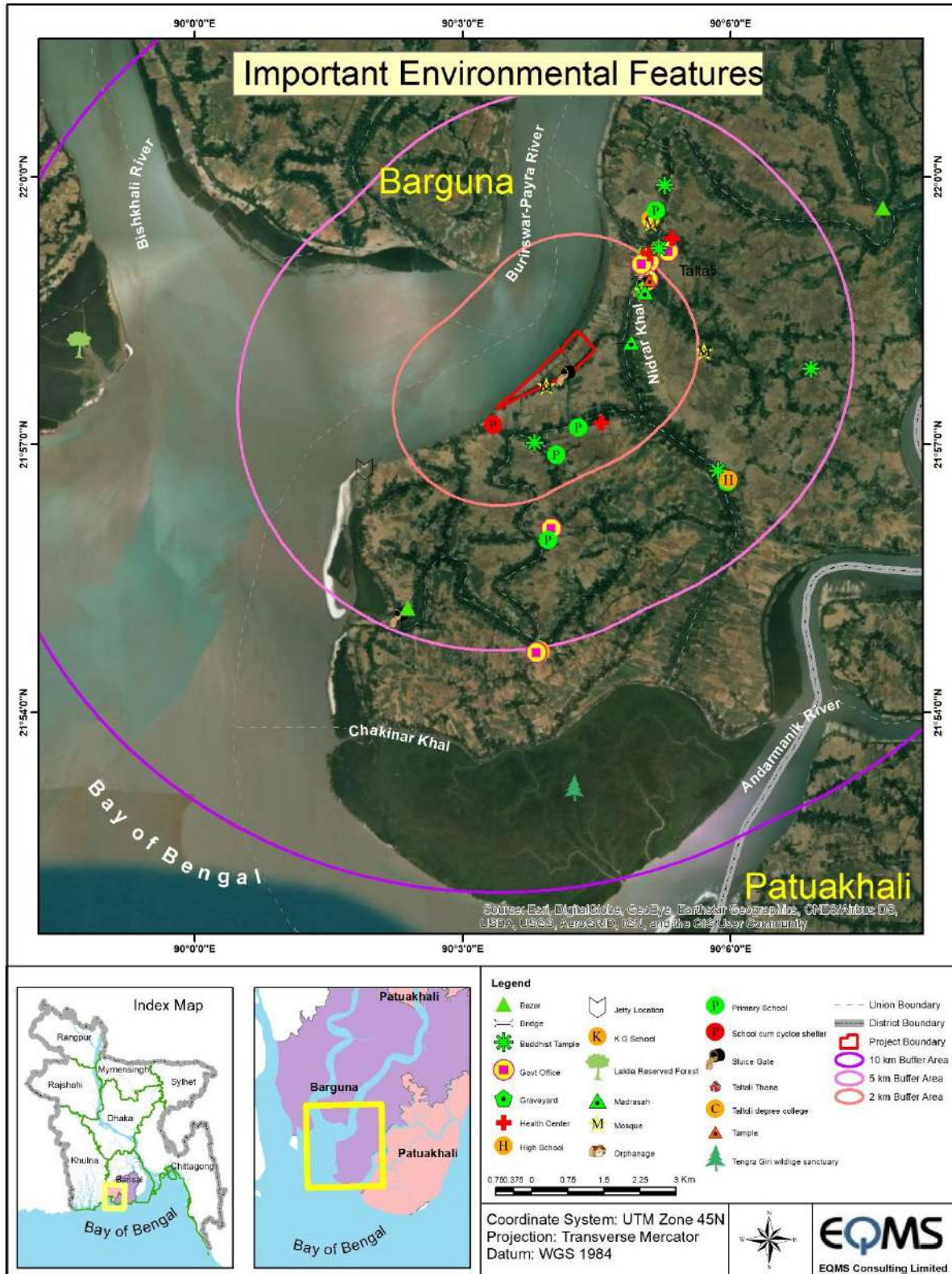
Source: EQMS, 2018

6.3 Sensitive Land Use of Study Area

The proposed project area is a rural area and there is no designated industry in and around the proposed project site. It has been found from physical feature survey conducted by EQMS that, most of the existing structures have been used as residential purposes in the project surrounding area. The other physical features consist of all structures according to their uses as residential, commercial,

education, religious and community facilities, roads, water bodies etc. Common facilities for the community like mosque, health complex and graveyards etc. have been found in the project area. The Bay of Bengal and Buriswar-Payra River are the major waterbodies in the study area. Existing physical features around the project site of the proposed power plant have been presented in Figure 6-4.

Figure 6-4: Physical Features Around the Project Site



Source: Physical Feature Survey by EQMS, 2018

CHAPTER SEVEN: DESCRIPTION OF ENVIRONMENT

7. Baseline Environmental Condition

7.1 Introduction

The technical details of the proposed 1x350 MW supercritical coal-based thermal power project have been described in the Chapter-3 and Chapter-4. In order to assess environmental and social impacts due to the proposed project, it is essential to monitor the appropriate environmental and social quality prevailing at the project site and its surrounding areas prior to implementation of the project. This chapter outlines the existing environmental and social baseline setting of the project site and its influence area (10 km radius from the site).

The parameters of environmental and social impact can be identified by elaborating the various aspects of environment, which can be divided as: (i) Physical aspects which include topography, physiography, geology, soil, hydrology and drainage, agro-ecology and bio-ecology etc.; (ii) Meteorological aspects which includes the micro-climatic factors; (iii) Environmental Quality aspect which includes air, surface water, groundwater, noise, soil, sediment test to evaluate the existing condition; (iv) Biological aspect including the type of flora and fauna, phytoplankton, zooplankton and benthos; (v) Hazards and vulnerability aspects relating to the seismicity, cyclone, tidal surges, flood, bank erosion, drought, tornadoes, landslides etc.; and lastly (vi) socio-economic aspects relating to demographic and socio-economic conditions of the population inside and around the project site.

7.2 Study Area, Period, Component and Methodology

7.2.1 Study Area and Period

For baseline data collection, an area covering 10 km radius from the proposed project boundary has been considered as per the guideline of the approved ToR by the DoE, Bangladesh. The baseline data was collected through detailed field investigations and the collection of available secondary data, review of existing documents/publications pertaining to the study area. Baseline data of prominent environmental and social attributes like meteorology, ambient air, surface water, ground water, noise, soil, sediment, geology, land use, hydrology, socio-economic features, terrestrial ecology, aquatic ecology etc. was collected. The baseline study for the project was conducted during the pre-monsoon season (March to May 2018) and monsoon season (June to September 2018).

7.2.2 Methodology

For collecting the baseline data (primary and secondary) during the study period, the following methodology was adopted for data collection:

- Sampling of ambient air quality, ambient noise level, surface water, groundwater, soil, sediment, phytoplankton, zooplankton, benthos and other field data collection were carried out by the EQMS team.
- Meteorological data such as temperature, rainfall, wind speed and direction, humidity for a long-term basis (1987 to 2016) of the Khepupara weather station was obtained from BMD.
- In order to assess the Ambient Air Quality, total sixteen samples of ambient air were collected considering two seasons (pre-monsoon and monsoon) at four different locations from the study area (project site, villages around site at various upwind, downwind and crosswind directions) during the EIA study period and analyzed for primary air pollutants to work out the existing status of air quality.
- Surface water samples (4 samples) were collected from Buriswar-Payra River and available local surface water body like pond and canal. The samples were analyzed for parameters necessary to determine water quality and those, which are relevant from the point of view of the environmental impact of the proposed thermal power plant.
- Groundwater samples (4 samples) were collected during the study period from existing tube-wells. The samples were analyzed for parameters necessary to determine water quality and those, which are relevant from the point of view of the environmental impact of the proposed thermal power plant.

- Soil samples (2 locations) were collected and analyzed for relevant physical and chemical characteristics in order to assess the impact of the proposed project on the soil.
- Sediment samples (2 locations) were collected and analyzed for relevant physical and chemical characteristics in order to assess the impact of the proposed project on the sediment.
- The ambient noise level measurements were made at eight (8) locations in 24 hours duration with the help of sound level meter in the study area to establish the baseline noise levels in the impact zone.
- Phytoplankton, zooplankton and benthos samples were collected from two (2) locations.
- Socio-economic data were collected from Questionnaire survey in the field and secondary sources like Housing and Population Census of Bangladesh 2011.
- Inventory of flora and fauna species was made by a team of ecologist during the site visit in March and September 2018 and collected data from secondary sources.

7.3 Coal availability, including distance to “mine mouth”, the non-sterilisation coal reserves and the feasibility of distance between station and coal

The details of coal specification, availability and transportation have been depicted in section 3.9 and 3.10 (Chapter-3) in this EIA report.

7.4 Water Availability

The water requirement and availability of water in the Buriswar-Payra has been depicted in section 4.6 (Chapter-4) in this EIA report.

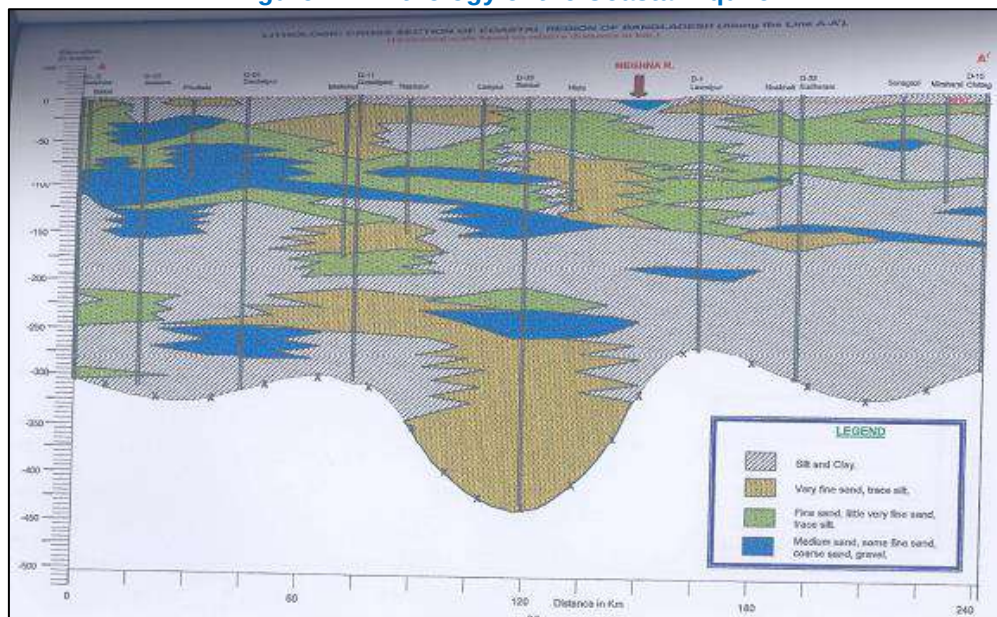
7.5 Sorbent Availability

These data will be provided during the detailed design stage of the power plant.

7.6 Hydrogeology

In the coastal areas of the Bengal Delta, hydrogeology as well as distribution of the type of aquifer sediments in the subsurface is very complex (BWDB, 2013; Zahid et Al. 2014). Considering the groundwater investigation and hydro-geological studies so far done by different agencies, the aquifer system of coastal area may be categorized into four different major aquifer systems. The depths of these aquifer systems are variable to sediment deposits and general topography. The lithology of the coastal aquifer has been shown in the following Figure 7-1.

Figure 7-1: Lithology of the Coastal Aquifer



Further, the main hydro-geological characteristics of the aquifers of the south region, as described by different units, are as follows:

Upper clay and silt: This unit is characterized by high porosity but low permeability. Due to its extensive thickness in parts of the area it effectively precludes major groundwater development because it is unable to support tube wells itself and makes the lower aquifers too deep to be economically exploited on a large scale for irrigation. In most parts of the area, its main importance is the extent to which it controls downward percolation to the deeper units below.

Composite Aquifer: This unit is characterized by high porosity and moderate permeability. Where it is shallow enough to be exploited is capable of providing water to HTW and Manually Operated Shallow tube well for irrigation (MOSTI).

Main Aquifer: This main aquifer is characterized by high porosity and moderate to high permeability. Where it is accessible, it is an important aquifer, which provides large quantities of water to DTW and STW/DSSTW.

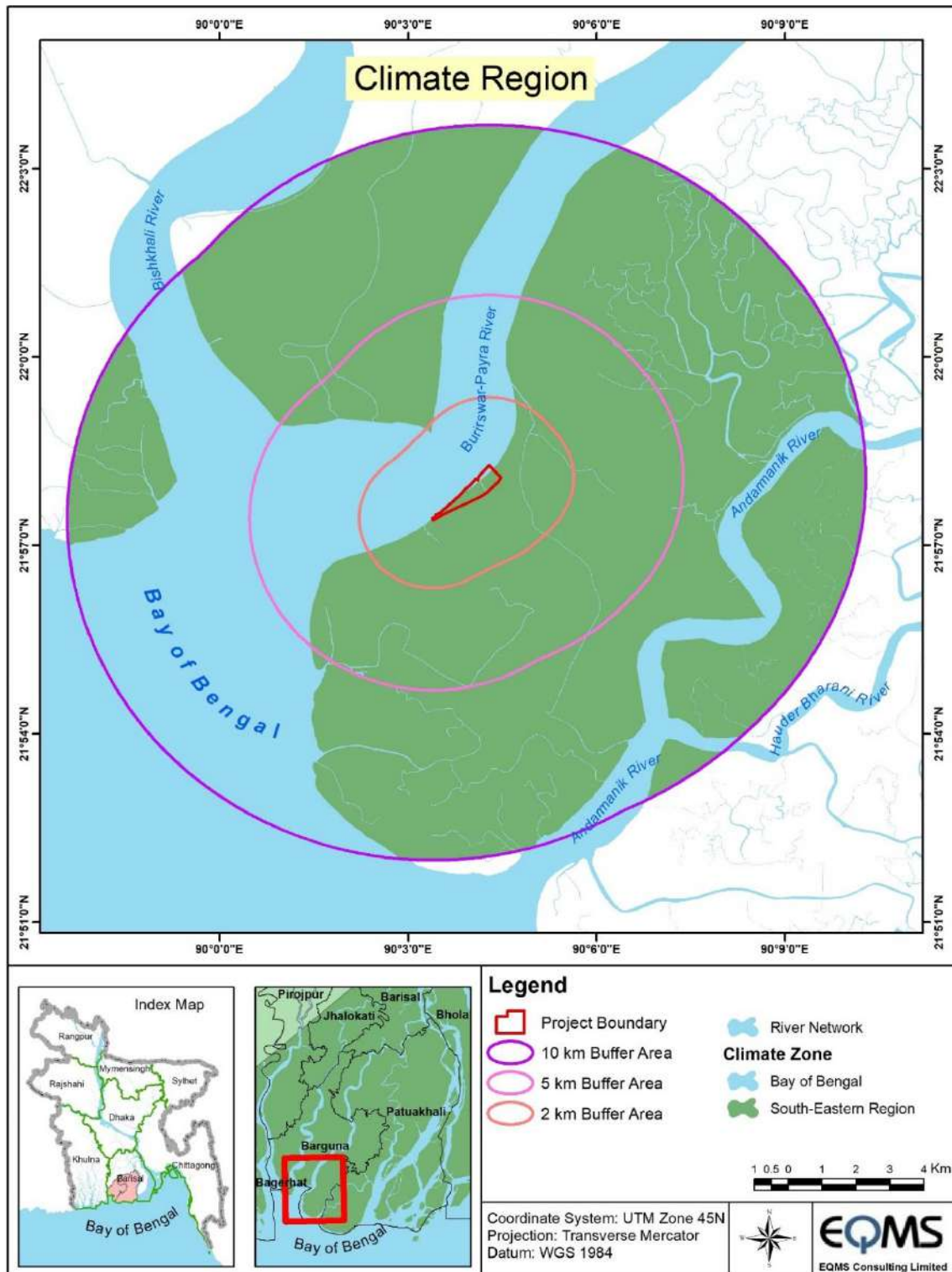
7.7 Meteorology

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass (Rashid, 1991). Brammer (1996) has identified four distinct seasons resulting from this weather pattern, namely:

1. **Pre-Monsoon Hot Season (March to May):** Characterized by the highest temperatures of the year – up to 36°C. Some rainfall may occur, with tropical cyclones occasionally affecting coastal areas;
2. **Rainy Monsoon Season (June to September):** Period of highest rainfall (up to 80% of the annual rainfall), humidity and cloud cover. Increased rain and cloud cover generally causes a small reduction in mean daily temperatures;
3. **Post-Monsoon Season (October to November):** Temperature remains hot and humid, though cloud cover decreases in this season. Limited tropical thunderstorms may still, particularly in coastal areas; and
4. **Cool Dry Winter Season (from December to February):** Coolest time of the year with mean minimum temperatures falling below 10°C in some areas. Reduced humidity and cloud cover. Rainfall is scarce.

Despite the general predictability of the seasons in Bangladesh, local conditions may still vary widely across the country. As such, Bangladesh can be divided into seven climatic sub-zones based on differences in a range of factors including rainfall, temperature, evapotranspiration and local seasonality (Rashid, 1991). According to the climatic sub-regions of Bangladesh, the proposed project area is located in the South-Eastern Region (Figure 7-2). The climatic data for the study area was obtained from the Bangladesh Meteorological Department (BMD).

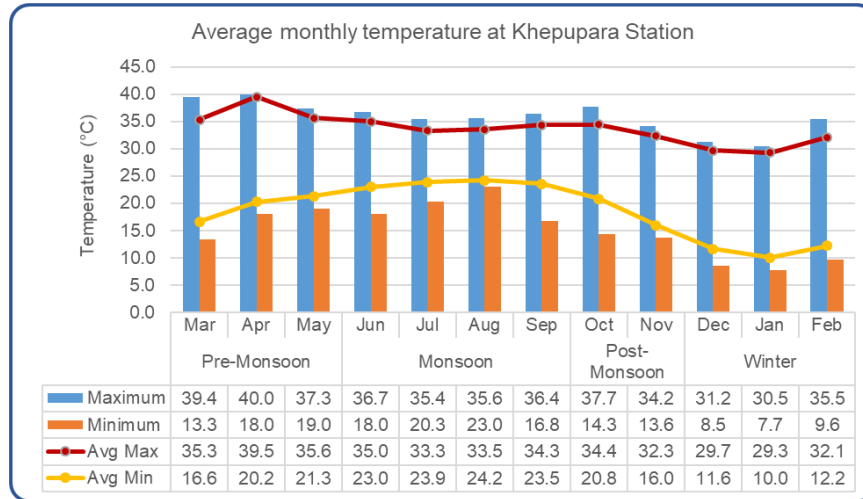
Figure 7-2: Climatic Sub-regions of Bangladesh



Source: EQMS, 2018

7.7.1 Temperature

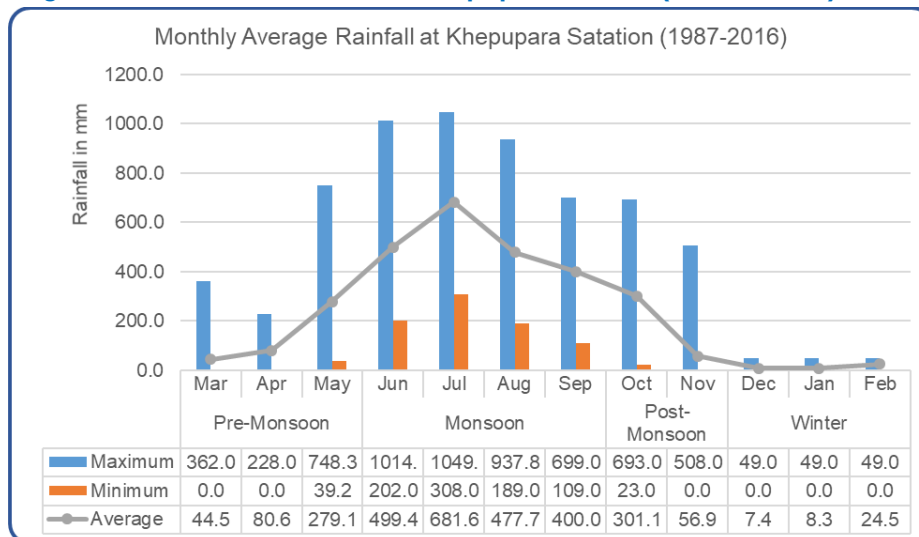
The variation of maximum, minimum and average temperature recorded at the Khepupara weather station is shown below in Figure 7-3. The data analysis of 30 years (1987-2016) shows that monthly maximum temperature varies from 30.5°C to 40°C whereas the monthly minimum temperature varies from 7.7°C to 23.0°C. The lowest average temperature recorded in the past 30 years was in January 2013 (7.7°C). The highest temperature reached 40°C in April 2014. Throughout the year, the highest temperatures are generally in March through October and the lowest temperatures are from December to January (Figure 7-3).

Figure 7-3: Temperature variation at Khepupara Station (1986 to 2016)

Source: Bangladesh Meteorological Department (BMD)

7.7.2 Rainfall

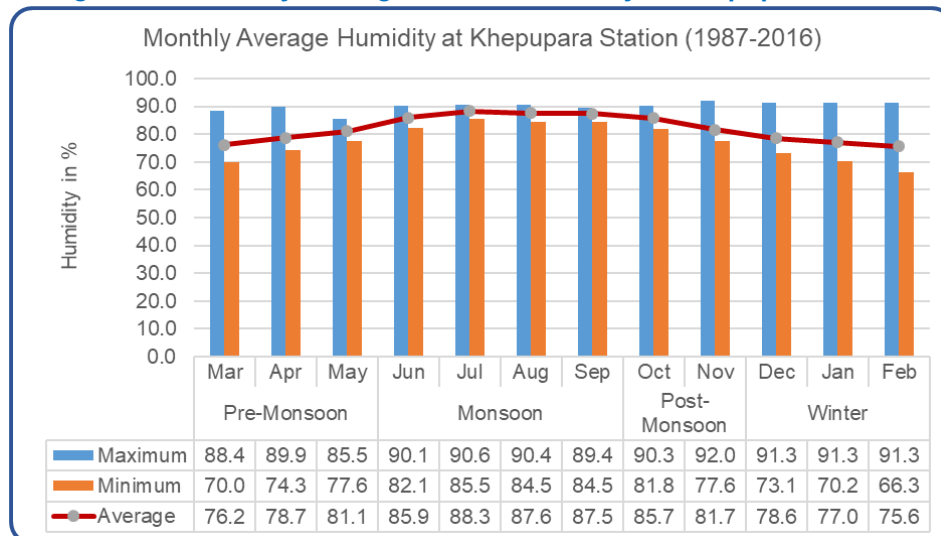
About 80% of the rainfall occurs over six months (May to October) with June to August getting the maximum rainfall. Minimum rainfall is reported during the months of December to February whereas average showering does occur in March, April and November. The last 30 years data of the Khepupara meteorological station shows that the annual average of total rainfall is recorded as 2861.0 mm/year. According to the analysis of the historical data, the highest annual total rainfall is recorded as 3510 mm in 1995 and the lowest annual total rainfall is recorded as 1874.4 mm in 2014. The peak one day highest rainfall is 373 mm recorded in July 1995. The variation of monthly maximum, minimum and average rainfall of the last 30 years (1987-2016) of Khepupara weather station is shown in following Figure 7-4.

Figure 7-4: Rainfall variation at Khepupara Station (1987 to 2016) in mm

Source: Bangladesh Meteorological Department (BMD)

7.7.3 Humidity

Due to the heavy rainfall and proximity to Bay of Bengal, the humidity levels in the proposed project area remains high. Humidity is also responsible for the fluctuation of temperature in the region. The monthly average relative humidity varies from 75.6% to 88.3% in the project area. Humidity remains high in monsoon (June to September) and post-monsoon (October and November) season and comparatively low in winter (December to February) season. Relative humidity in the project area is generally above 80% during June to December. The month of February is the driest with the relative humidity around 75%. The monthly maximum, minimum and average humidity of the last 30 years (1987-2016) of Khepupara weather station is shown in Figure 7-5.

Figure 7-5: Monthly Average Relative Humidity at Khepupara Station

Source: Bangladesh Meteorological Department (BMD)

7.7.4 Wind Speed and Direction

The tropic of Cancer passes through the central part of Bangladesh and therefore the southern-eastern zone has fallen under the tropical atmosphere. Mainly the climate of Bangladesh is directed by monsoon wind, which possesses reverse direction in specific seasons. The study area is prejudiced by the interaction of sea breeze; it has low topography similar to the sea level. Wind flow and directions are very important for the oceanic tides, waves, currents and atmospheric status.

Wind direction and speed exhibits seasonal variation. Winds are generally moderate during non-monsoon season whereas during the monsoon season, these are moderate to strong. The average wind speed in the project area is 2.72 m/s. Predominant wind speed varies from 1.50-3.50 m/s which is almost 60.1% of the year.

The annual wind rose shows that the predominant wind direction to be SSE to NNW. During pre-monsoon (March-May) the predominant wind direction is north to south and during monsoon season (June-September) it is SSE to NNW whereas during the post-monsoon (October-November) predominant wind direction is www to ESE direction and during the winter season (December-February) it is NNE to SSW. Annual wind rose diagram of the proposed project site is shown in Figure 7-6, monthly wind rose plot is shown in Figure 7-7 and seasonal wind roses are shown in Figure 7-8.

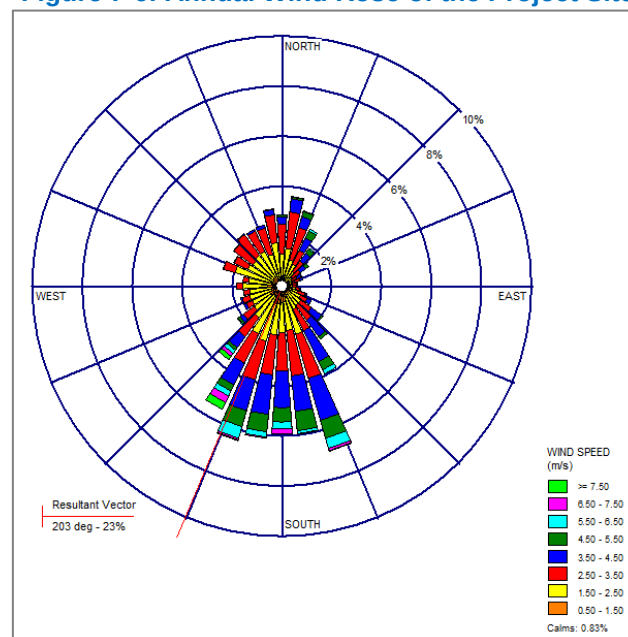
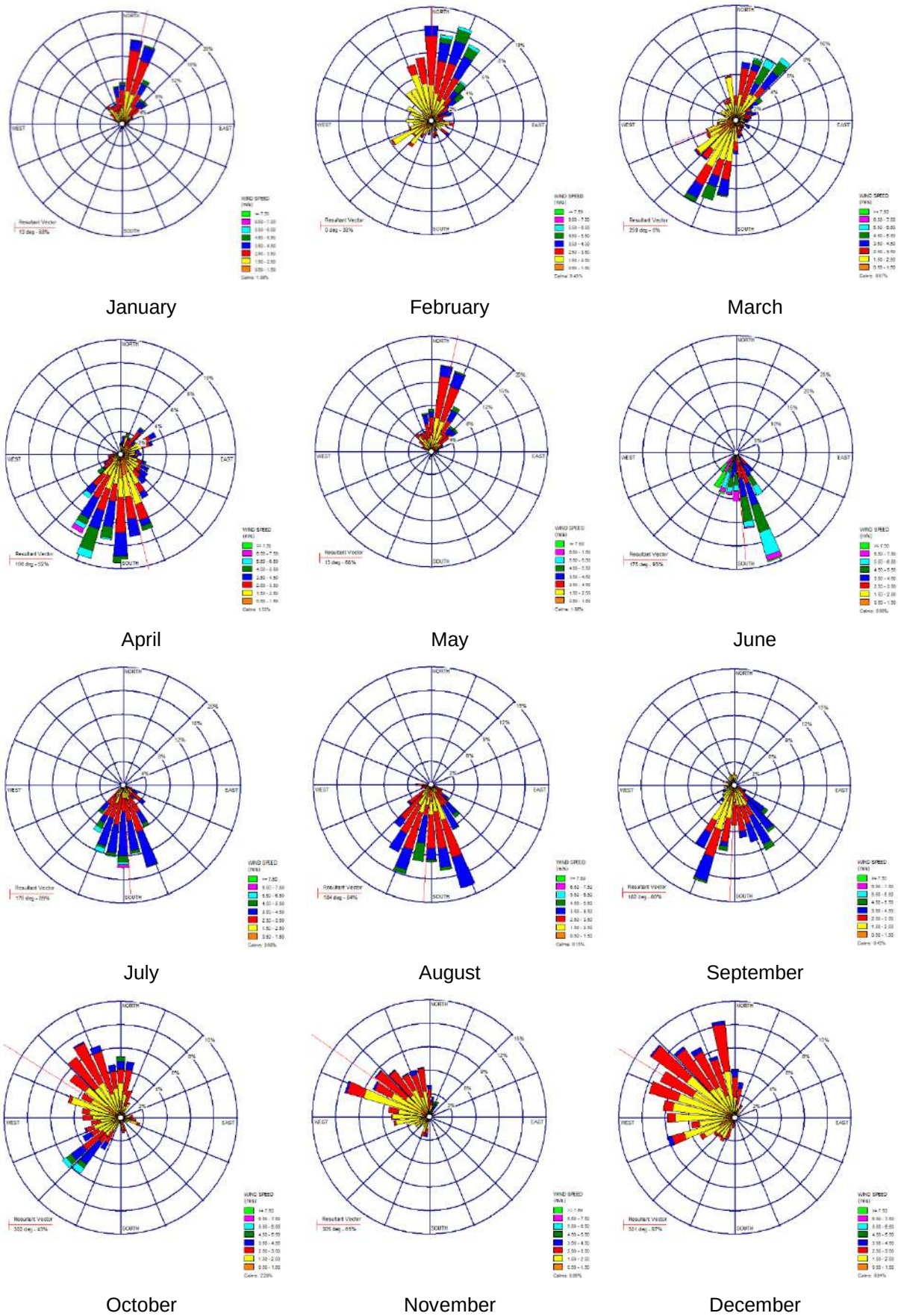
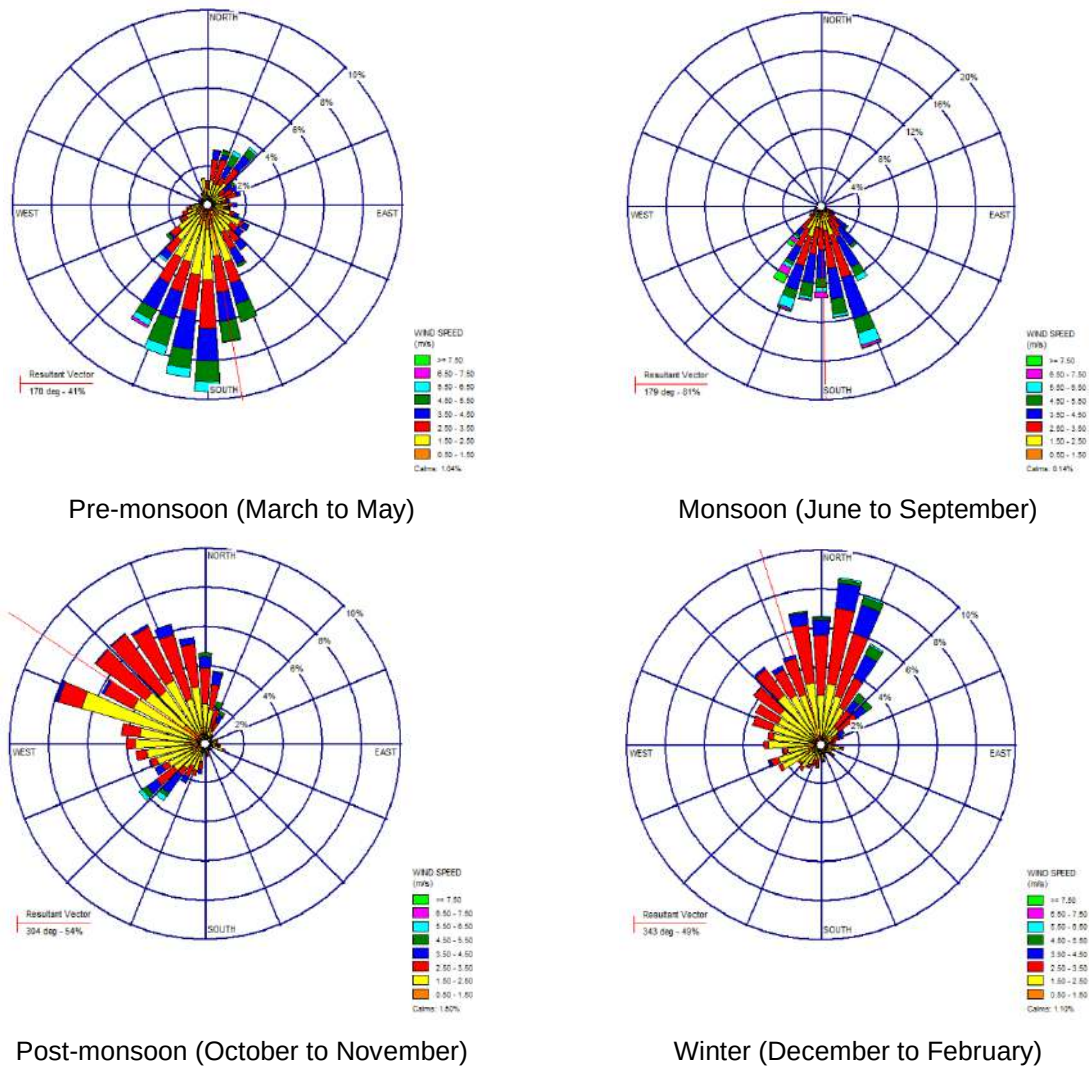
Figure 7-6: Annual Wind Rose of the Project Site

Figure 7-7: Monthly Wind Rose Diagram of the Project Site



Source: Bangladesh Meteorological Department (BMD)

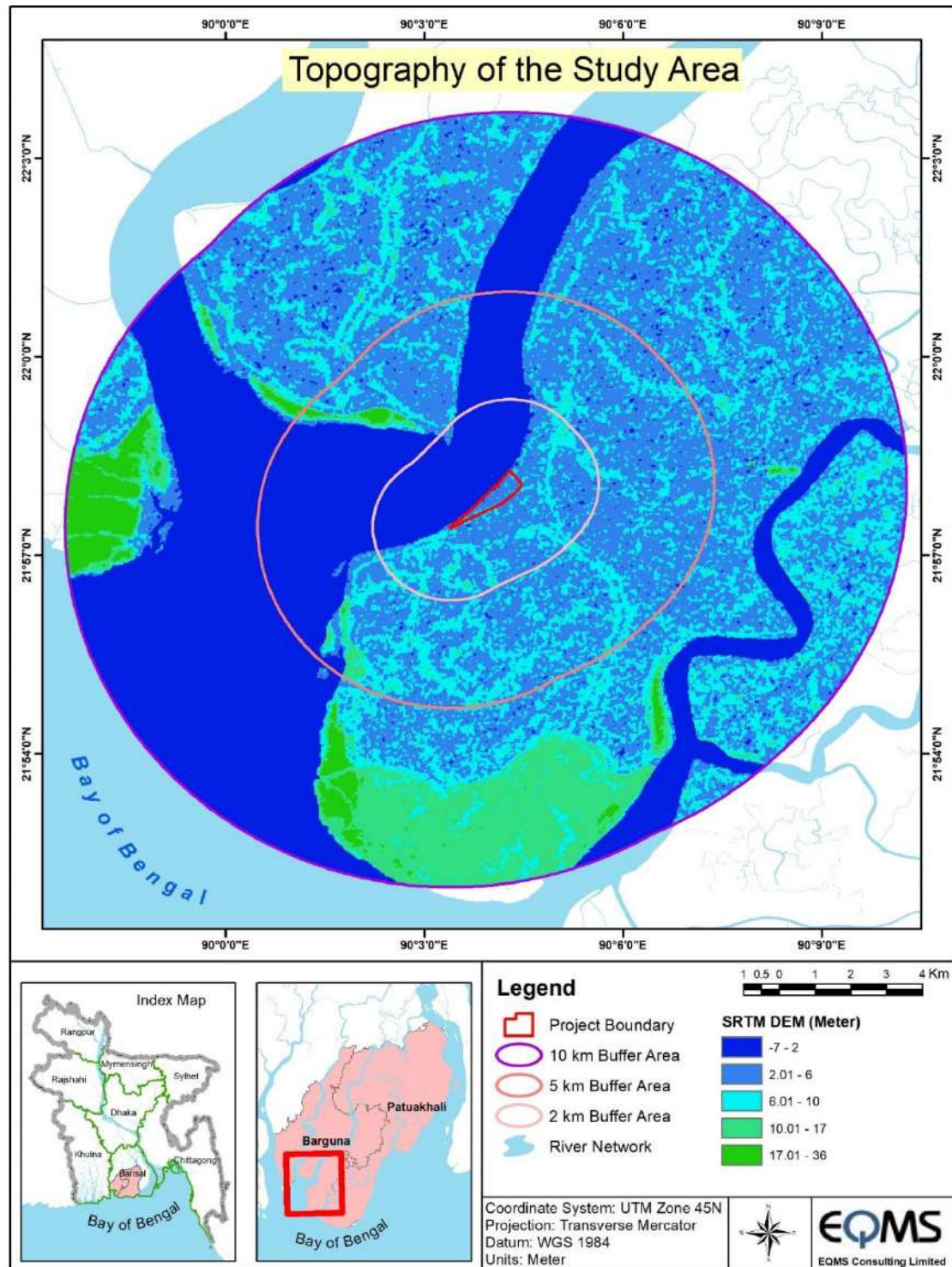
Figure 7-8: Seasonal Wind Rose Diagram of the Project Site

7.8 Topography

The terrain of the proposed study area is fairly flat gently sloping from west to east. According to the feasibility report, the proposed project site is on the wide and open terrain with an average elevation of 0~3.41m (based on Mean Sea Level). There have some ponds and depressed area inside of the project boundary. No hilly area has been found inside of the project site and its surroundings. The project is located on the bank of the Buriswar-Payra River on the west side, which is flowing from north to south and fall into the Bay of Bengal. The southern periphery of the study area is marked by the coastline of the Bay of Bengal. The nearest seaport is the Payra seaport, which is approximately 25 km (east) away from the project site.

Based on statistics from 1983 to 2012, the Buriswar-Payra River highest flood level was about 3.48m (in 2009); the tide level once-in-200a, the tide level once-in-100a and the wave height once-in-a-century is respectively 4.86m, 4.43m and 6~7m (MSL) in the sea area of the plant site. The site has appropriate hydro-meteorological conditions for the plant construction, whereas, the ground height requires to be raised by landfilling. According to the BEPCL, the landfilling will be required an approximate amount of 3.2 million cubic meters. The topography of the study area is shown in following Figure 7-9.

Figure 7-9: Topography of the Study Area



Source: USGS Earth Explorer

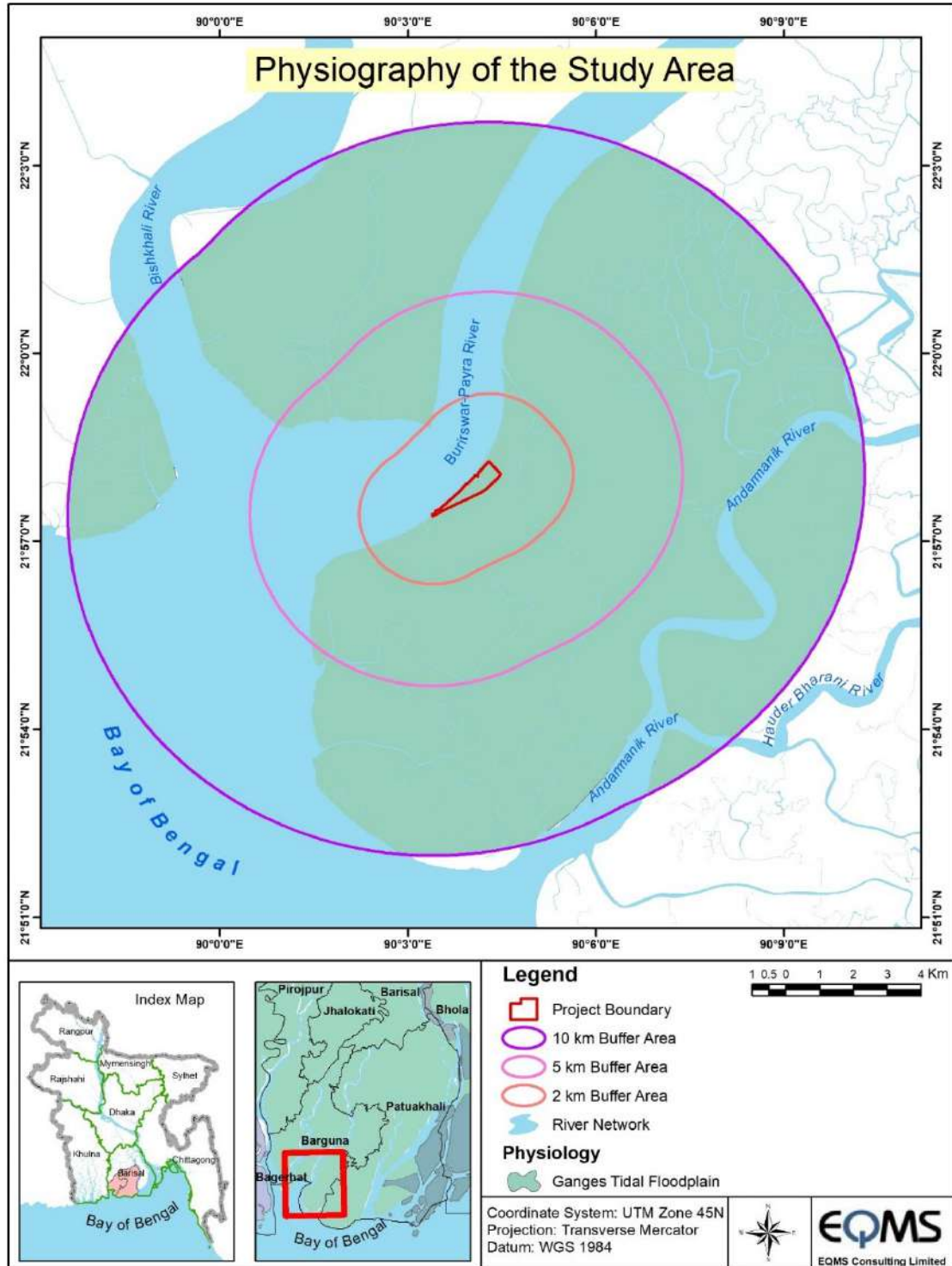
7.9 Physiography

According to the physiography of Bangladesh, the proposed project area falls under the physiographic unit of "Ganges Tidal Floodplain".

Ganges Tidal Floodplain: the area is criss-crossed by innumerable tidal rivers and creeks whose banks generally stand less than a meter above the adjoining basins. The whole of the area lies within the cyclone zone. Under natural conditions, this area flooded at high tide, either throughout the year or during the rainy season when review entering from the north brought in increased flows. The rivers are saline throughout the year in the west. The tidal sediments are predominantly non-calcareous silty clays. However, a narrow strip of slightly calcareous silts generally occupies riverbanks and

calcareous sediments occur more extensively in parts in the northeast of Barisal district. In the south and west, the tidal clays often overlie a buried humus topsoil or a peaty layer at 50-100 cm. the area is located within the cyclone zone. The frequency of cyclones is higher in the east than in the west. The south-eastern area is particularly exposed to damage by storm surges moving up the broad estuarine and tidal channels. The physiography map of the study area is presented in Figure 7-10.

Figure 7-10: Physiography Map of Bangladesh showing the Project Area



Source: SRDI, 1997; Rashid 1991, Reimann, 1933

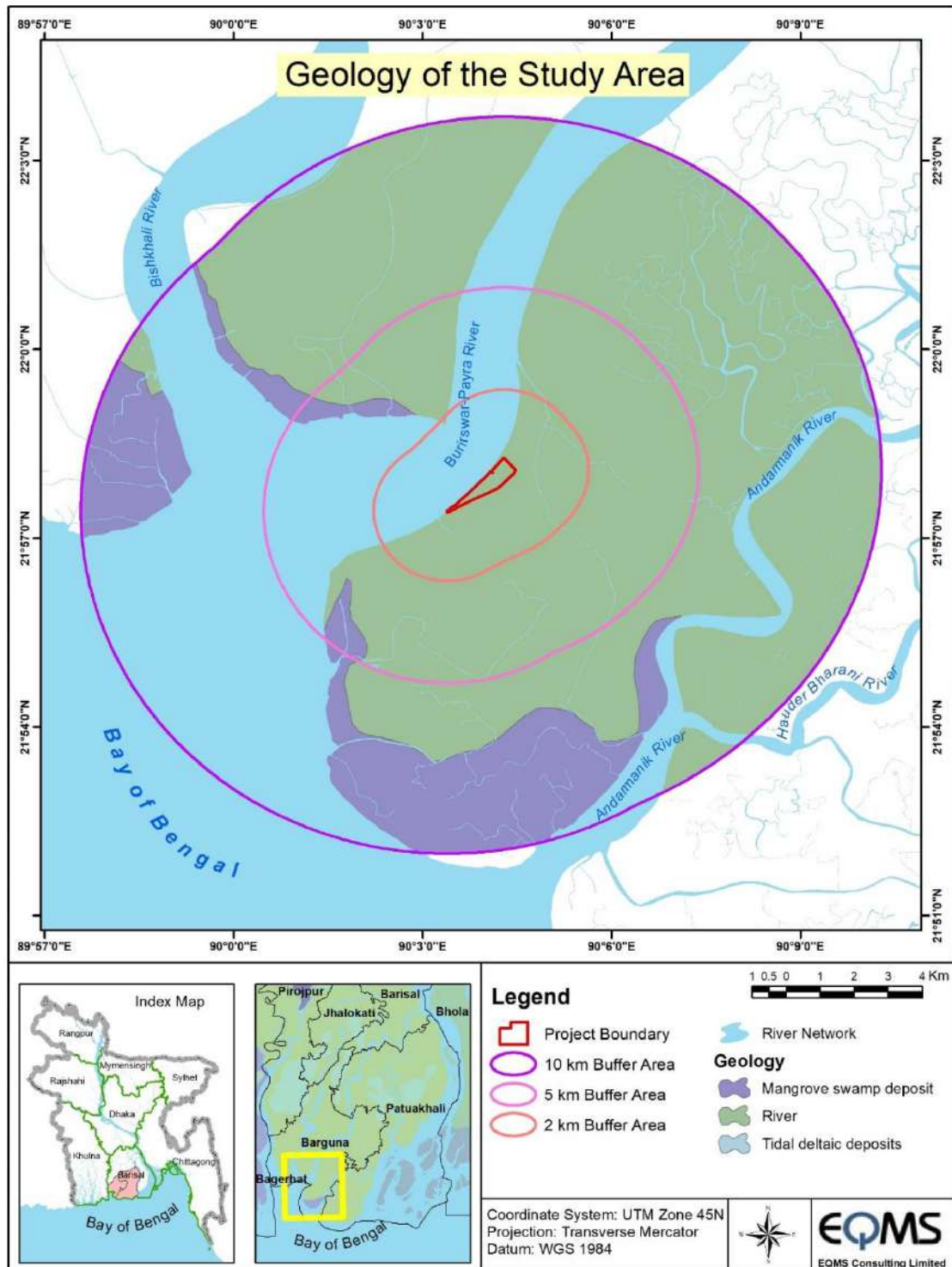
7.10 Geology

According to the Geological Survey of Bangladesh (GSB), the proposed project area falls in the two geological units “Tidal deltaic deposits and Mangrove swamp deposit”.

Tidal deltaic deposits: Tidal deltaic deposits light-to-greenish grey weathering to yellowish grey, silt to clayey silt with lenses of very fine to fine sand along active and abandoned stream channels, including crevasse splays. It contains some brackish water deposits. Numerous tidal creeks crisscross the area; large tracts are submerged during spring tides.

Mangrove swamp deposit: Dark grey to black silt and clay deposited in the active tidal zone, which is dominated by woody organic-rich, mangrove swamps. Areas between tidal channels covered with as much as 1m of brackish and covered by natural mangrove forest. Unit includes thin scattered deposits of beach sand at the seaward edge. The geological map of the study area is presented in following Figure 7-11.

Figure 7-11: Geology Map of Bangladesh showing the Project Area



Source: GSB, 1991

7.11 Soils

The SRDI has identified about 500 soil series in Bangladesh and FAO-UNDP has identified 21 different general soil types based on the diagnostic horizons and diagnostic properties of the soil (FAO-UNDP, 1998). The study area can be classified as “Non-calcareous Grey Floodplain Soils (Non-saline)”, which are described below:

Non-calcareous Grey Floodplain Soils (Non-saline): Generally, comprise a grey topsoil and a cambic B-horizon in the sub-soil 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. However, 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. The soil map of the study area is shown in following Figure 7-12.

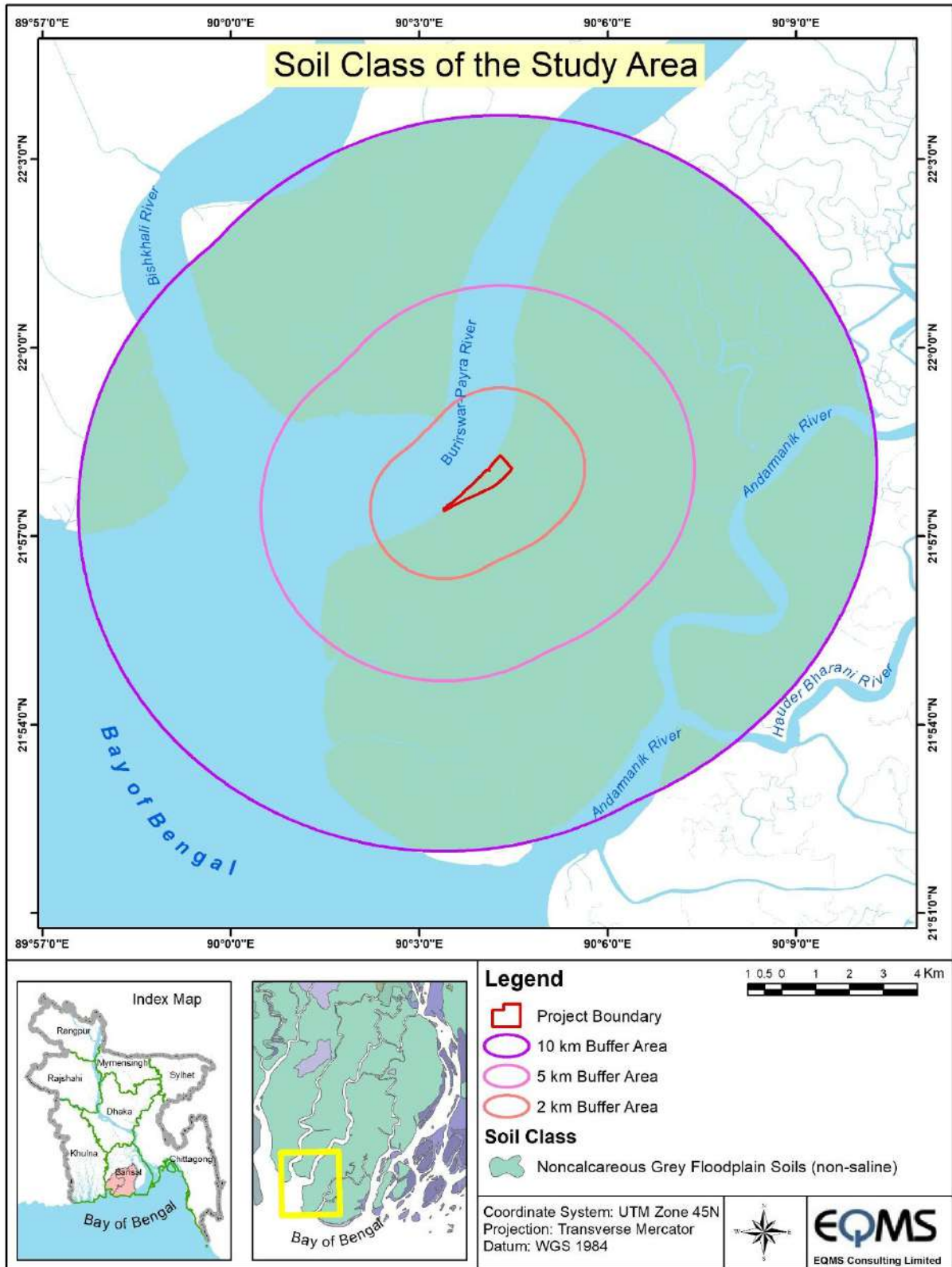
7.12 Hydrology and Drainage

The proposed plant site is located at the confluence of the Buriswar-Payra River, Bishkhali River and the Bay of Bengal. They flow into the same sea after confluence. Another important river in the study area is the Andarmanik River, which is located on south-west direction from the project site. All the rivers have the tidal river channel, of which the flow is obviously influenced by the rising and falling tides. In case of rising tide, the seawater flows into river channel and in case of falling tide, the river water flows into the sea, which cause the instability of river direction in the plant area. The plant site is situated on the concave bank of Buriswar-Payra River, which passes by the plant in the south and runs westwards, will be reliable water source for the proposed project.

7.12.1 Buriswar-Payra River

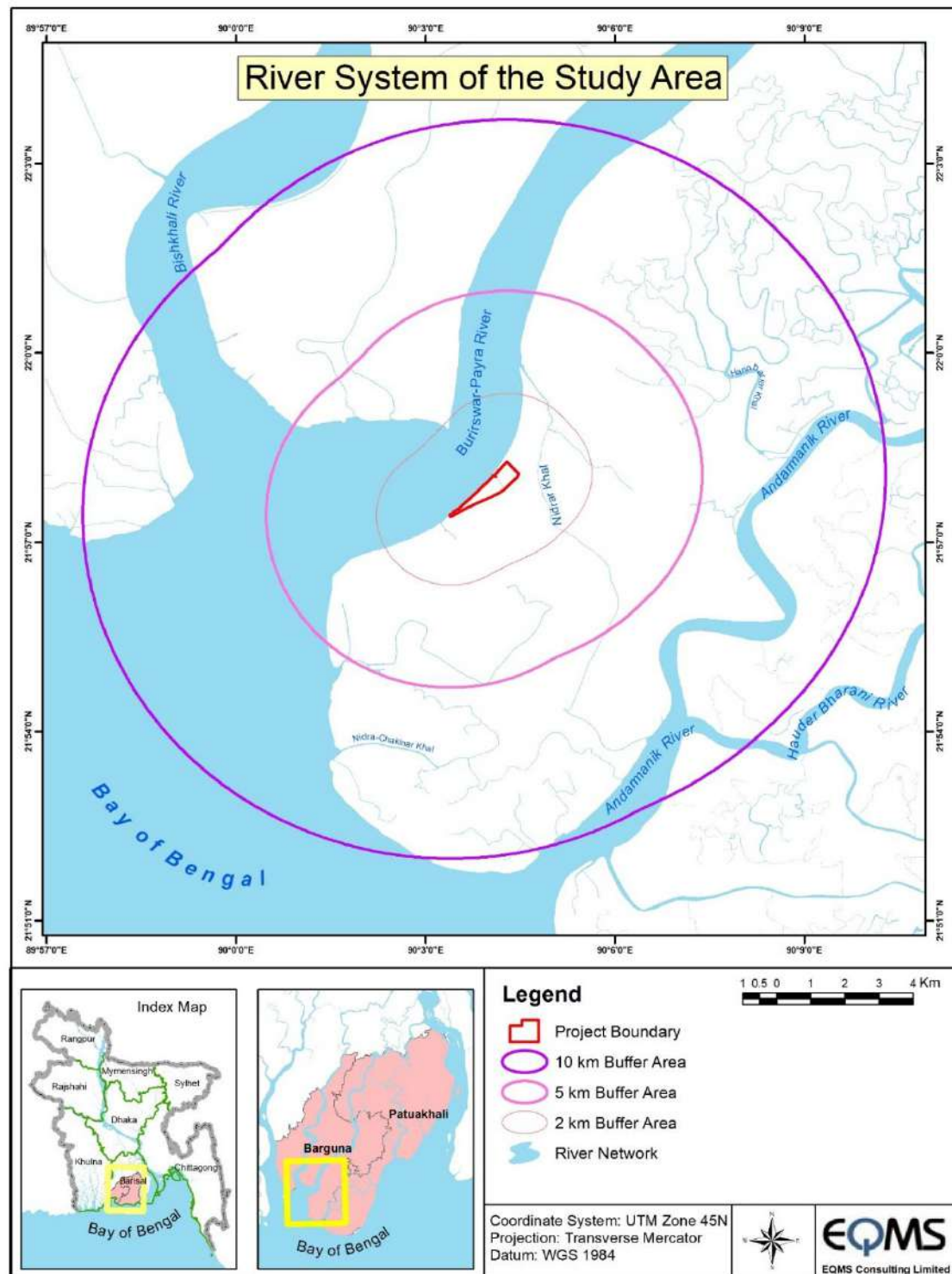
The Buriswar-Payra River originates from Pandab River in Kolskti Union of Bakerganj Upazila of Barisal district. It flowing down southwards by the side of Lebukhali meets the Patuakhali River (another flow from Patuakhali) just at the upstream of the ferry ghat and the combined flow moves further down as Payra River and crosses Amtoli Upazila of Barguna district. Its catchment area is reported to be 557 sq. km. The river is about 90km long. The river width at the ferry ghat is about 2 km and the river is a tidal one with a reported tidal variation of +/- 2m. Its recorded depth at Amtoli was 20m in monsoon (in August) and 12.5m in winter (in February). It moves further southwards and falls in the Bay of Bengal as Buriswar River. The normal direction of flow is from north to south. The river system of the study area is shown in following Figure 7-13.

Figure 7-12: Soil Map of the Study Area



Source: GSB, 1991

Figure 7-13: River System of the Study Area



Source: EQMS, 2018

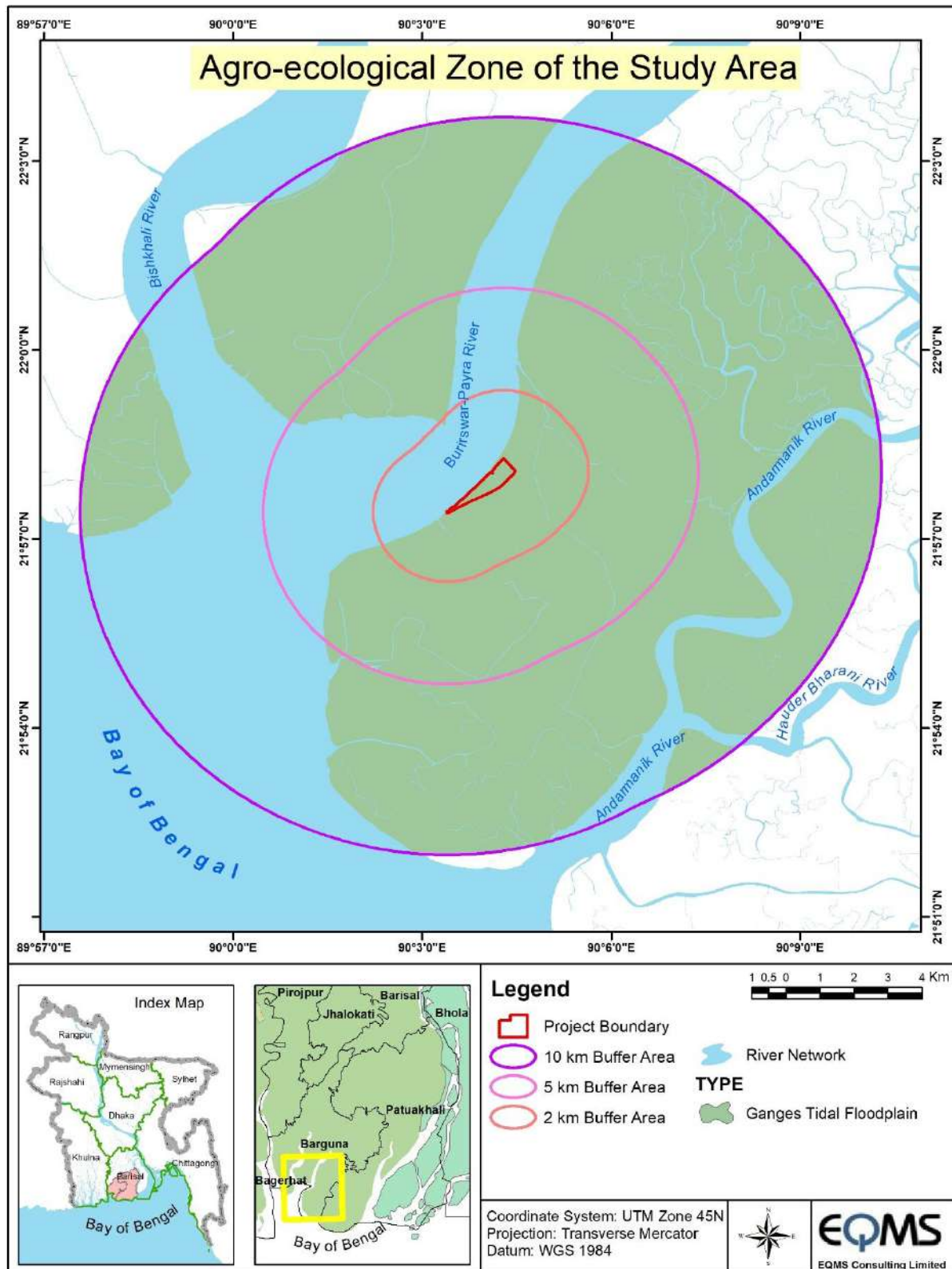
7.13 Agro-ecology

The major types of agro-ecological unit is reported from the study area is include “Ganges Tidal Floodplain” which have described below:

Ganges Tidal Floodplain: 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 topsoil's 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. The agro-ecology map of the proposed project area is given in Figure 7-14.

Figure 7-14: Agro-ecological Map of Bangladesh showing the Project Area

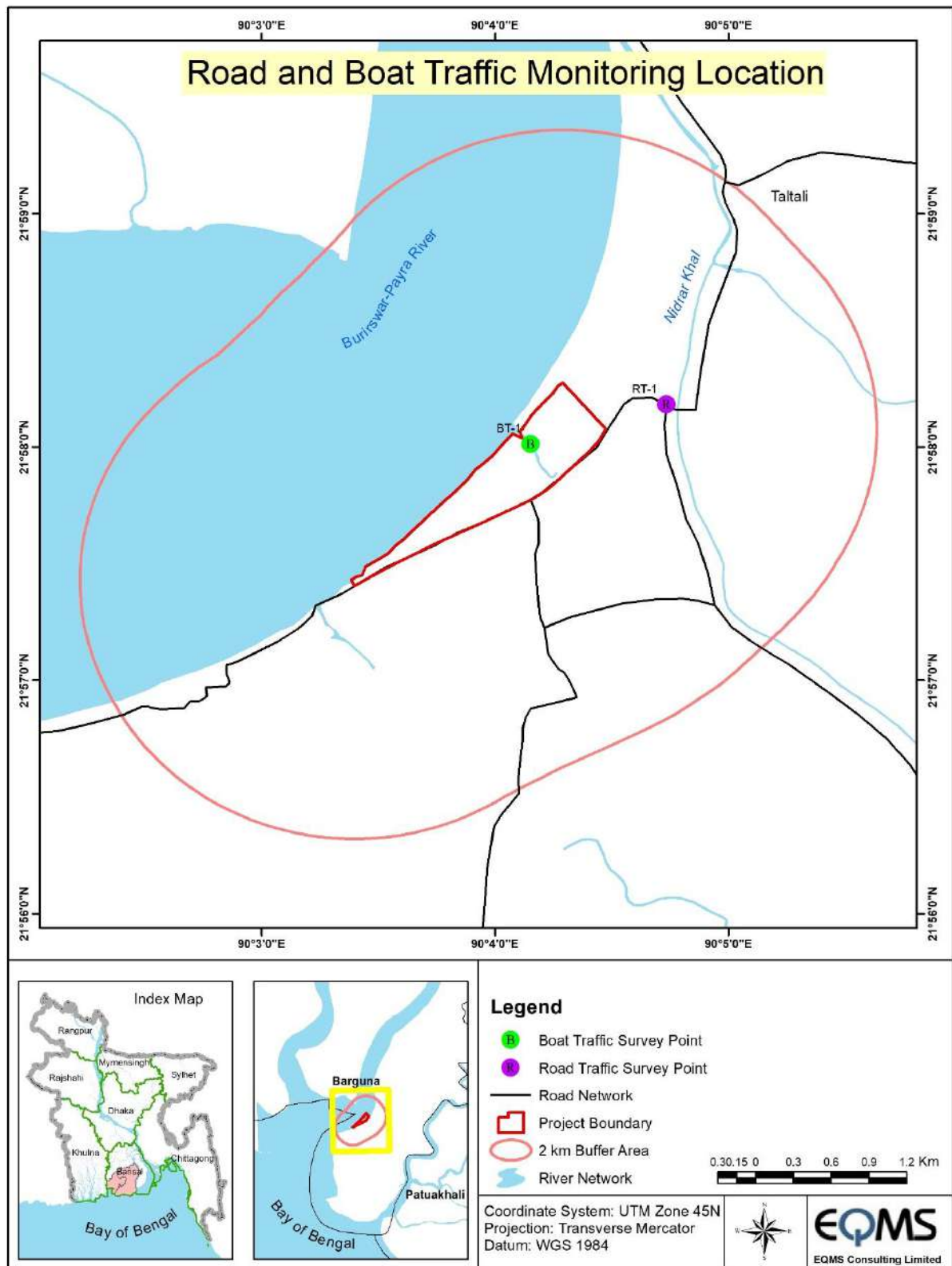


Source: BARC

7.14 Traffic

During the baseline data collection in the field, both the road traffic and boat traffic data were collected accordingly. The location of the traffic survey is shown in Figure 7-15.

Figure 7-15: Road and Boat Traffic Monitoring Locations



Source: Field Survey by EQMS Team, September 2018

7.14.1 Road Traffic

The road traffic monitoring was conducted continuously for 24 hours, one time during the study period at one location. The location was near the east corner of the proposed project boundary on Bridge Ghat (Taltoli Bazar side) to Joyalbhanga Bazar road. The road traffic monitoring was conducted for both way movement of vehicles and categorized as Truck Medium, Truck Small, Bus Heavy, Bus Light, Bus Mini, Utility, Car, Tempo, Auto Rick, Moto Cycle, Rickshaw/van, Animal Cart, Bicycle. The

road traffic monitoring was conducted during 16th to 17th September 2018. The details of the road traffic monitoring location is shown in following Table 7-1.

Table 7-1: Road Traffic Monitoring Location

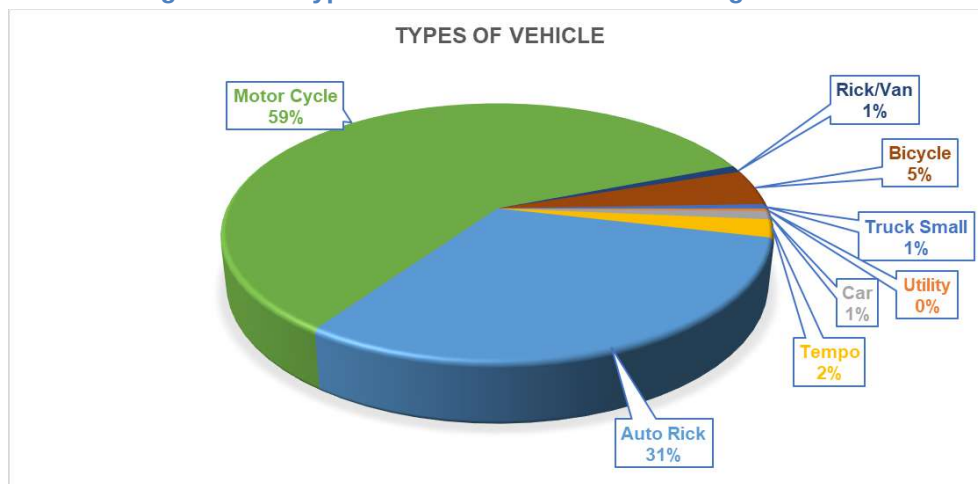
SL#	Code	Monitoring Locations	Date	Geographical Location
1	RT-1	Bridge Ghat (Taltoli Bazar side) to Joyalbhanga Bazar road	16/09/2018-17/09/2018	21°58'10.85"N 90° 4'44.11"E

Source: Field Survey by EQMS Team, September 2018

7.14.1.1 Status of Road Traffic

In the project approach road (Bridge Ghat to Joyalbhanga Bazar) total 1,028 numbers of vehicles were plying in 24 hours. Maximum traffic volume of 93 vehicles in an hour was recorded between 5-6 PM and during 6-7 AM minimum traffic was recorded (39 vehicles). However, no vehicles was recorded during after 9 PM to 6 AM due to the remote location and rural settings of the study area. Among the total counted vehicles motorcycle was 59%, auto rickshaw 31%, bicycle 5% and rest of them was rickshaw/van, small truck, utility, car and tempo. The types of vehicles that moves in the approach road is presented in Figure 7-16.

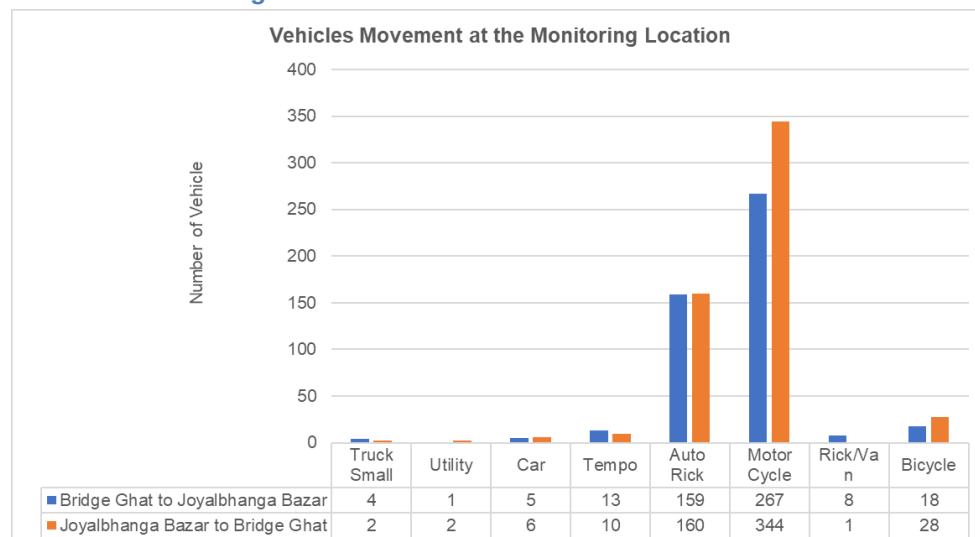
Figure 7-16: Types of Vehicles at the Monitoring Location



Source: Field Survey by EQMS Team, September 2018

A summary of traffic survey results at the monitoring location (both way movement) is presented in following Figure 7-17.

Figure 7-17: Number of Vehicles Movement



Source: Field Survey by EQMS Team, September 2018

7.14.2 Boat Traffic

The boat traffic survey was conducted continuously for 24 hours, one time during the study period at one location. The boat traffic monitoring location was the meeting point of the canal and Buriswar-Payra River. The boat traffic survey was done for both way movement of vessels in the canal and categorized as fishing boat (motorized), trawler (people and goods carrying), cargo (medium) and fishing boat (non-motorized). The boat survey was conducted during 16th to 17th September 2018. The details of the boat traffic monitoring location is shown in following Table 7-2.

Table 7-2: Boat Traffic Monitoring Location

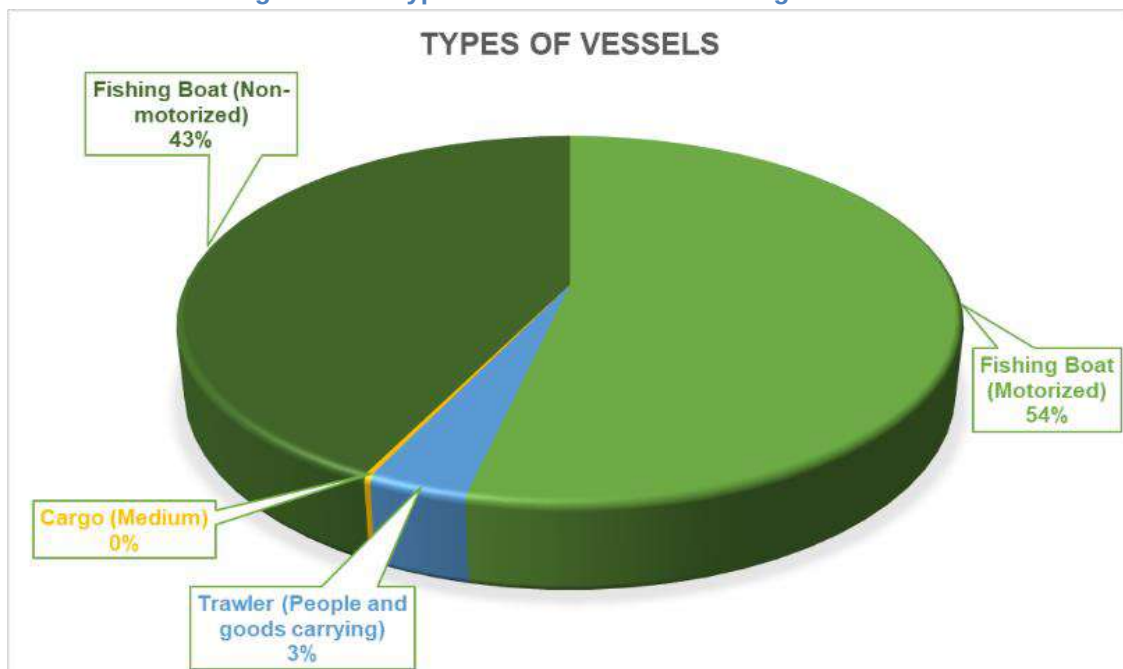
SL#	Code	Monitoring Locations	Date	Geographical Location
1	BT-1	Meeting point of the canal and Buriswar-Payra River	16/09/2018- 17/09/2018	21°58'0.72"N 90° 4'9.15"E

Source: Field Survey by EQMS Team, September 2018

7.14.2.1 Status of Boat Traffic

Total number of vessels recorded at the monitoring location was 420 numbers. At project site maximum vessels count of 93 nos. in an hour was recorded during 4-5 AM and minimum vessels count of 2 nos. was recorded during 8-9 AM. During the field survey, same boat was counted for several times due to their movement in the canal. In addition, discussions with the local community inform that numbers of boat movement depends on the high tide, low tide, fishing time and season in the river and sea. The number also increase during the emergency (Cyclone) as the boats take shelter in the canal to protect them from the cyclone. Among the total counted vessels, fishing boat (motorized) was 54%, fishing boat (non-mechanized) 43%, trawler (people and goods carrying) 3% and rest of them was cargo (medium). The frequency of vessels according to the types is presented in Figure 7-18.

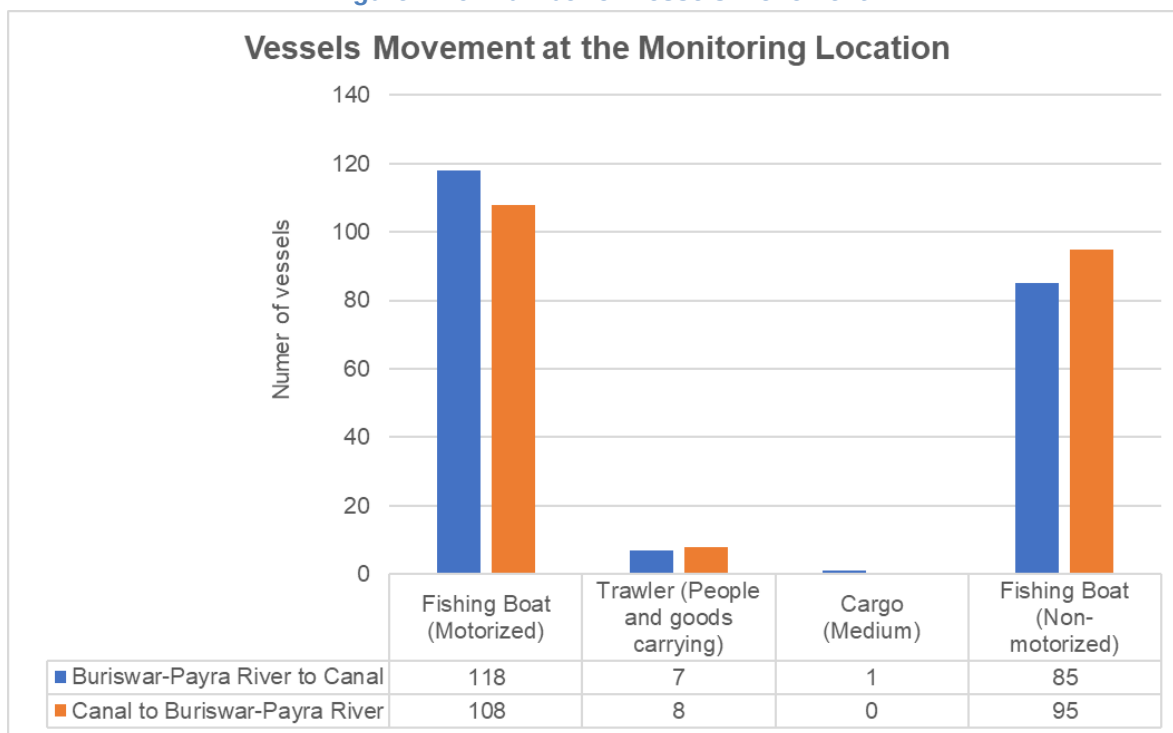
Figure 7-18: Types of Boat at the Monitoring Location



Source: Field Survey by EQMS Team, September 2018

A summary of boat survey results at the monitoring location (both way movement) is presented in following Figure 7-19.

Figure 7-19: Number of Vessels Movement



Source: Field Survey by EQMS Team, September 2018

7.15 Environmental Quality

7.15.1 Ambient Air Quality

The ambient air quality with respect to the study zone of 10 km radius around the proposed power plant project area forms the baseline information. The area is a rural and the major source of air pollution in the region is road dust, windblown dust, domestic heating and cooking, black smoke from diesel engine, exhaust emission from the moving vehicles and emissions from the water vessels moves in the Buriswar-Payra River and canal. The prime objective of the baseline air quality study was to assess the existing air quality of the area. This will also be useful for assessing the conformity to standards of the ambient air quality during the power plant operations. The study area represents mostly residential, waterbodies and agricultural lands environment. This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling.

7.15.1.1 Methodology Adopted for Air Quality Survey

Selection of Sampling Locations:

The baseline status of the ambient air quality has been assessed through a scientifically designed ambient air quality monitoring network. The design of monitoring network in the air quality surveillance program has been based on the following considerations:

- AAQ monitoring at project site;
- Meteorological conditions of the area based on information of BMD observatory at Khepupara;
- Topography of the study area; and
- Location of sensitive receptors such as major settlements.

Ambient Air Quality Monitoring stations were set up at four locations with due consideration to the above mentioned points. Logistical factors such as consent of villagers, mainly the house owners, power connection, accessibility, security, etc. were also taken into account in finalizing the monitoring stations. The particulate and gaseous samples collected during the monitoring have been analyzed as per the procedures specified in Table 7-3. Details of the monitoring locations are presented in Table

7-4 and map of the air monitoring locations are shown in Figure 7-20. The photographs of ambient air monitoring are presented in Figure 7-21.

Frequency and Parameters for Sampling:

Ambient Air quality monitoring was carried out at four locations (two seasons monitoring) within the study area during pre-monsoon and monsoon season. The baseline data of air environment was monitored for parameters mentioned below:

- Particulate Matter (SPM, PM₁₀ and PM_{2.5});
- Sulphur Dioxide (SO₂);
- Oxides of Nitrogen (NO_x); and
- Carbon Monoxide (CO).

Table 7-3: Methodology for Analysis of Ambient Air Quality

Parameter	Analysis Procedure
SPM	Gravimetric method
PM ₁₀	Gravimetric method
PM _{2.5}	Gravimetric method
SO ₂	Colorimetric method at 560 nm using spectrophotometer (West-Gaeke method)
NO _x	Colorimetric method at 540 nm using spectrophotometer (Jacob and Hochheiser method)
CO	Digital CO meter

Table 7-4: Ambient Air Quality Monitoring Locations

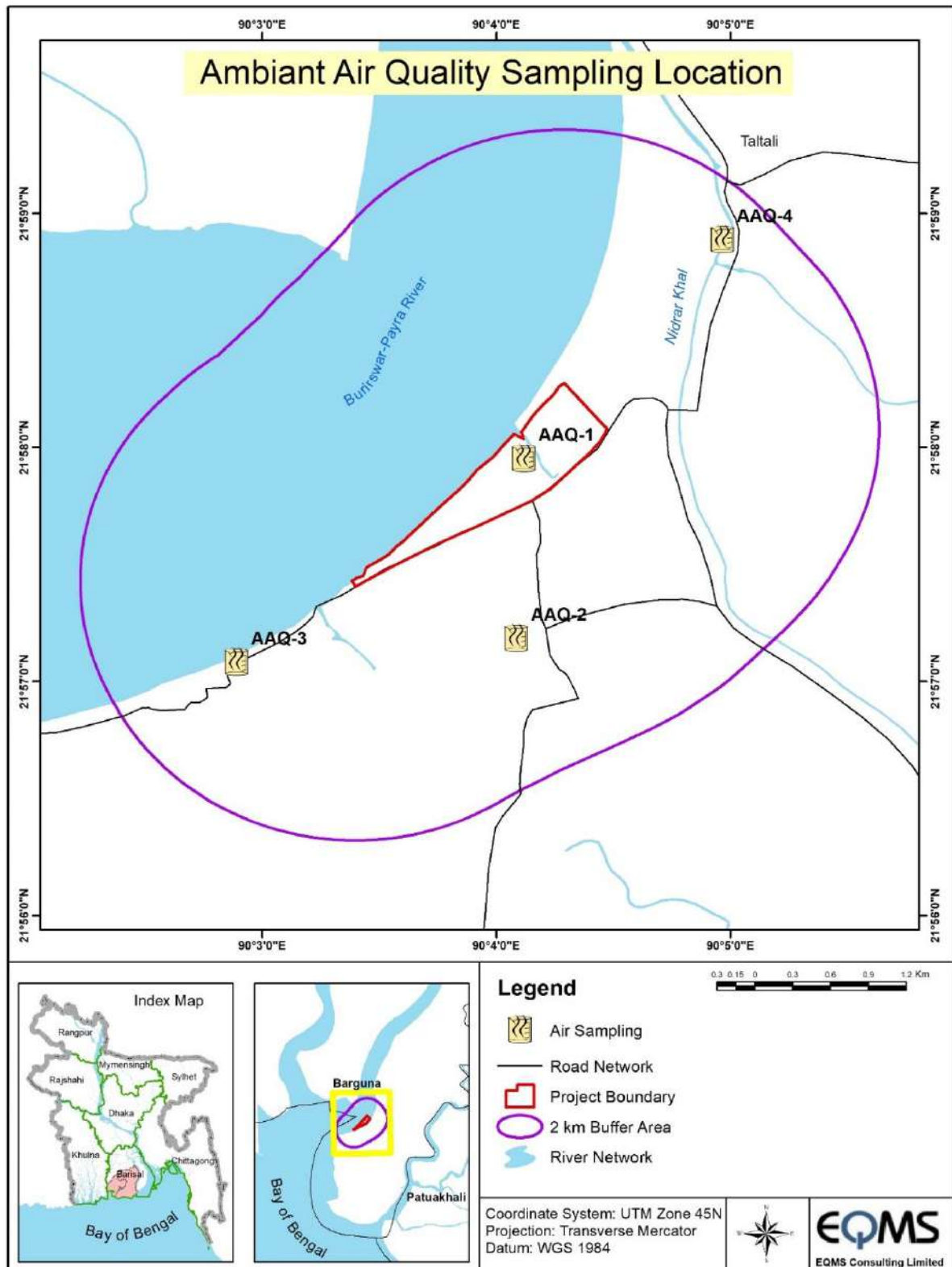
Station Code	Sampling Locations	Monitoring Date	Geographical Location	Direction
AAQ-1	Project Site	15/04/2018, 23/04/2018, 13/09/2018 and 21/09/2018	21°57'37.30"N 90° 3'47.44"E	Project site
AAQ-2	Choto Ankujan Para	16/04/2018, 24/04/2018, 14/09/2018 and 22/09/2018	21°57'11.30"N 90° 4'5.12"E	Upwind
AAQ-3	Near Joyalbhanga Bazar	17/04/2018, 25/04/2018, 15/09/2018 and 23/09/2018	21°57'5.16"N 90° 2'53.45"E	Crosswind
AAQ-4	Taltoli Bazar	18/04/2018, 26/04/2018, 16/09/2018 and 24/09/2018	21°58'40.00"N 90° 4'58.76"E	Downwind

Source: Field Survey by EQMS Team, April and September 2018

Duration of Sampling:

All parameters (PM₁₀, PM_{2.5}, SO₂ and NO_x) were monitored on 24-hourly basis during the duration of the study except SPM and CO. The SPM and CO was monitored for 8 hours. This is to allow a comparison with the present standards mentioned in the Environmental Conservation Rules 1997 and amendment 2005 (Schedule-2: Air Quality Standard).

Figure 7-20: Ambient Air Quality Sampling Locations



Source: Field Survey by EQMS Team, April and September 2018

Figure 7-21: Photographs of Ambient Air Quality Monitoring



AAQ-1: Project Site



AAQ-2: Choto Ankujan Para



AAQ-3: Near Joyalbhanga Bazar



AAQ-4: Taltoli Bazar

Source: Field Survey by EQMS Team, April and September 2018

7.15.1.2 Summary of Ambient Air Quality Monitoring Result

Summary of the ambient air quality results are presented in Table 7-5.

Table 7-5: Summary of Ambient Air Quality Monitoring Results

Code	Location	Season	Ambient Air pollution concentration in $\mu\text{g}/\text{m}^3$					CO* (ppm)
			SPM	PM _{2.5}	PM ₁₀	SO ₂	NOx	
AAQ-1	Project Site	Pre-monsoon	71.42	28.42	39.60	18.81	12.31	0.88
		Monsoon	61.62	23.11	35.58	11.58	8.16	0.70
AAQ-2	Choto Ankujan Para	Pre-monsoon	78.87	32.36	42.75	13.98	13.84	0.20
		Monsoon	69.04	27.86	37.90	10.88	12.52	0.08
AAQ-3	Near Joyalbhanga Bazar	Pre-monsoon	105.68	37.41	63.24	15.81	15.20	0.03
		Monsoon	89.46	27.60	57.60	10.73	11.63	0.02
AAQ-4	Taltoli Bazar	Pre-monsoon	111.17	41.87	64.01	24.06	22.70	0.18
		Monsoon	99.80	37.31	57.74	15.33	14.82	0.13
Duration (hours)			8	24	24	24	24	8
Weather Condition			Sunny					
Bangladesh Standard (according to ECR, 1997 and subsequent amendment in 2005)**			200	65	150	365	100 (annual)	9
Amendment of ECR 1997 (ECR, 2017)***			-	35	150	85	200	9

* 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 19th July 2005 vide S.R.O. No. 220-Law/2005.

*** Environment Conservation Rules (Draft) 2017, web: https://moef.portal.gov.bd/sites/default/files/files/moef.portal.gov.bd/notices/39d57d12_cdc2_4f19_bf74_1b89f92f902d/Draft_ECR_2017.pdf

Source: Laboratory Analysis in EQMS Lab, April and September 2018

7.15.1.3 Result Analysis

Concentration of Suspended Particulate Matter (SPM):

The 8-hourly SPM concentration in ambient air in the project study area was recorded in the range 61.62 $\mu\text{g}/\text{m}^3$ to 111.17 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum concentration of 111.17 $\mu\text{g}/\text{m}^3$ was recorded near Taltoli Bazar (AAQ-4) during pre-monsoon season and minimum concentration 61.62 $\mu\text{g}/\text{m}^3$ was observed to be at Project Site (AAQ-1) during monsoon season. The SPM level of all locations were reported below the NAAQS of Bangladesh.

Concentration of Particulate Matter ($\text{PM}_{2.5}$):

The 24-hourly $\text{PM}_{2.5}$ concentration in ambient air in the project study area was recorded in the range of 23.11 $\mu\text{g}/\text{m}^3$ to 41.87 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum $\text{PM}_{2.5}$ concentration was reported from AAQ-4 as 41.87 $\mu\text{g}/\text{m}^3$ and minimum concentration was reported from AAQ-1 as 23.11 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the NAAQS for $\text{PM}_{2.5}$ in Bangladesh.

Concentration of Particulate Matter (PM_{10}):

The 24-hourly PM_{10} concentration in ambient air in the project study area was recorded in the range of 35.58 $\mu\text{g}/\text{m}^3$ to 64.01 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum PM_{10} concentration was reported from AAQ-4 as 64.01 $\mu\text{g}/\text{m}^3$ and minimum concentration was reported from AAQ-1 as 35.58 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the NAAQS for PM_{10} in Bangladesh.

Concentration of Sulphur Dioxide (SO_2):

The 24-hourly SO_2 concentration in ambient air in the project study area was recorded in the range of 10.73 $\mu\text{g}/\text{m}^3$ to 24.06 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum SO_2 concentration was reported from AAQ-4 as 24.06 $\mu\text{g}/\text{m}^3$ and minimum concentration was reported from AAQ-3 as 10.73 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the NAAQS for SO_2 in Bangladesh.

Concentration of Oxides of Nitrogen (NO_x):

The 24-hourly NO_x concentration in ambient air in the project study area was recorded in the range of 8.16 $\mu\text{g}/\text{m}^3$ to 22.70 $\mu\text{g}/\text{m}^3$. During the monitoring period, the maximum NO_x concentration was reported from AAQ-4 as 22.70 $\mu\text{g}/\text{m}^3$ and minimum concentration was reported from AAQ-1 as 8.16 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the NAAQS for NO_x in Bangladesh.

Concentration of Carbon Monoxide (CO):

The 8-hourly CO concentration in ambient air in the project study area was recorded in the range of 0.02 ppm to 0.88 ppm. During the monitoring period, the maximum CO concentration was reported from AAQ-1 as 0.88 ppm and minimum concentration was reported from AAQ-3 as 0.02 $\mu\text{g}/\text{m}^3$. All the monitoring locations result was within the NAAQS for CO in Bangladesh.

7.15.2 Ambient Noise Quality

The proposed project area is located in the rural area of Barguna District. There is no industry in the proposed project adjoining area, so there is no major sources of noise pollution. The sources of noise are the vehicular movement on the internal road and river traffic (boat, ship, trawler etc.) in the Buriswar-Payra River and adjacent canals.

7.15.2.1 Noise Sampling Locations

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the study area. Noise at different noise generating sources has been identified based on the activities in the project area, ambient noise due to traffic and the noise at sensitive area like mosque, school etc. The noise monitoring has been conducted for determination of noise levels at

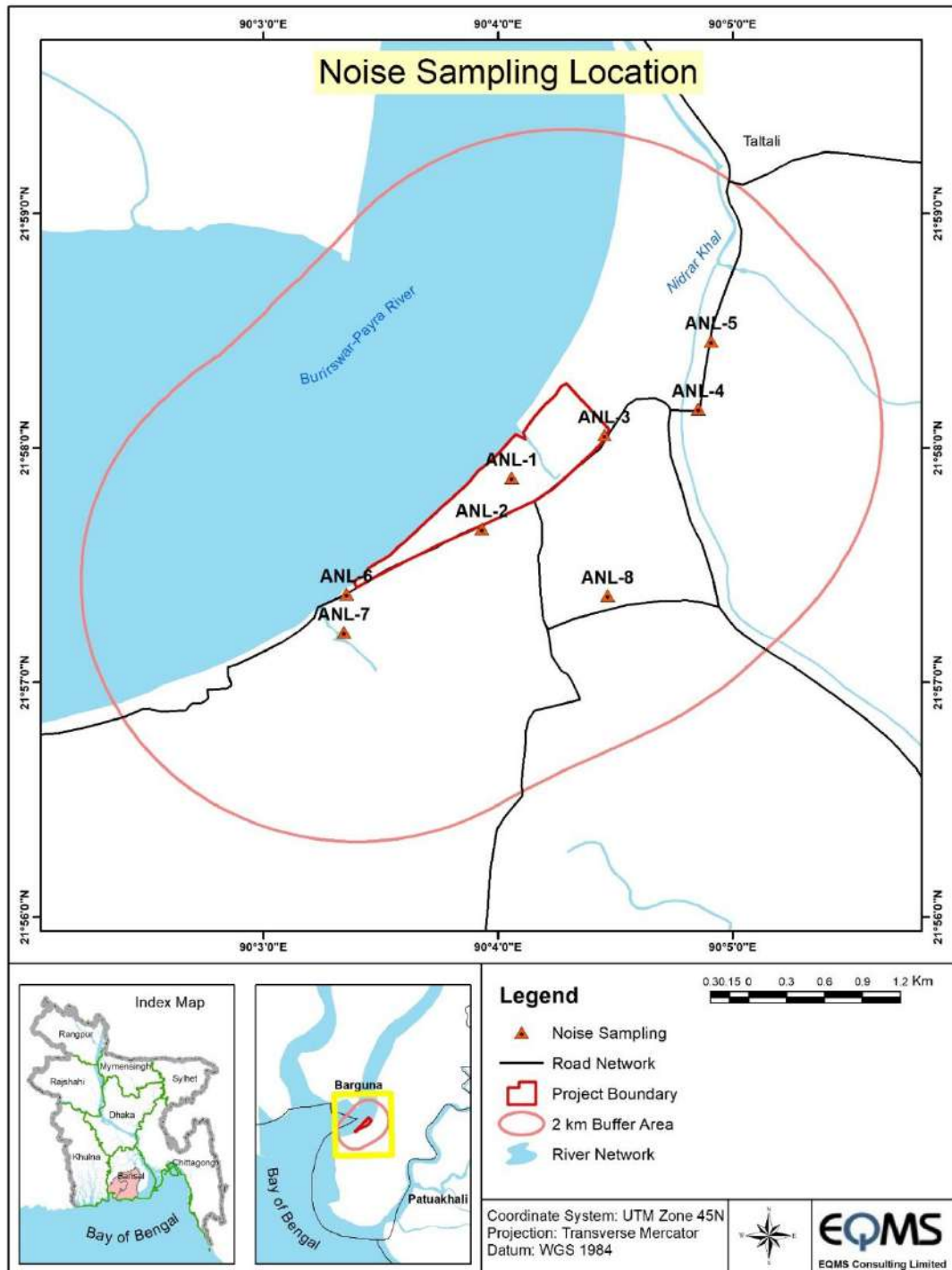
eight locations during September 2018 in the study area. The environment setting of each noise monitoring locations are given in Table 7-6 and map is depicted in Figure 7-22. The photographs of noise monitoring are presented in following Figure 7-23.

Table 7-6: Ambient Noise Monitoring Locations

Code	Sampling Location	Geographic Location	Monitoring Date	Category of Area/Receptor
ANL-1	Project Site	21°57'52.37"N 90° 4'3.49"E	13/09/2018- 14/09/2018	Project Site
ANL-2	Kadamtala Sirazia Jame Mosque	21°57'39.24"N 90° 3'55.90"E	14/09/2018- 15/09/2018	Silent
ANL-3	Shahidul Mia's House	21°58'3.24"N 90° 4'27.25"E	15/09/2018- 16/09/2018	Residential
ANL-4	Shahjahan Munsii Shop (Bara Ankujanpara Bridge Ghat)	21°58'9.94"N 90° 4'51.26"E	17/09/2018- 18/09/2018	Mixed
ANL-5	Taltoli Bazar (in front of Sagar Restaurant)	21°58'27.31"N 90° 4'54.56"E	17/09/2018- 18/09/2018	Commercial
ANL-6	Joyalbhanga Bazar	21°57'22.56"N 90° 3'21.24"E	18/09/2018- 19/09/2018	Commercial
ANL-7	Joyalbhanga Govt. Primary School	21°57'12.78"N 90° 3'20.61"E	19/09/2018- 20/09/2018	Silent
ANL-8	Abu Hanif Mia's House	21°57'22.26"N 90° 4'28.09"E	20/09/2018- 21/09/2018	Residential

Source: Field Survey by EQMS Team, September 2018

Figure 7-22: Noise Level Monitoring Locations



Source: Field Survey by EQMS Team, September 2018

Figure 7-23: Photographs of Noise Monitoring



ANL-1: Project site



ANL-2: Kadamtala Sirazia Jame Mosque



ANL-3: Shahidul Mia's House



ANL-4: Shahjahan Munsif Shop (Bara Ankujanpara Bridge Ghat)



ANL-5: Taltoli Bazar (in front of Sagar Restaurant)



ANL-6: Joyalbhanga Bazar



ANL-7: Joyalbhanga Govt. Primary School



ANL-8: Abu Hanif Mia's House



Noise measurement in the field

Source: Field Survey by EQMS Team, September 2018

7.15.2.2 Method of Monitoring

Sound Pressure Level (SPL) measurements were measured at all locations. The readings were taken for every hour for 24 hours. The day noise levels have been monitored during 6 am to 10 pm and night levels during 10 pm to 6 am at all the locations covered in 10 km radius of the study area.

