Environmental and Social Impact Assessment Report Under Feasibility Study for Development of Utility Scale Solar PV & Wind Projects in Bangladesh

Final Report

October 2018

Environmental and Social Impact Assessment (ESIA) Report
Under
Feasibility Study for Development of Utility Scale Solar PV & Wind Projects in Bangladesh

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Client

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ABBREVIATION

AC	:	Alternating Current
AoI	:	Area of Influence
ARIPO	:	Acquisition and Requisition of Immovable Property Ordinance
ASEI	:	Asia Solar Energy Initiative
ASTER	:	Advance Space-Borne Thermal Emission and Reflection Radiometer
BOD	:	Biological Oxygen Demand
BFIDC	:	Bangladesh Forest Industries Development Corporation
BFRI	:	Bangladesh Forest Research Institute
BMD	:	Bangladesh Meteorological Department
BNH	:	Bangladesh National Herbarium
BPDB	:	Bangladesh Power Development Board
BWDB	:	Bangladesh Water Development Board
CCTV	:	Closed-Circuit Television
CdTe	:	Cadmium Telluride
CO	:	Carbon Monoxide
COD	:	Chemical Oxygen Demand
CO_2	:	carbon dioxide
CIFs	:	Climate Investment Funds
CLAC	:	Central Land Allocation Committee
CNG	:	Compressed Natural Gas
CMS	:	Central Monitoring Station
CR	:	Critical
DoF	:	Department of Fisheries
DPHE	:	Department of Public Health and Engineering
DoE	:	Department of Environment
DC	:	Deputy Commissioner
DLACs	:	District Land Allocation Committees
DC	:	Direct Current
DEM	:	Digital Elevation Model
DO	:	Dissolved Oxygen
DMP	:	Disaster Management Plan
EGCBL	:	Electricity Generation Company of Bangladesh Limited
EQMS	:	Environmental Quality and Management System

ESIA	:	Environmental and Social Impact Assessment
EMP	:	Environmental Management Plan
ESMP	:	Environmental and Social Management Plan
EHS	:	Environmental Health and Safety
ECR	:	Environmental Conservation Rule
EQS	:	Environmental Quality Stand
ECAs	:	Ecologically Critical Areas
ECC	:	Environmental Clearance Certificate
EPC	:	Engineering, Procurement and Construction
EHS	:	Environmental Hotspots
EC	:	Electrical Conductivity
EN	:	Endangered
EEZ	:	Exclusive Economic Zone
EPRP	:	Emergency Preparedness and Response Plan
ERT	:	Emergency Response Team
FD	:	Forest Department
FGD	:	Focus Group Discussion
FPIC	:	Free Prior Informed Consultation
GOB	:	Government of Bangladesh
GHG	:	Green House Gas
GIS	:	Geographic Information System
GDP	:	Gross Domestic Product
GRM	:	Grievance Redress Mechanism
GI	:	Galvanised Iron/ Global Irradiation
HHs	:	Households
HYV	:	High Yielding Varieties
HTWs	:	Hand Tube Wells
HSE	:	Health, Safety, and Environment
IFC	:	International Finance Corporation
IEE	:	Initial Environmental Examination
IECs	:	Important Environmental Components
ILO	:	International Labor Organization
IUCN	:	International Union for Conservation of Nature
kWh	:	Kilowatt hour
LGED	:	Local Government Engineering Department

LC	:	Least Concern
LOTO	:	Lockout/Tagout
MW	:	Mega Watt
MoEF	:	Ministry of Environment & Forest
NAAQS	:	National Ambient Air Quality Standard
NEMAP	:	National Environmental Management Action Plan
NSRs	:	Noise Sensitive Receptor
NTWL	:	Non Tidal Water Level
NOx	:	Oxides of Nitrogen
OSHA	:	Occupational Safety and Health Administration
OHSP	:	Occupational Health and Safety Plan
OT	:	Overtime
PPE	:	Personal Protective Equipment
PGCB	:	Power Grid Company of Bangladesh
PS	:	Performance Standards
PV	:	Photovoltaic
RAP	:	Resettlement Action Plan
RERED	:	Rural Electrification and Renewable Energy Development
RoI	:	Region of Interest
SCADA	:	Supervisory Control and Data Acquisition
SES		Socio-economic Survey
SO_2	:	Sulphur Dioxide
SRDI	:	Soil Resources Development Institute
SREP	:	Scaling-up Renewable Energy Program
SREDA	:	Sustainable and Renewable Energy Development Authority
SRTM	:	Shuttle Rader Topography Mission
SPM	:	Suspended Particulate Matter
SBE	:	Small Business Enterprise
TDS	:	Total Dissolved Solid
TDWL	:	Tidal Water Level
UPS	:	Uninterrupted Power Supply
UAW	:	United Auto Workers
WTGs	:	Wind Turbine Generators

EXECUTIVE SUMMARY

0. Executive Summary

0.1 Introduction

As per the National Renewable Energy Policy 2008, the plan is to add generation capacity of 800 MW by 2015 and 2,000 MW by 2020 from renewable sources. In addition, the Ministry of Power, Energy, and Mineral Resources has announced in 2013 to develop 500 MW of installed generation capacity from solar energy through Asia Solar Energy Initiative (ASEI).

The Electricity Generation Company of Bangladesh Limited (EGCBL) has acquired 999.65 acres land to establish 100 MW Solar and 100 MW Wind Power plant project at Sonagazi upazila of Feni district (Figure 1). World Bank has shown their interest to finance EGCB Ltd for implementation of 50 MW Solar Power Plant on 165.5 acres land of that acquired land. Others renewable energy generating power plant will set up on rest of the acquired land based on the government mandate and suitable option outlined in feasibility study report.

Joint Venture of WindForce Management Services Pvt. Ltd. (India), Suntrace GmBH (Germany) and EQMS Consulting Limited has been appointed by "Power Cell", Power Division, Ministry of Power, Energy and Mineral Resources for conducting the feasibility study for development of utility scale solar PV and Wind project in Bangladesh with the financial assistance by World Bank under the ongoing Rural Electrification and Renewable Energy Development II (RERED II) project. The ESIA study is an integral part of the feasibility study of the proposed project. This ESIA study report is prepared for the first 50 MW solar project on 165.5 acres land as well as solar and wind hybrid project along with aquaculture facility on rest of the acquired land based on the relevant World Bank safeguard policies and GoB guidelines.