7.15.2.3 Presentation of Results

The statistical analysis is done for measured noise levels at eight locations during the baseline study. The parameters like Leq_{day} , Leq_{night} , L_{max} and L_{min} are analyzed. The results of the ambient noise level monitoring are tabulated in following Table 7-7.

Table 7-7: Noise Level in the Study Area

Code	Category of area/receptor	Leq_{day} dB(A)	Leq_{night} dB(A)	L_{max}	L_{min}	Bangladesh Noise Standards*	
						Day	Night
ANL-1	Project Site	49.07	45.24	68.7	32.6	-	-
ANL-2	Silent	49.90	43.04	62.2	31.6	50	40
ANL-3	Residential	47.21	44.0	67.3	31.4	55	45
ANL-4	Mixed	59.02	44.56	78.6	31.2	60	50
ANL-5	Commercial	65.79	50.47	86.9	31.6	75	70
ANL-6	Commercial	54.29	45.40	62.0	31.4	75	70
ANL-7	Silent	46.75	43.09	63.0	32.1	50	40
ANL-8	Residential	50.67	46.49	71.3	33.1	55	45

*Environmental Conservation Rules, 1997 (Schedule 4) (subsequent amendment in 2006)

Source: Field Survey by EQMS Team, September 2018

7.15.2.4 Result Analysis

Daytime Noise Levels (Leq_{day}):

The day time noise levels at all the locations were ranged in between 46.75 dB(A) to 65.79 dB(A). The maximum value 65.79 dB(A) was recorded at the commercial area (Taltoli Bazar) (ANL-5) and the minimum value 46.75 dB(A) was recorded at Silent area (Joyalbhanga Govt. Primary School) (ANL-7).

Nighttime Noise Levels (Leq_{night})

The nighttime noise levels were ranged in between 43.04 dB(A) to 50.47 dB(A). The maximum value 50.47 dB(A) was recorded at the commercial area (Taltoli Bazar) (ANL-5) and the minimum value 43.04 dB(A) was recorded at silent area (Kadamtala Sirazia Jame Mosque) (ANL-2).

7.15.3 Surface and Ground Water Quality

Selected water quality parameters of ground water and surface water resources within 10 km radius of the study area has been studied for assessing the water environment and evaluate anticipated impacts of the proposed power plant operation. Understanding the water quality is essential in preparation of the EIA and to identify critical issues with a view to suggest appropriate mitigation measures for implementation. The purpose of this study is to:

- Assess the water quality characteristics for critical parameters; and
- Predict the impact of water quality by power plant operation and related activities.

The information required has been collected through primary survey and secondary sources. Four surface water sources and four groundwater sources covering 10 km radial distance were examined for physico-chemical, heavy metals and bacteriological parameters. The samples were collected and analyzed once during the study period.

7.15.3.1 Surface Water Sampling Locations

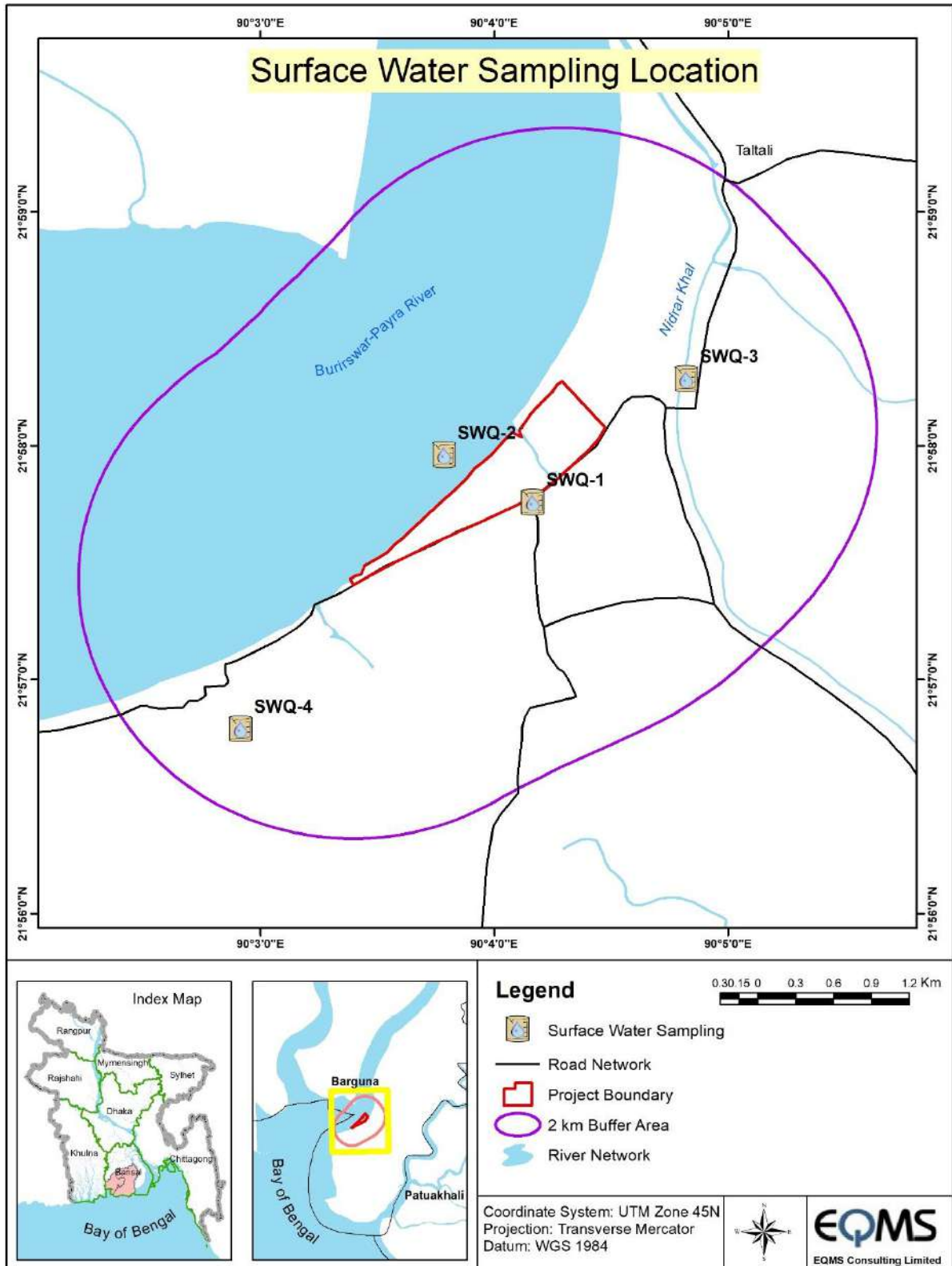
Four surface water samples were collected during the baseline survey from the proposed project area. Two samples were collected from the Buriswar-Payra River (one from upstream of the project and another one from downstream of the project site). The two surface water samples were also collected from the Joyalbhanga Canal and pond near the project site. These samples were taken as grab samples and were analyzed for various parameters to compare with the national standards. The surface water sampling locations details are given in Table 7-8 and map of the sampling locations is depicted in Figure 7-24. The surface water sampling photographs are shown in Figure 7-25.

Table 7-8: Surface Water Sampling Locations

Sampling location	Sampling Code	Date	Geographic location
Buriswar-Payra River (upstream of the project site)	SWQ-1	18/09/2018	21°58'38.05"N 90° 4'12.32"E
Buriswar-Payra River (downstream of the project site)	SWQ-2	18/09/2018	21°57'57.56"N 90° 3'47.18"E
Joyalbhanga Canal	SWQ-3	19/09/2018	21°57'13.41"N 90° 3'17.44"E
Pond (Near Project Site)	SWQ-4	19/09/2018	21°57'45.45"N 90° 4'9.95"E

Source: Field Survey by EQMS Team, September 2018

Figure 7-24: Sampling Location Map of the Surface Water



Source: Field Survey by EQMS Team, September 2018

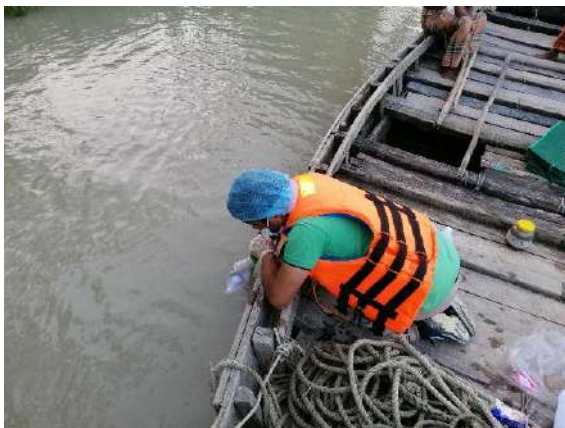
Figure 7-25: Photographs of Inland Surface Water Collection



SWQ-1: Buriswar-Payra River (upstream of the project site)



SWQ-2: Buriswar-Payra River (downstream of the project site)



SWQ-3: Joyalbhanga Canal



SWQ-4: Near Project Site (Pond)

Source: Field Survey by EQMS Team, September 2018

7.15.3.2 Result Analysis

The results for the surface water samples analyzed are presented in following Table 7-9 and it was compliance to the use in different purposes as per the standards of ECR, 1997 (Schedule 3: Standards for water).

- **pH:** The pH of the surface water samples collected ranges from 7.47 to 8.39 the maximum pH of 8.39 was observed at SWQ-1 and minimum 7.47 was observed at SWQ-3. From the test result, pH level of all the surface water samples are within the standard limit of the ECR, 1997.
- **Biochemical Oxygen Demand (BOD):** Biochemical Oxygen Demand was observed to be in the range of 0.8 to 2.4 mg/l. The maximum value of BOD 2.4 mg/l was observed at SWQ-4 and minimum value of BOD 0.8 mg/l was observed at SWQ-3. From the test result, it is found that the BOD level at SWQ 2 and SWQ-4 is not suitable for “source of drinking water for supply only after disinfecting”. However all the surface water samples are usable in other purposes and in acceptable limit of the ECR, 1997.
- **Dissolve Oxygen (DO):** Dissolved Oxygen was observed to be in the range of 3.88 to 7.7 mg/l. The maximum value of DO 7.7 mg/l was observed at SWQ-4 and minimum value of DO 3.88 mg/l was observed at SWQ-3. The water quality in SWQ-3 indicates that it is not suitable for any kind of use.

Table 7-9: Surface Water Analysis Results

Parameter	Unit	Sampling Location				Bangladesh Standard*					
		SWQ-1	SWQ-2	SWQ-3	SWQ-4	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by various process and cooling industries	Water usable for irrigation
Alkalinity	mg/l	80	78	83	85	-	-	-	-	-	-
Arsenic	mg/l	<0.010	<0.010	<0.010	<0.010	-	-	-	-	-	-
BOD	mg/l	1.4	2.2	0.8	2.4	2 or less	3 or less	6 of less	6 of less	10 or less	10 or less
Cadmium	mg/l	0.00015	0.00015	0.00015	0.00015	-	-	-	-	-	-
Calcium	mg/l	21.1	19.8	21.2	21.6	-	-	-	-	-	-
Chloride	mg/l	4.3	4.2	4.2	4.0	-	-	-	-	-	-
Chromium	mg/l	0.020	0.004	0.003	0.0005	-	-	-	-	-	-
COD	mg/l	20	32	4	12	-	-	-	-	-	-
EC	µS/cm	240	220	460	700	-	-	-	-	-	-
DO	mg/l	5.5	7.3	3.8	7.7	6 or above	5 of more	6 or more	5 or more	5 or more	5 or more
Fluoride	mg/l	0.58	0.56	0.47	0.56	-	-	-	-	-	-
Iron	mg/l	0.13	0.15	0.15	0.17	-	-	-	-	-	-
Lead	mg/l	0.002	0.003	0.004	0.001	-	-	-	-	-	-
Manganese	mg/l	0.00	0.00	0.00	0.00	-	-	-	-	-	-
Mercury	mg/l	<0.001	0.002	0.003	0.002	-	-	-	-	-	-
Nitrate	mg/l	1.3	1.3	1.2	1.3	-	-	-	-	-	-
Nitrite	mg/l	5	5	10	6	-	-	-	-	-	-
Oil and Grease	mg/l	<1	<1	<1	<1	-	-	-	-	-	-
Phosphate	mg/l	2.5	2.5	2.4	2.8	-	-	-	-	-	-
Potassium	mg/l	30	30	32	29	-	-	-	-	-	-
pH	-	8.39	8.10	7.47	7.69	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5

Parameter	Unit	Sampling Location				Bangladesh Standard*					
		SWQ-1	SWQ-2	SWQ-3	SWQ-4	Source of drinking water for supply only after disinfecting	Water usable for recreational activity	Source of drinking water for supply after conventional treatment	Water usable by fisheries	Water usable by various process and cooling industries	Water usable for irrigation
Salinity	ppt	0.11	0.09	0.22	0.33	-	-	-	-	-	-
Sodium	mg/l	17	33	6	92	-	-	-	-	-	-
Sulphate	mg/l	15	14	15	16	-	-	-	-	-	-
Temperature	°C	27.6	27.2	27.5	27.4	-	-	-	-	-	-
TDS	mg/l	120	110	230	350	-	-	-	-	-	-
Hardness	mg/l	113	118	129	122	-	-	-	-	-	-
Turbidity	NTU	81	140	79	10	-	-	-	-	-	-

Source: Laboratory Analysis by DPHE, BCSIR and EQMS laboratory

* Bangladesh Environment Conservation Rules (ECR), 1997, Schedule-3: Standards for Water (Standards for Inland Surface Water)

7.15.3.3 Ground Water Sampling Locations

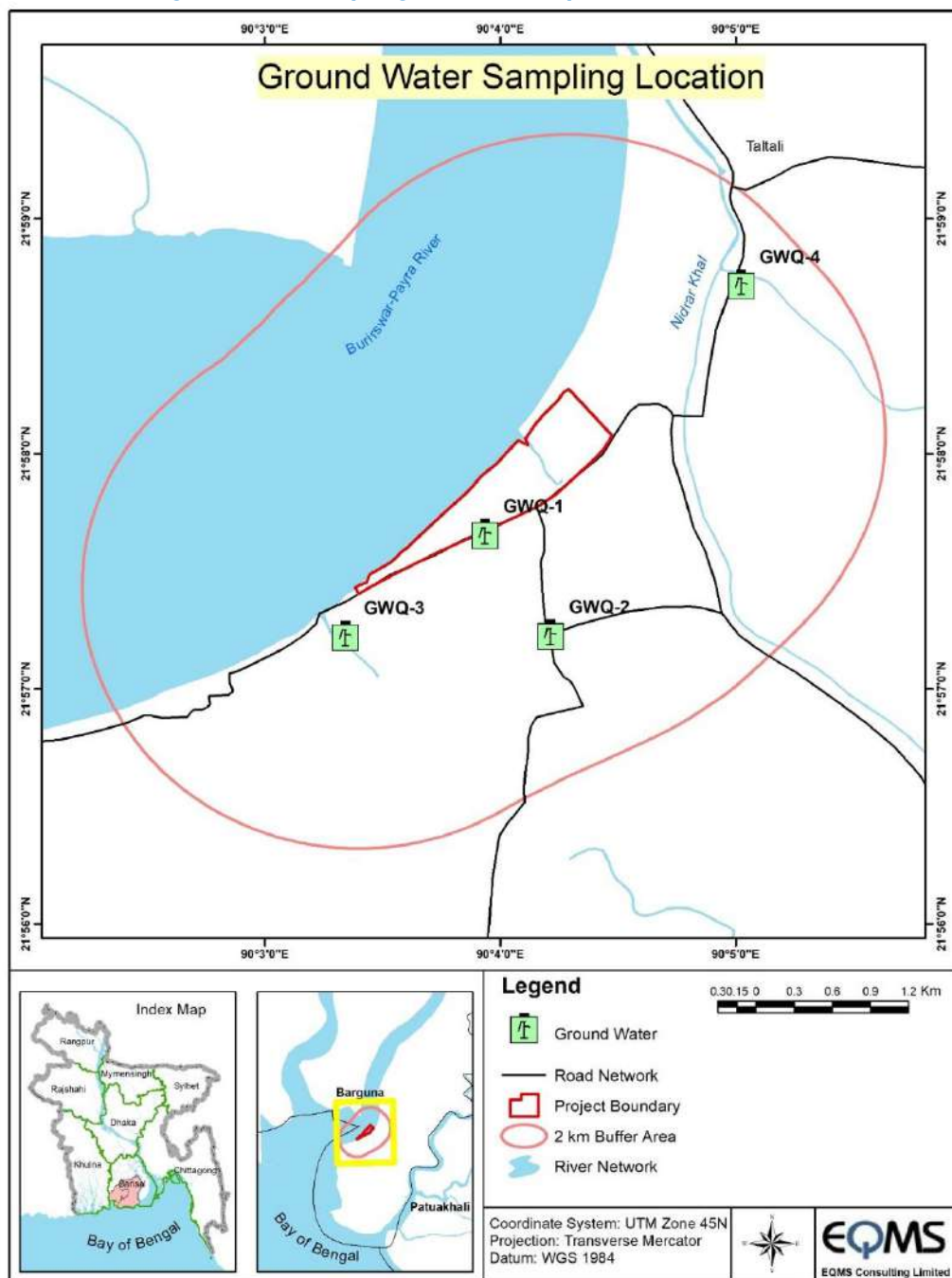
Groundwater is most important for drinking, household uses, commercial activities and irrigation purposes. Groundwater is available in the study area. Four groundwater (deep tube well) samples were collected from the study area. After collection, the groundwater samples were sent to the DPHE and BCSIR laboratory at Dhaka for further examination of the ground water parameters. Water samples were collected in pre-washed one liter plastic bottles and 250 ml sterilized clean PET bottle for complete physio-chemical and bacteriological tests respectively. The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the groundwater sampling locations are presented in Table 7-10 and the ground water sampling location map are shown in Figure 7-26. The photographs of groundwater sample collection are shown in Figure 7-27 and quality of the groundwater are given in Table 7-11.

Table 7-10: Details of Ground Water Sampling Locations

Sampling Location	Sampling Code	Sampling Date	Geographic location	Type of Source
Near Joyalbhanga Bazar	GWQ-1	18/09/2018	21°57'39.10"N 90° 3'56.03"E	Tube-well
Choto Ankujanpara	GWQ-2	18/09/2018	21°57'13.39"N 90° 4'12.72"E	Tube-well
Joyalbhanga Govt. Primary School	GWQ-3	19/09/2018	21°57'13.11"N 90° 3'20.43"E	Tube-well
Taltoli Bazar	GWQ-4	19/09/2018	21°58'42.75"N 90° 5'1.36"E	Tube-well

Source: Field Survey by EQMS Team, September 2018

Figure 7-26: Sampling Location Map of the Groundwater



Source: Field Survey by EQMS Team, September 2018

Figure 7-27: Photographs of Ground Water Sample Collection



GWQ-1: Near Joyalbhanga Bazar



GWQ-2: Choto Ankujanpara



GWQ-3: Joyalbhanga Govt. Primary School



GWQ-4: Taltoli Bazar

Source: Field Survey by EQMS Team, September 2018

7.15.3.4 Results Analysis

The results for the groundwater samples analyzed are presented in Table 7-11 and are compared with the standards of ECR 1997, Schedule-3 (Standards for water: B. Drinking Water).

- **Alkalinity:** The alkalinity of the ground water samples collected ranges from 483 to 498 mg/l. Maximum alkalinity was observed at GWQ-4 and minimum alkalinity was observed at GWQ-2.
- **Arsenic (As):** As was observed to be <0.010 mg/l in all samples. All the values were within the permissible limit of ECR, 1997.
- **Calcium (Ca):** Ca was observed to be in the range from 7.1 to 8.9 mg/l. The maximum Ca was observed at GWQ-4 and minimum was observed at GWQ-1. All the values were within permissible limit of ECR, 1997.
- **Chloride (Cl):** Cl was observed to be in the range from 18.8 to 20.0 mg/l. The maximum Cl was observed at GWQ-2 and minimum was observed at GWQ-1. All the values were within permissible limit of ECR, 1997.
- **Chromium (Cr):** Cr was observed to be in the range from 0.00015 to 0.0009 mg/l. The maximum Cr was observed at GWQ-1 and minimum was observed at GWQ-4. All the values were within permissible limit of ECR, 1997.
- **Electrical Conductivity (EC):** EC was observed to be in the range from 1880 to 1920 $\mu\text{S}/\text{cm}$. The maximum EC was observed at GWQ-1 and minimum was observed at GWQ-2.
- **Fluoride (F):** F was observed to be in the range from 0.18 to 0.25 mg/l. The maximum F was observed at GWQ-1 and minimum was observed at GWQ-2. All the values were within permissible limit of ECR, 1997.
- **Fecal Coliform (FC):** FC was absent in all the ground water samples.
- **Iron (Fe):** Fe was observed to be in the range from 0.07 to 0.09 mg/l. The maximum Fe was observed at GWQ-1 and minimum Fe was observed at GWQ-3. All the values were within the permissible limit of ECR, 1997.
- **Mercury (Hg):** Hg was observed as 0.003 mg/l in all samples. All the values were exceeds the permissible limit of ECR, 1997.
- **pH:** pH was observed to be in the range from 8.54 to 8.72. All the values were exceeds the permissible limit of ECR, 1997.
- **Potassium (K):** Potassium was observed to be in the range from 27 to 35 mg/l. The maximum potassium was observed at GWQ-4 and minimum was observed at GWQ-3. All the values exceeds the permissible limit of ECR, 1997.
- **Sodium (Na):** Sodium was observed to be in the range from 317 to 419 mg/l. The maximum sodium was observed at GWQ-2 and minimum was observed at GWQ-1. All the values exceeds the permissible limit of ECR, 1997.
- **Total Coliform (TC):** TC was absent in all the ground water samples.

- **TDS:** TDS was observed to be in the range from 940 to 960 mg/l. The maximum sodium was observed at GWQ-1 and minimum was observed at GWQ-2. All the values were within permissible limit of ECR, 1997.

Table 7-11: Ground Water Quality in the Project Area

Parameters	Unit	Ground Water Quality				ECR, 1997 *
		GWQ-1	GWQ-2	GWQ-3	GWQ-4	
Alkalinity	mg/l	496	483	492	498	-
Arsenic	mg/l	<0.010	<0.010	<0.010	<0.010	0.05
Cadmium (Cd)	mg/l	0.00015	0.00015	0.00015	0.00015	0.005
Calcium (Ca)	mg/l	7.1	7.2	7.2	8.9	75
Chloride (Cl)	mg/l	18.8	20.0	19.8	19.2	150-600
Chromium (Cr)	mg/l	0.0009	0.0004	0.0003	0.00015	0.05
EC	μS/cm	1920	1880	1900	1900	-
Fluoride (F)	mg/l	0.25	0.18	0.19	0.20	1
Fecal Coliform	N/100ml	0	0	0	0	0
Iron (Fe)	mg/l	0.09	0.08	0.07	0.08	0.3-1.0
Lead (Pb)	mg/l	0.002	0.003	0.003	0.001	0.05
Mercury (Hg)	mg/l	0.003	0.003	0.003	0.003	0.001
pH	-	8.54	8.55	8.54	8.72	6.5-8.5
Potassium (K)	mg/l	30	28	27	35	12
Phosphorus (P)	mg/l	3.0	3.2	3.1	3.1	0
Salinity	ppt	0.96	0.98	0.99	0.98	-
Sodium (Na)	mg/l	317	410	419	392	200
Temperature	°C	27.3	27.5	27.6	27.7	20-30
Total Coliform	N/100ml	0	0	0	0	0
TDS	mg/l	960	940	950	950	1000
Hardness	mg/l	283	267	269	291	200-500

Source: Laboratory Analysis by DPHE, BCSIR and EQMS

*Bangladesh Environment Conservation Rules (ECR), 1997, Schedule-3: Standards for Water (Standards for Drinking Water)

7.15.4 Soil Quality

Soil samples were collected from two locations for the analysis of physicochemical parameters. The selected locations were from the project site and outside of the project boundary (Choto Ankujanpara). Soil samples were collected using a hand auger from the top soil surface. After collecting Soil samples, it was packed in plastic jars and sealed. The sealed samples were sent to the SRDI laboratory in Dhaka for analysis. According to the SRDI laboratory, it will takes longer time to provide the soil quality test report, that's why available secondary data of the proposed project area is considered in this report. However, after getting test result from the SRDI, this section will be updated accordingly. A detail of the sampling locations are presented in Table 7-12 and sampling location map are shown in Figure 7-28. The photographs of the soil samples collection are given in Figure 7-29 and quality of soil is given below in Table 7-13.

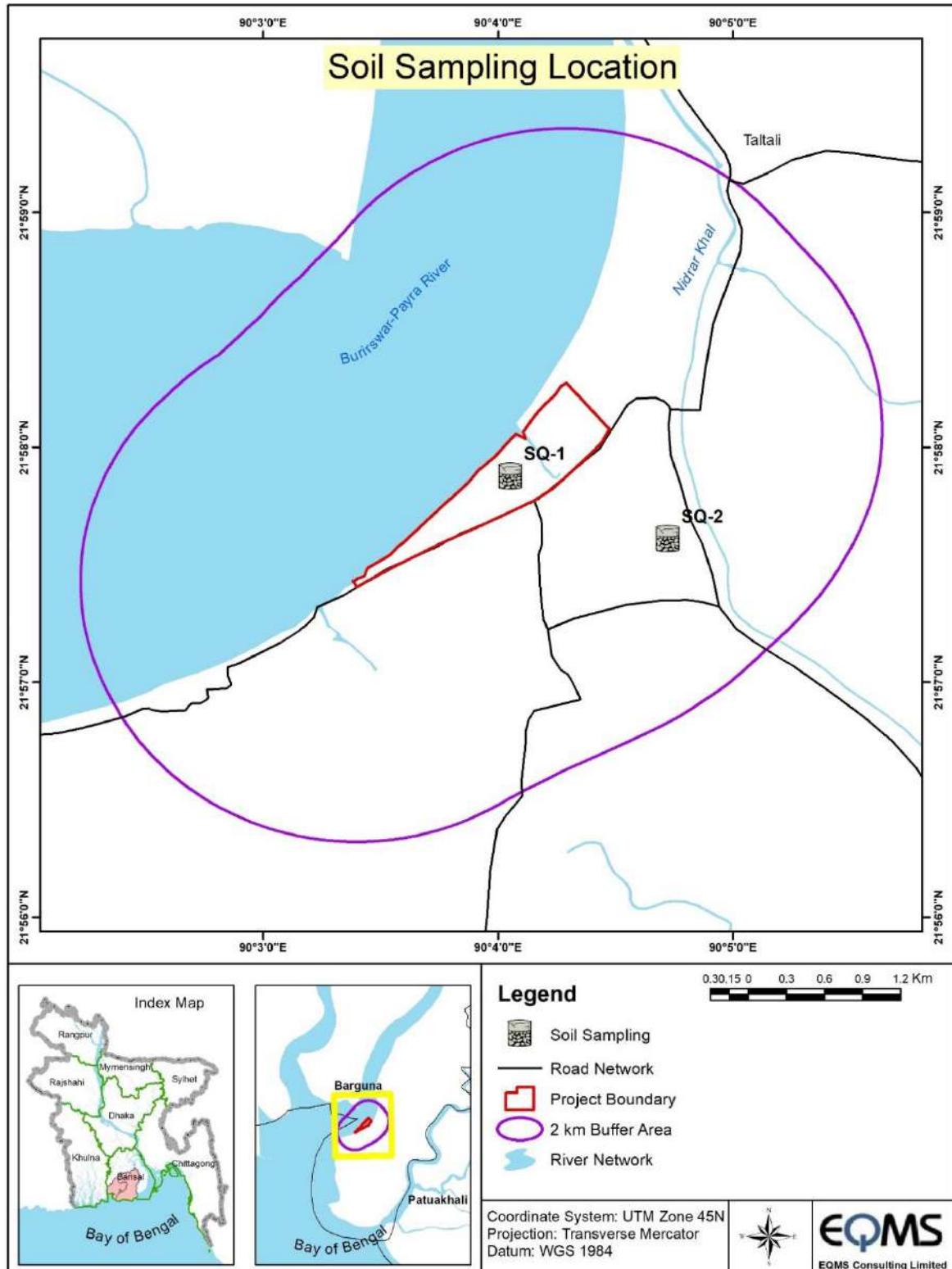
Table 7-12: Soil Sampling Locations

Soil sampling locations	Code	Sampling Date	Geographical location

Soil sampling locations	Code	Sampling Date	Geographical location
Project Site	SQ-1	16/09/2018	21°57'52.59"N 90° 4'3.12"E
Choto Ankujanpara	SQ-2	16/09/2018	21°57'36.57"N 90° 4'43.34"E

Source: Field Survey by EQMS Team, September 2018

Figure 7-28: Soil Sampling Location Map



Source: Field Survey by EQMS Team, September 2018

Figure 7-29: Photographs of Soil Sampling

SQ-1: Project site



SQ-2: Choto Ankujanpara

Source: Field Survey by EQMS Team, September 2018

7.15.4.1 Result Analysis

The soil quality of the proposed project area based on the secondary sources is presented in following Table 7-13.

Table 7-13: Soil Quality of the Project Area

SL#	Parameter	Unit	Soil Quality
			SQ-1
1	Soil Moisture	%	23.51
2	Organic Matter	%	0.84
3	pH	-	7.91
4	EC	dSm ⁻¹	1.23
5	Salinity	dS/m	2.8
6	K	mg/kg	0.37
7	N	mg/kg	0.04
8	P	mg/kg	1.97
9	S	mg/kg	21.79
10	Cu	mg/kg	4.06
11	Fe	mg/kg	18
12	B	mg/kg	0.44
13	Mn	mg/kg	7.9
14	Zn	mg/kg	0.38
15	K ⁺	Cmol/kg	0.21
16	Na ⁺	Cmol/kg	1.7
17	SO ₄ ²⁻	ppm	374.4
18	HCO ₃ ⁻	ppm	146.4
19	Cl ⁻	Cmol/kg	19.2
20	CO ₃ ²⁻	Cmol/kg	0

Source: Ansari, S.B, 2009; CEGIS, 2015 and SRDI, 2010

The soil moisture in the study area is 23.51%, organic matter is 0.84%, pH is 7.91, EC is 1.23 dSm⁻¹, salinity is 2.8 dS/m, potassium is 0.37 mg/kg, nitrogen is 0.04 mg/kg, phosphorus is 1.97 mg/kg, sulfur is 21.79 mg/kg, copper is 4.06 mg/kg, iron is 18 mg/kg, boron is 0.44 mg/kg, manganese is 7.9 and zinc is 0.38 mg/kg etc..

7.16 Biological Environment

Biodiversity is the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable. The biodiversity component of the study, focused on a few groups of biological components comprising of flora (tree, herbs, shrubs and climbers) and fauna (birds, reptiles, amphibians, mammals and fisheries) as well as the surrounding ecosystems. Due to the implementation of the proposed project in the Taltoli, Barguna and adjoining area could result in the deterioration of nearby ecosystem directly and indirectly. To assess the probable impact of the proposed 350 MW coal-fired power plant project in Barguna three ecologists of EQMS conducted ecological survey from 19th March to 24th March 2018 (Phase-1) and from 10th August to 15th August 2018 (Phase-2) with a total of 12 days.

The study area for ecological survey includes an area within 10 km radius of the proposed project site. The study area covers Tengragiri Wildlife Sanctuary, which is the second largest mangrove forest of Bangladesh and Laldia Reserve Forest, which is a delta of the Sundarban Reserve Forest. Land use of buffer area includes agricultural land, ocean, river, canal, homestead forest, mangrove forest etc. As the proposed project location is situated adjacent to the planted mangrove patches and confluent of the Buriswar-Payra River and the Bay of Bengal, it covers a rich biodiversity. The climatic condition during the ecological survey was clear and sunny from late morning. The overall objective of this study is to establish the baseline data for flora and fauna of this proposed project area.

The ecological survey was conducted with the following objectives:

- Identification of various habitats available within the study area;
- Enumeration of terrestrial and aquatic floral and faunal species within the study area;
- Identification of floral and faunal species of conservation significance;
- Collection and compilation of secondary information on the status of floral and faunal components and habitats from the concerned stakeholders; and
- To develop the ecological mitigation and management plan.

7.16.1 Bio-ecological Zone of Bangladesh

The International Union for Conservation of Nature (IUCN) has classified Bangladesh into twenty-five (25) Bio-ecological Zones (Nishat et al., 2002) in the context of physiographic and biological diversity. The study area has fallen under two bio-ecological zones: i) Saline Tidal Floodplain; and ii) Coastal and marine waters.

7.16.1.1 Saline Tidal Floodplain

The Saline tidal floodplain has a transitional physiography, which is located in the administrative districts of Satkhira, Khulna, Bagerhat, Jahalakhathi and Borguna. It has a low ridge and basin relief, crossed by innumerable tidal rivers and creeks. Local differences in elevation are less than 1m. The sediments are mainly composed of non-calcareous clays, although in the riverbanks, they are salty and slightly calcareous. The soils are non-saline throughout the year over substantial amount of areas in the north and east, but they become saline to varying degrees in the dry season in the southwest and are saline for much of the year in Sundarbans. The rivers carry fresh water throughout the year to the east and northeast, but saline water penetrates increasingly further inland towards the west mainly in the dry season, and for most or all of the monsoon season in the southwest. In the northeast, there is moderately deep flooding during the monsoon season, mainly due to accumulation of rainwater on the land when the Ganges distribution and the lower Meghna are at high flood levels. Elsewhere, there is mainly shallow flooding at high tide, either throughout the year or only in the monsoon season, except where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater (Brammer, 1996).

Except for the Sundarbans, the floral diversity of this zone is similar to those of the adjoining zones. Innumerable indigenous weeds grow in beel areas. Several types of palms and bamboo dumps grow in almost all the villages. The Mango (*Mangifera indica*) and Jackfruit (*Artocarpus heterophyllus*) supply the commonest timber and are used for making doors, windows, boxes, etc. (Bari, 1978).

This zone affords a very lucrative place to game bird watches. At the advent of winter season, numerous game birds, which include wild goose, wild duck, cranes, spine, jungle fowl and various other waterfowl, begin to flock both in the Sundarbans and in the beel and char areas of this zone. Moreover, the network of rivers and expanse of beels of this zone teem with different species of fish (Bari, 1978).

7.16.1.1.1 Floral Diversity

Trees: Hargoza (*Acanthus illicifolius*), Narikel (*Cocos nucifera*), Khejur (*Phoenix sylvestris*) and Bhadi (*Lannea coromandelica*).

7.16.1.1.2 Faunal Diversity

Mammals: Jackal (*Canis aureus*), Smooth-coated otter (*Lutra perspicillata*), Gray mask shrew (*Suncus murinus*), Small Indian civet (*Viverricula indica*).

Birds: Sarus crane (*Grus antigone*), Black-winged stilt (*Himantopus himantopus*), Little grebe (*Tachybaptus ruficollis*), Red-wattled lapwing (*Vanellus indicus*).

Reptiles: Ring lizard (*Varanus salvator*), Banded sea snake (*Hydrophis fasciatus*), Estuarine sea snake (*Hydrophis obscura*).

Amphibians: Maculated tree frog (*Polypedates maculatus*), Tree frog (*Polypedates leucomystax*), Cricket frog (*Limnonectes limnocharis*).

7.16.1.2 Coastal and Marine Waters

There is over 25 million acres of marine area, which comprise the territorial waters and the exclusive economic zone of Bangladesh. The coastline along the Bay of Bengal is 1200 km long including the coastlines of numerous islands, but not measuring minor indentations. A large area in the south, therefore, is the coastal zone, which has its own dynamics and deserves special attention as a very distinct terrain (GoB, 1994). The coastal area, comprising the complex delta of the Ganges-Brahmaputra-Meghna river system, has immense biological resources. The river system, while flowing through Bangladesh on its way to the bay of Bengal, carries an estimated annual sediment load of about 2.0 billion tons; these sediments are subjected to coastal dynamic processes generated mainly by river flow and tidal wind actions, leading to accretion and erosion in the coastal areas of Bangladesh. Knowledge based on the status of the biological wealth, both in terms of flora and fauna, is very rudimentary of this zone (IUCN, 2000).

7.16.1.2.1 Floral Diversity

Not available

7.16.1.2.2 Faunal Diversity

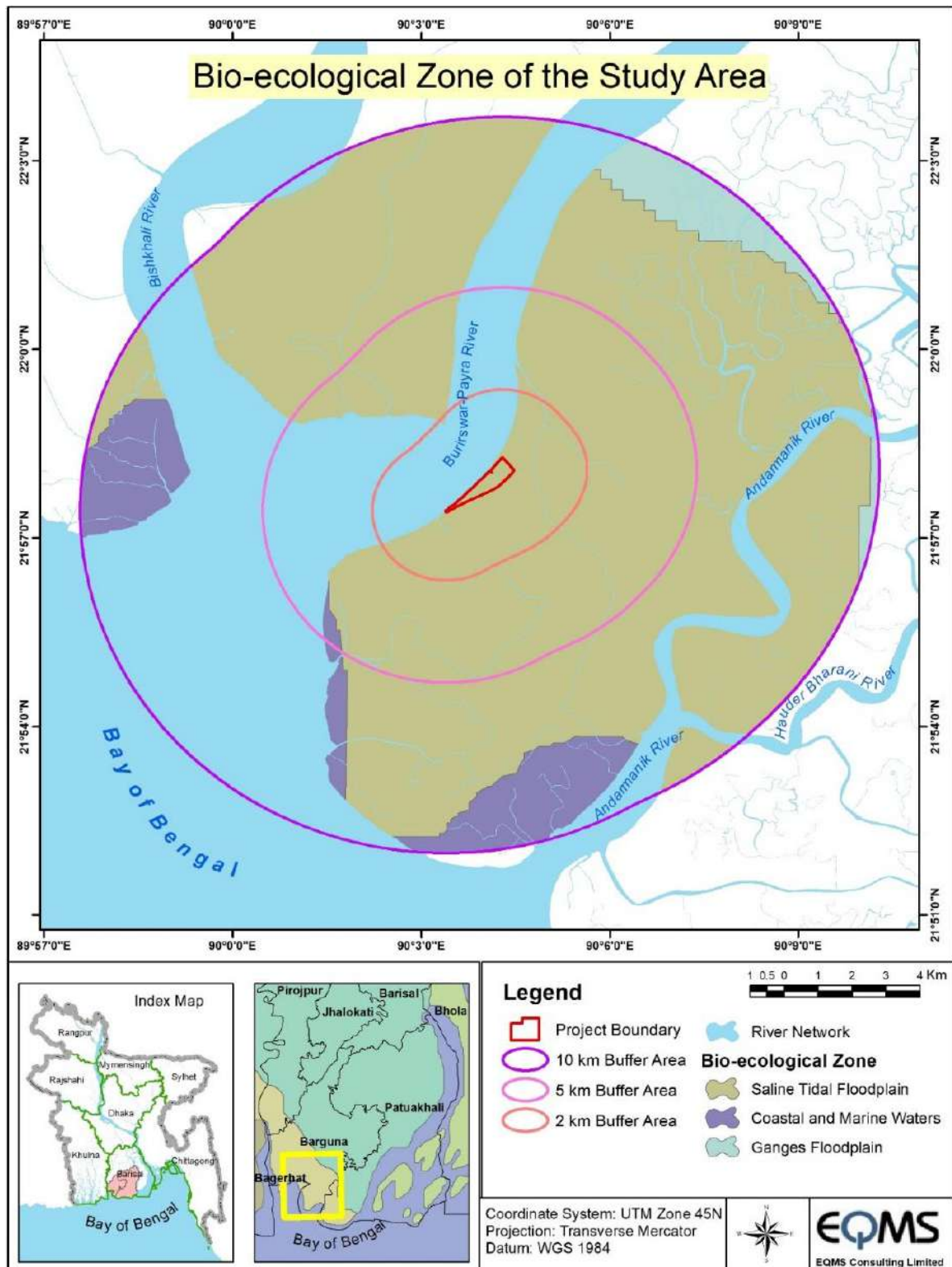
Mammals: Irrawaddy dolphin (*Orcaella brevirostris*), Short-finned pilot whale (*Globicephala macrorhynchus*), Melon-headed dolphin (*Peponocephala electra*) and Indo-Pacific hump-backed dolphin (*Sousa chinensis*).

Birds: Laggar falcon (*Falco jugger*), Oriental hobby (*Falco severus*), Small pratincole (*Glareola lactea*).

Reptiles: Green turtle (*Chelonia mydas*), Olive ridley turtle (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*), Hawksbill turtle (*Eretmochelys imbricata*).

Amphibians: Common toad (*Bufo melanostictus*), Cricket frog (*Limnonectes limnocharis*).

Figure 7-30: Bio-ecological Zones of Bangladesh



Source: IUCN, 2002

7.16.2 Protected Areas of Bangladesh

The protected area refers to an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources and managed through legal or other effective means i.e. protected area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. According to the Wildlife (Conservation and Security) Act, 2012 types of protected areas

are national park, sanctuary, eco-park, botanical garden, community conservation area, safari park, Kunjaban etc. According to the Bangladesh Forest Department list of the protected areas, the closest protected area (Tengragiri Wildlife Sanctuary) is located within the 10 km buffer of the project area. Description about the Tengragiri Wildlife Sanctuary is given in the subsequent section. However, the Sundarbans East Wildlife sanctuary is located on west side from the proposed power plant site and approximately 15.14 km away. The Kuakata National park is 10.96 km away on south side and Dudhmukhi Wildlife Sanctuary is 28.72 km away on west side. The following Table 7-14 shows the protected areas of Bangladesh and the map showing the distance between protected areas and project boundary is shown in Figure 7-31 and distance between marine protected areas and project boundary is shown in Figure 7-32.

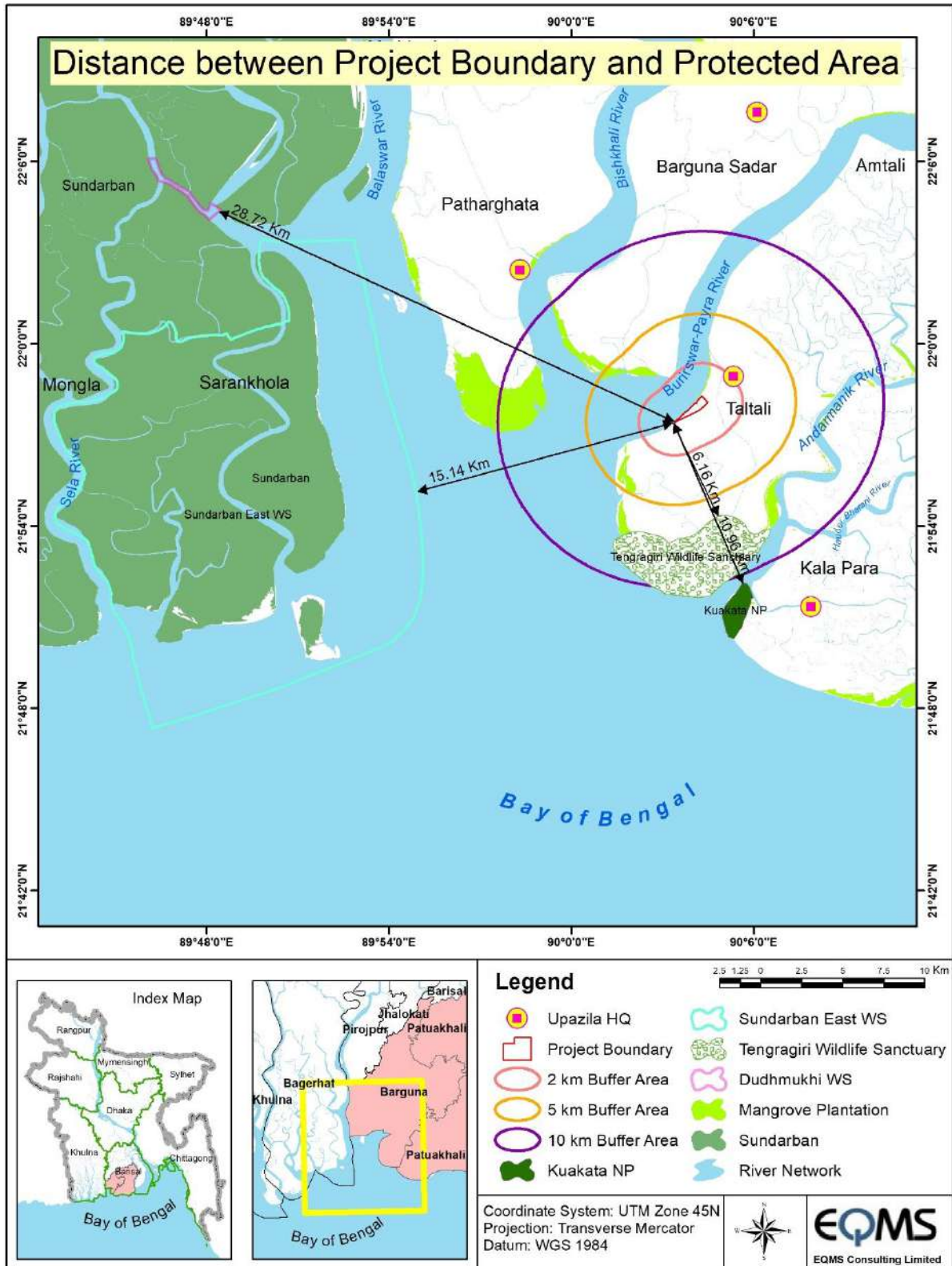
Table 7-14: Protected Areas of Bangladesh

SL	Protected Areas	Location	Area (Ha)	Date of declaration
A. National Parks (NP)				
1	Bhawal NP	Gazipur	5022.29	11/05/1982
2	Modhupur NP	Tangail & Mymensingh	8436.13	24/02/1982
3	Ramsagar NP	Dinajpur	27.75	30/04/2001
4	Himchari NP	Cox's Bazar	1729.00	15/02/1980
5	Lawachara NP	Maulavibazar	1250.00	07/07/1996
6	Kaptai NP	Rangamati	5464.78	09/09/1999
7	Nijhum Dweep NP	Noakhali	16352.23	08/04/2001
8	Medha Kachapia NP	Cox's Bazar	395.92	04/04/2004
9	Satchari NP	Habiganj	242.91	10/10/2005
10	Khadim Nagar NP	Sylhet	678.80	13/04/2006
11	Baraiyadhala NP	Chittagong	2933.61	06/04/2010
12	Kuakata NP	Patuakhali	1613.00	24/10/2010
13	Nababganj NP	Dinajpur	517.61	24/10/2010
14	Shingra NP	Dinajpur	305.69	24/10/2010
15	Kadigarh NP	Mymensingh	344.13	24/10/2010
16	Altadighi NP	Naogaon	264.12	14/12/2011
17	Birganj NP	Dinajpur	168.56	14/12/2011
B. Wildlife Sanctuary (WS)				
1	Rema Kalenga WS	Habiganj	1795.54	07/07/1996
2	Char kukri mukri WS	Bhola	40.00	19/12/1981
3	Sundarban East WS	Bagerhat	122920.90	19/06/2017
4	Sundarban West WS	Satkhira	119718.88	29/06/2017
5	Sundarban South WS	Khulna	75310.30	29/06/2017
6	Pablakhali WS	Hill tracts	42069.37	20/09/1983
7	Chunti WS	Chittagong	7763.97	18/03/1986
8	Fasiakhali WS	Cox's Bazar	1302.42	11/04/2007
9	Dudpukur-Dhopachari WS	Chittagong	4716.57	06/04/2010
10	Hajarikhil WS	Chittagong	1177.53	06/04/2010

SL	Protected Areas	Location	Area (Ha)	Date of declaration
11	Sangu WS	Bandarban	2331.98	06/04/2010
12	Teknaf WS	Cox's Bazar	11614.57	09/12/2009
13	Tengragiri WS	Barguna	4048.58	24/10/2010
14	Dudmukhi WS	Bagerhat	170.00	29/01/2012
15	Chandpai WS	Bagerhat	560.00	29/01/2012
16	Dhongmari WS	Bagerhat	340.00	29/01/2012
17	Sonarchar WS	Patuakhali	2026.48	24/12/2011
18	Najirganj Dolphin Sanctuary	Pabna	146.00	01/12/2013
19	Silonda Nagdemra Dolphin Sanctuary	Pabna	24.17	01/12/2013
20	Nagarbari-Mohanganj Dolphin Sanctuary	Pabna	408.11	01/12/2013
21	Swatch of No Ground	South Bay of Bengal	173800	27/10/2014
C. Special Wildlife Sanctuary				
1	Ratargul Special WS	Sylhet	204.25	-
2	Altadighi Special WS	Naogaon	17.34	-
D. Safari Park				
1	Bangabandhu Sheikh Mujib Safari park	Cox's Bazar	900.00	-
2	Bangabandhu Sheikh Mujib Safari park	Gazipur	1390.00	-
E. Eco-park (EP)				
1	Sitakundu EP	Chittagong	808.00	1998
2	Modhutila EP	Sherpur	100	1999
3	Madhabkundu EP	Moulavibazar	265.68	2001
4	Banshkhali EP	Chittagong	1200	2003
5	Kuakata EP	Patuakhali	5661	2005
6	Tilagorh EP	Sylhet	45.34	2006
7	Barsijora EP	Moulavibazar	326.07	2006
8	Jamuna bridge West side EP	Pabna	50.02	2008
9	Pirojpur Riverview EP	Pirojpur	2.54	2010
10	Sheikh Rasel Aviary and eco-park	Chittagong	210.00	-

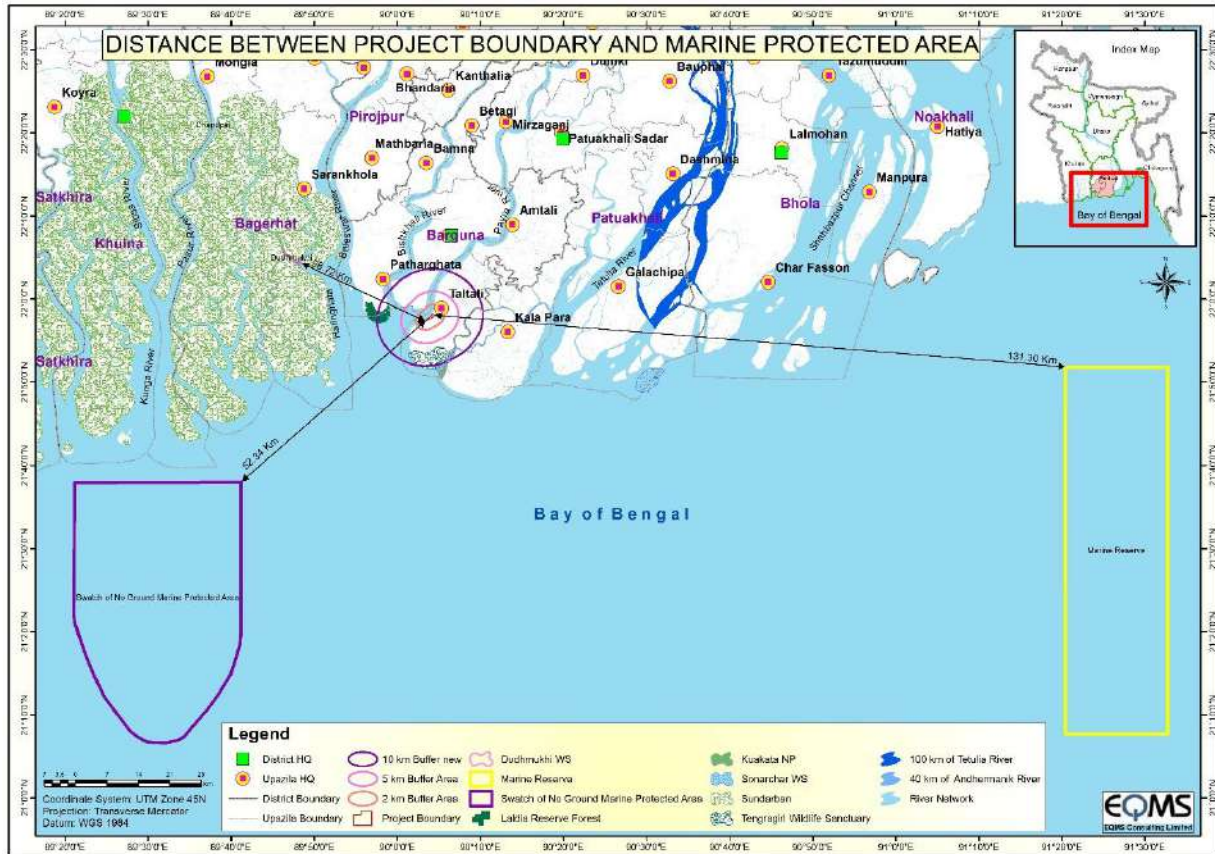
Source: Forest Department, July 2018

Figure 7-31: Distance between Protected Areas and Project Boundary



Source: EQMS, 2018

Figure 7-32: Distance between Marine Protected Areas and Project Boundary

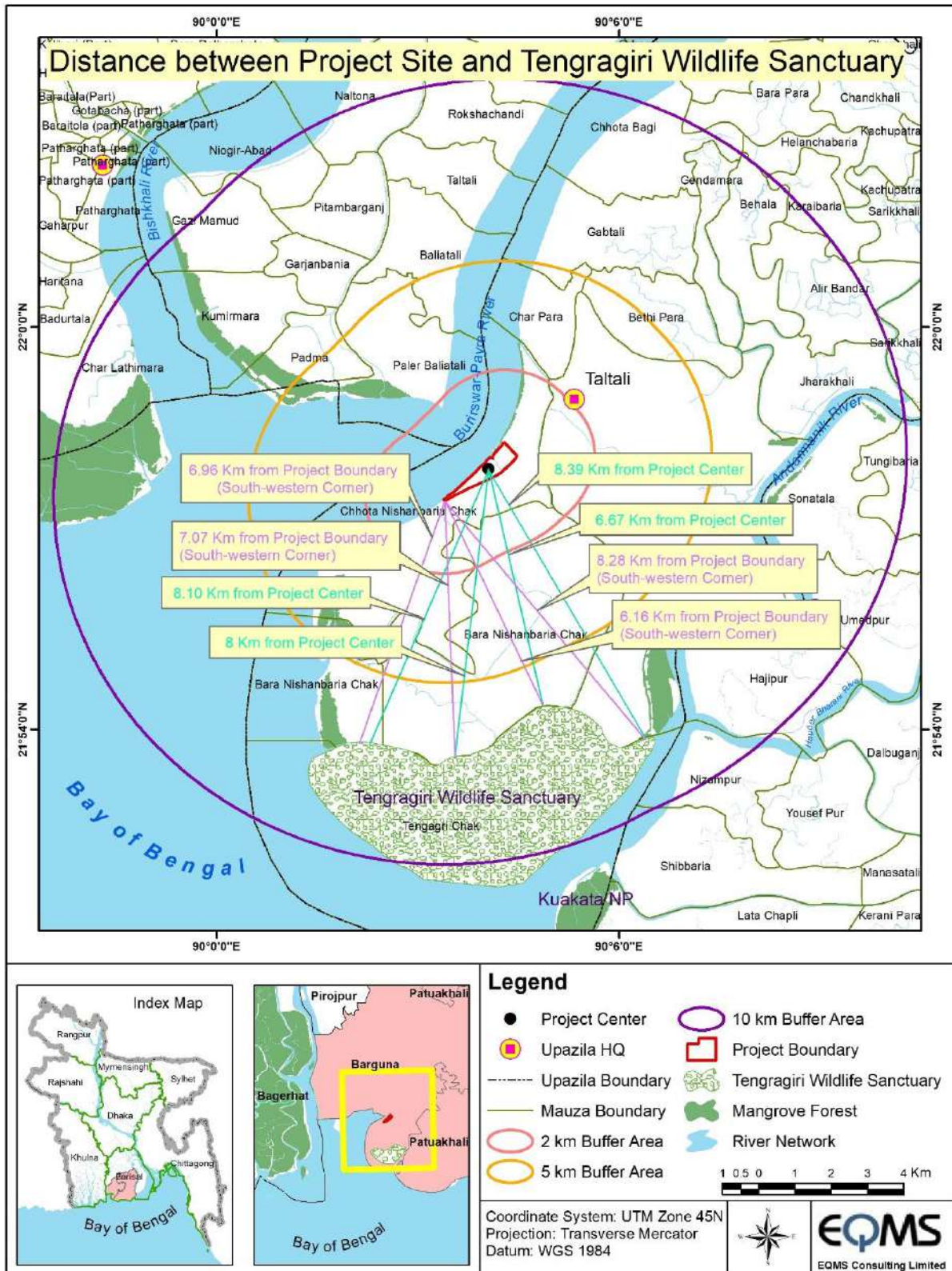


Source: EQMS, 2018

7.16.2.1 Tengragiri Wildlife Sanctuary

The Wildlife Sanctuary is an area that assures the natural conditions necessary to protect nationally significant species, groups of species, biotic communities or physical features of the environment. The nearest wildlife sanctuary from the proposed project site is the Tengragiri Wildlife Sanctuary. A notification has been published by the Ministry of Environment and Forest (now the Ministry of Environment, Forest and Climate Change) on 24th October 2010 and declared that the Tengragiri wildlife sanctuary is located in the Tengragiri Mouza. However, the proposed project is going to be established in the Nishanbaria Mouza. According to the Wildlife (Conservation and Security) Act, 2012, in Chapter-4, Section-16, Sub-section 2(e), there is a restriction for the detrimental activities to environment within the 2 km from the border of the sanctuary area. The Tengragiri wildlife sanctuary is located on the south side from the proposed project. It is approximately 6.67 to 8.30 km far from the center of the project site and 6.16 to 8.28 km far from the most west (nearest point from the Tengragiri WS) point of the project boundary. The location map showing the distance between the Tengragiri WS and proposed project site is given in following Figure 7-33.

Figure 7-33: Distance between Tengragiri Wildlife Sanctuary and Project Site



Source: EQMS, 2018

According to the Upazila Forest Officer of Taltoli Upazila, Barguna and Beat Officer of Tengragiri Wildlife Sanctuary, there is a planted mangrove patches on the west to south-west side from the project site, which is approximately 3.33 km away from the center of the proposed project and it is spread towards the Nidra Sluice Bazar. The photographs of the planted area vegetation is shown in following Figure 7-34 and map of the planted mangrove area is shown in following Figure 7-35. There is also a planted mangrove patches on the North and North-East side between the project boundary and along the Buriswar-Payra river. However, such kind of planted mangrove patches is very common

along the coast of Bangladesh. According to the project proponent (BEPCL), the proposed power plant will not encroach any planted mangrove forest and land of the forest department. From this point of view, the project proponent already collected the No Objection Certificate (NOC) from the Forest Department of the Taltoli Upazila, Barguna is given in Annex-F (Volume-II). The project proponent also expected that the mangrove patches will be beneficial for the proposed power plant by reducing the coastal erosion, heavy cyclonic wind during cyclone events, cyclone induced tidal surges as well as maintaining the environmental balance in the project area.

Figure 7-34: Types of Vegetation in the Planted Forest Area



Planted mangrove patches near the project boundary (north side) and along the river bank



Planted forest area west and south-west from the project site (near the Nidra Sluice Bazar)



Planted forest area south-west from the project



Planted forest area south-west from the project



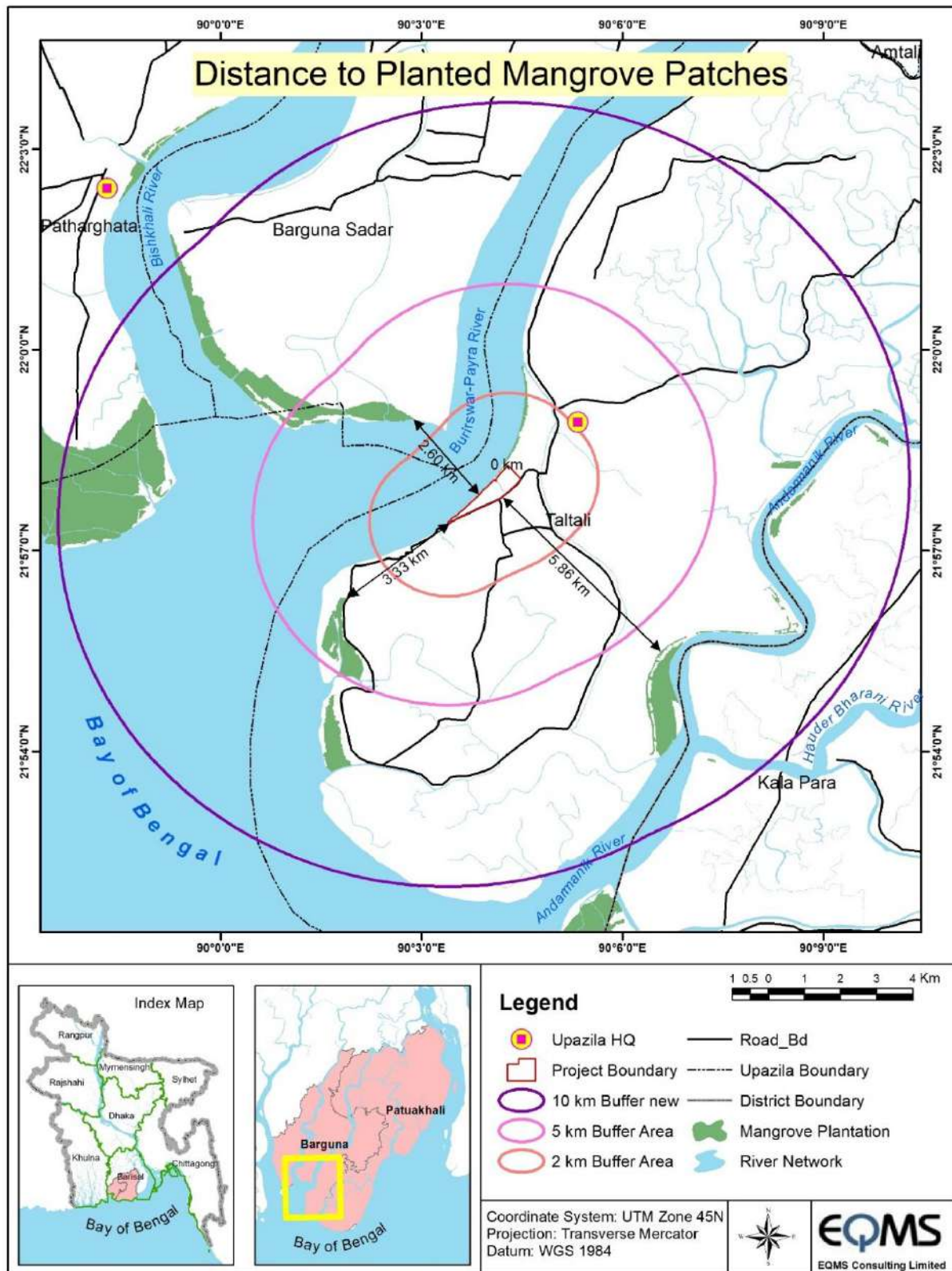
Planted forest along the coast



Planted forest along the coast

Source: Field Survey by EQMS Team, September 2018

Figure 7-35: Distance between Planted Mangrove Patches and Project Site



Source: EQMS, 2018

7.16.3 Ecologically Critical Area

An Ecologically Critical Area (ECA) is an environmental protection zone in Bangladesh. In 1995, specific areas in Bangladesh could be deemed Ecologically Critical Areas as a result of the Environmental Conservation Act. The Government after considering the human habitat, ancient monument, archeological site, forest sanctuary, national park, game reserve, wild animals' habitat, wetland, mangrove, forest area, biodiversity and other relevant factors of the area can declare as

ECA. As per the legal mandate, the MoEF till now declared 13 areas as ECA (Table 7-15). The Department of Environment (DoE) as a statutory body is entrusted to manage the ECAs. The nearest ECA area from the proposed project boundary is the “Sundarbans (10 km landward periphery)”. The description of ECA areas are discussed in following subsequent sections.

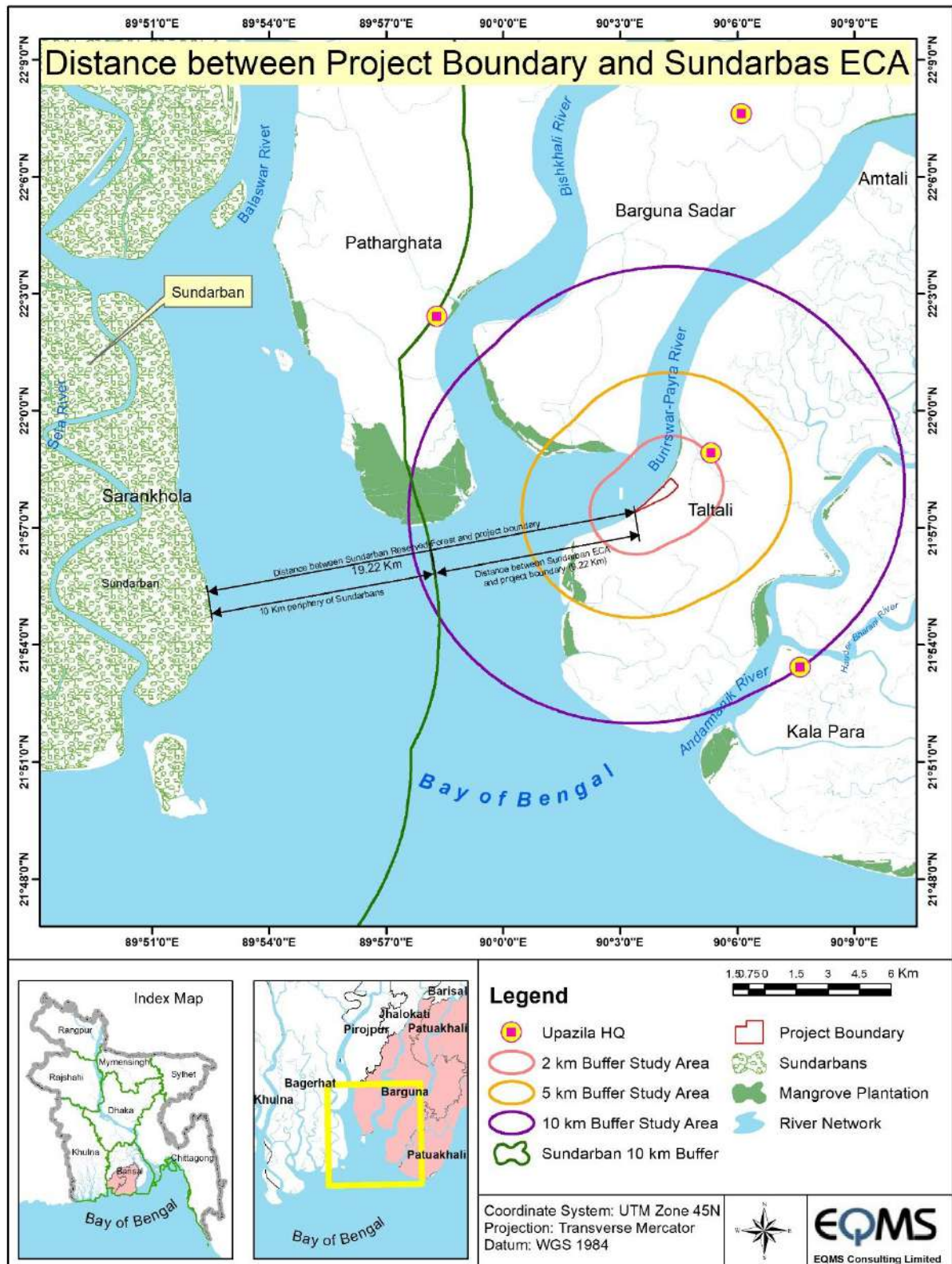
Table 7-15: Ecologically Critical Areas (ECA) of Bangladesh

SL#	Areas	Types of Ecosystem	Location	Area (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, Cox's Bazar	1,214	1999
4	Hakaluki Haor	Inland Freshwater Wetland	Sylhet & Moulavibazar	40,466	1999
5	Sonadia Island	Marine Island	Cox's Bazar	10,298	1999
6	Tanguar Haor	Inland Freshwater Wetland	Sunamganj	9,727	1999
7	Marjat Baor	Oxbow Lake	Jhenaidah	325	1999
8	Gulshan-Baridhara Lake	Urban Wetland	Dhaka City	101	2001
9	Buriganga	River	Around Dhaka	1,336	2009
10	Sitalakhaya	River	Around Dhaka	184	2009
11	Turag	River	Around Dhaka	3,771	2009
12	Balu	River	Around Dhaka	1,315	2009
13	Jaflong-Dawki	River	Jaflong, Sylhet	1,493	2015

Source: DoE, 2015

The Sundarbans reserve forest is the nearest reserve forest and environmentally sensitive area from the proposed coal-fired power plant, which is approximately 19.22 km far from the proposed project site. In addition, the Ecologically Critical Area (ECA) 10 km buffer of the Sundarbans is approximately 9.22 km far from the proposed project site. The distance between Sundarbans reserve forest, ECA area and proposed power plant is shown in following Figure 7-36.

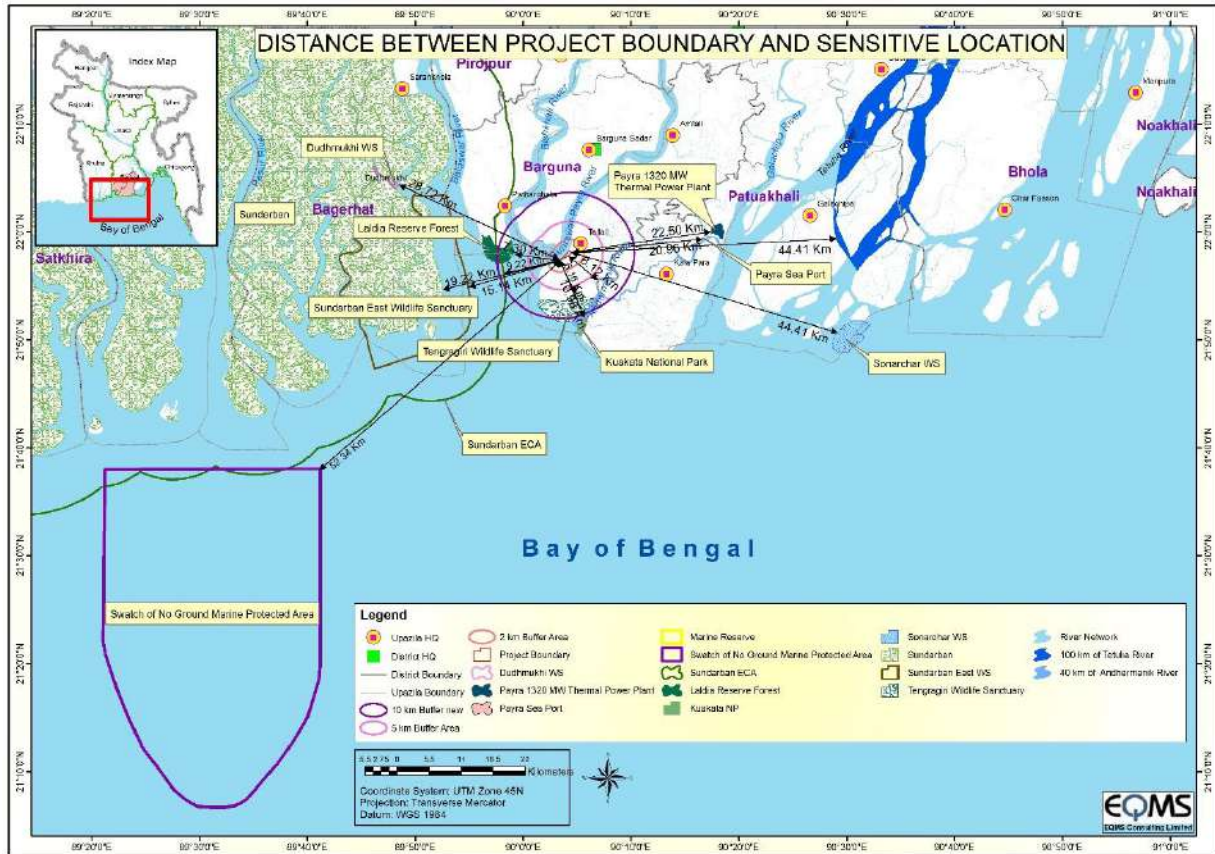
Figure 7-36: Distance between Sundarbans ECA Area and Proposed Power Plant



Source: EQMS, 2018

As per the field visit in the proposed project site and review of available secondary documents, no important ecologically sensitive locations/hotspots are found within the 5 km radius of the proposed project. However, the sensitive locations/ecological hotspots around the proposed project site are Sundarbans Reserve Forest, Sundarbans (10 km landward periphery), Sundarbans East Wildlife Sanctuary, Tengragiri Wildlife Sanctuary, Andharmanik River (Hilsa sanctuary) etc. A map showing the sensitive locations/hotspots in and around the proposed project shown in the following Figure 7-37 and a large size map is also given in Annex-D (Volume-II).

Figure 7-37: Sensitive Locations/Ecological Hotspots in and around the Project Site

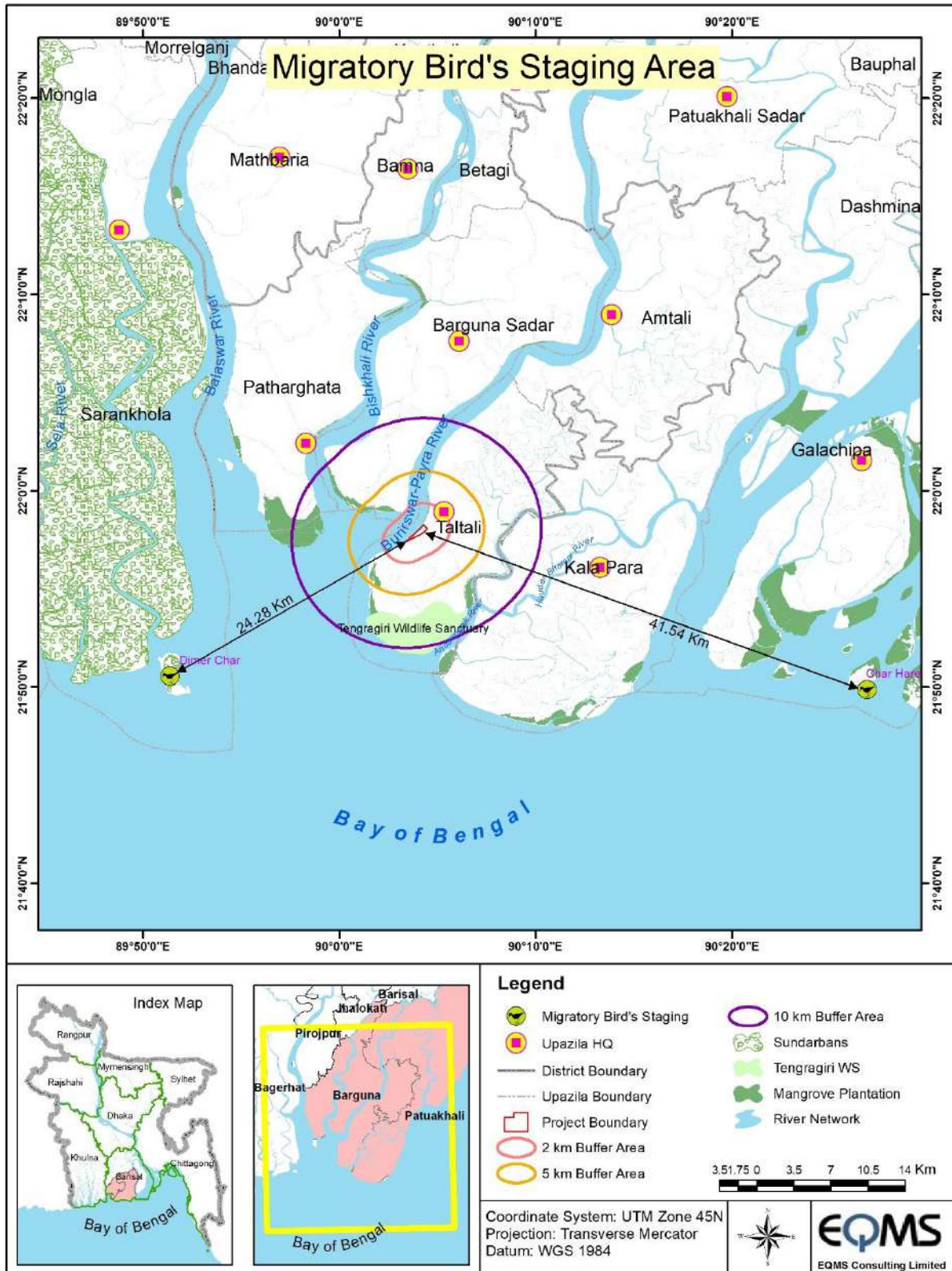


Source: EQMS, 2018

7.16.4 Migratory Bird Staging Area

Bangladesh gets a large number of guest birds from Europe, Central Asian States and India every year. These birds reside in various wetlands, mangroves and mudflats area in Bangladesh during winter season. After the winter season, they go back to their native habitats. According to the field visit, the proposed project site is not a protected wetland area and not part of a game sanctuary or game reserve. According to the Birdlife international, they have identified about 20 important bird areas in Bangladesh. The proposed project area does not fall in any Important Bird and Biodiversity Areas (IBAs). A map of the migratory bird's staging sites in Bangladesh is given in Figure 7-38.

Figure 7-38: Migratory Birds Staging Sites



Source: Birdlife International

7.16.5 Archaeological Site

There is no designated archaeological site in the project area and its surrounding area.

7.16.6 Methodology for Assessment of Biodiversity

7.16.6.1 Methodology for Floral Survey

The field data collection mainly included biodiversity status assessment of different life forms of floral elements such as trees, shrubs, climbers, herbs and grass. The study area was divided according to habitat types followed the random sampling method in the selected area. For plant biodiversity study in the ecosystems, the transect method was followed and accordingly, transects or straight lines were marked starting from the base of the study area to the end of the vegetation zone in four selected site. The location of quadrature study in the project area is shown in Table 7-16.

Floral survey in the study area was undertaken during the study period using quadrature sampling method for different habitats. It has been found existing mangrove forest, coastal reserve forest, fallow land and homestead forest covering the study area. According to the consultation with the local people, the proposed project site is used as single cropped land.

Table 7-16: Location of Quadrature Study in the Project Area

Area	Habitat Type	Quadrature size	Quadrature	GPS Coordinates
Tengragiri Wildlife Sanctuary on south direction	Mangrove Forest	10m x 10m	Q1	21°53'32.1"N 90°02'07.0"E
Babuganj Khal on the west direction	Homestead Forest	10m x 10m	Q2	21°59'03.6"N 90°02'30.3"E
Inside the project site	Fallow land	5m x 5m	Q3	21°57'43.97"N 90°03'53.52"E
Laldia Reserved Forest on west direction	Coastal Reserve Forest	10m x 10m	Q4	21°58'12.60"N 89°59'06.16"E

Source: Field Survey by EQMS Team, March 2018

The field data collection was mainly included on biodiversity assessment of different life of floral elements such as trees, shrubs, climbers, herbs and grasses. The photographs of the quadrature study in the project area is shown in following Figure 7-39.

Figure 7-39: Quadrature Study in the Project Area



Photographs of Quadrature Study



Photographs of Quadrature Study



Photographs of Quadrat Study



Photographs of Quadrat Study

Source: Field Survey by EQMS Team, March 2018

7.16.6.1.1 Diversity Indices

A diversity index is a quantitative measure that reflects how many different types (such as species) there are in a dataset (a community), and simultaneously takes into account how evenly the basic entities (such as individuals) are distributed among those types.

When diversity indices are used in ecology, the types of interest are usually species, but they can also be other categories, such as genera, families, functional types or haplotypes. The entities of interest are usually individual plants or animals, and the measure of abundance can be, for example, number of individuals, biomass or coverage. In demography, the entities of interest can be people and the types of interest various demographic groups. In information science, the entities can be characters and the types the different letters of the alphabet. The most commonly used diversity indices are simple transformations of the effective number of types (also known as 'true diversity'), but each diversity index can also be interpreted in its own right as a measure corresponding to some real phenomenon (but a different one for each diversity index).

Many indices only account for categorical diversity between subjects or entities. Such indices however do not account for the total variation (diversity) that can be held between subjects or entities which occurs only when both categorical and qualitative diversity are calculated.

On the diversity scale, biologically realistic H' values range from 0 (only one species presents with no uncertainty as to what species each individual will be) to about 4.5 (high uncertainty as species are relatively evenly distributed). In theory, the H' value can be much higher than 4.5, although most real-world estimates of H' range from 1.5 to 3.5.

The Equation is:

Shannon diversity index, $H = -\sum [(p_i) * \ln(p_i)]$

Evenness, $E = H/H_{\max}$

Where, SUM = Summation

p_i = Number of individuals of species /total number of samples

S = Number of species or species richness

$H^{\max}$ = Maximum diversity possible

E = Evenness = $H/H_{\max}$

7.16.7 Biodiversity of Flora

In the study area of proposed Barisal 350 MW coal-fired power plant at Taltoli, Barguna terrestrial flora covers most of the vegetation. Inside it and around the adjoining area's (study area) terrestrial and aquatic floral ecosystems were divided into four category.

- Homestead Plantation;
- Roadside Vegetation;
- Mangrove Vegetation; and

- Aquatic Flora.

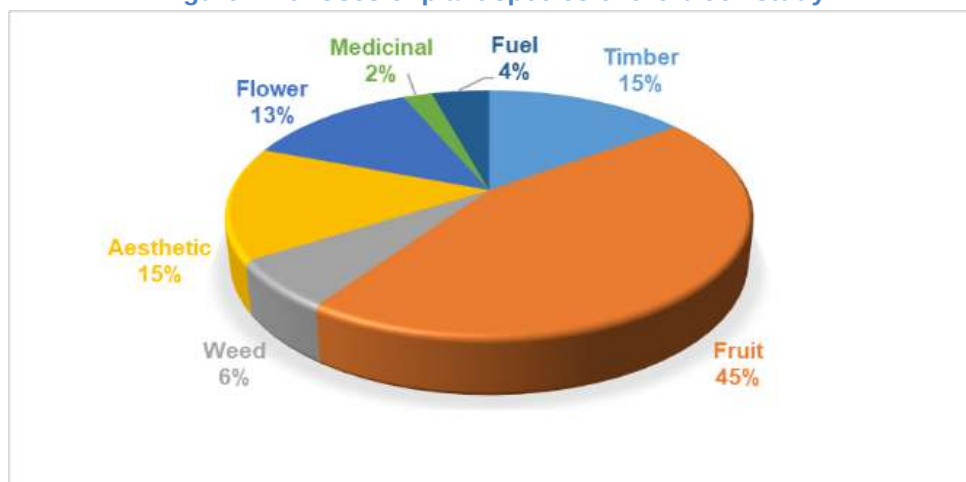
7.16.7.1 Homestead Plantation

Project site is adjacent to local houses and people are planted numerous plants according to their own uses. Due to connection with the coastal area as well as plain land, the site belongs to some mixed habitat. The number of homestead plants are very common and not in big scale. Species are mainly Kola (*Musa acuminata*), Koroi (*Samanea saman*), Nim (*Azadirachta indica*), Babla (*Vachellia nilotica*), Khejur (*Phoenix dactylifera*), Tal (*Borassus flabellifer*), Kochu (*Colocasia esculenta*), Narikel (*Cocos nucifera*), Kath Badam (*Terminalia catappa*) etc. No vulnerable species were found during the survey. From them, dominant 4 species are from Arecaceae family, 2 species from the Fabaceae family and 1 species are found from other family. Currently the project site is a null/barren land where limited scale of paddy (*Oryza sativa*) are produced.

On the other hand, Total twenty-nine (29) homestead species of twenty (20) families were listed from the study area (10 km radius) of the project site during the field survey. Common planted tree species in the study area are Supari (*Areca catechu*), Mehogany (*Swietenia mahagoni*), Keora (*Sonneratia apetala*) etc. Raintree (*Samanea saman*), Narikel (*Cocos nucifera*), Tal (*Borassus flabellifer*) and Supari (*Areca catechu*) occupied the top canopy. Homestead flora consists of both native and exotic species *Acacia* (*Acacia auriculiformis*) and some of them are naturalized. Majority of the tree species belongs to the family Arecaceae. Moreover second highest occupied from the family Fabaceae (4 spp.) followed by Moraceae, and Myrtaceae (3 spp.) each. A detailed list of the homestead plantation species and photographs is given in Annex-H (Volume-II).

Among all plant species of the study site, it has been found that about half (45%) of the tree species are used as a source of fruit. Both 15% are used as timbers and aesthetic purpose. Only 2% plants are used for medicinal purpose. The use of plant species of the block study is shown in Figure 7-40.

Figure 7-40: Uses of plant species of the block study



Source: Field Survey by EQMS Team, March and September 2018

7.16.7.2 Floral Diversity Index of Study Area

To observe the species diversity and evenness Shanon Index method was estimated. Four (4) types of land use class were considered such as Mangrove Forest, Coastal Reserve forest, Fallow land and Homestead land. Among of them Mangrove Forest shows the highest (1.85) species diversity. On the other hand, Homestead land represents the highest Evenness magnitude (0.91). The estimation of species diversity and evenness is given in following Table 7-17 and Figure 7-41.

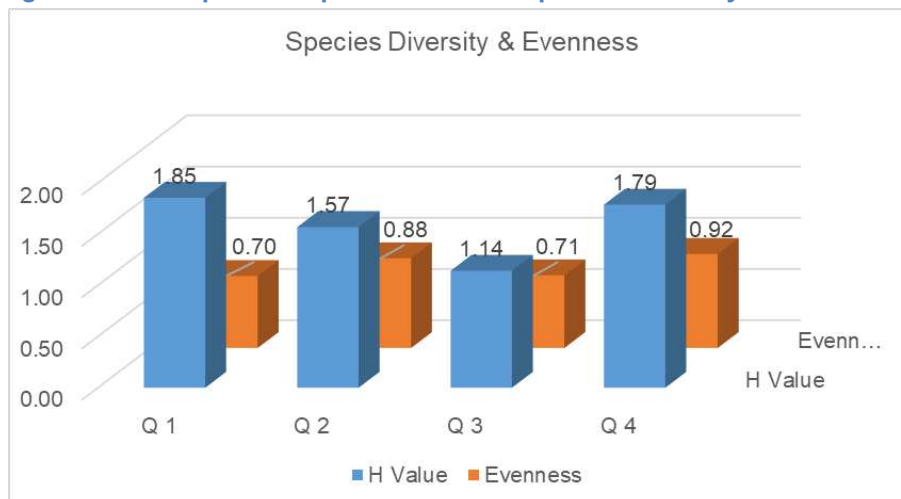
Table 7-17: Estimation of Species Diversity and Evenness

Quadrates No	Habitat Type	Number of Species	Total Abundance	Species Diversity (H)	Evenness (E)
Q1	Mangrove Forest	14	93	1.85432253	0.702646
Q2	Coastal Reserve forest	6	28	1.56875655	0.87554

Quadrates No	Habitat Type	Number of Species	Total Abundance	Species Diversity (H)	Evenness (E)
Q3	Fallow land	5	29	1.141450457	0.709223
Q4	Homestead land	7	59	1.786735	0.9182

Source: Field Survey by EQMS Team, March and September 2018

Figure 7-41: Graphical Representation of Species Diversity and Evenness



Source: Field Survey by EQMS Team, March and September 2018

7.16.7.3 Roadside Vegetation

A total of thirty-four (34) species of plant were found under twenty-one (21) families during the field survey. Major tree species observed in and around the roadside of the project area were Tal (*Borassus flabellifer*), Hergoza (*Acanthus ilicifolius*), Keora (*Sonneratia apetala*), Koroï (*Samanea saman*), Mehegony (*Swietenia mahagoni*), Debbaru (*Polyalthia longifolia*) and Supari (*Areca catechu*). A detailed list of the roadside vegetation is given in Annex-H (Volume-II).

7.16.7.4 Mangrove Vegetation

The proposed project area is situated at the bank of the Buriswar-Payra River, which is connected to the Bay of Bengal. The proposed project area is adjacent to a planted Keora (*Sonneratia spp.*) vegetation implemented by department of forest. A total of thirty-seven (37) mangrove species were found during the study. Along with the Keora (*Sonneratia spp.*), there are some other mangrove species like Chorkochu (*Cryptocoryne ciliate*), Hental (*Phoenix paludosa*), Golpata (*Nypa fruticans*), Dakur (*Cerbera manghas*), Bawali Lota (*Sarcolobus globosus*), Nonajau (*Tamarix gallica*) etc. Species composition and a detailed list is given in Annex-H (Volume-II).

7.16.7.5 Aquatic Flora

Aquatic plants are important ecological components of rivers, lakes, wetlands and coastal to marine environments. They create habitats ranging from seagrass meadows and mangrove forests to free-floating communities in freshwater ponds and lakes. These valuable ecosystem service providers play a major role in the structure and functioning of these environments. A total number of seventeen (17) aquatic plant species belonging to fourteen (11) families have found at the study area (10 km of the project boundary).

The species are mainly Alligator Weed (*Alternanthera philoxeroides*), Coco Yam (*Colocasia esculenta*), Water Lettuce (*Pistia stratiotes*), Helencha (*Enhydra fluctuans*), Esthwaite Waterweed (*Hydrilla verticillata*) and Four Leaf Clover (*Marsilea quadrifolia*) etc. specification of the species are given in Annex-H. During the survey in the proposed project area, different types of water bodies (Bay of Bengal, Buriswar-Payra Rivers, Biskhali River, Andarmanik River and ponds) were found within the study area (10 kilometer radius) of the study area. The aquatic vegetation survey has been conducted by visual observation and FGD with local people as well as secondary information sources.

Among them Araceae, Pontaderiaceae and Polygonaceae family have found maximum two times. However, the population of Common water hyacinth was highest in and everywhere in the aquatic bodies of the study site. A detailed list and photographs of the aquatic flora is given in following Annex-H (Volume-II).

7.16.8 Biodiversity of Fauna

Total faunal biodiversity of the study area are divided into four major classed such as:

- Birds;
- Amphibians and Reptiles;
- Mammals; and
- Fisheries.

7.16.8.1 Birds

Ecology refers to the relationships between animals and plants, as well as the physical environment that surrounds them. The complex interactions between organisms reflect every aspect of their lives. The balance between birds and other animals and plants is a delicate one, and the consequences of changes to any aspect of this balance are never restricted to a single species, but affect many, either in terms of food (eating or being eaten), shelter or breeding opportunities. The ecology of birds tells us how they fit into the environment in which they live, and how they coexist with other organisms. There are two main aspects of ecology of birds: feeding ecology and breeding ecology.

During the survey tenure, a total of seventy two (72) species of birds were identified belonging to forty three (43) families at the study area. The highest number of birds dominated in the study area belonging to the family Alcedinidae. However, the birds belong to the family Accipitridae, Cuculidae and Columbidae has found as second dominated family among all. Homestead forest, Mangrove forest and some aquatic habitat of this area have supported the wild birds for feeding and roosting ground. Only Brown winged kingfisher (*Pelargopsis amauroptera*) which is a common bird in the mangrove forest is found as Vulnerable (VU) (found in Tengragiri WS) but rest all of the bird species found within the study area are least concern (LC) both locally and globally according to IUCN Red List 2015. A detailed list of the bird's species is given in Annex-H (Volume-II).

7.16.8.2 Amphibians and Reptiles

Human welfare depends directly or indirectly on the services provided by ecosystems. Amphibians and reptiles represent a high proportion of global species diversity and include species that are widely distributed throughout the world and play a variety of roles that benefit humans. The team found some species near the project area and most significant's are Tiktiki (*Hemidactylus frenatus*), Roktochosa (*Calotes versicolor*), Angina (*Eutropis carinata*), Dora shaap (*Xenochrophis piscator*) and sutanoli (*Ahaetulla nasuta*) etc.

During field investigation, fourteen (14) species of amphibians and reptiles were recorded in the study area. Furthermore, four (4) near threatened reptiles such as Bengal Monitor (*Varanus bengalensis*), Indian Rat snake (*Ptyas mucosus*), Monocled Cobra (*Naja kaouthia*), Spectacled Cobra (*Naja naja*) and one vulnerable species Water Monitor (*Varanus salvator*) was found in the Tengragiri Wildlife Sanctuary during the study period as per IUCN red category list. In addition, only one (1) Data Deficient species (*Hylarana taipehensis*) was found at the study area among four (4) amphibians. A detailed checklist of herpetofauna is given in Annex-H (Volume-II).

7.16.8.3 Mammals

Mammals have incredible biological diversity, showing extreme flexibility in eco-morphology, physiology, life history and behavior across their evolutionary history. Undoubtedly, mammals play an important role in ecosystems by providing essential services such as regulating insect populations, seed dispersal and pollination and act as indicators of general ecosystem health. However, the macro-ecological and macro-evolutionary processes underpinning past and present biodiversity patterns are only beginning to be explored on a global scale. It is also particularly important, in the

face of the global extinction crisis, to understand these processes in order to be able to use this knowledge to prevent future biodiversity loss and loss of ecosystem services.

It has been recorded eleven (11) mammal species in the study area. According to the review of secondary data, FGD and Consultation with the local people Rhesus Macaque (*Macaca mulatta*) and Ganges River Dolphin (*Platanista gangetica*) were found as vulnerable, one endangered species Fishing Cat (*Prionailurus viverrinus*) and one critically endangered species Smooth Coated Otter (*Lutrogale perspicillata*) has been found at the Tengragiri Wildlife Sanctuary and associated River according to the IUCN red category list 2015. A detailed list of the mammals and photographs is also given in Annex-H (Volume-II).

7.16.8.4 Fisheries

No fishing practice have been found within the project area except one sample fishery plot for Cuchia (*Monopterusuchia*). Most lands are inundated with tidal water and habitat are disturbed with high anthropogenic activities. People mainly use these lands for crop production and repairing of mechanized boat. Few fisherman catches fishes with long net joined with large bamboo stick made a fixed system and they remain that net for 3-5 month. The total catch per day is approximately 20-27 kgs. Most of them are small fishes. Other large scale fishing occurred into the downstream and far from the project area.

There are two different kinds of fishing activities are found in the study area (i) deep sea fishing: the fishermen who went to deep sea with mechanized larger boats and stayed 5-10 days or even more depending on the distance fishermen cross for a single trip with a group of 7 to 14 or more and (ii) Estuarine and near shore fishing: the fishermen who catch fish near shore and went on a daily basis and used smaller boats or non-mechanized boats that usually carry 1 to 10 fishermen on board. The fishermen who fish near shore mostly fish all the year round. However, the fishermen who capture fish at deep sea mainly considered October to March as peak fishing season whereas April to mid-September as a lean fishing season. According to the field visit and review of secondary documents, no fish sanctuary and breeding ground (except the Hilsa fish) was found in the project study area.

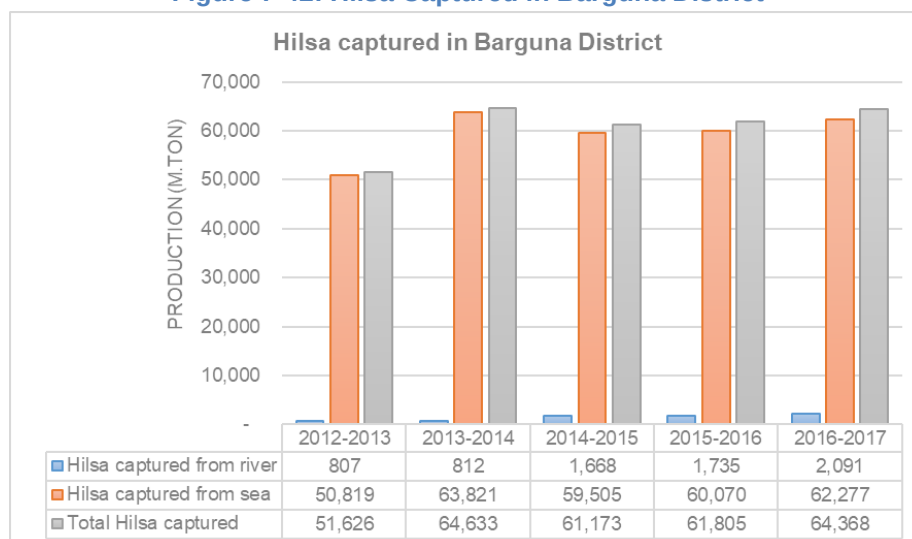
Total fifty six (56) fish species were enumerated based on consultation with the fishermen, fishing ground analysis and fish market survey. The common fish species found in the study area are Aila (*Seriolina nigrofasciata*), Bata (*Liza parsia*), Koral bata (*Mugil cephalus*), Chowkha (*Ilish filligera*), Pan mach (*Drepane punctate*), Poysha mach (*Scutoruconius*), Futki chapa (*Scomberoides commersonianus*), Faissa/dati faissa (*Thryssa setirostris*), Sada datina (*Pomadasys hasta*), Hilsha (*Tenualosa ilisha*), Ram chowkkhya (*Ilisha elongate*), Chowkkhya faissa (*Ilisha megalopteran*), Kata gogut (*Arius nenga*), Hatir kan (*Ephippus orbis*), Toli (*Hilsa toil*), Ram kata (*Arius maculates*), Kaua mach (*Megalaspis cordyla*), Khoilla (*Mugil corsula*) and Koral (*Lates calcarifer*) etc. None of the species were listed as the threatened as per IUCN classification. A detailed list of the fish species and photographs is given in Annex-H (Volume-II).

7.16.8.4.1 Hilsa in the Study Area

The marine fish *Tenualosa ilisha* (Ham.), popularly known as Hilsa, (Ilish in Bengali), belongs to the order clupeiformes of clupeidae family is an anadromous species. It inhabits in freshwater rivers, estuaries and marine environments. The Hilsa is a unique commercial food fish in the indo-pacific region, especially in Bangladesh, India and Myanmar.

According to the District Fisheries Office of the Barguna District, approximately 19% of the total Hilsa fish captured in the country is came from the Barguna District. Actually, Hilsa fish is captured from the Bishkhali River, Payra River, Khakdon River and Baleshwar River and the Bay of Bengal. They also inform that, in Taltoli Upazila, there are 9,258 numbers of registered fisherman's who have valid license for capturing fish in the sea. A government fish landing station is also located in Patharghata Upazila of Barguna District. The Hilsa captured data for five years in Barguna district was collected from the district fisheries office and given below in following Figure 7-42.

Figure 7-42: Hilsa Captured in Barguna District



Source: District Fisheries Office, Barguna, 2018

Hilsa Fish Sanctuary and Spawning Ground:

Five Hilsa sanctuaries and four major spawning grounds in the coastal and freshwater areas of the country have been established under the “Protection and Conservation of fish Act-1950” for the effective conservation of Jatka and brood Hilsa in the major nursery and spawning areas (Table 7-18). According to the Bangladesh Gazette, 13th September 2017, Ministry of Fisheries and Livestock (MoFL) Spawning period has been extended to 22 days. The details of the spawning period of Hilsa are presented in Table 7-19. Catch, carry, transport, offer, sell, barter, expose or possess of all kinds of fishes prohibited in a certain period in particular areas. Notwithstanding, anything contained in these rules, no person shall catch or cause to be caught². According to the government gazette, the proposed project site is not located inside of any Hilsa sanctuary and spawning ground. The nearest Hilsa sanctuary is the Andharmanik River, which is located outside of the 5 km radius of the project boundary. The closest distance between the river and project site is approximately 6.12 km. According to the project proponent, the Andharmanik River will not be impacted by any kind of the proposed project activities.

Table 7-18: Hilsa Sanctuary in Bangladesh

Sanctuary Area	Co-ordinates	Area length	District
From Shatnol to Char Alexander	Shatnol: 90°37.12' E & 23°28.19' N Char-Alexander: 90°49.30'E & 22°40.92 N	100 km	Chandpur-Laxmipur
Char Ilisha to Char Pial	Char-ilisha Mosque: 90°38.85 E & 22°47.30'N Char-Pial Point: 90°44.81'E & 22°5.10'N	90 km	Bhola
Bheduria to Char Rustam	Bheduria Ferry Ghat Mosque Point: 90°33.89' E & 22°42.31N Mandolbazar (Char Rustam): 90°31.40' E & 21°56.32' N	100 km	Bhola-Patuakhali
Kalapara Golbunia point to the confluence of Bay of Bengal and Andharmanik river	Golbunia: 90°19.20' E & 21°57.68' N Confluence of Bay of Bengal and Andhermanik River: 90°3.91'E & 21°49.43N	40 km	Patuakhali
Tarabunia to Vomkora	Kachikata Point: 90°32.6' & 23°19.8' N Bhomkara Point: 90°28.8' E & 23°18.4' N Beparipara Point: 90°37.7' E & 23°15.9' N Tarabunia Point: 90°35.1' E & 23° 13.5' N	20 km	Shariatpur

Source: Ministry of Fisheries and Livestock (MoFL)

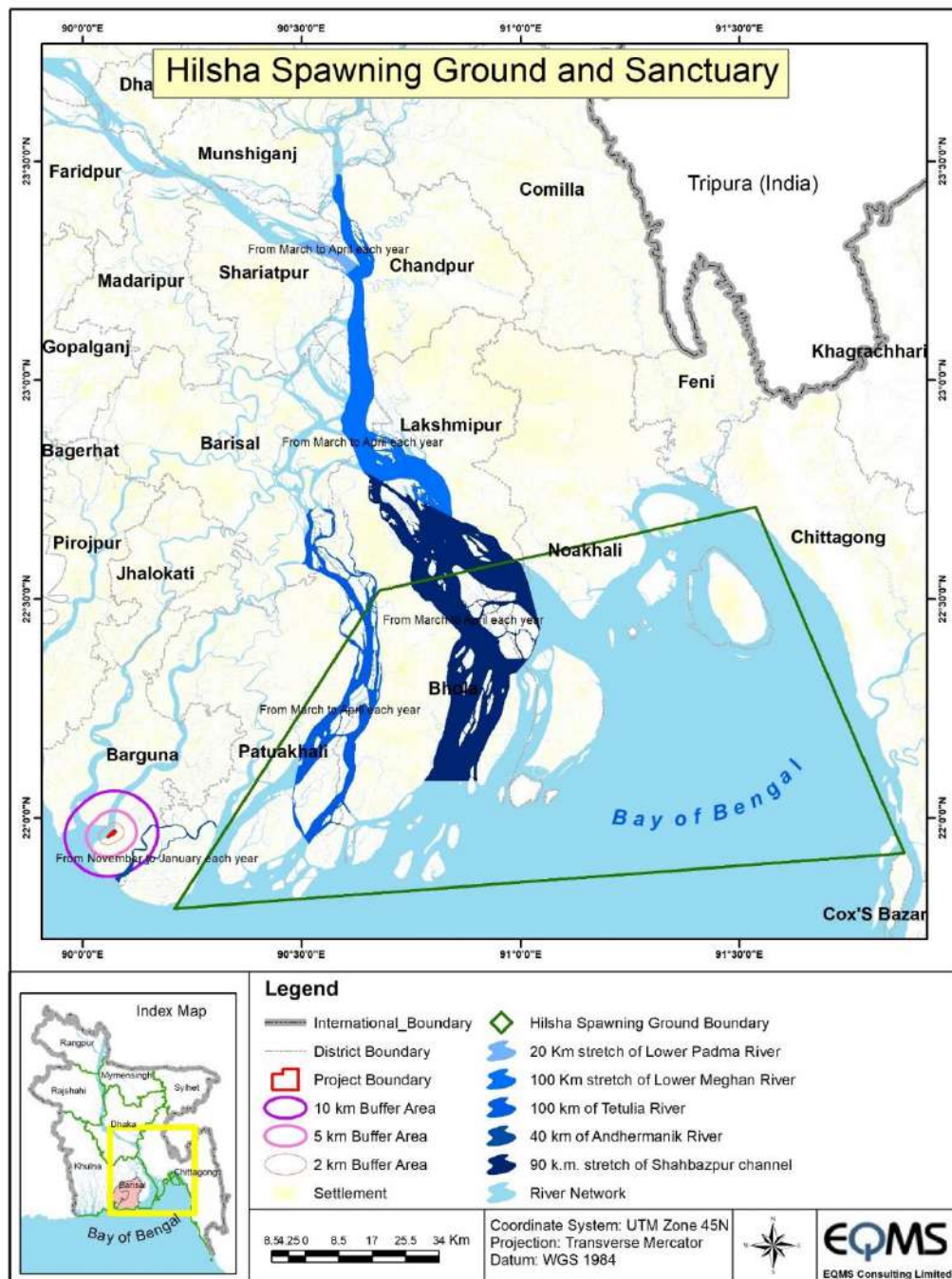
² Bangladesh Gazette, 27th November 2014, MoFL.

Table 7-19: Hilsa Spawning Ground and Ban Period in Bangladesh

SL#	Spawning Ground	Coordinates	Spawning Period	District
1	Mayani point, Mirsarai	91°32.15" E 22°42.59" N	4 (four) days before and 17 (seventeen) days after the full moon including the day of full moon, that is, total 22 (twenty-two) days of the moon, which will be first appeared in the Bengali month of Ashwin each year	Chittagong
2	Paschim Syed Awlia point, Tajumuddin	90°40.58" E 22°31.16" N		Bhola
3	Paschim Syed Awlia point, Tajumuddin	90°40.58" E 22°31.16" N		Cox's Bazar
4	Lata Chapali point, Kalapara	90°12.59" E 21°47.56" N		Patuakhali

Source: Ministry of Fisheries and Livestock (MoFL)

Figure 7-43: Hilsa Spawning Ground and Sanctuary Area



Source: Ministry of Fisheries and Livestock (MoFL)

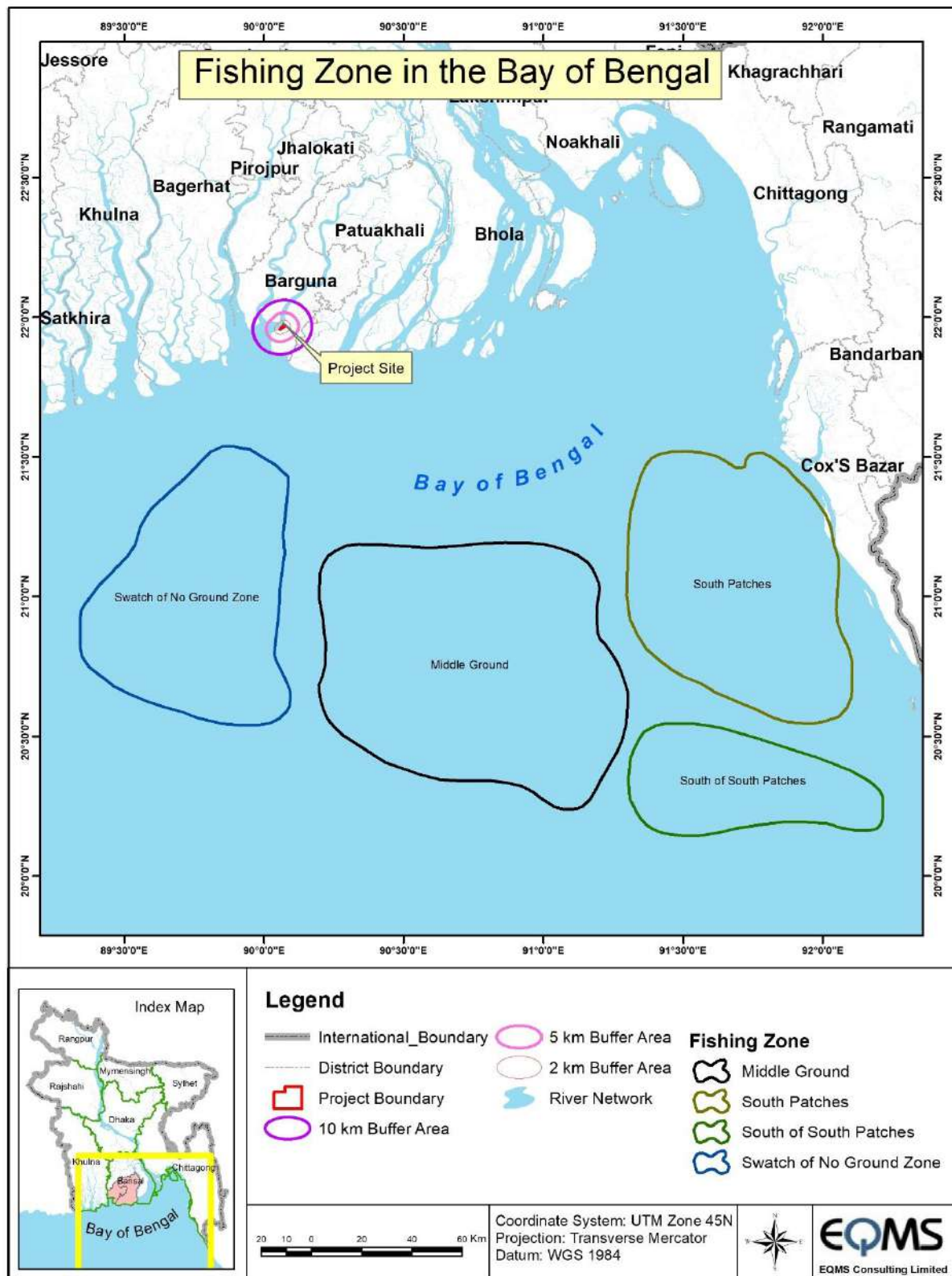
According to the review of the secondary document, it was found the Buriswar-Payra River near the project site fall in moderately suitable habitat for Hilsa breeding. The breeding areas of Hilsa in the coastal waters of Bangladesh is given below in Figure 7-44.

Figure 7-44: Breeding Areas of Hilsa in the Coastal Waters of Bangladesh



Source: Hossain et al. 2014

Figure 7-45: Fishing Zone in the Bay of Bengal and Project Site



Source: FAO

7.16.8.4.2 Status of the Turtle

Factors such as beach elevation or accessibility of beach, beach height, type of sediment or substrate type (muddy or sandy) and grain size of sand, compressibility of sand and thermal variations in the sandy beach have been found to influence the choice of beach for nesting by sea turtles (Stoneburner and Richardson, 1981). Different turtles prefer different types of beaches for nesting. For example,

olive ridleys and leatherbacks most often prefer open areas, wide beaches with steep slopes and sand bars at river mouths (Shanker et al., 2003a; 2003b).

Most of the riverbank site within the footprint of the project area are clay with planted mangrove vegetation, which may prevent sea turtle from nesting or accessing the beach. Also, the soil type at the riverbank in the project area is too compacted for any successful digging of egg chamber. Major parts of the riverbank site within the immediate impact zones of the project are therefore unlikely to support significant sea turtle nesting. The presence of intense disturbance from activities of the local communities such as light from homes, cattle movement, mangrove plantation, fishing net, fishing activities and boats movement in the river reduces the suitability of these areas for turtle nesting. During the field survey, KII and FGD was conducted with the local fishing community in order to collect data regarding the status of turtle in the project area. According to them, the presence of turtle in the proposed project site is absent. The photographs showing the existing condition of the riverbank side is given below in following Figure 7-46.

Figure 7-46: Existing Condition of the Riverbank Side



Planted mangrove area and cattle movement



Human interference in the river side



Human activities and soil condition



Dense vegetation along the river bank

Source: Field Survey by EQMS Team, September 2018

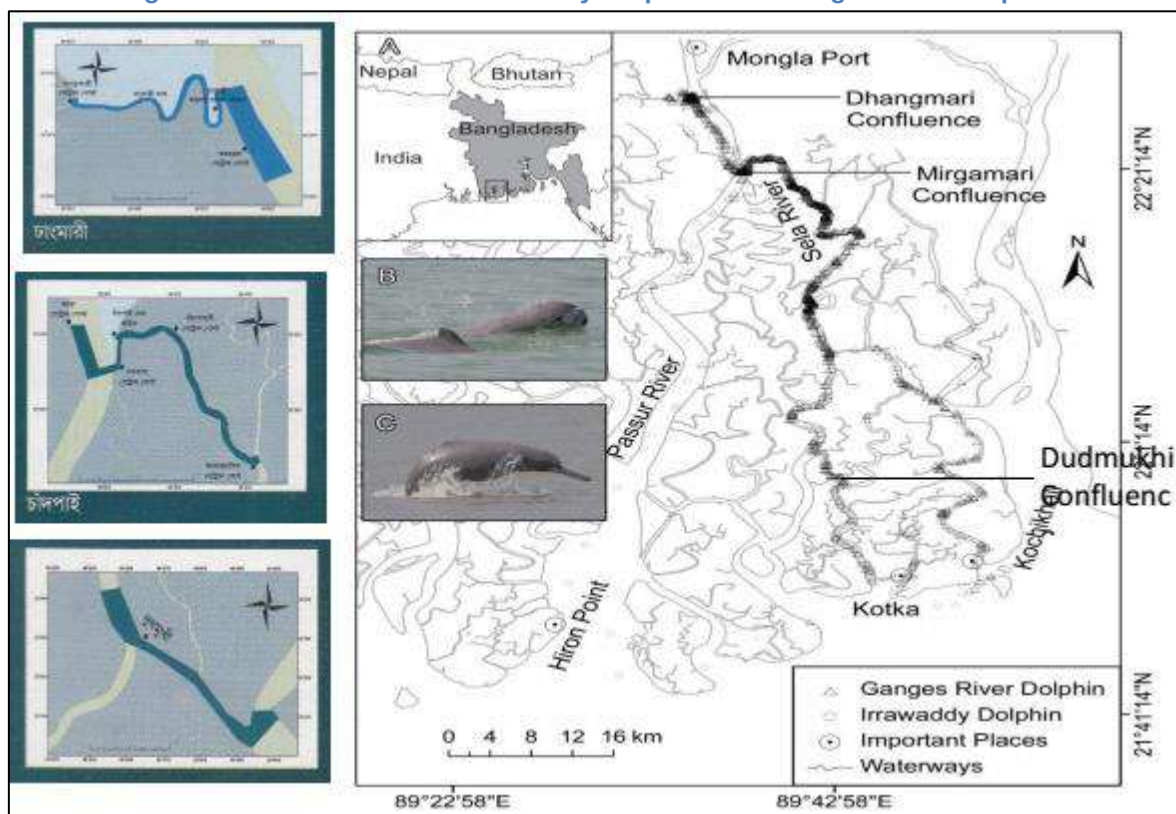
7.16.8.4.3 Status of the Dolphin

Dolphin, one of our marine mammal friends, deserves not only an attention but also a good care and respect to survive because stability of their societies are integrally tied to the health of the planet Earth. At least ten species of marine and six species of freshwater dolphins are available in Bangladesh. Conservationists say of them, Ganges river dolphins and Irrawaddy dolphins, which are available in the rivers of Sundarbans mangrove forest, are most endangered. According to a government notification, about 12 km from Ghagmari check-post of Chandpai Range to Karamjal check-post of the forest through Dhangmari canal and Pashur River, 15 km from Jongra check-post to Andharmari check-post through Mrigamari check-post and 5 km from Dudhkhali check-post to Supati canal through Bemara canal have been declared as the wildlife sanctuary for the underwater mammals.

The proposed 350 MW coal fired power plant is going to be establish on the bank of the Buriswar-Payra River, which is connected to the Bay of Bengal and associated Bishkhali and Baleswar River network. An organization, named Wildlife Conservation Society (WCS), working for cetacean conservation have marked different route of migration of Ganges River Dolphin. The presence of Ganges River Dolphin and Irrawaddy Dolphin were reported in the Sundarbans area that was confirmed by the WCS. According to the WCS, the Ganges River Dolphins have been found in Baleswar River. Based on the review of available secondary documents, no clear information about the presence of Dolphins was recorded in the Buriswar-Payra River. However, it cannot be role out that there is no presence of Dolphins in the Buriswar-Payra River due to the environmental settings and connectivity of the surrounding river system including the Bay of Bengal.

The Sundarbans is the only environment that supports the Endangered Ganges River dolphin and Vulnerable Irrawaddy dolphin, the last two remaining species of freshwater dolphins in Asia (UNDP, 2016). In 2002, the population of Ganges and Irrawaddy Dolphins in the Bangladesh portion of the Sundarbans was estimated to be around 225 and 451 individuals respectively (Smith et al., 2006). The density of Ganges River dolphin is particularly high in the low-salinity eastern portion of the mangrove forests with greater concentrations found at channel confluences. The density of Irrawaddy dolphins is high in the high-salinity western portion but the range of both species overlaps in the eastern side. At a waterscape scale, both Ganges River and Irrawaddy dolphins prefer low salinity waters. However, both species also partition themselves such that Ganges River dolphins generally occupy the north-eastern portion (which receives freshwater input from the Ganges River), while Irrawaddy dolphins generally occupy the south-western part with more salinity (Smith et al., 2009). Based on the existing characteristics of the proposed project area, it can be said that, there is the possibility of presence of Ganges River Dolphins in Buriswar-Payra River. Additional study is required to assess the status of dolphins in the Buriswar-Payra River and it is expected that the project proponent will ensure the study in different phases of the power plant project as proposed in EMP. A map showing the distribution of Irrawaddy Dolphins and Ganges River Dolphins in the Sundarbans and adjoining area is shown in following Figure 7-47.

Figure 7-47: Distribution of Irrawaddy Dolphins and Ganges River Dolphins



Note: A) Map of the Sundarbans mangrove forest, Bangladesh, including sighting data of Ganges river dolphins (triangles) and Irrawaddy dolphins (circles). Inserts show pictures of B) Irrawaddy dolphin, and C) Ganges river dolphin, taken by E. & R. Mansur, WCS. (Source: Jensen et al., 2013)

The EQMS ecological team conducted a survey during March and September 2018, to find out the existence of dolphins in the Buriswar-Payra River near the proposed project site. During the field survey, the study team was not observed any dolphins in the project site river. However, during the consultation with the fishermen group, they said they observed Ganges Dolphins near the confluence zone of the surroundings river and the Bay of Bengal and number of dolphins are observed more during the monsoon season. According to the consultation with the Upazila Fisheries Officer, Taltoli, the presence of dolphin (capture in fishing net, killing or died) in the project site (Buriswar-Payra River) is not reported. During the field visit, human activities like use of fishing net, mechanized boat movement etc. were observed in the Buriswar-Payra River. According to the consultation with the fisherman, this kind of activities they continue for round the year except the Hilsa capture ban period. Such kind of environment in the river can disturb the dolphin's movement and it is a big challenge for dolphin's movement through the river channel by avoiding fishing net. The photographs of the existing human activities in the project site river is shown in Figure 7-48.

Figure 7-48: Activities in the Project Site that can Disturb Dolphin Movement



Fishing activities in the Buriswar-Payra River



Use of fishing net in the Buriswar-Payra River



Fishing net near the proposed project site



Fishing net middle of the Buriswar-Payra River



Fishing activities in the Buriswar-Payra River



Net used by the fisherman to catch fish in river

Source: Field Survey by EQMS Team, March and September 2018

7.16.9 Aquatic Monitoring

Phytoplankton are photosynthesizing microscopic biotic organisms that inhabit the upper sunlit layer of almost all oceans and bodies of fresh water on Earth. They are agents for "primary production," the creation of organic compounds from carbon dioxide dissolved in the water, a process that sustains the aquatic food web.

In Primary Productivity analysis of Inland Open Water ecosystem, the biological part of the limnology study of Phytoplankton and Zooplankton are of paramount importance. These play a vital role in the food chain (in water body) of fish, plankton, benthos and other animals, etc. and provides data/information in the productivity of a given aquatic ecosystem as well as to determine the type of Aquatic Habitat which is related to the seasonal abundance, relative occurrence of planktonic flora and fauna and their relationship with some important physio-chemical quality conditions of water bodies of Buriswar-Payra river adjacent to the Proposed Power Plant Area. Fundamentally, this experiment is needed for knowing and relating the availability of fishery.

7.16.9.1 Phytoplankton

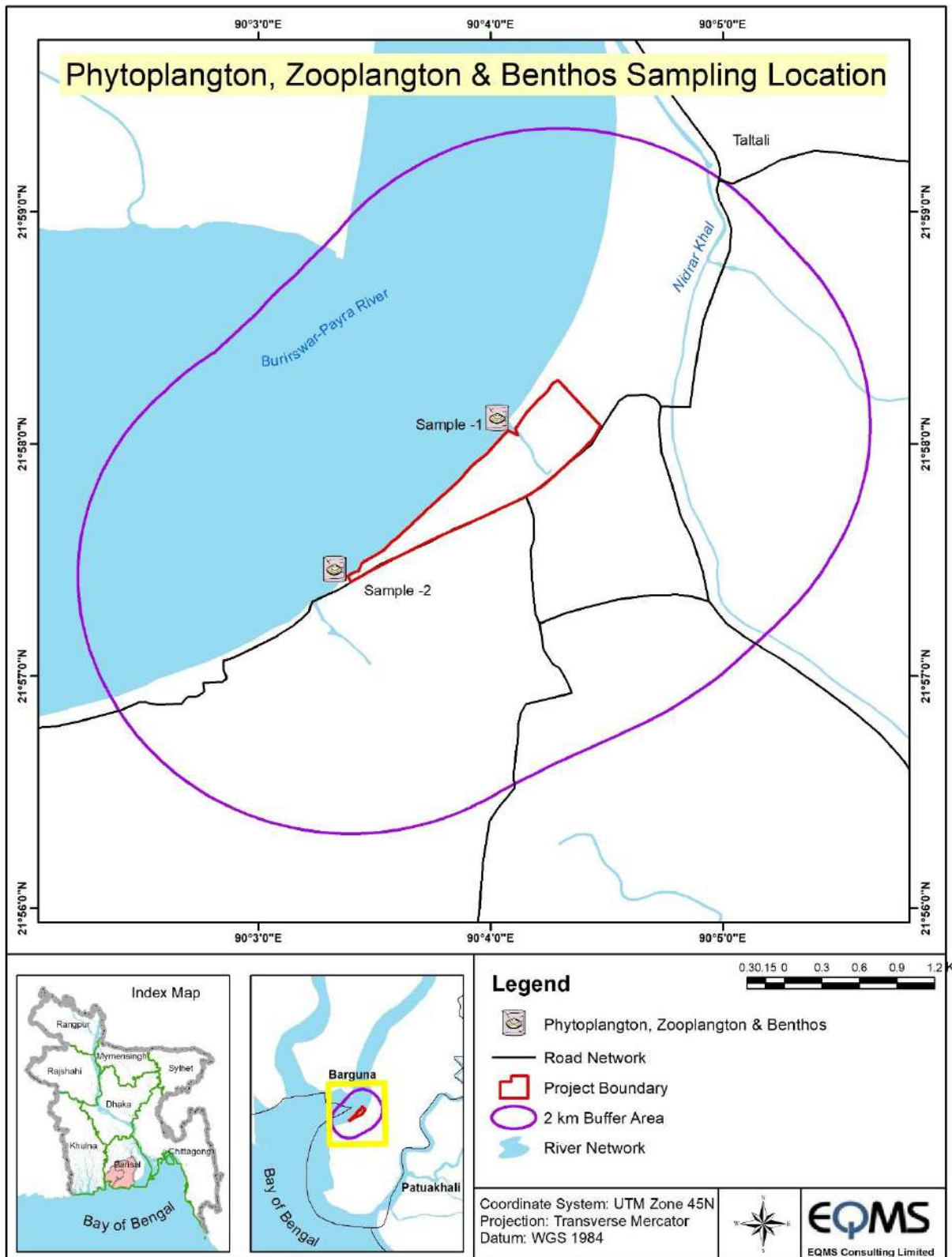
Two phytoplankton samples were collected from Buriswar-Payra River in order to assess the phytoplankton types and their population. The net was lowered into the water and sample water was collected by pulling the net horizontally and vertically. For quantitative study, phytoplankton was collected by plankton net (No. 20 silk bottling cloth, mesh size: 75 μ m) by passing 10 liters of water through it. After collection, samples were preserved in 3% formalin and few drops of Glycerine and by Lugol's solution. After adding preservatives, samples were brought to the laboratory for species identification and numerical abundance. Detailed analysis were done by Sedgewick-Rafter Counter Chamber and by drop method and results was expressed by unit/l. The phytoplankton sampling location details are given in Table 7-20. Map of the phytoplankton, zooplankton and benthos sampling locations and photographs of the sample collection are given in Figure 7-49 and Figure 7-50 respectively.

Table 7-20: Phytoplankton Sampling Location

SL#	Sampling Locations	Code	Sampling Date	Geographical Location
1	Buriswar-Payra River (Upstream from the project site)	P1	12/09/2018	21°58'9.28"N 90° 3'57.56"E
2	Buriswar-Payra River (Downstream from the project site)	P2	12/09/2018	21°57'30.87"N 90° 3'15.73"E

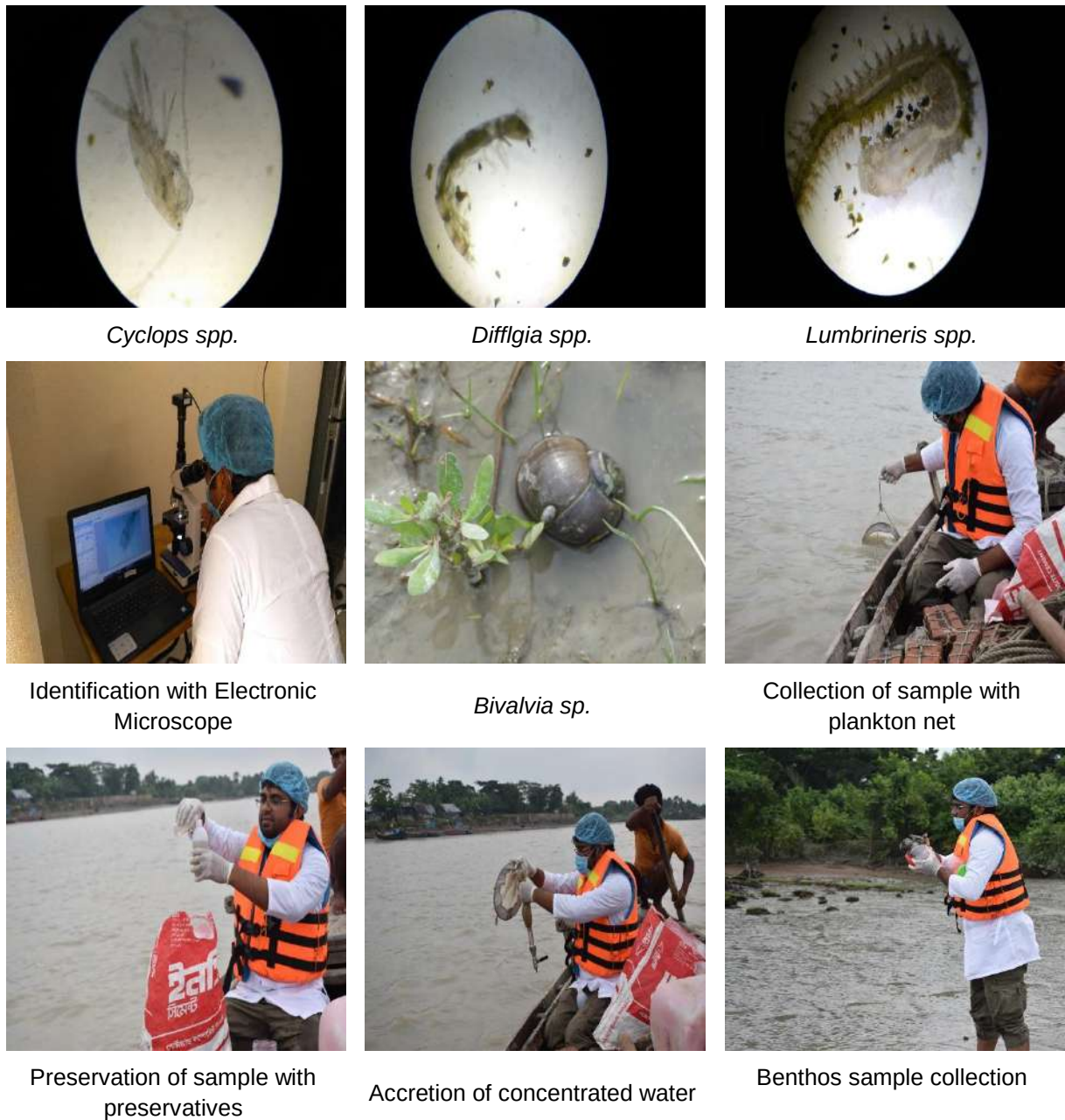
Source: Field Survey by EQMS Team, September 2018

Figure 7-49: Sampling location of Phytoplankton, Zooplankton and Benthos



Source: Field Survey by EQMS Team, September 2018

Figure 7-50: Photographs of Phytoplankton, Zooplankton and Benthos Collection



Source: Field Survey by EQMS Team and Laboratory Analysis, September 2018

Phytoplankton Analysis:

Phytoplankton community was represented by 58 genera. Among the phytoplanktonic genera, *Ulothrix spp.* was the most dominant followed by *Zygnema spp.*, *Nitzschia spp.*, *Oedogonium spp.*, *Cosmorium spp.*, *Navicula spp.*, *Nostoc spp.*, *Pediastrum spp.*, *Gyrosigma spp.* and *Oocystis spp.* The phytoplankton community compositions at the monitored locations are presented in the Table 7-21.

Table 7-21: Phytoplankton Community Composition at the Monitored Locations

SL#	Phytoplankton Taxa/Species	Number (Individuals/L)	
		P1	P2
1	<i>Amphora spp.</i>	65	56
2	<i>Asterinella spp.</i>	76	78
3	<i>Bacillaria spp.</i>	120	90

SL#	Phytoplankton Taxa/Species	Number (Individuals/L)	
		P1	P2
4	<i>Biddulphia spp.</i>	80	67
5	<i>Chaetoceros spp.</i>	43	49
6	<i>Cosmorium spp.</i>	323	256
7	<i>Cyclotella spp.</i>	32	16
8	<i>Coscinodiscus spp.</i>	65	70
9	<i>Diatoma spp.</i>	131	97
10	<i>Fragilaria spp.</i>	53	67
11	<i>Gomphonema spp.</i>	121	79
12	<i>Gyrosigma spp.</i>	311	223
13	<i>Melosira spp.</i>	45	56
14	<i>Navicula spp.</i>	343	226
15	<i>Nitzschia spp.</i>	332	342
16	<i>Pleorosigma spp.</i>	121	96
17	<i>Pinullaria spp.</i>	34	21
18	<i>Rhizosolenia spp.</i>	64	56
19	<i>Surirella spp.</i>	83	78
20	<i>Synedra spp.</i>	56	34
21	<i>Tabellaria spp.</i>	96	88
22	<i>Triceratium spp.</i>	121	111
23	<i>Thalassionema spp.</i>	223	189
24	<i>Actinastrum spp.</i>	245	167
25	<i>Ankistrodesmus spp.</i>	126	79
26	<i>Botryococcus spp.</i>	89	56
27	<i>Chlorella spp.</i>	11	25
28	<i>Closterium spp.</i>	90	76
29	<i>Coelastrum spp.</i>	47	35
30	<i>Closteridium spp.</i>	48	39
31	<i>Microspora spp.</i>	23	11
32	<i>Micractinium spp.</i>	242	156
33	<i>Muogeotia spp.</i>	7	0
34	<i>Zygnema spp.</i>	454	335
35	<i>Oedogonium spp.</i>	332	287
36	<i>Oocystis spp.</i>	263	221
37	<i>Pediastrum spp.</i>	323	217
38	<i>Scenedesmus spp.</i>	232	198
39	<i>Spirogyra spp.</i>	133	134
40	<i>Staurastrum spp.</i>	172	167
41	<i>Stichococcus spp.</i>	89	97

SL#	Phytoplankton Taxa/Species	Number (Individuals/L)	
		P1	P2
42	<i>Tetraedron spp.</i>	121	93
43	<i>Ulothrix spp.</i>	567	445
44	<i>Uroglena spp.</i>	34	21
45	<i>Volvox spp.</i>	161	176
46	<i>Selenestrum spp.</i>	67	35
47	<i>Anabaena spp.</i>	180	195
48	<i>Aphanizomenon spp.</i>	176	146
49	<i>Aphanocapsa spp.</i>	96	86
50	<i>Chroococcus spp.</i>	170	121
51	<i>Gomphosphaeria spp.</i>	93	78
52	<i>Merismopedium spp.</i>	78	23
53	<i>Microcystis spp.</i>	121	89
54	<i>Nostoc spp.</i>	325	223
55	<i>Oscillatoria spp.</i>	127	96
56	<i>Spirulina spp.</i>	156	121
57	<i>Euglena spp.</i>	79	65
58	<i>Phacus spp.</i>	221	132
Total		8,636	6,890

Source: Laboratory Analysis in EQMS Lab, September 2018

7.16.9.2 Zooplankton

Two Zooplankton samples were collected from the Buriswar-Payra River by a plankton net (No. 25 silk bottling cloth, mesh size: 67 μ m). The net was lowered into the water and sample water was collected by pulling the net horizontally and vertically. For quantitative study, Zooplankton were collected by a plankton net by passing 10 liters of water through it. After collection, samples were preserved in 3% formalin and few drops of Glycerine and by Lugol's solution. After adding preservatives, samples were brought to the laboratory for species identification and numerical abundance. Detailed analysis was done by Sedgewick-Rafter Counter Chamber and by drop method and results was expressed by unit/l. The analysis of zooplankton was executed in the EQMS laboratory. The zooplankton sampling locations are given in Table 7-22.

Table 7-22: Zooplankton Sampling Locations

SL#	Sampling Locations	Code	Sampling Date	Geographical Location
1	Buriswar-Payra River (upstream from the project site)	Z1	12/09/2018	21°58'9.28"N 90° 3'57.56"E
2	Buriswar-Payra River (downstream from the project site)	Z2	12/09/2018	21°57'30.87"N 90° 3'15.73"E

Source: Field Survey by EQMS Team, September 2018

Zooplankton Analysis:

Zooplankton community was represented by 18 genera in the Buriswar-Payra River. Among the zooplankton genera, *Diffugia spp.* was most dominant followed by *Brachionus spp.*, *Poliarthra spp.*, *Moina spp.*, *Bosmina spp.* and *Hexarthra spp.* The Zooplankton community compositions at the monitored locations are presented in the following Table 7-23.

Table 7-23: Zooplankton Community Composition at the Monitored Locations

SL#	Zooplankton Taxa/Species	Number (Individuals/L)	
		Z1	Z2
1	<i>Asplanchna spp.</i>	45	33
2	<i>Bosmina spp.</i>	145	135
3	<i>Brachionus spp.</i>	223	176
4	<i>Cyclops spp.</i>	56	77
5	<i>Daphnia spp.</i>	115	98
6	<i>Diaphanosoma spp.</i>	137	112
7	<i>Diaptomus spp.</i>	13	23
8	<i>Diffugia spp.</i>	221	213
9	<i>Favella spp.</i>	45	67
10	<i>Filinia spp.</i>	126	112
11	<i>Hexarthra spp.</i>	145	135
12	<i>Keratilla spp.</i>	134	121
13	<i>Mesocyclops spp.</i>	121	112
14	<i>Moina spp.</i>	176	167
15	<i>Naupleus spp.</i>	17	28
16	<i>Poliarthra spp.</i>	220	127
17	<i>Sida spp.</i>	22	13
18	<i>Trichocerca spp.</i>	123	97
Total		2,084	1,846

Source: Laboratory Analysis in EQMS Lab, September 2018

7.16.9.3 Benthos

Benthic samples were collected at two locations in the Buriswar-Payra River. The sediment samples were collected by Ekman Grab Sampler. After collecting, samples were passed through a sieve (0.5 & 1 cm mesh size net). After that again the samples were sieved by US sieve no. 30 and preserved the sample by 10% formalin or 70% Ethanol. For better identification Rose Bengal (200 mg/l) colour was added. Salt and sugar solution were also be used to separate the benthic animal from the sediment for better identification. These benthic samples were analysed in the EQMS laboratory. The benthos sampling locations are given in Table 7-24.

Table 7-24: Benthos Sampling Locations

SL#	Sampling Locations	Code	Sampling Date	Geographical Location
1	Buriswar-Payra River (upstream from the project site)	B1	12/09/2018	21°58'6.51"N 90° 4'1.74"E
2	Buriswar-Payra River (downstream from the project site)	B2	12/09/2018	21°57'27.61"N 90° 3'24.97"E

Source: Field Survey by EQMS Team, September 2018

Benthos Analysis

Benthos community was represented by 12 genera in the Buriswar-Payra River. Among the zooplankton genera, *Nematode spp.* was most dominant followed by *Crustacea spp.*, *Bivalvia spp.*,

Macra spp., *Nereis* spp., *Batillaria* spp., *Umbonium vestiarium*, and *Dosinia* spp. The Benthos community compositions at the monitored locations are presented in the following Table 7-25.

Table 7-25: Benthos Community Composition at the Monitored Locations

SL#	Benthos Taxa/Species	Number (Individuals)	
		B1	B2
1	<i>Batillaria</i> spp.	2	3
2	<i>Umbonium vestiarium</i>	1	4
3	<i>Dosinia</i> spp.	2	3
4	<i>Trachycardium</i> spp	-	1
5	<i>Scapharsa</i> spp.	1	3
6	<i>Macra</i> spp.	1	5
7	<i>Tellina</i> spp.	2	1
8	<i>Nereis</i> spp.	3	2
9	<i>Lumbrineris</i> spp.	4	-
10	<i>Bivalvia</i> spp.	11	10
11	<i>Crustacea</i> spp.	23	1
12	<i>Nematode</i> spp.	17	12
Total		62	23

Source: Laboratory Analysis in EQMS Lab, September 2018

7.17 Natural Hazards, Vulnerability for the project

7.17.1 Seismicity and Faults

Bangladesh has continually been one of the seismically active regions of the world and has experienced numerous large earthquakes during the past 200 years. Many of seismic tectonic studies have been undertaken on the area comprising the Indo-Burman ranges and their western extension and in the northern India. A seismic zoning map of Bangladesh has been proposed in 1979 by Geological Survey of Bangladesh (GSB) dividing the country into three seismic zone, which was accompanied by and outline of a code for earthquake resistant design. Later, a new updated seismic zoning map and detailed seismic design provisions have been incorporated in Bangladesh National Building Code (BNBC, 1993). Bangladesh has been classified into three seismic zones with Zone-1 is the most and Zone-3 is the least vulnerable to seismic risks. According to the GSB, the proposed project area falls under Seismic Zone-3 means the low level vulnerable to seismic risks (Figure 7-51).

According to the feasibility report, the proposed project site is on the coastal tidal flat, wide and even, without conditions for adverse geologic actions (such as landslide, collapse, mud-rock flow, etc.) and for karst. The site is relatively stable and favorable for power plant construction. The proposed site is in III-IV building site category with medium soft-soft soil, tentatively considered as slight-medium liquidation. According to the BNBC, the proposed project is located in Zone-1 (low seismic intensity) of Seismic Zoning Map, with seismic coefficient $Z=0.12g$. A list of the historical earthquake that takes place in Bangladesh and its surrounding area is given in Table 7-26.

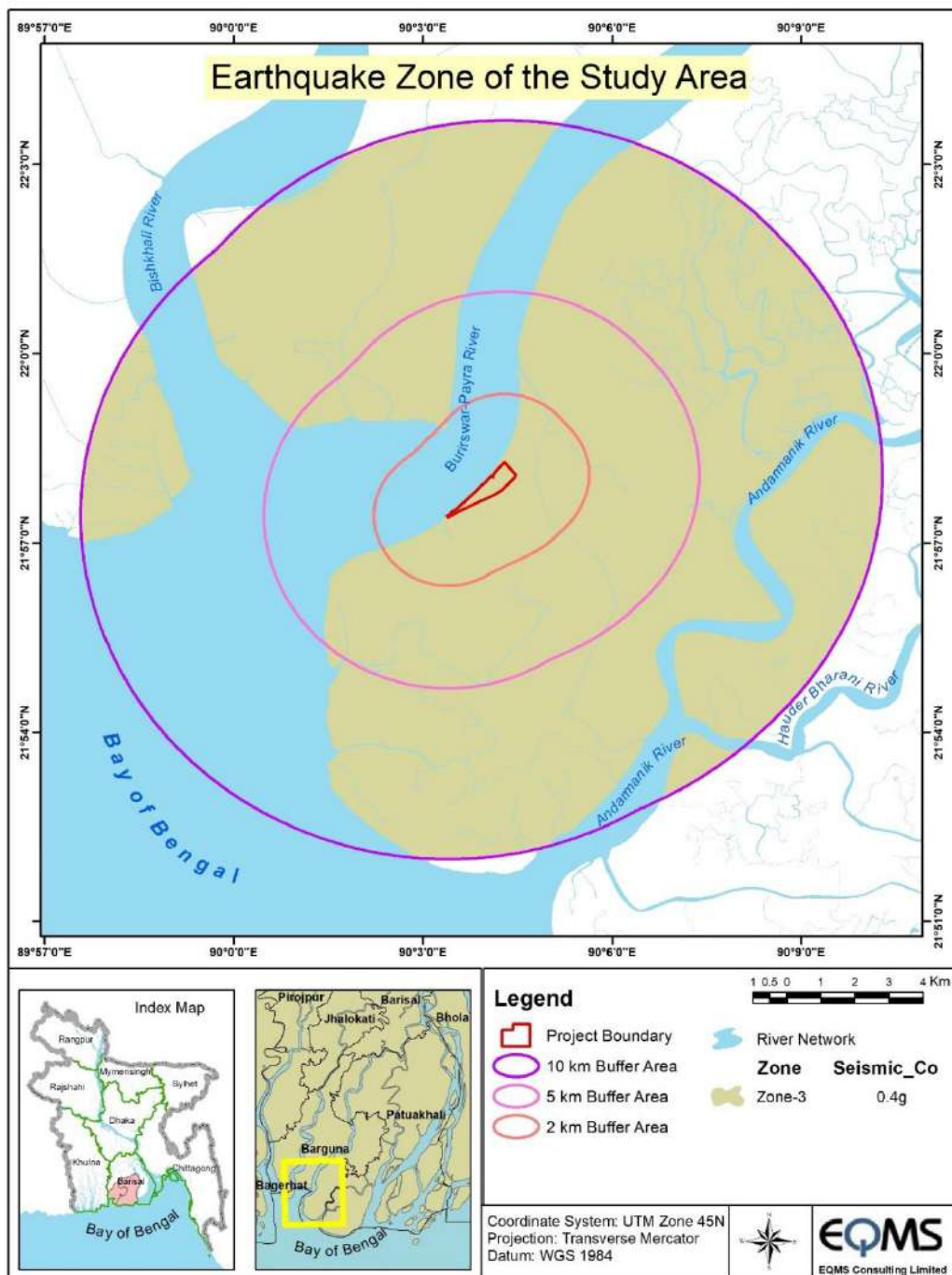
Table 7-26: Historical Earthquake in Bangladesh

Location	Magnitude	Date
Cachar, India	7.5	10/01/1869
Manikganj, Bangladesh	7.0	14/07/1885
Great Indian Earthquake (Shillong Plateau, India)	8.7	12/06/1897
Srimangal, Bangladesh	7.6	08/07/1918

Location	Magnitude	Date
Dhubri Earthquake	7.1	02/07/1930
Bihar-Nepal earthquake (Bihar, India)	8.3	15/01/1934
Assam, Himalaya	8.5	15/08/1950
Monipur, India	7.4	21/03/1954
Assam, India	6.7	08/07/1975
Sikkim, India	6.8	18/09/2011
Monipur, India	6.6	03/01/2016
India-Myanmar border	7.2	13/04/2016

Source: Choudhary, 2005, BMD and Banglapedia

Figure 7-51: Earthquake Zone Map of Bangladesh



Source: GSB, Bangladesh

7.17.2 Cyclone and Storm Surges

Bangladesh coast is one of the most cyclone-prone areas of the world due to its geographical location and funnel-shaped coast of the Bay of Bengal. Most of the damage occurs in the coastal regions of Khulna, Barguna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore islands of Bhola, Hatiya, Sandwip, Manpura, Kutubdia, Maheshkhali, Nijhum Dwip, Urir Char and other newly formed islands. Devastating cyclones hit the coastal zones almost every year and are usually accompanied by high-speed winds, sometimes reaching 250 km/hr or more and with 3 m to 10 m high waves, causing extensive damage to life, property and livestock. These cyclones usually occur in two seasons, April-May and October-November – i.e. before and after the monsoon season.

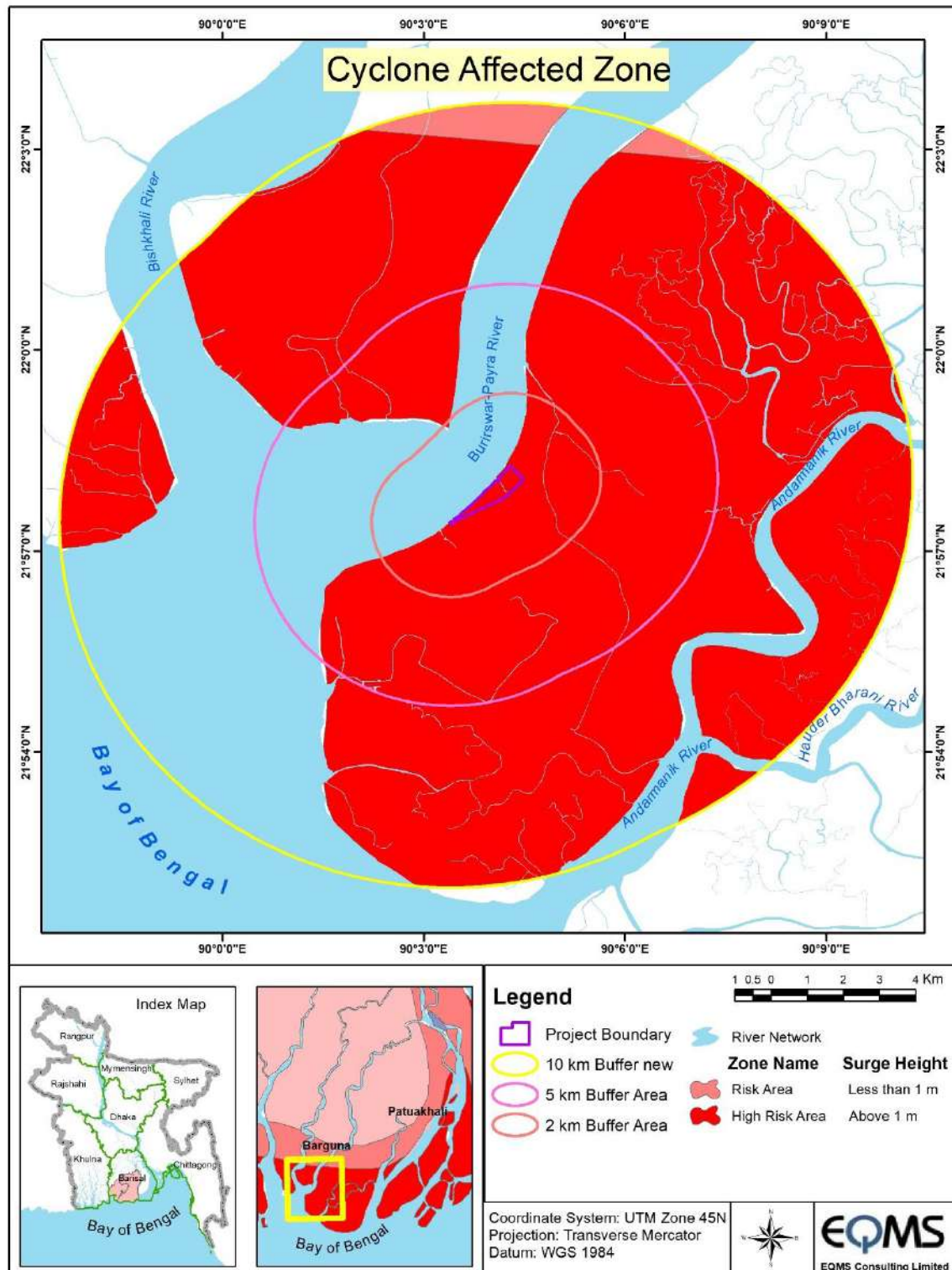
The proposed coal-fired power plant project area is located in the high-risk zone for the cyclone and its associated disaster like storm surges. A list of major cyclonic storms and associated storm surge height is given in Table 7-27. The cyclone affected areas including tidal surges risks are shown in Figure 7-52.

Table 7-27: Major Cyclonic storms and tidal surge height in Bangladesh

Date and Year	Max. Wind Speed (Km/hr)	Storm Surge height (meter)	Human Deaths
30 th October, 1960	210	4.5-6.0	5149
30 th May, 1961	146	2.5-3	11466
28 th May, 1963	203	4.0-5.0	11520
11 th May, 1965	162	3.5	19279
15 th December, 1965	210	4.5-6.0	-
1 st November, 1966	146	4.5-9.0	850
23 rd October, 1970	163	3.0-4.9	-
12 th November, 1970	223	6-9	500000
25 th May, 1985	154	3.0-4.5	11069
29 th November, 1988	160	3.0-4.0	-
29 th April, 1991	225	6.0-7.5	138000
2 nd May, 1994	200	2.0-3.0	170
25 th November, 1995	140	2.0-3.0	-
19 th May, 1997	225	3.1-4.2	126
15 th November, 2007 (Sidr)	223	3-4	3363
25 th May, 2009 (Aila)	92	3.0	190
16 th May 2013 (Mahasen)	88	1.5-2.0	17
29 th July 2015 (Komen)	75	-	132
21 st May 2016 (Roanu)	100	-	26
31 st May 2017 (Mora)	110	-	-

Source: Department of Disaster Management (DDM), Bangladesh

Figure 7-52: Cyclone and Storm Surges affected area in Bangladesh Coast



Source: SPARSO, Bangladesh

7.17.3 Flood

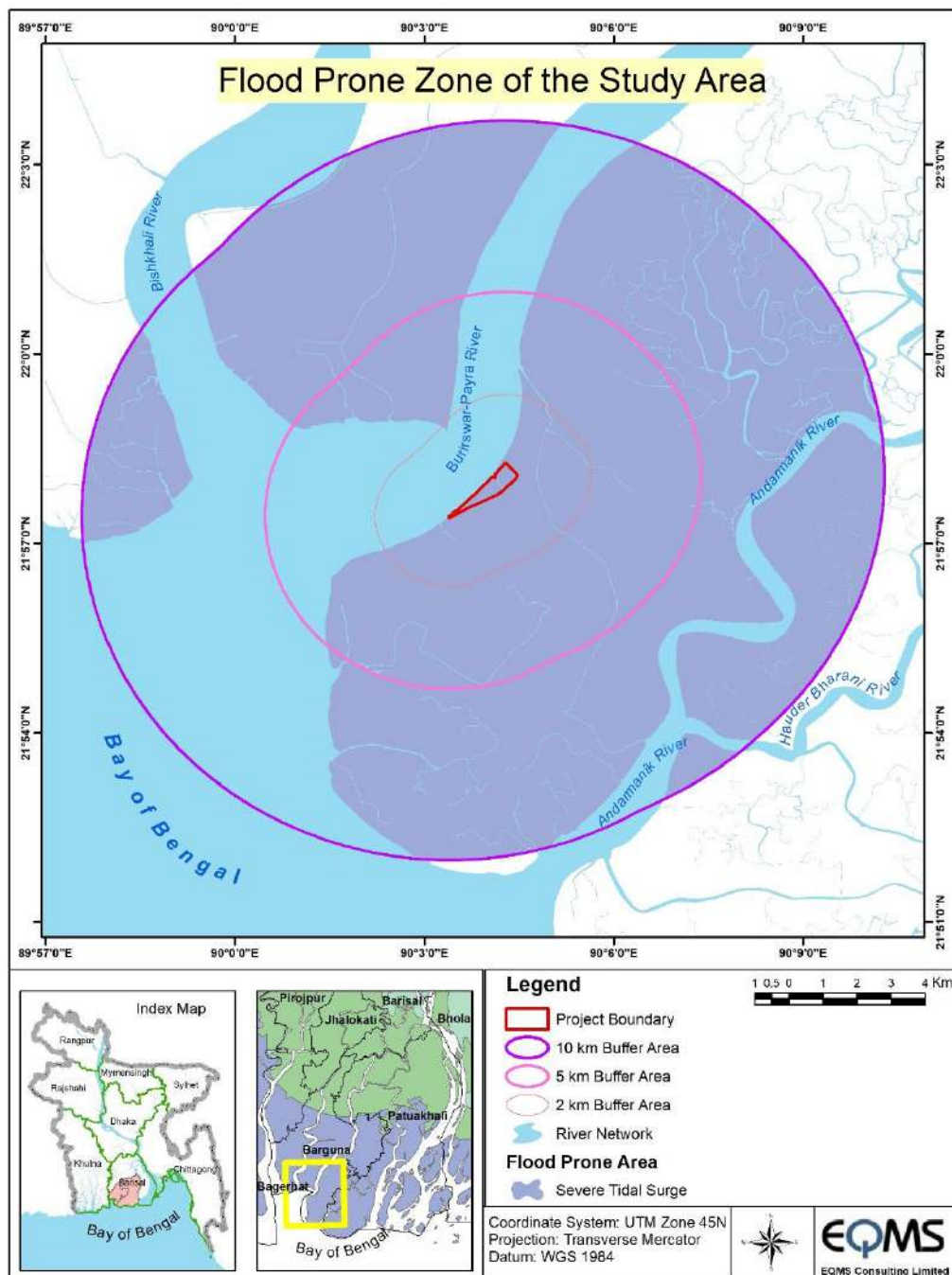
Every year near about one-fifth of Bangladesh undergoes flood during the monsoon season. A flood season in Bangladesh may start as early as May and can continue until November. Floods of Bangladesh can be divided into three categories: (i) monsoon flood - seasonal, increases slowly and decreases slowly, inundate vast areas and causes huge loss to the life and property; (ii) flash flood-from sudden torrential flows, following a brief intense rainstorm or the bursting of a natural or man-made dam or levee; and (iii) tidal flood - short duration, height is generally 3-6m, prevents inland flood drainage. Floods are annual phenomena in Bangladesh. Normally the most severe floods occur

during the months of July and August (DMB, 2010). Regular river floods (during monsoon season) affect 20% of the country which may increase up to 67% in extreme years like the 1998 flood. The floods of 1988, 1998 and 2004 were simply disastrous (SDC, 2010). There are four types of flood in Bangladesh (DMB, 2010):

- Monsoon floods along major rivers during the monsoon rains (June-September);
- Flash floods caused by overflowing of hilly rivers of eastern and northern Bangladesh (Normally during April-May and September-November);
- Rain floods caused by drainage congestion during heavy rains; and
- Coastal floods caused by tidal/storm surges.

The proposed study area is located on the bank of the Buriswar-Payra River and the river is connected with the Bay of Bengal. As a result, there is no occurrence of flood due to well drainage system. However, the proposed project site is highly vulnerable for the coastal floods caused by tidal/storm surges. The map of the flood-prone area is shown in the following Figure 7-53.

Figure 7-53: Flood-prone Area of Bangladesh

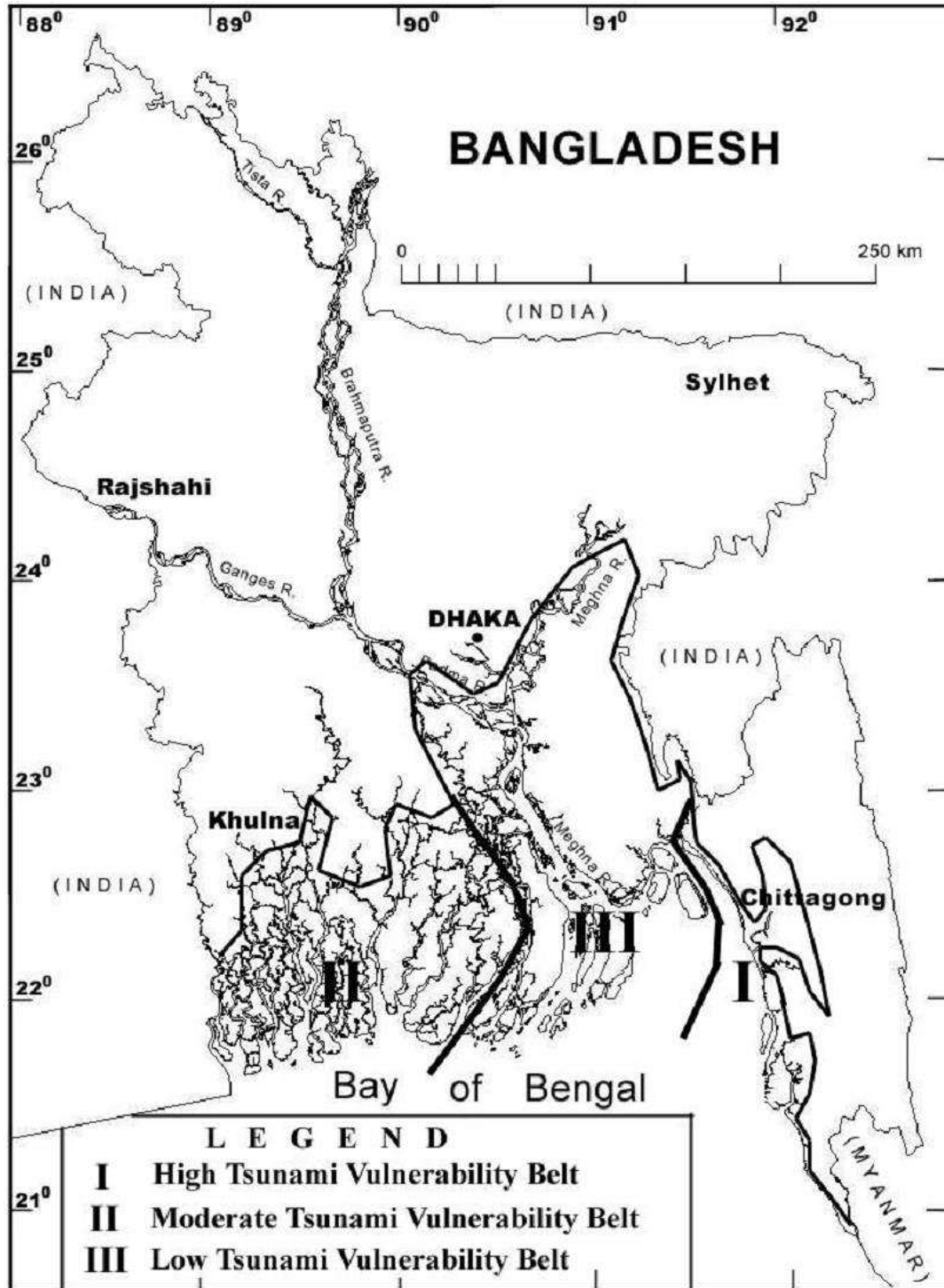


Source: BARC

7.17.4 Tsunami

Considering the state of tsunami vulnerability and potential seismic sources, the coastal belt is classified into three tsunamigenic zones (ICZMP Report, Uddin, 2005) as shown in Figure 7-54. According to this classification, the proposed 350 MW coal-fired power plant project area falls within Zone-II, which is reportedly moderate tsunami-vulnerable belt.

Figure 7-54: Tsunami Vulnerability Map of Bangladesh



Source: Uddin, 2005

Historical Tsunami in the Bay of Bengal:

Though the Indian subcontinent is in a seismically active region, tsunamis along the coastline of India and Bangladesh have been rare, but not unprecedented. The historical records of the Tsunami in the Bay of Bengal are given in following Table 7-28.

Table 7-28: Historical Tsunami in the Bay of Bengal

Date	Place of occurrence	Height of water	Damage	Source
11 th & 12 th October, 1737	Mouth of the river Ganges	40 ft	NA	Khan, 2007
02 April 1762	Arakan Coast	22 ft	200 people with all their cattle loss; permanent submergence of 60 sq. miles near Chittagong	Mathur, 1998; Bangladesh District Gazetteers Chittagong, 1975)
11 th November 1842	Near the northern end of Bay of Bengal	NA	NA	Rastogi et. al., 2006
May 1874	Bhola District	-	Killing several hundred thousand people	http://www.freejournal.net ; Rastogi et. al., 2006
31 December 1881	Car Nicobar Island (7.9 magnitude)	0.8 m - 1.0 m	NA	Berninghausen, 1966; Rastogi et. al., 2006
1884	Western part of the Bay of Bengal	-	NA	Rastogi et. al., 2006 Murty et al. 1999
June 1941	Andaman Sea (8.1 magnitude)	0.75 m - 1.25 m	Damage masonry structures and property in places like Chennai	Rastogi et. al., 2006 Murty and Bapat, 1999
December 2004	Sumatra-Andaman earthquake	Few meters	Some buildings in Chittagong got cracked and two deaths were caused in the coast	-

7.17.5 Drought

Droughts mainly occur in the western parts (Rajshahi and Rangpur Division) of Bangladesh and Chittagong Hill Tracts area. During the period 1949 to 1991, country faced droughts 24 times. However, the proposed project site is located in the coastal area of Bangladesh, which is not fall in the drought- prone area. The humidity is comparatively high in the project area due to the adequate rainfall and close proximity of the Bay of Bengal.

7.17.6 Tornadoes

Tornados (locally called Kalbaishakhi) are mainly occurring in two transitional periods (Pre-monsoon and Post-monsoon). They are suddenly formed and of brief duration and are extremely localized in nature. Therefore, it is very difficult to locate Tornados or forecast their occurrence with the available techniques at present. They may cause also a lot of havoc and destructions (SDC, 2010). Since independence in 1971, Bangladesh has experienced at least eight major tornados, killed on an average more than 100 people in each event and caused severe damage in their narrow paths (SDC, 2010). From the field data collection and secondary literature no tornado occurrence was found in the proposed power plant project area. However, preparedness should be taken for the Tornado Disasters.

7.17.7 Landslide

The proposed project site is located in the plain land close to the bank of the Buriswar-Payra River, which is connected with the Bay of Bengal. There is no hilly area close to the project site and within the 10 km radius of the project site. As a result, landslide is not expected in the proposed power plant project site at Taltoli, Barguna.

7.18 Demography Profile and Occupational Pattern

The present socio-economic conditions of the people of the project area will provide sound reference and assess probable socio-economic impact of the proposed interventions. This will enable us to compare the changes and impacts of the project interventions in future. The socio-economic baseline scenario describes the socio-economic characteristics of project area on the basis of primary and secondary data. The socio-economic characteristics include administrative area, demographic, household size, education, occupation, housing, employment opportunity, access to water and sanitation status etc.

7.18.1 Administrative Area and Location

The proposed 350 MW coal-fired power plant project is located at Bara Ankujan Para village, Nishanbaria Union, Taltoli Upazila, Barguna District. Based on the assessment of the project, its surroundings and its environmental & social influence, a 5 kilometers radius is considered as the study area for the social study. The following Table 7-29 shows the study area of the project across Union, Upazila and District. The socio-economic features of the study area are discussed in this section.

Table 7-29: Study Area

District	Upazila	Union
Barguna	Taltoli	Nishanbaria
		Barabagi
		Sonakata
		Chhota Bagi
	Barguna	M.Baliatali
		Naltona

Source: EQMS Survey, 2018

The proposed project study area lies within the administrative area of Taltoli Upazila under Barguna District. The total area of the district is 1,831.31 sq. km. (707.07 sq. miles) of which 399.74 sq. km. is riverine and 97.18 sq. km. is under forest. The district is bounded on the north by Barisal, Jhalokati and Patuakhali districts, on the east by Patuakhali district, on the south by the Bay of Bengal and on the west by Pirojpur district and a part of Sundarbans under Bagerhat district. It lies between 21°48' and 22°29' north latitudes and between 89°52' and 90°22' east longitudes. The Buriswar-Payra, Bishkhali, Khagdum and Baleshwar are the principal rivers flowing over Barguna District.

7.18.2 Demography

In the proposed study area, there are about 25,321 households (HHs) including squatters with a total population of 104,439 that will be influenced by the implementation of the proposed 350 MW coal-fired power plant project. The average sex ratio is 98 and the average household size is 4.0, whereas average population density is 358 per sq. km. The demography of the study area is shown in the following Table 7-30.

Table 7-30: Demography of the Study Area

District	Upazila	Union	Total Pop	Total HHs	Avg. HH size	Pop Density (sq. Km)	Sex Ratio
Barguna	Taltoli	Nishanbaria	12,928	3,226	4.0	275	102
		Barabagi	18,399	4,321	4.3	343	101
		Sonakata	11,266	2,921	3.9	156	100
		Chhota Bagi	13,197	2,932	4.5	335	99
	Barguna	M.Baliatali	28,944	7,093	4.1	462	92

District	Upazila	Union	Total Pop	Total HHs	Avg. HH size	Pop Density (sq. Km)	Sex Ratio
		Naltona	19,705	4,828	4.1	577	96
Project Study Area			104,439	25,321	4	358	98

Source: Population and Housing Census, BBS, 2011

7.18.3 Religion

According to the population and housing census (2011), the population of the study area is dominated by the Muslim community constituting almost 95.2% of the total population. The remaining 3.78% is Hindu, whereas, Buddhist (1%), Christian (0.01%) and others (0.05%) are very negligible in percentage. The following Table 7-31 indicates the various religious profile of the project study area.

Table 7-31: Religious Profile of the Study Area

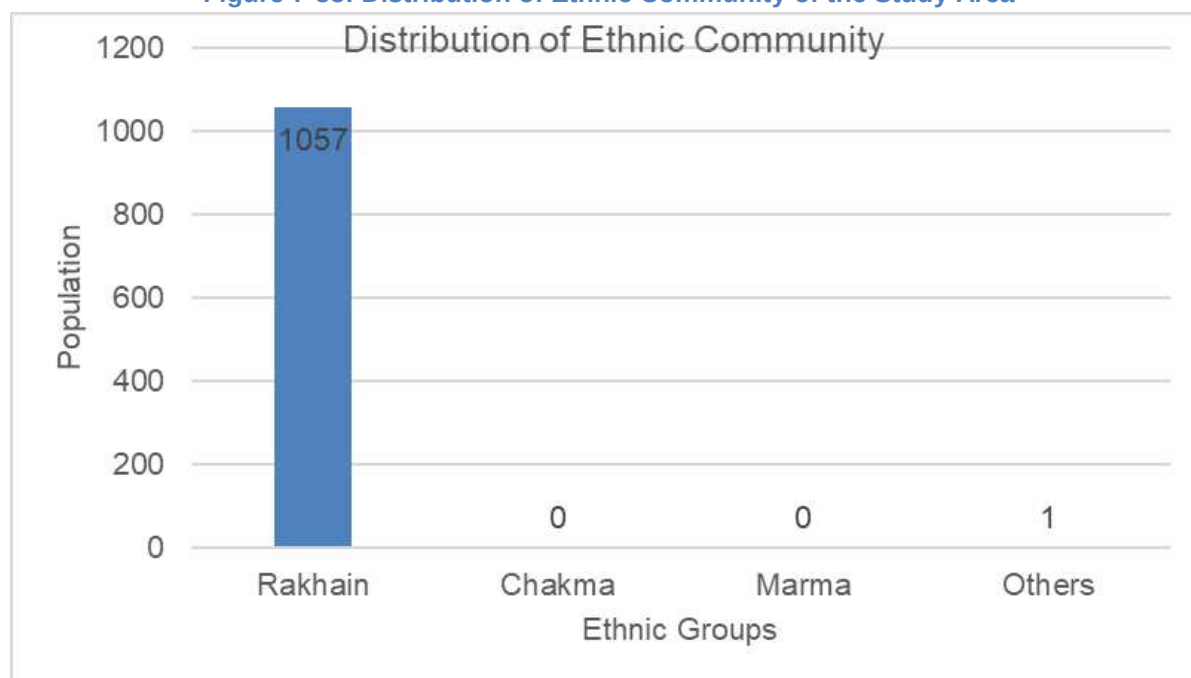
Upazila	Union	Total popn.	Muslim		Hindu		Christian		Buddhist		Others	
			Pop	%	Pop	%	Pop	%	Pop	%	Pop	%
Taltoli	Nishanbaria	12928	12647	12.1	84	0.08	0	0.00	193	0.18	4	0.00
	Barabagi	18399	17066	16.3	687	0.66	11	0.01	635	0.61	0	0.00
	Sonakata	11266	11044	10.6	60	0.06	0	0.00	133	0.13	29	0.03
	Chhota Bagi	13197	11641	11.1	1543	1.48	0	0.00	13	0.01	0	0.00
Barguna	M.Baliatali	28944	27831	26.6	1024	0.98	1	0.00	72	0.07	16	0.02
	Naltona	19705	19155	18.3	550	0.53	0	0.00	0	0.00	0	0.00
Project Study Area		104439	99384	95.2	3948	3.78	12	0.01	1046	1.00	49	0.05

Source: Population and Housing Census, BBS, 2011

7.18.4 Ethnic Composition

According to the population and housing census (2011), about 1,058 people (Rakhain-1,057 and others-1) of the ethnic community has been found in the proposed project study area. The following Figure 7-55 shows the ethnic groups of the project area.

Figure 7-55: Distribution of Ethnic Community of the Study Area



Source: Population and Housing Census, BBS, 2011

7.19 Land Use and Cropping Pattern

The primary livelihood activity of the community is fishing and farming. However, other livelihood activities including day labour, agricultural labour, service and trading etc. are complementary economic activities, which the population engage in. Crop farming is not intensively practiced in the proposed project site as envisaged. This is attributed to the poor soil fertility, productivity level for crop production, salinity intrusion, tidal effect etc. consequently, the main crop cultivated by the people is Aman rice. According to the consultation with the Upazila Agriculture Officer, Taltoli Upazila and review of secondary data, the land of the Nishanbaria Union is dominated by agricultural crop cultivation, which is cultivated mainly under rain fed condition followed by fisheries. According to the land zoning report, the cropping intensity of the union is 121%, which is low compared to national average. The present cropping patterns of this union are given in Table 7-32.

Table 7-32: Present Cropping Patterns of the Nishanbaria Union

SL#	Major Cropping Patterns	Cropping Intensity (%)
1	Khesari - B. aus - T. aman (HYV / LIV) (HYV/LIV)	121
2	Rabi crops - B. aus -T. aman (HYV / LIV)	
3	Fallow - Boro (HYV) - T. aman (HYV / LIV)	
4	Fallow - Fallow - T. aman (HYV / LIV)	

Source: Ministry of Land and Upazila Agriculture Office, Taltoli, Barguna

The major problems of this union are water stagnation/drainage congestion, salinity intrusion, low organic matter contents in soil, soil moisture deficit during the dry months, essential plant nutrient deficiency and risk of flood. Floods occurred frequently and cause degradation of natural vegetation and loss of agricultural crops. Rapid conversion of agricultural lands to other uses is a common problem.

7.20 Socio-Economic Scenario

7.20.1 Education

According to the population and housing census (2011), it shows that the concentration of literate people in three and two unions of Taltoli and Barguna Upazila. The literacy rate in the study area is 54.6%, which is higher than the national average of 47.68%. The following Table 7-33 shows the literacy rate of the project study area.

Table 7-33: Literacy Rate of the Study Area

Upazila	Union	Literacy (%)
Taltoli	Nishanbaria	51.3
	Barabagi	59.2
	Sonakata	55.7
	Chhota Bagi	52.3
Barguna	M.Baliatali	55
	Naltona	54.3
Project Study Area		54.6

Source: Population and Housing Census, BBS, 2011

7.20.2 Settlement and Housing

According to the population and housing census (2011), total household of the project study area is 10,468. The predominant structure of this study area is Kutcha (52%) followed by Jhupri (15%), Semi-pukka (43%) and Pukka (0%). Housing tenancy of the study area is owned by (92%), rented (1%) and rent free (6%). The following Table 7-34 shows the type of structure and housing tenancy in the project study area.

Table 7-34: Types of Structure and Housing Tenancy in the Study Area

District	Upazila	Union	Type of Structure (%)				Housing Tenancy (%)		
			Pucka	Semi-pucka	Kutcha	Jhupri	Owned	Rented	Rent free
Barguna	Taltoli	Nishanbaria	0.1	1	88.2	10.7	84.8	0.2	15
		Barabagi	1	2.9	88.1	8	93.8	3.6	2.6
		Sonakata	0.5	0.7	91.2	7.6	97	2	1
		Chhota Bagi	0	99.7	0.3	17.2	94.5	0.8	4.7
	Barguna	M.Baliatali	0.1	95.7	4.2	20.6	92.1	0.8	7.2
		Naltona	0.9	56.6	42.6	23.4	91.7	0.5	7.8
Project Study Area			0	43	52	15	92	1	6

Source: Population and Housing Census, BBS, 2011

7.20.3 Public Utilities

7.20.3.1 Water Supply

At the project study area, the major source of drinking water is tube-well where about 90.78% population use tube-wells water. About 0.20% people have access to tap water. Other 9.03% people have access neither tube-well nor tap water. An overview is depicted in Table 7-35 below.

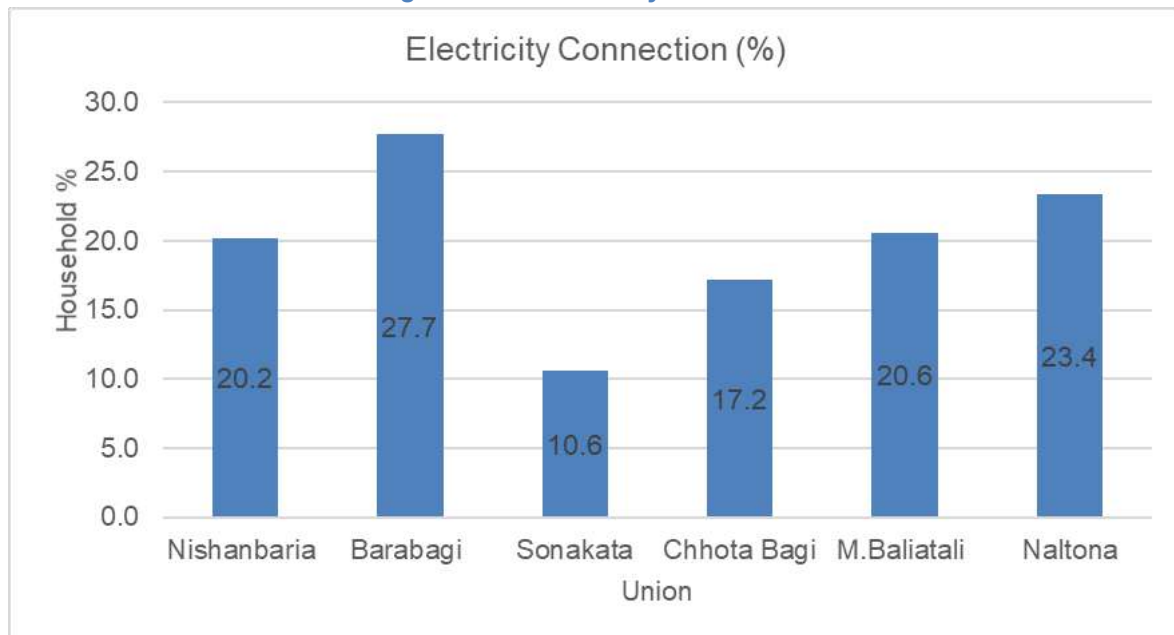
Table 7-35: Sources of Drinking Water in the Study Area

Upazila	Union	Source of Drinking Water (%)		
		Tap	Tube-well	Other
Taltoli	Nishanbaria	0.1	98.9	1.0
	Barabagi	0.1	96.5	3.4
	Sonakata	0.0	97.3	2.7
	Chhota Bagi	0.0	99.7	0.3
Barguna	M.Baliatali	0.1	95.7	4.2
	Naltona	0.9	56.6	42.6
Project Study Area		0.20	90.78	9.03

Source: Population and Housing Census, BBS, 2011

7.20.3.2 Electricity

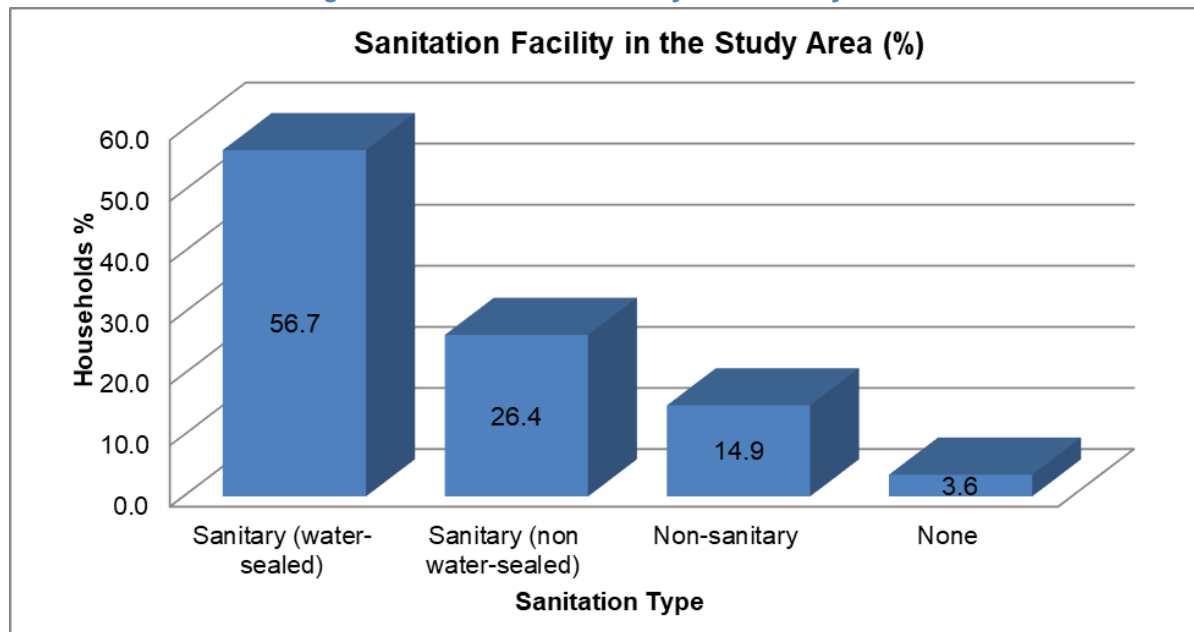
Electricity is an important indicator for measuring the quality of life in the study area. In the study area, almost 20.0% of the households have grid electricity connection. The following Figure 7-56 shows the details electricity connection situation by union. However, households, mostly use the electricity for lighting and farming purposes.

Figure 7-56: Electricity Connection

Source: Population and Housing Census, BBS, 2011

7.20.3.3 Sanitation

In the study area, about 56.7% and 26.4% of households use water-sealed and non-water-sealed sanitary latrine facility, respectively, whereas about 14.9% households use non-sanitary facilities. Around 3.6% households defecate in open places with no access to hygienic latrine facilities. The following Figure 7-57 shows sanitation facility of the project area.

Figure 7-57: Sanitation Facility in the Study Area

Source: Population and Housing Census, BBS, 2011

7.20.3.4 Health Care Facility

Taltoli Upazila lie under the study area. According to Taltoli Upazila Office information (2018), within the Upazila, number of MBBS and FCPS is only one, L.M.F are three and homeopathy are eleven persons. There is one government hospital (20 bedded) and one private clinic/diagnostic centre in the Upazila. According to the BBS 2011, Barguna Sadar Upazila have three MBBS and FCPS doctor available. Moreover, seven private hospitals and two diagnostic centres available at the Upazila.

7.20.3.5 Solid Waste

Uncontrolled waste generation coupled with inadequate collection and disposal systems have the potentiality to give rise to pollution and environmental degradation as well as disease. While no specific data on local waste management was collected from the study area, it is likely that - as with many other parts of rural Bangladesh - the villages within the study area have no formal waste management facilities, and that in general people dispose of their waste in landfills or in fallow land.

7.20.4 Economy and Employment

According to the Population and Housing Census (2011), agriculture including crops cultivation, fishing, direct farming, sharecropping, agricultural labourers etc. Agriculture is the dominant source of employment in the study area. Approximately, 4,649 male and 233 female involved in agricultural activities. Moreover, around 513 male and 113 female of the study area are employed in services. Agriculture (crops cultivation and agricultural labour) is the primary income source in the study area. The following Table 7-36 shows the employment status of the project area.

Table 7-36: Employment Status of the Study Area

Upazila	Union	Population Aged 7+, not attending school but employed			Field of Activity					
					Agriculture		Industry		Service	
		Total	Male	Female	Male	Female	Male	Female	Male	Female
Taltoli	Nishanbaria	713	663	50	633	46	3	3	27	1
	Barabagi	1,006	954	52	701	24	51	6	202	22
	Sonakata	680	548	132	536	121	2	5	10	6
	Chhota Bagi	473	454	19	418	14	14	0	22	5
Barguna	M.Baliatali	1722	1630	92	1403	21	49	5	178	66
	Naltona	1084	1064	20	978	7	12	0	74	13
Project Study Area		5678	5313	365	4669	233	131	19	513	113

Source: Population and Housing Census, BBS, 2011

7.20.5 Traffic and Transport

According to LGED Statistics (2018), in Taltaoli Upazila total earthen and pavement road is respectively 453.27 km and 102.15 km, which is total 555.42 km. There is no railway (broad gage, meter gage and duel gage) in the Upazila. According to District statistics 2011, metalled road 72 km, semi-metalled road 60 km, kutcha road 918 km in a total of 1,049 km available at Barguna Sadar Upazila. There is no railway (broad gage, meter gage and duel gage) in the Upazila.

7.21 Socio-Economic Study (Primary Data)

7.21.1 Villages Adjacent to Project Site

Socio-economic assessment of adjacent population of the proposed project is very much crucial for project planning and implementation. Therefore, villages adjacent to proposed power plant within 2 km radius were surveyed for intense socio-economic assessment.

Villages situated within the 2 km radius from the proposed project were considered for conducting social survey. To get the actual population/households of the studied villages, secondary sources such as Population and Housing Census, District Statistics, District Web Portal and respective Union Parishad Office information have been verified. When total numbers of the households/populations had been confirmed, considering all villages as cluster of several percentage according to distance (radius) from the project site and households were finalized for random sampling along with specific interval.

Whenever conducting social survey in 152 numbers of households along with 660 members, the villages were selected through cluster sampling method around the proposed project site within the

limit of 2 km radius. The overall cluster has been given below with respect to the adjacent unions of proposed project site. The numbers of households surveyed in 2 km study area is given in Table 7-37.

Table 7-37: Numbers of Households Surveyed in the 2 km Study Area

Upazila	Union		
	Name	Frequency	Percentage
Taltoli	Nishanbaria Union	107	70.4
	Barabagi Union	21	13.8
	Sonakata Union	24	15.8
Total		152	100

Source: EQMS Survey, 2018

7.21.2 Basic Demographical Characteristics of the Households

Basic demographic characteristics include total population, age, marital status, health status and religion. Table 7-38 illustrates the basic demographical characteristics of the households. A total of 152 households have been surveyed including three areas/locations specifically at Nishanbaria, Barabagi and Sonakata Union.

In the surveyed areas, analysis result has found about a total number of 660 population are living within the 152 households, whereas about 52.9% are male and rest 47.1% are female. Average family size is 4.3. On the other hand, 1-70+ age range has been formulated to capture the age distribution of the studied population. Importantly around 66.5% population belongs to 14-69 age range, which signifies that most of the populations are eligible for being active in economic activities. Contrary, 33.5% population is found depended. Additionally, 59.7% population is married. All over health status among the households has been found quite well. Around 97.1% populations are found physically normal, only 1.1% are handicapped by birth and 1.8% are found complicated health problems. Study area is found Muslim dominated where about 98.9% surveyed households were found Muslims. On the contrary, 0.5% and 0.6% households are Hindu and Buddhist community respectively.

According to Secondary data (BBS) it has been stated that there exist ethnic minority around the 5 km radius area of proposed project site. However, during conducting social survey only one family of ethnic community (Rakhine) was found in the study area. The basic demographic characteristics of the selected unions/pourashava is given in Table 7-38.

Table 7-38: Basic Demographic Characteristics of the Selected Unions/Pourashava

Demography		Nishanbaria Union		Barabagi Union		Sonakata Union		Total	
		n	%	n	%	n	%	n	%
Total Population	Male	248	37.6	48	7.3	53	8.0	349	52.9
	Female	229	34.7	44	6.7	38	5.8	311	47.1
	Total	477	72.3	92	13.9	91	13.8	660	100
Age	1-13	144	21.8	26	3.9	31	4.7	201	30.5
	14-27	132	20.0	26	3.9	18	2.7	176	26.7
	28-41	111	16.8	25	3.8	28	4.2	164	24.8
	42-69	74	11.2	13	2.0	12	1.8	99	15.0
	70- 70+	16	2.4	2	0.3	2	0.3	20	3.0
	Total	477	72.3	92	13.9	91	13.8	660	100
Marital Status	Married	285	43.2	54	8.2	55	8.3	394	59.7
	Unmarried	185	28.0	37	5.6	36	5.5	258	39.1

	Widowed/Divorced/ Separated	7	1.1	1	0.2	0	0.0	8	1.2
	Total	477	72.3	92	13.9	91	13.8	660	100
Health Status	Physically Normal	466	70.6	88	13.3	87	13.2	641	97.1
	Birth Handicapped	5	0.8	2	0.3	0	0.0	7	1.1
	Complicated Health Problems	6	0.9	2	0.3	4	0.6	12	1.8
	Total	477	72.3	92	13.9	91	13.8	660	100
Religion	Muslim	470	71.2	92	13.9	91	13.8	653	98.9
	Hindu	3	0.5	0	0.0	0	0.0	3	0.5
	Buddhist	4	0.6	0	0.0	0	0.0	4	0.6
	Total	477	72.3	92	13.9	91	13.8	660	100

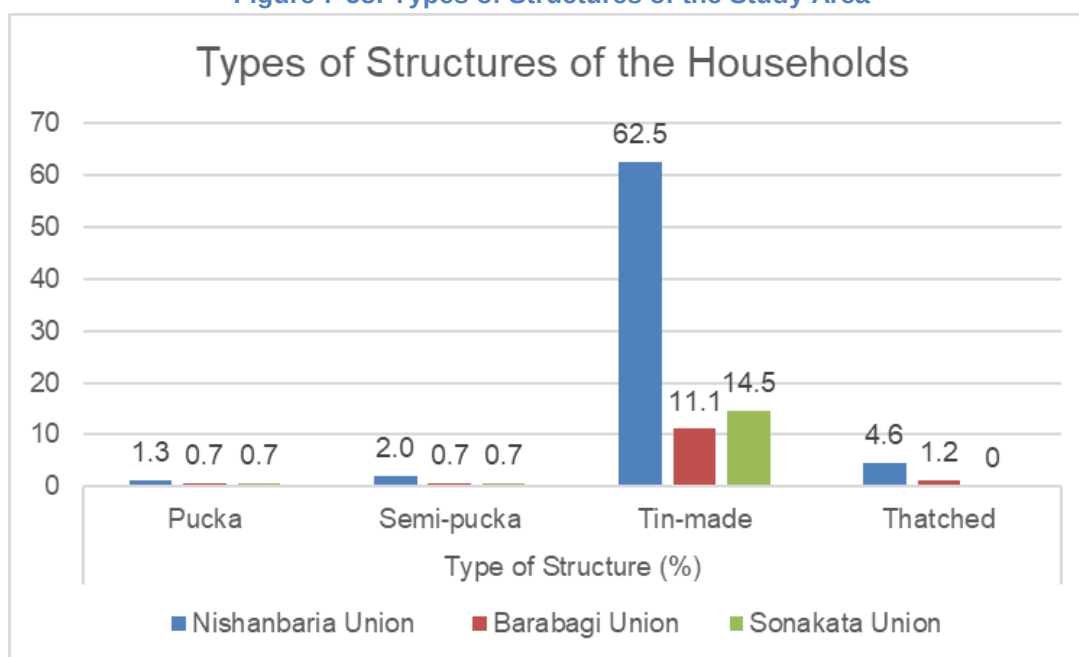
Source: EQMS Survey, 2018

7.21.3 Households Structures and Assets

7.21.3.1 Households Structures

In the study area, predominating household structures are Tin made. Survey finds that among the all surveyed locations 62.5% in Nishanbaria Union, 11.1% in Barabagi Union and 14.5% in Sonakata Union households have Tin-made households' structures. Second major household structure type is thatched structure representing 4.6% in Nishanbaria Union, 1.2% in Barabagi Union and 0.0% in Sonakata Union. Besides these, semi-pucka and pucka (building) structures are also available in some proportion in the studied area. The following Figure 7-58 shows the types of structures of the study area.

Figure 7-58: Types of Structures of the Study Area



Source: EQMS Survey, 2018

7.21.3.2 Household Domestic Animals

Poultry rearing is a very common practice in all households and this study finds that average 4.1 Poultry followed by 3.8 Goat, 1.8 Cow, 0.5 Sheep and 0.4 Buffalo rearing practices in the studied area. Study finds that this domestic animal rearing activities in this area happens to meet household need rather than economic gain. Though sometimes small numbers of selling activities happens but this is an unusual event. The following Table 7-39 shows the households domestic animals in the study area.

Table 7-39: Households' Domestic Animals

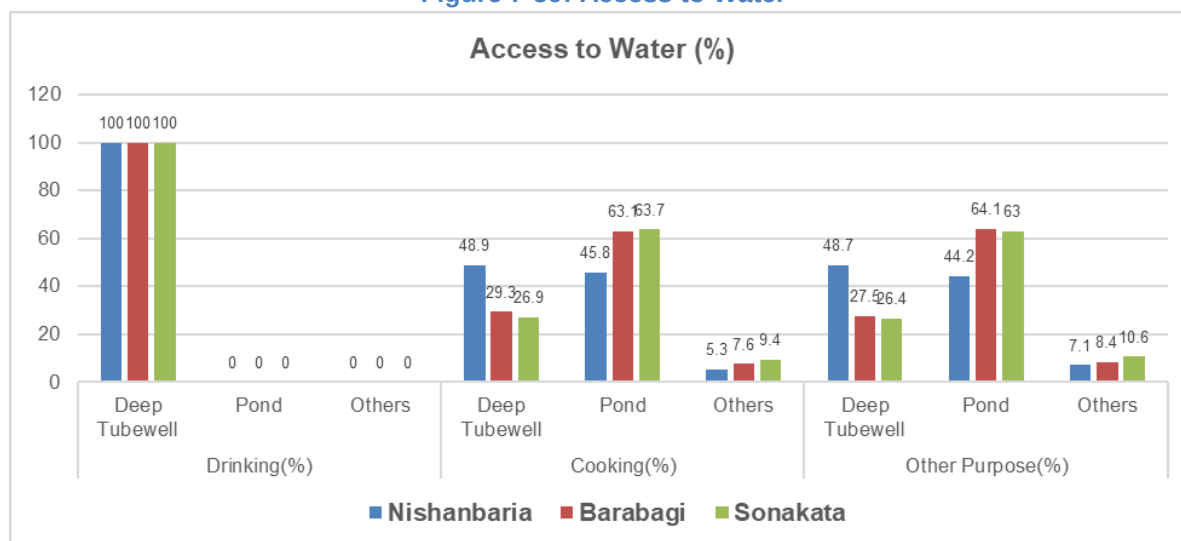
Domestic Animals	Nishanbaria Union			Barabagi Union			Sonakata Union		
	Mean	Std. Dev	Specification	Mean	Std. Dev	Specification	Mean	Std. Dev	Specification
Cow	0.03	0.82	2.3% has at least 3 or more	0.03	0.3	1.4% has at least 3 or more	0.01	0.75	1.8% has at least 3 or more
Buffalo	0.01	0.43	1.2% has at least 2 or more	-	-	-	-	-	-
Sheep	0.01	0.31	1.4% has at least 2 or more	-	-	-	-	-	-
Goat	0.17	0.84	4.3% has at least 2 or more	0.02	.78	3.1% has at least 3 or more	0.15	.82	3.9% has at least 2 or more
Poultry	0.26	0.70	4.8% has at least 3 or more	0.02	0.81	3.3% has at least 3 or more	0.13	.24	4.1% has at least 3 or more

Source: EQMS Survey, 2018

7.21.4 Water and Sanitation

In the study area, deep tube-well water is the major source of drinking (100%), cooking (28.4%) and other purposes (7.4%). Survey finds that average 100% households of the three unions depend on deep tube-well water for drinking purpose. Survey also finds that surveyed households depend on deep tube-well, pond and other sources (ditch, river, canal, etc.) respectively average 35.0%, 57.5% and 7.4% for cooking purpose. Besides, surveyed households depend on deep tube-well, pond and other sources respectively average 34.2%, 57.1% and 8.7% for using other purposes. The following Figure 7-59 shows the access to water of the studied area.

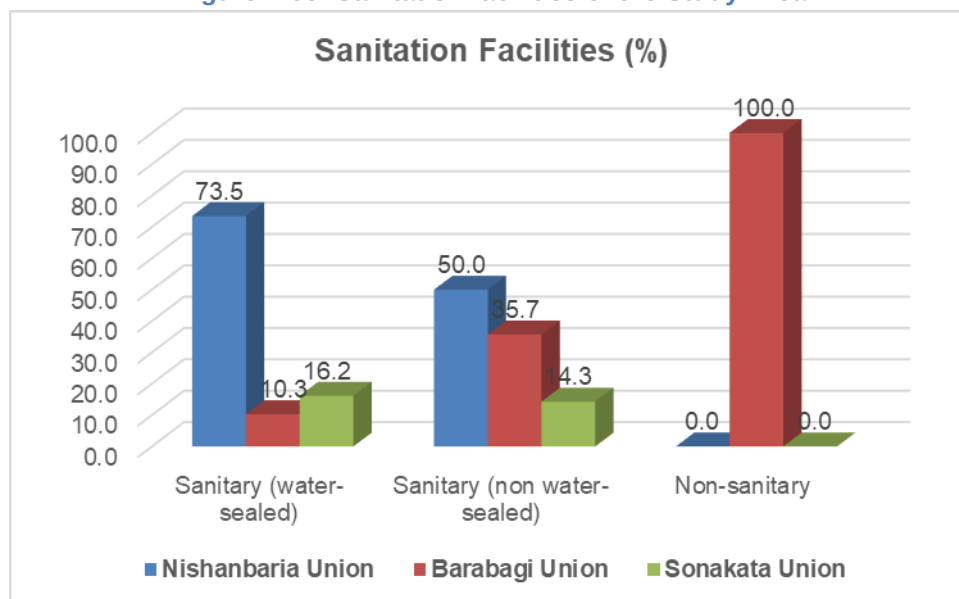
Figure 7-59: Access to Water



Source: EQMS Survey, 2018

Majority among the surveyed households use sanitary toilets having water sealed or non-water sealed (average 66.7%). Few households have non-sanitary toilet (33.3%) facilities also. Sanitation facility of the study area is shown in following Figure 7-60.