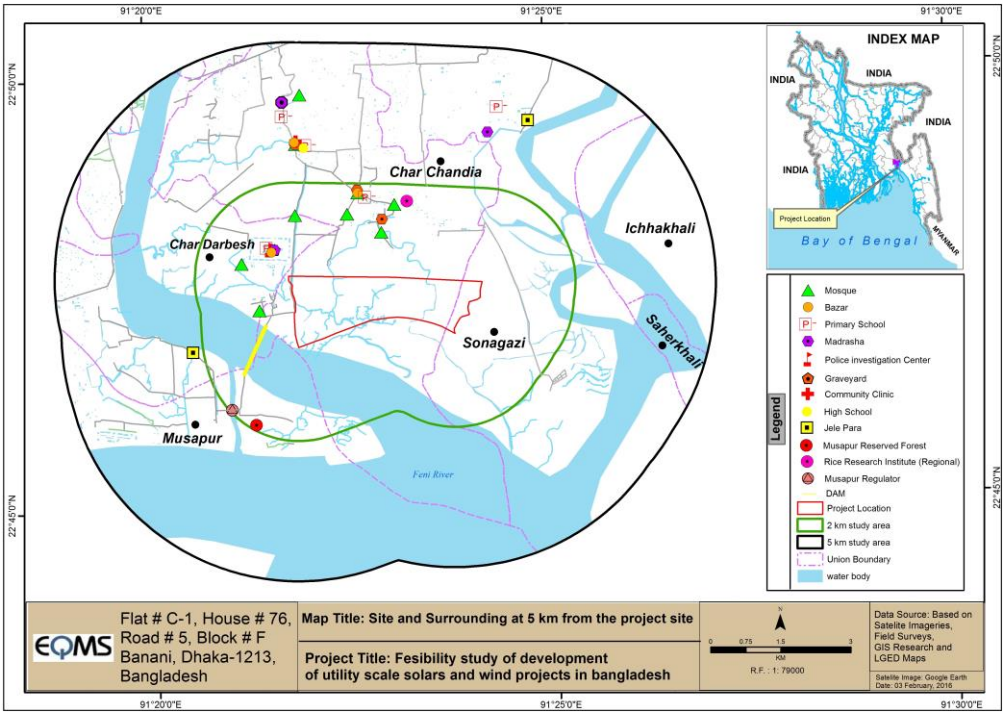


Figure 1: Project Location and Surrounding Features

0.2 Approach and Methodology for the ESIA Study

Both desk-based secondary study and field level primary study approach were adopted for this ESIA study. Desk based secondary study was completed initially before engaging for field level primary study. Secondary study helps formalize primary study's elements/requirements as well as selecting key stakeholders and affected groups. Moreover, primary study approach was designed using both quantitative and qualitative tools. Quantitative study consists different types of surveys relevant to different aspects i.e. Air, Water including surface and ground level, Noise, Ecology and Social etc. All quantitative data was recorded properly and analyzed using appropriate analyzing software. On the other hand, Qualitative study consists Public consultation, FGDs, KII and formal/informal interviews. Here also qualitative data was systematically recorded and analyzed; and merged with the quantitative findings where appropriate.

A two days reconnaissance visit was undertaken to understand the site setting, environmental and social sensitivities and to identify the relevant local stakeholders. A detailed desk-based study was undertaken to collect relevant environmental and social information.

Primary baseline survey was carried out for two seasons. Dry season survey was carried out during February 2017 for Air quality, Surface water, Ground water and Noise Level whereas Wet season survey was carried out during April for Air Quality, Surface water and Ground water. Traffic survey for assessing the road and river traffic in the project area was also undertaken. A primary ecological survey also carried out to access the biodiversity of the project study area.

Secondary data from Bangladesh Bureau of Statistics (BBS), District web portal, Land zoning report etc. was assessed to get social pictures of the surrounding villages within 5km radius from the project area. After assessing the social conditions of the project area, primary Socio-economic Survey was conducted among the villages lying within 2km from the project area. Using secondary data it was identified that there are four villages; Adarsha Gram, Purba Baradhali, Dashkkhin Char Chandia and Bara Char Dhali, situated within the survey study area consisting a total of 1719 households with average 5.2 household size. Average population density of these areas is found 573 only which is almost half of the national score 976. This depicts the low population intensity within this area. Therefore, 5% (n-88) of total households were surveyed randomly from each selected villages following specific proportionality and interval.

Socio-economic survey helped to verify the socio-economic conditions along with the social structures, services and access pattern of surrounding area. Moreover, it helped to get insights of livelihood patterns, various groups and their interactions. As a result, livelihood or group based extent of impacts were identified which accelerated the identification of relevant stakeholders and the degree of interests.

After the confirmation and cross validation with all secondary and primary survey data findings, qualitative tools; Public consultation, FGDs, KII and formal/informal interview, were used following proper procedures to get in-depth understanding on the different aspects relevant to potential project impacts and measures. Based on all the information, project intervention impact assessment and evaluation was carried out. This study thus, has prepared

and proposed a detail Environmental and Social Management Plan (ESMP) including monitoring plan to mitigate the adverse environmental and social impact.

0.3 Applicable Administrative Framework

The applicable reference framework has been followed for the study is as follows:

- Applicable Bangladesh national and local regulatory requirement
- Applicable World Bank Operational Policies
  - ✓ Environmental Assessment (OP 4.01), Natural Habitat (OP 4.04), Involuntary Resettlement (OP 4.12), Physical Cultural Resources (OP 4.11), Indigenous People (OP 4.10)
- Performance Standards for Private Sector Activities (OP 4.03)The World Bank Group's General EHS Guidelines (2007);
- The World Bank Group's EHS Guidelines for Wind Energy (2015)

0.4 Description of the Proposed Project

0.4.1 Project Location

The project site is located at Purbo Barodhuli mauza in Char Chandia union of Sonagazi Upazila under Feni District. The project site is single cropped medium high land and has limited impacts on total agriculture production as National Land Zoning Report (NLZR, 2017) suggests, it will impacts on only 20% single cropped land productions of Char Chandia Union. The project site becomes inundated during the monsoon season for 4-5 months. During the inundation period, only aman rice is cultivated in the land and rest of the time remains fallow.