Figure 7-60: Sanitation facilities of the Study Area



Source: EQMS Survey, 2018

7.21.5 Education

Study finds that about 76.8% of total population is at least literate among them 45.5% has primary (class 1-5) education followed by 23.0% secondary (class 6-10) education, 6.5% H.S.C and rest 1.8% who completed Degree/Master level. About 23.2% populations are found underlie within the Illiterate category where around 14.7% populations are children (<5 years age) who have future potentiality to enrol in school. The following Table 7-40 shows the educational attainment of the population in the study area.

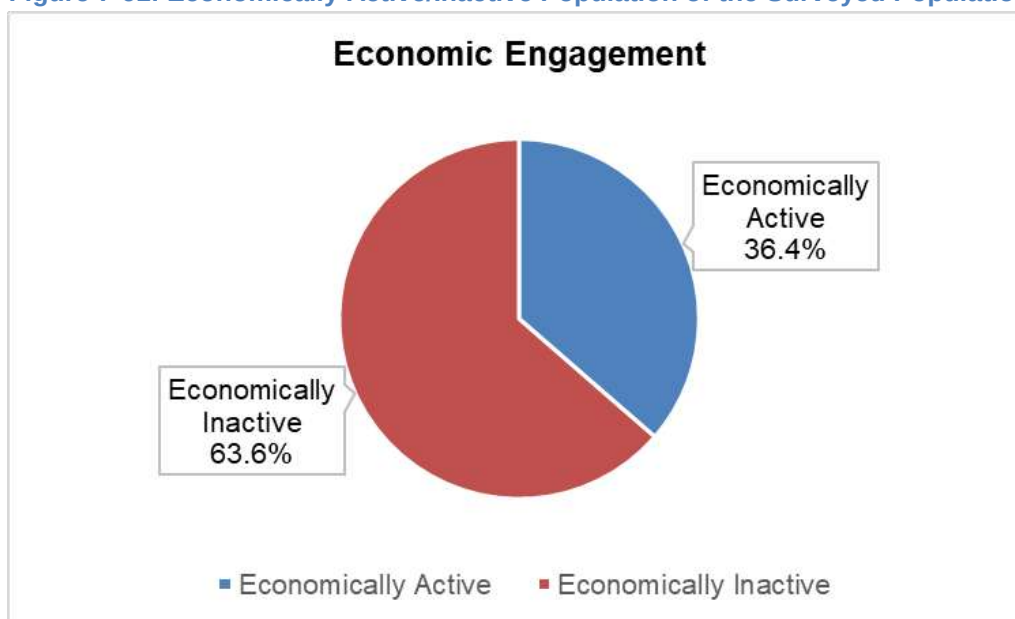
Table 7-40: Educational Attainment of the Population

SL#	Education	Nishanbaria Union		Barabagi Union		Sonakata Union		Total	
		n	%	n	%	n	%	n	%
1	Illiterate	112	17.0	21	3.2	20	3.0	153	23.2
2	Class 1-5	225	34.1	43	6.5	32	4.8	300	45.5
3	Class 6-10	112	17.0	17	2.6	23	3.5	152	23.0
4	H.S.C	24	3.6	8	1.2	11	1.7	43	6.5
5	Degree/Master	4	0.6	3	0.5	5	0.8	12	1.8
Total		477	72.3	92	13.9	91	13.8	660	100

Source: EQMS Survey, 2018

7.21.6 Occupation and Income

Among the total surveyed population, 36.4% are economically engaged by engaging in various occupations. Thus, this study finds that 10.0% and 9.4% of total surveyed populations are engaged with fishing and non-agricultural labour activities respectively, which represent the highest representation of the total economic-active population. Besides this, 4.7%, 3.9% and 3.3% of the surveyed populations are engaged with agriculture, business and agricultural labour. Moreover, Private Service (2.4%), Govt. Service (0.9%) and Servant (1.1%), etc. are also found in the study area. The Figure 7-61 shows the economically active/inactive population of the surveyed population.

Figure 7-61: Economically Active/Inactive Population of the Surveyed Population

Source: EQMS Survey, 2018

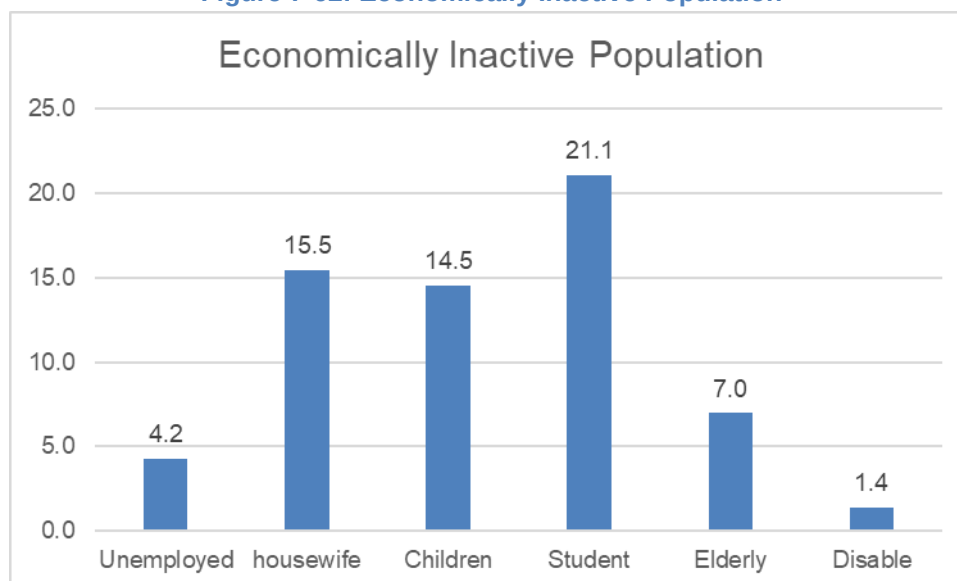
On contrary, 63.6% of the surveyed populations are economically inactive populations including 19.7% capable but inactive workforce, 35.6% future workforce and 8.4% incapable and inactive workforce. In the capable but inactive workforce category, 15.5% populations are engaged with household works and rests 4.2% are unemployed who are looking for job. Moreover, 7.0% and 1.4% are elderly person and physically handicapped who have no ability to work. On the contrary, 35.6% of the total populations are potential workforce of the studied population including 14.5% children and 21.1% students. The following Table 7-41 shows the occupational profile of the surveyed households of the study area.

Table 7-41: Occupational Profile of the Surveyed Household

Occupations	Frequency	Percent
Agriculture	31	4.7
Agricultural Labour	22	3.3
Non-agricultural Labour	62	9.4
Business	26	3.9
Fishing	66	10.0
Govt. Service	6	0.9
Private Service	16	2.4
Servant	7	1.1
Others	4	0.6
Sub-total	240	36.4
Unemployed	28	4.2
housewife	102	15.5
Children	96	14.5
Student	139	21.1
Elderly	46	7.0
Disable	9	1.4
Sub-total	420	63.6

Occupations	Frequency	Percent
Total	660	100

Source: EQMS Survey, 2018

Figure 7-62: Economically Inactive Population

Source: EQMS Survey, 2018

7.21.7 Household Income

Households' monthly income reveals the poor economic situation of the studied area. According to HIES 2010, after including the inflation rates monthly income BDT 10,000 is the poverty line limit of the studied area. Study finds that 19.7% households of the total surveyed households have equals or less than BDT 10,000. Second largest concentration has been found in BDT 10,001 - 20,000 category where 46.1% households fall. On the contrary, only 18.4%, and 5.3% households have monthly income respectively BDT 20,001 - 30,000 and BDT 30,001 - 40,000. 10.5% households have more than BDT 40,000. Poor or insufficient economic gain hindrances accessing to other basic and social services that leads to low inclusion rate and accelerates high poverty rate. The monthly household's income in the project area is given in Table 7-42.

Table 7-42: Monthly Households Income

Monthly Income (BDT)	Nishanbaria Union		Barabagi Union		Sonakata Union		Total	
	n	%	n	%	n	%	N	%
Less than 10000	25	16.4	3	2.0	2	1.3	30	19.7
10001-20000	50	32.9	7	4.6	13	8.6	70	46.1
20001-30000	19	12.5	5	3.3	4	2.6	28	18.4
30001-40000	4	2.6	3	2.0	1	0.7	8	5.3
40000+	9	5.9	3	2.0	4	2.6	16	10.5
	107	70.4	21	13.8	24	15.8	152	100.0

Source: EQMS Survey, 2018

7.21.8 Energy Access

Lighting and cooking sources are the very important energy requirements for any households where high quality and easy access to these energies can ease household's daily life. Results have found

that 58.6% of the total households use solar energy followed by electricity (36.2%) and kerosene (5.3%) as lighting source. The different energy access by households is shown in Table 7-43.

Table 7-43: Different Energy Access by the Households

SL#	Details	Frequency	Percent
1.	Lighting Source	Electricity	55
		Kerosene	8
		Solar	89
		Total	152
2.	Fuel/energy used for Cooking	LPG	13
		Firewood, Crop residue and Cow-dung Cake	138
		Kerosene	1
		Total	152
			100

Source: EQMS Survey, 2018

In the case of cooking fuel, it is found that maximum households are relying on the conventional ways of cooking. Firewood, crop residue and cow-dung cake are the source of natural fuels in the surveyed area. Usually women are engaged for preparing these cooking fuels. In absence of modern cooking system women have to work and prepare these fuels, consequently women are depriving themselves from engaging economic activities. About 90.8% households are relying on natural fuels (Firewood, crop residue and cow-dung cake) where rests 8.6% and 0.7% use LPG and kerosene for cooking.

7.21.9 Access to Social Institutions

Convenient and easy access to market and medical services help households get basic needs and health services when it is necessary or urgent. Distance may create barrier from easy access to these services, which ultimately leads to poor livelihood status. On the contrary, close proximity and easy access to social services leads better livelihood and development.

7.21.9.1 Market

Survey results have found that 100% households have easy access to main markets and around 45.4% lie within 1-2 km distance from the main market from where they can get all the goods; including perishable and non-perishable, for their daily life. For main market service, 71.1% and 28.9% of the populations goes to Taltali Bazar (located in Taltali Upazila Headquarter) and Laupara Bazar (located in Sonakata Union). The following Table 7-44 shows the access to social institutions in the study area.

Table 7-44: Access to Social Institutions

SL #	Social Institutions	Distance						Total	%
		< 1 km	%	1 to 2 km	%	> 3 km	%		
1	Market Distance	62	40.8	7	4.6	83	54.6	152	100.0
2	Hospital Distance	9	5.9	6	3.9	137	90.2	152	100.0
3	Primary School Distance	144	94.7	8	5.3	0	0.0	152	100.0
4	High School Distance	43	28.3	9	5.9	100	65.8	152	100.0
5	College Distance	10	6.6	5	3.3	137	90.1	152	100.0

SL #	Social Institutions	Distance						Total	%
		< 1 km	%	1 to 2 km	%	> 3 km	%		
6	Religious Institution Distance	151	99.3	1	0.7	0	0.0	152	100.0

Source: EQMS Survey, 2018

Easy access to hospitals enhances the frequency of health services taking. Higher distance may hinder taking health services, which ultimately increase the health risk. Survey results have found that only 9.8% households are staying within 1-2 km distance from the health service point. On the contrary, 90.2% households exist within 1-3 km distance from the hospital services. For general health service, 100% of the surveyed populations goes to Taltali Bazar (especially Taltali Upazila Health Complex and other clinic/diagnostic centre/doctor's chamber/pharmacy). General health services include paramedical, pharmacy services for normal or seasonal health problems.

Study finds that 94.7% primary schools are within <1 km distance from the households of local communities. Besides, only 34.2% high schools are within 1-2 km distance from the households. Study also finds that 9.9% colleges are within 1-2 km distance from the households of local communities. In generally, religious institution situates very close to the local community. In this study, it is found that 99.3% studied populations have access to religious institutions within <1 km distance.

7.21.10 Gender Analysis

Study finds the common patriarchic scenario in the study area. Among all the surveyed households 3.9% households have been found female headed. The gender analysis of the study area is shown in following Table 7-45.

Table 7-45: Proportion of Male and Female Household Head

Union	Male Headed	%	Female Headed	%	Total	%
Nishanbaria Union	102	67.1	5	3.3	107	70.4
Barabagi Union	20	13.2	1	0.6	21	13.8
Sonakata Union	24	15.8	0	0.0	24	15.8
Total	146	96.1	6	3.9	152	100.0

Source: EQMS Survey, 2018

7.21.11 Vulnerability Analysis

According to the head count rate of HIES (2010), it has been found that about 19.7% households are underlying below the poverty line. Additionally, 3.9% households were found women headed. The vulnerability status of the study area is shown in Table 7-46.

Table 7-46: Vulnerability of the Study Area

Vulnerabilities	Nishanbaria Union	Barabagi Union	Sonakata Union	Total
Monthly income =< 10,000	16.4	2.0	1.3	19.7
Female Headed Households	3.3	0.6	0.0	3.9

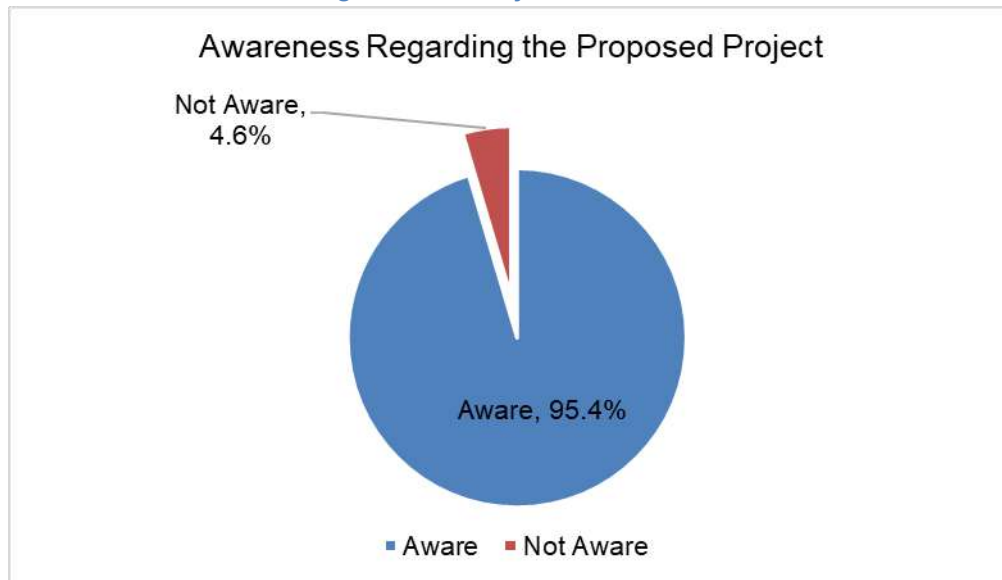
Source: EQMS Survey, 2018

7.21.12 Project Awareness

Project awareness and perception may hinder or facilitate any project work's successful implementation. Survey result shows that 95.4% of total households are completely aware of this proposed project. Conversely, 4.6% of total households are found indifference and know nothing

regarding this project. The awareness regarding the proposed project is shown in following Figure 7-63.

Figure 7-63: Project Awareness



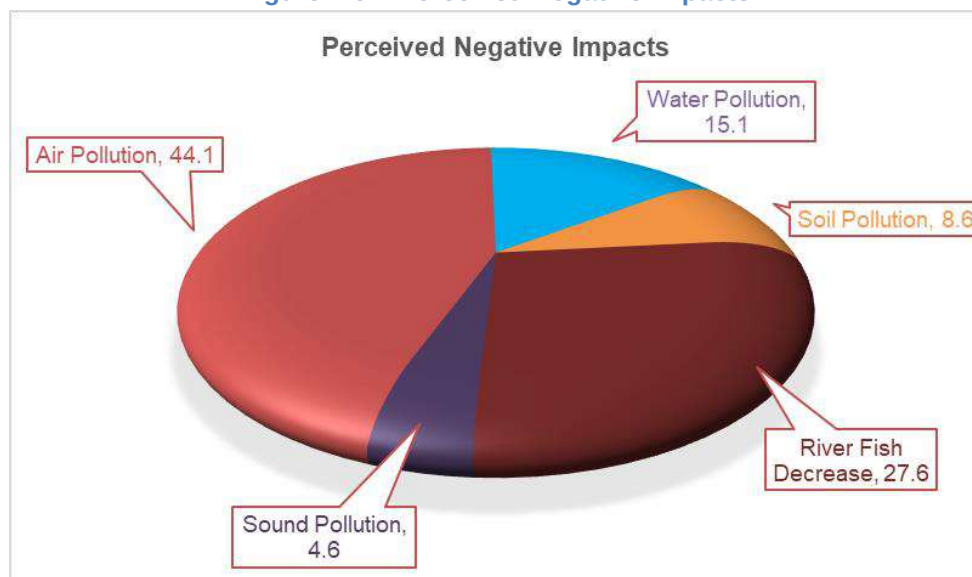
Source: EQMS Survey, 2018

7.21.12.1 Perceived Impacts

A. Negative Impacts

Study finds that, about 44.1% people believe that when the proposed power plant starts operation, it will create air pollution. Besides this, 27.6% population perceived that the proposed project will harm fishes of their surrounding rivers. Additionally, 15.1% people stated that it pollute water of their locality. Moreover, 8.6% indicated that this power plant will create soil pollution at the adjoin area of the proposed plant. Likewise, 4.6% pointed out that the proposed plant will create sound pollution during construction phase as well as operation phase. The perceived negative impacts due to the implementation of the proposed project in the project area is given in following Figure 7-64.

Figure 7-64: Perceived Negative Impacts



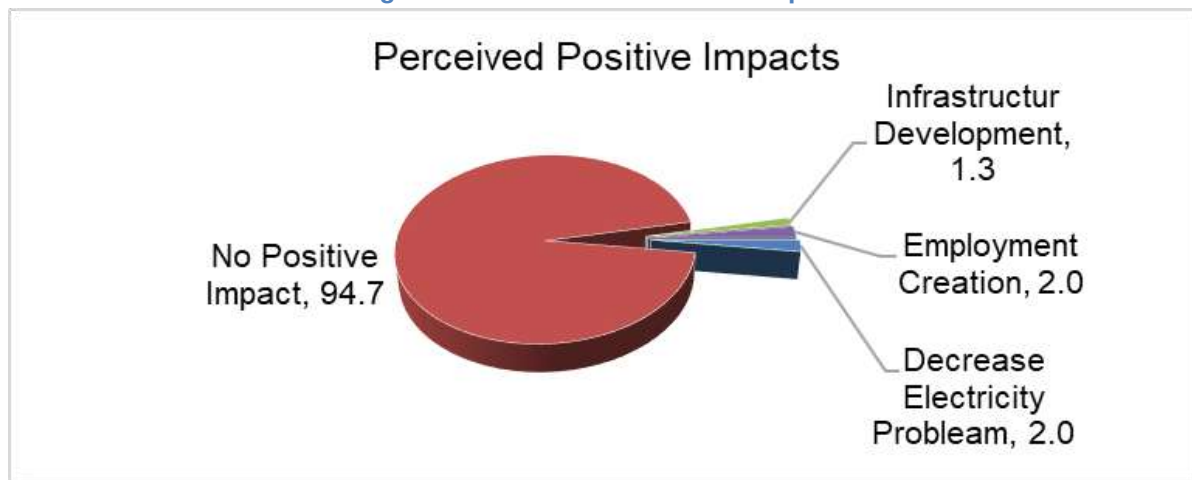
Source: EQMS Survey, 2018

B. Positive Impacts

Among the surveyed population, about 94.7% believe that this project will bring no positive impacts on the development of the local community. Among the studied populations, only 5.3% think that market

demand, business opportunity and work opportunity at the project construction activities will be increased. Therefore, employment will be created as well as local people will be blessed with these opportunities. Besides this, people think that other infrastructural developments like educational institute, residence, roads and hospital will be developed. Some believe that electricity problem will be decreased. The perceived positive impacts due to the implementation of the proposed project in the project area is given in following Figure 7-65.

Figure 7-65: Perceived Positive Impacts



Source: EQMS Survey, 2018

7.22 Distance to Urban and Rural Communities

The proposed project site is located on agricultural land, bushes, shrubs waterbodies and settlement including homestead vegetation. The Buriswar-Payra River flows on the north side of the proposed power plant. Land use in the immediate vicinity of the project area is mainly rural and no industries are developed in the surroundings of the project area. The settlement area inside of the proposed project area (outside of the embankment) will be required to remove before starting the construction activities. The rural community is also living opposite site of the embankment. This rural area is administratively located under the Taltoli Upazila of Barguna District. The distance of surrounding important features from the site is stated in the following Table 7-47.

Table 7-47: Important Features of the Project Influence Area

SL#	Places/Areas	Direction	Distance	Features/Remarks
1	Ankujanpara Village	South	Adjacent	Settlement
2	Joyalbhangra Bazar	South-West	Adjacent	Settlement, SBE
3	Taltoli Bazar	North-East	2 km	Settlement, SBE
4	Taltoli Upazila HQ	East	2.50 km	Settlement, SBE
5	Payra Port	East	22 km	SBE
6	Mosque	South	Adjacent	EHS
7	School	South	0.35 km	EHS
8	Dhaka- Kuakata National Highway	East	9.90 km	Road

HH- Households, SBE- Small Business Enterprise, EHS- Environmental Hotspots (Mosque, School and College)

7.23 Transmission Capacity/options for linking to Grid

The single-circuit transmission line will led from 1x350 MW coal-fired power plant GIS and connected to 400kV substation (temporarily referred to as 400kV Kalapara substation) that is about 13 km in the north-east of Kalapara. The power plant is situated on the southwest coastal area of Bangladesh and the proposed 400kV substation is about 26 km to the northeast of the plant. This transmission line is temporarily considered in the length of 32 km. Under the principle of minimizing house demolition, timber cutting and crossing-over.

7.24 Distance to Existing Infrastructure

An asphalt pavement road in good traffic condition for small vehicles connects the proposed project site with the Taltoli and Amtoli Upazila. According to the feasibility report, existing road is not adequate for the transportation of heavy cargos and recommended that logistics and heavy goods for the proposed project will be transported using the waterway. There is no existing railway transportation system in the whole of the Barisal division. However, the present government has taken a major initiative to set up rail access from Faridpur to Barisal and capital Dhaka through the Padma Multipurpose Bridge. The capital city Dhaka is about 200 km away from the project site. The nearest airport is located at Barisal is about 95 km away.

7.25 Current and Surrounding Land Use and Associated Communities

The details land use of the proposed 350 MW coal-fired power plant project area and 10 km radius of the project area has been depicted in Chapter-6 in this EIA report.

CHAPTER EIGHT: ENVIRONMENTAL IMPACTS ASSESSMENT AND EVALUATION

8. Environmental Impacts Assessment and Evaluation

8.1 Identification of Impact

This chapter presents identification and assessment of various impacts due to the establishment of the proposed power plant project in its lifecycle. The possible impacts have been identified based on the information from the project proponent, feasibility study report and detailed field investigation at the project site. The identified impacts significance have been evaluated based on nature, extent and location, duration, intensity/severity, irreplaceable loss, probability and magnitude. The detailed impact assessment methodology is given in Section 1.6 (Chapter-1) in this report. Evaluations were made following expert judgment and considering without mitigation measures. A matrix method (Table 8-1) has been adopted for identifying the possible environmental and social impacts.

The proposed project would involve the development, operation and decommissioning of 1x350 MW supercritical coal-fired power plant with affiliated coal handling jetty. The development is envisaged to result in a number of potential impacts arising from activities related to the pre-construction, construction, operational and decommissioning phases of the project, which may affect the various receptors and the nature conservation interest within the area of influence.

The proposed project will be operated by the 100% imported coal from Indonesia, Australia and South Africa. The project will use the local available natural resources like land, air, water and soil etc. One of the most important issue is the land acquisition for implementing the proposed project and success of the project is depending on how well the project-affected people are resettled and rehabilitated. The proposed major activities will involve construction of labor camp, site preparation, transportation of machinery and ancillaries, storage of equipment and materials for construction, erection of all equipment and machineries, construction of jetty etc. These activities will have diversified impacts on the environment and socio-economic conditions of the local people with various natures and significance.

The mitigation measures proposed for minimizing the impacts have also been discusses in the report. An Environmental Management Plan (EMP) is developed to minimize adverse impacts and to ensure that the environment in and around the project site is well protected. The EMP has been prepared for pre-construction, construction and operation phases of the proposed facilities. Various impacts on the environment have been studied to estimate the impacts on the environmental attributes and are discusses in the subsequent sections.

8.2 Sustainability of Quality of Coal and Continuity of Supply

The proposed project sponsor, BEPCL will be responsible for the coal sourcing and coal quality. All the coal sources, its availability and sustainability of coal quality have been depicted in Section 3.9 in this report.

Table 8-1: Impact Identification Matrix for the Proposed Project

Potential Impacts/Risks Activity	Environmental, Ecological and Social component																								
	Aesthetic & Visual Impact	Landscape	Land use	Soil Quality	Sediment Quality	Surface Water Quality	Surface Water Quantity	Ground Water Quality	Ground Water Quantity	Air Quality	GHG Emission	Noise Level	Vibration level	Drainage Pattern	Traffic (Road & River)	Terrestrial Ecology	Aquatic Ecology	Occupational Health & Safety	Economy and Livelihood	Employment	Population Displacement	Social and Cultural Structure	Infrastructure & Services	Community Health & Safety	Social Conflict
Pre-construction and Development Phase																									
Land Acquisition, Requisition and Lease																									
Removal of vegetation/trees																									
Soil collection (dredging) and transportation to the project site																									
Landfilling, levelling, excavation and compaction																									
Equipment & machinery operation in the project site																									
Maintenance, replacement of vehicles & equipment																									
Establishment of temporary labor camp & employment opportunities																									
Construction Phase																									
Establishment and maintenance of Labor camp																									
Generation of solid waste from labor camp and disposal																									
Abstraction of water for construction activities and labor camp																									

Potential Impacts/Risks Activity	Environmental, Ecological and Social component																			
	Aesthetic & Visual Impact	Landscape	Land use	Soil Quality	Sediment Quality	Surface Water Quality	Surface Water Quantity	Ground Water Quality	Ground Water Quantity	Air Quality	GHG Emission	Noise Level	Vibration level	Drainage Pattern	Traffic (Road & River)	Terrestrial Ecology	Aquatic Ecology	Occupational Health & Safety	Economy and Livelihood	Employment
Construction of Jetty (riverside)																				
Transportation and storage of construction materials																				
Storage and handling of chemicals																				
Machineries and equipment's operation and maintenance in the construction site																				
Civil construction																				
Mechanical and Electrical Erection Activities																				
Influx of labor																				
Removal of labor camp																				
Operation Phase																				
Imported coal from abroad and transport through vessels to coal handling jetty																				
Unloading, Crushing and Storage of Coal																				
Emission generated from stack																				

Potential Impacts/Risks Activity	Environmental, Ecological and Social component																			
	Aesthetic & Visual Impact	Landscape	Land use	Soil Quality	Sediment Quality	Surface Water Quality	Surface Water Quantity	Ground Water Quality	Ground Water Quantity	Air Quality	GHG Emission	Noise Level	Vibration level	Drainage Pattern	Traffic (Road & River)	Terrestrial Ecology	Aquatic Ecology	Occupational Health & Safety	Economy and Livelihood	Employment
Fugitive emissions are envisaged from handling and storage of coal in the stockyard, fly ash handling systems and transfer operations																				
Generation of noise from boiler sections areas, loading and unloading area, machineries and vehicles movement																				
Utilization of surface water from Buriswar-Payra river for the power plant operation																				
Generation, treatment and disposal of effluent																				
Domestic and other non-hazardous wastes handling, storage and disposal																				
Hazardous material and waste storage																				
Maintenance and replacement of equipment																				
Greenbelt development																				

8.3 Pre-Construction and Development Stage Impact

8.3.1 Impact on the Sites from Where Material Would be Collected

During the pre-construction and development stage only site preparation and landfilling work will be done. According to the BEPCL, for the land development in the proposed project site, it will be required an approximate amount of 3.2 million cubic meter landfilling material (dredge soil). This landfilling material will be collected from the nearest sea (Bay of Bengal) by dredging. According to the project proponent, the tentative location of the dredging site is about 6.5 km on the west side of the power plant. The Power China Harbour Co. Ltd. will be responsible for landfilling activities in this project. Before starting dredging activity in the Bay of Bengal, the project proponent must be ensured the avoidance of Protected Area, Wildlife Sanctuary, Reserve Forest, Ecologically Critical Area, Marine Protected Area, Designated Fishing Ground, Hilsa breeding and migration route, Dolphins or others aquatic faunal migratory route and taken appropriate written approval from the concerned authority. The dredge material will be transported by two vessels, approximately 280 operators, labors will be dispatched on site in order to quickly finish the dredging activities and for the landfilling materials transportation, about 100 operators will be needed. There will be 85 numbers of equipment's including dredger(s), bulldozers, dump trucks and loaders for dredger operation. The duration of the dredging activities in the sea and landfilling in the project site is expected to be limited during pre-construction phase. The dredge materials collection process in the sea will increase noise, turbidity and number of vessels movement will be increased, which may impacts on aquatic ecosystem and disturbance the river traffic temporarily. Any accidental spillage of fuels and lubricants and improper management of the solid and liquid waste from the dredgers will impacts on the aquatic ecosystem. Exhaust emission from the burning fossil fuel in the dredger will impact on ambient air quality. However, the impacts from the material collection activities in the sea is assessed to be Medium-High.

Impact	Impacts due to material collection from the Sea					
Impact Nature	Direct	Indirect		Induced		
Impact Scale	Dredging site (in the Bay of Bengal)					
Frequency	Limited to pre-construction phase (Only dredging period)					
Extent and location	Project Site	Local	Regional	National	Trans boundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium - High	High	Very High
Probability of Impact	Unlikely		Low	Medium	High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-High	High	Very High
	Significance of impact consider Medium-High					

8.3.2 Impact on Landform

According to the BEPCL, approximately 174 acres of land will be required for the establishment proposed power plant in Taltoli, Barguna. Primarily the existing proposed project area land is low lying and gradually lower towards the riverside. The existing project site land will be developed through filling, levelling and grading, prior to start the construction activities. There is no hilly area and designated wetland area inside of the project area. However, there is an unrecorded canal flowing through inside of the proposed project boundary. During the site preparation and land development,

the existing canal needs to be fill up. There are settlement area including homestead trees/vegetation in the proposed project area, will be required to remove. Land development activities will change the existing landform and land use of the project site but might not the surrounding area. Land use pattern of the project site will be changed from single cropped land, barren land, settlement area, canal, pond, homestead vegetation shrubs and bushes to industrial category. Natural or artificial drainage of the proposed project area and its surrounding area might be impacted due to landfilling activities and close the existing canal. Ambient air quality will be impacted due to the generation of dust from landfilling, levelling, excavation and backfilling activities. The impacts on landform due to the site development activities are assessed to be Medium-High.

Impact	Impacts on landform due to site development					
Impact Nature	Direct	Indirect		Induced		
Impact Scale	Inside of the project boundary					
Frequency	Limited to pre-construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-High	High	Very High
	Significance of impact consider <i>Medium-High</i>					

8.3.3 Impact on Natural Resources

8.3.3.1 Impact on Land Resources

The existing land comprises single cropped land, barren land, settlement area, canal, homestead vegetation, shrubs and bushes etc. According to the BEPCL, approximately 174 acres of land will be required for the proposed power plant establishment. According to the BEPCL, now the project company is going to take lease the required land from the Iso Tech Electrification Company (local partner/shareholder) and government (Khas) land. However, all the land will be transferred to the project company name in future except the government lease land. The land title/lease document of the proposed project is given in Annex-G (Volume-II). The project proponent already initiated a RAP and LAP study in the project area to resettle the existing community those who are living on the slope of the BWDB earthen embankment and inside the project boundary. According to the RAP preliminary survey, approximately 112 number of households will be required to resettle from the proposed project site. Due to the land development for the establishment of the proposed project, land use pattern of the project site will be changed from single cropped land, barren land, settlement area, canal, ponds, homestead vegetation, shrubs and bushes to industrial category. It is expecting that the land use of the surrounding area will not be affected for pre-construction phase of the project but in future, the surrounding area might be changed due to the proposed project implementation. The land price will be increased due to the industrial development, direct and indirect employment opportunities, business opportunities, influx of population and improvement of infrastructures in the locality. However, the impacts on land resources due to the implementation of the proposed project is assessed to be Medium-Low.

Impact	Impacts on Land resources					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary					
Frequency	Whole lifecycle of the project					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.3.3.2 Impact on Fish Resources

During the field survey, no major fishing activity was observed inside of the proposed project boundary except limited scale fishing in small ponds, ditches and canal near the settlement areas. However, many fisherman's are living in the surrounding area of the proposed project and they catch fish in the Buriswar-Payra River and the Bay of Bengal. Most of the people in the project area is dependent of fish resources and important earning source for them. It is anticipated that, during landfilling in the project site no significant impacts on fish resources will be occurred. However, the impacts on open water fisheries habitat like Buriswar-Payra River and adjoining sea may be affected due to dredging activity, vessels movement, turbidity, noise from dredger, attraction by the light, spillage of wastes and hazardous fuel or chemical into the waterbodies from dredger. Dredging activities may also alter the habitat of the bottom feeder fish for short period. The impacts on fish resources due to dredging in the sea and land development is assessed to be Low.

Impact	Impacts on Fish Resources					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary and dredging site					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-	Medium-	High	Very High

			Low	high	
Significance of impact consider Low					

8.3.3.3 Impact on Forest Resources

The proposed project site does not fall any designated forest area or protected area. Most of the part of the proposed project area is an open surface area and homestead planted trees are available in the settlement areas only. During the pre-construction and development stage, the homestead vegetation or trees needs to be remove or cut. According to the RAP preliminary survey, approximately 14,526 trees will be affected due to the project implementation consisting 6,315 big size (≥ 90 cm), 3,382 medium size ($=60-89$ cm), 2,520 small size (<60 cm) and 2,309 sapling trees. In addition that, approximately 2,346 number of annual plants including Banana, Bamboo and Papaya will be affected. A list of the affected trees is given below in Table 8-2.

Table 8-2: List of Affected Trees in the Proposed Project Site

SL#	Name	Big Size (≥ 90 cm)	Medium Size ($=60-89$ cm)	Small Size (<60 cm)	Sapling
1	Akashmoni	24	21	10	41
2	Amlaki	3	0	0	1
3	Amra	48	43	23	3
4	Arjun	10	15	0	0
5	Ata/Sharifa	20	13	2	6
6	Babla	90	10	0	0
7	Bel	25	14	6	14
8	Boroi	180	103	94	45
9	Chalta	1	0	0	0
10	Chambal	528	362	269	383
11	Coconut	442	105	122	149
12	Dewa	1	0	0	0
13	Eucalyptus	100	0	0	0
14	Gab	33	15	10	4
15	Gewa	128	65	60	0
16	Golpata	152	50	0	0
17	Guava	229	122	102	95
18	Jackfruit	173	71	19	9
19	Jalpai	0	5	0	0
20	Jam	33	40	15	23
21	Jambura	22	12	12	0
22	Jamrul	65	23	0	21
23	Kadam	17	15	20	0
24	Kamranga	1	1	5	0
25	Karamcha	9	3	27	0
26	Katbadam	24	19	26	4
27	Khejur	1127	410	542	285
28	Koroi	1264	999	616	643

SL#	Name	Big Size (>=90 cm)	Medium Size (=60-89 cm)	Small Size (<60 cm)	Sapling
29	Lebu	4	2	0	0
30	Litchi	7	0	20	0
31	Lotkon	0	0	1	1
32	Mahogany	200	164	128	32
33	Mango	393	179	113	229
34	Neem	89	101	49	29
35	Sabeda	31	10	8	6
36	Shimul	290	142	133	119
37	Supari	305	104	55	94
38	Tal	139	88	9	63
39	Tetul	108	56	24	10
Total		6,315	3,382	2,520	2,309

Source: Preliminary RAP Survey, 2018

During the field survey, a planted mangrove patches was found on the north side of the project boundary and along the bank of Buriswar-Payra River. The project proponent or BEPCL confirm that, the proposed power plant project will not encroach the planted mangrove forest area. Dust will be generated in the proposed project site due to the landfilling, levelling, backfilling etc. activities and it will be dispersed by wind action. The prevailing wind direction in the project area is toward the mangrove forest area. Therefore, it is assuming that, dust will be accumulated on leaf surfaces, which will impacts trees respiratory/photosynthetic activities. However, the impacts on forest resources due to site cleaning and development is assessed to be Low.

Impact	Impacts on forest resources					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.3.4 Impact on Ecosystems

The initial pre-construction work at the project site involves site cleaning, trees/vegetation removal, landfilling and levelling etc. Currently, the proposed project site are covered with single cropland, ponds, canal, homestead vegetation/trees, barren land, shrubs and herbs, which are the feeding ground and nesting habitat of different terrestrial common birds. Before starting the construction activities, all the trees will be cut and remove from the project site, waterbodies including ponds and canal will be filled. The removal of vegetation and trees from the soil and loosening of the topsoil generally cause soil erosion. In addition, there would be considerable movement of construction machinery with related considerable noise generated.

The impact on plants during pre-construction phase is potential loss of vegetation resulting from land clearing and levelling, which would destroy the original vegetation. However, the plants are not rare species, so only the quantity will be reduced and not extinct, consequently the impact would be partial, and therefore may not effectively cause regional ecological damage. According to the RAP preliminary survey, approximately 14,526 trees will be affected due to the project implementation consisting 6,315 big size (≥ 90 cm), 3,382 medium size ($=60-89$ cm), 2,520 small size (<60 cm) and 2,309 sapling trees. In addition that, approximately 2,346 number of annual plants including Banana, Bamboo and Papaya will be affected.

The proposed project site at Barguna, is noted to have very low fauna diversity and abundance. No species of international conservation interest was encountered in the project site. The proposed project is therefore unlikely to have any significant adverse impact on the fauna of the area due to the very low faunal population and poor species diversity currently in the project area. In addition, the impact zone (footprint) of the project is limited and therefore not expected to have any significant impact on wildlife within the area of influence and beyond. Dredging activities in the sea for soil collection will impacts on aquatic ecosystem including fishes and others aquatic life. Physical presence of the workers and noise from vehicles and machineries in the project site can disturb the faunal species. The impacts on the ecosystem due to pre-construction and development phase activities is assessed to be Low.

Impact	Impacts on ecosystem due to material collected from the sea & site cleaning					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project site and dredging site					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.3.5 Impact on Ambient Air

Particulate matter will be the predominant pollutant affecting the ambient air quality during the pre-construction and development phase of the proposed power plant project. Gaseous emission from the operation of machineries, equipment's, vessels, dredgers and vehicles will impacts on ambient air quality. Considerable quantities of dust will be generated mainly during landfilling, site establishment, earthwork etc. along with transportation activities in dry condition. The particulate matter that would be released into the air could reduce visibility. The particles may settle on leaf surfaces thereby blocking stomata pores through which gaseous exchange occur during respiratory/photosynthetic activities. Windblown dust from landfilling site can accumulate in the nearest surface water body and impact on aquatic life. These impacts are, however, reversible and of short duration, limited to the project boundary and dredging site and only during the pre-construction and development stage. The impacts on ambient air quality due to land development activities and soil collection is assessed to be Low.

Impact	Impacts on Ambient Air					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Landfilling, levelling, compaction site and dredging site					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transbound ary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignific ant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insigni ficant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.3.6 Impact on Ambient Noise

During the pre-construction and development stage of the proposed project, the noise generation sources will be the dredging activities in the dredging site, dredge material transportation, landfilling, levelling, compaction of soil, traffic movements, operation of vehicles and machinery in the site. It will also be increased due to the removal of trees and vegetation from the site. Ambient noise level in the proposed project site will be increased and impact on terrestrial fauna, aquatic fauna, occupational and community health and safety. It is expected that the impact will be minimum and short-term during the pre-construction stage. The impacts on ambient noise due to dredging and land development activity can be assessed to be Low.

Impact	Impacts on ambient noise				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Dredging site, landfilling and levelling site				
Frequency	Limited to pre-construction Phase				
Extent and location	Project Site	Local	Regional	National	Transboun

					dary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.3.7 Impact on Water Bodies

The proposed project site is situated on the bank of the Buriswar-Payra River and local hydrology is influenced by the Bay of Bengal. The proposed project area is also influenced by the tidal effect two times in a day. There is an existing canal inside of the proposed project site, which is connected with the Buriswar-Payra River, will be fill-up by the project authority during land development. According to the local people, existing canal is being use as a natural drain to pass the high tide and low tide water from the project site and its surrounding area. During the high tide, water enters into the canal from the Buriswar-Payra River and enters inside of the embankment area. The local farmers are use this surface water for irrigation purposes. A sluice gate is constructed by the BWDB to regulate the high tide and low tide water enter into the embanked area and drain out water from the surrounding area. During the site preparation, about 174 acres of land will be fill-up by dredging soil. By the landfilling and land development activities, existing drainage system in the proposed project site and its surroundings will be impacted. The project surrounding area including agricultural land, settlement and homestead vegetation will be affected by the serious waterlogging problem. The project proponent also ensure that, they would excavate new canal outside of the project boundary and towards the east from the project. Dredging activities in the waterbodies will change the bottom topography, increase the turbidity, solid waste, liquid waste and accidental spillage of oil and lubricant from the dredger will be significantly impact on the water resources as well as the aquatic life. Accidental spillage of fuels and lubricant from the vehicles in the land development site can be mixed with the rainfall-runoff and impact on aquatic environment. Windblown dust from the land-filling site can be dispersed and accumulated on the waterbody as a result TSS of the surface water will be increased. The impacts on waterbodies due to dredging and land development activities is assessed to be Medium-High.

Impact	Impacts on water bodies due to landfilling for site development				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Within the project site and surrounding area				
Frequency	Entire the project cycle				
Extent and location	Project Site	Local	Regional	National	Transbounda ry
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High

Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium-High					

8.3.8 Impact on Soil

Site preparation activities (like site cleaning and leveling, excavation and earth movement) would result into permanent loss of fertile topsoil of the project site. Landfilling soil will be collected from the sea (Bay of Bengal) area by dredging. The project area soil will be impacted if contaminated dredge soil is used for land development. During the removal of the trees/vegetation and establishment of the temporary labor camp, soil compactness will be loose and erosion by the rainfall water and strong wind can be occurred. Heavy machineries and vehicles will be operated in the project site during pre-construction and development phase for site establishment. Maintenance of these machineries and vehicles will also be required. As a result, accidental spillage of fuels and lubricants can mixed with the surface soil and contaminate. The impacts on soil quality due to land development activities is assessed to be Very Low.

Impact	Impacts on soil					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project location					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Very Low					

8.3.9 Impact on Workers Health, Sanitation and Safety

Site preparation involving cleaning and earthworks, operation of the machinery, movement of vehicles and machinery would generate dust, fumes and noise that could lead to possible respiratory problems, hearing loss and other health-related problems. Use of power tools and accessories, falling gadgets, cuts from sharp objects as well as the inhalation of exhaust fumes from vehicles and equipment could cause potential injuries and harm to health of workers and neighboring residence. Improper management of the labor camp will also impacts on workers' health, sanitation and safety. The impacts on workers health, sanitation and safety is assessed to be Low.

Impact	Impacts on Workers Health, Sanitation and Safety					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within land development site and labor camp					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High		Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.3.10 Impact on Key Point Installations and Others

As there is no major key point installations in and around the project boundary so impact on key point installation and others will be insignificant.

8.3.11 Solid Waste Disposal

Pre-construction activities may generate different categories of solid wastes and might have impact on local environment only if not managed properly. Wastes may be generated from earthworks, removal of trees/vegetation, removal of existing settlements and solid waste from the workers camp during site establishment activities. The wastes might be piece of wood, bamboos, tin, excavated spoils, spilled oil from machinery and vehicles etc. The site development activities shall be carried out following environmental rules and regulation so that no significant environmental impact would be resulted from the pre-construction and development stage activities. However, the impacts due to solid waste generation and disposal is assessed to be Very Low.

Impact	Impacts due Solid waste generation and disposal					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within project site and workers camp					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transbounda ry	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium- low	Medium- high	High	Very High

Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Very Low					

8.3.12 Impact due to Transportation of Raw Materials

During pre-construction and development phase of the proposed power plant project, raw materials for the landfilling activities will be the dredging soil from the sea (Bay of Bengal) area. According to the BEPCL, the dredge spoil will be transported through vessels. Dredging activities in the sea area and movement of vessels in the project surrounding area will be increased during the raw materials transportation and impact will be insignificant. The raw materials transportation will be done using waterway so no impacts on road traffic is expected. During the transportation of raw materials, the ambient noise will be increased and impact on aquatic animals. Accidental spillage of fuels, lubricants, disposal of waste from the dredgers and vessels will impacts on water quality and aquatic ecosystem. Ambient air quality will be impacted insignificantly by the use of fossil fuel in the dredgers and vessels. However, the impacts due to transportation of raw materials is assessed to be Very Low.

Impact	Impacts due to transportation of raw materials					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Dredging site to project site					
Frequency	Limited to pre-construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Very Low					

8.3.13 Social Impacts

8.3.13.1 Community Displacement due to Land Acquisition

The proposed 1 x 350 MW coal-fired power plant project is envisaged to acquire large tract of land estimated to 174 acres of land area for the development of infrastructure and installation of project facilities. The potential impact would include loss of agricultural land and related loss of income, livelihoods, displacement of residents with the acquired areas and potential family litigation resulting from management of compensation payment. If the land acquisition is done by improper way, this may lead to community or social unrest. According to the BEPCL, they have already initiated a RAP and LAP study in the project area to resettle the existing community those who are living on the slope of the BWDB earthen embankment and inside the project boundary. According to the RAP preliminary survey, approximately 112 number of households will be required to resettle from the proposed project site. Before land development activities in the project site, project authority must be ensured proper compensation. Impacts on the local community displacement due to land acquisition is assessed to be High.

Impact	Impacts due to land acquisition					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary					
Frequency	During pre-construction Phase and continue whole life cycle					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>High</i>					

8.3.13.2 Employment Generation

The pre-construction phase activities will generate direct and indirect employment opportunities for the local community within the Taltoli Upazila and other areas in the country. The principal receptors are the local inhabitants and especially the economically active fisherman's and farmers. The pre-construction and development phase activities of the power plant is envisaged to engage approximately 380 workers in pre-construction works including operator and laborers. In addition, considerable indirect employment could be generated through contractors and other service providers and suppliers. Vendors would also emerge to provide food and catering services to the workers as well as trading in variety of items.

8.3.13.3 Disturbance of Boat Communication

According to the boat traffic survey in the proposed project site (meeting point between canal and Buriswar-Payra River, approximately 420 numbers of boat including fishing boat (motorized), fishing boat (non-mechanized), trawler (people and goods carrying) and cargo (medium) access the internal canal every day. During the field survey, same boat was counted for several times due to their movement in the canal to catch fish in the Buriswar-Payra River and back to home. In addition, discussions with the local community inform that numbers of boat movement depends on the high tide, low tide, fishing time and season in the river and sea. The number also increase during the emergency (Cyclone) as the boats take shelter in the canal to protect them from the cyclone. Among the total counted vessels, fishing boat (motorized) was 54%, fishing boat (non-mechanized) was 43%, trawler (people and goods carrying) was 3% and rest of them was cargo (medium). Due to the land acquisition and landfilling, the existing canal will be closed and it will disrupt the existing boat communication system. However, the project proponent confirm that, they will excavate alternate canal on the outside (east side) of the project boundary by considering the existing canal depth, width and volume of water flow etc. The impacts on boat communication due to close the existing canal in the proposed project site is assessed to be Medium-Low.

Impact	Impacts on boat communication due to land acquisition and landfilling		
Impact Nature	Direct	Indirect	Induced
Impact Scale	Existing internal canal of the project site		
Frequency	Limited to construction Phase		

Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.4 Construction Stage Impact

Most of the construction phase activities would exhibit reversible and short-term impacts, which can be readily controlled and mitigated through robust and scientifically designed construction work-method statements as per the best engineering and management practices. It is expected that, the duration of construction period will be 30 months after getting the environmental clearance from the DoE, Bangladesh. The following impacts are expected during the construction of the proposed 350 MW coal-fired power plant project at Taltoli, Barguna.

8.4.1 Impact on Landform

During the landfilling and development works in pre-construction phase and before starting the construction activities, the project site will be levelled and compacted. No major changes of landform is expected during the construction phase. Only uneven places soil will be cut and fill and it will not involve major cutting and filling.

Constructions activities including the establishment of storage tanks, pump house, pipeline and construction of buildings and internal road network may change the visual landscape of the project site. Site clearance activities, gathering of equipment and construction materials, machinery and labor camp establishment on greenfield site may reduce the scenic beauty. Nevertheless, the impact is for a short duration and reversible as the project plan includes landscape planning, green belt development etc. The impacts on landform due to the construction activities is assessed to be Very Low.

Impact	Impacts on landform					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within project boundary					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High

Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Very Low					

8.4.2 Impact on Natural Resources

8.4.2.1 Impact on Agricultural Resources

The proposed project site will be developed during the pre-construction and development stage of the power plant project. The project site is comprising single cropland, settlement, homestead vegetation/tree, ponds, canal, barren land consists of shrubs and bushes. Crop farming is not intensively practiced in the proposed project site as envisaged. The major problems are poor soil quality, productivity level for crop production, salinity intrusion, tidal effect, natural hazards like cyclone and tidal surges etc. Consequently, the main crop cultivated by the people is Aman rice. Therefore, no major impacts are expected on agricultural resources including loss of crop production. The impacts on agricultural resources by the establishment of the power plant is assessed to be Very Low.

Impact	Impacts on agricultural resource					
Impact Nature	Direct	Indirect		Induced		
Impact Scale	Within project boundary					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Very Low					

8.4.2.2 Impact on Fisheries

During the construction phase of the proposed power plant, major construction materials for the plant will be transported by the waterway. As a result, number of vessels movement in the Buriswar-Payra River near the project site will be increased during the construction phase. The movement of vessels in the river and accidental spillage of oil and lubricants, blast water, oil mixed water, solid waste from vessels and jetty construction activities will impact on the open water fisheries resources. During the construction of coal handling Jetty (north side of the project) in the Buriswar-Payra River, will be increased the ambient noise level, vibration and increase the turbidity in the river. The fish and others aquatic animal will be disturbed by the noise and lighting from the vessels in the construction site. Pilling activities in the river during the jetty construction will increase the turbidity and impact on surface water quality. Construction phase activities will restrict the fisherman's to catch fish near the bank of the river and close to the project boundary. It will impacts on fish production, income and livelihoods of the fisherman's those who are engaged with the fishing activities near the project site. According to the fisherman, approximately 20 to 27 kg/day of fish is captured by the fisherman using the fishing net from the bank of the river close to the proposed project boundary. Improper

management of wastes and disposal from the construction workers camp or facilities can pollute the surface water as well as the fish resources. The impacts of fisheries during the construction phase of the power plant project is assessed to be Medium-Low.

Impact	Impacts on Fisheries					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the construction site and jetty site in the river					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Transbounda ry	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High		Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium-low</i>					

8.4.2.3 Impact on Forest

The proposed power plant project site is located on the bank of the Buriswar-Payra River. A planted mangrove patches is found on the north side from the project boundary. The mangrove patched is situated between the riverbank and the project boundary. Major construction equipment's and machineries for the power plant will be imported from abroad and will be transported by waterway. For unloading the machineries and equipment's a jetty will be required near the project site. This jetty will be used as coal handling jetty during the operation phase of the proposed project. During the construction of Jetty in the river, approximately 100 to 200 numbers of planted mangrove trees needs to be removed from the riverbank site. For the removal or cut planted mangrove trees, the project proponent must take prior approval from the forest department. During the construction phase dust will be generated from the construction site and it will be dispersed by wind and accumulate on leaf surfaces which will impacts trees respiratory/photosynthetic activities. The impacts on the forest resources during the construction phase is assessed to be Low.

Impact	Impacts on Forest Resource					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within project boundary and surrounding area					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica	Low	Medium-	Medium-	High	Very High

	nt		low	high		
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.2.4 Impact on Livestock

The proposed coal-fired power plant project site doesn't encroach any grazing land. During the baseline data collection from the field, no grazing activities were observed inside of the project boundary. It is expected that livestock resources in the proposed project area will not be affected by the implementation of the proposed project.

8.4.3 Impact on Ecosystems

The proposed power plant project site does not cover any environmentally sensitive area. However, reserve forest, wildlife sanctuary are found with the 10 km radius of the proposed project. No major impacts on terrestrial flora and fauna inside of the project boundary are expected because during pre-construction and development phase potential loss of vegetation resulting from land cleaning and leveling will be occurred, which will destroy the original vegetation. However, during the construction of Jetty in the Buriswar-Payra River approximately 100 to 200 number of trees need to remove or cut. In addition, there would be considerable movement of construction machinery and vehicles will generate noise may disturb the terrestrial fauna in the project site and approach road. During the construction period, the surface soil may also get carried out away by the winds and get deposited on the surrounding area, thereby interfering in the free gaseous exchange of the plants. Improper management of construction waste and waste from the labor camp can impacts on the terrestrial and aquatic ecosystem in the project site. All the construction activities will be carried out in the premises of the project boundary only. Therefore, no major adverse impacts are envisaged on terrestrial and aquatic ecology. The impacts on the ecosystem due to the construction activities is assessed to be Low.

Impact	Impacts on ecosystem					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary and approach road					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transbounda ry	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.4 Impacts on Ambient Air

Earthworks, operation of construction machinery, movement of vessels and movement of vehicles including delivery trucks to and from the site would be the principal sources of air pollution generating fugitive dust emissions and exhaust emissions into the atmosphere. The principal pollutants would include sulfur dioxide (SO₂), nitrogen oxides (NO_x), particulate matter (PM) and carbon monoxide (CO). The particulate matter would be the predominant pollutant affecting the air quality during the construction phase of the power plant project. The proposed plant involves construction activities like civil construction, handling and stocking of construction material etc.

According to the BEPCL, approximately 15 dump trucks, 4 flat cars and 8 concrete mixer trucks will be operated in the construction site during the construction period. Emission of SPM, CO₂, Nitrogen oxides may be emitted from combustion of the petroleum products in project related vehicles, machinery, generators and vessels etc. A marginal increase in the levels of oxides of nitrogen, carbon monoxide and hydrocarbons is envisaged due to the movement of vehicles for transportation of construction material and diesel generators required during the construction phase. Most of the large construction materials and equipments will be transported by waterway. However, this increase in concentration would be temporary in nature and localized. The access to the site is over an existing paved road. The movement of trucks bringing in construction materials is therefore not expected to create significant dust nuisance. As the site is located away from urban areas and limited human settlements and no developed industrial area surrounding the proposed project, these will not create any significant negative impacts. However, the impacts on ambient air quality during construction phase is assessed to be Low.

Impact	Impacts on Ambient Air					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within project boundary and approach road					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.5 Impacts on Ambient Noise

Earthworks and construction works including drilling, blasting, excavation, cutting, hammering, welding etc., operation of machinery and vehicles (bulldozers, excavators, loaders, dumpers, trucks), generators, cement mixing, materials handling and batching plant, movement of machinery and vehicles and increased human activities would be the identified principal sources of noise generation and nuisance in the power plant construction site and approach road. The key receptors include close by communities, workers, people who will access the approach road. Noise emission during construction can impact on the terrestrial fauna in the approach road. The generated noise is also likely to cause a nuisance to the workers and site visitors. However, noises will be confined to the site

(local) and of temporary nature. The impacts on ambient noise due to power plant construction is assessed to be Low.

Impact	Impacts on ambient noise					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within construction site and approach road					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.6 Impact on Water Bodies

The water requirement during the construction period is estimated about 1,600 m³/day during construction peak and maximum 900 m³/day during civil construction. For the domestic purposes approximately 600 m³/day will be required. All the required water will be collected from the Buriswar-Payra River. Water will be mainly used for concrete mixing and curing, usage in spray and sprinklers for dust suppression, water for plantation and landscaping in the project site. The project proponent ensures that no groundwater will be used during the construction phase of the proposed project. The proposed project site is located on the bank of the river and the river is connected with the Bay of Bengal. Therefore, there is the availability of surface water sources round the year.

Improper management of waste in the construction site can deteriorate the surface water quality. During construction, approximately 2,200 numbers of people will be required during peak time of the construction. Domestic garbage and sanitary wastewater will be generated from various facilities such as workers shed units, which shall have to be properly managed. During monsoon with the surface runoff, the wastes may be wash away to contribute suspended solids in the nearest waterbodies (Buriswar-Payra River and Canals). Oil spillage from the workshop and vessels, rainwater runoff, water vessel may contaminate surface water near the construction site. Dust from the construction site will be dispersed by the wind action and accumulate on the water bodies which will increase the TSS in the surface water. Jetty construction in the Buriswar-Payra River will increase the turbidity. The impacts on the waterbodies during the construction phase of the proposed power plant project is assessed to be Medium-Low.

Impact	Impacts on water bodies				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Within the project boundary and adjacent area				
Frequency	Limited to construction phase				
Extent and location	Project Site	Local	Regional	National	Transbounda ry
Impact Duration	Short Term	Medium Term	Long-term	Permanent –	Permanent –

				Mitigated	no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifican t	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.4.7 Impact on Soil

All major construction activities tend to create certain changes in the soil of the area. Excavation denudes the topsoil and makes it loose. Destruction of topsoil leads to reduction of fertility and removal of vegetation cover with associated hazards of the soil erosion. Construction wastes, such as metal cutting, debris, packaging materials, which may contaminate soil at the construction site. Liquid and solid wastes that will be generated from the construction labor camp facilities and improper disposal during the construction phase can pollute soil quality. Accidental spillage or inappropriate management of fuels, engine oil and hazardous chemicals during the maintenance and replacement of vehicles and equipment's can pollute the surface soil.

Improper disposal of the excavated earth during installation of tanks, pipeline and internal road construction may cause irreversible negative impacts on soil environment. During high wind and storm, some of the excavated soil and construction material such as sand etc. would be blown up in the air and dispersed around the proposed project site. This disperse soil can interfere in the free gaseous exchange of the plants. The impacts on soil resources is assessed to be Medium-Low.

Impact	Impact on soil quality					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High		Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.4.8 Impact on Workers Health, Sanitation and Safety

The sources of impact to the workers health, sanitation and safety of the power plant project's construction workforce are listed below:

- Accidents and injuries associated with the operation of heavy machinery and other construction activities; and
- Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions to air, water, land and noise emissions from construction activities as well as from storage and handling of waste, particularly hazardous waste.

8.4.8.1 Accidents and Injuries from General Construction Activities

Over-exertion, ergonomic injuries and illnesses, such as repetitive motion, over-exertion, and manual handling, are among the most common causes of injuries on construction sites. Loose construction materials, liquid spills, and uncontrolled use of electrical cords and ropes on the ground, are also among the most frequent causes of lost time accidents at construction sites. Falls from elevation associated with working with ladders, scaffolding, and partially built structures are also among the most common causes of fatal or permanent disabling injury at construction sites.

Construction activities may pose significant hazards related to the potential for dropping materials or tools, as well as ejection of solid particles from abrasive or other types of power tools, which can result in injury to the head, eyes, and extremities.

Vehicle traffic, use of lifting equipment and the movement of machinery and materials on a construction site may pose temporary hazards, such as physical contact, spills, dust, emissions, and noise. Heavy equipment operators have limited fields of view close to their equipment and may not see pedestrians close to the vehicle. Center-articulated vehicles create a significant impact or crush hazard zone on the outboard side of a turn while moving. These risks could create long-term impacts to the health and safety of the construction workforce. The impacts on workers health safety due to accidents and injuries from general construction activities is assessed to be Medium-Low.

Impact	Impacts on workers health and safety due to Accident and Injuries in the construction site					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary and construction camp					
Frequency	Construction phase and continue					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium Low					

8.4.8.2 Health Impact associated with Environmental Conditions

Changes in the environmental quality of air, surface water, groundwater and soil quality may occur as a result of construction activities. High noise levels are also expected from the operation of heavy machinery. An increase in dust and noise during the construction period has the potential to lead to health impacts associated with eye irritation and general disturbance to daily activities.

Construction sites may pose a risk of exposure to dust, chemicals, hazardous or flammable materials, and wastes in a combination of liquid, solid, or gaseous forms. Access to construction areas, including the pipeline corridor and the access road, will be restricted to reduce risks to public health and safety. Measures will be implemented to ensure that these risks are considered prior to the commencement of construction and that all risks are communicated to the workforce. The impacts on workers health and safety due to the changed environmental condition is assessed to be Low.

Impact	Impacts due to associated environmental condition					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary and construction camp					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.9 Impact on Key Point Installations and Others

As there is no major key point installation in and around the project boundary so impact on key point installation and others will be insignificant.

8.4.10 Solid Waste Disposal

The solid waste, during the construction phase, will be generated due to the usage of different type's raw materials for the construction of the proposed project. The raw materials used for construction purpose, the packing material used for packing of various items used in creation of power plant infrastructure and other procedures carried out during construction phase generates solid waste. The solid waste generation from packaging materials like cartons, wooden cases and pallets and domestic activities including food wrappers and leftovers. The wastes might be metals, concrete, spoiled construction material, excavated spoils, spilled oil from machinery and vehicles etc. Waste from packaging materials could be significant as well as waste from domestic activities in labor camp. The main receptor is the physical environment, which would receive the waste materials. During the construction phase of the project, the project proponent must ensure proper collection, storage and disposal of solid waste that would be generated from the construction site and labor camp facilities. The impacts on environment from solid waste disposal is assessed to be Low.

Impact	Impacts due to Solid waste disposal				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Within the project site and surrounding area				
Frequency	Limited to construction phase				
Extent and location	Project Site	Local	Regional	National	Transboundary

Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignif ant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.11 Impacts due to Waste Water Generation and Disposal

Construction work and activities will consume considerable amounts of water and generate significant amount of wastewater. The principal activities consuming water include concrete and construction works, ground watering and domestic applications. During the construction period of the proposed project, water will be collected from the Buriswar-Payra River. For the concreting work, more water will be required and it is expected that its amount will be approximately 1600 m³/day during construction peak, maximum 900 m³/day during civil construction and domestic purposes approximately 600 m³/day will be required. Wastewater resulting from construction works and ground watering would be insignificant, if well managed and monitored. However, domestic sewage would be a key source of wastewater generation in the construction site. Similarly, considering the scale of development and related operational requirements, the human activities would be significant as it is estimated that more than two thousand people would be involved in the peak time of the constructional phase.

Consequently, the domestic sewage could be very significant if not well manage and controlled, and could possibly pollute the receiving water bodies. The principal receptor would be nearby surface water body (Buriswar-Payra River), the sea (Bay of Bengal) and likely, the groundwater as the sewage may be drained into these water bodies. Due to the improper management and disposal of wastewater into the open environment will impacts on soil quality, sediment quality, surface water quality, groundwater quality and aquatic environment. The impacts of wastewater generation and disposal s assessed to be Medium-Low.

Impact	Impacts due to Wastewater disposal					
Impact Nature	Direct	Indirect		Induced		
Impact Scale	Project location and surrounding area					
Frequency	Limited to construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	

Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium Low					

8.4.12 Social Impact due to Industrial Set up and Harnessing of Coal and Other Resources Locally

8.4.12.1 Employment Generation during Construction Phase

The proposed project will involve huge construction activities that will offer direct and indirect employment opportunity to local community. During the construction phase, local labors, civil engineers, electrification engineer, mechanical engineer and managers will be required. According to the BEPCL, total 2,200 numbers of people will be required during peak time of the power plant construction. Surrounding of the project area there are availability of laborers that can be used for the project. During hiring employees, priority should be given to the project affected people and the locals.

In addition, considerable indirect employment could be generated through contractors and other service providers and suppliers. Vendors would also emerge to provide food and catering services to the workers as well as trading in variety of items. This will be a positive socio-economic development for the region. There will be a general upliftment of standard of living in the region.

8.4.12.2 Harnessing of Coal

There is no available coalmine locally to supply coal to the proposed power plant at Taltoli, Barguna. Coal is the primary fuel for the proposed project and required coal will be imported from abroad.

8.4.12.3 Impacts on Local Resources and Infrastructures

The proposed power plant project area is located inside of the rural area where there is no industry around the proposed project site. As a result, the existing infrastructures are not well developed in the project area. The existing access road in the project area is very narrow and continuous by the project construction proposes can damage the road. During the construction phase of the project, a good number of workers will be required on site and could lead to unwarranted pressure on key local resources and infrastructures such as water, healthcare, electricity, school, mosque and road etc. The construction activities usually attract a sizeable influx of population, which leads to construction of temporary hutments, having an effect on land-use pattern of the areas surrounding the project. The market price of the locally available products may be increased. However, the impacts on local resources and infrastructures by the construction of power plant is assessed to be Low.

Impact	Impacts on local resources and infrastructures					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project surrounding area					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low		Medium	High	Definite
Impact Significance	Very low	Low	Medium-	Medium-	High	Very High

		Low	high	
Significance of impact consider Low				

8.4.12.4 Community Health and Safety

The construction activity could lead to increased nuisance level from air emissions and noise due to transportation of material and equipment, loading and unloading, heavy machineries and equipment's movement as well as laborers. The construction activity could also lead to water logging in mud pockets leading to breeding of mosquito and related health impacts. The increasing number of vehicles on the project site and surrounding road due to movement of personnel and equipment can increase the road accidents. During the pre-construction stage the existing community will be displaced from the project boundary. Due to the influx of large number of workers and increase in financial flow could lead to social vices such as violence, alcoholism, attraction of commercial sex workers, substances abuse and teenage pregnancies. This could lead to increase in sexually transmissible diseases (HIV/AIDS, syphilis among others), injuries and loss of life or properties. The impacts on community health and safety due to the construction of power plant is assessed to be Low.

Impact	Impacts on Community Health and Safety					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project site and approach road					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transbounda ry	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.12.5 Impacts on Income and Livelihoods

There will be twofold impacts in the project area during the construction phase of the proposed power plant project. Local community to be employed by the project will get income opportunity. Indirect employment and income opportunities will also be created for the local community. On the other hand, project-affected people may lose their income opportunity especially the fisherman, farmer, agricultural laborer etc. During the construction phase, vessels will be mobilize in the Buriswar-Payra River near the project site jetty to transport the construction machineries, equipment's etc. from abroad. Therefore, there will be a restriction for the local community to access the riverside for fishing and other activities. No impacts is envisaged on the farmer's community because the land will be purchased and proper compensation must be ensured by the project proponent as per the RAP study. If proper compensation is paid and local people get access to project employment, then income level of the locals will increase. The impacts on income and livelihoods by the construction of proposed power plant project at Taltoli, Barguna is assessed to be Low.

Impact	Impacts on income and livelihoods

Impact Nature	Direct		Indirect		Induced	
Impact Scale	Adjacent to the project site					
Frequency	Limited to construction Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.4.13 Aesthetic and Visual Impact

The surrounding landscape is an important aspect of the lives of the people, contributing to individual, community and national identity and representing vast variety of benefits in relation to quality of life, well-being and economic activity. Construction activities including the establishment of jetty, breakwater, ash yard, coal stockyard, pipeline, buildings, labor camp and internal road network may change the visual landscape of the project site. At the construction stage, removal of vegetation, storage of solid waste, gathering of equipment and construction materials, machinery and camp establishment on greenfield site may reduce the scenic beauty. During the construction phase of the proposed project, planted mangrove trees near the project site will be required to cut for the construction of jetty.

The construction would therefore result in huge and giant structures and infrastructure arranged within the project site. A breakwater embankment will also be required to construct along the Buriswar-Payra river site. The landscape would therefore lose the bank line view. Fencing off construction areas during the construction operation to prevent exposure of construction area, which could contribute immensely to mitigating the likely impact of potential visual adverse effect. Nevertheless, the impact is for a short duration, and reversible as the project plan includes landscape planning, green belt development etc. The impacts on aesthetic and visual environment is assessed to be Low.

Impact	Aesthetic and Visual Impact				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Construction site and surrounding area				
Frequency	Limited to construction Phase				
Extent and location	Project Site	Local	Regional	National	Transboundary
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High
Potential for irreplaceable loss of resources	Low		Medium		High

Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
Significance of impact consider Low						

8.4.14 Impacts due to Transportation of Raw Materials

During construction phase of the proposed project, most of the major construction materials and heavy equipment's shall be transported through the waterway (Bay of Bengal and Buriswar-Payra River). Heavy equipment of 350 MW coal-fired power generation unit mainly including boiler structural girders, STG stators and rotors, main transformer etc. imported principally from China would be transported to the affiliated material offloading facility. The units would then be transferred to flat transporters at the project site and transported to the erection site. This operation is not expected to have any potential impact on the river traffic in the area. Therefore, traffic load on the waterway may be increased during construction period and accidents might be increased. The main receptor could be the vessels movement in the river channel, fisherman's and fishing site near the project site river, jetty construction site and particularly river users.

Heavy-duty vehicles and trucks carrying construction and building materials, personnel and equipment's to and from the project site during construction may affect traffic flow and could even cause accidents on existing access roads, which is relatively narrow. Existing project site access road is used by the small types of vehicles like Truck Medium, Truck Small, Bus Heavy, Bus Light, Bus Mini, Utility, Car, Tempo, Auto Rick, Moto Cycle, Rickshaw/van, Animal Cart, Bicycle etc. According to the traffic survey during the baseline data collection, total 1,028 no of vehicles were plying in 24 hours. Maximum traffic volume of 93 vehicles in an hour was recorded between 5-6 PM and during 6-7 AM minimum traffic was recorded (39 vehicles). According to the BEPCL, during the construction period, approximately 27 nos. vehicles per day will be required in the project site and it will be continuously mobilize in the project area. During the construction period vehicles movement in the project site and surrounding area will be increased due to the transportation of raw materials and construction materials. The traffic movement on the access road will be created dust pollution and exhaust emission from the fuel combustion. From the traffic movement noise level will be increased, terrestrial fauna will be disturbed and community health and safety will be impacted. The impacts on traffic during the construction phase due to transportation of raw materials is assessed to be Low.

Impact	Impacts due to transportation of raw materials					
Impact Nature	Direct	Indirect	Induced			
Impact Scale	Project Site and surrounding area					
Frequency	During construction phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-	Medium-	High	Very High

			Low	high		
Significance of impact consider Low						

8.5 Operation Stage Impact

8.5.1 Impact on Natural Resources

8.5.1.1 Impact on Livestock

During the operation phase of the proposed power plant, will not have any impact on livestock resources of the locality.

8.5.1.2 Impact on Fisheries

The proposed 350 MW coal-fired power plant is going to establish on the bank of the Buriswar-Payra River, which is rich in fisheries resources. According to the baseline study, the river at the project site is moderate suitable breeding areas of Hilsa fish. According to the consultation with the fisherman, different types of fishes are also available in the river round the year. During the operation phase of the proposed project, required water for the power plant operation will be intake from the Buriswar-Payra River and heated cooling water will be discharged into the river through discharge outlet. According to the feasibility report, total water requirement for the proposed project is around 48,115 m³/hour during its operational phase. A plume water modelling study also conducted by Hebei Electric Power Design and Research Institute (HBED), China for the proposed project. According to the study, cooling water will be discharged at the speed of 2.69 m/s in the horizontal direction with an angle of 45° against the main pipeline. The water depth near the outlet will be about 7 m. The proposed power plant is adopting once-through cooling system, so it has direct impact on fish diversity and may lead to bring permanent change to fish diversity and composition. Accidental spillage and waste disposal from coal transportation vessels will impacts on the fish resources. Fish production from the river can be impacted due to the restriction in the coal handling jetty area and movement of coal transfer barge through the fishing area. The impacts on fisheries is assessed to be medium High.

Impact	Impacts on Fisheries					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Water intake, discharge and jetty area in the river					
Frequency	Operation period					
Extent and location	Project Site	Local	Regional	National	Transbounda ry	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium-High</i>					

8.5.2 Impact on Ecosystems

The emission of chemicals and gases as waste materials from the power plant has massive impacts on local ecosystems that can lead to disasters. Coal and coal waste products, including fly ash, bottom ash and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel,

vanadium, beryllium, barium, cadmium, chromium, selenium and, radium, which are dangerous if released into environment. Major portion of these heavy metals may remain with ash. Negative impact of power plant on ecosystems can be irreversible. However, the presence of flora and fauna on proposed power plant site are limited. During the operation phase of the power plant, flue gas will be emitted to the atmosphere by the proposed project stack. Vehicles will be operated for transporting workers and number of vehicles will be increase in the project area. Movement of vehicles will be created dust emission and exhaust emissions from the burning of fossil fuels. Dust will be deposited on the plants leaves of nearby trees, this can abduct the growth of trees.

The stack emissions from the coal-fired power plant that contribute to tropospheric ozone, which has serious human health and ecological impacts. Sulphur dioxide and nitrogen oxides also contribute to acid rain, which will impacts both terrestrial and aquatic ecosystems. Untreated disposal of wastewater from the power plant may lead to pollute one of the nearest Buriswar-Payra River. Disposal of heated cooling water in the river will affect the surface water quality as well as the aquatic ecosystem in the Buriswar-Payra River. Leachate or spillage of wastewater from the ash yard can impacts on groundwater quality, if not properly collected and send to the ETP for treatment and reuse. Accidental spillage of coal near the coal-handling jetty in the river, it will impacts on soil quality, sediment quality and water quality. Lighting and noise in the coal-handling jetty will create disturbance for the fish community. Improper management of solid waste and disposal of untreated wastewater and liquid waste will impacts on local ecosystem. The impacts on ecosystem is assessed to be Medium-Low.

Impact	Impacts on Ecosystem					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project site and immediate surrounding area					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium Low					

8.5.3 Impact due to collection of Resources from local sources within the country

The main fuel to be used for generating electricity in the proposed project will be the imported coal. Based on the estimations of the Feasibility report, the daily coal requirement for generation of 350 MW power by operating 1 x 350 MW power plant shall be 3304.84 tons and 1.1185 million tons per year. All the required coal will be imported from Indonesia, Australia and South Africa. So no impact has been predicted locally for collection of resources.

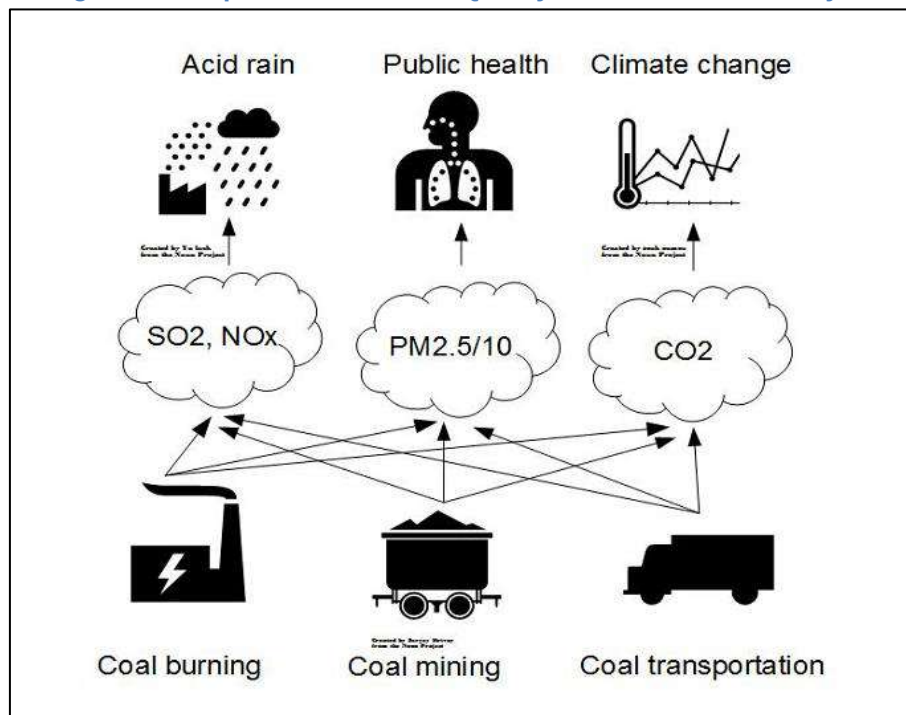
8.5.4 Impacts on Ambient Air

During operation of the proposed power plant, the main source of air pollution will comes from combustion of coal in the boiler. In the project, imported coal will be used as primary fuel to generate electricity, however the generating units are designed to be able to use coal from a variety of sources

including Australia, South Africa and Indonesia; additionally, fuel oil will be used for start-up or emergency purposes if power is unable to supply the power needed for start-up. The air emission impacts associated with the operation of the power plant are permanent and of adverse significance without any mitigation measures. The key emission sources include the SO_x, NO_x and particulate matter will be released from boilers, generators, fugitive emissions from materials handling and transfer, heavy-duty vehicles, stockpile loading and unloading, wind erosion, paved roads and unpaved roads.

The air quality impacts of the proposed coal power plant have been assessed using baseline information gathered through desk and field studies, analysis of the information provided by the BEPCL and advanced air modelling using preliminary design and technical information. The stack heights have been determined as 220 m based on DoE guidelines to avoid excessive ground level concentrations and minimize impacts. The specifications of the coal that can be utilized in the proposed 350 MW coal-fired power plant are given in Table 3-8 (Chapter-3) in this report.

Figure 8-1: Impact of Coal to Air Quality from its Whole Life Cycle



Source: Minh Ha-Duong, et. al, 2016

During the operation of the proposed power plant, a number of activities and plant equipment will result in air emissions, which have the potential to impact upon the ambient air quality within the coal power plant and surrounding areas. In order to adequately assess, the potential impacts to the air environment during the operational phase of the proposed plant, it is therefore necessary to undertake predictive air dispersion modelling. The following aspects are considered:

- Emission characteristics from the proposed power plant; the air dispersion model is run to estimate the stack emission impact. The purpose is to determine the permissible environmental limits to satisfy at source environmental and ground concentration.
- This study determines the requirements for the wet limestone-gypsum FGD system with SO_x removal capacity from coal having a sulfur content of 0.3 to 0.9%.

In order to estimate ground-level concentrations for each study pollutant, an atmospheric dispersion modelling study was undertaken using the USEPA preferred AERMOD dispersion models. Resultant results also calculated by adding emission of BEPCL Power plant. AERMOD is a modeling system consisting of three separate modules: AERMET, AERMAP and AERMOD. AERMET is a meteorological pre-processor and uses hourly surface observations, cloud cover and upper air parameters from twice-daily vertical sampling of the atmosphere to create two output files consisting

of surface and vertical profile data, respectively. The terrain pre-processor AERMAP uses Digital Elevation Model (DEM) maps as well as user-generated receptor grids. AERMAP's output file consists of the x, y locations of each receptors, mean sea level (MSL) elevation and hill profile parameters.

Model Options: The following regulatory default options were run in AERMOD in this assessment:

- Stack-tip downwash;
- Elevated terrain effects;
- Use of calms processing routine;
- Use of missing data processing routine; and
- No exponential decay

According to the baseline survey, there are few households within 200 meters from the proposed power plant center. The Project site and its surroundings have been considered as rural area and therefore, the rural dispersion coefficient was used in the Model.

Meteorological Data: The input meteorological data for the AERMOD was generated using the MM5 model, which was downscaled to fine grid data suitable for modeling. The data used in the study was site-specific and was collected over a one-year period (2016). In all, there were 8760 hours of meteorological data used in the model. This quantity of data allows an adequate assessment of hourly, 24-hourly, daily and annual average pollutant concentrations around the Project site.

Terrain Data: Terrain data for the AERMAP model were taken from the 30 m SRTM database, while land cover data was sourced from satellite imagery of the Project site and its surroundings.

Receptors locations are shown in Table 8-3.

Table 8-3: Receptors Location with Respect to the Project

SL#	Sampling Station	Station Code	Geographic Location	Direction and Distance
1	Project site	AAQ-1	21°57'37.30"N 90° 3'47.44"E	Project site
2	Choto Ankujan Para	AAQ-2	21°57'11.30"N 90°4'5.12.00"E	Upwind Direction (910 meters)
3	Near Joyalbhanga Bazar	AAQ-3	21°57'5.16"N 90°2'53.45"E	Crosswind Direction (1,000 meters)
4	Taltoli Bazar	AAQ-4	21°58'40.00"N 90°4'58.76"E	Downwind Direction (1,400 meters)

An assessment of the potential impacts has been undertaken through an air quality modeling exercise. This assessment is based on a coal-fired power plant configuration consisting of supercritical boiler and its specification. Discharge to atmosphere from the plant occurs via one stack considering 220 m height. The location of the power plant stacks is in Table 8-4.

Table 8-4: List of Stack Locations

Stack Number	X coordinate (meter)	Y coordinate (meter)
1	196875.29	2431650.59

A summary of the emission inventory of the proposed project (when operational) considering the abatement measures (FGD, ESP and Low NO_x burner) and without abatement measures is provided in following Table 8-5. BCPCL has selected the inbuilt low NO_x burner boiler technology as a result NO_x emission concentration will be almost same.

Table 8-5: Emission Inventory of the Proposed Project

Scenario	Unit	Value (with Abatement Measures)	Value (without Abatement Measures)
Stack Parameters			
Stack Height	m	220	220
Stack Number	No.	1	1
Stack Internal Diameter	m	5	5
Stack Exit Temperature	K	319.45	372.6
Exit Velocity	m/s	21.36	24.92
Gas Exit Flow Rate	m ³ /s	358.53	489.33
Stack Emission			
SO ₂	g/s	57.83	826.11
NO _x	g/s	165.30	165.30
PM	g/s	12.98	9271.69

The input parameters considered for the air dispersion modelling have been summarized in Table 8-6.

Table 8-6: Input Data Considered for Air Dispersion Modeling Exercise

SL#	Scenario	Value
1	Control Pathway	
	Dispersion option	Non Default Option
	Terrain	Flat
	Dispersion Coefficient	Rural
	Flagpole Receptor	No
2	Meteorological Input	
	Met Input Data	Meteorological data from 1 January 2016 to 31 December 2016 (Pre-processed Meteorological Data)
	Wind Speed Categories	A: 1.54 m/s B: 3.09 m/s C: 5.14 m/s D: 8.23 m/s E: 10.8 m/s F: No upper bound
	Latitude	196875.29m E
	Longitude	2431650.59m N
	Anemometer Height	14 m
	Base Elevation	1 m
3	Receptor Pathway	
	No. of X-axis Receptors	101
	No. of Y-axis Receptors	101
	Spacing for the X axis	200
	Spacing for the X axis	200

SL#	Scenario	Value
	Sensitive Receptor	4
4	Source Pathway	Point Source
5	Output Pathway	Pollutants Ground Level Concentration
	SO ₂	1 Hourly, 24 Hourly and Annual
	NO _x	1 Hourly, 24 Hourly and Annual
	PM	1 Hourly, 24 Hourly and Annual

8.5.4.1 Air Dispersion Considering Abatement Measures

The proposed 350 MW coal-fired power plant will adopt Flue Gas Desulfurization (FGD) for reduction of SO₂, Electrostatic Precipitator (ESP) to arrest ash and Low NO_x burner to reduce NO_x level in the flue. The modeling output considering all abatement measures are described in following sections.

Nitrogen Oxide (NO_x)

The predicted 24-hour incremental ground level concentration of NO_x at all the monitored locations for ambient air quality is presented in Table 8-7 below.

Table 8-7: Predicted NO_x Concentration in the Receptor Point

Receptor s	Baseline NO _x level (24 hour) (µg/m ³)	Predicted NO _x level (24 hour Average maximum concentration)	Predicted NO _x level (Annual maximum concentration)	Total Concentration (Predicted + Background) (µg/m ³)	ECR, 1997* (24 hour) (µg/m ³)	ECR, 1997* & ECR 2017 (Annual Average) (µg/m ³)	IFC, 2008 Limit (24 Hours) (µg/m ³)
AAQ-1	12.31	11.47	0.86	23.78	200	100	-
AAQ-2	13.84	8.84	1.28	22.68			
AAQ-3	15.20	7.81	1.23	23.01			
AAQ-4	22.70	7.25	1.07	29.95			

* Worst case scenario has been considered;

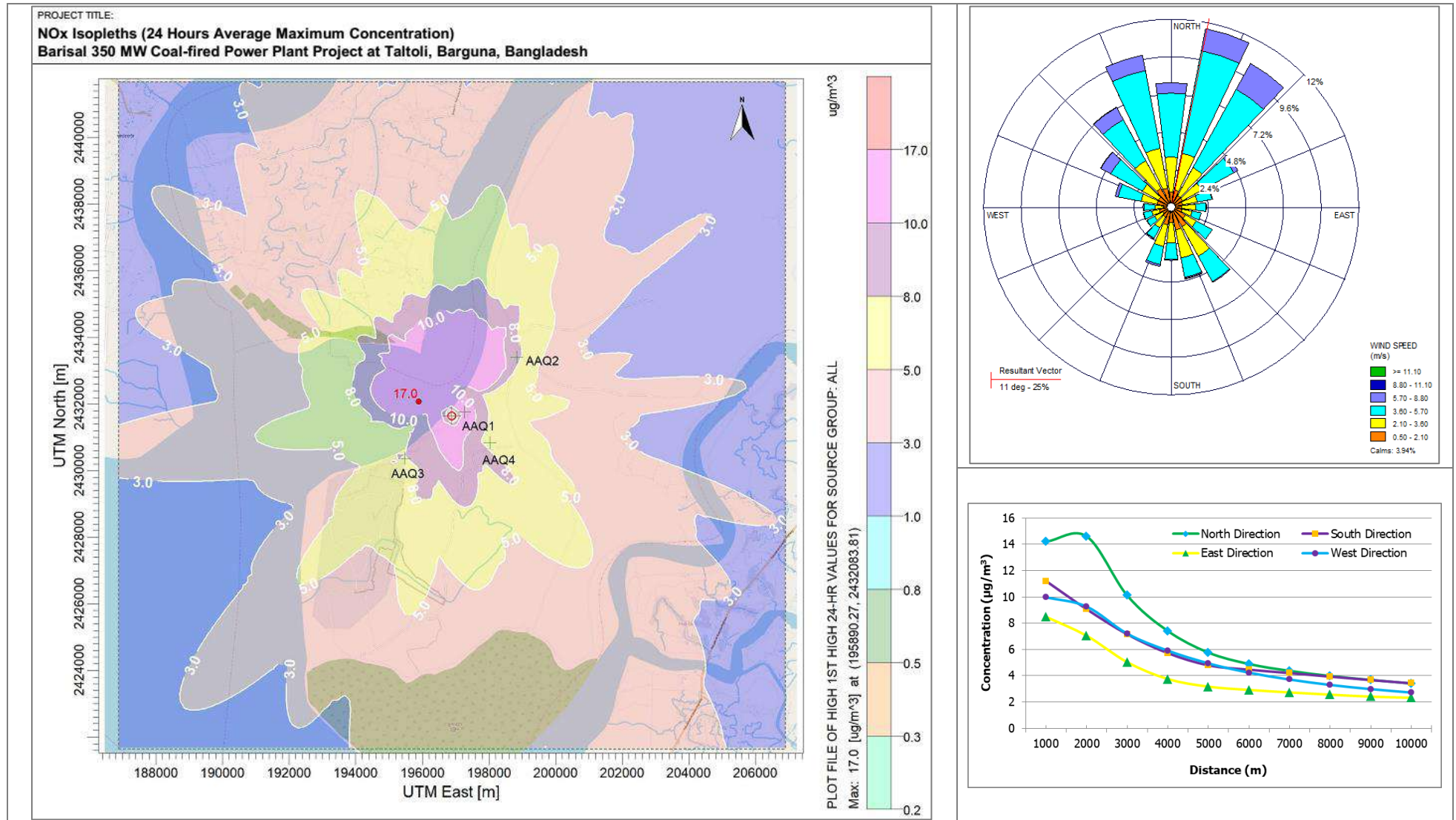
* The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19 July 2005 vide S.R.O. No. 220-Law/2005.

The maximum concentration of NO_x was observed to 17.0 µg/m³ at coordinates of (195890.27m E 2432083.81m N) to the NNW direction of the stack at a distance of 1.05 km. The corresponding isopleth for NO_x emissions from the power plant operations is as given in Figure 8-2.

The ground level concentration of NO_x is decreasing with the increase of distance. The wind rose of the study area shows that the prevailing wind directions are SSW to NNE and SSE to NNW. The following Figure 8-2 shows the incremental ground level concentration of NO_x in all four (North, South, East and West) directions dispersed from the stack at various distances. Among all directions, the pollution concentration is higher to the North direction.

From the model prediction, it is observed that ground level NO_x at the receptors will be increased in comparison to baseline value. There is no stipulated 24 hourly standard for NO_x in ECR 1997 (amendment in 2005). Ministry of Environment, Forest and Climate Change, Bangladesh has prepared a draft ECR 2017 including 24 hourly NO_x standard. It has been concluded that the ground level incremental concentration of NO_x in the ambient air quality monitored locations will be within the acceptable limit (Table 8-7).

Figure 8-2: NO_x Isopleths of 24 Hourly Average Maximum Ground Level Concentration and Pollution Concentration at all Four Directions



Sulphur Di-Oxide (SO₂)

The predicted incremental ground level concentration of SO₂ at all the monitored locations for ambient air quality is presented in Table 8-8 below.

Table 8-8: Predicted SO₂ Concentration in the Receptor Point

Receptor	Baseline SO ₂ level (24 hour) (µg/m ³)	Predicted SO ₂ level		Total Concentration (Predicted + Background) (µg/m ³)		ECR, 1997*		ECR, 2017		IFC, 2008 Limit (24 Hours) (µg/m ³)
		24 hour	Annual	24 hour	Annual	24 hour	Annual	24 hour	Annual	
AAQ-1	18.81	4.01	0.30	22.82	19.11	365	80	85	80	125 (Interim Target-1)
AAQ-2	13.98	3.09	0.45	17.07	14.43					
AAQ-3	15.81	2.73	0.43	18.54	16.24					
AAQ-4	24.06	2.54	0.38	26.60	24.44					

* Worst case scenario has been considered;

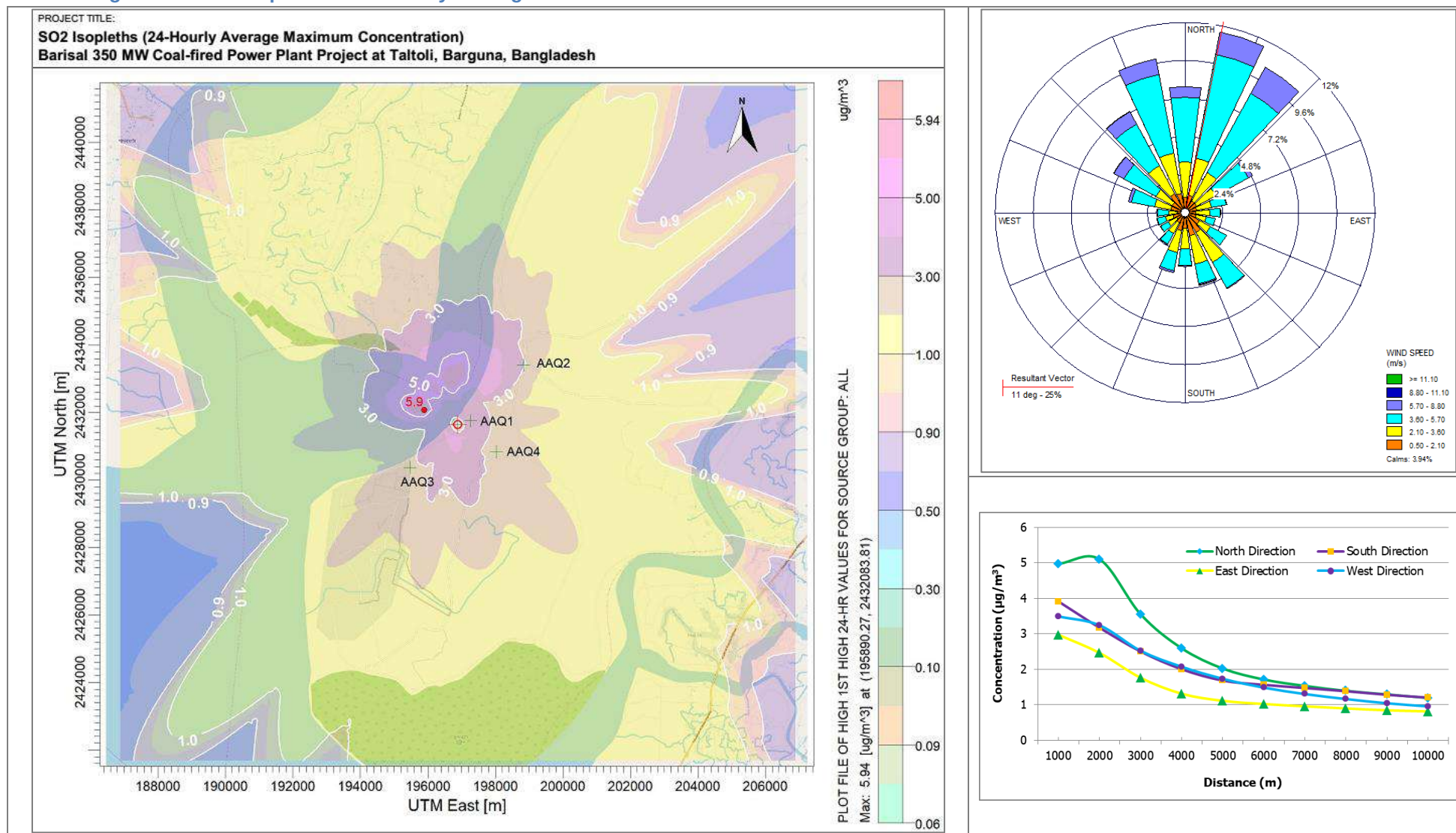
* The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19 July 2005 vide S.R.O. No. 220-Law/2005.

The maximum 24-hourly concentration of SO₂ was observed to 5.94 µg/m³ at coordinates of (195890.27m E 2432083.81m N) to the NNW direction of the stack at a distance of 1.05 km. The corresponding isopleth for SO₂ emissions from the power plant operations is given in Figure 8-3.

The ground level concentration of SO₂ is decreasing with the increase of distance. The wind rose of the study area shows that the prevailing wind directions are SSW to NNE and SSE to NNW. The following Figure 8-3 shows the incremental ground level concentration of SO₂ in all four (North, South, East and West) directions dispersed from the stack at various distances. Among all directions, the pollution concentration is higher to the North direction.

The existing SO₂ status at the receptors will be increased due to the operation of the coal-based power plant. However, the predicted SO₂ level will satisfy the Bangladesh Air Quality Standard, which is set as 80 µg/m³ for annual average and 365 µg/m³ for 24 hours (Table 8-8).

Figure 8-3: SO₂ Isopleths of 24 Hourly Average Maximum Ground Level Concentration and Pollution Concentration at all Four Directions



Particulate Matter (PM)

The 8 hours average maximum PM concentration at ground level receptors are presented in following Table 8-9.

Table 8-9: Predicted PM Concentration in the Receptor Point

Receptor	Baseline SPM level (8 hour) ($\mu\text{g}/\text{m}^3$)	Predicted SPM level (8 hour) ($\mu\text{g}/\text{m}^3$)	Total Concentration (Predicted + Background) ($\mu\text{g}/\text{m}^3$)	ECR 1997* (8 hour) ($\mu\text{g}/\text{m}^3$)
AAQ-1	71.20	2.25	73.45	200
AAQ-2	78.70	1.67	80.37	
AAQ-3	105.68	1.76	107.44	
AAQ-4	111.17	1.71	112.88	

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

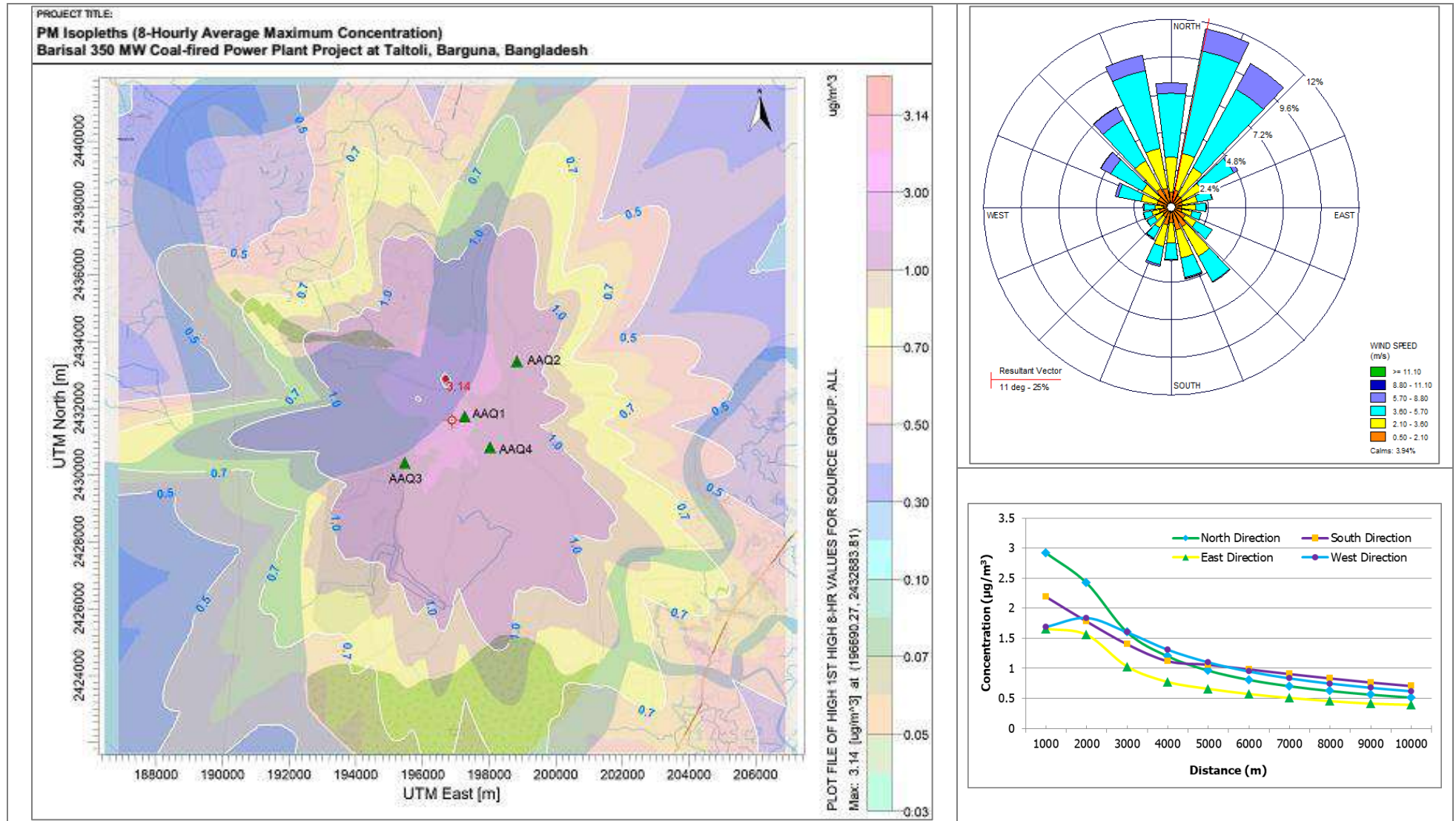
The maximum concentration of PM was observed to $3.14 \mu\text{g}/\text{m}^3$ at coordinates of (195890.27m E 2432083.81m N) to the NNW direction of the stack at a distance of 1.05 km. The corresponding isopleth for PM emissions from the power plant operations is as given in Figure 8-4.

The ground level concentration of PM is decreasing with the increase of distance. The wind rose of the study area shows that the prevailing wind directions are SSW to NNE and SSE to NNW. The following Figure 8-4 shows the incremental ground level concentration of PM in all four (North, South, East and West) directions dispersed from the stack at various distances. Among all directions, the PM concentration is higher to the North direction.

The existing PM concentration at the receptors will be increased due to the operation of the coal-based power plant. However, the predicted PM level will satisfy the Bangladesh Air Quality Standard, which is set as $200 \mu\text{g}/\text{m}^3$ for 8 hours (Table 8-9).

The proposed project will adopt all abatement measures (FGD, ESP and Low NOX burner). Therefore, it has been concluded that from the above description, all pollutions (SO_2 , NO_x and PM) concentration due to the proposed 350 MW coal-fired power plant operation will meet the national ambient air quality standard as well as IFC standard.

Figure 8-4: PM Isopleths of 8 Hourly Average Maximum Ground Level Concentration and Pollution Concentration at all Four Directions



8.5.4.2 Air Dispersion without Abatement Measures

Though the proposed project will adopt all abatement measures, the air dispersion model has been run to compare the scenario considering abatement measures and without abatement measures. The following subsequent sections describe the ground level pollution concentration considering the without abatement measures.

Nitrogen Oxide (NO_x)

The proponent has selected a boiler technology including the inbuilt Low NO_x burner. According to the design institution, without considering the low NO_x burner, the design of the power plant has to be changed. Therefore, the model did not run for the NO_x without low NO_x burner.

Sulphur Di-Oxide (SO₂)

The predicted incremental ground level concentration of SO₂ without FGD at all the monitored locations for ambient air quality is presented in Table 8-10 below.

Table 8-10: Predicted SO₂ Concentration in the Receptor Point

Receptor	Baseline SO ₂ level (24 hour) (µg/m ³)	Predicted SO ₂ level		Total Concentration (Predicted + Background) (µg/m ³)		ECR, 1997*		ECR, 2017		IFC, 2008 Limit (24 Hours) (µg/m ³)
		24 hour	Annual	24 hour	Annual	24 hour	Annual	24 hour	Annual	
AAQ-1	18.81	22.3	1.67	41.11	20.48	365	80	85	80	125 (Interim Target-1)
AAQ-2	13.98	31.7	4.37	45.68	18.35					
AAQ-3	15.81	23.6	3.72	39.41	19.53					
AAQ-4	24.06	25.9	3.15	49.96	27.21					

* Worst case scenario has been considered;

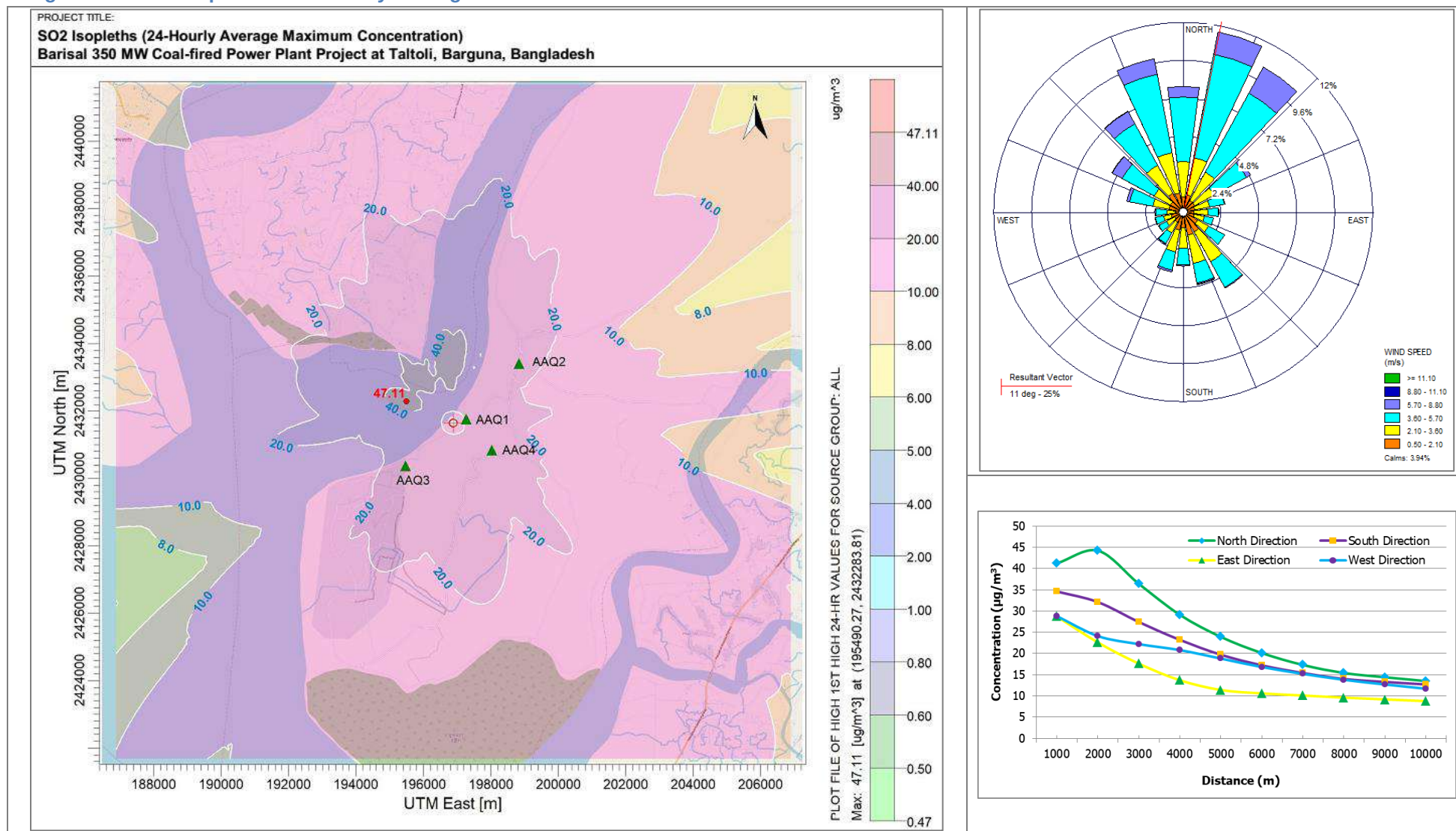
* The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19 July 2005 vide S.R.O. No. 220-Law/2005.

The maximum concentration of SO₂ was observed to 47.11 µg /m³ at coordinates of (195890.27m E 2432083.81m N) to the NNW direction of the stack at a distance of 1.05 km. The corresponding isopleth for SO₂ emissions from the power plant operations is as given in Figure 8-5.

The ground level concentration of SO₂ is decreasing with the increase of distance. The wind rose of the study area shows that the prevailing wind directions are SSW to NNE and SSE to NNW. The following Figure 8-5 shows the incremental ground level concentration of SO₂ in all four (North, South, East and West) directions dispersed from the stack at various distances. Among all directions, the pollution concentration is higher to the North direction.

The existing SO₂ concentration at the receptors will be increased due to the operation of the coal-based power plant without FGD. However, the predicted SO₂ level will satisfy the Bangladesh Air Quality Standard, which is set as 80 µg/m³ for annual average and 365 µg/m³ for 24 hours (Table 8-10).

Figure 8-5: SO₂ Isopleths of 24 Hourly Average Maximum Ground Level Concentration without FGD and Pollution Concentration at all Four Directions



Particulate Matter (PM)

The 8 hours average maximum PM concentration at ground level receptors are presented in following Table 8-11.

Table 8-11: Predicted PM Concentration in the Receptor Point

Receptor	Baseline SPM level (8 hour) ($\mu\text{g}/\text{m}^3$)	Predicted SPM level (8 hour) ($\mu\text{g}/\text{m}^3$)	Total Concentration (Predicted + Background) ($\mu\text{g}/\text{m}^3$)	ECR 1997* (8 hour) ($\mu\text{g}/\text{m}^3$)
AAQ-1	71.20	669.8	741	200
AAQ-2	78.70	892.8	971.5	
AAQ-3	105.68	757.4	863.08	
AAQ-4	111.17	729.2	840.37	

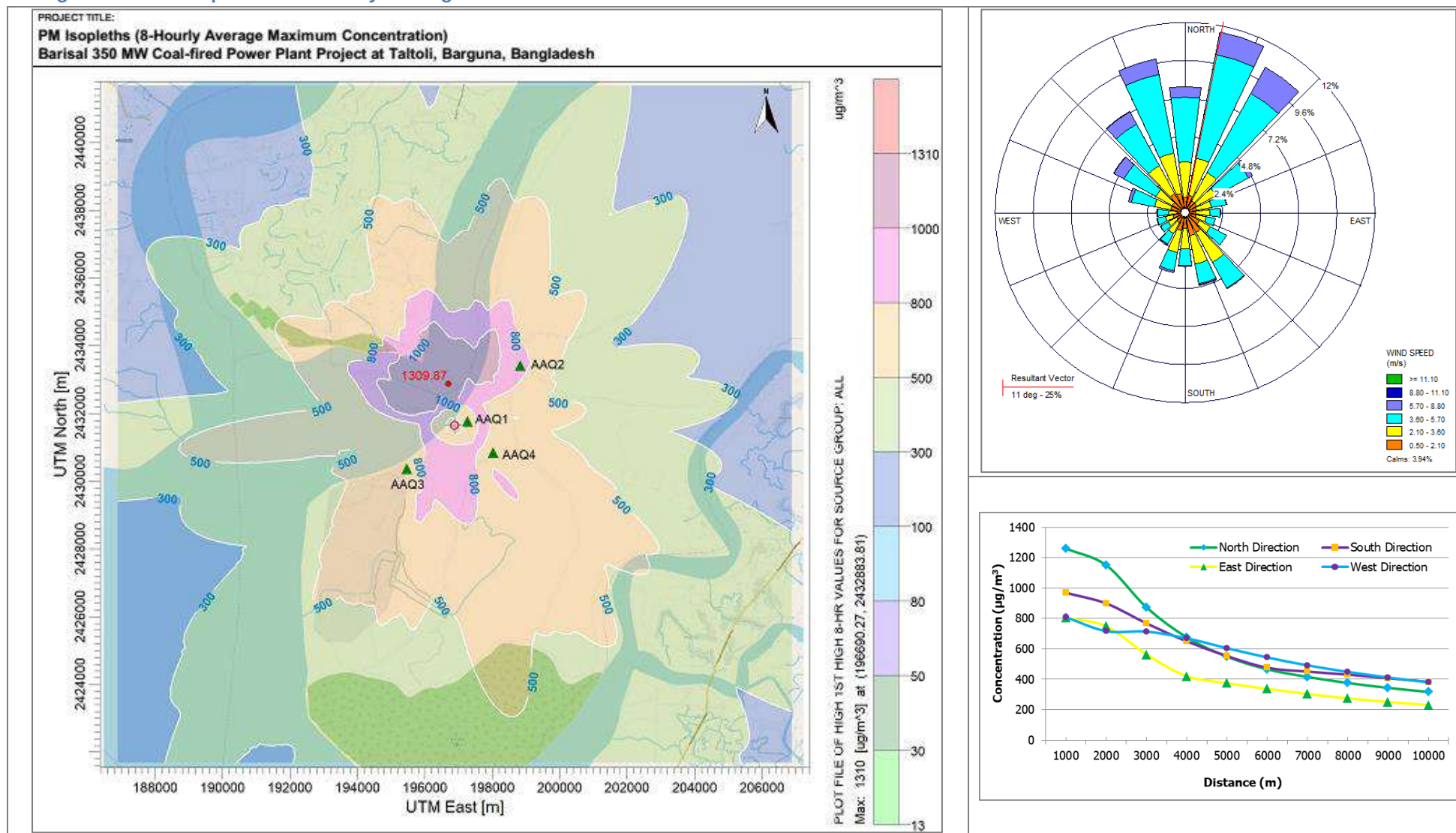
* The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19 July 2005 vide S.R.O. No. 220-Law/2005.

The maximum concentration of PM was observed to $1310 \mu\text{g}/\text{m}^3$ at coordinates of (195890.27m E 2432083.81m N) to the NNW direction of the stack at a distance of 1.05 km. The corresponding isopleth for PM emissions from the power plant operations is as given in Figure 8-6.

The ground level concentration of PM is decreasing with the increase of distance. The wind rose of the study area shows that the prevailing wind directions are SSW to NNE and SSE to NNW. The following Figure 8-6 shows the incremental ground level concentration of PM in all four (North, South, East and West) directions dispersed from the stack at various distances. Among all directions, the PM concentration is higher to the North direction.

The existing PM concentration at the receptors will be increased due to the operation of the coal-based power plant. The predicted PM level will exceed the Bangladesh Air Quality Standard, which is set as $200 \mu\text{g}/\text{m}^3$ for 8 hours (Table 8-11).

Figure 8-6: PM Isopleths of 8 Hourly Average Maximum Ground Level Concentration without ESP and Pollution Concentration at all Four Directions



8.5.4.3 Seasonal Air Dispersion of the Proposed Project

Pre-monsoon Season

The prevailing wind directions during pre-monsoon season in the project area are SW by S to NE by N and SSW to NNE. The 24 hourly highest average maximum concentration and pre-monsoon season maximum concentration of SO₂ & NO_x and 8 hourly highest average maximum concentration of particulate matter have been presented in following Table 8-12. The predicted 24 hourly highest average maximum concentrations of SO₂, NO_x are 5.47 and 15.6 µg /m³ at distance of 1.18 km in NW direction whereas 8 hourly PM concentration is 3.06 µg /m³ at the same distance and direction. The predicted maximum concentration of SO₂, NO_x and PM during pre-monsoon season were found as 1.84, 5.26 and 0.41 µg /m³ at distance of 1.18 km in NNE direction. The 24 hourly and pre-monsoon season isopleths of SO₂, NO_x and PM as well as pollution concentration at all four directions are presented in Annex-L (Volume-II). Among all directions, the pollutant concentration is higher to the North (NNE) direction.

Table 8-12: Maximum Pollution Concentration at distance and Direction during Pre-Monsoon

Parameters	Duration	Highest Concentration (µg/m ³)	Distance (Km)	Direction
NO _x	24-Hourly	15.6	1.18	NW
	Seasonal	5.26	1.86	NNE
SO ₂	24-Hourly	5.47	1.18	NW
	Seasonal	1.84	1.86	NNE
PM	8-Hourly	3.06	1.18	NW
	Seasonal	0.41	1.86	NNE

Monsoon Season

The prevailing wind direction during monsoon season in the project area is SSE to NNW. The 24 hourly highest average maximum concentrations and monsoon season maximum concentration of SO₂ & NO_x and 8 hourly highest average maximum concentration of Particulate matter have been presented in following Table 8-13. The predicted 24 hourly highest average maximum concentrations of SO₂, NO_x are 5.94 and 17.0 µg /m³ at distance of 1.06 km in NW direction whereas 8 hourly PM concentration is 3.14 µg /m³ at the same distance and direction. The predicted maximum concentration of SO₂, NO_x and PM during monsoon season were found as 1.47, 4.20 and 0.33 µg /m³ at a distance of 1.60 km in NNW direction. The 24 hourly and monsoon season isopleths of SO₂, NO_x and PM as well as pollution concentrations at all four directions are presented in Annex-L (Volume-II). Among all directions, the pollutant concentration is higher to the North (NNW) direction.

Table 8-13: Maximum Pollution Concentration at distance and Direction during Monsoon

Parameters	Duration	Highest Concentration (µg/m ³)	Distance (Km)	Direction
NO _x	24-Hourly	17.0	1.06	NW
	Seasonal	4.20	1.60	NNW
SO ₂	24-Hourly	5.94	1.06	NW
	Seasonal	1.47	1.60	NNW
PM	8-Hourly	3.14	1.06	NW
	Seasonal	0.33	1.60	NNW

Post-monsoon Season

The prevailing wind directions during post-monsoon season in the project area are NW by N to SE by S and NNW to SSE. The 24 hourly highest average maximum concentrations and post-monsoon season maximum concentration of SO₂ & NO_x and 8 hourly highest average maximum concentration of particulate matter have been presented in following Table 8-14. The predicted 24 hourly highest average maximum concentrations of SO₂, NO_x are 4.17 and 11.9 µg /m³ at distance of 578 meters in S direction whereas 8 hourly PM concentration is 2.34 µg /m³ at the same distance and direction. The predicted maximum concentration of SO₂, NO_x and PM during post-monsoon season were found as 0.86, 2.46 and 0.19 µg /m³ at a distance of 1.47 km in SSE direction. The 24 hourly and post-monsoon season isopleths of SO₂, NO_x and PM as well as pollution concentrations at all four directions are presented in Annex-L (Volume-II). Among all directions, the pollutant concentration is higher to the South (SSE) direction.

Table 8-14: Maximum Pollution Concentration at distance and Direction during Post-Monsoon

Parameters	Duration	Highest Concentration (µg/m ³)	Distance (Km)	Direction
NO _x	24-Hourly	11.9	578 m	S
	Seasonal	2.46	1.47	SSE
SO ₂	24-Hourly	4.17	578 m	S
	Seasonal	0.86	1.47	SSE
PM	8-Hourly	2.34	578 m	S
	Seasonal	0.19	1.47	SSE

Winter Season

The prevailing wind directions during winter season in the project area are NW by N to SE by S and NNW to SSE. The 24 hourly highest average maximum concentrations and winter season maximum concentration of SO₂ & NO_x and 8 hourly highest average maximum concentration of Particulate matter have been presented in following Table 8-15. The predicted 24 hourly highest average maximum concentrations of SO₂, NO_x are 3.98 and 11.4 µg /m³ at distance of 1.32 km in NNW direction whereas 8 hourly PM concentration is 2.39 µg /m³ at the same distance and direction. The predicted maximum concentration of SO₂, NO_x and PM during winter season were found as 0.97, 2.80 and 0.22 µg /m³ at a distance of 1.02 km in NW direction. The 24 hourly and winter season isopleths of SO₂, NO_x and PM as well as pollution concentrations at all four directions are presented in Annex-L (Volume-II). Among all directions, the pollutant concentration is higher to the South (SSE) direction.

Table 8-15: Maximum Pollution Concentration at distance and direction during winter

Parameters	Duration	Highest Concentration (µg/m ³)	Distance (Km)	Direction
NO _x	24-Hourly	11.4	1.32	NNW
	Seasonal	2.80	1.02	NW
SO ₂	24-Hourly	3.98	1.32	NNW
	Seasonal	0.97	1.02	NW
PM	8-Hourly	2.39	1.32	NNW
	Seasonal	0.22	1.02	NW

According to the model study, it is found that air pollution concentration is towards the north direction due to the prevailing wind direction in the project area. Therefore, it is expected that the air pollution will not severely impacts on surrounding environment especially the Tengragiri Wildlife Sanctuary. The Tengragiri Wildlife Sanctuary is located on south direction (6.16 to 8.30 km far) from the project

site and close to the Bay of Bengal. The proposed project will construct a stack considering 220 m height. The emitted gas will be rise to the upper atmosphere and attenuate at the upper atmosphere. The impact significance for air emissions from the proposed power plant operational phase is assessed to be Medium-High.

Impact	Impacts on Ambient Air Quality					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project surrounding area					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional		National	Transbounda ry
Impact Duration	Short Term	Medium Term	Long-term		Permanent – Mitigated	Permanent – no mitigation
Impact Intensity/ severity	Insignificant	Low	Medium		High	Very High
Potential for irreplaceable loss of resources	Low		Medium			High
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium-High</i>					

8.5.5 Impacts due to Greenhouse Gas Emission

The proposed power plant will use the 100% imported coal from the abroad. The project qualifies as a High carbon intensity project as it will lead to significant emissions of carbon dioxide (CO₂), which is a greenhouse gas. The greenhouse gas emissions from the project were estimating using the Greenhouse Gas (GHG) Protocol, which is an international accounting tool developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). For the purpose of impact assessment, quantification of CO₂ emissions within the purview of Scope-1 of the protocol, which accounts for emissions from sources owned by company, was carried out. The sources identified under this scope area as follows:

SL#	Emission Source	Type of Source	Justification for identification under scope-1
1	Boiler	Stationery	Emissions due to electricity generation from coal will be accounted

The following mathematical equation was use for calculating CO₂ emissions from the proposed coal-fired power plant project due to coal combustion in boiler operation.

$$E = M_{\text{fuel}} \times \text{Carbon content} \times \text{O.F.} \times \text{E.F.}$$

Where,

E	=	Mass of CO ₂ emissions (tones/unit time)
M _{fuel}	=	Mass of fuel (coal) used in boiler operation (tones/unit time)
Carbon Content	=	Ultimate fixed carbon content of fuel (coal) (tons of carbon/tons of coal)
Oxidation factor (O.F)	=	Oxidation factor to account for fraction of carbon in fuel that remains as soot or ash
Emission Factor	=	Emission Factor i.e., mass of CO ₂ released per unit mass of carbon

$$(E.F.) \quad \text{combusted} \\ = \quad \text{Ration of molecular weight of CO}_2 \text{ to that of Carbon} = (44/12)$$

O.F. has been taken as unity (1) assuming complete carbon consumption (IPCC Guidelines)

Fuel Type	Amount of Fuel (tones/Year)	Carbon Content (%)	Oxidation Factor	Emission factor	Annual CO ₂ emissions (million tones/year)
Coal	1,118,500	45	1.00	3.667	1.845692775

Source: Feasibility Report and EQMS, 2018

The total CO₂ production due to coal combustion during boiler operation in the proposed project, has been estimated using the guidance document 'Calculation Tool for Direct Emissions from Stationary Combustion, GHG protocol' and will be about 1.85 million tones/year. The impacts due to Green House Gas emission is assessed to be Medium-Low.

Impact	Impacts due to greenhouse gas emission					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project region and consideration of national level					
Frequency	Entire lifecycle of the project operation					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.5.6 Impacts on Ambient Noise

During the operational phase of the proposed project, the principal sources of noise will be the operating machinery and equipment, which would include primary air fan, forced draft fan, induced draft fan, air compressors, transformer, steam turbine and auxiliaries, generator, crusher, mill, pumps, aeration fan, coal handling machines and conveyors, boiler and auxiliaries etc. The major noise generating sources from the proposed power plant are Boiler-Turbine-Generator and ID Fans.

Additionally, vehicle and associated transporters would contribute to the noise generation. Furthermore, metal fabrication works and maintenance processes would also contribute to the noise source as well as the human activities within the project area. The increased noise level will impacts on occupational health of the workers, community health who will use the project site road and terrestrial birds and fauna in approach road. The probable sound levels are shown in Table 7-6.

Table 8-16: Major Noise Sources during operation of the Power Plant

Equipment Description	Location	Noise at source dB(A) Leq at 1m or reference	Frequency
Main Plant Equipment			
Boiler Exhaust Vent	Outdoor	110-130	Intermittent
Turbines	Indoor	90	Continuous
Generator	Indoor	90	Continuous
Coal Pulverizer	Indoor	90	Continuous
Coal Mill	Indoor	90	Continuous
Auxiliary Plant Equipment			
Boilers Feed Pump(s)	Indoor	90	Continuous
Circulating Pump	Indoor	90	Continuous
Air Compressor	Indoor	90	Continuous
Induced Draft Fan	Outdoor	85	Continuous
Forced Draft Fan	Outdoor	85	Continuous
FGD Slurry Circulating Pump	Indoor	85	Continuous
FGD Oxidation Fan	Indoor	85	Continuous
Coal Handling Equipment			
Bucket Unloader	Outdoor	85	Continuous
Conveyors	Outdoor	85	Continuous
Others	Indoor/outdoor	85	Continuous

Source: Feasibility Report, 2018

In the absence of detailed design data, equipment has been integrated into noise model as either a point, area or block source, depending on the size and function of the item of equipment. In the absence of vendor noise data, all equipment has been modelled at the occupational noise threshold sound pressure level (Lp) of 85 dB(A) at a distance of 1 meter from any equipment façade. The sound power level data has been estimated based on the sound pressure level data and approximate equipment sizes estimated from data provided by the project engineers or based on approximate dimensions illustrated on project plot plans and facility layout drawings.

Model Assumptions:

The following assumptions have been made for the modelling assessment, and wherever possible, a conservative approach has been taken:

- Operation of equipment with 100% usage scenario was modeled to cover the operation phase of the power plant project;
- As a conservative approach to the assessment, atmospheric absorption during sound transmission was not included in the assessment;
- In addition, to represent a worst-case scenario for the assessment, all equipment was assumed to be operating simultaneously;
- In order to assess the impact on noise reflection/barrier due to the structures, buildings within the power plant complex and boundary wall have been taken into consideration;
- There is a 2.5 m wall around the entire project site;
- Equipment height has been based upon the plant layout plot plans and knowledge of similar projects;
- Noise sources have been modelled as point, area or blocks;

- The model does not incorporate features which might provide partial screening(e.g., columns, pipe racks, structural steelwork, and small equipment);
- Reasonable worst case meteorological conditions have been applied, i.e. steady wind conditions blowing in each direction;
- The model does not include noise from pipework or valves; and
- At nighttime one jetty and operation of coal yard is partially closed.

Noise Level Guidelines:

Ministry of Environment, Bangladesh has set standard for noise level for different area of use. Noise standard as per Bangladesh Noise Pollution (Control) Rules 2006 is presented in Table 8-17.

Table 8-17: Noise Standard for Bangladesh

SL#	Category of Area/Zone	Decibel dB(A) Leq	
		Day Time*	Night Time*
1	Silent zone	50	40
2	Residential Area	55	45
3	Mixed zone	60	50
4	Commercial Area	70	60
5	Industrial Area	75	70

* Daytime is defined as the period 6.00 am-9.00 pm and night-time is defined as the period 9.00 pm-6.00 am.

International Finance Corporation (IFC) has also set EHS guidelines for ambient noise level. EHS noise guidelines of IFC are given in following Table 8-18.

Table 8-18: IFC Noise Level Guidelines

Receptor	One Hour LAeq (dBA)	
	Daytime 07:00 - 22:0	Nighttime 22:00 - 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Prediction of Impacts:

Methodology: The environmental noise prediction model Sound PLAN 7.4 was used for modeling noise emissions from the power plant operation.

Noise Contour Map: Based on the noise propagation from the power plant noise contour map has been prepared using the modeling tool. Day and night time noise contour map for the power plant is shown in Figure 8-7 and Figure 8-8 respectively. Predicted noise level in the receptors point during operation of the power plant is shown in Table 8-19.

Table 8-19: Predicted Noise Levels at Receptors during operation of BECPL Power Plant

Receptor	Category of Area/Receptor	Baseline Sound Pressure Levels at Receptors, Leq (dBA)*		Predicted Sound Pressure Levels at Receptors, Leq (dBA)		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard, dB(A)**	
		Leqd	Leqn	Leqd	Leqn	Leqd	Leqn	Leqd	Leqn
ANL-1	Project Site	49.07	45.24	61.2	59.8	61.46	57.09	75	70
ANL-2	Silent	49.90	43.04	64.2	64.1	64.36	64.13	50	40
ANL-3	Residential	47.21	44.00	50.6	49.1	52.24	50.27	55	45

Receptor	Category of Area/Receptor	Baseline Sound Pressure Levels at Receptors, Leq (dBA)*		Predicted Sound Pressure Levels at Receptors, Leq (dBA)		Total Sound Pressure Level (Baseline + Predicted), Leq (dBA)		Applicable Standard, dB(A)**	
		Leqd	Leqn	Leqd	Leqn	Leqd	Leqn	Leqd	Leqn
ANL-4	Mixed	59.02	44.56	45	43.8	59.19	47.21	60	50
ANL-5	Commercial	65.79	50.47	42.8	41.7	65.81	51.01	75	70
ANL-6	Commercial	54.29	45.40	51.9	51.5	56.27	52.45	75	70
ANL-7	Silent	46.75	43.09	48.8	48.1	50.91	49.29	50	40
ANL-8	Residential	50.67	46.49	49.3	48.6	53.05	50.68	55	45

* Ambient noise levels as monitored during the baseline survey

** Environmental Conservation Rules, 1997 (Schedule 4) amended September 7, 2006

Figure 8-7: Noise Contour Map for BEPCL Power Plant operation during daytime (Leq day)

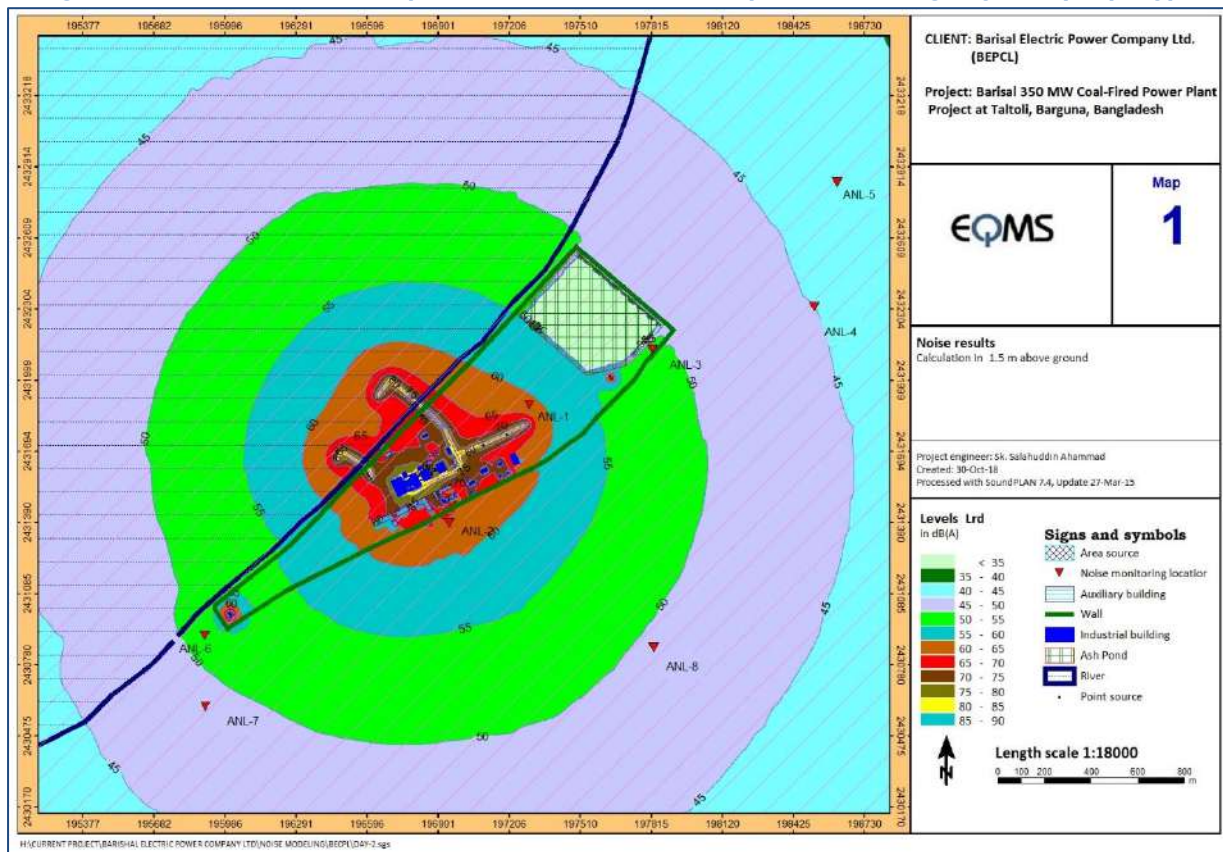
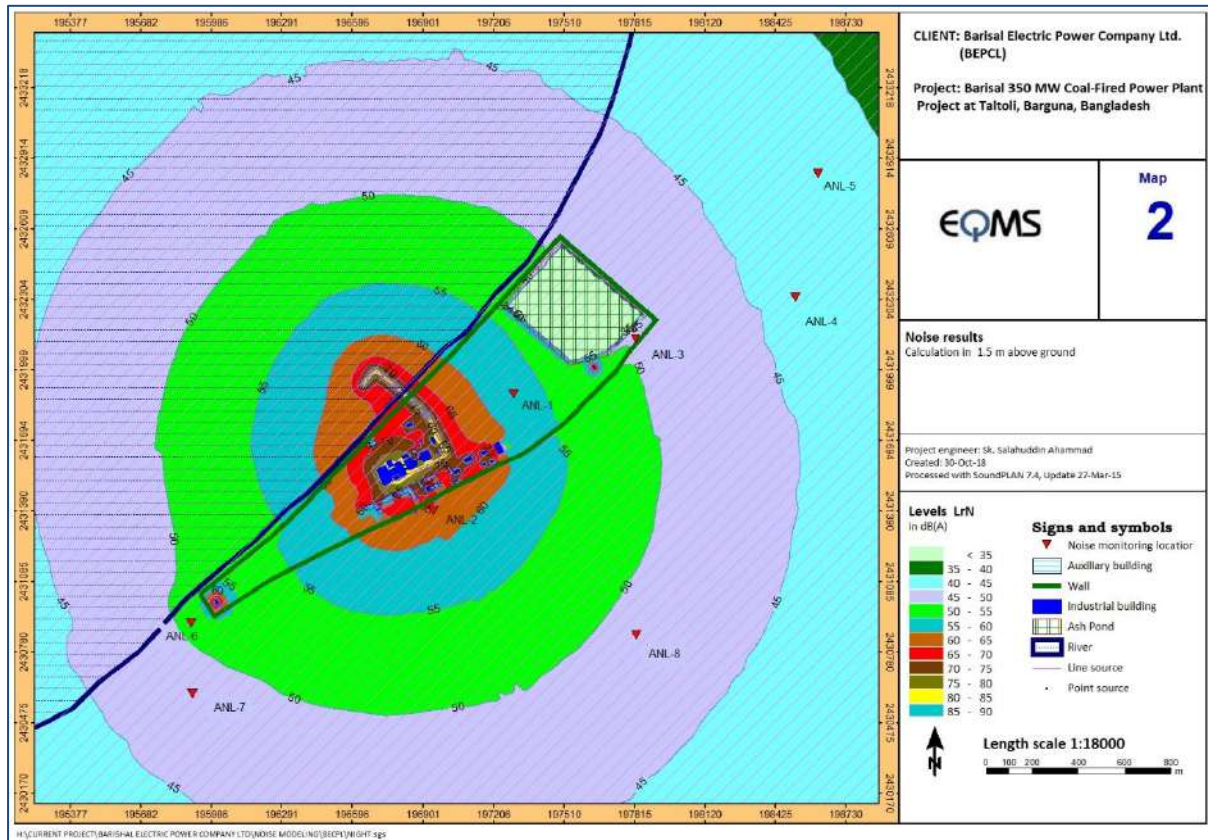


Figure 8-8: Noise Contour Map for BEPCL Power Plant operation during nighttime (Leq night)



The proposed 350 MW coal-fired power plant is located inside of the rural area and there is no industry around the project site. According to the model result, it is found that the noise level will be increased inside of the power plant operation site and surroundings of the project site silent and residential area especially during nighttime.

Predicted noise level at the receptors during operation phase is most of the case within limiting value set by DoE. Few places may experience 2-3 dB (A) excess noise than the present noise level during operation of the proposed 350 MW coal-fired power plant. The impacts on ambient noise level due to power plant operation is assessed to be Medium-Low.

Impact	Impacts on Ambient Noise					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project boundary and approach road					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-	Medium-	High	Very High

		Low	high	
Significance of impact consider Medium Low				

8.5.7 Impact on Water Bodies

8.5.7.1 Impacts on Surface Water Quantity

The proposed 350 MW coal-fired power plant is going to be established on the bank of the Buriswar-Payra River. The river is connected with the Bay of Bengal, as a result, plenty of water is found in the river round the year. The proposed project will get the benefits of the availability of water in the region. According to the discharge data of the Buriswar-Payra River provided by the BEPCL, the average flow is more than 60,000 m³/s or 216,000,000 m³/s. However, the average lowest flow has been found during the months of January and February. The withdrawal rate (48,115 m³/h) designed for the proposed project is very insignificant (0.02%) considering the availability in the river. The impacts on surface water quantity is assessed to be Very Low.

Impact	Impacts on Surface Water Quantity					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project boundary and adjacent river					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Very Low					

8.5.7.2 Impacts on Surface Water Quality

The proposed power plant will adopt once-through cooling system, to be used mainly for cooling Boiler Turbine Generator (BTG) condenser and closed cooling water system. Circulating water after heat exchange will return to Buriswar-Payra River through drainage system. It will increase the surface water temperature of the river. However, a model study has been done for the proposed project and discuss in subsequent sections.

The proposed power plant will include a seawater desalination plant for provision of boiler makeup, service water and fire water etc. The water discharged by the plant will have increased salinity and will be returned via the circulating water discharge pipe. The higher salinity of this water will have minimal impact once this water is mixed with the returning cooling water. During operation, small quantities of boiler water (boiler blow-down) will be discharged to avoid the build-up of impurities. This effluent will be virtually pure water, containing very small quantities of various chemicals that are used to prevent corrosion and scaling in the boiler.

The water discharged from the cycle must therefore be replaced with make-up water, which must be of high purity. Water from the desalination plant will therefore have additional treatment in a demineralized water treatment plant. During maintenance, it may be necessary to drain down the

boiler, the closed circuit cooling water system or parts of these systems. All such wastes will be discharged to the river water outfall after treatment. The boiler water will be identical to boiler blow-down and will be high purity water containing traces of ammonia, phosphate and suspended solids. The closed circuit cooling water will be high purity water containing small amounts of corrosion inhibitor. During the detailed engineering of the plant, consideration will be given to the storage, recovery and re-use of these effluents. However, the project proponent must be ensured that, no wastewater will be discharged into the river. All the waste will be properly collected and send to the ETP and STP for treatment and reuse in the plant area. The impacts on surface water quality and quantity is assessed to be Medium-Low.

Impact	Impacts on Surface Water Quality					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project site and adjacent river					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.5.7.3 Discharge of Once-through Cooling Water

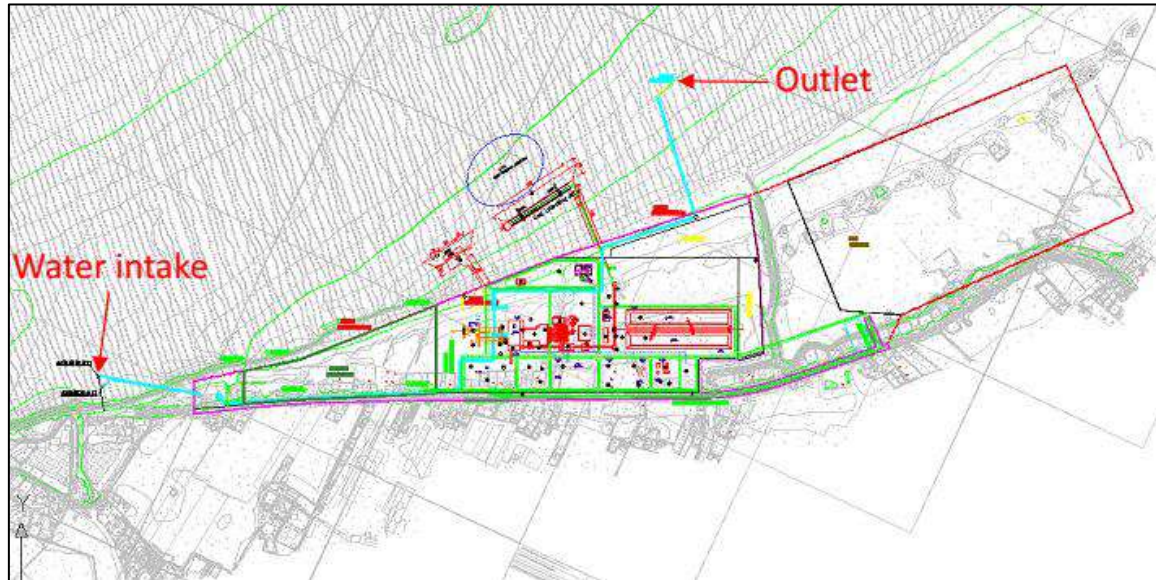
The proposed coal-fired power plant will utilize a once-through cooling system for the condenser. A once-through cooling system carries off waste heat from the power plant by means of water flowing through the condenser and discharge it to the natural water body. There, waste heat is transferred to the atmosphere, which is the ultimate heat sink.

According to the feasibility report, the power plant will adopts once-through cooling system, with the maximum water consumption at about 47,763 m³/h and the highest temperature increase of water discharge at about 7.5°C. Inlet water temperature is designed as 28.5°C, and outlet water temperature is expected to be lower than 36°C. The Buriswar-Payra River is connected with the Bay of Bengal. Water for cooling the systems will be obtained directly from the Buriswar-Payra River, used for cooling then released back into the Buriswar-Payra River. At the discharge point, the temperature differential of the ambient and discharged water will be about 7.5°C. Without adequate mitigation measures, waters with such elevated temperature differentials can potentially be harmful to sensitive habitats such as fisheries and aquatic ecosystem.

The Hebei Electric Power Design and Research Institute (HBED), China (prepared the plume water model for the proposed project and the report is given as Annex-I (Volume-II) proposed a scheme for the intake-outlet layout of cooling water for the proposed 350 MW Coal-fired Power Plant, Bangladesh (as shown in Figure 8-9). In the proposed scheme of intake-outlet layout by HBED, the cooling water will be discharged at upstream and withdrawn from downstream. The upstream outlet is about 345 m away from the coal-unloading jetty and about 350 m away from the shoreline. The cooling water will be discharged through multi-port diffusers submerged in the ambient flow. The main pipeline, with the inner diameter of 2.6 m, will basically arranged along the 7 m contour. Six nozzles, with the inner

diameter of 1 m and axis elevation of -6.1 m (The elevation is based on local MSL), will be linked to the main pipe. The cooling water will be discharged from these staggered nozzles in the horizontal direction with an angle of 45° against the main pipeline. The water intake downstream will be about 1800 meters away from the outlet upstream and about 100 m away from the shoreline. The dredging bottom elevation of the intake is about 13 m, and the top elevation of the 4 m high intake window is - 6.5 m.

Figure 8-9: Scheme of Arrangement of Water Intake and Outlet



Source: BEPCL/ HBED, 2018

According to the current World Bank Group EHS Guidelines for Thermal Power Plants, thermal discharges should be designed to ensure that discharge water temperature does not result in exceeding relevant ambient water quality temperature standards outside a scientifically established mixing zone. Further, the WBG General EHS Guidelines state that the temperature of wastewater prior to discharge should not result in an increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations.

The effects of thermal discharges on the aquatic environment can be sub-divided into direct effects (those organisms directly affected by changes in the temperature regime) and secondary effects (those arising in the ecosystem as a result of the changes in the organisms directly affected).

Direct effects:

The direct effects of thermal discharges on the aquatic environment include:

- Change to the temperature regime of the water column and perhaps the sediment of the receiving environment over a small area;
- Lethal and sub-lethal responses of organisms to the change in temperature regime;
- Stimulation in productivity in a range of organisms; and
- Minor reduction in the dissolved oxygen saturation. Changes to dissolved oxygen saturation potentially arise as a result of the reduction in solubility of oxygen in seawater with increasing temperature and as a consequence of the increased productivity of microbial communities in particular.

Indirect effects:

The indirect effects of thermal discharges on the aquatic environment include:

- Changes in the distribution and composition of communities of organisms comprising sites (particularly estuaries);

- Localized changes in bird distributions usually in response to increased macroinvertebrate or fish food supplies close to thermal discharges.

The following two models were used for the plume water modelling study:

- Initial mixing zone model (CORMIX, <http://www.cormix.info/>); and
- The three-dimensional hydrodynamic model (Delft3D, <https://oss.deltares.nl/web/delft3d>).

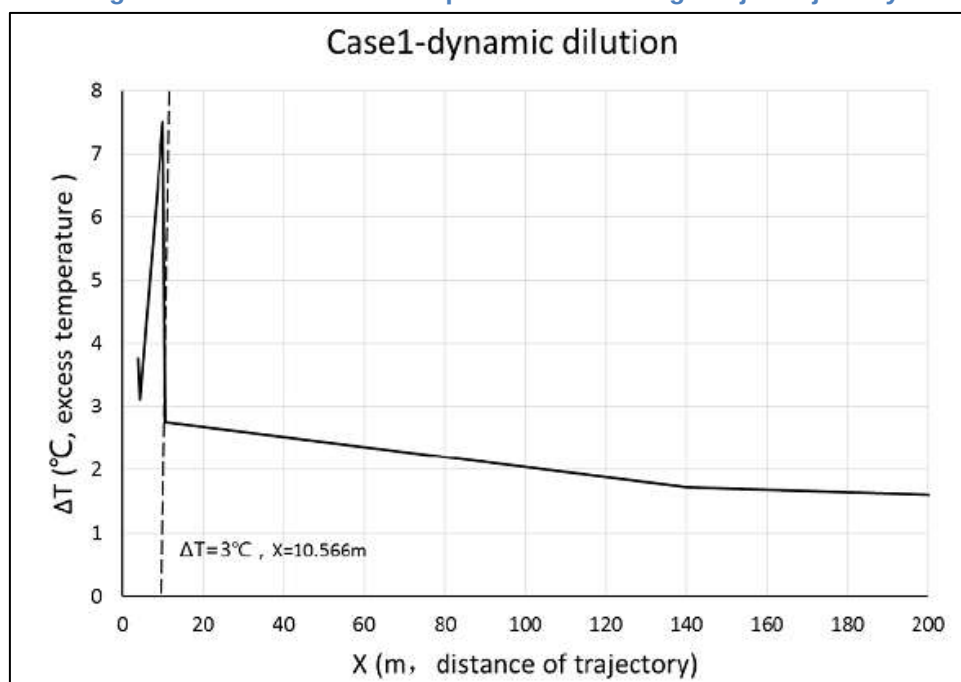
Only the result and analysis of these two models are given below and details of the modelling report is given in Annex-I (Volume-II).

8.5.7.3.1 Results of CORMIX Model

CORMIX is a widely used mixing zone model and decision support system to investigate the mixing of cooling water and pollutants in the near-field zone of outfalls, which was originally developed and is being continuously improved by DeFrees Hydraulics Laboratory, Cornell University, in the 1990s, under the support by US Environmental Protection Agency. CORMIX, as a buoyant jet model, focuses on the geometric and dilution features in the initial mixing zone. CORMIX consists of four hydrodynamic modules. The module CORMIX2, valid for multiport diffusers, is adopted in this study.

The following Figure 8-10 presents the variation of temperature rise along the jet trajectory. It is shown that, for the case of the multiport diffuser with outflow of 2.69 m/s, cooling water can mix with ambient water quickly and that the maximum distance of contours of temperature rise of 3°C away from the outlet is about 10.6 m (less than 100 m) which meets corresponding environmental protection requirement.

Figure 8-10: Variation of temperature rise along the jet trajectory



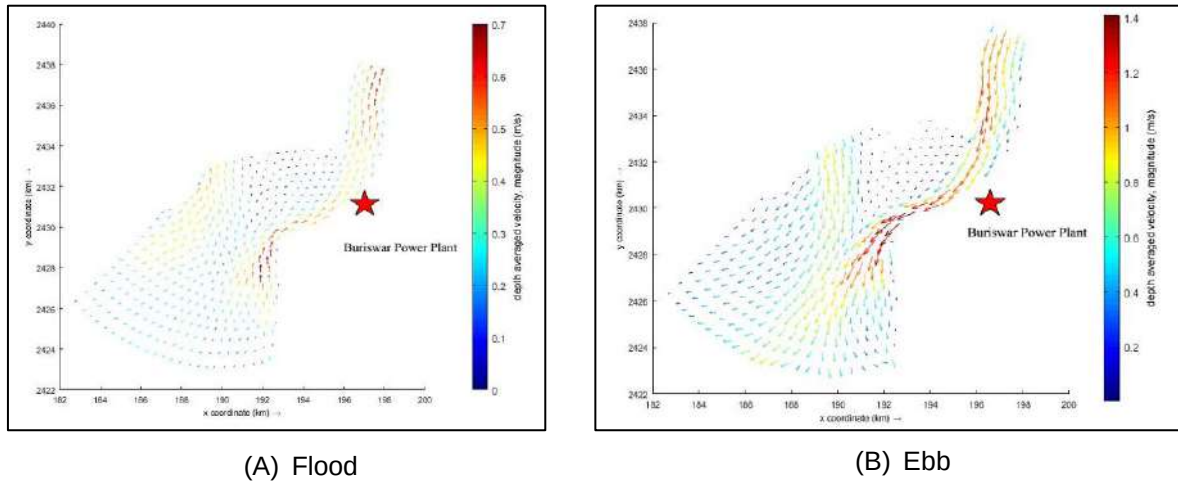
Source: BEPCL/ HBED, 2018

8.5.7.3.2 Results of Delft3D Model

The software Delft3D model, widely used in the world, is adopted to compute the cooling water transport for proposed coal-fired Power Plant, to predict the range influenced by cooling water and the temperature rise of water intake, and further to verify the rationality of the proposed water intake-outlet layout. The Buriswar-Payra River is a tidal river, in which the seawater flows toward the river in the flood tide, while the freshwater flows seaward in the ebb tide. The duration of the ebb tide is longer than that of the flood tide, and the flow velocity in the ebb tide is larger than that in the flood tide, under the combined action of river runoff and tidal flow. The following Figure 8-11 and Figure 8-12

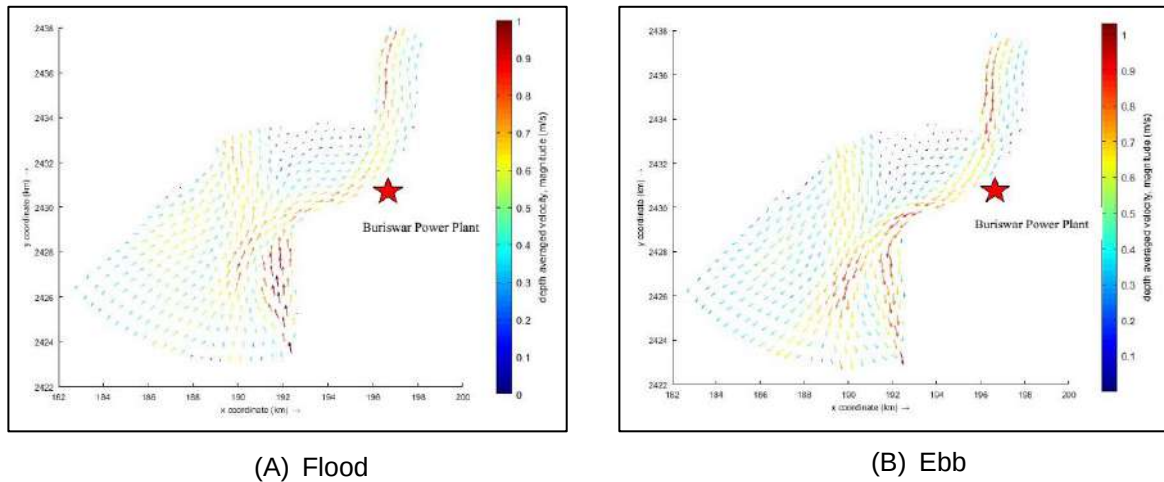
presents the computed velocity fields in the neap tide. Results show that the computed velocity field reflects the characteristics of flow in the sea region of Buriswar Coal-fired Power Plant.

Figure 8-11: Depth-averaged velocity fields during the neap tide in the wet season



Source: BEPCL/ HBED, 2018

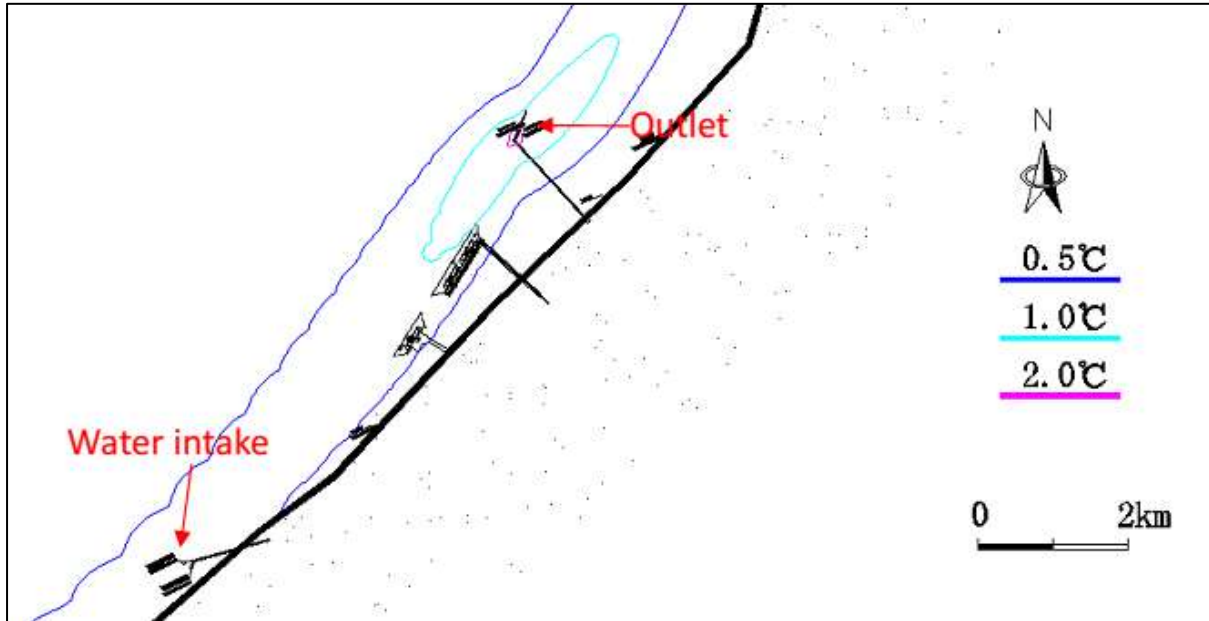
Figure 8-12: Depth-averaged velocity fields during the neap tide in the dry season



Source: BEPCL/ HBED, 2018

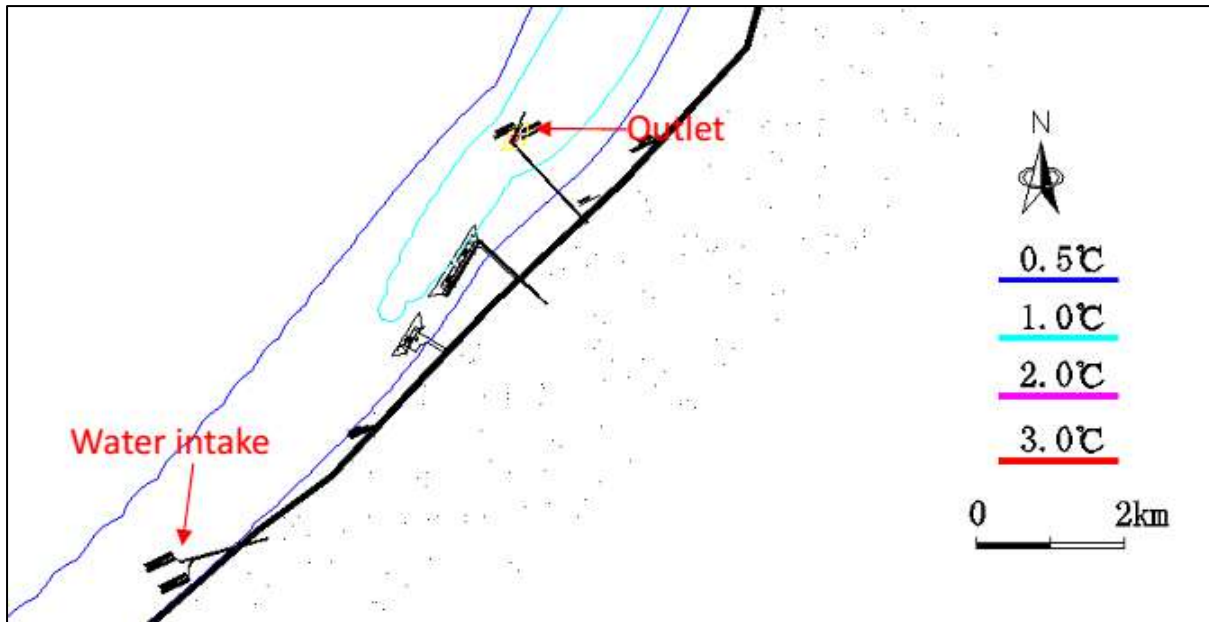
Numerical simulation of cooling water transport has been performed for the proposed Coal-fired Power Plant. The following Figure 8-13 and Figure 8-14 present the contours of maximum temperature rise (based on the projection of maximum temperature in the vertical direction during a tidal period) during the neap tide in the wet and dry seasons and corresponding area enclosed by these contours is shown in Table 8-20, in which the slash represents the area less than the minimum area of a grid cell (about $4E-4 \text{ km}^2$). The term for “Maximum temperature rise based on the vertical projection”, in Table 8-20, refers to the maximum area enclosed by the vertical projection of temperature rise field at different layers. The following Table 8-21 presents the maximum and mean temperature rises at intake during the neap tide.

Figure 8-13: Contours of Maximum Temperature Rise during the neap tide in the wet season



Source: BEPCL/ HBED, 2018

Figure 8-14: Contours of Maximum Temperature Rise during the neap tide in the dry season



Source: BEPCL/ HBED, 2018

Table 8-20: Temperature rise during the neap tide (unit: km²)

Season/Types of tide	Influence area	4°C	3°C	2°C	1°C
Wet/Neap	Surface layer	-	-	2.06E-3	1.67E-2
	Maximum temperature rise based on vertical projection	-	-	2.09E-3	1.26E-1
Dry/Neap	Surface layer	-	-	2.99E-3	4.15E-1
	Maximum temperature rise based on vertical projection	-	7.11E-4	4.85E-3	4.15E-1

Source: BEPCL/ HBED, 2018

Table 8-21: Temperature rise at intake during the neap tide (unit: km²)

Season/Types of tide	Characteristic values	
	Maximum temperature rises in a full neap tide	Mean temperature rises in a full neap tide
Wet/Neap	0.3	0.1
Dry/Neap	0.4	0.2

Source: BEPCL/ HBED, 2018

From the modelling result, it was found that cooling water transports mainly along the shoreline, forming a narrow banded distribution, due to the combined action of the shoreline, topography, as well as the flood and ebb tides. Cooling water moves northeast during the flood tide, while it moves in reverse during the ebb tide. The maximum distance of temperature rise contours of 3°C away from the outlet will be less than 20 m for the neap tide during the wet and dry seasons, meeting the requirement of environmental protection that the maximum distance of temperature rise contours of 3°C away from the outlet should not exceed 100 m.

For the operation of the proposed power plant, the maximum and mean temperature rise of water intake will be 0.3°C and 0.1°C respectively, during the neap in the wet season. The maximum and mean temperature rise of water intake will be 0.4°C and 0.2°C respectively, during the neap in the dry season. The mean temperature rise of water intake is less than 0.5°C, which meets the design requirement of mean temperature rise of water intake less than 0.5°C. The impacts on water bodies due to discharge of cooling water is assessed to be Medium-High.

Impact	Impacts on Water bodies due to discharge of once-through cooling water					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project Site river (Intake and discharge point)					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium-High					

8.5.8 Impacts due to Solid Waste Generation and Disposal

Ash is the main solid waste generated in the coal-based thermal power plant. The waste includes fly ash, bottom ash and boiler slag. According to the feasibility report, the coal consumption has been estimated as 3304.84 tons/day in the proposed project. Approximately 706.244 tons/day ash will be produced including fly ash and bottom ash. The bottom ash including slag is coarser and heavier. Consequently, fugitive fly ash may cause pollution to the surrounding. Ash and slag generated from the coal-fired power plant would be stored only temporarily. The ash residues may contain heavy metal and some organic compounds or potentially hazardous materials.

During the operation of the proposed power plant, others solid waste will be generated from the canteen, office, workers facilities, medical, maintenance workshop etc. in an insignificant amount. All these solid wastes needs to be collected and manage separately as per types. However, the impacts due to solid waste generation and disposal is assessed to be Low.

Impact	Impacts due to solid waste generation and disposal					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project Site					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.5.9 Impacts due to Wastewater Generation and Disposal

The main issues related to wastewater during the operational phase of the proposed coal-fired power plant include domestic (including sanitary) wastewater, oil-contaminated and/or chemical-containing wastewater and stormwater run-off. The wastewater streams in the power plant would include wastewater from ash handling and storage runoff, boiler blowdown and cleaning waste, backwash from demineralization plant, wastewater from ESP wash, cleaning wastewater, storm drains, laboratory wastes and wastewater from water purification and wastewater treatment units and sewage and other sanitary wastewater. The potential impacts that may result from these is described below.

Water consumption for daily activity used in the administration office and the colony (accommodations for workers on site) during plant operation is pegged at approximately 0.2 m³ per person per day. If approximately 172 workers are present on site, this will generate a daily sewage effluent volume of about 34.4 m³ for treatment. STP will be installed in the proposed power plant to treat the domestic sewage. Two sets of 5 m³/h domestic sewage treatment equipment will be set in this project. Improper design of the sewage treatment plant and/or noncompliance with the water quality regulations of the DoE could have detrimental effects on surface water quality.

The industrial process of the power plant facilities will generate wastewater from various streams e.g. workshops, process areas and vehicle parking yards. Some of these streams may contain hazardous components such as oily water and/or wastewater containing chemicals. If managed improperly, such wastewaters can potentially cause pollution of the Buriswar-Payra River.

The wastewater including coal and industrial wastewater and washing wastewater would be treated completely in a wastewater treatment system to control acidity and neutralize chemical load including elimination of metals such as chromium and zinc from chemical additives used for controlling fouling and other organisms and suitable steams would be recycled before eventually drained out. This is intended to minimize and control wastewater effluent generation from the plant by conserving and reducing water utilization. The treating capacity of the ETP in the proposed project will be 60 m³/h. In

the case of spray of ash piles, there is the potential of runoff water infiltrating into the ground. The impacts on environment due to wastewater generation and disposal is assessed to be Medium-High.

Impact	Impacts on environment due to wastewater generation and disposal					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project operation area and adjacent river					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-High	High	Very High
	Significance of impact consider Medium-High					

8.5.10 Impacts on Soil and Agriculture

Soils play a fundamental role in biodiversity conservation thus changes to the structure and chemical composition can have subsequent effects on vegetation structure and composition as well as altering watercourses. During the operation phase of the proposed project will generate fugitive dust and gas emissions. The soil, vegetation and agricultural crops will undergo perceptible qualitative changes due to the deposition of dust particles. The dust particles depending upon the size and weight settles down at varying distances on vegetation in the prevailing wind direction. Foliar deposition of dust interrupts gaseous exchange through stomatal clogging, thereby affecting plant growth.

Soil contamination is also a potential impact considering the project features especially coal storage, coal ash storage and wastewater disposal and chemical and hazardous substances management. These materials potentially could seep into the soil leaving heavy metals and other hazardous substances in the soil and further into ground water. Solid wastes, oil leakage and waste oils will emanate from the project's activities due to the high influx of personnel and activities in the area. Solid waste materials expected include cans, wrappings, paper and plastics waste, among others. Petroleum, oil leakage and waste oils may spill on the ground and ultimately into the soil and degrade the ecosystem.

The proposed project site will be developed during the pre-construction stage and all the construction will be completed. During the operation of the proposed project, the area will be converted as industrial area. The prevailing wind direction and dispersion of air emission from the stack in the study area is opposite of the agricultural land. So, no significant impacts on agriculture is expected from the operation of the proposed project. The impacts on soil and agriculture is assessed to be Low.

Impact	Impacts on Soil and agriculture				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Project boundary and approach road				
Frequency	Operation Phase				
Extent and location	Project Site	Local	Regional	National	Transboundary

Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.5.11 Impact on Groundwater

During the operational phase of the proposed project, surface water will be intake from the Buriswar-Payra River and used in entire project operation. According to the BEPCL, no groundwater will be extracted for the operation of the proposed project. However, the proposed coal-fired power plant will discharge fly ash, bottom ash and wet gypsum in the ash yard, which is located on the eastern side of the project. If the design of the ash yard does not include impermeable layers of protection, leachate from the ash yard could percolate into the sub-surface and potentially contaminate the groundwater. The inferred groundwater flow is northwards towards the Buriswar-Payra River and any leachate in the groundwater would have adverse impacts on the hydrology.

The upper sub-surface geology is vulnerable to the infiltration of pollutants from coal ash yard and hydrocarbon pollutants in the event of leakage of petroleum hydrocarbons from heavy vehicles operating in the project area during operation and maintenance, which could lead to the local aquifer systems potentially being contaminated. If the sanitary and industrial wastewater is not properly handled correctly or discharged accidentally or not treated properly, it will potentially impacts on aquatic environment, groundwater quality and surface water quality. The impacts on groundwater resources by the project activities is assessed to be Medium-High.

Impact	Impacts on Groundwater					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Ash storage area, waste storage, treatment and disposal site					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium		High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium-High					

8.5.12 Impact due to Ash Disposal

Coal and coal waste products, including fly ash, bottom ash and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and, radium, which are dangerous if released into environment. Major portion of these heavy metals may remain with ash. According to the feasibility report, the coal consumption has been estimated as 3304.84 tons/day in the proposed project. Approximately 706.244 tons/day ash will be produced, among this fly ash amount will be 600.314 tons/day and bottom ash will be 105.93 tons/day. After collecting fly ash and bottom ash, it will be disposed of in the on-site ash yard. The lack of a properly designed ash yard could potentially lead to sub-surface and groundwater contamination. Mercury emission from coal burning is converted into methylmercury, a toxic compound that harms people who consume freshwater fish. Failure of waste management and ash management system may cause release of these hazardous wastes to environment that might also contaminate food chain. A further potential impact associated with generation of fly ash, concerns the release of fly ash material into the environment. Due to its low density and fine particulate size, it has the potential to travel relatively large distances. However, the project proponent ensure that, a primary ash dam will be built around the ash yard, with height of 5.4m, internal and external side slope of 1:2.5 and top width of 4m, using materials inside the ash yard. The dam slope will be protected using dry masonry block stone. Drainage ditch will be set at dam foot to protect it from rainwater washing. The designed ash stacking height will be 11m and effective storage capacity will be about $144.3 \times 104 \text{ m}^3$, which satisfies storage demand of 1 x350 MW unit for about 5 years. The impacts due to ash disposal is assessed to be Medium-Low.

Impact	Impacts due to ash disposal					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Ash generation site and disposal site					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium Low					

8.5.13 Ecology

8.5.13.1 Aquatic Ecology

During the construction phase of the proposed project, pump house, pipelines, intake and outfall structures will be constructed in the Buriswar-Payra River. In addition, all the facilities will be operational during the operation phase. During the operation phase, aquatic macrophytic vegetation, aquatic fauna like fish, phytoplankton, zooplankton and benthos community may be impacted. The impact of intake on large fishes will be minimum as they can swim back and get away from the intake. However, small organisms, like planktons may enter and lost into the intake system. Coal transportation using barges will impacts on fisheries resources by noise generation, spillage of oil and

lubricants, solid waste, bilge water, ballast water etc. The proposed project area is also moderate suitable zone for the Hilsa fish breeding and possibility of movement of Dolphins in the Buriswar-Payra River. A detailed study will be required in the Buriswar-Payra River during construction and operation phase of the project. Transportation activities and handling in jetty area will be created more noise and lighting will attract the fish resources. Accidental spillage of coal, oil and discharge of untreated wastewater from the plant may change water quality and impact on the fish resources and aquatic animal in the Buriswar-Payra River. Major impacts on fish resources and benthic community will be occurred during the disposal of heated cooling water into the Buriswar-Payra River. Windblown ash and from coal handling in the jetty area may impact on water bodies may hardly affect health of aquatic flora. Impacts on aquatic ecology is assessed to be Medium-Low.

Impact	Impacts on Aquatic ecology					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project site and adjacent river					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-High	High	Very High
	Significance of impact consider Medium Low					

8.5.13.2 Terrestrial Ecology

Destruction of ecosystems can also be caused indirectly if emissions from a coal-power plant reduce productivity of vegetation. Dust for instance will affect plants growth by interrupting physiological processes like transpiration when lodged on leaf surfaces thereby blocking their stomata. Stack emissions such as Sulphur dioxide, nitrogen oxides, carbon monoxide and heavy metals (such as mercury) may contribute to acid rain, which in turn pollute and affect plants growth by corrosion of their surfaces and causes acidification of terrestrial ecosystems.

Project induced traffic, presence of workers, and other project activities may sometime disturb free movement of different fauna in the approach road, side vegetation and Jetty area. During the operational phase, the power plant will produce less than the permitted levels of noise recommended by the DoE. Lighting in the project area may disturb activities of nocturnal animals. On the other hand, green belt (to be developed) for the project shall provide important habitat to different wildlife, local common birds and other terrestrial birds. The impacts on terrestrial ecology is assessed to be Medium-Low.

Impact	Impacts on terrestrial ecology		
Impact Nature	Direct	Indirect	Induced
Impact Scale	Project site and approach road		
Frequency	Operation Phase		

Extent and location	Project Site		Local	Regional	National	Transboundary
Impact Duration	Short Term		Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation
Impact Intensity/ severity	Insignificant		Low	Medium	High	Very High
Potential for irreplaceable loss of resources	Low			Medium		High
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely		Low	Medium	High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

8.5.14 Impact on Occupational Health and Safety

According to the BEPCL, during the operation of the proposed power plant, there may be up to 172 workers. The operation of the power plant, may cause a number of occupational health and safety risks and impacts, which may include non-ionizing radiation, heat, noise and vibration, working in confined spaces, electrical hazards, fire outbreaks due to electrical faults and explosion hazards, chemical hazards, mishandling of flammable substances, occupational illness due to exposure to dust, being struck by falling or moving objects, vehicle related accidents and accidents associated with lifting equipment. The receptors for occupational health and safety impacts include direct workers of the power plant and sub-contractors visiting to work at the plant.

Without adequate controls, there will be potential adverse impacts on workers arising from inconsistent management of occupational safety and health. There may also be industrial hygiene hazards that workers could potentially be exposed to such as chemical handling without the use of proper personal protective equipment or studying the Safety Data Sheet (SDS) for the chemical on safe handling. The above hazards and risks associated with the operational phase may arise from the lack of a comprehensive written health and safety Plan drawn up by the BEPCL for the operation phase of the project. Operation of the power plant and affiliated facilities may cause dust and noise nuisance to the worker and could lead to respiratory problems and hearing loss respectively. Additionally, ground level gas concentration may be significantly high and could cause nuisance to the worker. The impacts on community health and safety is assessed to be Medium-High.

Impact	Impacts on occupational health and safety					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Inside the project boundary					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High

Probability of Impact	Unlikely		Low	Medium	High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium-High					

8.5.15 Impact on Public Health and Safety

Community Health and Safety risk include exposure to emissions, noise and vibration nuisance, non-ionizing radiation generated by the power transmission grid, dust emission, improper management of waste (solid, liquid, hazardous), improper drainage from the workers camp, accidents and injuries associated with increases in vehicular traffic, workers and pedestrians on existing roads, visual impact of changed landscape and traffic nuisance and the consequence potential health risk due to degraded air quality, visual impact and resulting emotional stress and increased public insecurity.

Housing impacts including increased incidence of vector-borne diseases, respiratory illnesses, food supply and quality issues, injuries, and solid/liquid waste disposal problems for sanitary and non-sanitary wastes. Vector-borne diseases are represented by malaria, filariasis and dengue fever, which are spread by mosquitos. The influx of migrant workers both national and international into the communities presents considerable social challenges including social vices. The community is likely to experience upsurge of sex workers and attendant health hazards including HIV AIDS. The community would also experience increased community population and attendant demand on community health and educational facilities. The impacts of the project on public health and safety is assessed to be Medium-Low.

Impact	Impacts on public health and safety					
Impact Nature	Direct	Indirect		Induced		
Impact Scale	Project surrounding area					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low		Medium	High	Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium Low					

8.5.16 Impact on Traffic Movement

The influx of construction workers in the project area will entail an increase in the traffic to and from the project site. During the operational phase of the project, increased traffic levels will be caused by public transport vehicles used by workers as well as service contractor vehicles leaving and entering the power plant. In addition, business and employment opportunities and better road condition will result in an increase in number of vehicles and number of accidents. It is expected that, in an average of 10 to 20 vehicles per day will mobilize in the project site. Increases in the volume of traffic have the potential to increase the risk of accidents and noise levels along the access road. Movement of vehicles will generated dust and impact on terrestrial flora and fauna. The coal required for the

proposed project will be transported by the waterway so no impacts is expected on road traffic due to the transportation of coal. During operation of the power plant, traffic nuisance is expected to be negligible as therefore would be very limited transportation. The impacts on traffic movement is assessed to be Low.

Impact	Impacts on Traffic Movement					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project site approach road					
Frequency	Operation phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.5.17 Social Impact

8.5.17.1 Creation of Employment

The proposed 350 MW coal-fired power plant project is envisaged to generate direct and indirect employment opportunities, enhance skills development for both skilled and unskilled workers in the Taltoli, Barguna. During the operation of the proposed 350 MW power plant, about 172 personnel will be required for operation, maintenance and administration purposes. Furthermore, the project would contribute to providing meaningful job opportunities for the locals within the local communities and economic empowerment for the surrounding communities.

The project would also provide additional electricity to the national grid; contributing to meeting electric power shortfall in Bangladesh and promote local economic development while stimulating the development of related industries such as manufacturing, transportation and commerce. The project would also contribute to the foreign direct investment inflow and contribute directly and indirectly to national revenue generation and export. Additionally, the project would create provisions for infrastructure development such as roads, schools and health facilities, impact on the potential land use in the area and also boost local economy.

8.5.17.2 Influx of Workers and Communicable Diseases

Due to the influx of laborers and workers, there is the likelihood of significant population expansion. Consequently, there would be attendant increased demand on social infrastructure and related facilities, including housing accommodation, utilities supply and health facilities. These demands and requirements would increase social cost including rent for accommodation. This would also contribute to expanding the both the economic power in terms of increased disposable incomes and market opportunities in the communities. More trading opportunities would be created for the indigenes. Additionally, the increased population and especially the boost in economic capacity of the project area would result in the potential for prostitution in the areas surrounding the project site. This therefore could lead to increased sexually transmitted diseases including HIV/AIDS, Gonorrhoea, and Syphilis etc. The principal receptors are the local inhabitants and especially the economically active farmers and fishermen's. The impacts on local community due to influx of workers and communicable diseases is assessed to be Low.

Impact	Impacts on community due to influx of Workers and Communicable Diseases					
Impact Nature	Direct	Indirect		Induced		
Impact Scale	Project site community					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Low					

8.5.17.3 Disruption and Loss of Livelihoods

Disruption and loss of livelihoods is defined as the loss of assets or access to assets that result in a loss of income or means of livelihood. This type of economic resettlement can have greater effects than physical resettlement. The land required for the proposed project is 174 acres, consisting of single cropped land, barren land, settlement area, homestead vegetation, ponds, bushes and shrubs etc. Approximately 112 number of households including 484 people's needs to be remove from the proposed power plant site. The communities in the project area are primarily dependent on fishing in the Buriswar-Payra River and the Bay of Bengal, agricultural land cultivation for income and livelihood. More than 60% of the communities are directly and indirectly engaged and dependent on fishing in the project area.

Disruption and loss of livelihoods related to the fishing industry was a concern expressed by the local community during stakeholder engagement meetings. The community's perception is that the proposed project may adversely impacts on fish capture sites, fish migration in the river, availability of fish, restriction on fishing near the jetty and coal transportation route, restriction on boat movement and poisoning of fish through hazardous discharges into the sea by the power plant. Majority of the fishermen's employ traditional techniques, which have limited their capacity to fish in deep seas (Bay of Bengal). An expressed concern was that project activities would destroy current fishing activities adjacent to the project site (in Buriswar-Payra River) and impact on breeding and migration of Hilsa fish. Due to the fill-up and leveling of the existing canal, boat movement will also be impacted if alternative canals are excavated. The extent of the impact associated with disruption of livelihoods will extend to the local community and is considered to be local.

The potential acquisition of land currently utilized for agriculture poses a risk in the loss of livelihoods from crop production. Those who conduct farming activities within the proposed project site. The agricultural is a single cropped land so expected that impacts will be very minimum. The loss of land in the project area and therefore impacts on livelihood and income generation will be permanent in duration for those cultivating in the project area. The impacts on local community due to disruption and loss of livelihoods is assessed to be Medium-Low.

Impact	Impacts on local community due to disruption and Loss of Livelihoods		
Impact Nature	Direct	Indirect	Induced

Impact Scale	Project site, jetty area and coal transportation route					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider Medium Low					

8.5.18 Impact on Tourism

Barguna is a district under the Barisal division. It is in the southwestern part of Bangladesh. There are many tourist spots in the district. According to the Barguna district website, the following tourist spots are found in the project area. These are Sonakata sea beach, Laldia reserve forest, Taltoli Rakhain Palli and Temple, and Tengragiri wildlife sanctuary or Fatrar Char and eco-park etc. The nearest tourist spot (Sonakata sea beach and Taltoli Rakhain Palli and Temple) is located within 5 km radius of the project. Others tourist spots are located outside of the 5 km radius of the project boundary. The tourist spots are located in different direction from the project site and no connection with the proposed project area. During the operation phase of the proposed project, activities will be confined in the project boundary, so no impacts on the tourism is expected from the implementation as well as operation of the proposed project. The impacts on tourism by the proposed project operational activities is assessed to be very low.

Impact	Impacts on Tourism					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Project area					
Frequency	Operation phase					
Extent and location	Project Site	Local	Regional	National	Transboundary	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignificant	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High	Definite	
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High

Significance of impact consider **Very Low**

8.5.19 Impacts due to Transportation of Primary Fuels

The 100% imported coal from the abroad will be the primary fuels for the proposed 350 MW coal-fired power plant at Barguna, Bangladesh. Coal transportation study was not in scope of the study as a result a brief section has been incorporated based on the feasibility report. Therefore, a separate EIA study will be required for transportation and transshipment of coal, breakwater and dredging (if required) for coal transportation and handling for this project. According to the feasibility report, the required coal for the proposed project will be transported by freighter from Australia, Indonesia and South Africa, with the capacity of tens of thousands of tons to the specified berth in the Bay of Bengal. Then the coal will be unloaded to the barge up to 3,000 tons and finally delivered to the coal-handling jetty near the project site. Total annual coal requirement for the operation of the proposed project is approximately 1.1185 million tons.

Dust will be generated during the transshipment and unload in the sea area and the project coal unloading jetty area. Windblown dust will impacts on the surface water quality as well as the aquatic environment. Air quality will be impacted due to the emission from the combustion of fuels. Noise may generate from operation of these vessels. Similarly, coal unloading system and handling system may also generate noise. Generally, different types of wastes are produces from ships. The waste includes residue of the bulk (coal in this case), ballast water, bilge water, oil, lubricant, garbage, domestic waste, food and kitchen waste, slurry of seawater, sewage, etc. Surface water may be polluted due to oil spillage, coal spillage and other malpractice like waste discharge, discharge of ballast and bilge water, etc., which are prohibited by IMO conventions. The impacts due to transportation of primary fuels is assessed to be Medium-Low.

Impact	Impacts due to transportation of primary fuels					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Coal transportation route and handling jetty site					
Frequency	Operation Phase					
Extent and location	Project Site	Local	Regional	National	Transbounda ry	
Impact Duration	Short Term	Medium Term	Long-term	Permanent – Mitigated	Permanent – no mitigation	
Impact Intensity/ severity	Insignificant	Low	Medium	High	Very High	
Potential for irreplaceable loss of resources	Low		Medium		High	
Magnitude	Insignifica nt	Low	Medium-low	Medium-high	High	Very High
Probability of Impact	Unlikely	Low	Medium	High		Definite
Impact Significance	Very low	Low	Medium-Low	Medium-high	High	Very High
	Significance of impact consider <i>Medium Low</i>					

CHAPTER NINE: MITIGATION OF IMPACTS

9. Mitigation of Impacts

9.1 Introduction

Key environmental and social impacts of the proposed 350 MW coal-fired power plant project at the Taltoli Upazila, Barguna have been identified and assessed in Chapter-8 in this EIA report. These analyses identify the scope of adopting mitigation measures or reconciliation the project design with the objective of preventing environmental pollution in compliance with ECA, 1995 and subsequent amendment. The following Table 9-1 to Table 9-3 describes mitigation measure required for limiting the negative impacts of the proposed power plant project activities and contingency measures required for reducing risk of accidental hazard and enhancement measures for enhancing positive impacts with the aim of sustainable implementation and operation of the project ensuring environmental and community safety. This also identifies lead responsibility for implementing the mitigation measures and supervision for such implementation. The Barisal Electric Power Company Limited (BEPCL) will be responsible for ensuring that the mitigation measures in the Environmental Management Plan are implemented throughout the lifespan of the proposed project.