The proposed project is situated about 6.5 km south-west as well as ends of the Sonagazi Upazila and 175 km south-east zero point of Dhaka city. The site is located north-west side of the confluence of Feni and Choto Feni River. The site is situated beside the left bank of the Choto Feni River, Sandwip channel on the south, agricultural land and village on the north, Feni River on the east and existing road on the west. The approximate project site coordinates are as follows:

NW- 22°47'40.00"N 91°21'52.32"E	NE- 22°47'32.58"N 91°24'8.95"E
SE- 22°46'58.19"N 91°23'47.78"E	SW- 22°46'50.78"N91°21'55.30"E

According to NLZR (2017), among the total 4800 farm families a total of 1850 absentee land owners are available in the Char Chandia Union which refers the high participations of share croppers (8520) and agriculture labors (4100) in the agriculture activities. Sharecroppers and agriculture labors are those who have no or marginalized amount of land ownership which leads them sharing or working in land owners' land. Primary socio-economic survey conducted by the ESIA team found similar scenario where among the 88 surveyed households 75 (85.5%) households are engaged agriculture in different scales i.e self (37.5%), sharecropping (18.2%) and some cases both self-sharecropping (25%). Usually, owners of the single cropped lands can't solely depend on one time low yields thus they have to harvest other places where double or triple cropping land is available. Those who have no additional land to harvest, they tend to sharecrop with others. Therefore, impact on livelihood is partial as land owners mostly depend on other lands.

The project site was government Khasland and distributed to the landless people in different time periods. Complexity on the landownership of the proposed land site has been observed. However, instead of complexity on the land ownership it is found that legal land owners, sharecroppers and illegal land users (who don't have any legal ownership but harvest on that land) use this land once in a year for agricultural production. Therefore, single cropped nature of the land suggests partial impact on the livelihood of the land owners and the other direct dependents i.e sharecroppers and illegal land users.

Land acquisition of 999.65 acres for the proposed project has been already done and handed over to EGCB in September 2017 including the 165.5 acres of land required for first 50 MW solar power plant. According to RAP study, 18 legal land owners, 22 sharecroppers and some illegal land users will be partially affected by the intervention of the first 50 MW solar power plant.

There are no trees, structures, common properties, major fishing resources on the land. Moreover, there are no tribal people in or around the project area who may have been affected by the intervention of the project.

0.4.2 Key Features of the Site and Surroundings

The Project site is located on the north bank of the Choto Feni River and falls within the Young Meghna Estuarine Floodplain. There is no large tree species and precious environmental component present in the project site. The site is almost flat; the land inundated for 4-5 months continuously at various depths up to 11 inches. The maximum historical high water level has been 5 meters during the super-cyclone of 1991. Musapur Dam on Choto Feni River is close to the project site at 800m distance. PGCB is going to establish a 230/132/33 kV Grid Substation in the land provided by BEZA. Distance of proposed 50 MW solar power plant site from PGCB grid substation under BEZA is around 9 km. The Musapur Regulator is 2.15 km south west of the project site. There is a forest cluster in Musarpur which is 1.40 km south west of the project boundary. There is no settlement as well as any utility in the project location.

In the close vicinity (within 2 km from the project boundary) of the Project site, habitation is only present in the western and northern parts and the nearest habitations are Purbo Barodhuli and Ashrayan/Adarsha villages of Char Chandia and the Char Darbesh Union. The nearest residential, sensitivity and infrastructure properties in each compass direction are as follows:

- Purbo Barodhuli Village – Approximately 250 m north from the Project Site boundary;
- Ashrayan/Adarsha Village – Approximately 400 m west-north-west from Project Site boundary;
- Musapur Dam – Approximately 700 m south-west from Project Site boundary;
- Musapur Regulator – Approximately 2.15 km south-west from Project Site Boundary;
- Musapur Reserve Forest – Approximately 1.4 km south-west from Project Site boundary.

0.4.3 Project Description

The proposed project involves setting up of first 50 MWac solar power plant on 165.5 acres land out of 999.65 acres acquired land and 116 MWac solar along with 10 MWac wind power generation facility on rest of the acquired land at Purbo Barodhuli mauza in Char Chandia union of Sonagazi Upazila under Feni District. Mirsarai 230 kV GSS of PGCB Or BEZA substation of PGCB (under construction) can be an option for power evacuation for this RE project. The following ts the key project information.

Table 0-1 presents the key project information.

Table 0-1: Key Project Information

Project at a glance – Solar PV	
The project	166 MWac grid-connected solar PV with Semi Intensive fishery activity beneath the Solar panels
Owner	EGCBL
RE technology	Solar PV Plant
Solar technology	Earth mounted fixed structures for 166 MWac solar PV system
Module Technology	Polycrystalline modules (Canadian Solar with 315 Watt peak and the model number CS6X-315P)
Inverter Technology	ABB PVS800-MWS-2000kW-C
Expected project completion period	April, 2019
Project at a glance – wind	
The project	10 MWac grid-connected wind power project
Owner	EGCBL
Rating of individual turbines	2 MW wind turbine generators of Class V as per IEC codes
Expected project completion period	April, 2020

Source: Feasibility Study for Development of Utility Solar & Wind Projects in Bangladesh, 2018

0.4.4 Resources and Utility Demand

Water will be required for both construction and operation phases. Water will require for foundation structure, office building construction approach road, culvert and bridge construction during the construction period. Water requirement for construction period will be estimated during the detail design stage. At the present stage, it has estimated that 31.5 million liters per annum will be required for cleaning the module. Following table shows the water requirement calculation.

Parameter	**Value**	**Unit**

Capacity (Option 7)	272160000	Watt
Number of Modules	864000	Number
Per module water required	1.5	liters per module
Module cleaning cycle	15	in every 15 days
Total water required per annum	31.5	million liters per year

Fuel will be required for the machinery running as well as backup diesel generator during the construction period and it will source from the local market. The fuel oil will be stored in the diesel drums in the storage yard. Insignificant lubricating will be required during the operation period which will store in the designated storage area.

The labor requirement varies during the construction phase from the initial phase to the commissioning phase. Approximately 100 labor will be required during the construction of first 50 MW and 190 persons for Phase II whereas total 50 persons will be required during the operation and maintenance phase for both phases. Unskilled labor will be recruited from the surrounding villages.