Table 9-1: Mitigation Measures of Impact during Pre-construction Phase

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Soil collection from sea by dredging	- Approximately 3.2 million m³ soil will be collected from the sea for site establishment; - Increase noise, turbidity and increase number of vessels movement, which may impact on aquatic ecosystem & disturbance the river traffic temporarily; - Accidental spillage of fuels, lubricants and improper management of the solid and liquid waste from the dredgers will impact on the aquatic ecosystem.	• The contractor must be select the dredging site in such a way that the dredging activities will not impact on protected area, wildlife sanctuary, fish sanctuary, marine protected area, fishing zone, fish breeding site, vessels traffic route, hilsa, dolphins and turtle movement route; • The contractor must be checked the quality of required dredge material/soil before starting the dredging activities in the sea; • Necessary permission must be taken from the concern authorities like Deputy Commissionaire Office, Payra Port Authority, DoE, Ministry of shipping before starting dredging activities, if required; • Avoid the monsoon season for dredging activities in the sea and dredging activities in the sea is preferred during dry season only; • Regular maintenance of water vessels, vehicles in accordance with manufacturer's specifications; • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures; • No disturbance of water vessels those who moves in the sea/river for accessing the nearest boat landing station must be ensured; • Dredged soil shall be covered and confined to avoid their wind drifted during transportation; • Switched off and park the dredgers in a designated area when not in use; • Instruct the workers to avoid disturbance of aquatic animals; • Instruct the workers to protect water resources and no disposal of waste in the sea/river from the dredgers; • Provide adequate space for movement and safe passage of fishes and other aquatic animals; • Schedule activities to avoid disturbance of fish and aquatic animal during critical periods of the day (e.g., night) or year (e.g., periods of breeding); • Turn off all unnecessary lighting at night to avoid attracting and disturbance of fishes; and • Regular monitoring the fish death and disturbance of fish and aquatic animals in	Implementation: EPC Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		the dredging site.	
Landform Changes	- Landform and land use of the project site will be changed; - Existing canal and low lying area needs to be fill up; - Settlement area including homestead trees/vegetation will be required to remove; - Natural/artificial drainage might be impacted.	• Avoidance of productive land and far from the nearest settlement area is preferable; • Avoidance of encroachment of waterbodies is preferable; • Trees/Vegetation clearance should be reduced as much as possible; • Greenbelt development as early as possible after completion of the construction activities immediately; • Complete the landfill and soil compaction as soon as possible before starting the construction activities for the power plant; • Landfilling and site development activities can be continued during dry season only to avoid drainage congestion/waterlogging in the project site and its surrounding area; • Adequate storm water drainage plan should be ensured by the project proponent during the pre-construction stage of the proposed project; • Parking of vehicles and stockpiling of materials/excavated earth should be done in systematic way to avoid the damaging of aesthetics of the site; and • Regular monitoring of the drainage condition and waterlogging situation in the project area.	Implementation: EPC Contractor Supervision: BEPCL
Land Resources	- About 174 acres of land will be required; - Land use pattern will be industrial category.	• Avoidance of productive land and far from the nearest settlement area is preferable; • Avoidance of encroachment of waterbodies is preferable; • Greenbelt development as early as possible after completion of the construction activities immediately; • The project proponent should ensure proper compensation.	Implementation: BEPCL Supervision: DC Office
Fish Resources	- Impacts on open water fisheries habitat like Buriswar-Payra River and adjoining sea may be affected due to dredging, traffic movements and oil and chemical spilling; - Dredging activities may also	• Restrict dredging only to the area where required; • Excavation and dredging methods should be selected to minimize suspension of sediments, minimize destruction of benthic habitat and increase the accuracy of the operation; • Dredging area should be checked every day prior to the commencement of dredging work. All dredging activities should be stopped at sight of aquatic mammals;	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	alter the habitat of the bottom feeder fish for short period.	• Avoid sensitive areas (dolphin, turtle and bird habitats, fish spawning areas, commercial fishing zone); • No dredging will be carried out within two kilometer from the sensitive areas; • Restricted dredging of the day during breeding periods of Hilsa and known migratory routes; • Minimize habitat loss by applying careful control of the cutter head, restrict digging to specified boundaries; • Dredging works should be carried in the lowest time frame possible; • No waste fuel will be disposed into the marine environment; • Schedule activities to avoid disturbance of fish and aquatic animal during critical periods of the day (e.g., night) or year (e.g., periods of breeding); and • Regular monitoring the fish death and disturbance of fish and aquatic animals in the project site and dredging site.	
Forest Resources	- Approximately 14,526 numbers of trees will be removed/cut; - Dust will be accumulated on leaf surfaces, which will impacts trees respiratory/ photosynthetic activities.	• Trees/Vegetation clearance should be reduced as much as possible; • Water spray to the dry earth/material stockpiles, access roads and bare soils as and when required to minimize the potential for environmental nuisance due to dust; • Regular water sprinkling will minimize the ecological disturbance due to wind-blown dust in the project site; • Create barrier around the landfilling site; • Stored materials such as: excavated earth, dredged soil, gravel and sand shall be covered and confined to avoid their wind drifted; • Limit the speed of the vehicles (it shall be 20 km/hour) and cover the vehicles during the movement or transportation of soil for landfilling on the existing road network; • The contractor in the landfilling site should carry dust monitoring out every day.	Implementation: Contractor Supervision: BEPCL
Ecosystem	- Potential loss of vegetation resulting from land clearing and leveling, which would destroy original vegetation; - Disturbance of terrestrial	• Trees/Vegetation clearance should be reduced as much as possible; • Workers shall be instructed to protect natural resources, flora and unauthorized tree/vegetation removal are prohibited; • Greenbelt development around the project site and surrounding area as early as possible;	Implementation: Contractor Supervision:

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	common birds. - Noise from movement of construction machinery will impact on terrestrial fauna; - Physical presence of the workers in the project site can disturb the faunal species; - Dredging activities will be impacted fish and aquatic life.	• Regular monitoring and keeping records of tree removal from the project site; • Tree felling, if unavoidable, shall be done only after compensatory plantation of at least five saplings for the every tree cut is done; • Workers shall be instructed to protect natural resources, fauna, including wild animals and aquatic life, hunting and unauthorized fishing are prohibited; • Avoid the unnecessary disturbance of the ecosystem; • No disturbance for aquatic animal and keep provision for the fish movement; • Create noise barrier and avoid unnecessary machineries and equipment's operation; • Turn off all unnecessary lighting to avoid attracting and disturbance of fishes and wildlife; and • Regular monitoring the fish death and disturbance of fish and aquatic animals in the dredging site.	BEPCL
Ambient Air	- Dust pollution from vehicles movement; - Gaseous emission from the operation of machineries, equipment's, vessels and vehicles will be impacted the ambient air quality.	• Water sprinkling will be regularly carried in order to arrest the fugitive dust on landfill sites; • Limit the speed of the vehicles (it shall be 20 km/hour) and cover the vehicles during the movement or transportation of soil for landfilling; • Ensure that vessels should be covered during transportation of soil; • Stored materials such as: excavated earth, dredged soil, gravel and sand shall be covered and confined to avoid their wind drifted; • Stop unnecessary vehicle and engine operation in the project site when it is not in working mode; • Vehicles, DG sets and machineries to be properly and timely maintained and serviced regularly to control the emission of air pollutants; • Equipment causing excess pollution (e.g. visible smoke) will be banned from project sites immediately prior to usage; • Use of good quality fuel and lubricants will be promoted. Moreover, low Sulphur content diesel shall be used as fuel for DG sets to control emission of SO₂; • Periodic checking of vehicles and construction machinery to ensure compliance to emissions standard following the National Motor Vehicles Standard (Schedule-6: Standards for emission from motor vehicles, ECR, 1997);	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		- Dust monitoring should be carried out every day by the contractor in the landfilling site; and - The Ambient Air quality monitoring should be carried out by the contractor following the National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR, 1997 and Amendment in 2005).	
Ambient Noise	- Noise level will increase due to dredging activities, soil transportation, landfilling, levelling, compaction of soil, traffic movements, operation of vehicles and machinery, removal of trees/vegetation. - Impact on terrestrial fauna, aquatic fauna, occupational and community health and safety.	- Inform the local community before starting the landfilling activities; - Trees/Vegetation clearance should be reduced as much as possible; - Provide appropriate Personal Protective Equipment (PPE) among the workers those who will work within or near the high noise generation source; - Avoiding unnecessary engine operations and horns (e.g. equipment's with intermitted use switched off when not working); - Activities that take place near sensitive receptors to be carefully planned (restricted to daytime, taking into account weather conditions etc.); - Maintain vehicles and construction equipment in good working condition including regular servicing; - Periodic checking of vehicles to ensure compliance to sound standard following the National Motor Vehicles Standard (Schedule-5: Standards for sound originating from motor vehicles or mechanized vessels, ECR, 1997); and - Regular monitoring of noise pollutants concentrations following the National Sound Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) rules 2006).	Implementation: Contractor Supervision: BEPCL
Waterbodies	- Impact on existing drainage system in the proposed project site and its surroundings; - Waterlogging problems; - Impact on aquatic environment due to accidental spillage of fuels and lubricant.	- Avoidance of encroachment of waterbodies is preferable; - Temporary drainage should be ensured by the contractor during landfilling and site development; - Regular monitoring of the drainage condition and waterlogging situation in the project area; - An alternate canal must be excavated by the project proponent before filling the existing canal; - During the excavation of new canal, it must be considered the depth and width of the canal to drain water from the surrounding area; - Site cleaning wastes should be dump primarily in a specific area in the project	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		site and immediately remove to the approved site; • Duration of stockpiling should be minimized as much as possible; • Accidental spill management plan should be introduced in the site; • Introduction of land/soil erosion and dust control practices in the project site; and • Monitor the surface water and groundwater by testing in designated laboratory should be done by the Contractor following the National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997).	
Workers Health, Sanitation and Safety	- Dust, fumes and noise that could lead to possible respiratory problems, hearing loss and other health-related problems; - Use of power tools and accessories, falling gadgets, cuts from sharp objects could cause potential injuries and harm to health of workers. - Improper management of the labor camp will also impacts on workers' health, sanitation and safety.	• Brief the workers before starting the activities in the project site; • Workers would be provided with appropriate and adequate personal protection equipment (PPE); • Ensure effective use of the personal protection equipment (PPE); • Provide health care and first aid facilities are readily available in the project site; • Establishment of safety sign in the accident-prone area/source in the project site and dredging site; • Restriction for unauthorized person in the project site; • Controlled vehicles speed on the proposed project site, it shall be 20 km/hour; • Provide adequate lighting in the landfilling area and along the roads in the project site; • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures; • Stop unnecessary engine operation when it is not in work; • Contractor should be ensured the availability of water for the workers camp; • Provision of clean drinking water in the construction camp in accordance with Schedule 3(b) of ECR, 1997; • Trained the workers by providing health and safety training on communicable diseases; • Educating project personnel, and area residents on risks, prevention, and available treatment for vector-borne diseases; • No child and/or forced labour will be employed by the EPC contractor, it is strictly prohibited as per the Bangladesh labour law; • The dredging work should be carried out in calm weather and sea condition and	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		avoid work during bad weather; • Provide proper navigational lighting and navigation aids for the vessels; • Working conditions and terms of employment will be fully compliant to the Bangladesh labour laws; and • The record of the accidents and incidents in the project site will be maintained using a register.	
Land Acquisition	- Community (approximately 112 households including 484 people) displacement due to land acquisition; - Loss of agricultural land and related loss of income and livelihoods, - Approximately 174 acres of land will be required for the project.	• A detailed Resettlement Action Plan (RAP) and Livelihood Action Plan (LAP) will be needed; • The land acquired would be appropriately compensated; • The land acquisition and compensation payment process would follow the national regulatory requirements and international practices; • Avoidance of productive land is as much as possible; • PAPs losing occupation may be involved in project's job opportunity based on their qualification, if possible; • The authority should be careful and take necessary measures that every displaced people can be resettled as per law of the land; • Encroachment of river, wetland, flood flow zone, forest etc. is strictly prohibited; • Keep river free from any encroachment and obstruction; • The displaced people may be resettled in suitable areas as per the PAPs preference and law of Bangladesh.	Implementation: BEPCL Supervision: DC
Employment Generation (positive impact)	- Approximately 380 workers including operator and laborers will be required during pre-construction phase.	• Employing local people for site cleaning and development activities as per the expertise to the maximum extent possible; • Equal employment opportunities for the local community and no discrimination based on race, religion, political influence etc.; • No child and/or forced labour will be employed by the EPC contractor, it is strictly prohibited as per the Bangladesh labour law; • Payment must be ensured by the contractor as per the present labour law in Bangladesh; • No entrance of unauthorized person in the project site without the permission from the concern officer; • Trained the workers by providing health and safety training on communicable	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		diseases; and Working conditions and terms of employment will be fully compliant to the Bangladesh labour laws.	
Boat Traffic	- Disturbance of boat communication due to fill-up of existing canal.	- Inform the local community before starting the landfilling and land development in the project site; - Avoid disturbance of boat communication and movement in the proposed project site as much as possible; - An alternate canal must be excavated by the project proponent before closing existing canal; - During the excavation of new canal, it must be considered the depth, width, number and types of vessels that will be access the canal in future and drainage of water from the surrounding area.	Implementation: Contractor Supervision: BEPCL

Table 9-2: Mitigation Measures of Impact during Construction Phase

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Impact on Fisheries	- Fisheries resources will be impacted by the increase of vessels movement, accidental spillage of oil and lubricants, blast water, oil mixed water, solid waste disposal; - Coal handling Jetty construction activities will be created noise, vibration and increase the turbidity in the river. - Restriction on fishing activity and reduction of fish production; - Improper management of waste and disposal from construction camp.	- Regular servicing and maintenance of vehicles and construction equipment's and only well-maintained equipment will be operated; - Workers shall be instructed to protect fisheries resources and unauthorized capture are prohibited; - No wastewater will be disposed into the aquatic environment; - Schedule activities to avoid disturbance of fish and aquatic animal during critical periods of the day (e.g., night) or year (e.g., periods of breeding); - Regular monitoring the fish death and disturbance of fish and aquatic animals in the project construction site river; - Create noise barrier and avoid unnecessary machineries and equipment's operation; - No restriction on fish capture in the river during the construction phase; - Avoid major activities in the river during fish breeding time; - Monitoring of ambient noise level as per the guidelines of the DoE (Schedules-4 of the ECR, 1997 and amendment in 2006);	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		• Ensure proper collection and disposal of solid wastes from construction camp; • All sewage and liquid effluent will be treated properly as per the guidelines of DoE (Schedules 9 and 10 of the ECR, 1997); • Careful handling of construction waste in the construction site; • A brief instruction of all workers about the noise control measures and disturbance on ecosystems in the construction site; and • Construction workers shall be instructed to protect natural resources, flora and fauna, including wild animals and aquatic life, hunting and unauthorized fishing are prohibited.	
Impact on Forest	- Approximately 100 to 200 numbers of planted mangrove trees needs to be removed at jetty construction site; - Dust will be dispersed by wind and accumulate on leaf surfaces which will impacts trees respiratory/ photosynthetic activities.	• Regular water sprinkling will minimize the ecological disturbance due to wind-blown dust; • Vegetation plantation after completion of the construction work; • Concrete mixing plant, crushing of bricks and stones plant should be located as far away from the sensitive receptors; • Trees/Vegetation clearance should be reduced as much as possible; • Workers shall be instructed to protect natural resources, flora and unauthorized tree/vegetation removal are prohibited; • Greenbelt development around the project site and surrounding area as early as possible; • Regular monitoring and keeping records of tree removal from the project site; and • Tree felling, if unavoidable, shall be done only after compensatory plantation of at least five saplings for the every tree cut is done.	Implementation: Contractor Supervision: BEPCL
Ecosystem (Flora and Fauna)	- Movement of construction machinery and vehicles will generate noise may disturb the terrestrial fauna; - Windblown dust will impact on gaseous exchange of the plants; - 100 to 200 nos. trees needs to be cut down during the Jetty	• Regular water sprinkling will minimize the ecological disturbance due to wind-blown dust; • Introduction of soil erosion protection and dust control practices in the construction site; • Create noise barrier and avoid unnecessary machineries and equipment's operation; • Regular servicing and maintenance of vehicles and construction equipment's and only well-maintained equipment will be operated;	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	Construction in the river; - Improper management of construction waste and waste from the labor camp can impacts on the terrestrial and aquatic ecosystem in the project area.	- Concrete mixing plant, crashing of bricks and stones plant should be located as far away from the sensitive receptors; - Trees/Vegetation clearance should be reduced as much as possible; - Greenbelt development around the project site and surrounding area as early as possible; - Regular monitoring and keeping records of tree removal from the project site; - Tree felling, if unavoidable, shall be done only after compensatory plantation of at least five saplings for the every tree cut is done; - Instruct the drivers to avoid unnecessary horn and limit the speed of vehicles in the construction site and approach road; - Ensure proper collection and disposal of solid wastes from the construction camps; - All sewage and liquid effluent will be treated properly as per the guidelines of DoE (Schedules 9 and 10 of the ECR, 1997); - Careful handling of construction waste in the construction site; - A brief instruction of all workers about the noise control measures and disturbance on ecosystems in the construction site; - Construction workers shall be instructed to protect natural resources, flora and fauna, including wild animals and aquatic life, hunting and unauthorized fishing are prohibited; and - Regular monitoring of death and disturbance of animals in the construction site.	
Ambient Air	- Fugitive dust generation from the earthworks, operation of construction machinery, movement of vehicles, civil construction, handling and stocking of construction material; - Exhaust emissions from combustion of the petroleum products in project related vehicles, machinery, generators	- Sprinkling of water on open surface of dust generation site, approach roads and construction site to reduce fugitive dust particles; - All routes within the project construction site facility will be paved providing hardened surface as early as possible upon the commencement of construction work; - Provision of tarpaulins for trucks delivering sand and gravels to the construction site; - Keeping the construction material in moist condition (if possible) at the construction site; - All vehicles, generators and other equipment's used during the construction will	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	and vessels etc.	be appropriately tuned and maintained in good working condition in order to minimize exhaust emissions; • The exhaust emissions of vehicles and heavy machinery and equipment would be monitored and controlled; • Construction traffic will maintain a maximum speed limit of 20 km/hour on all unpaved roads within the proposed site; • Exhaust vent of DG set will be kept at proper height to ensure quick dispersion of gaseous emissions; • Equipment causing excess pollution (e.g. visible smoke) will be banned from project sites immediately prior to usage; • Periodic checking of vehicles and construction machinery to ensure compliance to emissions standard following the National Motor Vehicles Standard (Schedule-6: Standards for emission from motor vehicles, ECR, 1997); • Dust monitoring should be carried out every day by the contractor in the construction site; and • The Ambient Air quality monitoring should be carried out by the contractor following the National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR, 1997 and Amendment in 2005).	
Ambient Noise	- Noise level will increase due to the construction activities and movement of vehicles and equipment's; - Impact on workers, settlement and terrestrial fauna.	• Strict measures for noise pollution control need to be undertaken during construction activities; • Create noise barrier and consider the minimum noise levels at sensitive receptor sites (e.g. residential area, mosque, schools etc.); • Stone breaking machine should be confined within a temporary shed so that noise pollution could be kept minimum; • Careful handling of construction materials unloading from the vehicles; • Working periods would be controlled and would be between 7:00 am to 6:00 pm; • Protection devices (ear plugs or ear muffs) shall be provided to the workers operating in the vicinity of high noise generating machines during construction; • Construction equipment and vehicles shall be fitted with silencers and maintained properly; • Provide appropriate PPE among the workers those who will work within or near	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		the high noise generation source; • Instruction to the drivers to avoid unnecessary engine operation and horn in the project site approach road; • Periodic checking of vehicles to ensure compliance to sound standard following the National Motor Vehicles Standard (Schedule-5: Standards for sound originating from motor vehicles or mechanized vessels, ECR, 1997); and • The Noise level monitoring should be carried out by the contractor following the National Noise Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) rules 2006).	
Impact on Waterbodies	- Water extraction from the river (about 1,600 m³/day during construction peak, maximum 900 m³/day during civil construction and domestic purposes approximately 600 m³/day); - Improper management of waste from construction camp and construction site can deteriorate the surface water quality; - Oil spillage from the workshop, rainwater runoff, water vessel may contaminate surface water; - Increase the TSS in the surface water.	• During construction necessary precautions will be taken, so that the runoff water from the site gets collected in sedimentation tank for treatment; • The treated water will be reused for construction purposes and for sprinkling on roads to control the dust emissions; • The domestic wastewater generated from temporary toilets used by the workforce will be diverted to septic tank followed by soak pit; • Labor camp should be constructed at a distance from the water bodies and 500 m away from the settlement area; • Before establishment of the construction camp in the project area, cyclone and tidal surges disasters needs to be consider; • No solid and liquid waste discharge is allowable into the water bodies from the construction camp; • Instruct workers to maintain clean environment in the construction camp; • The solid waste generation due to workers dwelling on the site will be segregated and will be transported and disposed of to waste disposal facility; • Adequate sanitation facilities shall be provided by the contractor in the construction camp; • Provide sufficient number of latrine and bin and aware the workers to use the bins and keep clean the latrine for better health management; • Wastewater will be generated from the construction camp must be treated using the soak pit; • Careful handling of oil and hazardous chemicals in the construction camp; and	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		Monitor the surface water and groundwater by testing in designated laboratory should be done by the Contractor following the National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997).	
Soil Resources	- Loose of topsoil due to excavation, leads to reduction of fertility; - Construction wastes, such as metal cutting, debris, packaging materials, which may contaminate soil; - Soil pollution from liquid and solid wastes from the construction labor camp facilities; - Accidental spillage or inappropriate management of fuels, engine oil and hazardous chemicals.	- Establishment of the waste management plan and hazardous material handling plan at the project construction site; - Construction wastes including metal, packaging materials should be dump primarily in a specific area in the project site and immediately remove to the approved site and finally disposed by approved vendors; - No direct disposal of waste into open environment from the construction camp, it is strictly prohibited; - Avoid the productive land, agricultural land, archaeological sites, protected area, forest area, natural habitat etc. for the construction of construction camp; - Provide sufficient number of latrine and bin and aware the workers to use the bins and keep clean the latrine for better health management; - The solid waste generation due to workers dwelling on the site will be segregated and will be transported and disposed of to waste disposal facility; - All the chemicals used during construction phase will be stored safely and shall have proper bund wall for the maximum volume of chemicals stored; - Solid waste collection bins at the site; and - The soil quality test in designated laboratory should be carried out by the contractor.	Implementation: Contractor Supervision: BEPCL
Accidents and Injuries from general construction activities	- Injuries and illnesses, accidents in the construction site.	- Adequate health care and sanitation facilities for construction workers will be provided by the contractor at the construction campsite; - Adequate first aid facilities in the construction site; - The contractor must be ensured the good quality drinking water facility in the construction site as per the DoE standard; - Proper H&S measures for the workers such as using of appropriate PPE (helmet, earplug, musk, safety shoes, hand gloves etc.) should be taken to avoid any accidents; - Safety sign in the accident/hazard-prone area/source; - Constructional and occupational safety measures to be adopted during	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		construction phase of the project; - The health of workers will be checked for general illness; first time upon employment and thereafter at periodic intervals, as per the local laws and regulations; - The workers will be diagnosed for respiratory functions at periodic intervals and during specific complaints etc. Health center and ambulance facility will be provided to the worker; - No entrance of unauthorized people in the construction site without the permission from the concern officer; - Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis; - Regular mosquito repellent spraying during monsoon periods; and - The contractor will take documentation of the accidents and illness in the construction site.	
Health Impact associated with environmental conditions	- Potential health impact due to changes in the environmental quality of air, surface water, groundwater and soil quality; - Increased dust and noise during the construction period has the potential to lead to health impacts associated with eye irritation and general disturbance to daily activities.	- Water spraying in dust generation sites for reducing dust pollutions; - Provide appropriate PPE among the workers those who will work within dust emission sites; - Instruct the workers about the health and safety issues in the construction site before starting the construction activities and ensure secure working environment; - Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis; - Adequate facilities for the health of construction workers will be provided at the construction camp; - Safety sign in the accident/hazard-prone area/source; - Establishment of the waste management plan and hazardous material handling plan at the project construction site; - Handling of hazardous liquid should be done carefully by the designated experienced person; and	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Solid Waste Disposal	- Solid waste generation from packaging materials like cartons, wooden cases and pallets and domestic activities including food wrappers and leftovers; - Waste from domestic activities in labour camp.	• Proper monitoring should be done by the contractor.	
		• Establishment of the waste management plan at the project construction site; • Construction wastes that will be generated during construction stage should be dump primarily in a specific area in the project site and immediately remove to the approved site; • Ensure proper collection and disposal of solid wastes within the construction camps and construction site; • Solid waste burning in the construction site is strictly prohibited; • Insist waste separation by source; organic wastes in one container and inorganic wastes in another container at sources; • The organic wastes should be always covered with a thin layer of sand so that flies, mosquitoes, dogs, cats, rats, etc. are not attracted; • Dispose organic wastes in a designated safe place on daily basis; • Indiscriminate dumping of waste would be avoided to ensure proper management and disposal of the waste generated using the waste management system; • Maximum effort would be made to reuse and recycle the generated solid waste; • Most of the solid waste material can be used for filling/leveling of low-lying areas; • Attempts will be made to keep the waste segregated into different heaps as far as possible so that further gradation and reuse is facilitated; • Materials, which would be reused for purpose of construction, levelling, making roads/pavement will also be kept in separate heaps from those which are to be sold or landfilled; and • Regular monitoring will be carried out by the contractor to record of generation and disposal of waste in daily basis.	Implementation: Contractor Supervision: BEPCL
Impacts due to wastewater generation and disposal	- Improper management and disposal of wastewater into the open environment will impacts on soil quality, sediment quality, surface water quality,	• Domestic sewage would be appropriately managed and disposed; • Establishment of the waste management plan and hazardous material handling plan at the project construction site; • Disposal of wastewater in open environment is strictly prohibited; • Instruct the workers to avoid improper disposal;	Implementation: Contractor Supervision:

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	groundwater quality and aquatic environment.	• Sufficient numbers of bin will be ensured by the contractor; • Insist waste separation by source; organic wastes in one container and inorganic wastes in another container at sources; • The organic wastes should be always covered with a thin layer of sand so that flies, mosquitoes, dogs, cats, rats, etc. are not attracted; • Containers and other waste can be recycled or disposed through licensed vendor; and • Regular monitoring will be carried out by the contractor to record of generation and disposal of waste in daily basis; • Soil and sediment quality will be monitored by the contractor.	BEPCL
Employment Generation (positive impact)	- Total 2,200 numbers of people will be required during peak time of the construction phase.	• PAP's should be given the priority in construction activities; • Local people can be engaged based on their qualification and expertise for construction work; • Child labour is strictly prohibited as per the present law in Bangladesh; • Equal employment opportunities for the local community and no discrimination based on race, religion, political influence etc.; • Payment must be ensured by the contractor as per the present labour law in Bangladesh; • No entrance of unauthorized people in the construction site without the permission from the concern officer; • Trained the workers by providing health and safety training on communicable diseases; • Educating project personnel, and area residents on risks, prevention, and available treatment for vector-borne diseases; and • Working conditions and terms of employment will be fully compliant to the Bangladesh labour laws.	Implementation: Contractor Supervision: BEPCL
Impacts on Local Resources and Infrastructures	- Unwarranted pressure on key local resources and infrastructures such as water, healthcare, electricity, mosque and road etc.	• All the facilities for the workers during construction period must be ensured by the contractor; • Must ensure the good quality living condition in the construction camp for the workers; • Local community workers can be engaged for the construction period;	Implementation: Contractor Supervision:

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		- Contractor should be ensured the availability of water for the construction activities; - Provision of clean drinking water in the construction camp in accordance with Schedule 3(b) of ECR, 1997; - Adequate first aid facilities in the construction site; - Trained the workers by providing health and safety training on communicable diseases; - Educating project personnel, and area residents on risks, prevention, and available treatment for vector-borne diseases; - Working conditions and terms of employment will be fully compliant to the Bangladesh labor laws.	BEPCL
Community Health and Safety	- Increased Air and noise pollution will impact on community health; - Waterlogging in mud pockets leading to breeding of mosquito and related health impacts; - Risk of road accidents; - Risk of violence, alcoholism, and sexually transmissible diseases (HIV/AIDS, syphilis among others), injuries and loss of life or properties.	- Inform the local community before starting the construction activities; - Water spraying in dust generation sites for reducing dust pollutions; - Maintain vehicles and construction equipment in good working condition including regular servicing; - Instruct the workers about the health and safety issues in the construction site before starting the construction activities and ensure secure working environment; - Adequate facilities for the health of construction workers will be provided at the construction camp; - Proper traffic monitoring should be done by the contractor and keep the record of accidents; - Limit the speed of construction vehicles in the construction site and project approach road, it shall be 20 km/hour; - Instruct the driver's to drive carefully in the project site and approach road; - Use of mobile phone during driving is strictly prohibited in the construction site; - Proper indication of accident-prone area, education and religious institutes in the project site. - Proper Traffic Management Plan (TMP) should be prepared by the contractor during starting of construction & follow it strictly; - In this TMP, the road safety measures such as speed breakers, warning	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		signs/lights, road safety signs, flagman etc. should be included to ensure uninterrupted traffic.	
Impacts on Income and Livelihoods	- Employment and income opportunity for the local community; - Indirect income opportunity will be created; - Reduction of income by losing income opportunity especially the fisherman.	• Job preference should be given for the project affected persons; • Local people can be engaged based on their qualification and expertise for construction work; • Equal employment opportunities for the local community and no discrimination based on race, religion, political influence etc.; • Payment must be ensured by the contractor as per the present labor law in Bangladesh; • No entrance of unauthorized people in the construction site without the permission from the concern officer; • Child labor is strictly prohibited as per the present law in Bangladesh; • Inform the local community before starting the construction activities; • No restriction on fisherman's or fishing activities in the Buriswar-Payra River and near the proposed project site.	Implementation: Contractor Supervision: BEPCL
Aesthetic and visual impact	- Impacts on surrounding landscape; - Change the visual landscape of the project site; - Reduce the scenic beauty.	• Construction debris will be removed continuously from the site • Construction debris will be stored at a designated area to ensure they do not find their way to water bodies. • On completion of works all temporary structures, surplus materials and wastes will be completely removed Optimization of land requirement through proper site layout design will be basic criteria at the design phase; • Trees/Vegetation clearance should be reduced as much as possible; • Greenbelt development around the project site and surrounding area as early as possible; • Regular monitoring and keeping records of tree removal from the project site.	Implementation: Contractor Supervision: BEPCL
Impacts due to Transportation of Raw Materials	- Construction materials and equipment's will be transported by waterway as a result river traffic will be increased; - Heavy-duty vehicles and trucks carrying construction and	• Proper Traffic Management Plan (TMP) should be prepared by the contractor during starting of construction & follow it strictly; • In this TMP, the road safety measures such as speed breakers, warning signs/lights, road safety signs, flagman etc. should be included to ensure uninterrupted traffic; • Movement especially at nearby the educational institute (schools, College,	Implementation: Contractor Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	building materials, personnel and equipment's to and from the project site during construction may affect traffic flow and could even cause accidents on existing access roads; - Dust and exhaust emission from the traffic movement; - Increase noise level and disturb the terrestrial fauna.	madrasha etc.), community infrastructure (mosques, graveyards, playground etc.), bazar and health complex should be careful and control the speed and avoid unnecessary horns; • In addition, BRTA traffic rules and regulations should be strictly followed; • Avoid disturbance and careful during construction vehicle and equipment movement in the project site and approach road; • Use of low Sulphur content fuel for vehicles operation; • Divert traffic to follow alternative routes to avoid traffic jams; • Limit the speed of construction vehicles in the construction site and project approach road, it shall be 20 km/hour; • Use of mobile phone during driving is strictly prohibited in the construction site and approach road; • Maintain vehicles and construction equipment in good working condition including regular servicing; • Instruct the driver's to drive carefully in the project site; • Instruct the drivers to avoid unnecessary horns and engine operation in the construction site and approach road; • Adequate lighting facilities in the construction site; and • Proper indication of accident-prone area, education and religious institutes in the project site.	

Table 9-3: Mitigation Measures of Impact during Operation Phase

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Impact on Fisheries	- Direct impact on fish diversity and may lead to bring permanent change to fish diversity and composition; - Establishment of intake and discharge structure in the river and cooling water discharge;	• Ensure the temperature of the cooling water in an acceptable limit before discharge into the Buriswar-Payra River; • Regular monitoring and ensure no fish death, disturb in the Buriswar-Payra River near the intake and discharge point; • Thermal discharge from the power plant needs to be controlled to ensure that the discharge water temperature does not result in thermal pollution; • The temperature of the condenser cooling water will be strictly maintained up to	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	- Accidental spillage and waste disposal from coal transportation vessels; - Impact on fish production/capture from the Buriswar-Payra River.	3°C at the boundary of mixing zone; • The project proponent must ensure regular monitoring of surface water temperature near the discharge point; • RO concentrated water and circulating cooling effluent water can be mixed before discharge; • Ensure no dumping of ballast water, bilge water, non-spillage of oil, non-discharge of wastewater and non-dumping of solid wastes; • Awareness growing for fisherman and facilitate the fisherman to use nets/boats provided with signals and marking in the river; • Reduce vessels speed if net is seen across the navigational route; • Fish migration and breeding season should be considered in planning; • On-site wastewater should be treated in WTP, OWTP and STP to achieve maximum reuse and recycling in the plant; • The project proponent must conduct a detailed study on fish resources in the Buriswar-Payra River. At least one-year monitoring should be conducted during construction and another one-year during operation phase of the project. Based on the suggestions from the study the monitoring duration will be changed or stopped; • The water supply pipeline intake point from the river should be provided with sufficient screening to filter out larger aquatic organisms (e.g., fish, frogs and toads) preventing this material from being drawn into the pumps; • Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible; • The intakes for the water pumps in the main pump-house will meet the IFC guidelines, including recommended intake velocity of 0.15 m/s and a mesh size of 9.5 mm; • Temporary water reservoir can be built for water storage rather than direct abstraction from Buriswar-Payra River, especially during Hilsa breeding time; • Fish Conservation Program in the project area and no restriction on fishing in project adjoining area and jetty location; and • Enforcement of fishing ban in the Buriswar-Payra River during breeding/nursing	

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		period.	
Impact on Ecosystem	- The emission of chemicals and gases by stack; - Heavy metal pollution from coal and coal waste products, including fly ash, bottom ash, and boiler slag - Dust pollution and exhaust emission from vehicles operation; - Disposal of wastewater and hot cooling water will impact on river ecosystem; - Accidental spillage of coal will impacts on soil, sediment and water quality; - Lighting and noise in the coal-handling jetty will create disturbance for the fish community; - Improper management of solid waste and disposal of untreated wastewater and liquid waste will impacts on local ecosystem.	• Stack monitoring data collected during commissioning and the subsequent operation period will be reported to the DoE, Barisal and also Head office at Dhaka on an annual basis as part of the statutory environmental audit and will be subject to inspection by external environmental auditors to verify the performance and compliance status; • The height of the chimney should be 220 m as per the DoE guideline; • Installation of continuous stack emission (SO₂, NO_x, CO and particulate matters) monitoring; • The BEPCL shall install Flue Gas Desulphurization (FGD) system to remove sulfur dioxide from the flue gas before the flue gas is emitted to the environment; • The BEPCL shall use low NO_x burners to reduce the nitrous oxide emissions before the flue gas is discharged to the atmosphere; • The BEPCL shall design and install an ESP for the power plant; • Regular maintenance of plant at the proposed facility will also be carried out in order to optimize and minimize emissions; • Use of good quality coal in the power plant operation; • The efficient ash management system should be adopted for the proposed power plant shall control release of ash as well as heavy metal into environment; • Dust suppression system should be introduced in the power plant premises; • Limit the vehicle speed (20 km/hour) near the project site approach road; • Greenbelt developed in the power plant premises and surrounding area; • In order to facilitate comprehensive utilization in the future, ash and slag will be stacked separately; • When stacking, the ash will be spread, rolled and compacted from bottom to top layer by layer, with stacking elevation at least 1.0 m lower than ash dam, meeting limits of safety rules requirements in ash storage area. The ash will be rolled with principle of normal operating of machines. The operation slope may be 1:20~1:30. When ash yard will be expected to reach full capacity, the ash surface will be afforested or converted into cultivated land;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		• Proper solid waste collection, treatment and disposal following the DoE guidelines; • Liquid and hazardous waste collection treatment and disposal; • Avoid unnecessary engine operation and noise nuisance; • Thermal discharge from the power plant needs to be controlled to ensure that the discharge water temperature does not result in thermal pollution; • The temperature of the condenser cooling water will be strictly maintained up to 3°C at the boundary of mixing zone; • The BEPCL should consider installation of cooling water intake technologies such as seasonal barrier nets screens to reduce impingement and entrainment of fish. The reduced intake flow rate also reduces the potential for entrainment of aquatic species; • During the initial testing at the plant and cooling water systems commissioning, it should be ensured the initial effluent and cooling water discharges fully comply with the DoE, ADB and/or IFC standards on thermal discharge; • No waste disposal in open environment; • Restrict trapping, killing or birds, fish, dolphin (if found); • Avoid unnecessary lighting and noise in the coal handling jetty area; and • The EHS department of BEPCL should ensure regular monitoring of health of ecosystems.	
Air Quality	- Air pollution from combustion of coal in the boiler and fuel oil as start-up or emergency purposes; - SO_x, NO_x and particulate matter released from boilers, generators; - Fugitive emissions from materials handling and transfer, heavy-duty vehicles, stockpile loading and unloading, wind erosion, paved roads and	• The BEPCL will ensure compliance with the requirements of air quality in accordance with the environmental standard of the DoE, Bangladesh and World Bank IFC EHS Guideline; • The height of the chimney will be 220 m for the proposed project; • The BEPCL shall install a continuous emission monitoring system (CEMS) mounted within the stack. The CEMS will be capable of continuously monitoring the SO₂, NO_x, CO and particulate matters, emissions to ensure compliant conditions are maintained through appropriate process controls; • Stack monitoring data collected during commissioning and the subsequent operation period will be reported to the DoE, Barisal and also Head office at Dhaka on an annual basis as part of the statutory environmental audit and will	Implementation: BEPCL Supervision: DoE

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	unpaved roads.	be subject to inspection by external environmental auditors to verify the performance and compliance status; • The BEPCL shall install Flue Gas Desulphurization (FGD) system (efficiency no lower than 93%) to remove sulfur dioxide from the flue gas before the flue gas is emitted to the environment; • The BEPCL shall use low NOx burners to reduce the nitrous oxide emissions before the flue gas is discharged to the atmosphere; • The BEPCL shall design and install an electrostatic precipitator (ESP) (efficiency of no lower than 99.72%) for the power plant. The ESP shall be installed upstream of the FGD/chimney and downstream of the air heaters in order to meet the environmental emission limits regulated by DoE, Bangladesh and IFC EHS Guidelines for Thermal Power Plants; • Fugitive emissions from the coal power plant site during operation will be controlled by visual inspection and maintenance program; • The power plant equipment must be performance tested during commissioning phase to ensure that standard has been maintained; • Regular inspection and maintenance of boiler, pressure part, FD fans, ID fans and ash separation and handling system and other ancillaries; • Coal stockyard should be covered so that wind cannot disperse storage coal; • Coal conveyor belt should be covered to avoid wind; • Dust suppression and extraction system will be provided at each critical location to minimize the impact of coal dust that is known to cause irritation to the eyes and mucous membrane; • Greenbelt development in and around the project site; • Limit the vehicle speed (20 km/hour) near the project site approach road; • Regular maintenance of plant at the proposed facility will also be carried out in order to optimize and minimize emissions; • Ambient Air quality monitoring should be carried out by the BEPCL following the National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR, 1997 and Amendment in 2005).	
Impacts due to	- About 1.85 million tones/year	• Ensure good quality coal during import from the source country;	Implementation:

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Greenhouse Gas Emission	GHG emission due to coal combustion during boiler operation in the proposed project.	• Installation of continuous stack emission (SO₂, NO_x, CO and particulate matters) monitoring; • Stack monitoring data collected during commissioning and the subsequent operation period will be reported to the DoE, Barisal and also Head office at Dhaka on an annual basis as part of the statutory environmental audit and will be subject to inspection by external environmental auditors to verify the performance and compliance status; • The height of the chimney should be 220 m as per the DoE guideline; • The BEPCL shall install Flue Gas Desulphurization (FGD) system to remove sulfur dioxide from the flue gas before the flue gas is emitted to the environment; • The BEPCL shall use low NO_x burners to reduce the nitrous oxide emissions before the flue gas is discharged to the atmosphere; • The BEPCL shall design and install an electrostatic precipitator (ESP) for the power plant; • Greenbelt development in and around the project site; • The power plant equipment must be performance tested during commissioning phase to ensure that standard has been maintained; • Regular inspection and maintenance of boiler, pressure part, FD fans, ID fans and ash separation and handling system and other ancillaries; • Regular maintenance of plant at the proposed facility will also be carried out in order to optimize and minimize emissions; and • Ambient Air quality monitoring should be carried out by the BEPCL following the National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR, 1997 and Amendment in 2005).	BEPCL Supervision: DoE
Impacts on Ambient Noise	- Noise generation from different process unit in the power plant, operation of vehicles and physical presence of workers; - Impacts on occupational health, community health, birds and others terrestrial fauna.	• The BEPCL will ensure that continuous noise characteristics of all equipment in the power plant do not exceed 85 dB(A); • The BEPCL shall always comply with the National Sound Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) rules 2006) or updated standards of the DoE, Bangladesh; • The BEPCL should ensure that all equipment and its mufflers is regularly serviced and immediately serviced/replaced if damaged;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		- Acoustic covers on all machine engines that generate excessive noise levels are to remain closed at all times; - Vehicles and generator sets to be serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them; - Silencer should be installed at boiler exhaust vent and fan inlet; - Construct high and thick boundary wall that could act as noise damper; - Central control building will be sealed by 250mm thick aerated concrete blocks. The central control room will be arranged in the middle of the central control building, surrounded by corridors or auxiliary rooms, which will be isolated from the external sound sources. - Buildings will be designed with improved acoustic performance and sound insulation will be provided; - Installation of acoustic barriers without gaps and with a continuous minimum surface density in order to minimize transmission of sound through the barriers; - Acoustic enclosures, concrete high wall and green belt development near the sensitive receptors (School, Mosque, Settlement etc.); - Avoiding continuous (more than 8 hours) exposure of workers to high noise areas in the plant operation site; - Exposure control through rotation of work assignments in intense noise areas; - Provision of appropriate Personal Protective Equipment (PPE) (ear muffs, ear plugs, noise helmets etc.) at the high noise generation areas; - Education and awareness creation among the workers ; - Avoid unnecessary use of alarms, horns and sirens; - Green belt will be developed as early as possible after completion of the construction activities and maintained; - The BEPCL should conduct regular inspection and spot checks of all noise generating equipment; and - Regular monitoring of noise pollutants concentrations following the National Sound Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) rules 2006).	
Impacts on Surface	- Increase the surface water	The EPC contractor will provide a performance guarantee of the ETP & STP	Implementation

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Water Quality	temperature from cooling water discharge; - High salinity water discharge from desalinization plant; - Pollution from ETP, STP and accidental spillage of oil and hydrocarbons.	equipment which should include compliance with physicochemical parameters, pollutants, microbiological and mixing zone standards; - All the waste that would be produced during the power plant operation units and workers facilities must be treated in the ETP and STP plant; - The BEPCL should ensure that all process systems are controlled to ensure that the effluent quality standards in DoE, Bangladesh; - The BEPCL should not over-chlorinate the cooling water; - Provision of storm water drainage system with adequate capacity, proper maintenance of stormwater drainage; - Vehicles and other equipment should not be serviced outside of the designated areas; - Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution; - After treating the oil mixed water in the Oily Waste Treatment Station it will be send to the ETP for further treatment and reuse for landscaping of the whole power plant, dry ash humidification and coal yard sprinkling etc.; - The oily sludge shall be reused or disposed offsite through authorized agency; - The processed water should be reused for greenbelt and dust suppression in the power plant; - Regular monitoring and maintenance of equipment's and vehicles to avoid oil and hazardous chemical spillage; - Water quality monitoring should be provided on all lines feeding the circulating water discharge. If process standards are accidentally exceeded, there should be an option of diverting the stream into a holding pond; - The BEPCL should undertake continuous flow and quality monitoring on the main outfall with alarms if standards are exceeded; - The BEPCL should conduct inspection and water quality monitoring at specified locations and at appropriate time intervals according to the environmental monitoring plan and report water quality data after each survey; and - Wastewater monitoring should be carried out by the BEPCL, following the national standard (Schedule-10: Standard for waste from Industrial units or	& Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		Projects waste).	
Impacts due to discharge of Once-through Cooling Water	- Change to the temperature regime of the water column; - Reduction in the dissolved oxygen saturation; - Increased productivity of microbial communities in particular; - Changes in the distribution and composition of communities of organisms comprising sites; - Changes in shorebird distributions usually in response to increased macroinvertebrate or fish food supplies close to thermal discharges.	• A cost-benefit analysis should be undertaken to determine the optimal design of the submerged diffuser design. Consideration should be given to utilize the shortest length of the diffuser and cooling water discharge in order to minimize construction-related impacts on the aquatic ecology; • Cooling water will be discharged back to the source water (Buriswar-Payra River) with almost no losses but at a higher temperature than the ambient water temperature; • The heated effluents can be discharged into the River at one end and water for cooling purposes may be withdrawn from the other end; • Thermal discharge from the power plant needs to be controlled to ensure that the discharge water temperature does not result in thermal pollution; • After circulating water and heat exchange, it can be return to the river; • RO concentrated water and circulating cooling effluent water can be mixed before discharge; • The temperature of the condenser cooling water will be strictly maintained up to 3°C at the boundary of mixing zone; • The BEPCL should consider installation of cooling water intake technologies such as seasonal barrier nets screens to reduce impingement and entrainment of fish. The reduced intake flow rate also reduces the potential for entrainment of aquatic species; • During the initial testing at the plant and cooling water systems commissioning, it should be ensured the initial effluent and cooling water discharges fully comply with the DoE, ADB and/or IFC standards on thermal discharge; • Over-chlorination of the condensed water will be prevented and should be achieved through process monitoring; • The BEPCL should periodically monitor flow and quality on the main outfall using alarms if standards are exceeded; • The project proponent must ensure regular monitoring of surface water temperature near the discharge point; • Monitoring of the phytoplankton, zooplankton and benthos near the intake and	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		discharge point should be tested by the project proponent; and A detailed fish survey for baseline data on fish population (abundance and richness) and behavior in the Buriswar-Payra River must be conducted by the BEPCL during construction and operation phase.	
Impacts due to Solid Waste Generation and Disposal	- Approximately 706.244 tons/day ash generation and disposal; - Fugitive fly ash may cause pollution to the surrounding; - Risk of heavy metal pollution; - Others solid waste generation from the canteen, office, workers facilities etc.	- The BEPCL will develop and implement a waste management plan for the operational phase of the power plant project; - Employees should be trained in the proper handling and disposal of the fly ash, bottom ash and wet FGD gypsum to minimize their risk of exposure in accordance with the BEPCL's occupational health and safety procedures; - Provision of different waste bin with color for different waste (recyclable, reusable, biodegradable, hazardous etc.) in roadside, parking places, office and other official and public places in the plant site; - Employees should be provided with appropriate PPE for handling the ash; - Proper handling and disposal by employees would minimize exposure or health-related issues to the public; - A drainage system should be provided in the ash field to discharge excess rainwater; - A groundwater monitoring system made up of wells should be installed and operated around the ash yard; - Based on the specific situation(s) at the time, the BEPCL should take suitable measures to prevent erosion of the ash pile during the monsoon season or a failure of part of the ash pile; - Employees should be trained in the proper handling and disposal of the fly ash and bottom ash to minimize their risk of exposure in accordance with the BEPCL's operational health and safety procedures. - Proper handling and disposal by employees would minimize exposure or health-related issues to the public; and - Regular monitoring of the ash yard will be ensured by the BEPCL.	Implementation & Supervision: BEPCL
Impacts due to Wastewater Generation and	Wastewater generation from domestic sources and industrial process (sewage, oil-	- The BEPCL should ensure that all hazardous materials and wastes on site are properly stored in closed systems in confined areas; - The BEPCL will establish STP and ETP in the plant premises and ensure proper	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Disposal	contaminated and/or chemical-containing wastewater and stormwater run-off) storage, treatment and disposal; - Approximately 34.4m ³ per day sewage effluent will generate.	collection, storage and treatment of all types of wastes; • Adequate fund allocation and manpower for waste management; • Disposal of waste in open environment is strictly prohibited; • Domestic and sanitary wastewater should be collected and treated properly in sewage treatment plant; • All hazardous materials, chemicals and waste materials shall be contained in proper storage facilities with adequately designed containments to prevent any impact sources or spills on the land and soil; • All hazardous wastes shall be securely stored, under a shed for eventual transportation and disposal to the authorized buyer/vendor; • The solid domestic waste shall be segregated and stored within the premises temporarily and then sent to waste management facility; • Process wastewater (e.g. oil-contaminated wastewater) should be treated separately from non-process run-off; • Oil separator(s) should be utilized to provide primary treatment of the oily wastewater; • After treating the oil mixed water in the Oily Waste Treatment Station it will be send to the ETP for further treatment and reuse for landscaping of the whole power plant, dry ash humidification and coal yard sprinkling etc.; • Used oil removed from the wastewater will be stored in drums and confined area and handover to the authorized buyer/vendor; • Wastewater containing chemicals resulting from various streams (e.g. chemical storage, boiler blow-down water, chemical cleaning effluents) will be pre-treated by neutralization and/or detoxification prior to being collected and treated at the wastewater treatment plant on site; • All wastewater is envisaged to be treated in the wastewater collection systems/treatment facilities will when in compliance with effluent discharge parameters, be re-used in the coal ash yard for dust suppression purposes; and • Ensure the treatment process will function properly and the effluent discharges comply with the discharge limits stipulated in ECR, 1997.	
Impacts on Soil and	- Soil contamination by mixing of	• Proper collection and disposal of fly and bottom ash should be ensured by the	Implementation

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
Agriculture	heavy metals from coal storage, coal ash storage and wastewater, chemical and hazardous waste management; - Solid wastes, oil leakage and waste oils will impact on soil; - Petroleum, oil leakage and waste oils may spill on the ground and ultimately into the soil; - Dust can accumulate on crops and impact on growth and production.	project proponent; • Chemical spillage management plan should be introduced in the power plant; • All hazardous materials, chemicals and waste materials shall be contained in proper storage facilities with adequately designed containments to prevent any impact sources or spills on soil; • All hazardous wastes shall be securely stored, under a shed for eventual transportation and disposal to the authorized buyer/vendor; • The solid domestic waste shall be segregated and stored within the premises temporarily and then sent to waste management facility; • All the wastes from the power plant should be collected properly and recycle for reuse; • Regular monitoring should be ensured by the BEPCL; • Install leakage detector, spillage control equipment's and emergency shut-off valves at closing magnetic type to prevent leakage/spillage at fuel storage tank area; • Soil quality monitoring should be done by the BEPCL following the international standards.	& Supervision: BEPCL
Impacts on Groundwater	- Groundwater pollution due to improper design and management of ash yard; - Contamination of groundwater by leakage or spillage of petroleum hydrocarbons from heavy vehicles and sewage and industrial wastewater; - Impacts on hydrology.	• Ash yard needs to be designed and constructed in accordance with the worldwide available best practices standards and methods; • Use of natural or artificial material to build an impermeable layer the thickness of which should produce an anti-seepage capacity; • Anti-seepage geo-membrane shall be laid on bottom of ash yard and side slope of dam to form a basin-shaped anti-seepage system; • A leachate collection system should be incorporated in the ash yard design and provided at the lowest point(s) of the ash yard; • The leachate and runoff should be collected from the coal ash pile and diverted it into a leachate storage or treatment system; • A groundwater monitoring system made up of wells should be installed and operated around the ash yard capable of verifying whether coal ash or leachate has penetrated the pad or HDPE liner; • Drainage ditches shall be constructed along the perimeter of the ash dam.	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		Water in the ditches can be directly discharged; • A 7 m wide road should be constructed around the perimeter of the ash yard complete with drains for access purposes; • Installation of an appropriately designed HDPE layer around the ash yard; • The HDPE liner should be inspected for uniformity, damage and imperfections during construction and installation; • Groundwater must be free from any harmful effluents and wastes leakage from oil and chemical tank or storage through seepage; • The BEPCL will develop and implement a waste management plan for the operational phase of the project; • Based on the specific situation(s) at the time, the BEPCL should take suitable measures to prevent erosion of the ash pile during the monsoon season in project site or a failure of part of the ash pile; • Employees should be trained in the proper handling and disposal of the fly ash, bottom ash and wet FGD gypsum to minimize their risk of exposure in accordance with the BEPCL's occupational health and safety procedures; • Employees should be provided with appropriate PPE for handling the ash. Proper handling and disposal by employees would minimize exposure or health-related issues to the public; • Groundwater monitoring wells should be checked regularly by sampling and analyzing water from them for compliance with National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997).	
Impact due to Ash Disposal	- Ash containing heavy metals will impacts on groundwater, soil, sediment, surface water, fish and food chain.	• The BEPCL will develop and implement a waste management plan for the operational phase of the project; • Employees should be trained in the proper handling and disposal of the fly ash, bottom ash and wet FGD gypsum to minimize their risk of exposure in accordance with the BEPCL's occupational health and safety procedures; • Employees should be provided with appropriate PPE for handling the ash. Proper handling and disposal by employees would minimize exposure or health-related issues to the public; • A leachate collection system should be incorporated in the ash yard design and	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		provided at the lowest point(s) of the ash yard. The leachate and runoff should be collected from the coal ash pile and diverted it into a leachate storage or treatment system; • A groundwater monitoring system made up of wells should be installed and operated around the ash yard; • Based on the specific situation(s) at the time, the BEPCL should take suitable measures to prevent erosion of the ash pile during the monsoon season or a failure of part of the ash pile; • Employees should be trained in the proper handling and disposal of the fly ash and bottom ash to minimize their risk of exposure in accordance with the BEPCL's operational health and safety procedures; • Proper handling and disposal by employees would minimize exposure or health-related issues to the public; and • Regular monitoring of the ash yard will be ensured by the BEPCL.	
Impacts on Aquatic Ecology	- Impacts on aquatic ecology due to establishment & operation of water intake and discharge structures; - Noise, spillage of oil and lubricants, solid waste, bilge water, ballast water etc. discharge from coal transportation vessels; - Impacts on Hilsa breeding and movement of aquatic animals; - Accidental spillage of coal, oil and discharge of untreated wastewater may change water quality, impact on fish resources and aquatic animals; - Major impacts on fish resources	• The BEPCL must conduct a detailed study on Dolphins in the Buriswar-Payra River. At least one-year monitoring study should be conducted during construction and another one-year during operation phase of the project; • The impingement and entrainment of marine organisms due to intake will be avoided by placing nets across the channel and moving screen at the intake; • As a navigational safeguard, marker buoys will be placed at intake and outfall locations. • Regular monitoring at the intake and outlet point in order to optimize and minimize impacts on aquatic ecology; • The efficient ash management system shall be adopted for the proposed power plant shall control release of ash as well as heavy metal into environment; • Dust suppression system should be introduced in the power plant premises; • Proper solid waste collection, treatment and disposal following the DoE guidelines; • Liquid and hazardous waste collection treatment and disposal; • Avoid unnecessary engine operation and noise nuisance; • Thermal discharge from the power plant needs to be controlled to ensure that	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	and benthic community due to discharge of cooling water into; - Windblown ash and coal from handling jetty area may hardly affect health of aquatic flora.	the discharge water temperature does not result in thermal pollution; • The temperature of the condenser cooling water will be strictly maintained up to 3°C at the boundary of mixing zone; • The BEPCL should consider installation of cooling water intake technologies such as seasonal barrier nets screens to reduce impingement and entrainment of fish. The reduced intake flow rate also reduces the potential for entrainment of aquatic species; • During the initial testing at the plant and cooling water systems commissioning, it should be ensured the initial effluent and cooling water discharges fully comply with the DoE, ADB and/or IFC standards on thermal discharge; • No waste disposal in open environment; • Avoid unnecessary lighting and noise during night in the coal handling jetty; and • The EHS department of BEPCL should ensure regular monitoring of health of aquatic ecosystems.	
Impacts on Terrestrial Ecology	- Impacts on terrestrial flora by emissions from a coal-power plant; - Dust for instance will affect plants growth by interrupting physiological processes; - Road traffic, presence of workers, and other activities may disturb free movement of different fauna in the approach road and side vegetation; - Lighting in the project area may disturb activities of nocturnal animals.	• The BEPCL should undertake a re-afforestation program to compensate areas destroyed by the construction activities; • Dust suppression measures must be implemented by the project proponent near the project site and dust generation site on a regular basis; • A traffic management system should be prepared and implement by the project proponent; • Control the speed of the vehicles (20 km/hour) in the approach road, paved and unpaved road and bare surface in the power plant; • Instruct the workers and awareness creation not to disturb the terrestrial ecology; • Avoid unnecessary lighting in the project site at bight time; • The contractor should install equipment that meets the environmental noise limits stipulated by DoE, Bangladesh environmental noise regulations; • The installed equipment should comply with the requirements of the occupational noise limits specified in the occupational noise regulations; • The contractor should limit cutting down trees and grass areas to the construction footprint areas;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		- The BEPCL should develop and implement a tree-planting program for the lifetime of the project; and - The BEPCL should monitor the health of the Health, Aging and Growth, Canopy coverage, Diseases of terrestrial flora in yearly basis.	
Impact on Occupational Health and Safety	- Accidents, injuries, illness and death of the workers due to the operational activities of the proposed power plant.	- Occupational electric and magnetic fields (EMF) exposure should be prevented or minimized through the preparation and implementation of an EMF safety program including identification of potential exposure levels in the workplace, monitors, training of workers, identification and establishment of safety zones; - Limit the exposure time through work rotation and increase the distance between the source and workers; - Ensure the integrity of insulation of combustion units, pipes and related hot equipment by regular inspection and maintenance the identified facilities; - Ensuring all work areas are adequately ventilated to reduce heat and humidity; - Suitable warning signage developed at appropriate high-temperature areas; - PPE as appropriate provided and effectively used at all times; - Identifying and marking high noise designated areas, typically including areas with noise levels greater than 85 dB(A); - Ensure appropriate operational and maintenance regimes to prevent and minimize noise generation; - Deactivation & proper grounding of live power equipment and distribution lines; - Use of voltage sensors in areas of high voltages; - Specialized electrical safety training to workers working with or around exposed components of electric circuits; - Use of automated combustion and safety controls; - Proper maintenance of boiler safety controls; - Implementation of startup and shutdown procedures to minimize the risk of suspending hot coal particles (e.g., in the pulverizer, mill) during startup; - Regular cleaning of the facility to prevent accumulation of coal dust; - Use of automated systems such as temperature gauges or carbon monoxide sensors to survey solid fuel storage areas to detect fires caused by self-ignition and to identify risk points;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		• Appropriate education of workers on handling and management of chemicals in accordance to MSDS; • Provision of occupational safety and health orientation training to all employees; • Periodic safety inspections should be ensured by the BEPCL; • The EPC Contractor should ensure there is an effective and efficient firefighting system together with an adequately trained Emergency Response Team; • Based on the health and safety risk assessment findings, BEPCL shall develop & implement a formal OHS Management System compliant with the applicable requirements of the OHSAS and IFC General EHS Guidelines ; • Adequate first aid facilities in the power plant premises; and • The BEPCL should ensure there is an effective and efficient firefighting system together with an adequately trained Emergency Response Team.	
Impact on public health and safety	- Risk from air emission, noise nuisance, radiation, dust emission, waste (solid, liquid, hazardous), improper drainage, accidents and injuries associated; - Risk of upsurge of sex workers and health hazards including HIV AIDS; - Pressure on existing infrastructure like health and educational facilities.	• Update technology and emission controlling equipment should be ensured by the BEPCL; • Regular maintenance, replacement and performance should be tested as per manufacturer guidelines; • All the waste from the power plant and workers facilities should be collected properly disposed as per best practices and followed the guidelines of the DoE, Bangladesh; • All the wastewater must be treated in the STP, WTP and OWTP; • Solid waste should be collected and disposed properly; • The BEPCL should ensure good quality drinking water supply in the plant premises as per the ECR, 1997; • Safety training should be given for the drivers; • Ban the faulty equipment's, machineries and vessels in connection with the power plant project; • Training on sanitation and hygiene, sexually transmitted diseases (STD)/HIV, education and communication should be incorporated by the BEPCL into new employee orientation programs; • Proper drainage system should be ensured in the project premises and surrounding area;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		• Instruct the workers about the waste generation and management; • Regular monitoring should be ensured by the BEPCL EHS department; • Greenbelt development in and around the power plant as early as possible after finishing the construction activity.	
Impact on Traffic Movement	- Increase the number of traffic movement; - Increase the number of accidents; - Disturbance of local traffic; - Noise and dust pollution along the access road; - Impact on terrestrial flora and fauna.	• The BEPCL and its contractor should develop a Traffic management plan for both the operational phase; • Regularly inspect the access roads conditions and, whenever necessary, repair damages related to traffic movement; • Dust suppression measures must be implemented by the project proponent near the project site and dust generation site on a regular basis; • Establishment of safety sign, warning light post, speed breaker should be ensured by the project authority and all sign should be written in local language; • Limit the vehicle speed near the narrow approach road, school, bazar, mosque and settlement area etc.; • Instruct the driver to avoid unnecessary engine operation and horns in the approach road; • Use of mobile phone during driving is strictly prohibited; • Greenbelt development around the project site.	Implementation & Supervision: BEPCL
Creation of Employment (Positive Impacts)	- Envisaged to generate direct and indirect employment opportunities, enhance skills development for both skilled and unskilled workers; - About 172 personnel will be required for operation, maintenance and administration purposes; - Contribute to providing meaningful job opportunities for the locals; - Create provisions for	• The BEPCL will give the priority of the local community in the allocation of job opportunities, prioritizing from the residents immediately neighboring and/or displaced by the project; • BEPCL should also ensure opportunities for capacity building are afforded to the local communities to enable them to benefit from the available employment opportunities. This includes training in skills set required during the operational phase of the project; • Job advertisements should be made through mediums that are easily accessible to the local community such as project site office noticeboards, local newspaper, local radio etc. • Where possible, expertise should be sourced locally then nationally before resorting to engagement of international experts; • The recruitment selection process should seek to promote gender equality and	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	infrastructure development such as roads, schools and health facilities, impact on the potential land use in the area and boost local economy.	- the employment of women where possible; - Management and enhancement measures for local employment should be included in the company's labor and human resources plan; - BEPCL should enhance the CSR activities for the local community; and - BEPCL should make a conscious effort to promote local businesspeople in the procurement of goods and services to assist in providing more economic and employment opportunities for the local community.	
Influx of workers and communicable diseases	- Increased demand on social infrastructure and related facilities, including housing accommodation, utilities supply and health facilities. - Increase social cost including rent for accommodation; - Risk of sexually transmitted diseases including HIV/AIDS, Gonorrhoea, and Syphilis etc.	• Providing appropriate infrastructure where necessary for development of economic activities include food vendor and related activities; • Employing local people for project operation activities as per the expertise to the maximum extent possible; • Equal employment opportunities for the local community and no discrimination based on race, religion, political influence etc.; • No child and/or forced labor will be employed by the EPC contractor, it is strictly prohibited as per the Bangladesh labor law; • Payment must be ensured by the contractor as per the present labor law in Bangladesh; • No entrance of unauthorized person in the project site without the permission from the concern officer; • Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis; and • Working conditions and terms of employment will be fully compliant to the Bangladesh labor laws.	Implementation & Supervision: BEPCL
Disruption and Loss of Livelihoods	- Land requirement for the project is 174 acres; - Approximately 76 numbers of HHs needs to be remove; - Fishing community (about 60%) will be affected more; - Impacts on fish capture,	• Avoidance of settlement area, agricultural productive land is preferable; • Development and implement a Resettlement Action Plan (RAP) for project affected persons following local rules, laws, policy and guidelines of Bangladesh; • Proper compensation and rehabilitation should be ensured by the BEPCL; • CSR activities for the fisherman and fishing community should be considered by the project proponent;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
	migration, availability, restriction on fishing; - Disturbance of boat movement and fishing activities adjacent to the project site (in Buriswar-Payra River) and impact on migration of Hilsa fish.	• No restriction on fishing activities near the project site river; • All types of wastes should be properly collected and disposed following the guidelines of the DoE; • Alternative canals should be excavated by the BEPCL considering the depth, width and use of the canals; • A details drainage study must be conducted by the project authority for ensuring proper drainage network establishment; • The BEPCL should have develop and implement a transparent recruitment plan for employment and business opportunities for the local community; • The BEPCL should implement a capacity building program for the local communities to enable them to benefit from the available economic opportunities; • The BEPCL should avoid contamination of and destruction of fish capturing sites while operation of the power plant and associated infrastructure; • Employment opportunities for the project affected persons (PAPs).	
Impact due to transportation of Primary Fuels	- Dust pollution from transshipment and unload; - Windblown dust will impacts on the surface water quality as well as the aquatic environment; - Air pollution due to emission from the combustion of fuels - Noise pollution from operation of vessels, coal unloading and handling system ; - Surface water polluted due to oil spillage, coal spillage and other malpractice like waste discharge, discharge of ballast and bilge water, etc.	• Efficient dust suppression systems, coal stockyard management and air quality management system to limit generation and dispersion of dust particle should be ensured by the project proponent; • Coal transportation agency shall limit generation within the DoE standard of noise adopting noise management plan; • Discharge of any waste directly to the environment especially within the territory (Exclusive Economic Zone) of any country is strongly prohibited by different IMO Conventions on Protecting Marine Environment; • Discharge of waste from ships may be minimized if the mentioned regulations are properly enforced and followed by the relevant authorities (PA, BIWTA and DG Shipping) and coal transportation agency. BEPCL shall mention enforcement of these conventions in the Coal Supply and Transportation Agreement so that the coal transportation agent feels obligatory to follow these conventions with the aim of preventing pollution from ships; • The responsible authorities (PA, BIWTA and DG Shipping) shall monitor and spot-check the shipping and barging activities;	Implementation & Supervision: BEPCL

Issues/ Components	Potential Impacts	Mitigation/Enhancement Measures	Responsibility
		• Coal conveyor should be fully covered so that windblown dust are not generate from the coal transfer process; • Avoid the protected areas or sensitive location during the selection of coal handling and transfer jetty in the Bay of Bengal.	

CHAPTER TEN: ENVIRONMENTAL MANAGEMENT PLAN

10. Environmental Management Plan

The main purpose of the Environmental Management Plan (EMP) is to identify project specific actions that will be undertaken by the project authority for mitigation of the specific impacts identified in the proposed project. These actions will be incorporated into project management system and integrated into the implementation at various stages of project development. The EMP describes both generic good practice measures and site specific measures, the implementation of which is aimed at mitigating potential impact associated with the project activity.

Objectives of the Environmental Management Plan:

The main objective of EMP is to warrant that the industrial development in an identified particular study area needs to be entangled with judicious utilization of non-renewable resources and to ensure that the stress/load on the ecosystem is within its permissible assimilative capacity i.e. its carrying capacity. In above context assimilative capacity refers to the maximum amount of pollution load that can be discharged into the environment without affecting the designated use of various environmental attributes and is governed by dilution, dispersion and removal due to physico-chemical and biological process. An effective EMP ensures that these environmental requirements and objectives are satisfied during all phases of project. The long-term objectives of the EMP for all the environmental attributes are as under:

- To comply with all the regulations/applicable laws stipulated by DoE, Bangladesh;
- To create good working conditions for employees;
- To encourage and achieve highest performance and response from individual employees and contractors;
- To plan out the complete strategy to take care of stakeholder engagement;
- Budgeting and allocation of funds for environment management;
- Continuous development and search for innovative technologies for a cleaner and better future environment; and
- To contribute significantly for sustainable development.

10.1 EMP During Preparation Stage

The boundary of the proposed project site shall be clearly identified on site before starting the land filling, leveling and compaction.

10.1.1 Land Development

The proposed project is going to be established within the premises of the leased land from Iso Tech Electrification Company Limited and lease of government (Khas) land. However, all the lease land will be transferred to the project company in future except the government (Khas) land. The land requirement for the proposed project is about 174 acres. In the proposed project area about 76 households are living that needs to be resettle before starting the construction activities. Therefore, a detailed Resettlement Action Plan (RAP) and Livelihood Action Plan (LAP) will required to solve the resettlement and compensation issues in the proposed project area. During the pre-construction and development stage only site preparation and land filling work will be done. For the site establishment and land filling in the proposed project site, an approximate amount of 3.2 million cubic meter landfilling material (dredge soil) will be required. According to the BEPCL, the Power China Harbour Co. Ltd. will be responsible for landfilling activities in this project. A separate EIA study for the dredging activities in the Bay of Bengal will be required prior to start the dredging activities. The quality of the dredge soil will be confirmed by the contractor before starting landfilling activities. During the land development, surface soil, drainage pattern, water quality and terrestrial ecology will be impacted. Any accidental spillage of fuels and lubricants and improper management of the solid and liquid waste from the dredgers will impacts on the aquatic ecosystem. To mitigate the impacts during land development stage following management plan should be considered by the project proponent:

- Quality of the dredge soil shall be ensured by the EPC contractor before starting the dredging and landfilling activities;

- Consideration of the landfilling activities to avoid extreme weather events like extreme rainfall, high wind, cyclonic events etc.;
- Proper stabilization of soil in the landfilling site;
- Regular spraying water on possible dust generation source and sites;
- If possible use the topsoil's that will be removed during site preparation;
- Maintain proper drainage facilities so that no rainfall water can accumulate in the project site and impact on surrounding drainage condition;
- Dredged spoil should be disposed of in such a manner so that it does not any additional environmental issues and refill the dredged channel;
- Proper management of dredged spoil should be planned and implemented during site development by the EPC contractor; and
- Contractor must obtain necessary approval from concerned authority.

10.1.2 Location and Sources of Soil and Other Material for Development

According to the BEPCL, the dredge materials or soil for the proposed power plant project land development will be collected from the Sea (Bay of Bengal) by dredging. Tentative location of the dredging site is about 6.5 km on the west side of the power plant. The Power China Harbour Co. Ltd. will be responsible for dredging and transportation of landfilling soil in this project. Dredging activities will be impacted on the surface water by increasing turbidity, aquatic life, migration of fish, disturbance of river traffic etc. Before starting the dredging activities, the EPC contractor and project authority must ensure the following things:

- Before selection of the dredging site in the Bay of Bengal, the project proponent and contractor must ensure the avoidance of the Protected Area, Wildlife Sanctuary, Fish Sanctuary, Fishing Zone, Fish Breeding and Spawning ground;
- Avoid sensitive areas;
- Avoid the migration route of Hilsa, Turtle and Dolphins and others aquatic animals and Hilsa captured season;
- Avoid the Hilsa breeding season and fishing zone;
- Selection of the best available technique dredging methods;
- Best equipment and barge used in the operation;
- Consider the formation time of cyclone disaster (April-May and October-November) and prefer the winter season for dredging;
- No disturbance of existing boat traffic near the dredging site and project adjacent river channel;
- Necessary approval or permission from the Deputy Commissionaire (DC) office, Bangladesh Inland Water Transport Authority (BIWTA), Department of Environment (DoE), Department of Fisheries (DoF), Ministry of Shipping etc.

10.1.3 Transportation of Soil and Other Material

The dredge material or soil will be transported from dredging site to the project site by two vessels. There will be 85 numbers of equipment's including dredger(s), bulldozers, dump trucks and loaders for dredger operation and land filling. About 280 operators and labors will be dispatched in the project site in order to quickly finish the dredging activities and for the landfilling materials transportation. Dust generation and number of traffic volume will be the main concern. Following should be considered:

- Proper planning and scheduling on the dredging and disposal to avoid strong wind, current and tides that will further add to widen the effect of spreading of sediments;
- Best equipment and barge used in the operation;
- Use of low Sulphur content of oil or natural gas for the transportation vehicles;
- Cover the transportation vessels using tarpaulin so that dust cannot blown;
- Any accidental oil and hazardous chemicals leakage and spillage will be contained and cleaned immediately; and
- Proper collection of oil and hazardous chemicals and stored for recycling or disposal.

10.1.4 Method and Equipment for Collection of Soil and Other Material

Dredging activities in the sea will be by the dredgers. The EPC contractor will determine the dredging methods and details equipment's requirement after getting the work order from the project proponent. Dredging activities will be preferred during the dry (winter) season.

10.1.5 Closing of Sites of Sources of Soil and Other Material

The Bay of Bengal will be the possible dredging source and transportation of dredge soil as the landfilling materials for the proposed project site.

10.2 EMP During Construction Phase

The boundaries of the construction site shall be clearly identified on site during the construction process. The method of identification shall be either permanent fencing, temporary fencing or construction / safety barricades or high visibility tape. Where existing or new permanent fencing is used to identify construction boundaries high visibility warning tape should be interwoven in the fence. All works and storage of materials and equipment shall be restricted to this area during the construction phase.

10.2.1 Site Preparation

10.2.1.1 Site Development by Backfilling

It is proposed that site development for power plant project will be developed sequentially one after another. Existing settlement including homestead vegetation/trees will be required to remove at the primary stage before starting landfilling. The major land development activities will be done during the pre-construction phase. The land development will be done using dredging spoil or soil from the sea. Encroachment of river, mangrove and flood flow zone is strictly prohibited.

Leveling activity will be required for providing roads, sewage network, storm water system and for providing administrative buildings and power plant erection. According to the engineering assessment, most of the excavated material shall be reused within the project boundary and the movement of cut and fill material will be limited. During site development necessary precautions will be taken, so that the runoff water from the site gets collected in a working pit. If any over flow occurs, the excess water will be diverted to nearby settlement, agriculture land and greenbelt/plantation area.

This site development activity will be conducted inside of the boundary wall so it is not expected that no loose earth materials can move to the surface water by run-off water. Before dumping of dredging materials, base stripping of top soil has to be made proper bonding and stripped materials has to be kept in safe place for reuse it after completion of site development. Backfilling has to be made layer by layer ensuring proper compaction and water spraying so that no dust can emit in air causing air pollution.

The necessary silt fences and erosion control measures must be implemented in areas where these risks are more prevalent. These include watercourses and steep areas.

10.2.1.2 Construction Site Management Plan

The construction camp and the site should be managed in such a way that would cause minimum degradation or damage to the surrounding environment. The contractor must take responsibility for the construction site to confirm contractual aspects and applicable environmental standards of Bangladesh. Adequate numbers of bins, sanitary toilet, water supply system, drainage system, firefighting system etc. should be provided in the site. However, good housekeeping is necessary for preventing environmental damage. All the construction materials and stockpiles should be maintained within the project area provided with rain and wind protection. Environment, Health and Safety department of BEPCL should be employed with responsibility of monitoring the activities, which causes any environmental effects, and ensuring enforcement of EMP during construction activities.

10.2.1.3 Construction Waste Management Plan

Construction waste should be managed properly. The rate of waste generation should be reduced adopting efficient technique and limiting waste generating activities. The measures for controlling construction waste may include limiting site clearance activities, planned stocking and gathering of construction materials and equipment's, fencing around the construction yard, maintaining existing right of way to carry construction materials, adopting proper sanitation system for employees, banning of waste burning, and quality housekeeping. A waste dumping place should be provided with efficient waste collection and disposal techniques. No waste should be dumped to the surrounding waterbodies. Burning of solid waste in the construction site is strictly prohibited.

Appropriate measures will be provided with run-on and run-off system might be constructed from controlling run off from construction yard and liquid waste. Initiatives must be taken to reuse and recycle of waste materials. Hazardous material including fuel and other combustible materials shall have to be stored with highest care and safety. Spillage, accidental release must be controlled adopting Hazardous material handling guideline.

10.2.2 Infrastructure Services

The Contractor shall follow the following management plan during construction stage of the proposed power plant project:

- The location of the construction camp should be in an acceptable location based on environmental, cultural or social point of view;
- Construction camp should be away from the local community to avoid social conflict and avoid adverse impacts on the community;
- Use of alcohol and drug is strictly prohibited in the construction site and use of local people for collection and transportation;
- Sufficient and good quality accommodation for the construction workers;
- The proposed project site is a cyclone prone area so before establishing the construction camp it should be considered;
- Ensure adequate supply of good quality ground water as per the national water quality standard of DoE, Bangladesh;
- Adequate hygienic sanitary facilities and sewerage system. The minimum number of toilet facilities required is one toilet for every ten persons;
- Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible;
- Ensure proper collection and disposal of solid wastes within the construction camp and treatment facilities for sewerage of toilet and domestic wastes;
- Insist waste separation by source; organic wastes in one pot and inorganic wastes in another pot at household level;
- Provide adequate health care facilities within construction sites;
- Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse and ambulance facilities;
- Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work;
- Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis;
- Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellent sprays during monsoon; and
- Carryout short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices.

10.2.3 Construction Equipment

During the construction stage of the proposed power plant project, heavy machinery will be used which causes noise, vibration and air pollution. The following measures should be taken by the contractor during the construction stage:

- Regularly maintain all diesel-powered equipment and reduce idling time to avoid emissions of NO_x, PM_{2.5}, PM₁₀ and SO₂;
- Minimize movement of construction vehicles and enforce a speed limit (20 to 30 km/hour) around the construction site;
- Where available use low Sulphur diesel and diesel powered equipment in collaboration with best management practices;
- Implement best practice procedures to control vehicle/equipment air emissions (such as turning off equipment when not in use);
- Only well-maintained equipment should be operated on-site;
- Vehicle/equipment exhausts observed to be emitting significant black smoke from their exhausts should be serviced/ replaced;
- Regular maintenance of equipment including lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Noise barriers should be installed around the construction site to reduce the noise pollution impacts on nearest sensitive receptors;
- Concrete mixing plant or high noise generation machineries should be kept as far as possible from the nearest receptors; and
- Normal working hours of the contractor will be between 09:00 AM to 06:00 PM. If work needs to be undertaken outside these hours, it should be limited to activities that do not lead to exceedance of the noise criteria as per the DoE guideline.

10.2.4 Safety Measures

Occupational health and safety plays an important role in the construction site for creating a good workable environment. A good working environment encourage the workers to increase the capability. During the construction phase of the proposed power plant, the contractor should take the following health and safety measures.

- The Contractor will prepare and implement a Health & Safety plan prior to commencing work;
- The plan will include method statements for working methods, plant utilization, construction sequence and safety arrangements;
- Inform the local community before starting the construction activities;
- The following measures should be taken by the contractor to reduce the likelihood and consequence of the following hazards like electric shock, falling objects, falling from height, lifting excessive weights, contact with dangerous substances, work with sharp, hot and rotating objects, slipping on greasy or icy walkways, entanglement with machinery, tripping over permanent obstacles or temporary obstructions, fire and explosion, variable weather conditions and traffic operations.
 - The contractor will allow the authorized persons only to gain entry in the construction site;
 - The contractor will arrange a briefing session on the risks and health and safety issues before starting the construction activities;
 - All workers will be properly informed, consulted and trained on health and safety issues;
 - The contractor will ensure adequate Personal Protective Equipment (PPE) all times in the construction site;
 - Before starting work all the appropriate safety equipment and the first-aid kit will be assembled and checked as being in working order. Breathing apparatus will be tested at regular intervals in the manner specified by the manufacturer;
 - All lifting equipment and cranes will be tested and inspected regularly. All hoist ways will be guarded;

- All scaffolding will be erected and inspected in conformity with the Factories Act and the appropriate records maintained by the Contractor; and
- The Contractor will be provided appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations when the work is in progress.

10.2.5 Air Quality Management Plan

Construction activities generate large volume of particulate matter and sometime significant volume of greenhouse gases. However, with the project activities like land filling, levelling, cutting etc., a large amount of particulate matter might be generated. Hence, an efficient air quality management plan has to be adopted. The mitigation plan includes limiting particulate matter generating activities, adopting dust suppression system, limiting vegetation clearance activities, avoiding earthen road for traffic movement, covering of stockpiles, traffic management, etc. The monitoring of air quality in the construction site should be monitored and ensured by the contractor following the monitoring plan as guided in the report.

10.2.6 Noise Level Management Plan

In the construction site, noise to be generated from different mechanical equipment's, machineries and vehicles used in construction activities and transportation shall have to be managed to ensure ECR, 1997 and Noise Pollution (Control) Rules, 2006 defined standard. Adopting the necessary mitigation measures might reduce the generation of noise from the construction activities. The monitoring of noise level in the construction site should be monitored and ensured by the contractor following the monitoring plan as guided in the report.

10.2.7 Water Resources Management Plan

According to the project proponent, water required during the construction phase of the proposed project only surface water will be used. Waste from the construction camp should be monitored and ensure the proper disposal to avoid surface water pollution. Construction wastewater management would control the discharge of waste into the Buriswar-Payra River. The contractor will instruct and provide proper training to the monitoring professionals during construction work.

10.3 EMP During Operation Phase

10.3.1 Air Pollution Management

The major pollutants envisaged from the proposed 350 MW coal fired power plant at Taltoli, Barguna are particulate matter, sulfur dioxide, oxides of nitrogen and fugitive dust from the internal roads, coal handling area, ash pond area etc. The following mitigative measures will be employed to reduce the impacts on air quality:

- Twin-chamber five-electric-field Electrostatic Precipitator (ESP) with dust collection efficiency of not lower than 99.72% will be adopted; meanwhile, desulfurization system with dust collection efficiency of 50% is considered, in order to assure smoke dust concentration at chimney outlet lower than 50 mg/Nm³;
- Flue Gas Desulfurization (FGD) system will be constructed for this project. Limestone-gypsum wet type desulfurization will be adopted with desulfurization efficiency of not lower than 93%. The sulfur dioxide concentration at chimney outlet will be lower than 200 mg/Nm³, which can satisfy the requirement of World Bank IFC EHS standard;
- The boiler adopts low NO_x burner and staged air distribution combustions to assure NO_x emission concentration at boiler outlet lower than 510 mg/Nm³, which satisfies the requirement of limit value required by standards;
- In this project, one 220 m high chimney will be constructed. High chimney emission is conducive to pollutants diffusion;
- Continuous online monitoring system will be installed to monitor Particulate matter, SO₂, NO_x and other pollutants; and
- All the internal roads will be of concrete/asphalt to reduce the fugitive dust generated due to the vehicular movement.

10.3.1.1 Ambient Air Quality Monitoring

A laboratory equipped with the necessary instruments for carrying out air quality monitoring will be provided within the plant. The concentration levels of PM₁₀, PM_{2.5}, SO₂, NO_x, and CO in the ambient air will be monitored for the project site and nearby villages. The monitoring will be done as per the ECR, 1997 and subsequent amendments of the DoE, Bangladesh.

10.3.1.2 Stack Gas Monitoring

The emissions from the stack will be monitored continuously for sulfur dioxide, oxides of nitrogen, and particulate matter. If the pollutant concentration levels exceed the standard limit, necessary control measures will be taken to bring them back within the standards. Sampling ports will be provided in the stacks according to the DoE guidelines.

10.3.1.3 Meteorological Observations

An automatic weather monitoring station will be installed within the power plant premises and daily observations of micro-meteorological parameters such as ambient temperature, wind speed, wind direction, relative humidity, cloud cover, rainfall and solar radiation etc. will be recorded.

10.3.1.4 Transportation, Handling and Storage of Raw Materials and Products

The proposed coal-fired power plant project site is located on the bank of the Buriswar-Payra River. During the construction phase of the project, a coal-handling jetty will be constructed in the river north side from the power plant. For the operation of the power plant approximately 1.1185 million tons coal will be required and it will be imported from the foreign countries (Indonesia, South Africa and Australia). For the transportation of coal up to the offshore lighterage area in the Bay of Bengal, bulk carrier will be used. The capacity of the bulk carrier will be 35,000 tons. From the lighterage area to the project jetty area, coal will be transported by barge with 3,000 tons capacity. The depth of immersion for the 3,000 tons barge with full load is around 4.2m. According to the survey data, the depth of vessel passage from the Bay of Bengal to the plant's jetty is above 6m, which can meet requirements that the 3,000 tons barge can enter the harbor.

The vessel to be used for coal transportation shall have to satisfy all national laws and IMO conventions signed by GOB. Bangladesh is a signatory 25 IMO Conventions and Maritime Protocols to protect marine and terrestrial environment of the country. All of these conventions and protocols have been discussed in Chapter-2. Therefore, all activities relating to shipment of coal through the port shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements. Shipping, barging and transferring should be regularly monitored by the relevant authorities (e.g. Chairman) Shipping, Port Authority and BIWTA to ensure enforcement of these conventions and protocols. Coast guard might be given responsibility for inspecting whether the vessels are adopting mitigation measures, complying national and international rules of safety and environmental conservation. Besides, an Environment Manager shall be given responsibility of monitoring transportation activities and of auditing environmental efficiency of the transportation system.

Proper dust suppression and self-combustion mitigation system must be adopted. Practice to moisten the coal but not wet them should be followed. However, water treatment plant should be planned and constructed for management of runoff and wash off water from coal stockpile and unloading system. The unloading system and conveyor system should be enclosed type that would reduce generation of fugitive dust particles from coal.

10.3.1.5 Operation Stage

Operation and maintenance of boiler, stacks, ESP, FGD, pipelines and storage tanks facilities has to be carried out regularly as per the instruction given in the manufacturer's maintenance manual. At the same time, the quality of the imported coal has to be maintained as per design of the boiler and to comply with ECR, 1997. The low sulfur content coal should be imported and used in the proposed project. The potential dust generation source like ash handling system must be monitored and tested to evaluate the performance as per the standard. Regular inspection of boiler, FD and ID fans, separation and handling system and other ancillaries shall also be inspected and tested regularly

weather this level remains lower than the allowable limit. Emission level of SO₂, NO_x and particulate matter etc. will be monitored in the project site and surrounding area. The concern unit (Environment, Health and Safety) of the power plant will be responsible for the monitoring of emission level, mitigation measures and regular reporting of the inspection. The monitoring and inspection report shall have to be submitted to DoE, Bangladesh for renewing Environmental Clearance Certificate.

10.3.2 Waste Water Management

The wastewater of this project will be treated in the centralized treatment plant and the treated water will be reused. Domestic sewage treatment system will be mainly used to collect domestic sewage water of the whole power plant. Domestic sewage water mainly includes staff shower drains and flush water drains, toilet drains, canteen drains etc. The domestic sewage in plant area will be discharged into domestic sewage treatment plant through underground pipeline. The treated water will be reused for landscaping of the whole power plant.

Production wastewater mainly includes acid and alkaline wastewater from boiler make-up water treatment system, wastewater from condensate polishing system, drains from air pre-heater flushing, etc. The wastewater will be collected, pressurized and discharged to industrial wastewater central treatment plant. The treated wastewater will be discharged to recycling water system for dry ash humidification, coal handling system flushing, etc.

This project will be arranged coal slime water treatment room for flush water drains from coal handling system. The coal slime water treatment adopts flocculating, settling and dosing methods. The treated water will be reused for coal yard sprinkling, etc.

After separate treatment, desulfurization wastewater will be reused for ash yard sprinkling. This project will be arranged with oily wastewater treatment system. The oily wastewater will be discharged to oil-water separation pond and then pumped and delivered to oil-water separator to remove oil. After treating the oil mixed water in the Oily Waste Treatment Station it will be send to the ETP for further treatment and reuse in the plant.

Effluent quality shall have to be monitored at different stage of discharge and intake. Before discharging the treated effluent to the Buriswar-Payra River the effluent standard shall have to be complied with ECR, 1997 defined standard for effluent.

10.3.2.1 Storm Water Management

Based on the rainfall intensity of the proposed area, storm water drainage system will be designed and connected to final drains. The storm water drainage system will consists of well-designed network of open surface drains so that storm water will be efficiently drained off without any water logging in the project premises.

10.3.3 Noise Management

The noise of the power plant will be mainly from equipment vibration and friction. Major noise sources include: turbine-generator set, exciter, various pumps and fans and coal pulverizer. To become public nuisance, the noise shall have three indispensable elements, i.e. noise source, route of transmission and receiver. Therefore, the power plant noise can be effectively controlled in three aspects, i.e. reducing noise of sound source, controlling route of transmission and strengthening personnel protection. For noise control at sound source, energy saving & low noise products shall be selected in design; during equipment tendering, requirements on noise level of equipment shall be specified; associated acoustic enclosure and silencer shall be provided for the equipment. The Noise level should be monitored and different locations inside of the power plant and nearest sensitive receptors (settlement, school, mosque etc.). EHS department of BEPCL shall be responsible for monitoring efficiency of the management plan and regular monitoring of noise level. Generally, following measures shall be taken:

- Silencer shall be installed at boiler exhaust vent and fan inlet;
- Acoustic enclosure shall be installed for turbine-generator set;
- Turbine-generator set shall adopt rigid coupling;

- Low noise exciter shall be selected;
- All equipment's and mechanical machineries shall have to be maintained in good working order;
- Noise from other line sources like project vehicle, vessel, etc. shall be controlled;
- Central control building will be sealed by 250 mm thick aerated concrete blocks. The central control room will be arranged in the middle of the central control building, surrounded by corridors or auxiliary rooms, which will be isolated from the external sound sources; and
- Workers at high noise area shall wear noise-protecting earplug.

10.3.4 Solid Waste Management

The major solid waste generation from the coal-fired power plant is ash in form of fly ash and bottom ash. Maximum ash generation from the proposed power plant will be from the coal. The stream generating units will be the main sources of the solid waste where the coal will be burnt. The following Table 10-1 shows the ash generation from the power plant.

Table 10-1: Ash Generation from the Proposed Project

SL#	Item Description	Design Coal	Worst Coal
1	Coal consumption at full load (100%)	150.22	166.89
2	Ash generated per hour in tones	32.102	44.644
3	Ash generated per year in tones	23,7875.820	330,812.040
4	Fly ash generation (85% of total ash) tones	202,196.67	281,165.04
5	Bottom ash generation (15% of total ash) tones	35,679.15	49,647.00

Source: Feasibility Report, 2018

The proposed project will adopts positive-pressure dense-phase pneumatic ash handling system for fly ash and wet bottom ash extraction system for boiler bottom ash. Submerged scraper conveyor delivers the bottom ash directly to bottom ash silo. The fly ash and bottom ash will be collected for comprehensive utilization. Otherwise, they will be transported to ash yard for stacking. The ash shall be stacked in blocks in ash yard, so as to minimize the working face of ash stockpiling. Ash and boiler slag shall be stacked separately, for the ease of comprehensive utilization in the future. When stacking, the ash will be spread, rolled and compacted from bottom to top layer by layer, with stacking elevation at least 1.0 m lower than ash dam, meeting limits of safety rules requirements in ash storage area. The ash will be rolled with principle of normal operating of machines. The operation slope may be 1:20~1:30. When ash yard will be expected to reach full capacity, the ash surface will be afforested or converted into cultivated land;

Anti-seepage of Ash Yard:

In order to avoid underground water contamination caused by wet fly ash and bottom ash in rainy days, anti-seepage geo-membrane will be laid at the bottom of ash silo and the side slope of ash dam to isolate pulverized fuel ash from outside.

Ash surface sprinkling and soil covering:

Truck sprinkling is adopted during operation phase of ash yard, so as to provide water for humidifying and rolling compaction as well as ash surface sprinkling in ash yard. During strong wind season, the exposed ash surface shall be regularly sprinkled. If necessary, the ash pile shall be covered with soil, so as to avoid fly ash pollution. In order to prevent dust from polluting surrounding area, growing trees at exterior area of ash yard to form 13 m width Green belt in order to reduce wind speed and minimize flying dust.

Others solid waste to be generated from different point sources like office, labour camp, living facilities, maintenance workshop, process unit etc. shall be efficiently collected, disposed and managed. Waste shall be collected and managed separately as per type. Initiatives might be taken for recycling and re-use of waste. On site, waste disposal system should be constructed and their performance should be monitored.

10.3.4.1 Fly and Bottom Ash Utilization

The peak generation of ash due to use of coal in the proposed 350 MW power plant is estimated to be about 23,7875.820 tons/year based on the design coal. Maximum fly ash generation from the power plant is 706.244 tons/day. According to the feasibility report, pulverized fuel ash from the power plant can be used in the production of cement, used as concrete admixture and also can be used to build roads. However, the proposed project proponent yet not signed MOU with any companies and they will explore the possibility of exporting fly ash. Otherwise, it will be delivered to ash yard. The water-spray and rolling equipment will be provided to control dust pollution on external environment.

10.3.5 House Keeping

Good housekeeping is one of the prime steps of safety. Good housekeeping of mechanical parts, rotator parts, electrical equipment's, plant site, green belt, ESP, stack, etc. will ensure workplace safety and efficient functioning of the system. This good housekeeping has to be made in regular interval and as per need. The following practices can be done for good housekeeping in the project site.

- Regular cleaning of internal roads of the power plant to avoid accumulation of dust;
- Proper placement of adequate number of containers for collection of solid wastes and garbage at each office, plant units and workers and officers residence;
- Maintaining proper storage and disposal of wastes materials;
- Maintaining hygienic conditions in canteens, drinking water source and sanitation; and
- Developing a positive outlook among employees for keeping their workplace clean.

10.3.6 Safety and Occupational Health

Occupational safety and health is very closely related to productivity and good employer-employee relationship. The main factors that affect the occupational health in the project site are flue gas emissions and noise. To avoid any effects on the health of workers due to emissions and noise, sufficient measures have been proposed which include:

- Working conditions and terms of employment will be fully compliant to the Bangladesh labor laws and acts;
- Ensure appropriate PPE for the workers and officers inside of the power plant;
- Effective de-dusting system at loading, unloading, and transportation;
- Adequate and availability of first aid facilities in the power plant area;
- Awareness on safety and ensure using personal protective equipment's;
- Introduction of compulsory audiometric testing for all employees exposed to excessive noise in the workplace (i.e. 85 dB or above);
- The plant will be equipped with high-output energy-efficient light fixtures that are properly shielded to reduce glare;
- During working hours, temperatures inside the buildings may be considered as reasonable, ranging in some areas between 16° and 25°C;
- Offices would be equipped with air conditioners, which would be serviced regularly by contracted technicians;
- Portable fans and heat extractors would be used in the production area to achieve an adequate air flow at specific work areas to keep operators cool;
- Imparting basic and refresher training to new and old employees respectively;
- Ensure that everyone, from management to production workers, understands sanitation and hygiene issues;
- No child and/or forced labor is allowable;
- No entrance of unauthorized people inside of the power plant without approval from the authority;
- Regular health checkup of the power plant workers and appropriate treatment facilities;
- Comply with GoB/DoE/BEPCL acts, regulations, codes and other statutory requirements that are currently in force including the amendments and new regulations that may come in future;

- The proposed project will comply with the emission and effluent standards of national regulations.

10.3.6.1 Measures to Prevent Occupational Diseases

The Occupational Health Survey of the employees in the proposed power plant shall be carried out at regular intervals.

- Regular monitoring of working environment and implementation of safety and control measures to prevent hazards and risks; and
- Use of protective equipment's, clothing, helmets, dust mask, shoes, etc.

10.3.7 Community Health and Safety

The community health risks and insecurity resulting from project implementation and subsequent increased community population and attendant demand on community health and educational facilities would be addressed as following:

- Improved community health facilities and management;
- Increased community health education and sensitization on potential health risks including emotional stress and sexually transmitted diseases (STD);
- Traffic and transportation management plan;
- Controlled community access to construction sites and restricted areas;
- Public security management plan involving improvement of the Police camp and operations;
- Institution of grievance mechanism to address emerging concerns; and
- Community Health and Safety Management Plan; and
- Implementation of CSR activities and regular monitoring.

10.4 Greenbelt Development

Development of a greenbelt or green area in and around the project site mitigates the potential negative impacts on the environment due to air emission, dust, fugitive emission and noise level. Presence of a green cover itself acts as containment for dust, lead to microclimate and soil quality balancing, by retaining of soil moisture, recharge of groundwater as well as self-control of microclimate of that area. It also improves the aesthetic value of the project area; later on, it becomes the natural habitat of various bird species.

To maintain the ecological balance in the proposed power plant project area, the project proponent already proposed an area of approximately 33.01% for the development of green area in the plant premises. The greenbelt can be developed outside of the project boundary as the Corporate Social Responsibility (CSR) activities with the discussion with the local community and Forest Department. The plant species suitable for greenbelt development need to be selected based on the following criteria:

- The scenario of planting arrangement and size should be based on the optimum use of available land;
- Plants suitable local/native fast growing trees to abate the pollution;
- No alien species would be planted;
- It should be tolerant to air pollutants present in the area mainly dust pollution;
- It should be evergreen in habitat having minimum of leaf fall;
- It should maintain ecological, land and hydrological balance of the region;
- Large leaf area index;
- Attractive appearance with good flowering and fruit bearing;
- Sustainable green cover with minimal maintenance; and
- Species which can trap/sequester carbon.

Areas in front of various buildings and the entrance of power plant would be landscaped with ground cover, plants, trees based on factors like climate, adaptability etc. The green belt would consist of native perennial green and fast growing trees. Trees would also be planted around the coal stockpile

area and ash disposal area to minimize the dust pollution. The following species can be planted in the proposed project site for Green Belt Plantation in the project area (Table 10-2).

Table 10-2: Species Recommended For Green Belt Plantation

SL#	Local Name	Scientific Name
1	Babla	<i>Acacia nilotica</i>
2	Bat	<i>Ficus bengalensis</i>
3	Bottle brush	<i>Callistemon viminalis</i>
4	Chandramalika	<i>Chrysanthemum coronarium</i>
5	Chimul	<i>Bombax ceiba</i>
6	Mahogany	<i>Swietenia mahagani</i>
7	Mandar	<i>E. Variegata</i>
8	Mango	<i>Mangifera indica</i>
9	Narkel/coconut	<i>Cocos nucifera</i>
10	Neem	<i>Azadirachta indica</i>
11	Rain tree	<i>Pithecolobium saman</i>
12	Tetul	<i>Tamarindus indica</i>

10.5 Rainwater Harvesting Plan

The proposed project area is located in the coastal area of Bangladesh and sufficient amount of rainfall occurs in the area. Adoption of the rainwater harvesting technology can reduce the pressure on consumption of water resources. It deals with the collection, storage and use of rainwater from open land and rooftops of the high-rise buildings. Rainwater harvesting helps in reducing the run-off, decrease pollution of groundwater and improve the groundwater table. However, the project proponent did not adopt the rainwater harvesting technology in the proposed power plant project.

10.6 Rehabilitation and Resettlement Plan

The proposed 350 MW coal-fired power plant project will be set up within the premises of the leased land from Iso Tech Electrification Company Limited and lease of government (Khas) land. However, all the lease land will be transferred to the project company in future except the government (Khas) land. According to the IEE report, the land requirement for the proposed project is approximately 174 acres. According to the preliminary RAP survey, approximately 112 number of household's needs to be displaced from the project site. This will necessitate the acquisition of the land and subsequent relocation of all legitimate project affected persons (PAPs) within the delineated project site including those who live on, have assets on, and or engage in commercial activities on the required land through a Resettlement Action Plan (RAP). According to the BEPCL, they have already initiated the Resettlement Action Plan (RAP) and Land Acquisition Plan (LAP) study in the proposed project site. The RAP will be conducted in accordance with the available rules, law, policy and guidelines of Bangladesh and requirements of the lenders safeguard policy, if any.

Implementation of the RAP in accordance with the requirements of national legislation and lender requirements is a significant issue in the pre-construction phase of the project. Some of the potential socio-economic concerns associated with land acquisition and involuntary resettlement was arise during the community consultation and it needs to be address during the RAP implementation. These are follows:

- Relocation of the PAPs to areas with fewer resources compared to the project site. This may include loss of farmland due to relocation to smaller parcels of land, absence of forests, fishing grounds etc.;
- The project proponent should ensure proper compensation before starting the site development activities;

- Involvement of local administration and ensure transparency in the rehabilitation, resettlement and compensation plan and procedures;
- Involuntary resettlement shall be avoided to the extent possible or minimized wherever feasible, exploring all viable alternative project designs;
- Where displacement is unavoidable, people losing assets, livelihood or other resources shall be assisted in improving or at a minimum regaining their former status of living at no cost to themselves;
- Community participation in planning and implementing resettlement should be encouraged;
- A detailed livelihood restoration plan needs to be prepared by the project proponent;
- Employment opportunities for the PAPs and preference should be given;
- Permanent employment opportunities for the PAPs based on their qualification and skill; and
- A CSR plan for the local community.

10.7 Thermal Pollution Management

Coal fired power plants constitute a major source of thermal pollution. Common causes of the thermal pollution is the flue gas has and use of water as a coolant by power plants. The proposed project will construct a stack considering 220 m height. The emitted gas will be rise to the upper atmosphere and attenuate at the upper atmosphere. It will not make any harm related to heat to the surroundings of lower atmosphere of Taltoli area.

The proposed coal-fired power plant will utilize a once-through cooling system for the condenser. For the cooling purposes, water will be withdraw from Buriswar-Payra River and heated water to be discharged into river thereby raising the water temperature by 7.5°C. Heated effluent will decrease the dissolved content of water resulting in death of fish and other aquatic organisms. The sudden fluctuation of temperature will also leads to "thermal shock" killing aquatic life that have become acclimatized to living in a steady temperature. Temperature changes cause total disruption to the entire ecosystem.

The following measures should be adapted by the proposed project to control thermal pollution caused by thermal discharge into the Buriswar-Payra River:

- Cooling water will be discharged back to the source water (Buriswar-Payra River) with almost no losses but at a higher temperature than the ambient water temperature;
- The heated effluents can be discharged into the River at one end and water for cooling purposes may be withdrawn from the other end;
- Thermal discharge from the power plant needs to be controlled to ensure that the discharge water temperature does not result in thermal pollution;
- After circulating water and heat exchange, it can be return to the river;
- RO concentrated water and circulating cooling effluent water can be mixed before discharge;
- The temperature of the condenser cooling water will be strictly maintained up to 3°C at the boundary of mixing zone;
- The IFC environmental guidelines for Thermal Power Plants state, "The effluent should result in a temperature increase of no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge when there are no sensitive aquatic ecosystems within this distance";
- The project proponent must ensure regular monitoring of surface water temperature near the discharge point; and
- A detailed fish survey for baseline data on fish population (abundance and richness) and behavior in the Buriswar-Payra River will be conducted by the BEPCL.

10.8 Coal Washery

Coal plays a major role for power generation all over the world. Coal is highly variable with respect to the physical and chemical properties that affect its use. Coal based power plants that use coal specify a range of properties that are required for their intended process. The quality and quantity of coal for

the proposed 350 MW coal fired power plant at Taltoli, Barguna are specified which to be carried by mother vessels through distant countries like Indonesia, Australia and South Africa.

Coal suppliers try to find coals that most closely match those requirements. For effective utilization, it is necessary to beneficiate them. Therefore, coal mines of South Africa, Australia and Indonesia has adapted to coal washery accompanied with other systems for processing the coal after mining. Coal is treated in a process called “beneficiation” to prepare a material that meets the customers’ need and is as homogenous as possible. According to the BEPCL, the proposed power plant project will use the washed coal. Therefore, coal washery will not be affecting the surroundings of the power plant.

10.9 Coal Yard Management

The imported coal will be the primary fuel for the proposed power plant operation. Annual total coal requirement for the proposed project is 1.1185 million tons. During the construction and management of coal yard following thing needs to be followed by the project authority:

- Ash yard structures should be designed considering flood, cyclone, self-heating, aeration and heavy wind resistant;
- The total quantity of coal shall be stored in separate stockpiles, with proper drains;
- Coal stacking should be done adopting standard practice to avoid auto ignition;
- Continuous monitoring of the inside temperature of coal stockpile;
- Fire hydrants will be provided in the coal yard at suitable locations;
- Water sprinkling system shall be installed on stocks of coal in required scales to prevent spontaneous combustion and consequent fire hazards;
- The stock geometry shall be adopted to maintain minimum exposure of stock pile areas towards predominant wind direction;
- The equipment's and conveying system in the coal handling plant should be properly maintained to avoid fugitive emission;
- Suitable dust extraction system will be provided;
- Care should be taken to control aerosol formation after water spraying;
- The runoff and wash off from the stockpile and coal unloading system should be treated properly before discharging it to open environment;
- The recommended practice is to fog spray or mist the stockpile surface as frequently as necessary to maintain the surface of the coal in moist condition, not in wet condition; and
- Provision of regular monitoring has to be kept for inspection in proper pathway with entry and exit should be provided in stockpile area and conveyor belt.

10.10 CDM Inlet

The CO₂ will be emitted from the proposed power plant project, which will be one of the major greenhouse gases. Since supercritical boiler technology has been considered for this project, the CO₂ emission is comparatively lower than other conventional coal based thermal power plant. For the same amount of carbon used, more electricity is generated. The supercritical technology is becoming standard practice day by days in the power industry in developed economies for large coal-fired power plants due to a higher efficiency than subcritical technology. The lifecycle costs of the supercritical power plants are lower than subcritical power plants. Due to the increased efficiency and operating costs of the supercritical power plant, the fuel costs are considerably lower. However, the costs about 2% more than a subcritical power plant. Supercritical power plants have lower emissions than subcritical power plants per unit of electricity generated. A 1% increase in efficiency reduces the specific emissions of nitrogen oxides, sulfur dioxide, particulates, and carbon dioxide by 2.5%–3.0%. More than 400 supercritical plants are operating in the United States, Europe, Russia, and Japan.

The use of ultra-supercritical technology is also an option for the project and would provide the highest coal combustion efficiency and lowest emission rate of the three alternative boiler technologies. Ultra-supercritical plants have been constructed in countries such as Denmark, Germany, Japan, and the United States to utilize high-quality coal. The installation of ultra-supercritical plants has not been widespread in developing countries, and as yet no such

plants operate on low-quality coal. The use of this technology in Bangladesh is constrained by: higher capital costs; limited suppliers for the boiler-turbine generator package, which restricts multi-company sourcing and the availability of spare parts; lack of local experience with the required technology; and reliability issues with respect to using coal with a very high ash content.

Based on the above considerations, the proposed project has adopted supercritical boilers with a rated super heater outlet steam pressure of 25.47 MPa(g), rated super heater outlet steam temperature of 571°C, rated reheat steam rated flow 879.71 t/h and rated hot reheat steam temperature of 569°C. These boilers are at the high end of supercritical technology. This technology, more expensive than subcritical plant, becomes economically viable when compared to subcritical technology if Clean Development Mechanism (CDM) under the Kyoto Protocol carbon credits are granted for the reduction in CO₂ emissions that will result.

The proposed project will harness the benefits of CDM as use of supercritical boilers for coal based power plant. The estimated CO₂ emission from the proposed project is about 1.85 million tones/year. However, several green building concepts will be used in the project. Therefore, implementing energy efficiency programs in power sectors and other electricity consumers not only makes the production cost-effective but also reduces greenhouse gas emissions. The recommendations for reducing greenhouse gas emission are given below:

- Use of high performance monitoring and process control techniques, good design and maintenance of the combustion system so that initially designed efficiency performance can be maintained. This will be achieved through online PM, SO₂, NO_x, CO, O₂ and CO₂ monitors in the stack.
- The township in the proposed project should be designed with 'Green Buildings' concept;
- Compact Fluorescent Lamps (lighting system), energy efficient refrigerators and air-conditioners, water-cooled screw type HVAC system, CFC and HCFC free refrigerants and chillers have been considered;
- Energy efficient building materials should be considered for construction of structures. For external walls and boundary wall fly ash bricks and blocks should be considered. Fly ash, which is a waste of power plant, should be mixed with cement to make concrete;
- Natural ventilation system comprising screen walls, low emissive double glazed glass with U value of less than 2.8 W/m²K, shading coefficient of 0.5 should be considered for the buildings;
- Moreover, green belt and spot green should be developed maximum allowable areas.

Energy efficient process and building structures should achieve 20% reductions in energy consumption. It is recommended that the project authorities should undertake yearly energy audit for their entire manufacturing process and ancillary facilities. Green banking should be promoted.

10.11 Budget for EMP

The capital cost for environmental management of the proposed plant is estimated to be BDT 44.5 million. Budget allocation of BDT 17 million will be required every year to meet the recurring expenditure for implementing the EMP excluding the monitoring. The following Table 10-3 shows the financial commitment of the BEPCL for various mitigation measures to ensure environmentally friendly operations of the proposed 350 MW coal-fired power plant at Taltoli, Barguna.

Table 10-3: Environmental and Social Mitigation Plan Estimated Costs

SL#	Description	Tentative Amount in BDT (in million)		
		Pre-construction	Construction	Operation/year
1	Dust pollution control (sprinkling)	0.2	1.5	5.0
2	Green Belt Development	-	2.5	1.0
3	Waste Generation and management	0.7	2.0	1.0

SL#	Description	Tentative Amount in BDT (in million)		
		Pre-construction	Construction	Operation/year
4	Drainage system management	2.0	1.0	0.2
5	Provision for PPE	0.3	2.0	0.5
6	Labor camp management	0.2	5.0	-
7	Controlling air pollution	0.5	2.0	-
8	Controlling GHG emission	0.1	0.5	1.0
9	Controlling noise pollution	0.5	1.0	-
10	Water resources management	-	0.5	-
11	Air pollution control system ESP, Low NOx burner, FGD, Stack	Included in project cost		
12	Occupational health management	0.5	2.0	0.2
13	Resettlement of the community	Included in project cost		
14	Socio economic development plant/CSR	-	-	5.0
15	Effluent Treatment Plan	Included in project cost		
16	Water Treatment Plant	Included in project cost		
17	Sewage Treatment Plant	Included in project cost		
18	Construction and maintenance of access roads with necessary infrastructures	-	-	2.0
19	Provision of first aid, clinic, ambulance and personnel	0.5	1.0	0.6
20	Contingency	0.5	0.5	0.5
Total		6	21.5	17

Note: These mentioned costs (e.g. the external cost) are tentative at the time of this study and might be changed during detail design of the project. The EPC contractor shall be appointed after obtaining of Environmental Clearance Certificate from DoE

10.12 Contingency Plans

10.12.1 Dolphin and Turtle Conservation Plan

Coal for the power plant will be transported by the water vessels (2,000 to 3,000 ton barges) from the offshore transshipment to the project site jetty (in the Buriswar-Payra River). The daily coal consumption for the proposed power plant is approximately 3304.84 tons. So we can say that, only one barge is enough to meet the daily coal requirement for the proposed project. However, the number of vessels movement in the project area will be increase during the coal transportation time. Considering the number of water vessels and motorized fishing boat in the area, the number is insignificant.

All shipping and barging activities shall ensure zero waste dumping, zero ballast water dumping, zero pollution causing activities as per the IMO Conventions and national Environmental Regulations. DG Shipping, BIWTA, Coast Guard should regularly inspect shipping and barging activities to enforce the relevant clauses of conventions and rules. In addition, the following measures should be taken in to account during shipping and barging activities and other project related activities during power plant operation:

- The project proponent must conduct a detailed study on Dolphins in the Buriswar-Payra River. At least one year monitoring should be conducted during construction and another one-year during operation phase of the project. Based on the suggestions from the study the monitoring duration will be changed or stopped;

- Avoid the dolphins and turtles movement path during dredging in the sea;
- Avoid dredging activities and movement of water vessels during surfacing, swimming time and season of Dolphin movement i.e. at dawn, evening and monsoon season;
- Protect the egg, breeding period and juvenile turtle of that region, if found;
- No trapping and killing of Dolphin and turtle in the project site;
- No waste water discharge from the power plant ETP and STP plant without treatment;
- Raw water intake point in the Buriswar-Payra River for the proposed power plant must be covered by the net so that no aquatic fauna can be affected by the water intake structure;
- Plan measures for accidental oil and chemical spillage from the power plant;
- Anchorage of water vessel only in designated sites;
- Throttle down vessel speed if dolphin activities are seen in navigational route;
- Keeping noise from vessels within the limit of ECR, 1997;
- Ensure the temperature of the cooling water in an acceptable limit before discharge into the Buriswar-Payra River; and
- Ensure zero waste dumping, ballast water, oily water etc. dumping to the Buriswar-Payra River.