0.5 Environmental and Social Baseline

A study area of 5 km from the project boundary has been taken into consideration for baseline survey. The baseline information was collected from both primary and secondary sources. Ambient air quality, noise level, surface and groundwater were collected and analyzed. Ambient air quality and water quality has been analyzed for both dry and wet seasons. The population and housing census, 2011 data of Bangladesh Bureau of Statistics has been analysed for 5 km study area to know the demography and socio-economic condition of the study area. The primary socio-economic survey was conducted within 2 km radius from the project periphery.

0.5.1 Meteorology

Meteorological data for last thirty years (1987-2016) of Feni weather station were analyzed. Based on the data analysis it has been demonstrated that monthly maximum temperature varies from 31.5°C to 39.4°C whereas monthly minimum temperature varies from 6.1°C to 21.7°C.

Average Relative humidity in the project area is generally above 80% during May to October. The month of February is the driest with the relative humidity around 73%. The monthly average relative humidity near the project area varies from 73% to 87% throughout the year.

The last 30 years data from the Feni meteorological station shows that the annual average of total rainfall is recorded as 2990.5 mm/year. According to the analysis of the historical data, a monthly highest average of total rainfall occurs in July 679.9 mm whereas monthly minimum rainfall recorded during the winter season (December and January).

0.5.2 Air Quality

In the project area and its surroundings, there are no major air pollution sources. Air quality samples were taken from four locations for twice covered both dry and wet season. The concentration of SPM (73.5-120.4 µg/m^3), PM_{10} (35.4-66.8 µg/m^3), PM2.5 (16.8 – 34.1µg/m^3),

SO_2 (3.0 – 9.4 µg/m^3), NOx (6.8 – 18.9µg/m^3) and CO were found to be in compliance with the national standards presented under the ECR, 1997 (amended on 19th July 2005 vide S.R.O. No. 220-Law/2005).

0.5.3 Noise Level

Noise level was recorded from six locations during the monitoring period. Ambient daytime noise level (Leqday) was recorded in the range of 42.5 to 53.6 dB (A). Whereas, ambient night time noise level (Leqnight) in the study area varied in the range of 38.4 to 47.2 dB (A). All noise levels were found to in compliance with the Noise Pollution (Control) Rules, 2006.

0.5.4 Water Quality

Total four water samples were collected during the survey period of which two were surface and two were groundwater. Analysis of the water quality shows both surface and groundwater quality was well within the standard for inland surface water of ECR, 1997 (Schedule 3).

0.5.5 Traffic

Total tree primary traffic surveys were conducted during 27th – 28th February 2017 of which one was on the access road and other two were river traffic for Choto Feni River and Feni River. The traffic surveys were conducted for 24 hours. Road traffic was less on the access road. The average traffic volume was 6 per hour from 3 pm to 4 pm. Total 151 traffic was counted for 24 hours.

The river traffic was more in Feni River compare to the Choto Feni River. Average water vehicle was 26/hr on Feni River whereas only 6 on Choto Feni River.

0.5.6 Ecology

The project area does not encompass any tree species. Total nine blocks survey was conducted during the ecological study in the project site and surrounding area. Total 12 homestead plantations were found from the block survey whereas 3 different species of forest land found during the survey period. Total 23 species of avifauna were found in the project study area. Detail ecological survey description is shown in Section 4.8.

0.5.7 Socio-Economic Environment

This study has identified social impacts of the proposed project on the local community. Four adjacent villages situated within 2km radius from the proposed project site have been surveyed and the extant of impacts have been confirmed in all villages. Local community is agricultural in nature. Primary study finds that about 85.2% households of the total surveyed households are somehow engaged in agricultural activities. Rice is the major agricultural product in this area and its average production rate per decimal is 15.27 Kg. Gender analysis of this study has depicted the conventional patriarchic scenario of rural Bangladesn. Women are found lagging behind in education and job opportunities. Along with the male population female engagement in agricultural activities has also be found, although this number is not very large. Key Environmental and Social Impacts

During the study period, all possible source of impact were identified for both construction and operation phase of the proposed power plant and evaluated the significance of the impact.

0.5.8 Impact during Construction Phase

During the construction phase, the most potential identified impacts are land use change, agricultural resources, surface water pollution, drainage pattern, air and noise pollution, increased traffic volume, waste generation, occupational health, and safety hazard.

Social Impact

Primary study suggests that the extant of livelihood impact may be incurred irrespective of farmers, sharecroppers and illegal land user. Study finds that the number of total legal land owners may vary 150-200 persons for 999.65 lands. On the other hand, RAP report for first 50 MW solar project identifies only 18 legal households among 61, listed by DC office, who will lose the right of land ownership. **It is found that** 60-80 sharecroppers along with some other users' (illegal) livelihood will be affected from the land acquisition of 999.65 acres. Where RAP report for first 50MW solar power plant identifies 22 sharecroppers whose livelihood will be affected due to the land acquisition of 165.5 acres. Moreover, gender impact assessment suggests very low impacts on women as *RAP report for first 50 MW solar project* confirmed that no women headed households will be directly affected due to the land acquisition.

Moreover, there are no trees, structures, common properties, major fishing resources on the land. Moreover, there are no tribal people in or around the project area who may have been affected by the intervention of the project.

In this study, all relevant negative impacts have been identified and proper mitigation measures have been suggested. In addition to these, additional measures for vulnerable affected households and unforeseen impacts have also been suggested.

Land Use Change

The present land use of the project area will be changed due to the construction of the temporary structure (site office, labor camp), dike around the project boundary for flood control, PV module and WTGs foundation and internal access road. Total 999.65 acres land, which is low land and used for seasonal agricultural activities will be changed to industrial setup.

Impact on Land Resources

Top Soil Removal

During the site preparation top soil will be stripped out and leveling the land. There will be a direct impact to topsoil within the boundaries of the project site. However, as the loss of topsoil will be limited to the project site and will not have off-site impact.

Soil Compaction

Soil will be compacted during the site preparation, internal access road(s), temporary laydown area and buildings (accommodation and control). The transport of materials and equipment will involve the additional movement of vehicles, construction machinery that will also lead to some degree of compaction within the site premises. The soil compaction would lead to impact on the soil physical properties such as reduction in pore spaces, water infiltration rate etc.

Waste Generation and Soil Compaction

General construction waste (concrete, wooden pallets, steel cuttings/filings, packaging paper or plastic, wood, metals) and municipal domestic wastes (food waste, plastic, glass, aluminum cans and waste paper) will be generated. A small proportion of the waste generated during construction phase will be hazardous and may include used oil, hydraulic fluids, waste fuel, grease and waste oil containing rags. If improperly managed, these wastes could create impacts on land.

Impact on Water Resources

Water Abstraction

Water will be required during the construction phase are mainly to moisture condition for proper compaction of internal roads and foundation works within the site premises, domestic requirement of workers. Water will be sourced from the river or ground water. The groundwater table in and around the project area is shallow (around 6 meters). Water is available both in river and underground to meet the water demand during the construction therefore the impact on water resources due to the water abstraction is low.

Water Quality

Two canals are following within the project site, which are the major receptor of water pollution due to the construction work. The major sources of water pollution during the construction period are domestic waste generated form the labor camp, accidental spills/leaks from equipment/machinery and storage area, wastewater from the washing of equipment and machinery. This wastewater may contain concentrations of suspended solids and traces of hydrocarbon. Sediment content would be increased in the surface water body due to the surface runoff during the embankment construction, Runoff and erosion of exposed bare soil, slopes and earth, and stockpiles; Release of cement materials with rain-wash; and washing water from dust suppression sprays and vehicle wheel washing facilities.

Drainage Pattern

Two natural canals flow in the project site, which are connected with the river. Both the canals get water during high tide. During monsoon season water drained out through these two canals from the villages located northern side of the project. Dike construction around the project boundary may interrupt the drainage if proper measurements not consider during the dike design.

Impact on Air Quality

Dust will generate from earthwork, construction of internal access road, WTG and PV module foundation, construction of building, loading and unloading equipment etc. Exhaust emissions of SO_2, NOx, CO, CO_2, and PM_{10} will be attributed predominantly to the construction of the plant, DG set operation and road vehicles such as movement of trucks and vehicles during construction work.

Impact on Noise

Operation of construction equipment, vehicle, construction activity and operation of DG sets will increase the noise level in the surrounding area. The nearest settlement is 250 m of the northern boundary and 275 m and 265 m of the western and north-western side of the project boundary. The closest reserve forest is located 1.30 km from the south-west side of the project boundary. As the closest receptor present, more than the 200m from the project site so the impact due to the noise generation from the project site will be low.

Traffic and Transport

The construction phase shall involve transportation of construction materials, solar PV modules, wind turbine equipment and mounting structures. Traffic volume will increase in the existing road during the construction period of the power plant. No major vehicle is running on the road only auto rickshaw, CNG, motorcycle, and bicycle are using the access road. Excess traffic on the road will create discomfort for locals due to increment in noise level and fugitive dust and gaseous pollution expected to exhaust from the vehicles.

Impact on Ecology

The potential sources of impact on ecological resources during the construction phase of the project are project site clearance, construction activities and vehicular movement. There is no tree species in the project site. The project sire is used as grazing during the pre-monsoon season. Removal of vegetation may result in loss of habitat for small mammals and birds. Construction activities will result in noise generation that may affect avifauna. Sediment load may increase in the existing canals of the project site due to improper management of soil that will lead to an impact on aquatic ecosystem.

Occupational Health and Safety

The construction activities include site preparation, infrastructure utilities installation and building structures. Loading and unloading operation of the construction material may cause an injury if not handled properly. During construction works, physical injury result due to road accidents, construction accidents, and other occupational hazards. Overexertion injuries and illness are potentially the most common health hazards associated with construction activities.

Impact on Community Health and Safety due to Influx of Migrants Workers

The Semi-Skilled and Skilled personnel will come from the outside of the Sonagazi during the construction period that may increase the community conflict between migrants and locals and spread of communicable diseases, especially sexually transmitted diseases.

Employment Opportunity

The construction phase activities of the project including construction of access road, civil works, foundation activities, site clearance and security will involve semi-skilled and unskilled workers, who are likely to be recruited from the local community. Therefore, local villagers living near to the project site as well as Sonagazi upazila or surrounding upazila will be benefited.

0.5.9 Impact during Operation Phase

The potential impacts assessed during the operation phase of the proposed project are a waste generation, water availability, ecological impact, visual impact and occupational health and safety.

Waste Generation

PV module cleaning wastewater, dielectric fluids, cleaning agents and solvents during routine operation, waste oil from the use of lubricant oil and transformer oil, defunct/damaged photovoltaic cells are the major source of solid and liquid waste during operation of proposed power plant. Improper disposal and maintenance of waste may lead to contamination of soil, surface and groundwater environment, which could result in indirect impacts to humans, flora, and fauna.

Water Availability

During the operation phase, approximately 31.5 million liters per year water will be required for PV module and rotor blade cleaning. The source of water has not been finalized yet. There are both surface and ground water source to meet the water requirement during operation. As there is the availability of water in the project site, therefore it would not be a major problem due to the abstraction of surface and groundwater.

Impact on Air Quality

No emissions are expected to be released during the operation phase, due to the fact that solar PV and wind power plants do not release greenhouse gases or any toxic pollutants during their operation as solar and wind power plants do not involve combustion processes. Dust will be generated during the movement of the vehicle during maintenance of power plant which is very limited scale.

Impact on Ambient Noise Level

The major sources of noise during the operation of the plant are WTG operation, vehicular movement, noise from inverters and transformers. No major noise will be generated from the solar power plant whereas WTGs will generate noise during the operation period. The closest settlement is located 900 m away from the WTG location therefore the impact will be negligible.

Impact on Ecology

Glare/reflection from solar module and collisions with wind turbines blades and electrocution from transmission line may increase the fatalities of birds and bats. Glare/reflection from solar module will be minimum as PV module capture sunlight therefore impact due to Glare/reflection from solar module is insignificant. The fatalities of birds and bats are general in nature with windmill projects throughout the world. The fatalities of birds and bats due to the wind turbine operation will not significant, as the project will set up only five turbines.