10.12.2 Fisheries Resources Management Plan

The fisheries resources management plan has been developed with the aim of avoiding pollution causing activities and to protect fisheries of the Buriswar-Payra River and adjoining Bay of Bengal. The EMP includes the followings:

Measures for Navigational Activities in the Channel:

- Enforcement of ECR 1997, IMO Conventions, etc.;
- Ensure non dumping of ballast water, bilge water, non-spillage of oil, non-discharge of waste water and non-dumping of solid wastes;
- Awareness growing for fisherman and facilitate the fisherman to use nets/boats provided with signals and marking in the river;
- Reduce vessels speed if net is seen across the navigational route; and
- Fish migration and breeding season should be considered in planning.

Measures for Power Plant Operation:

- Should follow the EMP for effluent discharge from the power plant; and
- On-site wastewater should be treated in WTP, OWTP and STP to achieve maximum reuse and recycling.

Measures for Water Intake Structure:

- The project proponent must conduct a detailed study on fish in the Buriswar-Payra River. At least one year monitoring should be conducted during construction and another one-year during operation phase of the project. Based on the suggestions from the study the monitoring duration will be changed or stopped;
- The water supply pipeline intake point from the feeder canal should be provided with sufficient screening to filter out larger aquatic organisms (e.g., fish, frogs and toads) and foreign matter, preventing this material from being drawn into the pumps;
- Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible;
- The intakes for the water pumps in the main pump-house will meet the IFC guidelines, including recommended intake velocity of 0.15 m/s and a mesh size of 9.5 mm;
- Temporary water reservoir can be built for water storage rather than direct abstraction from the Buriswar-Payra River, especially during the Hilsa breeding time;
- Monitoring should continue during construction and operation phase of the proposed project to ensure that the deterrents are working effectively;
- Fish Conservation Program; and

- Enforcement of fishing ban in the Buriswar-Payra River during breeding/nursing period specially hilsa fish.

Measures for Water Discharge Structure:

- The project proponent must conduct a detailed study on fish in the Buriswar-Payra River. At least one year monitoring should be conducted during construction and another one-year during operation phase of the project. Based on the suggestions from the study the monitoring duration will be changed or stopped;
- Ensure the temperature of the cooling water in an acceptable limit before discharge into the Buriswar-Payra River;
- Avoid the fish breeding season and migration route dredging;
- Regular monitoring and ensure no fish death, disturb in the Buriswar-Payra river;
- No waste water discharge from the power plant ETP and STP plant without treatment; and
- Plan measures for accidental oil and chemical spillage from the power plant.

10.12.3 Drainage Study

During the field survey, a canal was found inside of the proposed project boundary, which is connected with the Buriswar-Payra River. However, it not a recoded canal in the land document and Mouza map. According to the field visit and consultation with the local community, the existing canal drains tidal water during high tide and low tide and excess rainfall water from the surrounding area. As per the project design, the canal need to be fill-up and a new canal will be excavated on the east side of the project boundary. According to the Chairman, Nishanbaria Union Parishad, due to the filling of the existing canal and improper drainage in the proposed project site, approximately 2,000 acres of agricultural land will be waterlogged. This waterlogging will not only affects agricultural production but also affects the settlement, homestead forest, livestock's and human health etc. in the project surround area. Therefore, the project proponent must ensure the alternative canal before filling the existing canal. Before implementation of the plan, a detailed drainage study will be required and following things needs to be considered:

- Inform local administration and consult with the local community before filling the existing canal;
- Consider the existing depth, width and use of the canal;
- Consider the height of the water level during high tide, low tide and cyclone events and seasonal variation;
- Site visits for reconnaissance survey and on the spot collection of data necessary for satisfactory completion of the area drainage study;
- Topographical survey and review of topographical features of the proposed power plant site and its surrounding area;
- Preparation of DEM for the study area for delineation of catchments and drainage network; and
- Review and analysis of rainfall information in the project area and its surrounding area to estimate the volume of rainfall runoff water.

10.12.4 Stakeholder Engagement Plan

10.12.4.1 Objectives and Principles

The project proponent or BEPCL will establish a stakeholder engagement plan for the proposed project that will be applicable for the entire project lifecycle. The plan will consider the analysis, mapping and feedback of consultations that have been undertaken for the project thus far. The stakeholder engagement plan will take into consideration the applicable legal framework for public disclosure in Bangladesh and lenders. The main objective of the plan will be to increase the effectiveness of BEPCL's relationships with all their stakeholders. This framework provides details on the general principles for BEPCL's stakeholder engagement as well as suggestions on the mechanisms and tools, which can be used.

10.12.4.2 Principles of Stakeholder Engagement

The BEPCL will commits to the following principles for effective and long-term engagement:

- Providing meaningful information in a format and language that is readily understandable and tailored to the needs of the target stakeholder group(s);
- Providing information in advance of consultation activities and decision-making;
- Providing information in ways and locations that make it easy for stakeholders to access it and that are culturally appropriate;
- Respect for local traditions, languages, gender sensitivities, timeframes and decision-making processes;
- Two-way dialogue that gives both sides the opportunity to exchange views and information, to listen, and to have their issues heard and addressed;
- Inclusiveness in representation of views, including ages, women and men, vulnerable and/or minority groups;
- Clear and simple mechanisms for responding to people's concerns, suggestions, and grievances; and
- Incorporating, where appropriate and feasible, feedback into project or program design and reporting back to stakeholders.

10.12.4.3 Implementation Plan

Based on the framework for stakeholder engagement planning, BEPCL will develop a detailed implementation plan with the following suggested information:

- Identification of key stakeholders that BEPCL considers most relevant on the basis of those provided in the EIA and developing mechanisms to engage with the same;
- Structure a stakeholder engagement program that will describe the most culturally appropriate mechanisms to consult the prioritized stakeholders;
- Provide a schedule outlining dates and locations when various stakeholder engagement activities will be conducted;
- Indicate what staff and resources will be devoted to managing and implementing the company's Stakeholder Engagement Program;
- Describe in detail the Grievance Mechanism that has been finalized by the senior management in consultation with local communities; and
- Describe any plans to involve project stakeholders (including affected communities) or third-party monitors in the monitoring of project impacts and mitigation programs.

The Implementation Plan will include a clear plan of actions with deadlines and responsibilities in order to assure the maximum engagement level for all relevant stakeholders.

10.12.4.4 Grievance Management Procedure

The proposed project owner or BEPCL will adopt the Community Grievance Procedure outlined below, which requires interaction, consultation, targeted information and timely resolution of legitimate grievances. This approach is aimed at building a reputation of responsiveness, concern and responsibility among the community, with a view to building and sustaining acceptance and support for the pre-construction, construction and operation of the proposed 350 MW coal-fired power plant project at Taltoli, Barguna.

The BEPCL and its Contractor(s) shall foster a sense of working with the local community and demonstrate that the proposed project takes a proactive stance to grievances. The grievance management system and database will comply with and has the flexibility to feed information into the Community Grievance Procedure. The project proponent will also provide all Contractor(s) teams with training in Community Grievance Procedures. The following Figure 10-1 shows the community grievance management procedure that will be followed for the proposed project.

Figure 10-1: Community Grievance Management Procedure



In implementing BEPCL's Community Grievance Procedure, the Contractor(s) shall:

- All grievances record using the template of the grievance form;
- Assess and advise the resolution of the grievance in the time frame required by the assessment;
- All grievances will be investigated and a response (outlining a resolution) provided by BEPCL/ Contractor(s) as soon as possible and not more than 30 days after receiving the grievance. If more time is required for resolution, the person raising the grievance and BEPCL shall be kept informed;
- While the Contractor(s) is not prevented from initiating the grievance resolution, any corrective action taken must be in coordination with BEPCL;
- BEPCL, through the Community Liaison Officer, will ensure that the details of the Community Grievance Procedure are publicized at community meetings and via posters and other means to all communities in the vicinity of the proposed project;
- In addition, BEPCL and its Contractor(s) shall ensure that the local populations working/residing in the local area receive necessary information for contacting and initiating a grievance through meetings, pamphlets and similar community outreach programs under the direction of the Community Liaison Officer; and
- BEPCL and its Contractor(s) shall ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of this plan. The Contractor Plan shall describe the resources allocated to and responsibility for the execution of each task and requirement contained therein, and shall describe how roles and responsibilities are communicated to relevant personnel.

10.12.4.5 Commitment Register

BEPCL should develop a commitment register to record, implement and track any public commitment or request that is made to the project's stakeholders. This includes any requests of direct development interventions, expectations on employment, petty procurement etc.

10.12.4.6 Roles and Responsibilities

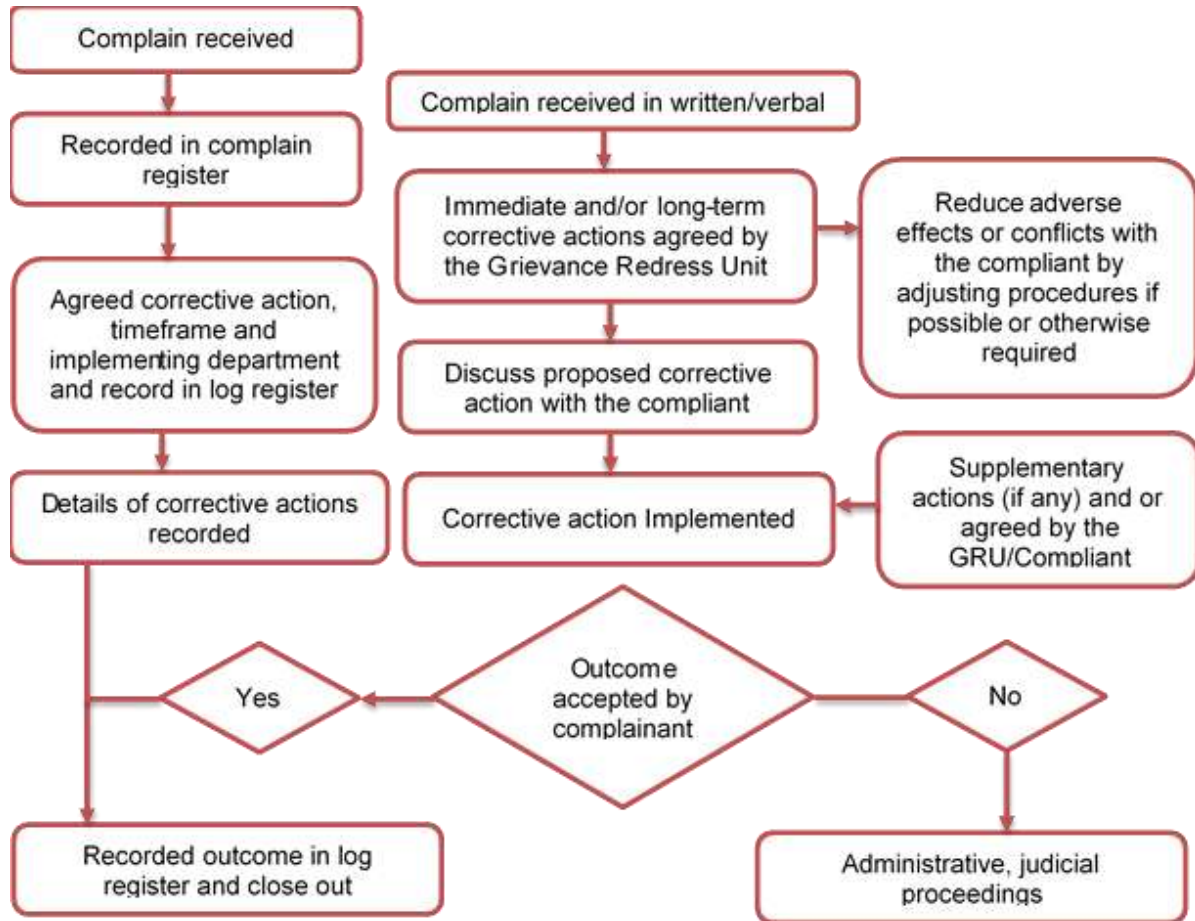
Stakeholder engagement will be on going throughout the entire project lifecycle and will be coordinated across project activities and contractors by designated personnel the community relations team. The Community Relations team will support the EHS Coordinator/officer in implementing the Environmental and Social Management and Monitoring Plan and will lead the stakeholder engagement process, which will have the following tasks:

- Interface between BEPCL, contractors, sub-contractors and the local community;
- Disclosure of project specific information for all components to village settlements within the footprint area and other external groups as required;
- Establish a mechanism to obtain, report, redress and monitor all grievances from the local community;
- Regular engagement with key informants and local leaders to ensure a transparent feedback process in to the project; and

- To plan, implement and evaluate community development programs.

The Community Relations Team will consist of Two (02) personnel who would coordinate with the overall Environmental and Social Manager. This will include the Community Relations Officer and the Human Resources Officer.

Figure 10-2: Grievance Redressal Mechanism



10.12.4.7 Community Development

BEPCL's personnel will commence the process of identification of community support projects. All the activities will be streamlined under the framework of stakeholder engagement to develop a detailed Community Development Plan, which looks into options of CSR activities and social investments and suggests models of interventions to suit the needs of the community.

To the extent possible the CSR activities should be relevant to the needs of the locality and in no case should be detrimental to the environment and social sensitivities of the project area. These plans and activities are to be implemented in consultation with the local community. The plan will also include indicators for regular monitoring of these development activities in order to assess their impacts and to suggest changes in the approach.

10.12.4.8 Monitoring and Evaluation

BEPCL will monitor the principles and commitments of the stakeholder engagement process and will need to report on the status of implementation of different aspects, such as information disclosure, grievance redressal etc. Engagement levels can be monitored by developing a set of indicators, which will include:

- Number and Type of Communications and Issues discussed;
- Frequency of communications;
- Type, subject and number of grievances;
- Sources of complaints;

- Average time taken to resolve and close grievances;
- Number of presentations and frequency on EHS and economic status of the company;
- Number and diversity of stakeholders involved per action;
- Comments on any disclosed documents/presentations;
- Level/degree of involvement for stakeholders;
- Partnerships with stakeholders; and
- Number of mass media articles/announcements.

10.12.4.9 Performance Indicators

The following Table 10-4 outlines the indicators used for measuring and verifying performance in relation to community engagement. However, BEPCL may modify or add to these indicators to enhance the plan based on learning from the performance indicators.

Table 10-4: Performance Indicator in Relation to Community Engagement

SL#	Performance Indicator	Measures	Internal assessment frequency
1	Maximum use of the project community grievance procedure	Number of grievances (except those related to workers issues) channeled through the community grievance procedure	Monthly
2	Resolution of community grievances	Number of grievance resolved (from the project perspective) within 30 days, categorized according to cause of grievance	Monthly
3	Disruption of work	Number or hours/days lost due to community disruption categorized according to the cause of disruption	Based on disruption
4	Compensation payments	Amount of compensation paid as a result of project impacts	Monthly

CHAPTER ELEVEN: RISK ASSESSMENT

11. Risk Assessment

11.1 Introduction

This chapter deals with various types of hazard analysis and finding a Risk Assessment (RA) in the proposed 30 MW coal-fired power plant at Taltoli, Barguna. The safe working operation of the plant needs to identify the hazards, assess the associated risks and bring the risks to tolerable level on a continuous basis. There are several unsafe conditions, practices in various process and equipment of the coal-fired power plant lead to a number of accidents, which can cause loss and injury to human lives, damages the property, interrupt production etc. A risk assessment is an important step in protecting the plant from such conditions. It helps us to focus on the risks that really have the potential to cause harm. The hazard resolution process is to assess the identified hazards in terms of the severity or consequence of the hazard and the probability of occurrence of each type of hazard. Risk classification by severity and probability can be performed by using a risk assessment matrix. Hazard can happen because of the nature of chemicals handled and also the nature of process involved. Therefore, for risk analysis first step is to identify the hazardous chemicals, which are to be studied for risk analysis. It involves the identification and assessment of risks at the project site and in the neighboring population who could get exposed to, as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc.

In this EIA report, detailed assessment has been carried out to identify and mitigate the potential hazard associated with construction and operation of the power plant.

11.2 Objective of the Risk Assessment Study

The overall objective of this risk assessment with respect to the proposed project involves identification and evaluation of major risks, prioritizing risks identified based on their hazard consequences and using the outcome to guide and strengthen both onsite and offsite Emergency Response Plan (ERP). Hence, in order to ensure effective management of any emergencies that may arise from failure of various fuel storages or others natural and manmade disasters. The following specific objectives need to be achieved:

- Identify potential risk scenarios that may arise from storage of volatile fuels in the power plant;
- Review existing information and historical databases to arrive at possible likelihood of such risk scenarios;
- Predict the consequences of such potential risks scenarios and if consequences are observed to be high, establish the same through application of quantitative simulation; and
- Recommend feasible preventive and risk mitigation measures as well as provide inputs for strengthening of the project Emergency Response Plan (ERP).

11.3 Risk Assessment Process

The risk assessment process is primarily based on likelihood of occurrence of the risks identified and their possible hazard consequences particularly being evaluated through hypothetical accident scenarios. With respect to the proposed project, major risks viz. leak and rupture of storage tanks and pipelines been assessed and evaluated through a risk matrix generated to combine the risk severity and likelihood factor. The overall approach of risk assessment is summarized below in Figure 11-1.

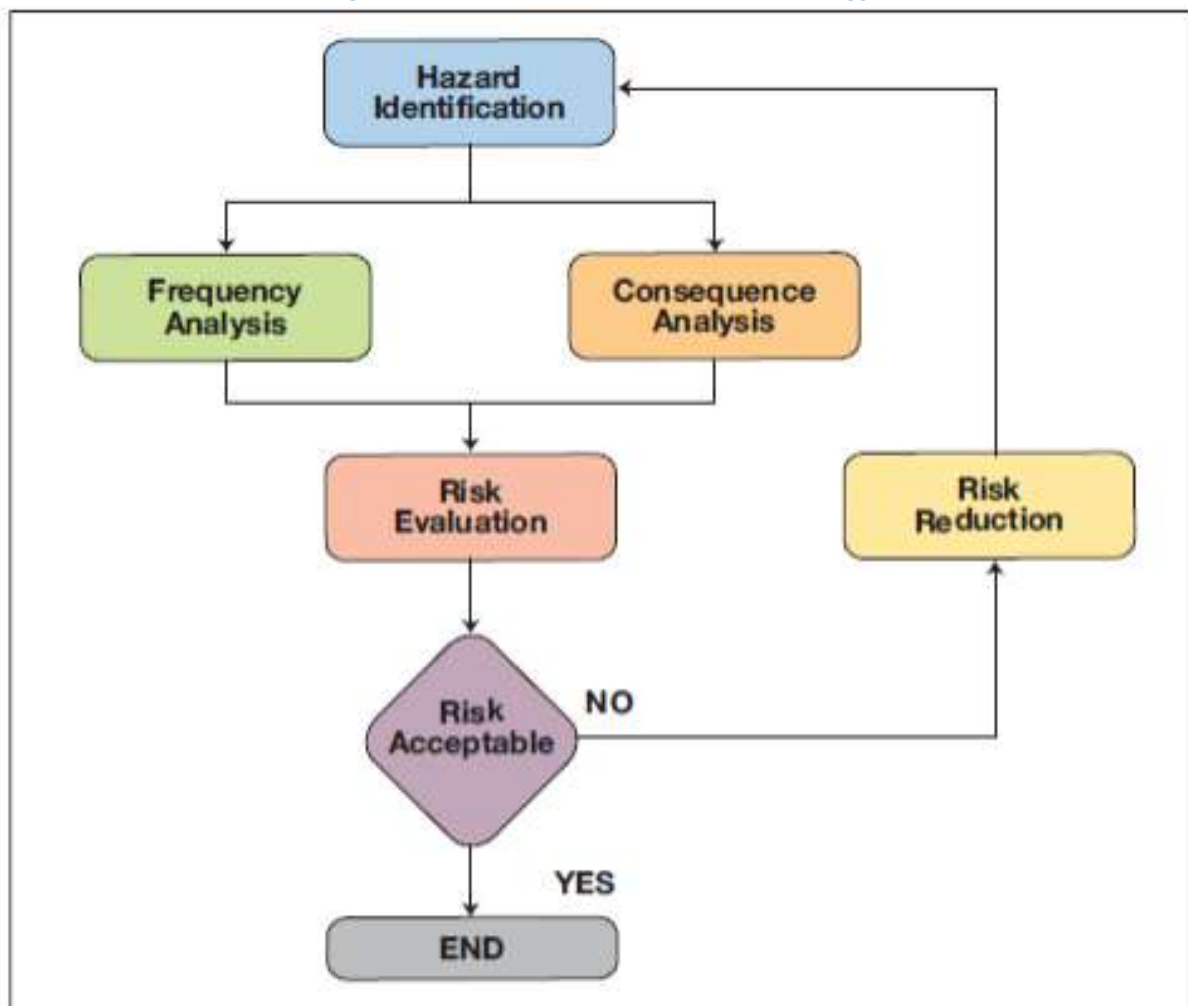
11.4 Hazard Identification

Potential hazards have been identified depending on its effect on health and environmental consequences. The location and types of the substances, physiochemical properties and adjacent key points are important for such study. The following categories of hazards can be identified:

- **Physical Hazards** (e.g. electrical, ergonomic/manual handling, mechanical, thermal, electromagnetic, noise, vibrations, radiations, working at height, lifted loads etc.);
- **Chemical Hazards** (e.g. toxic, corrosive, harmful, flammable, oxygen depletion by inert substance, hazardous for the environment etc.); and

- **Biological Hazards** (e.g. alien evasive species, bacteria/virus in biological wastes etc.) Information related to hazard identification can be obtained from the manufacturer's instructions or data sheets for chemicals and equipment and any history of Environment, Health and Safety (EHS) events for the activity.

Figure 11-1: Risk Assessment Methodology



11.5 Potential Hazard and Risk during different stages

Major potential hazard has been identified for the proposed 350 MW coal-fired power plant. The potential hazards and risk during pre-construction, construction and operation of the proposed power plant are given in Table 11-1 and Table 11-2.

Table 11-1: Potential Hazard and Risk during Pre-construction and Construction Phase

Location of Hazard	Project Activities	Potential Hazard	Root Causes	Consequences
Pre-construction Phase				
▪ Machinery and equipment	▪ Bringing in machines, equipment and vehicles for site clearance activities	▪ Trips and falls ▪ Cuts and bruises	▪ Fatigue or prior sickness ▪ Mechanical failure ▪ Lack of safety training ▪ Not abiding to general health and safety and traffic rules	▪ Health injury ▪ Disability ▪ Life loss
Construction Phase				
▪ Construction site	▪ Construction of building, steel structures and its foundation, cutting, welding, painting works, drilling work etc.	▪ Accidents (burns), electric shocks etc.) ▪ Injuries from falls and slips ▪ Cuts and bruises	▪ Fatigue or prior sickness ▪ Electric failure ▪ Equipment failure ▪ Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) ▪ Not maintain a designated place for backfilling storage ▪ Not maintaining enough lighting during the night (for those working overtime)	▪ Physical injury ▪ Disability ▪ Life loss
	▪ Work at heights	▪ Accidents ▪ Injuries from falls and slips (e.g. broken bones, fractures, traumas, etc.) ▪ Fatalities	▪ Fatigue or prior sickness ▪ Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) ▪ Not maintain a designated place for backfilling storage ▪ Not maintaining enough lighting during night	▪ Health injury ▪ Disability ▪ Life loss
	▪ Vehicles movement	▪ Noise generation ▪ Accident ▪ Emission from vehicles ▪ Spread of dust and minute particles due to vehicle movement	▪ Running engine, hydraulic horns, sirens etc. ▪ Mechanical failure ▪ Old engine or engine parts/lack of maintenance	▪ Injuries ▪ Health problems (e.g. respiratory, hearing and/or cardiac problems) ▪ Fatalities ▪ Disabilities

Location of Hazard	Project Activities	Potential Hazard	Root Causes	Consequences
	- Chemical storage area - Handling of hazardous chemical	- Accidental release of chemicals - Acute/chronic toxicity from exposures to chemicals - Fire/explosion	- Lack of safety protocols - Carelessness (e.g. smoking near chemical storage area) - Not proper bounding of chemical storage area - Improper chemical storage (e.g. faulty/leaky containers, improper containers, improper sealing of containers etc.)	- Health injuries (burns, anxiety, depression etc.) - Disabilities - Fatalities - Loss of properties
	Occupational Hazard	- Cuts, bruises, and burns - Falls, slips, and tips - Health injuries - Sickness and illness	- Lack of safety awareness - Not use of PPE - Carelessness in maintaining safety protocols - Use of faulty machineries and equipment - Improper hygiene - Prior sickness or illness - Heavy workload	- Health injuries (burns, anxiety, depression etc.) - Disabilities - Fatalities

Table 11-2: Potential Hazard and Risk during Operation Phase

Location of hazard	Project Activities	Potential Hazard	Root Causes	Consequences
Machinery and equipment	Plant operation	- Mechanical hazard - Fire hazard/explosion - Electrical hazard - Noise generation	- Mechanical failure - Lack of sound buffers	- Health injury - Fatalities - Property damage - Environmental pollution
- Boilers and pressure parts - Compressed air system and pipeline - Furnace area - Coal supply system - Oil handling and storage tanks area	- Operate pressure valve, switch, and control system - Flows live high pressure steam from boiler to distillation unit	- Fire - Release of high- pressure steam - Explosion	- Failure of water pumps - Electric failure - Equipment failure - Mechanical failure of safety valves - Steam pipe crack - Accidental leakage, lack of heat sink for combustion process and non-functional safety and bypass valve.	- Incomplete combustion - Equipment damage - Health injury - Loss of life - Environmental pollution - Disability - Life loss
Chemical Storage	Use for water treatment in different	Toxic accidental releases due to malfunction of	- Chemical spillage - Chemical fire	Health injury (chronic or acute toxicity)

Location of hazard	Project Activities	Potential Hazard	Root Causes	Consequences
	phases of demineralized water, cooling water and potable water	equipment. ▪ Carelessness of the operator.	▪ Mishandling and operational error	▪ Disabilities ▪ Loss of life ▪ Environmental pollution
▪ Inside boiler furnace	▪ Operate pressure valve, switch, and control system	▪ Asphyxiation	▪ Deficient supply of oxygen ▪ High concentration of CO, toxic vapors etc.	▪ Suffocation ▪ Unconsciousness ▪ Coma and Death
▪ Tank farm	▪ Storing fuel oil and raw material	▪ Explosion ▪ Pool fire ▪ Toxic vapor cloud ▪ Shockwave	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Instrumental malfunction ▪ Improper maintenance	▪ Health injuries ▪ Disabilities ▪ Fatalities ▪ Environmental pollution
▪ Receipt and dispatch section, loading	▪ Transportation of raw materials	▪ Accident ▪ vessel capsizing	▪ Improper traffic control of vehicles and vessels ▪ Overspeeding of vehicles	▪ Injuries ▪ Death
▪ ETP	▪ Waste water treatment	▪ Toxic chemical release	▪ Spillage/accidental release ▪ Improper management	▪ Impact on health ▪ Loss of life ▪ Environmental pollution
▪ STP	▪ Sewage treatment	▪ Sewage leakage ▪ Health hazard	▪ Bacterial exposure ▪ inflammation ▪ gastrointestinal tract	▪ Illness ▪ Health injury (chronic or acute inflammation)
▪ Occupational hazard	▪ Plant operation	▪ Cuts, bruises, and burns ▪ Falls, slips, and tips ▪ Health injuries ▪ Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Improper hygiene ▪ Prior sickness or illness ▪ Heavy workload	▪ Health injuries ▪ Disabilities ▪ Fatalities ▪ Sickness ▪ Anxiety and depression

11.6 Hazardous Chemicals

As per feasibility study, the project will use significant quantity of HSD, HCl and NaOH during operation period of the power plant. In most of the cases, stored quantities of liquid fuel and chemicals are considered in hazard identification. Major flammable chemical tanks present in BEPCL power plant site is presented in Table 11-3.

Table 11-3: List of Fuel Tank in the Power Plant

Tank	No of tank	Diameter (m)	Height (m)	Capacity (m3)
Storage tank	2	11.5	13.3	1000

Source: BEPCL, 2018

11.7 Storage Scenario Development

The identification of specific scenarios is based on the assessment of likely events and incidence of failures. Fire and chemical release may occur due to the storage of fuel and chemicals. Those potential hazardous chemicals, in case of failure of the systems, the likely incidents to occur are listed in following Table 11-4.

Table 11-4: Incident Considered for Consequence Analysis

Fuel/Chemicals	Incident
HSD	Pool fire and tank top fire
CI	Puddle inside the bund

11.8 Frequency Analysis

The frequency analysis of the hazards identified with respect to the proposed project was undertaken to estimate the likelihood of their occurrences during the project life cycle. Hazard frequencies in relation to the proposed project were estimated based on the analysis of historical accident frequency data and professional judgement. Based on the range of probabilities arrived at for different potential hazards that may be encountered with respect to the storage of diesel, the following frequency categories and criteria have been identified (Table 11-5).

Table 11-5: Frequency Categorizes and Criteria

Likelihood Ranking	Criteria Ranking (cases/year)	Frequency Class
5	Likely to occur often in the life of the project, with a probability greater than 10^{-1}	Frequent
4	Will occur several times in the life of project, with a probability of occurrence less than 10^{-1} but greater than 10^{-2}	Probable
3	Likely to occur sometime in the life of a project with a probability of occurrence less than 10^{-2} but greater than 10^{-3}	Occasional/Rare
2	Unlikely but possible to occur in the life of a project, with a probability of occurrence less than 10^{-3} but greater than 10^{-6}	Remote
1	So unlikely it can be assumed that occurrence may not be experienced, with a probability of occurrence less than 10^{-6}	Improbable

Source: Guidelines for Developing Quantitative Safety Risk Criteria – Centre for Chemical Process and Safety

11.8.1 Frequency Analysis- Diesel Storage Tank

The most credible scenario of a thermal power plant tank will be pool fire. In order to determine the probability of a pool fire occurring, the failure rate needs to be modified by the probability of the material finding an ignition source. The probability of a pool fire occurring in the event of a release is therefore equal to the product of the failure rate and the probability of ignition. Diesel Tank failure frequency is given in following Table 11-6.

Table 11-6: Diesel Tank Failure Frequency

SL#	Types of Release	Failure Rate	Frequency
1	Catastrophic Tank Failure	5.0×10^{-6}	Remote
2	Small Bund Fire	9.0×10^{-6}	Remote
3	Large Bund Fire	6.0×10^{-6}	Remote

Source: OGP Risk Assessment Data Directory Report No 434 – 3, March 2010, Section-2 – Summary and Recommendation Data

11.9 Consequence Analysis-Tankages

The facilities at the Fuel Dyke area terminal mainly comprise of Diesel storage tanks. The hazards posed by it is mainly in the fire. There is a possibility of pool fire taking place in the event of large spill of hydrocarbons, mainly major failure scenarios were evaluated to assess the effect on people and property inside the plant area as well as outside.

The effect of fire on people and property outside will chiefly manifest itself in the form of thermal radiation. A criterion was selected for deciding the maximum level of thermal radiation to which the outside population can be subjected. Thermal radiation levels from fire scenarios of each tank are worked out at various distances and their effects are evaluated against the set criteria.

The main hazards associated with the storage and handling of fuels are pool fires resulting from the ignition of released material as well as explosions. Hazardous chemicals also can be released following tank overfilling and leaks/failures in the storage tank and ancillary equipment such as transfer pumps, metering equipment, etc. Fuel oil is a combustible liquid, which will burn if the temperature of the liquid exceeds the flash point and the vapor generated at the liquid surface is ignited. The resultant incident is a pool fire that radiates heat to the surrounding area resulting in potential equipment damage and or injury/fatality. Fuel oil is also a contaminant to the biophysical environment and its release can damage sensitive environmental areas surrounding the storage area in the event a leak occurs and escapes to the environment. Fuel will also float on water and be carried a significant distance from a leak point by a watercourse.

Damage Due to Fire

The flammable liquid in a pool will burn with large turbulent diffusion flame. This releases heat based on the heat of combustion and the burning rate of the liquid. A part of heat is radiated while the rest is convected away by rising hot air and combustion products. The radiations can heat nearby storage or process units to above their ignition temperatures and thus result in spread of fire.

The radiation can also cause severe burns or fatalities to workers or firefighters located within a certain distance. Hence, it will be important to know beforehand the damage potential of flammable liquid pool likely to be created due to leakage or catastrophic failure of storage or process vessel. This will help decide the location of other storage/process vessels, decide the protective clothing the workers/ firefighters need, the duration of time for which they can be in the zone, the fire extinguishing measures needed and the protection methods needed for nearby storage vessels. Effect of thermal radiation on equipment and people is tabulated in Table 11-7.

Table 11-7: Effect of thermal radiation on equipment and people

SL#	Incident Radiation (kw/m ²)	Type of damage caused	
		Damage to Equipment	Damage to People
1	37.5	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50% Lethality in 1 min. Significant injury in 10 sec.
3	19.0	Maximum thermal radiation	-

SL#	Incident Radiation (kw/m ²)	Type of damage caused	
		Damage to Equipment	Damage to People
		intensity allowed on thermally unprotected adjoining equipment	
4	12.5	Minimum energy to ignite with a flame; melts plastic tubing	1% lethality in 1 min. First-degree burn in 10 sec
5	4.5	-	Causes pain if duration is longer than 20 sec, but blistering is unlikely
6	1.6	-	Causes no discomfort on long exposures

Source: Techniques for Assessing Industrial Hazards, World Bank Technical Paper 55

11.9.1 Risk Modeling Scenarios

ALOHA modeling software was used to assess risk. ALOHA (Areal Locations of Hazardous Atmospheres) is a modeling program that estimates threat zones associated with hazardous chemical releases, including toxic gas clouds, fires, and explosions. A threat zone is an area where a hazard (such as toxicity) has exceeded a user-specified Level of Concern (LOC). ALOHA is part of the CAMEO® software suite of products for emergency responders and planners.

Accidental release of fuel from Diesel tank can create a pool fire in presence of an ignition source. Following an accidental release, fuel will form a confined pool within the dyke area. If the vapor above the pool ignites, the liquid will burn as a pool fire. The pool fire will result in thermal radiation. It could also damage the storage tanks located within the common dyke area. The pool fire simulation scenarios for the major tanks of the power plant are given in the following sub-section.

11.9.2 Diesel Storage Tank

Oil stored in diesel storage tank 1 and 2 at ambient temperature and atmospheric pressure. For diesel storage tank, only pool fire scenario from tank leakage has been considered.

11.9.2.1 Pool Fire: leak size 200 mm

Site Data:

Criteria	Description
Location	Barguna, Barisal, Bangladesh
Building Air Exchanges Per Hour	0.5 (user specified)
Time	October 20, 2018, 1342 hours ST
ATMOSPHERIC DATA	MANUAL INPUT OF DATA
Wind	8.9 meters/second from SSW at 10 meter
Ground Roughness	Cloud Cover: 0 tenths
Air Temperature	35° C
Inversion Height	No
Relative Humidity	75%

SOURCE STRENGTH:

- Statement 1: Leak from hole in vertical cylindrical tank
- Statement 2: Flammable chemical is burning as it escapes from tank

Criteria	Description

Criteria	Description
Tank Diameter	11.5 meters
Tank Length	13.3 meters
Tank Volume	1,381 cubic meters
Internal Temperature	35° C
Chemical Mass in Tank:	987 Tons (Tank is 90% full)
Circular Opening Diameter:	20 centimeters
Burn Duration:	ALOHA limited the duration to 1 hour
Result	
Max Flame Length	24 meters
Max Burn Rate	1390 kilograms/min
Total Amount Burned	82,477 kilograms
Puddle spread diameter	19.8 meter

Note: The chemical escaped as a liquid and formed a burning puddle.

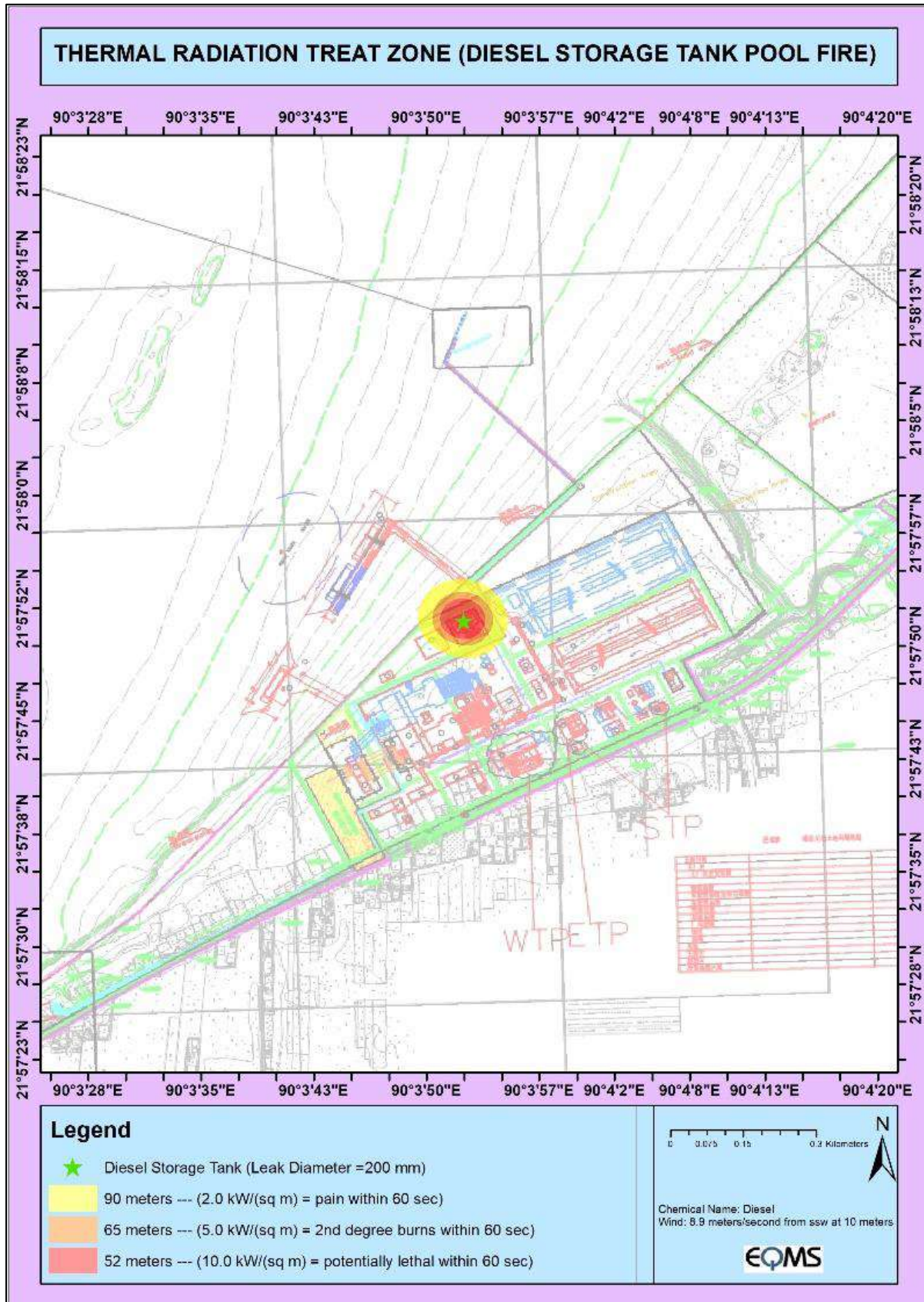
THREAT ZONE:

- Threat Modeled: Thermal radiation from pool fire

Legend	Diameter (m)	Indicated radiation (kW/m ²)	Remarks
Red	52	10.0	Potentially lethal within 60 sec
Orange	65	5.0	2 nd degree burns within 60 sec
Yellow	90	2.0	Pain within 60 sec

The pool fire thermal radiation threat zone of the power plant diesel tank is presented in Figure 11-2.

Figure 11-2: Pool Fire Thermal Radiation Threat Zone for Diesel Tank Leakage (20 cm)



11.9.2.2 Pool Fire: leak size 400 mm**Site Data:**

Criteria	Description
Location	Barguna, Barisal, Bangladesh
Building Air Exchanges Per Hour	0.5 (user specified)
Time	October 20, 2018, 1342 hours ST
ATMOSPHERIC DATA	MANUAL INPUT OF DATA
Wind	8.9 meters/second from SSW at 10 meter
Ground Roughness	Cloud Cover: 0 tenths
Air Temperature	35° C
Inversion Height	No
Relative Humidity	75%

SOURCE STRENGTH:

- Statement 1: Leak from hole in vertical cylindrical tank;
- Statement 2: Flammable chemical is burning as it escapes from tank.

Criteria	Description
Tank Diameter	11.5 meters
Tank Length	13.3 meters
Tank Volume	1,381 cubic meters
Internal Temperature	35° C
Chemical Mass in Tank	987 Tons (Tank is 90% full)
Circular Opening Diameter	40 centimeters
Burn Duration	ALOHA limited the duration to 1 hour

Results	
Max Flame Length	40 meters
Max Burn Rate	5560 kilograms/min
Total Amount Burned	329909 kilograms
Puddle spread diameter	40 meter

Note: The chemical escaped as a liquid and formed a burning puddle.

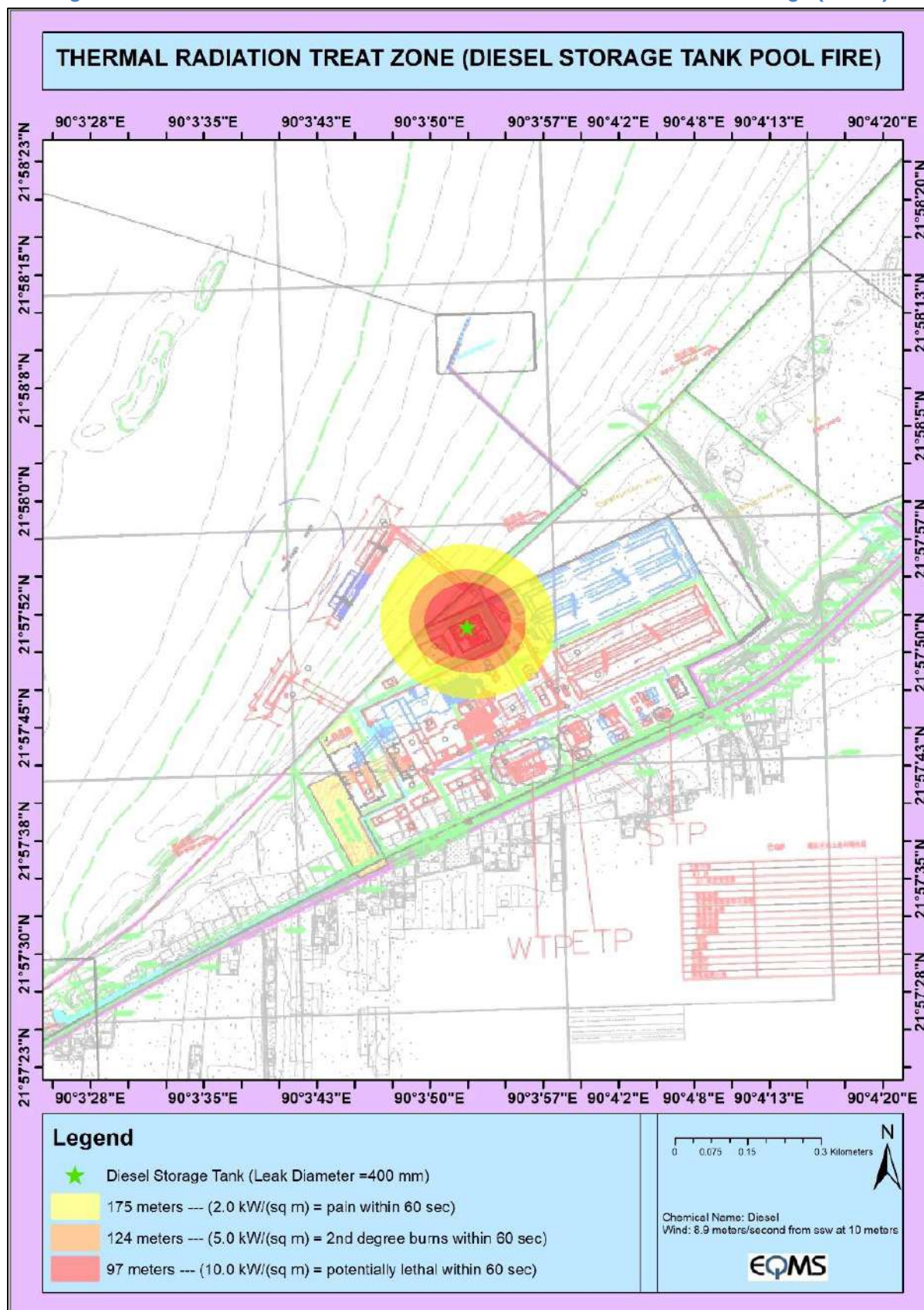
THREAT ZONE:

- Threat Modeled: Thermal radiation from pool fire

Legend	Diameter (m)	Indicated radiation (kW/m ²)	Remarks
Red	97	10.0	Potentially lethal within 60 sec
Orange	124	5.0	2 nd degree burns within 60 sec
Yellow	175	2.0	Pain within 60 sec

The pool fire thermal radiation threat zone of the Diesel storage tank is shown in Figure 11-3.

Figure 11-3: Pool Fire Thermal Radiation Threat Zone for Diesel Tank Leakage (20 cm)



11.9.2.3 Pool Fire: leak size 800 mm**Site Data:**

Criteria	Description
Location	Barguna, Barisal, Bangladesh
Building Air Exchanges Per Hour	0.5 (user specified)
Time	October 20, 2018, 1342 hours ST
ATMOSPHERIC DATA	MANUAL INPUT OF DATA
Wind	8.9 meters/second from SSW at 10 meter
Ground Roughness	Cloud Cover: 0 tenths
Air Temperature	35° C
Inversion Height	No
Relative Humidity	75%

SOURCE STRENGTH

- Statement 1: Leak from hole in vertical cylindrical tank
- Statement 2: Flammable chemical is burning as it escapes from tank

Criteria	Description
Tank Diameter	11.5 meters
Tank Length	13.3 meters
Tank Volume	1,381 cubic meters
Internal Temperature	35° C
Chemical Mass in Tank	987 Tons (Tank is 90% full)
Circular Opening Diameter	40 centimeters
Burn Duration	ALOHA limited the duration to 1 hour
Results	
Max Flame Length	68 meters
Max Burn Rate	22,500 kilograms/min
Total Amount Burned	3447,696 kilograms
Puddle spread diameter	80 meter

Note: The chemical escaped as a liquid and formed a burning puddle.

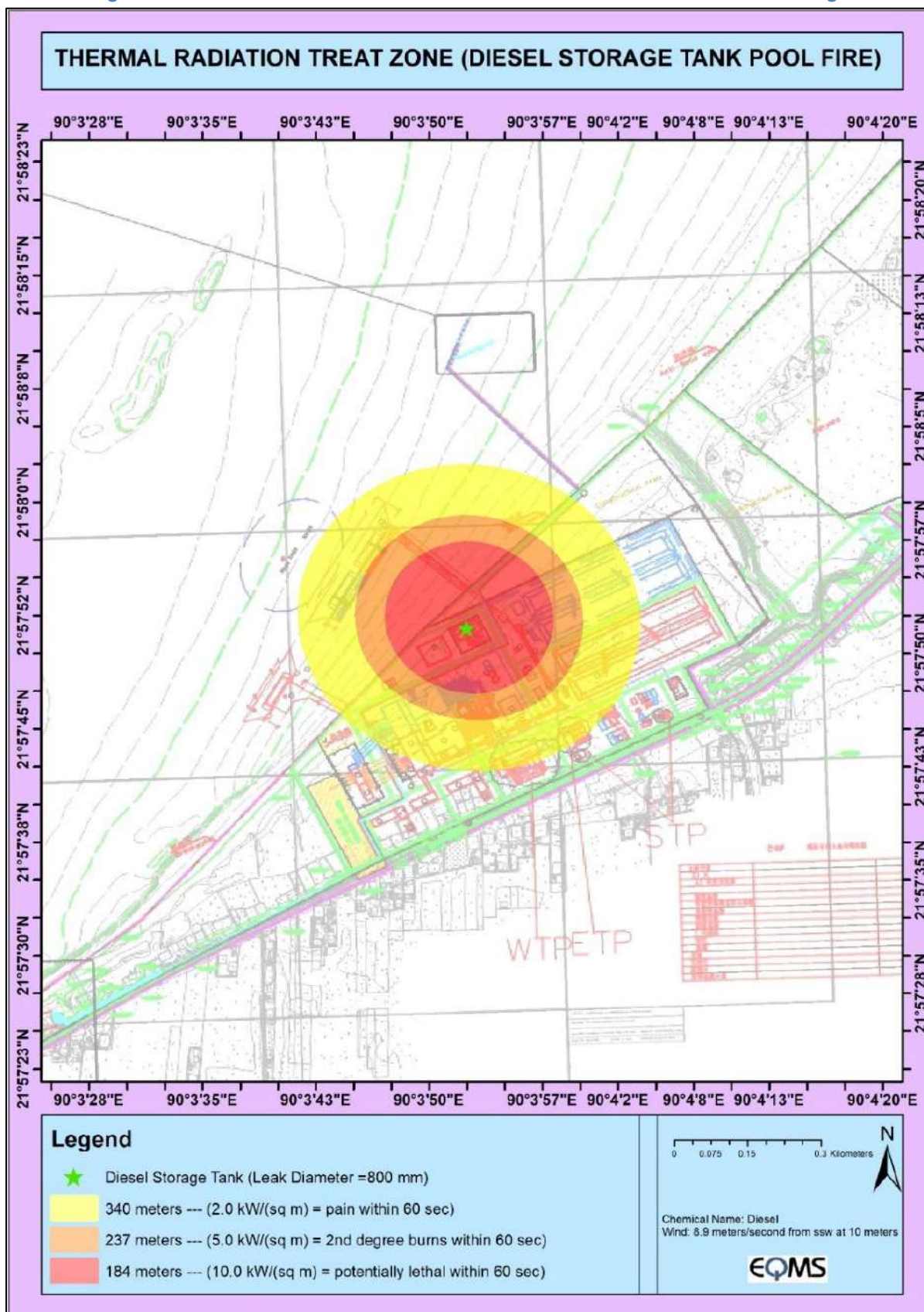
THREAT ZONE

- Threat Modeled: Thermal radiation from pool fire

Legend	Diameter (m)	Indicated radiation (kW/m ²)	Remarks
Red	184	10.0	Potentially lethal within 60 sec
Orange	237	5.0	2 nd degree burns within 60 sec
Yellow	340	2.0	Pain within 60 sec

The pool fire thermal radiation threat zone of the Diesel storage tank is shown in Figure 11-4.

Figure 11-4: Pool Fire Thermal Radiation Threat Zone for Diesel Tank Leakage



11.9.2.4 Pool fire: Leak size 1600 mm**Site Data:**

Criteria	Description
Location	Barguna, Barisal, Bangladesh
Building Air Exchanges Per Hour	0.5 (user specified)
Time	October 20, 2018, 1342 hours ST
ATMOSPHERIC DATA	MANUAL INPUT OF DATA
Wind	8.9 meters/second from SSW at 10 meter
Ground Roughness	Cloud Cover: 0 tenths
Air Temperature	35° C
Inversion Height	No
Relative Humidity	75%

SOURCE STRENGTH

- Statement 1: Leak from hole in vertical cylindrical tank
- Statement 2: Flammable chemical is burning as it escapes from tank

Criteria	Description
Tank Diameter	11.5 meters
Tank Length	13.3 meters
Tank Volume	1,381 cubic meters
Internal Temperature	35° C
Chemical Mass in Tank	987 Tons (Tank is 90% full)
Circular Opening Diameter	40 centimeters
Burn Duration	ALOHA limited the duration to 1 hour

Results	
Max Flame Length	128 meters
Burn Duration	9 minute
Max Burn Rate	127,500 kilograms/min
Total Amount Burned	447,696 kilograms
Puddle spread diameter	190 meter

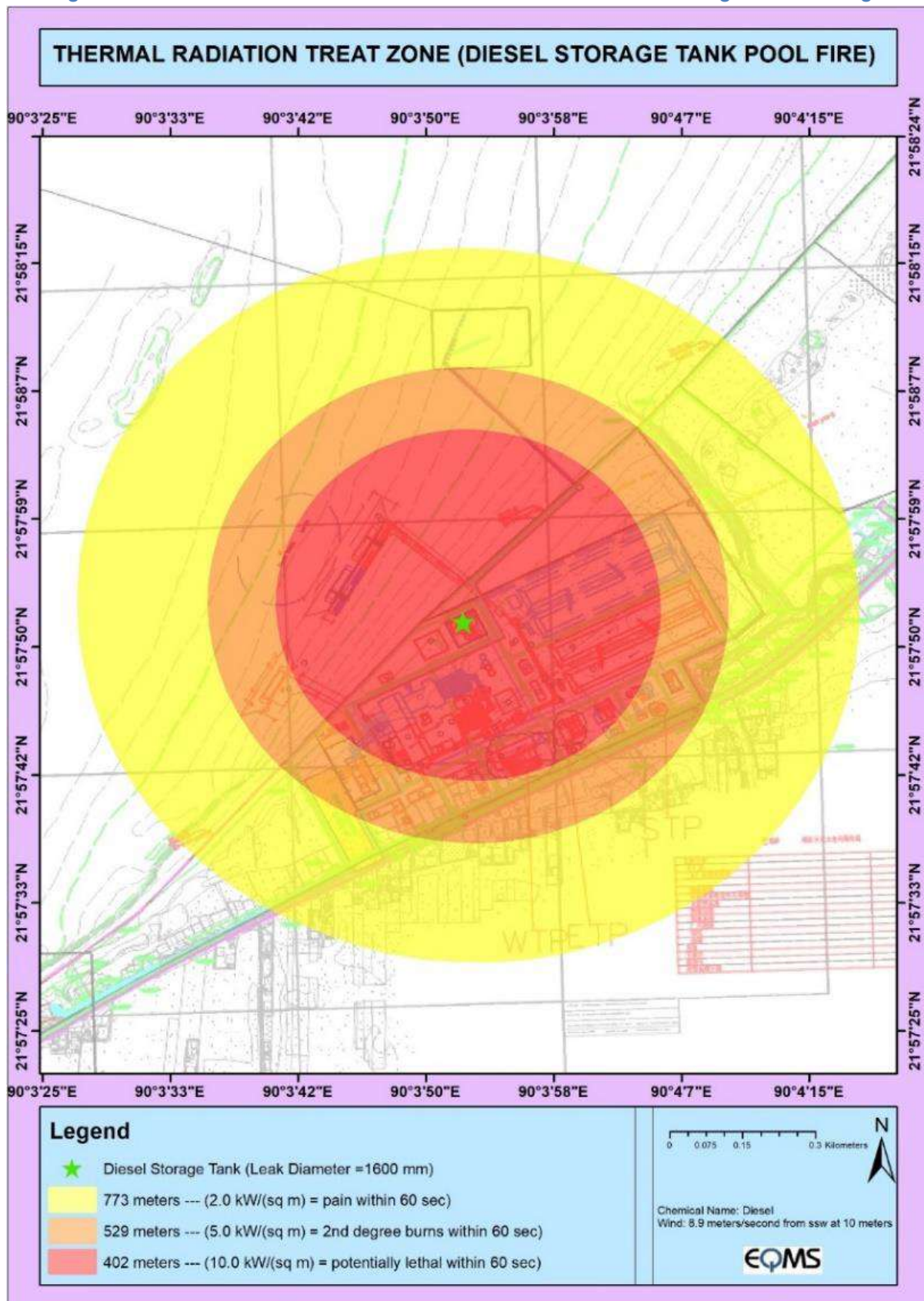
Note: The chemical escaped as a liquid and formed a burning puddle.

THREAT ZONE

Legend	Diameter (m)	Indicated radiation (kW/m ²)	Remarks
Red	402	10.0	Potentially lethal within 60 sec
Orange	529	5.0	2 nd degree burns within 60 sec
Yellow	773	2.0	Pain within 60 sec

The pool fire thermal radiation threat zone of the diesel tank is shown in Figure 11-5.

Figure 11-5: Pool Fire Thermal Radiation Threat Zone for diesel storage Tank Leakage



11.9.2.5 Prevention Measures for Storage of Diesel Storage Tank Leakage

Fire is one of the major hazards, which can result from diesel storage tanks. The preventive measures include the following:

- Fire prevention and relevant code enforcement. The fire service facilities should be equipped with:
 - Smoke and fire detection alarm system;
 - Water supply;
 - Fire hydrant and nozzle installation;
 - Foam system;
 - Water for sprinkler system;
 - Mobile firefighting equipment; and
 - First aid appliances.
- Periodical training/awareness to be given to work force at the project site to handle any emergency situation;
- Periodic mock drills to be conducted so as to check the alertness and efficiency and corresponding records should be maintained;
- Signboards including emergency phone numbers and 'no smoking' signs should be installed at all appropriate locations;
- Plant shall have adequate communication systems;
- All major units / equipment should be provided with smoke / fire detection and alarm system;
- 'No smoking zone' to be declared at all fire prone areas;
- Sand buckets, fire hydrant points and fire extinguishers to be provided at strategic locations;
- Storage location to be selected at an isolated place with proper fencing and guarding;
- Co-ordination with local authorities such as fire, police, ambulance, district administration and nearby industries should be ensured to manage/control, meet any eventuality; and
- Naked flame, welding etc. to be not permitted in storage area.

Preventing Fire and Explosion Hazards:

- Proper marking to be made for identification of locations of flammable storages;
- Provision of secondary containment system for all fuel and lubricating oil storages;
- Provision of fire and smoke detectors at potential sources of fire and smoke;
- Storing flammables away from ignition sources and oxidizing materials;
- Providing specific worker training in handling of flammable materials, and in fire prevention or suppression;
- Equipping facilities with fire detectors, alarm systems, and fire-fighting equipment;
- Fire and emergency alarm systems that are both audible and visible;
- For safety of people the building, regulations concerning fire safety to be followed. Some of the requirements include:
 - Installation of fire extinguishers all over the building;
 - Provision of water hydrants in operative condition;
 - Emergency exit;
 - Proper labelling of exit and place of fire protective system installation;
 - Conducting mock drills; and
 - Trained personnel to use fire control systems.

11.9.3 Hazards from Chlorine

Chlorine is a highly toxic chemical being extremely irritating to the mucous membranes of the eyes and respiratory tract. It combines with moisture to liberate nascent oxygen and form hydrochloric acid. Both these substances, if present in quantity, cause inflammation of the tissues with which they come in contact. If the lung tissues are attacked, pulmonary edema may result. The current OSHA standard for chlorine is a ceiling level of ppm averaged over a 15-minute period and an IDLH value of 10 ppm. NIOSH has recommended that the permissible exposure limit to be 0.5 ppm measured over a 15-minute period. Overexposure to concentrations moderately above the TLV of 1 ppm irritates the eyes and respiratory tract. Chlorine is extremely irritant to the mucous membrane of the eyes at 3 ppm and respiratory tract; 15 ppm causes immediate irritation of the throat. Concentrations of 50 ppm are

dangerous for even short exposures. Concentrations of about 400 ppm and beyond are generally fatal over 30 minutes, and at 1,000 ppm and above, fatality ensues within only a few minutes.

The physiological effects of various concentrations of chlorine gas are shown in the following Table 11-8.

Table 11-8: Effects of Chlorine at various concentration

SL#	Effects	Concentration of Chlorine in Air (ppm)
1	NIOSH-TLV	0.5
2	OSHA PEL	1.0
3	Extreme irritating to the mucous membrane of the eye	3.0
4	Immediately Dangerous to Life or Health (IDLH)	10.0
5	Concentration causing immediate irritation of throat	15.0
6	Concentration dangerous for even short exposure	50
7	Fatal even if the exposure is brief	1000

11.9.3.1 Frequency Analysis

The frequency analysis of the hazards identified with respect to the proposed project was undertaken, to estimate the likelihood of their occurrences during project life cycle. Hazard frequencies in relation to the proposed project were estimated the historical accident frequency data and professional judgment. Based on the range of probabilities arrived at for different potential hazards that may be with respect to age of diesel, supply of natural gas handling of chlorine, the following frequency categories criteria have been defined (Table 11-9).

Table 11-9: Frequency Categories and Criteria

Likelihood Ranking	Criteria Ranking (cases/year)	Frequency Class
5	Likely to occur often in the life of the project, with a probability greater than 10^{-1}	Frequent
4	Will occur several times in the life of project, with a probability of occurrence less than 10^{-1} but greater than 10^{-2}	Probable
3	Likely to occur sometime in the life of a project with a probability of occurrence less than 10^{-2} but greater than 10^{-3}	Occasional/Rare
2	Unlikely but possible to occur in the life of a project, with a probability of occurrence less than 10^{-3} but greater than 10^{-6}	Remote
1	So unlikely it can be assumed that occurrence may not be experienced, with a probability of occurrence less than 10^{-6}	Improbable

Source: Guidelines for Developing Quantitative Safety Risk Criteria-Centre for Chemical Process and Safety

An effort has been made to understand the causal factors for release of chlorine from tonner based on review of thesis on "Consequence analysis Vulnerability Assessment and Fuzzy Tree Analysis of Storages in an Industrial Areal". The thesis indicates that release of chlorine from storage tanks can occur in the following circumstances:

- Exothermic chemical reaction;
- Exposure to external heat;
- Insulation failure and temperature rise; and
- Failure of level indicators/ alarm devices.

The failure frequency of chlorine is established based on review of the UK HSE Database - Rate and Event Use Risk Assessments. The failure rates for chlorine storages are presented in Table 11-10 below.

Table 11-10: Chlorine Storage-Failure rates based on type of release

SL#	Types of release	Failure rate (per storage per year)	Frequency
1	Catastrophic	4.0×10^{-6}	Remote
2	500 mm diameter hole	5.0×10^{-6}	Remote
3	25 mm diameter hole	5.0×10^{-6}	Remote
4	13 mm diameter hole	1.0×10^{-6}	Remote
5	6 mm diameter hole	4.0×10^{-6}	Remote

11.9.3.2 Consequences Analysis-Tankage

As discussed before, the release of chlorine from storage tanks can result due to corrosion, exothermic reaction, exposure to heat, failure of alarm devices/ detectors etc. Generally, chlorine is stored as a liquid under pressure in steel containers within a specifically designed enclosure equipped with various detection and safety devices. When a rupture or leak occurs in a liquid chlorine container, the sudden reduction in pressure that occurs causes a portion of the liquid to vaporize as it is released. The remaining liquid chlorine vaporizes as it is warmed by the environment. When it becomes a vapor, liquid chlorine expands to 450 times the liquid volume. Consequently, a liquid chlorine release can affect a significantly greater than a chlorine gas release from a vessel or pipe with similar size hole. In all cases (depending upon the release volume), the incident will be a toxic vapor cloud moving upwind.

Chlorine released from process could result in significant consequences to the health of personnel within the affected areas due to its highly toxic nature. Taking into account the above tankage failure consequences and frequency analysis the following hypothetical risk scenarios (Refer Table 11-11) have been considered for risk modelling for chlorine release from tanks at the storage yard.

Table 11-11: Chlorine Tonner-Risk Modelling Scenarios

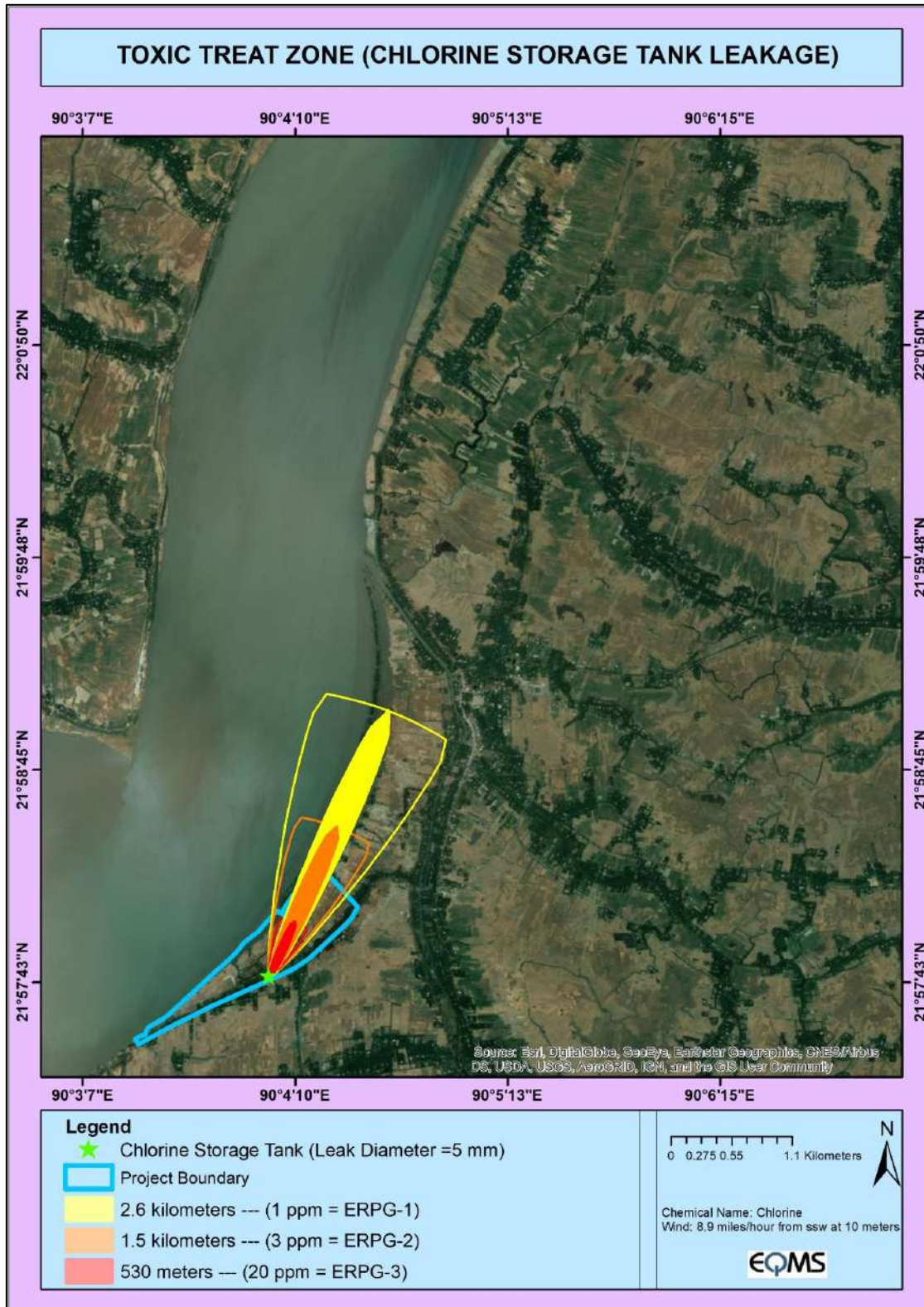
Scenario	Storage	Storage diameter	Storage length	Tank Volume	Accident Scenario
1	Chlorine Tonner	0.76	2.08	930 kg	5 mm leak
2		0.76	2.08		10 mm leak
3		0.76	2.08		Catastrophic failure

For chlorine release from tonners, the LOC has been interpreted in terms of health effects on general public on exposure to specific concentration of chlorine expressed in terms of part per million (ppm). Based on review of the standard reference documents on chlorine - NIOSH, OSHA and Dangerous Materials Handbook by Irving Sax, the following threat zones have been considered for risk modeling of chlorine release from pipelines using ALOHA.

- Scenario 1: Chlorine Tonner leak (5mm dia)**

The toxic vapor Cloud threat zone for release of chlorine gas from (5 mm dia) of chlorine tanner is represented in Figure 11-6.

Figure 11-6: Toxic Threat Zone Plot-Chlorine Tonner Leak (5mm dia)



THREAT ZONE

Legend	Diameter (km)	Concentration (ppm)	Remarks
Red	0.53	20.0	Dangerous to Life or Health , EPRG-3
Orange	1.5	3.0	Irritation to the mucous membrane of eye EPRG-2
Yellow	2.6	1.0	Permissible Exposure Limit (PE L)/ EPRG-I,

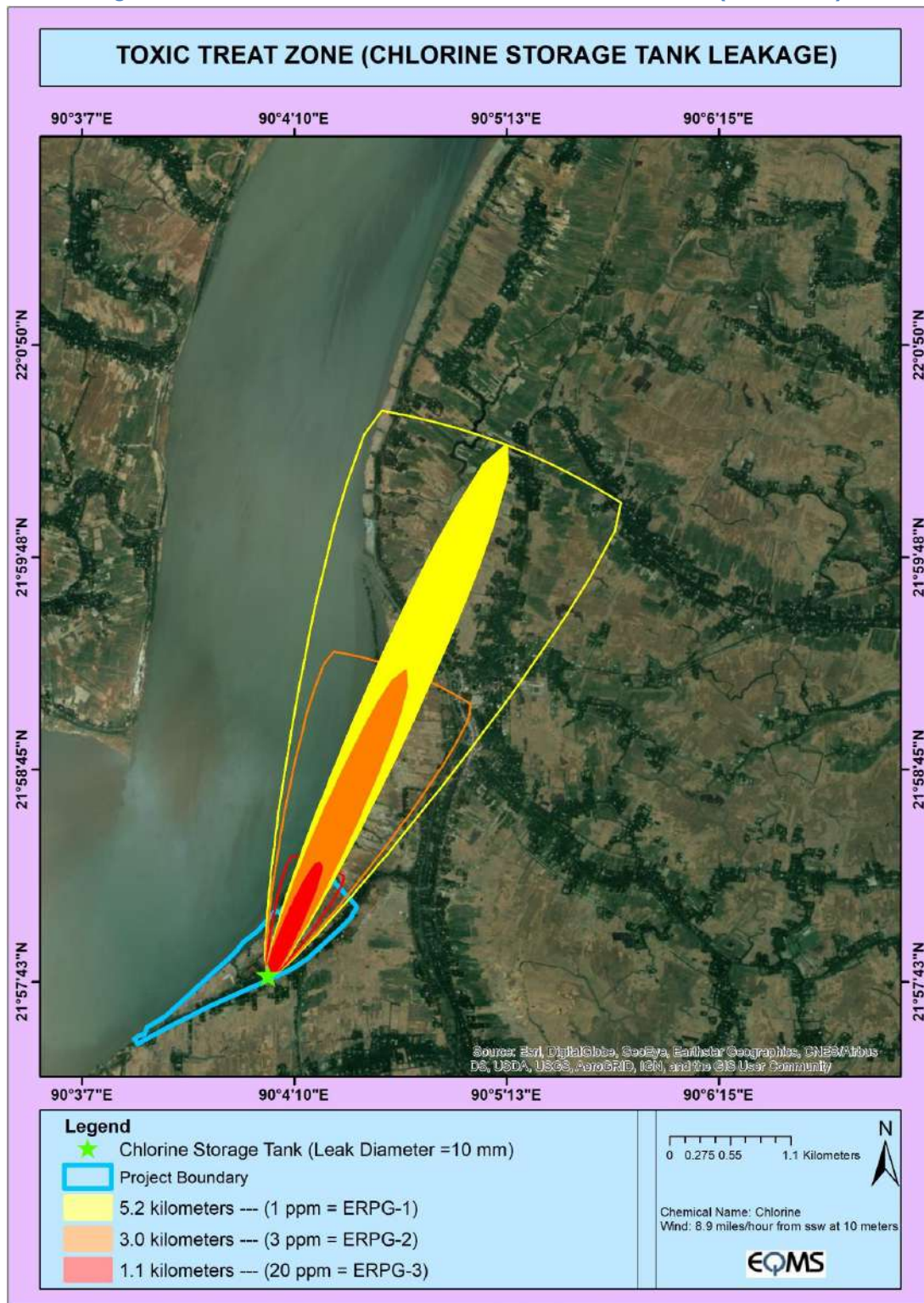
Legend	Diameter (km)	Concentration (ppm)	Remarks
PEL/EPRG-1			

The hazard for release of toxic chlorine Vapor from 5mm leak of a chlorine tonner will be experienced within a radial distance of 2.6 km from Source.

- **Scenario 2: Chlorine Tanner Leak**

The toxic vapor cloud threat zone plot for release of chlorine gas from leak of is given in Figure 11-7.

Figure 11-7: Toxic Threat Zone Plot-Chlorine Tonner Leak (10 mm dia)



THREAT ZONE

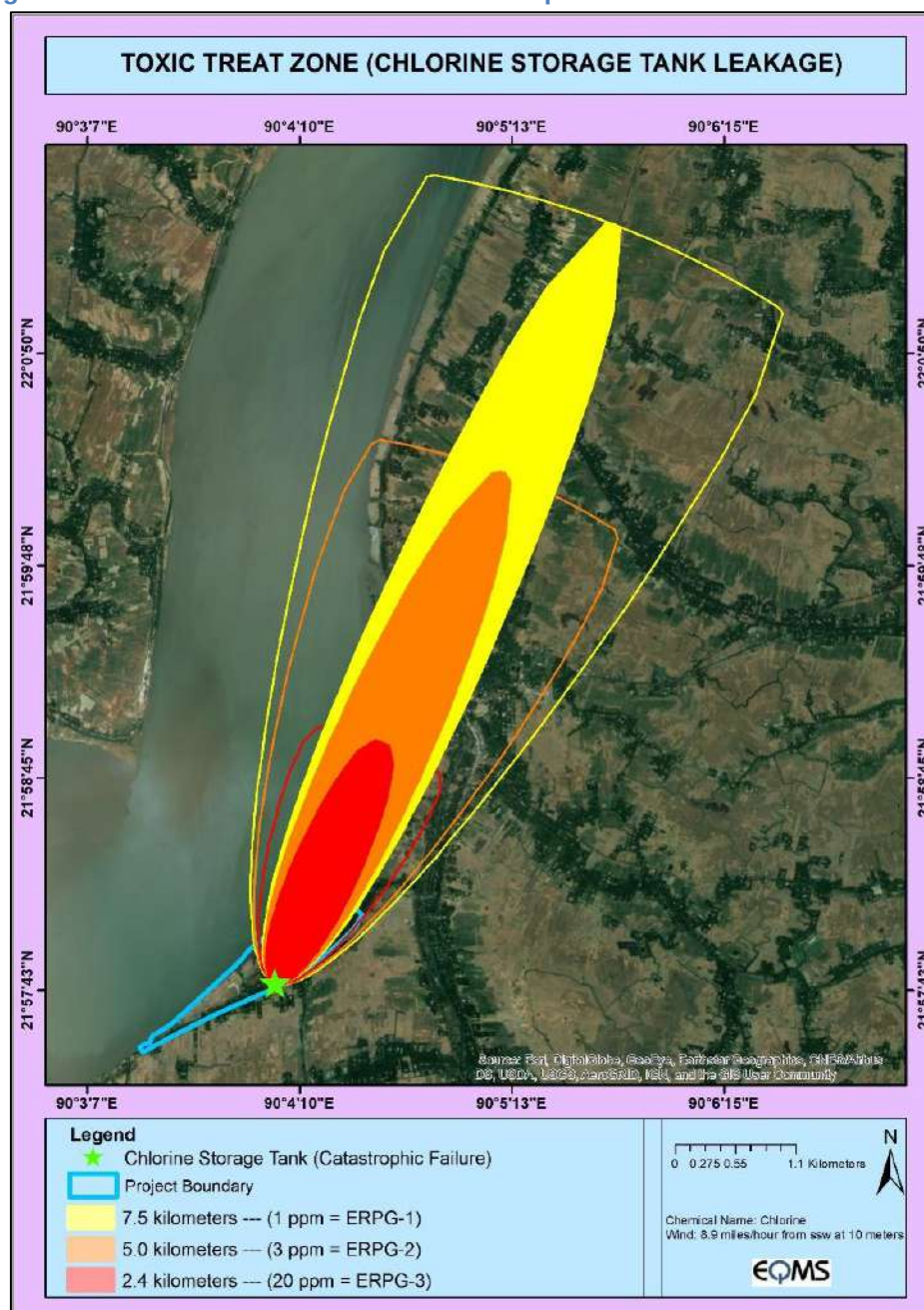
Legend	Diameter (km)	Concentration (ppm)	Remarks
Red	1.1	20.0	Dangerous to Life or Health , EPRG-3
Orange	3	3.0	Irritation to the mucous membrane of eye EPRG-2
Yellow	5.2	1.0	Permissible Exposure Limit (PE L)/ EPRG-I, PEL/EPRG-1

The worst hazard for release of chlorine vapor from leak of a chlorine tonner will be experienced within a radial distance of 5.2 km from source.

- Scenario 3: Chlorine Tonner-Catastrophic Failure**

The toxic vapor cloud threat zone plot for release of chlorine gas from a catastrophic failure of a chlorine tonner is represented in Figure 11-8.

Figure 11-8: Toxic Threat Zone Plot- catastrophic failure Chlorine Tonner Leak



THREAT ZONE

Legend	Diameter (km)	Concentration (ppm)	Remarks
Red	2.4	20.0	Dangerous to Life or Health , EPRG-3
Orange	5.0	3.0	Irritation to the mucous membrane of eye EPRG-2
Yellow	7.5	1.0	Permissible Exposure Limit (PE L)/ EPRG-I, PEL/EPRG-1

The worst hazard for release of toxic chlorine vapor from a catastrophic failure of a chlorine will be experienced within a radial distance of 7.5 km from source.

11.9.3.3 Safety Measures for Chlorine

Detectors for gases which create an immediate health hazard (danger to life) need be placed at appropriate locations. The following applies to selection of detectors in these categories:

- Detection shall be fast and reliable and preference shall be given to speed of response of precision;
- All aspects of HSE shall be included in the design study.

Detection equipment shall be suitable for detecting the specific toxic gases or vapors that can be present in the area covered by the detectors. The method for toxic gas detection shall be electrochemical except where:

- This is unsuitable (e.g. low humidity conditions where the electrochemical cell may dry out, or presence of interferences from other gases);
- Or other methods provide rapid detection (acoustic) of release events, or;
- Other emerging provide detection optical, or;
- Other are required by regulation.

Care should also be taken in the case of electrochemical sensors, which have a very limited shelf life if left unpowered. Electrochemical sensors should be powered up within the time specified by the manufacturer or delivery should be delayed until shortly before plant commissioning. For the sake of functional loop testing, a "sacrificial" head should be used to verify that the transmitter is responding to test gas (i.e., a single head from location to location).

Acoustic detectors shall be considered for detecting loss of containment of pressurized toxic gas where the release is into an open area and equipment, and where rapid response to loss of containment of pressurized gas is required.

Sensitivity: The minimum sensitivity of the detector should be greater than 25 % of the high alarm concentration. The detector concentration range maximum should be between 2x and the highest alarm concentration, e.g. if the highest level is 20 ppm, then the range should be between 0-40 ppm and 0-80 ppm.

Manual Alarm Call: Manual alarm call devices shall (PS) be capable of being operated by simple operations lift flap push button, or lift flap and pull handle, or break glass.

11.10 Emergency Response and Disaster Management Plan**11.10.1 Introduction**

Industrial accidents result in great personal and financial loss. Managing these accidental risks in today's environment is the concern of every industry including power plants, because either real or perceived incidents can quickly jeopardize the financial viability of a business. Many facilities involve various manufacturing processes that have the potential for accidents, which may be catastrophic to the plant, work force, environment, or public.

An Emergency Response Plan (ERP) is a written document, which is required for an organization according to occupational health safety standards and must be displayed at every job site with a certain number of employees (usually five to ten). It is a detail step-by-step procedure to follow in emergency such as fire or a major accident. An emergency response plan also includes information such as whom to notify, who should do what, and location of emergency stock. The Emergency Response Plan includes any measures that should be in place at all facilities to combat an accident resulting from fire, explosion or due to any natural calamities (e.g. Earthquake, cyclones, fire etc.).

11.10.1.1 What is Emergency

A major emergency can be defined as an accident/incident that has potential to cause serious injuries or loss of life. It may cause extensive damage to property, serious disruption both in production and working of plant and may adversely affect the environment. The following factors may cause major emergency:

- Plant failure;
- Human error;
- Vehicle crash;
- Sabotage;
- Earthquake;
- Cyclone and tidal surges;
- Lightning; and
- Fire.

11.10.2 Potential Causes of a Power Plant Accident

The potential causes of an industrial accident are as like as follows:

- Fire and explosion: explosives, flammable material;
- Snapping of cables, ropes, chains, slings;
- Handling heavy objects;
- Electricity (electrocution);
- Falls from height inside industrial units or on the ground;
- Slipping on wet surfaces;
- Sharp objects;
- Oxygen deficiency in confined spaces;
- Lack of PPE, housekeeping practices and safety signs;
- Hackles, hooks, chains; and
- Cranes, winches, hoisting and hauling equipment's.

11.10.3 Objectives of Emergency Planning

When an emergency occurs, the main concern is to preserve life and safeguard property and the environment. Therefore, an Emergency Contingency Plan, catering for both minor and major emergencies needs to be designed with the following objectives:

- Rescuing people;
- Treating the injured;
- Safeguarding others;
- Minimizing damage to property and environment;
- Controlling the incident, removing the hazard, preventing escalation;
- Maintaining the welfare of personnel involved in controlling the occurrence;
- Identifying casualties;
- Informing and assisting relatives;
- Informing the news media;
- Informing/collaborating with the authorities and emergency services; and
- Preserving records.

11.10.4 Emergency Management Plan

The main elements of an emergency plan are as like as follows:

- Leadership and Administration;
- Role and Responsibilities of Key Personnel;
- Emergency action;
- Emergency Light and Power;
- Source of energy control;
- Protective and rescue equipment;
- Communication;
- Medical care/First Aid;
- Public relation;
- Protection of vital records;
- Training; and
- Periodical revision of plan.

11.10.4.1 Emergency Action Plan at project site

The action plan should consist of the following:

- Emergency Control Centre/Room; and
- Key Personnel.

It is very important to establish an emergency control center at the plant site for managing any kind of emergency. This center will be the main center from where the operations to handle the emergency will be directed and coordinated. After establishing the control center/room, the following facilities to be made available in the emergency control center/room:

- Internal and external communication system;
- Computer and other essential records;
- Daily attendance of workers employed in the plant/factory;
- Records of the storage of hazardous material and manufacturing;
- Pollution records;
- Walky-talky;
- Plan of the plant showing:
 - Storage area of hazardous materials;
 - Storage of safety equipment's;
 - Firefighting system and additional source of water;
 - Site entrance, roadway and emergency exist;
 - Assembly points;
 - Truck parking area; and
 - Surrounding location.
- Note Book, Pad and Pencil; and
- List of Key Personnel with addresses, telephone number etc.

Assembly Points:

A safe place far away from the plant should be pre-determined as assembly point where in case of emergency personnel evacuated from the affected areas are to be assembled. The plant workers, contract workers and visitors should assemble in assembly point in case of emergency and the time office clerk should take their attendance so as to assess the missing persons during emergency.

The Key Personnel for Emergency in the plant

The following key personnel will be played vital role during the emergency in the power plant. Their roles and responsibilities for the emergency management are also given below:

- A. Works Main Controller;

- B. Works Incident Controller;
- C. Other Key Officers
 - Communication Officer;
 - Security and Fire Officer;
 - Telephone Operators;
 - Medical Officer; and
 - Administrative Officer.

A. Works Main Controller

The Project Manager of the power plant should act as main controller. His duties are to:

- Assess the magnitude of the situation and decide whether the evacuation of staff from the plant is needed;
- Exercise and direct operational control over areas other than those affected;
- Maintain a continuous review of possible development and assess in consultation with work incident controller and other key personnel;
- Liaison with Police, Fire Service, Medical Services, Factory Inspectorate and other Government Agencies;
- Direct and control rehabilitation of affected area after emergency; and
- Ensure that evidence is preserved for enquiries to be conducted by statutory authorities.

The Works Main Controller will declare the emergency and he will instruct gate office to operate the emergency siren after assessing the gravity of the situation.

B. Work Incident Controller

He is the next responsible officer after the works main controller. Generally, the manager (EHS) is designated as work incident controller. In case of emergency he will rush to the place of occurrence and take overall charge and report to the works main controller by personnel communication system like cell phones or walky-talky and inform about the magnitude of emergency. His duties are to:

- Assess the situation and considering the magnitude of emergency he will take decision and inform Communication Officer to communicate the news of emergency to different agencies;
- Give direction to stop all operations within the affected area;
- Take the charge of Main Controller till the Main Controller arrives;
- Order for shutdown and evacuation of workers and staffs from affected area;
- Inform all Key Personnel and all outside agency for help;
- Inform security and fire officers and Fire Services;
- Ensure that all non-essential workers/staff are evacuated to assembly point and areas searched for casualties;
- Report all significant development to Communication Officer; and
- Advise to preserve evidence of emergency into the cause of emergency.

C. Other Key Personnel and their duties

1. Communication Officer

On hearing the emergency siren/alarm:

- He will proceed to the control center and communicate to work incident controller;
- He will collect information from the emergency affected area and send correct message to work main controller for declaration of emergency;
- He will maintain a log book of incident;
- He will contact all essential departments;
- He will take stock of the meteorological condition from local meteorological department;
- He will communicate all information as directed by works main controller.

2. Security and Fire Office

The Security or Fire officer will be responsible for the firefighting. On hearing the emergency alarm/siren:

- He will reach the incident area with fire and security staff;
- He will inform through telephone or walky-talky to the communication officer;
- He will inform to the work incident controller about the situation and requirement of outside help like Fire Service and other mutual aid members;
- At the site, the entire fire squad member will respond to the advice and information given by the works incident controller; and
- The security will control the visitors and the vehicle entry.

3. Telephone Operator

In case of fire is discovered but no emergency siren is operated, he shall ensure the information about the location of the fire/emergency incident from the persons discovered/notices the above and communicate to different Key Personnel immediately with clear message.

4. Medical Officer

Medical Officer with his team will report to the works incident controller on hearing the fire/emergency siren immediately. The ambulance will be parked nearest to the site of incident. Name of injured and other casualties carried to the Hospital will be recorded and handed over to Works Incident Controller. The ambulance will carry the injured to the nearest hospital for treatment.

5. Administrative Officer

He should work as a liaison officer liaising with works main controller and other essential departments such as Police, Press and Statutory authorities. His responsibilities shall include:

- To ensure that casualties receive adequate attention to arrange additional help if required and inform relatives;
- To control traffic movement into the factory and ensure that alternative transport is available when needed;
- When emergency is prolonged, arrange for the relief of personnel and organize refreshment and catering facilities; and
- Arrange for finance for the expenditure to handle the emergency.

11.10.4.2 Emergency Procedure

Safety Operating Procedure of Emergency Response Plan means executing step-by-step operation of any Emergency which can occur inside the plant. Based on these events, the required actions are determined. For Example:

- Declare emergency;
- Siren/Sound and alert;
- Evacuate danger zone;
- Close main shutoffs;
- Call for external aid;
- Initiate rescue operation;
- Attend to casualties; and
- Fight against the hazard.

The final consideration is a list and the location of resources needed:

- Medical supplies;
- Auxiliary communication equipment;
- Power generator;
- Chemical and radiation detection equipment ;
- Emergency protective clothing;
- Mobile equipment;
- Firefighting equipment;

- Ambulance;
- Rescue equipment; and
- Trained personnel.

Any person noticing the emergency shall report to their Department Head/Shift Executive/Shift Supervisor either in person or through the intercom. The department Head/Shift Executive/Shift Supervisor on receipt of the emergency shall visit the site to assess the situation. If the situation is an emergency, then he calls for an emergency.

11.10.5 Emergency Facilities

The following facilities should be provided in the plant to tackle any emergency at any time:

- Fire protection and firefighting facilities;
- Emergency lighting and standby power;
- Emergency equipment and rescue equipment:
 - Breathing apparatus with compressed air cylinder.
 - Fire proximity suit.
 - Resuscitator.
 - Water gel Blanket.
 - Low temperature suit.
 - First aid kit.
 - Stretchers.
 - Torches.
 - Ladders

Safety Equipment:

- Respirators.
- Gum boots.
- Safety helmets.
- Asbestos Rubber hand gloves.
- Goggles and face shield.
- Toxic gas measuring instruments.
- Explosive meter.
- Oxygen measuring instruments.
- Wind direction indicator.

Alarm System:

Alarm system varies and will depend on the size of the works area - simple fire bell, hand operated siren-break open type, fire alarm etc. Automatic alarm may be needed for highly hazardous nature of plant.

Communication System:

Communication is a key component to control an emergency. The following communication system may be provided in the plant:

- Walky-Talky;
- Telephone (internal and external);
- Cell Phone;
- Intercom;
- Runners (verbal or written messages).

Siren for Emergency:

Siren for emergency should be different from the normal siren. The emergency siren should be audible to a distance of 5 KM radius. The emergency siren should be used only in case of emergency.

Escape Route:

The escape route from the plant should be clearly marked. The escape route will be the shortest route to reach out of the plant area to open area, which leads to assembly point. This route should be indicated on the layout plan attached to the Emergency Plan.

Evacuation:

All non-essential staff should be evacuated from the emergency site. As soon as the emergency siren rings the workers have to shut down the plant and move to the assembly point. The plant shut down procedure in case of emergency should be prepared and kept ready and responsible persons should be nominated for the purpose.

Counting of Personnel:

All personnel working in the plant should be counted. Time office persons should collect the details of personnel arriving at the assembly point. These should be checked with the attendances of regular workers, contract workers present in the site on the day of emergency. The accident control should be informed and arrangement should be made for searching missing persons in the emergency affected area. The employees' address, contact number of next to kin should be maintained in the time office so that during emergency relatives of those affected due to emergency may be informed accordingly. Information in respect of emergency should be given to the media and other agency.

All Clear Signal:

After control of emergency the work incident controller will communicate to the works main controller about the cessation of emergency. The main controller can declare all clear by instructing the time office to sound "All Clear Sirens".

Mutual Aid System:

Mutual aid scheme should be introduced so that in case of emergency necessary help from mutual aid partner may be extended. Essential elements of this scheme are:

- Mutual aid must be a written document signed by the Chief Executive of the industries concerned;
- Specify key personnel who are authorized to give requisition of materials from other industries;
- Specify the available quantity of material/equipment that can be spared;
- Mode of requisition during emergency;
- Mode of payment/replacement of material given during an emergency;
- May be updated from time to time based on experience gained.

Mock drills on emergency planning should be conducted once in 6 months and sequence of events should be recorded for improvement of the exercise. Exercises on Onsite Emergency Planning should be monitored by Factory Inspectorate and the high officials of the organization and the plan is reviewed every year.

Activities Due to Emergency:

- Attendee of incident place shall inform Control Room & Emergency Response Team in case of emergency;
- Stop work immediately and vacate the workplace;
- Shut down the electrical connection;
- All employees will go to the designated Fire Assembly Point located & mark in the specific area of BEPCL;
- Any Emergency Response Team member or designated person shall notify the fire department and fire service and important person by phone;
- Once fire department has been notified and it is safe to do so, trained Fire Fighting team may attempt to extinguish small fires. All fires need to be reported to the senior authority;

- When the incident place has been evacuated a head count shall be done by the designated person accounting for all employees on place including those who may be trying to extinguish the fire;
- A List of personnel on place, updated and current will be kept in the Personnel office;
- The Emergency Response Team is responsible to ensure the requirement of fire department and gives all pertinent information; and
- Facility should provide first aid attendants as well as medical equipment suitable for the people if any injury took place during incident and quickly react to give maximum medical facility.

Record Keeping:

Record is a combination of information and helps employers and workers to understand industrial hazards its causes and implementation of proper task. Recordkeeping of any incident shows require steps need to be taken and weakness of previous incident. For proper recordkeeping need to maintain some regular procedure as-

- Emergency Response Plan;
- Emergency training records;
- Previous incident record;
- Module and materials used for training;
- Emergency preparedness drill/rehearsal;
- Evaluation feedback from training and emergency drills; and
- Records and information about previous incidents.

Responsibility:

- **ERP Coordinators:** Any person of Emergency Response Team can act as a responsible person during working day. They are responsible to handle any types of emergency individually and follow up the all-preventive procedure followed by respective team. They communicate to all local administrative personal or offices during emergency occur.
- **Shift Executive:** Shift Executive is acting as a site controller's role during night shift operation and will be continuing the role till any above mention person comes to the factory. Security supervisor is to assess all types of emergency work with the shift executive.
- **Security supervisor:** Security supervisors acting as a site controller role during Holiday or weekly off day and he will be continuing the role till any above mention persons comes to the factory.
- **First Aid Team:** The member of the first aid team is totally responsible to handle any type of personal injury / accident and communicate the same to crisis management team and follow up their guidance and procedure as illustrated bellow.

11.10.5.1 Emergency Response for Natural Hazards

Cyclone and tidal surges:

- Consideration of cyclonic wind/wind velocity in the design of the project and associated infrastructures;
- Construction of dike around the proposed project site. The dikes should be designed to prevent flooding during high astronomical tides and during cyclone-generated storm surge too;
- Suitable dike height can be selected based on the analysis of last 50 years historical data;
- Plantation of selected species at different layer around the proposed project site as well as parallel to the coastline in response to cyclone wind;
- Regular monitoring of the weather news/bulletin especially for the cyclone disasters during April to May and October to November;
- Close communication with the volunteers of the Cyclone Preparedness Programme (CPP) for the preparedness of cyclone disaster;
- Establishment of site emergency evacuation and management plan for the cyclone disasters;

- Foundation structure of machines and buildings should be elevated to avoid cyclones associated storm surges water;
- Breakwaters along the coast can be provided the necessary cushion against cyclone hazards;
- The proposed project operating personnel and other key personnel will be trained to manage cyclone disasters;
- Switch off the Power Supply of Sub-station;
- Close all the in and out doors where possible wind enters;
- Regular monitoring of
- Open windows, exhaust at the top of the walls if present and allow the wind go from top which enters into the plant shades;
- Instruct all the associates including workmen not to allow them to go outside till the wind & cyclone effect reduces to the normal level; and
- After the cyclone, inform to Emergency Response Team to investigate the property loss in the plant for further action.

Earthquake:

- Adopting and enforcing updated building code of BNBC provisions to reduce earthquake damage risk;
- The proposed project and its associated infrastructure shall be designed and developed considering the applicable zone wise seismic risk and impact;
- Make all utilities like water supply system, communication networks, electricity lines etc. earthquake proof;
- The proposed project operating personnel and other key personnel shall be trained to manage emergency situations during an earthquake;
- Emergency firefighting system should be ensured in the project site;
- Fire drill can be conducted once in a year;
- Adequate first aid provision in the project site;
- The high-risk electrical area should be clearly marked with warnings to avoid dangerous practices in the vicinity so that there would be less chance of accidents from those installations.
- Isolate electrical supply where ever it is possible;
- Do not use elevators;
- All electric connection of the BEPCL should be cut off on that time. And the important thing is that, everybody will go in a safe place from near of the building;
- Ensure fire and siren alarm system in all floors. During earthquake all the employees will come down in safe place in a row through stair after hearing the alarm;
- Have to follow the instruction regarding earthquake;
- Have to evacuate as per evacuation plan;
- We should have Rescue Team to help the injured employees or who get down. And they will also take the injured employees in a safe place;
- Isolate all pipelines of steam, compressed air, fuel and CO₂ when they are not in use;
- Check availability of security personnel and have a chat with them in view of likely immediate action to be taken;
- Empty such tanks which are installed in vertical and relatively unstable conditions;
- Take a review of material storage and ensure that maximum of such material is removed from places from where it can fall down. Uniform Material distribution at a lowest height from floor is the safest way of storage;
- Ensure caps on all compressed gas cylinders;
- Immediate ready to use all Emergency equipment like stretchers, breathing equipment, PPEs, Dewatering, portable welding gas cutting equipment, emergency lights, Battery operated public address equipment, Ropes, lifting tackles, trolleys, emergency medical equipment, etc.;
- Emergency transport vehicle shall be parked in open so that it is free from any falling object;
- Identify critical and weak areas of the building and organize to support them adequately to prevent collapse;

- Check storage of Hazardous Chemicals to comply with normal storage safety requirements;
- Keep Fire Hydrant accessible, Keep newest and good conditioned fire hoses and Fire extinguishers readily available;
- Remove unwanted combustible material;
- Review that room heater, electric hot plates and other sources of ignition that are normally used in winter situations are operated, handled and stored safely;
- Ensure that flammable liquids i.e. Petrol, Diesel and other petroleum products are stored under secondary containment with due precautions;
- Over and above ensure that personnel are alert and do not panic; and
- Ensure the average 6 feet height of raw materials and finish good.

11.10.5.2 Emergency Response Plan for Other Hazards

Fire:

- Evacuate the people from Fire occurred surrounding area and send through safe exit direction;
- Remove unwanted combustible material;
- Keep cool and do not panic;
- Inform to substation and electrician to get the affected area isolated from power supply;
- Keep Fire Hydrant accessible;
- Keep newest and good conditioned fire hoses and Fire Extinguishers readily available;
- Ensure one operator is always present at Hydrant system area when using the fire Hydrant system;
- If the fire is very small, use the correct Fire Extinguisher for extinguishing the fire;
- Try to isolate the fire by removing the surrounding inflammable material from within reach of fire;
- In case of big fire use local Hydrant system for extinguishing the fire;
- If the fire is beyond the control inform the security or higher authority to call local fire Brigade and Inform Senior manager (Factory In charge) or Emergency Response Team;
- On arrival of the fire brigade pave way for them reach the exact site of fire; and
- In case of any accident in human life please call first aid team and get medical attention as quickly as possible.