Visual Impact

As total 7, 43,040 Nos. of the module and 5 wind turbine generators (WTG) will be set up in the proposed project area so the presence of a large area of PV panels is expected to constitute a risk for glare. The reflection from the PV panels may create a visual impact on local community. Besides this, lighting in the power plant area and building structure also sources of visual impact. Now the solar PV panel has the anti-reflecting coating, which reduces the sun's reflection from photovoltaic panels. Therefore, the visual impact due to the glare from PV panel will be low.

Occupational Health and Safety

There are many hazards associated with a solar PV and wind power plant if sufficient precautions are not taken during the operation stages. The impact origins are leaching of materials from broken or fire damaged PV modules, emergency fire hazard, electrocution of workers, working at height for WTGs maintenance. Workers would be injured during the operation of the plant due to the accidental event.

The following Table 0-2 shows the outcomes of the comprehensive assessment of identified impacts as a result of the various phases of the Project.

Table 0-2: Impact Assessment Summary

Impact Description	Impact Nature	Significance of Impact	
		Without Mitigation	With Mitigation
Pre-Construction Phase			
Land loss	Negative	Medium-High	Low
Livelihood loss	Negative	Medium-High	Low
Construction Phase			
Land Use Change	Negative	Medium-High	Medium-Low
Loss of Top Soil	Negative	Low	Very Low
Soil Compaction and Erosion	Negative	Low	Very Low
Soil Contamination	Negative	Low	Very Low
Impact on Land due to the Improper Waste Disposal	Negative	Low	Very Low
Impact on Agricultural Resources	Negative	Medium-High	Medium-Low
Water Abstraction	Negative	Low	Very Low
Water Quality	Negative	Low	Very Low
Increased Sediment Content of Surface Water	Negative	Medium-Low	Low

Ground Water Contamination	Negative	Low	Very Low
Impact on Drainage Pattern	Negative	Medium-High	Low
Dust from Construction Activities	Negative	Medium-Low	Low
Exhaust Emission	Negative	Low	Very Low
Impact on Noise Level	Negative	Low	Very Low
Traffic and Transport	Negative	Medium-Low	Low
Solid and Liquid Waste Generation, Storage and Disposal	Negative	Medium-Low	Low
Impact on Ecology	Negative	Medium-Low	Low
Occupational Health and Safety Hazard	Negative	Medium-High	Low
Influx of the migrant worker and labour	Negative	Low	Very Low
Employment Opportunity	Positive		
Operation Phase			
Impact on Land due to Improper Waste Disposal	Negative	Low	Very Low
Soil Contamination due to Leaks/Spills	Negative	Low	Very Low
Waste Generation	Negative	Medium-Low	Low
Water Availability	Negative	Medium-Low	Low
Impact on Water Quality	Negative	Low	Very Low
Impact on Air Quality	Negative	Very Low	Very Low
Impact on Noise Levels	Negative	Low	Very Low
Impact on Ecology	Negative	Medium-High	Medium-Low
Visual Impact	Negative	Medium-Low	Low
Occupational Health and safety	Negative	Medium-Low	Low
Traffic and Transport	Negative	Very Low	Very Low
Impact on Climate Change	Positive		
Decommissioning Phase			
Environmental, Health and Safety Impact	Negative	Medium-Low	Low

0.6 Environmental and Social Management Plan (ESMP)

A comprehensive environmental and social management plan has been prepared including the monitoring plan and budget, institutional setting and implementation arrangement. Role and responsibilities for the individual task are shown in the section 9.1. A set of the following plan also suggested in the ESMP for both construction and operation phase of the power plant.

- Waste management
- Occupational health and safety plan
- Construction Labour Management Plan including Labor Influx
- Framework for Emergency Preparedness and Response Plan
- Disaster Management Plan

The Following Table 0-3 and Table 0-4 summarize the potential significant environmental impacts and mitigation measures during construction and operation phases.

Table 0-3: Potential Significant Environmental Impacts and Mitigation Measures during Construction Phase

Project Activity	Potential Significant Impact	Proposed Mitigation Measures	Responsible Parties
Land acquisition	Land owners will lose land due to acquisition	• Periodical consultation with the land owners during the land acquisition; • Payment of replacement value of land; • Payment of severity allowance for fragmentation of land. Where the remaining land becomes unviable in case of fragmentation, the Project to compensate for the full land parcel; • Establishing a grievance redress mechanism; • Redressing grievances according to the established GRM; • Prioritization for work during project construction period;	EGCB
Land acquisition	Land owners, share croppers and illegal users will lose their livelihood from the land	• Prior notification before land development as crops harvesting not get impacted; • Payment of transitional assistance to support economic loss; • Livelihood restoration measures for severely affected households or skill improvement training; • Establishing a grievance redress mechanism; • Redressing grievances according to the established GRM; • Prioritization for work during project construction period.	EGCB
Land acquisition	Vulnerable group will be impacted due to the loss of their land or livelihood	• Additional cash/ other assistance; • Livelihood restoration measures or skill improvement training; • Establishing a grievance redress mechanism; • Redressing grievances according to the established GRM; • Prioritization for work during project construction period.	EGCB
Construction of temporary structure, approach road & internal access road, dike around the project boundary, installation of PV module and WTGs	Permanent and temporary changes in land use	• The construction activities will be restricted within the boundary of the proposed plant and will not alter the land use of the adjacent areas; • On completion of construction activities, land used for temporary facilities should be restored to the extent possible; • The land use in and around the permanent project facilities should not be disturbed	EPC Contractor (Supervised by EGCB)
Topsoil removal for site preparation	Loss of topsoil	• The removal of vegetation and soil cover should be restricted to only those areas necessary for the development. All topsoil will be retained and reused for leveling the land;	EPC Contractor (Supervised by EGCB)

Project Activity	Potential Significant Impact	Proposed Mitigation Measures	Responsible Parties
		• Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds; • Covering or spraying water on stockpiles of excavated material	
• Site cleaning, leveling, compaction • Civil construction activities	Soil compaction and erosion	• It is recommended to grow turf grass beneath solar panels to avoid soil erosion • Construction vehicles will remain on designated and prepared compacted gravel roads;	EPC Contractor (Supervised by EGCB)
• Improper disposal of hydraulic fluids, diesel, lubricating oils and other used oil • Improper storage of construction materials	Soil Contamination	• Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area. • Sewage generated from the project site will be treated and disposed of through septic tank and soak pits; • Construction vehicles and equipment will be serviced regularly	EPC Contractor (Supervised by EGCB)
Project will be set up on medium high land where only aman rice is cultivated	Loss of agricultural production	• Inform the landowner prior to starting land development work so they can harvest the standing crop; • Best utilize the designated land area for fisheries	EGCB
Water demand for construction work	Surface and ground water quantity	• Periodical training need to provide to workers for best utilization of water; • Keep provision for rainwater harvesting; • Take permission for installation of bore well from Upazila Parishad; • Recycle/reusing of used water to the extent possible	EPC Contractor (Supervised by EGCB)
• Sewage from labor camp • Liquid effluent from washing of equipment and vehicles • Storage of hazardous waste onsite	Water contamination	• Fuel, oil and used oil storage areas should be contained in bunds of 110 percent capacity of the stored material; • Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal; • Septic tanks will be provided to treat sanitary wastewater • Use of licensed contractors for management and disposal of waste and sludge and • All sewage and liquid effluent will be treated to meet the standards specified in Schedules 9 and 10 of the ECR, 1997	EPC Contractor (Supervised by EGCB)
• Dike construction • Land development	Changes of drainage pattern	• Detail hydrology study should be carried out prior to design the dike; • Appropriate number of cross drainage channels should be provided during access road construction to maintain flow in the existing natural channels	EPC Contractor (Supervised by EGCB)

Project Activity	Potential Significant Impact	Proposed Mitigation Measures	Responsible Parties
		• Design the dike and plant considering the normal functioning of the canals	
• Earthworks and movement of vehicles, stockpiles of waste, topsoil handling and moving excavated material • Construction work	Dust generation	• Implementation of a regular watering and sprinkling dust suppression regime, during the dry season; • Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site; • Speed of vehicles on site and approach road will be limited to 15-20 km/hr which will help in minimizing fugitive dust emission due to vehicle movement • Idling of vehicles and equipment will be prevented	EPC Contractor (Supervised by EGCB)
• Exhaust emission from operation of machinery like pile drivers, vehicles • Point source emission from diesel generator • Vehicular emissions	Exhaust emission	• The movement of construction vehicles will be minimized and a 20 km/hr speed limit; • All diesel-powered equipment will be regularly maintained and idling time reduced to minimise emissions; • Vehicle/equipment air emissions will be controlled by good practice procedures and • Solid waste burning in the project site is strictly prohibited	EPC Contractor (Supervised by EGCB)
• Construction activities • Transportation of construction materials, plant materials, machinery and personnel • Operation of DG sets;	Noise generation	• The contractor should undertake additional post development noise monitoring in accordance with National and International noise standards. • The number of equipment operating simultaneously should be reduced as far as practicable; • All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50m away from the site boundary; padding/noise isolators will be used for construction equipment • Temporary noise barriers shall be provided surrounding the high noise generating construction equipment; • The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels; • Construction vehicles and machinery will be well maintained and not kept idling when not in use;	EPC Contractor (Supervised by EGCB)
• Transportation of construction materials, plant materials,	Increase traffic load on the local road	• The contractor should ensure that all PV module and mounting structure components are transported in appropriate vehicles that adhere to the axle load limits.	EPC Contractor (Supervised by EGCB)

Project Activity	Potential Significant Impact	Proposed Mitigation Measures	Responsible Parties
machinery and personnel		• Only trained drivers with valid license shall be recruited by the construction contractor; • Additionally, speed limits for all construction related vehicles shall be adhered to at all times to prevent damage to roads and other infrastructure • Notify the school governing body and villagers prior to start the construction work and put signage before the school, mosque and madrasah on both way and instruct the driver for carefully driving in close to the sensitive area and • The traffic movement in the settlement areas should be limited for the daytime only	
• Project site clearance; • Project site leveling; • Construction activities at site;	Impact on terrestrial flora and fauna, aquatic fauna	• The noise generating activities should be scheduled during daytime only. • Movement of construction and transport vehicles should be restricted to dedicated paths to minimise any harm to small mammals near to the proposed site. • Project related activities should be avoided during the night time; • Any animal trapping, hunting or injuring by the labor should be prohibited; • Solid and liquid waste should not dumped in the canals/water bodies	EPC Contractor (Supervised by EGCB)
• Accidents and injuries associated with the operation of heavy machinery and other construction activities; • Loading and unloading activities of the construction materials • Working at height, working with rotating machinery and falling objects	Occupational health impact	• The workers (both regular and contractual) on the project will be provided with training on the Health and Safety policy in place; the same and refresher courses will be provided throughout the life of the project; • Establish a grievance redressal mechanism in place, to allow for the employees and workers to report any concern or grievance related to work; activities; • Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional; • Child labor during the project construction should be prohibited; • Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures; shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries;	EPC Contractor (Supervised by EGCB)

Project Activity	Potential Significant Impact	Proposed Mitigation Measures	Responsible Parties
		• Safety sign should also be marked at appropriate places; • It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls; • PPEs such as safety harnesses during work at height, safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas	
• Influx of Migrant Workers; •	Community Health and Safety due to migrant labour influx	• Engage as many locally available unskilled, semi-skilled and skilled human resources; • Provision of infrastructure and amenities for migrant labour in construction camp to avoid dependence on limited local resources; • Adequate sanitation facility at labour camps to maintain hygiene and minimise spread of diseases; • If local existing medical services are inadequate, arrange the provision of medical service for migrant workers; • Providing awareness program about local tradition and culture among outside migrant workers; • Providing awareness training regarding sexually transmitted diseases among the migrant; • Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area; • Avoid unnecessary movement of vehicles through settlement areas to avoid disturbance and traffic safety related issues; Engage as many locally available unskilled, semi-skilled and skilled human resources • Engage as many locally available unskilled, semi-skilled and skilled human resources	EPC Contractor (Supervised by EGCB)

Table 0-4: Potential Significant Environmental Impacts and Mitigation Measures during Operation Phase