Fatal Accidents:

- During emergency operation if there is any injured person, carry out victim /causality to the security room and Conference Room also OHS Room beside the support of company recommended nursing home;
- Call First Aid Team and carry out the first aid with the help of first aid item;
- Inform to Emergency Response Team;
- If the accident is severe then call emergency vehicle and immediately rush the injured person to local hospital or company recommended nursing home; and
- Fill in the accident report form with the help of witness and deposit the same to the Emergency Response Team.

Utilities Failure:

Examples of utility failure that may occur are electrical outage, plumbing failure/flooding, natural gas leak, steam line break, ventilation problems and/or elevator failure. In the event of a failure, immediately notify Emergency Response Team.

- For emergencies and potential danger or after hours call to Control room;
- In a situation where a building needs to be evacuated, please proceed to the building specific evacuation area;
- Turn off equipment, machines and computers;
- Assist disabled persons as needed;
- Do not use elevators;

- Stay at the designated evacuation area until the fire department or designated representative has given the “all clear” to re-enter the building.

Emergency Plan should contain:

The BEPCL power plant authority will prepare immediately an emergency plan before the starting of commercial production. In this emergency plan, following matters will be considering:

- Site plan and Topographic plan;
- Plan showing the firefighting facilities;
- Plan showing hazardous material storage area;
- Material safety data sheets for hazardous chemicals;
- Facilities available in main control center;
- List of emergency equipment's; and
- List of safety equipment's.

The emergency plan shall be documented in a printed form in sufficient copies to give all concerned for knowledge, study and easy follow up. The emergency plan shall be rehearsed and practiced at regular intervals to test efficiency of personnel, equipment coordinated efforts and to increase confidence and experience to operate such plan. The plan so prepared should be updated annually and uploaded in the factory website for easy reference.

11.10.6 Off-site (notifying external agencies)

Depending on the type and severity of emergency, the Main Controller should notify the appropriate external agencies. The major emergencies should be notified to:

- Law enforcement departments - Factory Inspectorate, Department of Environment, Police station;
- Fire departments and other response teams - Fire Brigade;
- Hospital and emergency medical services;
- Ambulance services;
- Local Government officials; and
- Local environmental agencies.

11.10.6.1 Making the Emergency known to General Public

In a situation where the public can be affected by the accident, two possible courses of action can be taken – evacuation or sheltering inside building or houses. Whichever decided upon, the public must be informed of it. This can be quite a challenging task, to the point of becoming nearly impossible if an effective communication process is not already in place.

Siren system can only be effective if the public is already aware of what actions to take if the alarm is blown. The content of the message should be as brief and clear as possible, and provide information on the action to be taken. In addition, the people should be asked to refrain from using the telephone (to minimize for overload) to notify neighbors the using the phone). Should evacuation be recommended the messages should inform the public of where the designated reaction areas are, and the evacuation routes to escape.

CHAPTER TWELVE: ENVIRONMENTAL MONITORING PLAN

12. Environmental Monitoring Plan

The effectiveness of various mitigation measures are described will be monitored through a well-defined environmental monitoring programme. This will be done by direct measurement of parameters related to environmental quality, emissions, discharges etc.

An environmental monitoring programme is important as it provides useful information on the following aspects:

- a) It helps to verify the predictions on environmental impacts presented in this study;
- b) It helps to identify the need for improvements in the management plans;
- c) It helps to verify compliance with statutory and community obligations; and
- d) It helps to indicate warnings of the development of any alarming environmental situations and thus, provides opportunities for adopting appropriate control measures.

The monitoring programme in different areas of environment, outlined in the next few sections, has been based on the findings of the impact assessment studies, described earlier.

12.1 Monitoring Plan

The purpose of the monitoring programme is to ensure that the intended environmental measures are achieved and result in desired benefits to the target population. To ensure proper implementation of the Environment Monitoring Plan (EMP), it is essential that an effective monitoring programme is designed and carried out.

The broad objectives of the environment monitoring program are:

- To monitor impacts on the surrounding environment and the effectiveness of mitigation measures during the pre-construction, construction and operation;
- To ensure that the environmental control systems installed at the power plant and are operating satisfactorily; and
- To suggest ongoing improvements in management plan, if required, for subsequent effective monitoring.

12.1.1 Stack Emission Monitoring

The height of the stack will be 220 meter for the proposed 1x350 MW power plant. The emissions from the stack will be monitored continuously for sulfur dioxide, oxides of nitrogen and particulate matter. If the pollutant concentration levels exceed the standard limit, necessary control measures will be taken to bring them back within the standards. Sampling ports will be provided in the stacks according to the DoE guidelines.

12.1.2 Ambient Air Monitoring

A laboratory equipped with the necessary instruments for carrying out air quality monitoring will be provided within the plant. The concentration levels of PM₁₀, PM_{2.5}, SO₂, NO_x, and CO in the ambient air will be monitored for the project site and nearby villages. The monitoring will be done as per the ECR, 1997 and subsequent amendments of the DoE, Bangladesh.

12.1.3 Meteorological Monitoring

An automatic weather monitoring station will be installed within the power plant premises and daily observations of micro-meteorological parameters such as ambient temperature, wind speed, wind direction, relative humidity, cloud cover, rainfall and solar radiation etc. will be recorded.

12.1.4 Equipment and Ambient Noise

Ambient Noise levels would be monitored at major noise generating locations and impact areas within the plant premises and neighboring areas.

12.1.5 Surface Water and Waste Water Monitoring

Monitoring of Water Consumption:

Continuous efforts would be made to reduce the water consumption and thereby to reduce the waste water generation. Flow meters would be installed at all major water inlet points and flow rates would be continuously monitored.

Monitoring of Wastewater Treatment:

The treated effluent would be monitored for the flow rate and quality to identify any deviations in performance of effluent and sewage treatment plants. The monitoring parameters are as per stipulations of the DoE, Bangladesh. The parameters to be monitor include flow, pH, EC, temperature, turbidity, TDS, TSS, SO₄, NO₃, Cl, F, Oil and Grease, BOD, COD, Hg, Cd, As, Na, Cr, Pb, Ni, Cu, Fe, Zn, NH₃, PO₄³⁻ and Cl.

12.1.6 Groundwater Monitoring

Ground Water Quality and depth of water table will be monitored for any ground water contamination to be monitored. The monitoring locations will be close to the ash pond area and nearest community.

12.1.7 Solid and Hazardous Waste Monitoring

Solid waste that will be generated in the proposed power plant premises like empty packing materials, drums, glass, paper, plastic, wood etc. will be properly collected and stored in a confined area. The EHS department will conduct regular monitoring of the waste generation volume and disposal. After storage all the solid wastes will be sold to the licensed vendors.

Spent oil and lubricants generated from various process equipment, machines, vehicles, instruments, oil storage tanks, are categorized as Hazardous Wastes. It should be stored in drums, properly sealed and stored in earmarked place for auction. Records of sale should be kept and annual returns should be submitted to DoE. Used Batteries should be stored in earmarked place and given back to dealers as per buy-back arrangement. Soiled cotton waste is generally fired in Boilers along with gas. Electronic wastes should be given to authorized re-processors

The following hazardous materials like coal, LDO/diesel, and painting materials need to be stored at the project site during operation. All these materials would be stored as per international safety standards.

12.1.8 Flora and Fauna Monitoring

Ecological impact will also be monitored for symptoms of visible damage/death/kill/disturbance etc. will be done.

12.1.9 Workers Health and Safety Monitoring

Occupational Health and Safety is very closely related to productivity and good employer-employee relationship. The main factors that will be affected the occupational health and safety in the project site are flue gas emissions and noise. To avoid any effects on the health of workers due to emissions and noise, sufficient measures have been proposed which include:

- Provision of personal protection equipment (PPE) including clothing, helmets, dust mask, shoes, etc. to the workers;
- Awareness training on safety and ensure using personal protective equipment's;
- Availability of first-aid facilities in the project premises;
- Regular health checkup of the workers should be ensured'
- Effective de-dusting system at loading, unloading and transportation; and
- Regular monitoring of working environment and implementation of safety and control measures to prevent hazard.

12.1.10 Community Health Monitoring

The health and safety of the local community those are living immediate surrounding of the project site should be monitored. The parameters like respirable disorders, heart diseases, diabetes, reproductive health, child health and ENT problems can be monitoring or survey. The BEPCL should organize health camps in surrounding villages with qualified doctors and support staff, inviting

surrounding people for health checkup in yearly basis. A traffic management plan will be prepared and implement by the BEPCL to reduce the road accidents at the approach road and coal transportation route.

12.1.11 Monitoring of DMP

The proposed project site is located in the coastal area of Bangladesh, which is highly vulnerable for the cyclones and its associated disasters. According to the approved ToR from the DoE, a risk assessment study for the proposed project has been conducted and identified the possible sources of risk and disasters in the power plant project area. Based on the assessment of the risk, hazards and disasters, an emergency management plan is proposed in Chapter-11 in this report. An emergency may be arise at any time due to the failure or accident in the power plant, manmade activities or natural events in the proposed project area.

During the emergency period, the Onsite and Offsite Disaster Management Plan should be initiated. In order to monitor the effectiveness of the plans, mock drills at regular intervals should be carried out by the BEPCL. The firefighting systems of the power plant and living facilities should be checked at regular intervals. The emergency response team of the BEPCL will take necessary steps to refill and certify the fire extinguishers. Awareness programs should be initiated to make the employees aware of their role and responsibility during any emergency as proposed in the report. The surrounding community should be made aware through awareness camps about the probable disasters and the emergency response plans.

12.1.12 Monitoring and CSR Activities

12.1.12.1 Proposed CSR Plan/Activities

The Barisal Electric Power Company Limited (BEPCL) will be actively contribute to improve the socio-economic conditions of the project surrounding area by providing assistance as CSR activates for the local community. The proposed project will create opportunities for direct and indirect employment, which will help in improving the socio economic status of the region. The following social activities and development schemes can be implement by the project company in the project area:

Health and Sanitation:

- Periodic health camps for the nearest community or project affected persons;
- Supply of medicines for the poor and PAP's;
- Improvement of existing health care facilities & create awareness about sanitation.

Education and Sports:

- Provide school dress, books and stationary for the poor and meritorious students;
- Scholarship scheme for the poor and meritorious students;
- Promotion of sports for the students;
- Improvement of class rooms(s), drinking water facility, electricity and fans etc. in the nearby village school as per requirement.

Community Infrastructure Development:

- Repairing, construction and donation in the nearby mosque as per requirement;
- Improvement of existing project site approach road and repairing of roads if damaged;
- Construction of jetty or boat landing station.

CSR for Fisherman Community:

There are many fisherman community/villages within 10 km radius of the proposed project site. According to the Taltoli Upazila Fisheries office, there are 2,009 registered fisherman's in Nishanbaria Union. A focus group discussion was conducted with the fishing community to know their needs, problems and concern issues. They reply that, their income and livelihoods will be impacted by the implementation of the proposed project, due to the restriction in the jetty area and adjoining river,

pollution from the power plant will impact on water quality as well as the fish resources in the area. As per discussion with them, the following CSR activities can be taken for the fisherman community:

- Subsidy and loan for procuring modern fishing boats and equipment like fishing gear and craft;
- Training in modern fishing techniques such as GPS and Eco-sounder when they go for fishing in the deep sea like Bay of Bengal;
- Training on value addition;
- Providing electricity and provide necessary infrastructure including ice cutting machines;
- Training in hygienic handling of fish and export facilities; and
- Training and demonstration for alternative livelihoods opportunities for men and women.

Environment Protection program:

In addition to the green development programs, social forestry can be promoted as part of the CSR program by afforestation program in the public places, roadsides, riverbanks, government lands etc.

Others:

- Skill development training;
- Livelihoods improvement and women empowerment;
- Awareness program for the local community.

A need based assessment will be carried out by the BEPCL and further CSR activities will be taken up as per priority. The tentative CSR capital cost is BDT 40 lakhs and annual recurring cost BDT 10 Lakhs.

12.1.12.2 Monitoring mechanism for CSR Activities

The BEPCL will form a CSR cell in the project site for implementing CSR activities. The community liaison office of BEPCL will monitor implementation of the listed activities of CSR. He will prepare the annual report and submit to the project higher authority. The local Union Parishad can be included in the monitoring plan and the Chairman of the Union Parishad will be engaged for conducting annual social audit once in a year.

12.1.13 Monitoring Plan for Pre-construction Phase

During the course of the pre-construction of the proposed 350 MW coal-fired power plant at Taltoli, Barguna, regular environmental monitoring of all environment parameters will be required. The monitoring period is considered as four months during pre-construction phase. The suggested monitoring plan for the pre-construction of the proposed project is given in Table 12-1.

Table 12-1: Environmental Monitoring Plan during Pre-construction

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
General	Inspection of mitigation compliance	Land filling, labor camp and dredging site	Visual inspection of all active work areas	Daily	Monitoring	Implementation: Contractor Supervision: BEPCL
Ambient Air Quality	Dust	Landfilling site	Visual inspection of all active work areas	Daily	Monitoring	Implementation: Contractor Supervision: BEPCL
	PM ₁₀ , PM _{2.5} , SO ₂ , NO _x , CO	4 sampling sites (project site and surrounding area) AAQ-1: Project Site (21°57'37.30"N and 90° 3'47.44"E); AAQ-2: Choto Ankujan Para (21°57'11.30"N and 90° 4'5.12"E); AAQ-3: Near Joyalbhanga Bazar (21°57'5.16"N and 90° 2'53.45"E) and AAQ-4: Taltoli Bazar (21°58'40.00"N and 90° 4'58.76"E)	Onsite measurement and analysis	Monthly	National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR 1997 and amendment in 2005)	Implementation: Contractor Supervision: BEPCL
Ambient Noise Level	Noise level in dB(A)	8 sampling sites (project site and surrounding area) ANL-1: Project Site (21°57'52.37"N and 90° 4'3.49"E); ANL-2: Kadamtala Sirazia Jame Mosque (21°57'39.24"N and 90° 3'55.90"E); ANL-3: Shahidul Mia's House (21°58'3.24"N and 90° 4'27.25"E); ANL-4: Shahjahan Munsii Shop (Bara Ankujanpara Bridge Ghat) (21°58'9.94"N and 90° 4'51.26"E); ANL-5: Taltoli Bazar (in front of Sagar Restaurant) (21°58'27.31"N and 90° 4'54.56"E); ANL-6: Joyalbhanga Bazar	Onsite measurement and analysis	Monthly	National Noise Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) Rules 2006)	Implementation: Contractor Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
		(21°57'22.56"N and 90° 3'21.24"E); ANL-7: Joyalbhanga Govt. Primary School (21°57'12.78"N and 90° 3'20.61"E) and ANL-8: Abu Hanif Mia's House (21°57'22.26"N and 90° 4'28.09"E)				
Surface Water Quality	pH, TDS, TSS, BOD, DO, COD, turbidity, EC, Oil and Grease, Lead, Iron, Zinc, Copper, Total Chromium	3 sampling sites (nearest waterbodies from the landfill site, upstream and downstream of the dredging location)	Surface water sampling and laboratory analysis	Once	National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997)	Implementation: Contractor Supervision: BEPCL
Groundwater Quality	pH, Fe, Mn, As, FC, TC, Salinity, Zn, Pb, Ni, Fe, Hg, Cu etc.	1 sampling site (nearest deep tube well from the project site) (21°57'34.19"N and 90° 3'46.16"E)	Groundwater sampling and laboratory analysis	Once	National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997)	Implementation: Contractor Supervision: BEPCL
Soil Quality	Heavy metal	1 sample from the project site (21°57'48.73"N and 90° 3'56.74"E)	Soil sampling and laboratory analysis	Once	-	Implementation: Contractor Supervision: BEPCL
Sediment Quality	Heavy metal	1 sample from the dredging site	Sediment sampling and laboratory analysis	Once	-	Implementation: Contractor Supervision: BEPCL
Terrestrial Ecology (Flora and fauna)	Monitoring of death/cut/disturbance of terrestrial flora and fauna	Tree/vegetation removal site, landfill site and approach road	Visual inspection and record keeping	Daily	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
Aquatic Ecology (Flora and fauna)	Monitoring of death/movement/disturbance of aquatic flora and fauna specially the dolphins	Dredging site, soil transportation route and project site	Visual inspection and record keeping	Daily	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
Drainage congestion/water logging	Monitoring the drainage condition of the project area and surroundings	Landfilling site and immediate surrounding area	Visual inspection	Daily	Monitoring	Implementation: Contractor Supervision: BEPCL
River Traffic	Disturbance of the boat/vessels movement	Dredging site, soil transportation route and landfill site	Visual inspection	Daily	Monitoring	Implementation: Contractor Supervision: BEPCL
Solid and Liquid Waste	Quantity/volume generated and disposal	Dredging and project site	Visual inspection of waste in generation and disposal site	Daily	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
Community Health and Safety	Accidents, incidents, diseases, dangerous occurrences and community complains	Dredging site, soil transportation route and project site	Visual inspection	Based on occurrence	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
Occupational Health and Safety	Number of accidents, first aid, PPE	Dredging site, soil transportation route, approach road and project site	Visual inspection	Based on occurrence	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
Land acquisition and livelihood restoration	Loss of land, income, livelihoods etc. as per RAP report	Land acquisition area	According to RAP report	Regular during RAP implementation	Monitoring and record keeping	Implementation: Consultant Supervision: BEPCL

12.1.14 Monitoring Plan for Construction Phase

During the course of the pre-construction of the proposed 350 MW coal-fired power plant at Taltoli, Barguna, regular environmental monitoring of all environment parameters will be required. The monitoring period is considered as thirty months during construction phase. The suggested monitoring plan for the construction of the proposed project is given in Table 12-2.

Table 12-2: Environmental Monitoring Plan during Construction

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
General	Inspection of mitigation compliance	Construction site and labor camp	Visual inspection of all active work areas	Daily	Monitoring	Implementation: Contractor Supervision: BEPCL
Air Quality	Dust	Construction sites and material storage sites	Visual Inspection to ensure dust suppression measures are in place	Daily	Monitoring	Implementation: Contractor Supervision: BEPCL
	PM ₁₀ , PM _{2.5} , NO _x , SO ₂ , CO	5 sampling sites (project site and surrounding area) AAQ-1: Project Site (21°57'37.30"N and 90° 3'47.44"E); AAQ-2: Choto Ankujan Para (21°57'11.30"N and 90° 4'5.12"E);	Onsite measurement and analysis	Monthly	National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR 1997 and amendment in	Implementation: Contractor Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
		AAQ-3: Near Joyalbhanga Bazar (21°57'5.16"N and 90° 2'53.45"E); AAQ-4: Taltoli Bazar (21°58'40.00"N and 90° 4'58.76"E); and AAQ-5: Joyalbhanga Govt. Primary School (21°57'13.37"N and 90° 3'20.43"E)			2005)	
	Noise level in dB(A)	Construction site	Visual inspection to ensure good standard equipment are in use	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
Ambient Noise Level	Noise level in dB(A)	8 sampling sites (project site and surrounding area) ANL-1: Project Site (21°57'52.37"N and 90° 4'3.49"E); ANL-2: Kadamtala Sirazia Jame Mosque (21°57'39.24"N and 90° 3'55.90"E); ANL-3: Shahidul Mia's House (21°58'3.24"N and 90° 4'27.25"E); ANL-4: Shahjahan Munsu Shop (Bara Ankujanpara Bridge Ghat) (21°58'9.94"N and 90° 4'51.26"E); ANL-5: Taltoli Bazar (in front of Sagar Restaurant) (21°58'27.31"N and 90° 4'54.56"E); ANL-6: Joyalbhanga Bazar (21°57'22.56"N and 90° 3'21.24"E); ANL-7: Joyalbhanga Govt. Primary School (21°57'12.78"N and 90° 3'20.61"E) and ANL-8: Abu Hanif Mia's House (21°57'22.26"N and 90° 4'28.09"E)	Onsite measurement and analysis	Monthly	National Noise Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) Rules 2006)	Implementation: Contractor Supervision: BEPCL
Surface Water	pH, TDS, TSS,	3 sampling sites (river, canal and nearest	Surface water	Monthly	National Water	Implementation:

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
Quality	BOD, DO, COD, turbidity, EC, Oil and Grease, Lead, Iron, Zinc, Copper, Total Chromium	pond water from the construction site) SWQ-1: Buriswar-Payra River (upstream of the project site) (21°58'38.05"N and 90° 4'12.32"E); SWQ-2: Buriswar-Payra River (downstream of the project site) (21°57'57.56"N and 90° 3'47.18"E) and SWQ-3: Nearest Pond (21°57'52.63"N and 90° 4'19.72"E)	sampling and laboratory analysis		Quality Standard (Schedule-3: Standards for Water, ECR, 1997)	Contractor Supervision: BEPCL
Ground Water Quality	pH, Fe, Mn, As, FC, TC, Salinity, Zn, Pb, Ni, Fe, Hg, Cu etc.	3 sampling sites (nearest tube well settlement/school/mosque areas) GWQ-1: Near Joyalbhanga Bazar (21°57'39.10"N and 90° 3'56.03"E); GWQ-2: Choto Ankujanpara (21°57'13.39"N and 90° 4'12.72"E) and GWQ-3: Joyalbhanga Govt. Primary School (21°57'13.11"N and 90° 3'20.43"E)	Groundwater sampling and laboratory analysis	Monthly	National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997)	Implementation: Contractor Supervision: BEPCL
Soil Quality	Heavy metal, oil & grease	2 sampling sites (construction site and adjacent agricultural land) SQ-1: Project Site (21°57'52.59"N and 90° 4'3.12"E) and SQ-2: Choto Ankujanpara (21°57'36.57"N and 90° 4'43.34"E)	Soil sampling and laboratory analysis	Quarterly	-	Implementation: Contractor Supervision: BEPCL
Sediment Quality	Heavy metal, oil & grease	2 sampling sites (upstream & downstream of the project site or Jetty site) SeQ-1: Upstream (21°58'10.72"N and 90° 4'5.52"E) and SeQ-2: Downstream (21°57'32.13"N and 90° 3'30.30"E)	Sediment sampling and laboratory analysis	Quarterly	-	Implementation: Contractor Supervision: BEPCL
Terrestrial Ecology (Flora)	Monitoring of death/cut/disturban	Tree/vegetation removal at jetty site	Visual inspection and record	Daily	Monitoring and record keeping	Implementation: Contractor

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
and fauna)	ce of terrestrial flora and fauna		keeping			Supervision: BEPCL
Aquatic Ecology (Flora and fauna)	Monitoring of death/movement/disturbance of aquatic flora and fauna	Jetty construction site, project site river and construction materials transportation route	Visual inspection and record keeping	Daily	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
	Numbers and movement of Dolphins	Buriswar-Payra river at project site	Visual inspection, record keeping and reporting	During monsoon and continue for 1 year	Monitoring and record keeping	Implementation & Supervision: BEPCL
Fish resources and fishing activity	Capture/Death/Killing/Disturbance/migration etc.	Buriswar-Payra River near the project site	Visual inspection that no disturbance of fishing activities	Daily	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
	Capture, production, availability, diversity index, richness, habitat suitability index, breeding, migration etc.	Buriswar-Payra River near the project site	Visual inspection to ensure local river traffic and fishing activities are not affected	Yearly stakeholder consultation	Fish catch, assessment survey, fish survey and fisherman interview	Implementation: Contractor Supervision: BEPCL
Solid Waste	Quantity, volume and waste management	Construction camp and construction sites	Visual inspection that solid waste is disposed at designated site	Weekly	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
Liquid Waste	Waste management	Construction camp	Visual inspection	Weekly	Monitoring and	Implementation:

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
			that liquid waste is disposed at designated site		record keeping	Contractor Supervision: BEPCL
Hazardous Waste	Hydrocarbon and chemical storage	Construction site	Visual Inspection of storage facilities	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
Drainage congestion/wat erlogging	Monitoring the drainage condition	Project construction site and immediate surrounding area	Visual inspection	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
Erosion	Mark of erosion	Construction areas and material storage sites	Visual Inspection	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
River Traffic	Burishwar-Payra River	Jetty construction area, parts and equipment transportation route	Visual inspection to ensure local river traffic	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
Road Traffic	Traffic safety	Approach road	Visual inspection to ensure local roads are not damaged, placement of traffic signs and proper traffic management	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
Material	Handling and	Construction sites and jetty area	Visual Inspection	Monthly	Monitoring	Implementation:

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
handling and storage	storage of parts and equipment at plant					Contractor Supervision: BEPCL
Drinking water and sanitation	According to the ECR, 1997	In construction sites and construction camp	Ensure the construction workers are provided the safe water and sanitation facilities in the site	Weekly	Monitoring	Implementation: Contractor Supervision: BEPCL
Community Health and Safety	Accidents, incidents, diseases, and community complains	Construction site and approach road	Visual inspection	Based on occurrence	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL
Occupational Health and Safety	Number of accidents, first aid, PPE	Construction site, jetty site and construction camp	Visual inspection	Based on occurrence	Monitoring and record keeping	Implementation: Contractor Supervision: BEPCL

12.1.15 Monitoring Plan for Operation Phase

During the course of the pre-construction of the proposed 350 MW coal-fired power plant at Taltoli, Barguna, regular environmental monitoring of all environment parameters will be required. The suggested monitoring plan for the Operation of the proposed project is given in Table 12-3.

Table 12-3: Environmental Monitoring Plan during Operation

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
Compliance monitoring	EIA, Mitigation Measures, Condition of Environmental Approval	All areas	-	Monthly	Environmental Management and Monitoring Plan (EMMP)	Implementation & Supervision: BEPCL
Meteorology	Wind speed, wind direction, temperature, humidity, rainfall, solar radiation, cloud cover	Project site	Establishment of weather station	Continuous	-	Implementation & Supervision: BEPCL
Stack Emissions	SOx, NOx, CO and Particulate Matter	At the stack	-	Continuous	DoE/ADB/IFC/WB	Implementation & Supervision: BEPCL
	Fugitive dust emission	Coal handling Jetty, ash yard, stock house, crushers mills, approach road	Visual inspection	Daily	-	Implementation & Supervision: BEPCL
Ambient Air Quality	PM ₁₀ , PM _{2.5} , SPM, CO, SO ₂ , NOx and O ₃	5 sampling sites (all operational areas including the residential area in the power plant vicinity and surrounding settlement area) AAQ-1: Project Site (21°57'37.30"N and 90° 3'47.44"E); AAQ-2: Choto Ankujan Para (21°57'11.30"N and 90° 4'5.12"E); AAQ-3: Near Joyalbhanga Bazar (21°57'5.16"N and 90° 2'53.45"E); AAQ-4: Taltoli Bazar (21°58'40.00"N and 90° 4'58.76"E); and AAQ-5: Joyalbhanga Govt. Primary School (21°57'13.37"N and	Onsite measurement and analysis	Once a month	National Air Quality Standard (Schedule-2: Standards for Air Quality, ECR 1997 and amendment in 2005)	Implementation & Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
90° 3'20.43"E)						
Power Plant Noise Levels	Average Leq values and maximum value of SPL in dB(A)	3 sampling sites (Project boundary, equipment and work place)	Onsite measurement and analysis	Monthly	National Noise Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) Rules 2006)	Implementation & Supervision: BEPCL
Ambient Noise Levels	Leq values in dB(A)	8 sampling sites (project site and surrounding area) ANL-1: Project Site (21°57'52.37"N and 90° 4'3.49"E); ANL-2: Kadamtala Sirazia Jame Mosque (21°57'39.24"N and 90° 3'55.90"E); ANL-3: Shahidul Mia's House (21°58'3.24"N and 90° 4'27.25"E); ANL-4: Shahjahan Munsii Shop (Bara Ankujanpara Bridge Ghat) (21°58'9.94"N and 90° 4'51.26"E); ANL-5: Taltoli Bazar (in front of Sagar Restaurant) (21°58'27.31"N and 90° 4'54.56"E); ANL-6: Joyalbhanga Bazar (21°57'22.56"N and 90° 3'21.24"E); ANL-7: Joyalbhanga Govt. Primary School (21°57'12.78"N and 90° 3'20.61"E) and ANL-8: Abu Hanif Mia's House (21°57'22.26"N and 90° 4'28.09"E)	Onsite measurement and analysis	Monthly	National Noise Quality Standard (Schedule-4: Standards for Sound, ECR, 1997 and Noise Pollution (control) Rules 2006)	Implementation & Supervision: BEPCL
Surface Water Quality	pH, TSS, TDS, Oil and Grease, Cl, Cr, Fe, Ca, Zn, Pb, Cd,	3 sampling sites (Jetty area, 500 m upstream and 500m downstream from coal handling Jetty location)	Surface water sampling and laboratory	Quarterly	National Water Quality Standard (Schedule-3:	Implementation & Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
	Hg, As, HCO ₃ , Nitrogen, Ammonia, BOD, COD, EC, Turbidity	SWQ-1: Jetty Location (21°57'58.29"N and 90° 3'48.47"E); SWQ-2: Upstream (21°58'12.21"N and 90° 4'1.17"E) and SWQ-3: Downstream (21°57'45.14"N and 90° 3'37.85"E)	analysis		Standards for Water, ECR, 1997)	
Groundwater Quality	Ground Water Level, pH, TDS, TSS, Total Hardness, Cl, NO ₃ , SO ₄ , F, O&G, Hg, FC, TC	2 sampling sites (from villages around the plant) GWQ-1: Near Joyalbhanga Bazar (21°57'39.10"N and 90° 3'56.03"E) and GWQ-2: Choto Ankujanpara (21°57'13.39"N and 90° 4'12.72"E)	Surface water sampling and laboratory analysis	Quarterly	National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997)	Implementation & Supervision: BEPCL
	Ground water Level and Heavy Metals	4 sampling sites (observation wells near ash dyke of piezometers in 4 directions)	Surface water sampling and laboratory analysis	Monthly	National Water Quality Standard (Schedule-3: Standards for Water, ECR, 1997)	Implementation & Supervision: BEPCL
Storm Water	Oil & Grease, Cl, TSS, COD, BOD	Discharge channel	Surface water sampling and laboratory analysis	Weekly during monsoon	National Standards for Waste (Schedule-10: Standard for waste from Industrial units or Projects waste)	Implementation & Supervision: BEPCL
Soil Quality	Heavy metal, oil & grease	2 sampling sites (waste storage site in the plant and nearest agricultural land)	Soil sampling and laboratory analysis	Quarterly	-	Implementation & Supervision: BEPCL
Sediment Quality	Heavy metal, oil & grease	2 sampling sites (Coal handling jetty and water discharge location in Buriswar-Payra River)	Sediment sampling and laboratory	Quarterly	-	Implementation & Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring analysis	Frequency	Applicable standard	Responsibility
Effluent (Waste Water) Quality	Flow, pH, EC, Temperature, Turbidity, TDS, TSS, SO ₄ , NO ₃ , Cl, F, Oil and Grease, BOD, COD, Hg, Cd, As, Na, Cr, Pb, Ni, Cu, Fe, Zn, NH ₃ , PO ₄ ³⁻ and Cl	2 locations (from Inlet and Outlet of STP/WTP, at the point where effluent leaves the power plant boundary)	Sampling and laboratory analysis of effluent	Monthly	National Standards for Waste (Schedule-10: Standard for waste from Industrial units or Projects waste)	Implementation & Supervision: BEPCL
Effluent (Cooling Water Discharge)	Flow, Temperature, Turbidity	At point of discharge for effluent and 100m downstream and upstream in the Buriswar-Payra River	Visual checks to assess the situation and onsite test	Daily	National Standards for Waste (Schedule-10: Standard for waste from Industrial units or Projects waste)	Implementation & Supervision: BEPCL
Non-hazardous Solid Waste (domestic and office waste)	Quality, quantity, collection system and disposal locations	Disposal site in project premises	Visual checks to assess the situation	Daily	Monitoring and record keeping	Implementation & Supervision: BEPCL
Hazardous Solid Waste	Types, quantity, storage, associated hazards, disposal method	Fly ash, bottom ash generating sources like ESP hopper, air preheated and disposal point all units of the plant	Visual checks to assess the situation	Monthly	Monitoring and record keeping	Implementation & Supervision: BEPCL
Hazardous Liquid Waste (from WTP,	Types, quantity, storage, associated hazards, disposal	Storage and discharge point	Visual checks to assess the situation	Monthly	Monitoring and record keeping	Implementation & Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
ETP, STP)	method					
Hazardous Spill	Spill on land, spent oil and lubricants	All operational areas and storage area	Visual checks to assess the situation	Daily	-	Implementation & Supervision: BEPCL
Fire and Safety	Fire hazards & safety protocols	All operational areas	Visual inspection	Daily	-	Implementation & Supervision: BEPCL
Road Traffic	Traffic management plan in the project area and disturbance in approach road	Entry exit routes of the plant and approach road	Visual inspection	Daily	TMP	Implementation & Supervision: BEPCL
River Traffic	Burishwar-Payra River	Coal transportation route and coal unloading jetty area	Visual inspection to ensure local river traffic and no disturbance	Daily	Monitoring	Implementation & Supervision: BEPCL
Accidents	Inspection and record keeping	All areas	Visual inspection	Based on occurrence	Health and Safety Policy of BEPCL	Implementation & Supervision: BEPCL
Fish	Capture/Death/Killing/Disturbance/migration etc.	Water intake and cooling water discharge point in Burishwar-Payra River	Visual inspection	Daily	Monitoring and record keeping	Implementation & Supervision: BEPCL
	Capture, production, availability, diversity index, richness, habitat suitability index, breeding, migration etc.	Burishwar-Payra River near the project site	Visual inspection to ensure local river traffic and fishing activities are not affected	Yearly stakeholder consultation	Fish catch, assessment survey, fish survey and fisherman interview	Implementation & Supervision: BEPCL

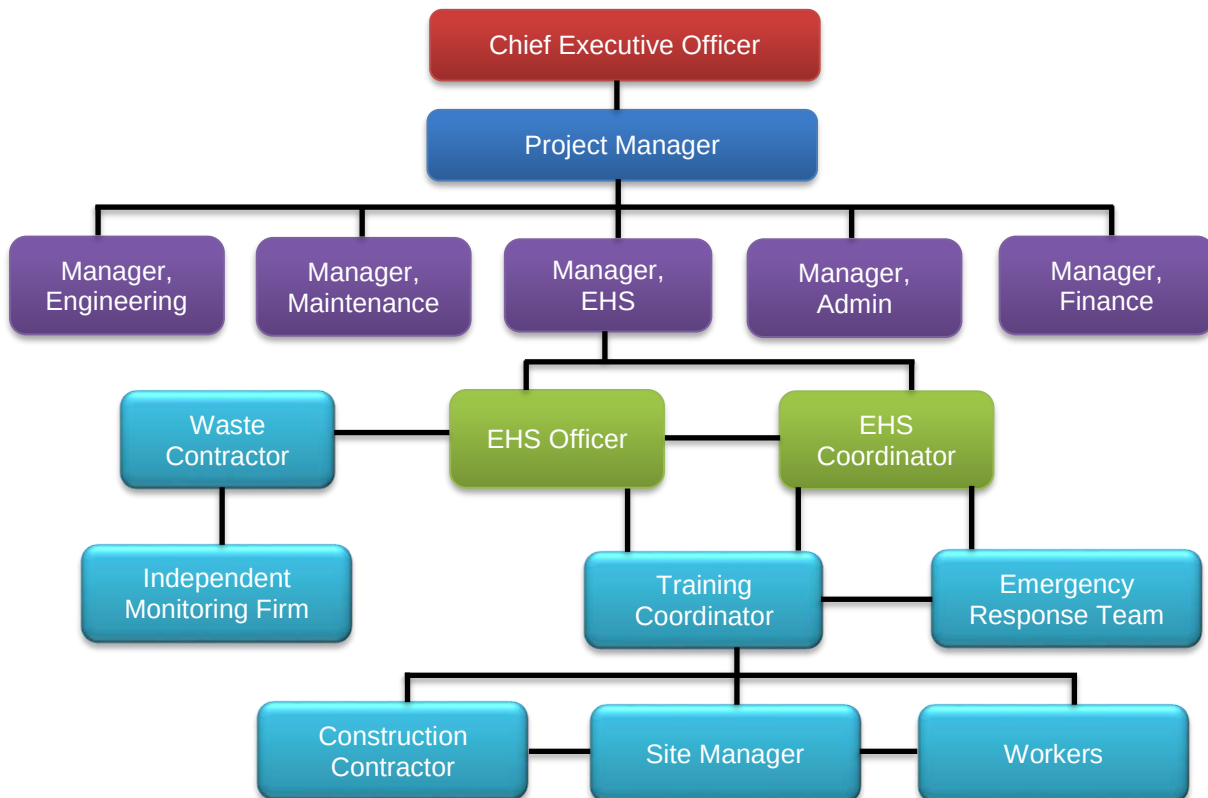
Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
Aquatic Fauna (Dolphins)	Numbers and movement of Dolphins	Burishwar-Payra River at project site, coal transportation route and jetty area	Visual inspection, record keeping and reporting	During monsoon & continue for 1 year	Monitoring and record keeping	Implementation & Supervision: BEPCL
Phytoplankton, Zooplankton and Benthos	Availability, diversity index, richness, habitat suitability index	Water intake and discharge point	Sampling and laboratory analysis	Quarterly	-	Implementation & Supervision: BEPCL
Terrestrial Flora	Health, Aging and Growth, Canopy coverage, Diseases	Project site, surrounding forest	One at greenbelt area in the plant and two at the surrounding village and forest	Yearly	-	Implementation & Supervision: BEPCL
Terrestrial Fauna	Death, Killing, Disturbance of fauna	Project site, surrounding forest	Visual inspection	Monthly	Monitoring and record keeping	Implementation & Supervision: BEPCL
Drainage Congestion	Monitoring of the obstacle into the water bodies	Project site and surrounding embankment area	Visual inspection	Daily	Monitoring	Implementation & Supervision: BEPCL
Green belt development	Number of trees are planted	Project premises and surrounding area	Plantation of trees and record keeping	Periodic and need based	Monitoring	Implementation & Supervision: BEPCL
Community health and safety	Respirable disorders, Heart diseases, Fluorosis, Diabetes, Reproductive Health, Child Health, ENT	Surrounding villages around the project	Health camps in surrounding villages with qualified doctors and health check-up	Yearly	-	Implementation & Supervision: BEPCL

Aspect/ Environmental Indicator	Parameters/Units	Monitoring Locations	Means of monitoring	Frequency	Applicable standard	Responsibility
problems						
Occupational Health and Safety	Accidents, PPEs, Diseases (respirable disorders, heart diseases, diabetes, reproductive and Child health, ENT problems, etc.)	Operational areas (all places where there is presence of workers all the time)	-	Weekly	Health and Safety Policy of BEPCL	Implementation & Supervision: BEPCL
Coal and fly ash specification	Heavy metals (As, Be, Cd, Cr, Pb, Hg and Ni)	Coal storage and ash pond area	Sampling and laboratory analysis	Every lot of coal (ash produced) received from abroad or quarterly	Test in recognized laboratory	Implementation & Supervision: BEPCL
Road condition	Damage to local roads	Approach road	Visual inspection to ensure local roads are not damaged	Monthly	Monitoring	Implementation & Supervision: BEPCL
CSR activities	Number of benefitted persons or family, activities	Surrounding villages around the project	Stakeholder consultation	Yearly	CSR policy of BEPCL	Implementation & Supervision: BEPCL

12.1.16 Institutional Setting and Implementation Arrangement

The environmental management will require specific approach in order to handle the issues effectively. Manager EHS will assign the roles and responsibilities to be performed during the pre-construction, construction and operation stages of 350 MW coal-fired Power Plant Project of BEPCL. It is expected that a certain degree of redundancy is inevitable across all management levels, but should be in the order to ensure that compliance with the environmental management plan can be cross-checked. The suggested organizational structure for environmental management is given below in Figure 12-1.

Figure 12-1: Suggested Organizational Structure for Environmental Management



Compliance with EMP will be the responsibility of BEPCL project management at each stage of project. BEPCL management will ensure that all executive activities during pre-construction and construction stage do not create adverse environmental effects. Contractor and sub-contractor will work in environment friendly manner under the supervision of EHS department of BEPCL. All the regulatory agencies including DoE will be contacted as and when required to get advice for environmental management and they will be kept informed of the environmental conditions of the area periodically by BEPCL management and their contractors/sub-contractors. Some of the approaches to be followed during the environmental management practices are given below:

- Complying with the relevant legislation and regulations of Bangladesh;
- Regularly reviewing of the impacts on the environment in the project site;
- Developing appropriate indicators to monitor core impacts;
- Setting appropriate annual objective, targets and publicly reporting on progress;
- Monitoring supplier's environmental management arrangements;
- Using sustainable materials for office supplies and environmentally safe raw materials with recycling options where appropriate; and
- Communicating openly with internal and external stakeholder on environmental issues.

12.1.16.1 Roles and Responsibilities

Environmental management will be the integral part of corporate policy of the BEPCL. Therefore, committing to reduce the environmental impacts will reflect the management approach and belief that good governance and performance in this area is synonymous with running a well-managed efficient business. Overall responsibility for environmental performance rests with the Chief Executive Officer of BEPCL while the daily management will be performed under the direction of Manager EHS. BEPCL's EHS officer and contractor will execute environmental management under the supervision of Manager EHS during construction and operations. The contractor will carry out field activities as part of the proposed BEPCL project that includes relevant and subsidiary construction work. The contractor will have certain liabilities under the environmental laws of the country, which will be specified in the contract document with the BEPCL Management. The overall responsibility for all matters pertaining to environment will be that of the organizational head of assigned contractor.

A brief make-up of the roles and responsibilities of the system is given below:

1. Chief Executive Officer (CEO) of BEPCL

The CEO of BEPCL will regulate the EMP. The key roles and responsibilities of CEO are given below:

- To consider and react to issues and solutions proposed by the HSE Department of BEPCL;
- To cooperate and consult the relevant environmental agency to perform better;
- To evaluate the progress of development and implementation of EMP; and
- To approve any change in decision-making and authorities in consultation with Manager EHS, if appropriate.

2. Manager EHS

The success of EMP depends on proper and effective management provided by EHS manager. The roles and responsibilities assigned to Manager EHS are given below:

- To ensure that the points of views of staff, contractors and EHS officers are considered and placed likewise in the EMP;
- To identify issues and propose solutions for inclusion in the EMP review process;
- To improve coordination and exchange of information between top management, employees, and contractors;
- To contribute to actions required to deliver the management plan and ensure its continued development;
- To review EMP every year, tracking issues and changing EMP in accord with the solutions and suggestions; and
- To monitor the progress of development and implementation of the EMP.

3. EHS Officer

The role of EHS officer will be authorized by EHS manager. The responsibilities of HSE officer will include:

- To integrate, as far as possible, the aims and objectives of different users within an agreed plan;
- To maintain a balanced, holistic approach to the solution of concerned issues in accordance with and compliance of legislative requirements;
- To provide professional guidance on questions relating to the environment management and issues raised by contractors/relevant personals; and
- To develop the EMP process by its implementation.

4. Contractor

The role and responsibilities of the contractor consist of the following:

- To carry out construction activities in environmentally sound manner;
- To coordinate with the EHS officer to resolve issues arising during construction phase;

- To manage and implement environmental management practices as given in the impact assessment report as well as EHS policies adopted/prepared by BEPCL;
- To administer construction crew and reduce the environmental risks;
- To appoint a dedicated environment officer to understand and handle environmental issues more easily in coordination with BEPCL's EHS officer/coordinator.

5. The Supervision Consultant

The BEPCL shall appoint an Independent Monitoring Consultant, who will oversee that the construction activities are in consonance with the provisions of the EIA. He shall be responsible for the preparation of monthly reports on the project progress. The consultant will maintain records, decisions made at meetings, progress on civil works, certified achievements and milestones, financial records, and any deviations from or changes to the contract plans. The consultant will assist the BEPCL and contractor in preparing quarterly project progress reports, a project completion report, and monitoring and evaluation reports as required under the agreement.

12.1.17 Action during Abnormal Operating Conditions

During abnormal operating conditions like process upsets or failure of pollution control devices, the emission concentration would exceed the prescribed limit. Air emissions from major stacks are measured using online instruments with real time display facility. In case of abnormal emissions, the Manager of EHS will directly contact the Chief Executive Officer (CEO) and head of all departments, and assess the situation. The emission load should be brought down to barest minimum level by reducing the production. In case it is observed that the failure/upset condition is likely to exceed reasonable time (say 8 hours or more) then the unit should be shut down till the defect is corrected. The proposed power plant projects should try to reduce the number of accidents among project workers (whether directly employed or subcontracted) to a rate of zero, especially accidents that could result in lost work time, different levels of disability, or even fatalities. The accident and fatality rates of the specific facility may be benchmarked against the performance of facilities in this sector in developing countries through consultation with published sources.

12.1.18 Budgets for Monitoring

The project proponent and EPC contractor will allocate separate budget for environmental and social management plan implementation, training, environmental monitoring, reporting and capacity building. Cost estimates are prepared for all the monitoring measures proposed in the report. The details of the cost estimates and the budget during pre-construction (4 months), construction (30 months) and first year of operation stage for the monitoring measures are given in Table 12-4. In addition to that, separate budget will be allocated for CSR activities, which will be conducted by the project proponent for community development.

Table 12-4: Summary of costs for Environmental Monitoring

SL#	Item/Activities	Unit	Unit cost	Qty.	Total cost (BDT in million)
A. Monitoring cost during pre-construction Phase					
1.	Ambient Air Quality Monitoring (4 locations @ monthly over 4 months)	Sites	30,000	16	0.48
2.	Ambient Noise Level Monitoring (8 locations @ monthly over 4 months)	Sites	10,000	32	0.32
3.	Surface Water Quality Monitoring (3 locations @ once)	Sites	30,000	3	0.09
4.	Groundwater Quality Monitoring (1 location @ once)	Sites	30,000	1	0.03
5.	Soil Quality Monitoring (1 location @ once)	Sites	25,000	1	0.025

SL#	Item/Activities	Unit	Unit cost	Qty.	Total cost (BDT in million)
6.	Sediment Quality Monitoring (1 location @ once)	Sites	25,000	1	0.025
7.	Contingency	LS	-	-	0.1
Total					1.07
B. Monitoring cost during construction Phase					
1.	Ambient Air Quality Monitoring (5 locations @ monthly over 30 months)	Sites	30,000	150	4.5
2.	Ambient Noise Level Monitoring (8 locations @ monthly over 30 months)	Site	10,000	240	2.4
3.	Surface Water Quality Monitoring (3 locations @ monthly over 30 months)	Sites	30,000	150	4.5
4.	Groundwater Quality Monitoring (3 locations @ monthly over 30 months)	Sites	30,000	150	4.5
5.	Soil Quality Monitoring (2 locations @ quarterly over 30 months)	Sites	25,000	20	0.5
6.	Sediment Quality Monitoring (2 locations @ quarterly over 30 months)	Sites	25,000	20	0.5
7.	Monitoring of Dolphins	LS	-	-	5.0
8.	Monitoring of Fish	LS	-	-	2.0
9.	Contingency	LS	-	-	0.5
Total					24.4
C. Monitoring cost during operation Phase/Year					
1.	Meteorology	Included in O&M cost			-
2.	Stack emission monitoring	Included in O&M cost			-
3.	Ambient Air Quality Monitoring (5 locations @ monthly over 12 months)	Sites	30,000	60	1.8
4.	Power Plant Noise Level Monitoring (3 locations @ monthly over 12 months)	Site	10,000	36	0.36
5.	Ambient Noise Level Monitoring (8 locations @ monthly over 12 months)	Site	10,000	96	0.96
6.	Surface Water Quality Monitoring (3 locations @ Quarterly over 12 months)	Sites	30,000	12	0.36
7.	Groundwater Quality Monitoring (2 locations @ Quarterly over 12 months)	Sites	30,000	8	0.24
8.	Groundwater Quality Monitoring (4 locations @ monthly over 12 months)	Sites	50,000	48	2.4
9.	Storm Water Quality Monitoring (1 location @ weekly over 4 months (June to September))	Sites	15,000	16	0.24
10.	Soil Quality Monitoring (2 locations @ quarterly over 12 months)	Sites	25,000	8	0.2
11.	Sediment Quality Monitoring (2 locations @ quarterly over 12 months)	Sites	25,000	8	0.2
12.	Effluent (waste water) Quality (2 locations @	Sites	60,000	24	1.44

SL#	Item/Activities	Unit	Unit cost	Qty.	Total cost (BDT in million)
	monthly over 12 months)				
13.	Effluent (cooling water discharge) Quality (1location @ daily over 12 months)	LS	-	-	1.0
14.	Phytoplankton, Zooplankton and Benthos (2 locations @ quarterly over 12 months)	Sites	50,000	8	0.4
15.	Flora monitoring	LS	-	-	0.5
16.	Coal and fly ash specification (quarterly over 12 months)	Sample	50,000	4	0.2
17.	Monitoring of Dolphins	LS	-	-	2.0
18.	Monitoring of Fish	LS	-	-	1.5
19.	Contingency	LS	-	-	1.0
Total					14.8

12.1.19 Reporting Schedule

A robust reporting system will provide the project with the necessary feedback mechanisms to ensure quality and timely implementation of the works. The reporting system will provide a mechanism for ensuring that the measures proposed in the EMP are implemented. Before starting the civil works, the EHS officer of BEPCL will finalize the format for reporting on the status and progress of environmental monitoring. The format will be designed to meet all the compliance conditions associated with the environmental clearance from the Department of Environment and the Government of Bangladesh. The contractor will be required to submit the duly filled up reporting form on a monthly basis to the Project Developer (i.e., BEPCL). A further report, detailing the results of pollution monitoring for air, noise, water, soil and sediment will be submitted as envisaged in the monitoring plan. A health and safety incident/ accident report will be prepared and submitted in the event of an incident or accident.

The EHS personnel will monitor the effectiveness of the EMP implementation. Quarterly Progress Reports that can be submitted to the regional office and head office of the DoE required as a part of environmental clearance process shall also be prepared and submitted based on the necessary monitoring and reporting formats. The Table 12-5 below indicates the types of report and corresponding actions to be taken.

Table 12-5: Summary of Report Type

SL#	Report Type	Frequency	Responsibility
1	Environmental Quality Performance	Monthly	Consultant/BEPCL
2	Environmental Quality Performance	Quarterly	Consultant/BEPCL
3	Annual Environmental Report	Annual	Consultant/BEPCL
4	Environmental Management Plan	3 Years	Consultant/BEPCL

CHAPTER THIRTEEN: WORK PLAN

13. Work Plan

The tentative work plan for the proposed 350 MW coal-fired power plant project is shown in the following Figure 13-1. The pre-construction phase will be 4 to 6 months duration and construction phase will be 30 months duration. The expected commercial operation will be started in June 2021.

Figure 13-1: Tentative Work Plan for the Proposed Project

SL#	Activity Description	Date
1	Start piling	01/01/2019
2	The main power building area hand over to excavation	17/03/2019
3	The foundation of main power building start to excavation	01/04/2019
4	The main power building first tank of concrete pouring	16/05/2019
5	Boiler foundation hand-over	15/06/2019
6	The boiler steel structure start to be erection	30/06/2019
7	The main power building more than 0m	30/06/2019
8	The steam turbine platform in place	28/10/2019
9	The main power building closed	25/05/2020
10	Chemical water produced qualified desalination salt water	24/06/2020
11	Boiler water pressure test completed	24/07/2020
12	DCS energized	23/08/2020
13	Back feed power	07/09/2020
14	The steam turbine cover completed	22/09/2020
15	The steam turbine oil cycle completed	22/10/2020
16	Boiler pickling completed	21/11/2020
17	The furnace ignition blowpipe completed	21/11/2020
18	Unit initial run up and grid-connected load test	20/01/2021
19	168 hours trial run completed	19/02/2021
20	The internal performance test completed	20/05/2021
21	Commercial operation date	19/06/2021

Source: BEPCL, 2018

**CHAPTER FOURTEEN: PROJECT BENEFITS
WITH BENEFIT COST ANALYSIS THAT
COVERS AMONG OTHERS,
ENVIRONMENTAL AND SOCIAL COST**

14. Project Benefits with benefit cost analysis that covers among others, environmental and social cost

The proposed 350 MW coal fired power plant will be established at Taltoli Upazila of Barguna District. The proposed project by BEPCL would enable to meet part of the electricity demand in the national grid. Small and medium scale industries may be further developed as a consequence. The proposed power plant will result in improvement of infrastructure as well upliftment of social structure in the area. It is anticipated that the plant will provide benefits for the locals in three phase's i.e. pre-construction, construction and operation phase.

14.1 Availability of Power

The proposed power plant project will generate 350 MW power and meet the energy deficit there by lessening the demand and supply gap in the Barisal region as well as national grid. The proposed project will be beneficial in government's target of providing power access to all people.

14.2 Employment Potential

14.2.1 Employment during Pre-construction Phase

The major benefit due to the proposed power plant project will be in the area of generation of temporary employment for substantial number of personnel. The pre-construction phase of power plant is expected to span over 4 to 6 months. During the pre-construction phase skilled, semi-skilled and unskilled laborer and officers will be required to complete the project in time. About 280 operators and labors will be dispatched in the project site in order to quickly finish the dredging activities. For the landfilling materials transportation, about 100 operators will be needed. During soil extraction, transportation, land filling, levelling, site cleaning, construction of boundary wall etc. activities will create unskilled job opportunities. This will be enhanced to skilled employment during the site preparation of the proposed coal fired Power Plant project.

14.2.2 Employment during Construction Phase

During construction phase of the project, this project will provide temporary employment to many unskilled and semi-skilled laborers. This project will also help in generation of indirect employment to those people who render their services for the personnel directly working in the project. During the construction phase, local labors, civil engineers, electrification engineer, machinery engineer and managers will be required. The construction phase of power plant is expected to span over 30 months. Total 2,200 numbers of people will be required during peak time of the construction phase. Surrounding of the project area there are availability of laborers that can be used for the project. The local population will be given preference to employment. The employment potential will ameliorate economic conditions of these families directly and provide employment to many other families indirectly who are involved in business and service oriented activities.

14.2.3 Employment during Operation Phase

The operation and management of this power plant project have the potential employment opportunities for qualified community indigenes (who may be employed in the project), new skills in building, construction and overall project development and management will be provided. Approximately 172 people will be employed during operational stage of the project for operation, maintenance and administration purposes. Among them about 32 numbers of people will be required for the administrative purposes, 134 for the production process and 6 for environmental management. Workers from neighboring districts, if found suitable, shall be employed during operational phase of the proposed project. During operational phase, considerable number of people will be benefited by provision of services to the residents. Thus, the direct and indirect employment generation by this project. The trend of out migration for employment, if any, is likely to be reduced due to better economic opportunities available in the area.

14.3 Community Services

The power plant authority will employ local people to the extent possible in order to reduce the need for additional infrastructure. In addition, they will develop necessary infrastructure like accommodation, water supply, sewage, medical facility etc. for catering to the needs of the project personnel and their families. It is proposed to develop township for employees within the plant site. The local people will be indirectly benefited by these developments. Community development activities such as training of local unemployed youth in various skills, personality development, development of self-help groups for women, providing drinking water facility, strengthening of rural roads etc.

14.4 Improved Business Opportunities/Economic Enhancement

The local economy will enjoy a “boom” that is expected to last throughout construction phase and even slightly beyond. Employment opportunities will increase with the establishment of project related processing plants and industries. The employment of local people in primary and secondary sectors of project shall upgrade the prosperity of the region. This in-turn will improve the socio-economic conditions of the area. Indirect employment arising out of a big infrastructural project like transport requirements, catering, ancillary industries, material handling, trading and other associated services.

14.5 Transportation

The power plant authority will be laying road around the project area so that all surrounding villages can avail better and faster connectivity between them. The construction of new roads/strengthening of roads in the project area will enhance the transportation facilities. With improved transportation facilities there is always a scope for development.

14.6 Improvement in the Physical Infrastructure

The presence and the operation of the project will potentially bring about the improvement of existing infrastructure and introduction of new infrastructure. For example, the provision of health facility and good access roads for the project's use will benefit the immediate and the surrounding communities.

The basic requirement of the community needs will be strengthened by extending healthcare, educational facilities to the community, building/strengthening of existing roads, religious institutes in the area. BEPCL will initiate the above amenities either by providing or by improving the facilities in the area, which will help in uplifting the living standards of local communities.

14.7 Improvement in the Social Infrastructure

- The project will create opportunities for direct and indirect employment;
- Increase in purchasing power and improved standard of living of the area;
- Further development of small and medium scale industries may be developed as consequence;
- Increased revenue to the state by way of royalty, taxes and duties;
- Overall Growth of the neighboring area viz.: Agriculture, Education, Health and family welfare and Infrastructure development.

In addition to above, due to increase in purchasing power of local habitants:

- There shall be significant change in the socio-economic scenario of the area;
- The proposed project shall enhance the prospects of employment;
- Recruitment for the unskilled and semiskilled workers for the proposed project will be from the nearby villages;
- The basic amenities viz. roads, transportation, electricity, proper sanitation, educational institutions, medical facilities, entertainment etc. will be developed as far as possible; and
- Overall, the proposed project will change living standards of the people and improve the socio-economic conditions of the area.

14.8 Enhanced Skills Acquisition

The construction, operation and management of this power plant project have the potential employment opportunities for qualified community (who may be employed in the project), new skills in building, construction and overall project development and management will be provided.

14.9 Increased Potential for Sustainable Rural-to-Urban Community Transformation

The project has the potential to increase the amenities in the area. Some workers attracted during the construction phase will not all depart even after demobilization of workers at the end of the construction phase. Through the process of natural increase (and further influx of people over time), the population of the community will be on the increase. Other types of need would evolve providing business economic opportunities, and this occurrence will increase demand and supply for essential infrastructure and services, features of urban communities.

14.10 Increased Potential for Corporate and Community Understanding

By encouraging the fostering of local institutional responsibilities, adopting a participatory approach and sustained dialogue, this project offers an opportunity for improved relations between project construction workers and the host communities.

CHAPTER FIFTEEN: PUBLIC CONSULTATION

15. Public Consultation

15.1 Introduction

This chapter presents all the stakeholders identified and consulted and elaborates on the main issues and concerns rose by these stakeholders during the scoping exercise and the detailed EIA study. Stakeholders were identified during the scoping stage and throughout the EIA study. Views from the general public, local leaders, surrounding institutions, communities and development partners who are interested in and/or would be potentially affected by the proposed project were consulted through interviews and public meetings. The stakeholder consultations were held to ensure that interested and affected parties were informed of the project. The consultations allowed stakeholders to present their views concerning the proposed project. Recording stakeholders' views and preferences was essential to inform the identification of impacts and drawing effective mitigation measures that are presented in this report.

15.2 Objective of the Consultation and Public Participation

The overall objective of the consultation process was to disseminate project information and to incorporate the views of stakeholders in the design of the environmental and social mitigation measures, management plan and monitoring plan. The specific objectives of the consultation process were to:

1. Improve project design and thereby, minimize conflicts and delays in implementation;
2. Increase long term project sustainability and ownership;
3. Reduce problems of institutional coordination; and
4. Consult stakeholders to gather the information needed to complete the assessment.

15.3 Public Involvement and Disclosure

Public participation is a process through which different stakeholders influence and share their views regarding development initiatives and the decisions and resources that affect them. Comprehensive planning is required to ensure that local government, institutions, NGOs, project staff and affected men and women interact regularly and purposefully during all stages of the project. Engagement with stakeholders and the public in general was mainly through consultations and meetings. These were held throughout the entire EIA study period in the core impact area and project area of influence.

15.4 Approach and Methodology for Consultation

The approach undertaken for information disclosure and consultation involved the following key processes.

- Mapping and identification of key stakeholders such as primary (direct project influence) and secondary (indirect project influence) stakeholders;
- Undertaking expert consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Assessing the influence and impact of the project on these stakeholder groups;
- Summarizing of key findings and observations from the consultations; and
- Preparing a future stakeholder engagement strategy consultation plan for a more detailed assessments at a microscopic level taking into account the various project lifecycle phases and their implications on the stakeholder.

15.5 Stakeholder Assessment

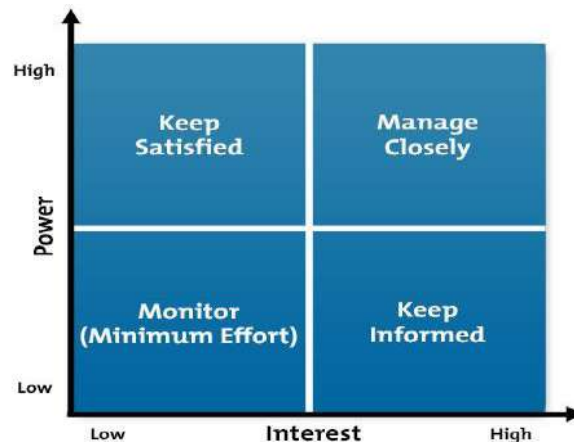
A stakeholder is defined as “a person, group, or organization that has direct or indirect stake in a project/organization because it can affect or be affected by the project or its proponent's actions, objectives and policies”. Stakeholders vary in terms of degree of interest, influence and control they have over the project or the proponent. In the present study, all the stakeholders have been primarily categorized into two categories that have been identified as:

- **Primary Stakeholders:** include people, groups, institutions that either have a direct influence on the project or are directly impacted (positively or adversely) by the project and its activities; and
- **Secondary stakeholders:** are those that have a bearing on the project and its activities by the virtue of their being closely linked or associated with the primary stakeholders and due to the influence they have on the primary stakeholder groups.
- Apart from categorization, the stakeholders have also been classified in accordance with the level of influence they have over the project as well as their priority to the project proponent in terms of importance.

The influence and priority have both been primarily rates as:

- **High Influence/Priority (Manage Closely):** People who have high power and interest are grouped in this category. They always must be managed closely. This implies a high degree of influence of the stakeholder on the project in terms of participation and decision making or high priority for project proponent to engage that stakeholder.
- **Medium Influence/Priority (Keep Satisfied/ keep informed):** People who have high power but low interest as well as who have high interest but low power should be kept satisfied or informed. This implies a moderate level of influence and participation of the stakeholder in the project as well as a priority level for project proponent to engage the stakeholder who are neither highly critical nor are insignificant in terms of influence.
- **Low Influence/Priority (Monitor with minimum effort):** This implies a low degree of influence or interest of the stakeholder on the project in terms of participation and decision making or low priority for project proponent to engage that stakeholder.

Figure 15-1: Power/Interest Grid for Stakeholder Prioritization



How they are likely to feel about and react to the project, how best to engage them in the project and how best to communicate with them, are measured by getting answers of following questions:

- What financial or emotional interest do they have in the outcome of your work? Is it positive or negative?
- What motivates those most of all?
- What information do they want from the project?
- How do they want to receive information? What is the best way of communicating?
- What is their current opinion? Is it based on good information?
- Who influences their opinions generally?
- If they are not likely to be positive, what will win them around to support the project?
- What should be done to manage stakeholders' opposition?
- Who else might be influenced by stakeholders' opinions?

Stakeholders were talked directly and asked their opinions in building a successful relationship with them.

Table 15-1: Stakeholder Mapping for the Project

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Project Management				
Barisal Electric Power Company Limited (BEPCL)	Primary	BEPCL is the primary project proponent own a controlling stake of 100% in the project	Highest	- Are the primary project proponents; - Responsible for establishment and operation of this project; - Primary financial beneficiaries; - Responsible for all the project related risks and impact liabilities.
EPC Contractor/ Developers	Primary	Construct to deliver a functioning facility or asset to their clients.	Medium	- Carry out the detailed engineering design of the project; - Procure all the equipment and materials necessary; - Carry out the works in accordance with the agreed scope of works and in accordance with the contract.
Community				
Land losers (Project Site)	Primary	Land owners impacted with respect to loss of land and potential livelihood impact.	Medium	- Lack of information during land acquisition process; - Support to land losers in terms to temporary sustenance and employment opportunities; - Preference for Employment opportunities.
Local Community	Primary	Primarily includes adjacent community to the project site.	Medium	- Improvement of infrastructure in the area; - Project will bring development to their area; - Increase in employment opportunities and preference in job; - Approach road and social infrastructures may be

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
				developed in future.
Vulnerable Groups (poor, old aged and destitute)	Primary	The marginal groups within the project area primarily comprises of landless households, households below poverty threshold, men headed households, old aged & destitute.	Low	- Employment opportunity during pre-construction and construction phase; - Priority for getting further assistance if any; - Job prospect for their children; - Secondary business opportunities; - Compensation paid to household; - Little control over compensation amount.
Local workers and laborers	Primary	Laborers and workers recruited from the area of influence mostly during the pre-construction and construction phase of the project.	Medium	- Responsible for undertaking mostly un-skill and semiskilled based work during pre-construction and construction phase of the project; - Engagement level primary in civil construction part of the work.
Fisherman	Primary	- Fisherman in the area are engaged in fishing in a large scale in adjoin river and sea; - Study area is a major fishing hotspot.	Medium	- Major source of income to the local household; - Plays important role in the local economy.
Regulatory/Administrative Authorities & Agencies				
Department of Environment (DoE), Bangladesh	Primary	The Department of Environment is the primary government regulatory authority for Environmental protection in Bangladesh.	High	- Government Regulatory agency to provide Environmental Clearance Certificate (ECC) to the project based on evaluation and approval of Environmental Impact Assessment (EIA) study , - Responsible for monitoring project's Environmental compliance throughout the project lifecycle; - High influence and high interest.
Forest Department, Ministry of	Primary	The forest department under the	Low	No major influence on project related activities.

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Environment, Forest and Climate Change, Bangladesh		Ministry of Environment, Forest and Climate Change is responsible for management of forests and ecological assets of national or international importance within Bangladesh.		
District Commissioner Office, Barguna	Primary	The District commissioners office is the primary agency responsible for land issues.	Medium	- Government authority will helps the project authority for identification of land and lease of land. - Assist for proper compensation and resettlement.
Local Government Engineering Department (LGED), Taltoli	Primary	LGED is one of the largest public sector organizations in Bangladesh entrusted with planning and implementation of local level infrastructure development programs.	Low	Is responsible for maintenance of the approach road to the project site over the lifecycle of the project.
Bangladesh Water Development Board (BWDB)	Primary	BWDB is responsible for surface water and groundwater management in Bangladesh.	Medium	- In the proposed project site there is an embankment and land of the BWDB; - For establishing power plant, project proponent needs to take lease/NOC from the authority to use their land.
Bangladesh Inland Water Transport Authority (BIWTA)	Primary	- BIWTA is controls the inland water transport in Bangladesh; - It is also responsible for managing development and maintenance of inland water transport system.	Medium	- A coal unloading Jetty will be constructed in the Buriswar-Payra river on north side from the project site; - A NOC from the BIWTA will be required for the jetty construction.
Department of Social Welfare	Secondary	Local governmental agency	Low	No major influence on project related activities;

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
(DSW)		responsible for implementation of governmental social welfare schemes and activities.		However, participation level and influence may increase in case community welfare activities proposed by the project proponent are implemented in coordination with this agency.
Department of Public Health Engineering (DPHE)	Secondary	Primary department responsible for managing the overall water supply and sanitation facilities in the Upazila	Low	- No major influence on the project relate activities; - Controlling out-break of any major disease and monitoring the disease pattern.
Other regulatory & permitting authorities	Primary	-	High	- Agencies required for obtaining permits and licenses for establishment and operation of the project; - Primary involvement during pre-construction and operation phases.
Contractor & Sub-contractors				
Other Contractors (local and foreign)	Primary	Other Contractors include OEM (Original Equipment Manufacturers), part suppliers, mechanical installers and maintenance service providers who would be engaged during the project lifecycle.	Medium	- Pre-construction and construction phase will require many peoples (for both civil and mechanical work) including both local and migrant workers over a span of 30 months; - Engagement levels would be mostly during pre-construction, construction, operation and decommissioning phases.
Migrant Workers and Laborers	Primary	Laborers and workers arriving from outside of Taltoli, Barguna for participating in pre-construction and construction activities.	Medium	- Responsible for undertaking mostly skill based work during construction phase; - Engagement level during both civil and mechanical phases of work.
Political Administration				
Thana/Upazila Political	Secondary	Elected representative of people at	Medium	Key linkage between the community and the

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Administration		Thana/Upazila level for a fixed tenure.		project proponent; Low interest with high influence.
Union/Ward leaders & local representatives	Secondary	Elected representative at ward level i.e. village level for a fixed tenure.	Medium	- Issuance of no objection certificate as the representative of the local level representative; - Plays important role in providing public opinion and sentiment on the project; - Empowered to provide consent and authorization for establishment of project on behalf of the community
Other Institutional Stakeholders Groups				
Local NGOs and Community & Social Welfare Groups (CSWG)	Secondary	Microfinance agencies, social welfare groups and charitable organizations working in the area	Medium	- No major involvement in the project yet; - Possible inclusion during future stages of the project with respect to project related community welfare activities.
Printed and Electronic Media	Secondary	-	Medium	- Public watchdog on the project related activities; - No major influence on the project.

15.6 Information Disclosure and Consultation

Numbers of consultation exercises were conducted during field visit and baseline data collection for EIA study report preparation. The stakeholder's were consulted include local people, community in the vicinity of project area, local elected representatives and other external stakeholders such as government officials. The details of consultations held with issues raised or discussed and suggestions provided by the respective stakeholders are presented in the following sub-sections. The details of consultation is given in following Table 15-2 and photographs of the stakeholder consultation are shown in following Table 15-2.

A combination of mixed methods of information disclosure and consultation process was adopted at this stage of EIA preparation. The method selected for consultation was basically designed keeping in mind the profile of the stakeholders, type of information desired and level of engagement required. In each consultation session the consultant introduced themselves, introduced the project and the purpose of engagement with the respective stakeholder. The primary methods followed in the consultation process are:

- Individual level consultation/discussion;
- Key Informant Interview (KII);
- Focus Group Discussion (FGD); and
- Public Consultation.

Table 15-2: Details of Consultations Held for the Project

Date	Stakeholder Details	Details of Participants	Response/Suggestions Made
10/09/2018	Department of Environment, Barisal	Mr. Abdul Halim, Director & Mr. Md. Arefin Badal, Assistant Director	• The land of the proposed project site is null type, single crop land and barren; • The planted mangroves patches located northern side of the project required to avoid; • Proposed project area is far from the Tengragiri Wildlife Sanctuary. Its almost 8 to 9 km by vertical distance and 12 km by road; • Canal is a public land and the project proponent will consider and ensure alternate canal outside of the project boundary (east side); • Alternative drainage should be ensured to avoid the waterlogging that may be occur due to rainfall water and tidal water; • Limited numbers of boats are using the canal to access the river and sea; • The project proponent already provided the actual amount of land; • There have many beneficiaries group in the proposed project area is trying to create social conflict and taking the advantages.
11/09/2018	Upazila Nirbahi Office, Taltoli, Barguna	Ms. Farjana Rahman, Upazila Nirbahi Officer	• The land of the proposed project area is included in the 1 no. Khas khatian; • The Government (Khas) land already distributed among the landless people; • For taking the Government (Khas) land permission from the Deputy Commissioner of

Date	Stakeholder Details	Details of Participants	Response/Suggestions Made
			Barguna will be required; - The peoples are living on the BWDB embankment from 30 to 40 years ago; - There is an existing canal inside of the proposed project area, which is currently using by the local community. Due to the land fill in the project site, waterlogging will be occurred in the surrounding area and social conflict will be raised; - Local administration is not well-informed about the resettlement plan and other project activities in the area.
26/09/2017	Upazila Parishad, Taltoli, Barguna	Mr. Moniruzzaman Mintu, Upazila Chairman	- This is a priority project of the government of Bangladesh. Therefore, every department associated with the project will cooperate to implement the proposed project; - Resettlement will be required; - Need to ensure proper compensation; - Increase job opportunity and improve the socio-economic condition of the locality.
16/09/2018	Department of Forest, Taltoli Range, Barguna	Mr. SM Shamsuddoha, Range Officer	- No natural forest land is included in the project area; - Avoid social forest areas; - Plant as much trees as possible in and around the project area after construction of the power plant.
26/09/2017	Department of Fisheries, Taltoli, Barguna	Mr. Shamim Reza, Upazila Fisheries Officer	- There are 2009 registered fisherman in Nishanbaria Union whereas in Taltoli Upazila, the total number of registered fisherman are 9258; - There is no dolphin in the project area river; - No red list species in Payra River; - At that moment, Upazila office cannot issue any No Objection Certificate (NOC) without permission from the Director General.
11/09/2018	Department of Agriculture, Taltoli, Barguna	Mr. SM Badrul Alam, Upazila Agriculture Officer	- The project site is situated in a single crop land; - Only Aman is cultivated in the project site land; - During the summer season, the lands are affected by saline water and become unsuitable for crop cultivation; - There are 800 acres single cropland, 250 acres double cropland and 30 acres triple cropland in the Choto Nishanbaria/Ankujanpara mouza.
12/09/2018	Bangladesh Water Development Board,	Mr. Masiur Rahman, Executive Engineer	Approximately 70 to 80 acres of land in the proposed project area is owned by the Bangladesh Water Development Board;

Date	Stakeholder Details	Details of Participants	Response/Suggestions Made
	Barguna		• They have land along the two sides of the embankment; • There is an opportunity to take the land from BWDB as lease; • This lease document will act as an NOC; • Permanent structures on the lease land will not be allowable. However, tin-shed buildings, green area and ash stock yard can be built; • The earthen embankment cum roads need to be well maintained; • The power plant should consider the highest flood level in the project area; • There are many canals in and around the proposed project site for water flow; • If the existing canal of the proposed project site needs to be fill-up then the project proponent will ensure alternate canal and well maintenance support will be required from the project proponent.
16/09/2018	Bangladesh Inland Water Transport Authority, Barguna	Mr. Md. Mamunur Rashid, Port Officer	• Project company must have to take NOC from BIWTA for the establishment of Jetty; • Project company has already applied for NOC, but BIWTA has some queries.
12/08/2018	Local Government Engineering Department, Barguna	Mr. Mehedi Hasan, Senior Assistant Engineer	• The approach road adjacent to the project is owned by the Bangladesh Water Development Board (BWDB); • The LGED is responsible only for the pavement and maintenance of the road; • The existing road will be impacted during the materials transportation for the proposed project; • If the existing road is impacted or damaged by using of the proposed project activities, then the maintenance activities of road can be done by the project authority; • NOC is not required from the LGED for using the existing road.
16/09/2018	Roads and Highways Department, Barguna	Mr. Arun Kumar Biswas, Sub-Assistant Engineer	• There is no highway of RHD in the proposed project location, even in Tatali Upazila; • NOC is not required from the RHD.
16/09/2018	Public Works Department, Barguna	Mr. Md. Abu Zafar, Executive Engineer	• At present, Public Works Department has not been engaged with any works in Tatali Upazila. Therefore, PWD's concern is not mandatory.
17/09/2018	Department of Public Health Engineering, Taltoli, Barguna	Mr. Md. Tariqul Islam, Sub-Assistant Engineer	• There are 1420 active deep tube-wells in Taltali Upazila. It is the main source of drinking water. Average depth of those deep tube-wells are around 870 feet to 960 feet. • Harmful impact on ground water (if happens) as a result of the proposed power plant should be controlled. Otherwise, it can create detrimental effects on drinking water in

Date	Stakeholder Details	Details of Participants	Response/Suggestions Made
			the adjoining areas of the project location.
12/09/2018	Department of Fisheries, Barguna Sadar, Barguna	Ms. Sayeda Yasmin, Fisheries Extension Officer	• Around 60% population of the project area depend on fish resources. • There are 9,258 numbers of registered fisherman's in Taltoli Upazila, who have valid license for capturing fish in the sea. • Harmful impact on river and water bodies as a result of the proposed power plant should be controlled. Otherwise, it may hamper the livelihood of the fishing community. • Proposed power plant should not discharge hot water/waste water/any kind of harmful substances in the river and other water bodies.
26/09/2017	Bangladesh Police, Taltoli Thana	Mr. Komollesh Chandra Halder, Officer in Charge	• Welcome the project in the locality; • Cooperation from every perspective will be ensured from his department; • The project will play important role in the electricity sector.
11/09/2018	Nishanbaria Union Parishad, Taltoli, Barguna	Mr. Md. Dulal Farazi, Chairman	• It will increase the employment opportunity in our area; • Agricultural lands will be impacted; • As most of the lands are one season cultivated land, the project will have minimal impact on the agricultural production; • Most of the people in the proposed project area are depended on fish resource; • Compensate the project-affected people properly; • Land for the proposed project not properly purchased from the local community; • Fishing and others boats stay in the canal during the normal time as well as emergency period (cyclone) and use as a shelter; • If existing canal system changes then about 2,000 acres of lands of the local areas will be waterlogged; • Consider hospital, school, health complex and road upgradation; • Take measures to control riverbank erosion; • However, the project company should assure the use of environment friendly technology.
11/09/2018	Nishanbaria Union Parishad, Taltoli, Barguna	Mr. Rafiqul Islam Zomaddar, Member, 1 no ward	• If the proposed project causes more negative impacts comparing the positives impacts, in that case they will not want to get such kind of development; • Proper compensation should be ensured by the project company; • It is expected that the proposed project will not hamper the Hilsa fishing in the Buriswar-

Date	Stakeholder Details	Details of Participants	Response/Suggestions Made
			Payra river; • The planted mangrove patches along the river bank needs to be save at any cost; • The project company should ensure actual price of land and resettlement for the fisherman and land looser community.
17/09/2018	Nazrul Smrity Sangsad (NSS), a Local NGO of Taltali/Amtali, Barguna	Mr. Shahabuddin Panna, Executive Director	• Harmful impact on water bodies as a result of the proposed power plant should be controlled. • Proposed power plant should not discharge hot water/waste water/any kind of harmful substances in the Buriswar-Payra River and other water bodies as well. • The power plant authority must have to use appropriate technology that ensures 100% re-cycle of water.

Figure 15-2: Photographs of the Stakeholder Consultation



Consultation with Mr. Abdul Halim, Director & Mr. Md. Arefin Badal, AD, DoE Barisal



Consultation with Ms. Farjana Rahman, Upazila Nirbahi Officer, Taltoli, Barguna



Consultation with Mr. Moniruzzaman Mintu, Upazila Chairman, Taltoli Upazila, Barguna



Consultation with Mr. Shamim Reza, Upazila Fisheries Officer, Taltoli, Barguna



Consultation with Mr. SM Badrul Alam, Upazila Agriculture Officer, Taltoli, Barguna



Consultation with Mr. SM Shamsuddoha, Range Officer, Taltoli, Barguna



Consultation with Ms. Sayeda Yasmin, Fisheries Extension Officer, Barguna



Consultation with Mr. Masiur Rahman, Executive Engineer, BWDB, Barguna



Consultation with Mr. Zahid Pramanik, Bit Officer, Tengragiri Wildlife Sanctuary



Consultation with Mr. Khanmong, Field Assistant, Fishery Office, Taltali, Barguna



Consultation with Mr. Kazi Moniruzzaman Ripon, Upazila Education Officer, Taltali, Barguna



Consultation with Mr. Md. Abu Zafar, Executive Engineer, PWD, Barguna



Consultation with Mr. Arun Kumar Biswas, Sub-Assistant Engineer, RHD, Barguna



Consultation with Mr. Shahabuddin Panna, Executive Director, Nazrul Smrity Sangsad (NSS), a Local NGO of Taltali/Amtali, Barguna



Consultation with Mr. Dulal Farazi, Chairman, Nishanbari Union Parishad, Taltoli, Barguna



Consultation with Mr. Md. Zakir Hossen, Secretary, Nishanbaria Union, Taltali, Barguna



Consultation with UP members and local community



Consultation with a fisherman near the proposed project site

15.7 Public Consultation Meeting

The public consultation meeting was held on 27th October 2017 (Friday) at the premises of the Kadamtola Jame Mosques, Bara Ankujanpara village, Nishanbaria Union in Taltoli Upazila, Barguna. The proceedings was commenced at 10:00 AM. The meeting was attended by a total of 60 people, which represent local people, businessman, farmer, fisherman, service, imam, social workers, student, senior citizen, housewife and officials from project proponent. At the beginning of the proceedings, EQMS Team welcomed all participants of the meeting. Then a brief description about the proposed project (350 MW coal-fired power plant) was given by Mr. Sabur Rahman of Iso Tech Electrification Company Limited as the representative from the Barisal Electric Power Company Limited (BEPCL). At the end of this session, the floor was opened for the public questions, recommendations, expectations and suggestions from the attendance. At the end of the session, concluding speech was given by Mr. Sabur Rahman. The summary of the public consultation meeting minutes has been given in following Table 15-3, photographs of the public consultation meeting is shown in Figure 15-3 and attendance sheet is given in Annex-C (Volume-II).

Table 15-3: Brief overview of the Public Consultation Meeting

Details of Participants	Comment/Question/ Suggestions/Expectations	Reply/response from project proponent
Md. Kalam Hossain, Businessman, Taltali, Barguna	• Welcomed the proposed project in the locality; • It is expected that the proposed project will be able to improve of the local infrastructure and regional development; • Compensate the affected persons/households according to their degree of loss; • Waterlogging can be occurred surroundings of the project area due to the landfilling and levelling.	• Adequate measures will be taken by the project proponent to compensate affected households; • The project proponent has already prepared a list of the existing affected households and based on that compensation will be given; • Newly constructed households/ peoples will not be considered for compensation.
Md. Abul Bashar, Farmer, Taltali, Barguna	• It would be highly appreciated if the project company allocate fund for the infrastructural improvement/ development of the nearby mosque.	• It is already incorporated in the plan to reconstruct the mosque.
Md. Rubel, Fisherman, Taltali, Barguna	• Buriswar-Payra River is rich in fish resources and the local community catch fish in the river; • Due to the establishment of the proposed project, the people who are	• They will be compensated properly for displacement; • Proposed project will create job opportunity during pre-construction and construction phase for the local community or

Details of Participants	Comment/Question/ Suggestions/Expectations	Reply/response from project proponent
	living on the slope of the existing BWDB embankment needs to be displaced; Displacement and establishment of the proposed project may impacts livelihoods of the fishing community.	affected people; Local people will get preferences in the job sector according to their qualification.
Md. Abdus Sobhan, Fisherman, Taltoli, Barguna	- Proper compensation and resettlement is expected from the project authority based on the detailed survey/investigation/assessment; - Job or income opportunities for the local community is expected from the project authority; - What measures will be taken against displacement?	- Proper compensation based on assessment and resettlement will be ensured; - With the help of local authority/ administration, the compensation will be dispatched among the affected households.
Md. Miraz, Businessman, Taltoli, Barguna	- A hospital need to be established at the locality for the treatment of injured workers and local people; - Consider the establishment or donation for school, mosque and madrasa at the locality. - Approximately 76 households will be affected due to the establishment of the proposed power plant project.	- Establishment of a hospital is already included in the master plan; - Mosque will be reconstructed as well.
Sattar Farazi, Fisherman, Taltoli, Barguna	- A separate area needs to be consider/prepare to rehabilitate/ relocate for all the project-affected people or households; - The riverbank of the Buriswar-Payra River on the southern part of the proposed project site is an erosion prone area. - On the other hand, opposite side of the Buriswar-Payra River from the proposed project site is also erosion prone area. - Riverbank erosion is a big issue; - Adequate measures for bank protection needs to be introduced.	- Measures should be taken to reduce/stop the riverbank erosion; - The project proponent will pay for resettlement. However, final decision will be taken after discussion with the local level and Upazila level administration. - Not only for protecting the local community but also bank protection activities will be introduced to save the power plant from erosion; - If necessary concrete block will be used for riverbank erosion protection.
Habibur Rahman, Businessman, Taltoli, Barguna	- The detailed displacement plan needs to be share with the local community and avoid the political persons in the resettlement and compensation process; - Proper compensation needs to be ensured by the project authority before starting land acquisition.	- It will be discussed latter after discussion with the government authority; - Priority will be given to the project affected people in the job sector.
Gazi Mohibullah, Businessman, Taltoli, Barguna	- Socio-economic condition of the locality is poor considering other area; - Lacking of good school, college,	The project will play important role in the improvement of socio economic condition of the

Details of Participants	Comment/Question/ Suggestions/Expectations	Reply/response from project proponent
	mosque and health complex in the project area; • Upgradation of school, college, mosque and health complex is required; • Total number of trees that needs to be cut down during site cleaning must be count and compensate accordingly.	locality. • The upgradation and reconstruction of the school, college and mosque is already incorporated in the plan. • Initiative will be taken to incorporate trees in the compensation.
Mawlana Mohibullah Kazi, UP Member, Nishanbaria Union	• Rehabilitation process needs to be followed available rules and laws of Bangladesh; • The proposed project will create employment opportunities and enhance the income generation activities in the locality; • Project affected persons and local people should be given preference for job in the project site; • Finally all the activities must be followed as practicing in others projects like Payra 1320 MW power plant in Patuakhali.	• This project will increase the employment opportunity in the locality. • According to the skills and qualification, the project affected people will get jobs in the project. • Standard procedures will be followed for this project to minimize the impact.
Abu Bokkor Siddik, Teacher, Taltoli, Barguna	• The proposed project will be able to solve the unemployment problems from the locality; • Quality of life will be increased; • Donation can be given for the upgradation of the mosque.	• It will create job opportunity not only for the local community but also workers from other locality. • It is already incorporated in the project planning.
Rokeya, Housewife, Taltoli, Barguna	• The security of the project area needs to be improved during pre-construction, construction and operation stage; • Value of the trees must be considered during the compensation.	• Security team of the project company will be ensured the security of the project area.
Nargis, Housewife, Taltoli, Barguna	• Proper land price shall be ensured by the project authority; • People are living on the slope of the BWDB embankment for more than 30 to 35 years; • There have government land (Khas land) in the proposed project site.	• According to the market price, land value will be given to the affected people/households.

Figure 15-3: Photographs of the Public Consultation Meeting



Welcoming speech by Mr. Sabur Rahman (Iso Tech Electrification Company Limited)



Introduction speech by EQMS Study Team



Question from open floor



Questions from open floor



Questions from open floor



Response of the proponent



Questions from open floor



Questions from open floor



Female Respondent



Questions from open floor



Question section moderated by EQMS Team



Closing speech

15.8 Focus Group Discussion

During the baseline data collection for the EIA study, three focus group discussions were conducted with the local community at Taltoli, Barguna. Date, location and the number of participants of each discussion are listed in Table 15-4. The local people attended the focused group discussion meeting included Fisherman, Farmer and Women group. The summary of focused group discussion is given in Table 15-5 and photographs of the focus group discussions is given in Figure 15-4. Attendance sheet of focus group discussions is given in Annex-C (Volume-II).

Table 15-4: Details of Focus Group Discussion

SL#	Date	Location	Participants	Category of participants
1	13/09/2018	Boro Ankujanpara, Nishanbaria Union	23	Fisherman
2	13/09/2018	Boro Ankujanpara, Nishanbaria Union	15	Farmer
3	13/09/2018	Boro Ankujanpara, Nishanbaria Union	17	Women

Figure 15-4: Photographs of the Focus Group Discussion



FGD with Fisherman group in the project site



FGD with Farmer group near the project site



FGD with Women/female group at project site



FGD with Women/female group at project site

Table 15-5: Summary of Focus Group Discussions

Issues Discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception about the project and the awareness about the proposed project	Most of the participants are in favor of the proposed project based on mitigating some conditions and have been made aware of the proposed project.	Accept the project based on mitigating some conditions such as environment and social control, proper land acquisition, resettlement and livelihood restoration.
Support of local people for the proposed project	Almost everybody said that they would support the project if the project authority solve the problems regarding land acquisition, resettlement and livelihood restoration. They advised the consultants to take precautions in the environmental and social mitigation to avoid the various impacts.	- The Consultant informed that during the study, the design and layout of all infrastructures have considered the anticipated adverse impacts. - EMP covers specific measures to follow during the construction process in protecting natural water bodies (with special emphasis on existing canal).
Will the proposed project create any problem with ambient air, noise quality or water quality?	People of the project area site were not aware of this problem.	Impact of the project upon ambient air, noise quality, water quality has been assessed during draft EIA report.
Land acquisition, resettlement and livelihood restoration	- Land acquisition, resettlement and livelihood restoration will be the major issues. - According to the participants, this can be mitigated through proper compensation and assistance to the affected persons.	- Land acquisition is required. - Compensation will be given as a result; overall impact on the community will be minimized. - Proper livelihood assistances will be provided to the affected fishermen, farmers and female groups.
Any critical issue or concern by the local people regarding the project? Or Any criteria you would like to see	Respondents requested that environmental hotspots (like school, health complex, mosque etc.) should be avoided as much as possible for dust suppression, noise mitigation and road safety.	- Dust suppression measures and noise mitigation are considered in the EMP. - Proper hydrological analysis has been done to design the drainage structures.

Issues Discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
considered during project design, construction and operation stage?		
Protected areas (national parks, protected forest, religiously sensitive sites, historical or archaeological sites), if any	- The proposed power plant area does not include any protected or ecological critical area. - However, Tengragiri protected forest is almost 10 km away from the project area.	Protective measures shall be taken.
Employment Status	Employment is expected to increase in the project area.	Job chance and employment will be increased and promoted once the construction has been started.
In the construction and operational phase, noise and dust will be generated. Are there any other issues about construction, including noise and dust that might worry you?	- The respondents agree to take the power plant project based on providing assurance to solve the above-mentioned problems. - Few of them mentioned that the measures are temporary and besides there will be more chances for local Communities to be employed during construction, providing both skilled and unskilled labor. - Participants did not mention any other problems, which might bother them other than following basic safety rules.	Residents expect to use modern construction instrument to reduce environmental impact and use safety measures to reduce the impact.

CHAPTER SIXTEEN: CONCLUSIONS AND RECOMMENDATIONS

16. Conclusions and Recommendations

16.1 Conclusions

The Barisal Electric Power Company Limited (BEPCL) has planned to establish a 350 MW coal fired power plant at Taltoli Upazila under Barguna District. The proposed power plant project is located on the bank of the Buriswar-Payra River and lease land from the Iso Tech Electrification Company Limited and lease of government (Khas) land. The tentative investment for the proposed project is estimated to be 629 million USD (approximately more than 5,000 crores in BDT). From the socio-economic and power energy security point of view the project is very important. It is expecting that, the proposed project will be able to add 350 MW electricity in national grid. However, the major question arise, how the proposed power plant will be established in environmental friendly manner at the proposed site. The environmental studies reveal the possible environmental issues and mitigation measures to reduce the environmental impacts of the project.

The EIA study team members observed that the site of the proposed project is situated near the confluent of the Bay of Bengal and Buriswar-Payra River and the land is a single cropped land including barren land, bushes, shrubs, settlement and homestead vegetation etc. are found the proposed project location. According to the BEPCL, for the establishment of the proposed project approximately 174 acres of land will be required. Approximately 112 number of households will be required to remove from the proposed site those who are living in the proposed project boundary and on the slope of the embankment. Due to the land acquisition for the proposed project, fishing community will be affected more because most of the peoples are dependent of fish resources in the project area. From the EIA study, it is found that, major environmental and social impact of the project would be land acquisition, resettlement and rehabilitation, dredging for material or soil collection, landforms, drainage congestion, disturbance of boat communication, impacts on income and livelihoods, air pollution, noise pollution etc. during pre-construction and development phase; air pollution, noise pollution, surface water pollution, ground water pollution, soil pollution, sediment pollution, waste water from construction camp and impacts on aquatic ecology in construction and operation phase due to gaseous emission, thermal water pollution from discharge of once-through cooling, wastewater disposal, accidental spillage of hazardous materials and noise from power plant, groundwater pollution from the leachate of ash yard, heavy metal pollution on soil and sediment, impact on fisheries and aquatic life, risk of accidents, community health and safety and occupational health and safety. These problems would be overcome by taking proper mitigation measures as stated in the environmental management plan. There are also very significant positive impacts during pre-construction, construction and operation like local people job opportunities, increase business opportunities, supply of electricity, development of infrastructures and CSR activities for the local community etc.

16.2 Recommendations

The following recommendations are made based on EIA study that should be considered for achieving the goal of optimum minimum environmental and social impact and optimum benefits:

- Proper resettlement and rehabilitation plan is necessary for proper compensation to project affected people;
- People those who are not owner but dependent on the land to be acquired should be compensated and created scope for alternative livelihoods;
- The project proponent must excavate alternative canal before starting the land development activities and site cleaning activities in the project site. It must be considered the width, length, depth and use of existing canal;
- A drainage study including detailed survey must be conducted by the project proponent to avoid the waterlogging in the proposed project surrounding area;
- Income and employment opportunities for the local community and strengthen the CSR activities for the local community;
- No disturbance of fishing in the Buriswar-Payra River near the project site;
- Green belt development in and around the project site;

- No disturbance of fish migration and reduce the activities during Hilsa Breeding season;
- Conduct fish survey and dolphins in the Buriswar-Payra River during construction and operation phase of the proposed project;
- All types of waste should be collected, storage and recycle/ treatment properly for further reuse;
- Findings and suggestion of EIA study in project planning, design and operation should be considered and implement with strong monitoring;
- All activities (pre-construction, construction and operation stage) should be implemented according to the proposed EMP;
- Environmental Management Plan and Emergency and Disaster Management Plan should be implement at every suggested steps of power plant pre-construction, construction and operation;
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety during pre-construction, construction and operation phases of the project;
- EMP has been formulated considering anticipated impacts. However, further updating of impact management procedure must be made with respect to spatial and temporal regularly based on monitoring of impacts during pre-construction, construction and operation of the project;
- The plant should be operated ensuring all pollution abatement measures; and
- The present EIA report finds that though there are certain adverse environmental impacts associated with the project unit, those are however manageable. In light of the above, the project proponent, BEPCL may be allowed to go ahead with the implementation of the Project.

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Response on DoE Comments on 14th and 15th November 2018

SL#	Comments from DoE	Response
1.	Photographs of the project boundary demarcation using pillar with flags should be included in the EIA report	Given in Figure 4-2 (Page No.: 4-4 and 4-5)
2.	No Objection Certificate (NOC) from AC land office or DC Office for land issue	NOC from AC land office in Annex F-2 (Page No.: F-2) (Volume-II)
3.	Large size map of the sensitive receptors and distance (wildlife sanctuary, breeding site, protected area and Payra project etc.) around the project site as like IEE report should be given in EIA report	Given in Figure 7-37 (Page No.: 7-50) and Annex-D (Page No.: D-31)
4.	Who are the surface water users of the Buriswar-Payra River except the proposed power plant project?	Incorporated in sub-section 4.6.3 (Page No.: 4-9)
5.	What are the possible sources of wastewater and amount that needs to be treated in the ETP?	Given in sub-section 4.12.3 (Page No.: 4-29 and 4-30) and amount is given in Annex-D (Water Balance Diagram)
6.	It should be included in the EIA report that “after treating the oil water in the Oily Waste Treatment Station it will be send to the ETP” and after treating how the treated water will be utilize.	Incorporated in Table 9-3 (Page No.: 9-27) and (Page No.: 9-30) Sub-section 10.3.2 (Page No.: 10-8)
7.	2x5 m ³ of ETP capacity needs to be clear. Is it 2 units consisting 5 m ³ capacity?	ETP capacity is 60 m ³ /hour. However, oil waste water treatment system is 2x5 m ³ /h, one set for back up, one set for operation. Given in sub-section 4.12.3 (Page No.: 4-29 and 4-30)
8.	How the boiler slag will be managed and mitigation measures should be incorporated in the EIA report.	Incorporated in Table 9-3 (Page No.: 9-22) and sub-section 10.3.4 (Page No.:10-9)
9.	Air quality modelling-seasonal variation should be shown	Given in sub-section 8.5.4 (Page No.: 8-32 to 8-47) and Annex-L (Page No.: L-1 to L-22)
10.	Air pollution concentration and distance should be shown showing with mitigation and without mitigation measures	Given in sub-section 8.5.4 (Page No.: 8-32 to 8-47) and Annex-L (Page No.: L-1 to L-22)
11.	Marine protected area (declared and proposed) map should be incorporated in the report showing the distance from the project site	Given in Figure7-32 (Page No.: 7-44)
12.	Whether any Fish sanctuary or breeding ground is exist or not?	Included in sub-section 7.16.8.4 (Page No.: 7-57)
13.	Tree name and number should be given as tabular format	Given in Table 8-2 (Page No.: 8-8 to 8-9)
14.	List of potential disasters and mitigation measures incorporate in the response plan	List of potential disasters in the proposed project area is given in section 7.17 (Page No.: 7-71 to 7-77) and emergency response plan is given in sub-section 11.10.5.1 (Page No.: 11-30 to 11-32)
15.	Recheck the forest department NOC and NOC collection from Division Forest Officer (DFO)	Application is given in Annex F3A

SL#	Comments from DoE	Response
16.	Local community comments about Dolphins availability in the Buriswar-Payra River	Given in sub-section 7.16.8.4.3 (Page No.: 7-62 to 7-64)
17.	It should be include in the EIA report “mesh should be used in water intake point”	Given in Table 9.3 (Page No.: 9-21) and sub-section 10.12.2 (Page No.: 10-17)
18.	No Objection Certificate (NOC) from BIWTA	Given in Annex F8.
19.	Which technology will be used in the proposed power plant?	Given in sub-section 4.9.1 (Page No.: 4-10)
20.	Status of RAP report	RAP study is ongoing and after finalization it will be shared. Preliminary survey result is given in sub-section 8.3.3.1 (Page No.: 8-6)
21.	Water availability/flow data in the Buriswar-Payra River should be given in the EIA report	Given in sub-section 4.6.2 (Page No.: 4-9)