Project Activity	Proposed Significant Impacts	Proposed Mitigation Measures	Responsible Parties
• Monitoring of solar PV and WTG operation; • Routine maintenance activities at PV module and WTG locations; • Material handling and storage • Hazardous and Non-hazardous material and waste management	Soil contamination due to improper waste disposal	• The waste generated during operation phase should be disposed of through approved vendors; • During the operation phase, the quantity of municipal waste and hazardous waste generated is less and probability of the hazardous waste generation is only during maintenance and therefore occasional. The waste generated would be routed through proper collection and containment with impervious flooring; • Ensure oil/ lubricants are stored on impervious floor in the storage area having secondary containment; • The EGCB should make a MoU with the local municipality to collect the daily domestic waste for disposing of in the designated dumping site.	EGCB
• Wastes likely to be generated during routine operations are dielectric fluids, clearing agents and solvents etc; • Repair and maintenance of underground cables and associated utilities will lead to generation of hazardous wastes as used oils; • Wastewater from PV module cleaning; • The defunct / damaged photovoltaic cells will also be generated; • Domestic liquid and solid waste	Contamination of soil, surface and groundwater	• Separate designated area should be earmarked for storage of hazardous waste like waste oil, transformer oil. These wastes shall be given to the DoE approved recyclers. • Material Safety Data Sheets for all applicable materials present on Site will be readily available to on-site personnel. • All wastes produced from project activities on site will be transferred to designated temporary storage areas and where possible into secure containers. • Solid wastes will be segregated to facilitate reuse and recycling of specific materials. • First of all, inspection of PV modules for defects that can appear in the form of burn marks, discoloration, or broken glass is to be undertaken. An authorized person will walk the site to confirm that there are no broken modules (shattered glass) and broken modules should not be sprayed with water. • Broken or damaged solar panels are required to be immediately shifted to a designated area in a scrap yard to avoid any type of land contamination. A photograph is to be taken of the broken panel at the site to cater to Insurance settlement claims. • Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer.	EGCB

Project Activity	Proposed Significant Impacts	Proposed Mitigation Measures	Responsible Parties
		• Use the soak pit and septic tank in the office building and guard room for sewage.	
• Water use for PV module and wind turbine rotor blades cleaning; • Water Consumption for domestic use; • Surface water pollution due to the surface runoff from the project to the drainage network passing through the project site and Choto Feni River; • Surface and groundwater pollution due to the accidental leakage and spills of oil	Water availability	• Periodical training need to provide to workers for best utilization of water; • Bore-wells should be established after requisite permission from the regulatory authority. Meters should be installed at the bore-wells to monitor the abstraction of water; • Wastage of water during cleaning of panels should be avoided; • The wastewater emanating from cleaning operations shall be used for the agriculture and aquaculture pond in the project site and excess water shall be discharged after settling of the sediment; • Appropriate drainage network should be planned in the project site;	EGCB
	Water Quality	• The drainage and sewerage system will be provided for the collection and treatment of wastewater at SCADA building/ CMS and substation areas. • No wastewater discharge on open land will be practiced; • The plant site should be provided with adequate drainage facility to drain-off the rain water and prevent any waterlogging at site or in the surroundings; • Fuel, oil and used oil storage areas will be contained in bunds of 110 capacity of the stored material.	EGCB
• Maintenance of vehicles • Transportation during operation and maintenance of the power plant	Air Pollution	• Vehicles traveling on gravel roads should not exceed a speed of 30 km/hr. • Regular water spray is required on unpaved road as the dust not move during heavy wind; • Use clean fuel in vehicle as the exhaust emission will be low	EGCB
• WTG Operations • Vehicular movement • Noise from inverters and transformers • Repair and Maintenance Works of solar panels	Increase noise level	• The wind turbines shall be maintained in good running conditions throughout the operational life of the project through routine maintenance; • Periodic monitoring of noise near to the sources of generation to ensure compliance with design specification; • Maintain the speed limit when car run through the settlement area; • Aware of the unusual horn use;	EGCB
• Fatalities of birds and bats due to possibility of collisions with wind turbines	Impact on avifauna	• Carry out detail birds and bat survey covering the full winter season to understand whether the project site is staging ground for migratory bird;	EGCB

Project Activity	Proposed Significant Impacts	Proposed Mitigation Measures	Responsible Parties
blades and electrocution from transmission line;		• Marking overhead cables and transmission poles using detectors and avoiding the use of areas of high bird concentrations, especially IBA area located close to the project site and for species vulnerable to collision. • Where possible, installing transmission cables underground in accordance with existing best practice guidelines for underground cable installation. Otherwise if possible, install overhead cables with proper insulation to avoid bat and bird electrocution through body touch.	
• Leaching of materials from broken or fire damaged PV modules • Vehicle accidents, replacement of components/parts • Emergency Fire Hazard • Electrocution of workers • Electromagnetic radiation from PV modules • Working at height for WTGs maintenance	Health risk of the worker	• Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. • Adequate training regarding health and safety will be provided to the workers. • A health, safety, and environment (HSE) management system will be developed, rolled out and implemented. • Workers at site handling broken solar panels shall be provided with adequate PPEs (safety gear, goggles, and gloves). • WTGs supplier shall provide instructions and procedures to all the workers involved in service repair of wind turbines; • Access to areas containing exposed electrical equipment (such as transformers) shall be fenced and locked. Warning signs shall be posted at hazardous locations; • Firefighting equipment's such as fire extinguishers and sand buckets shall be provided at appropriate locations; • First aid box/ arrangement to be ensured	EGCB

0.7 Public Consultation and Disclosure and Grievance Redress

Public consultation & disclosure process is conducted for any project to intimate the community about the project, its activities and associated benefits, impacts, risks etc. so that people can participate in the project activities in an informed manner and can raise their concerns to be addressed. A good consultation process effectively manages public apprehensions, identifies control measures for these apprehensions in association with the public stakeholder and also facilitates in implementation of the identified measures.

0.7.1 Approach to Consultation and Disclosure

The approach undertaken for information disclosure and consultation at the draft ESIA stage involved the following key processes.

1. Mapping and Identification of key stakeholders such as primary and secondary and prioritizing them according to their influence;
2. Conducting expert consultations, interviews and Focus Group Discussions (FGD);
3. Assessing the influence and impact of the project on these stakeholder groups and vice versa
4. Summing up of key findings and observations from the consultations
5. Preparing a future engagement plan taking into account the project lifecycle phases and their implications on the stakeholder.

0.7.2 Stakeholder Mapping and Identification

Mapping and identification of the Stakeholders has been done on the basis of interest and influence as follows

Type of Stakeholders	Stakeholders profile		
	Highest Influence	Medium Influence	Low Influence
Primary Stakeholder	EGCB, Project Financiers, PGCB, DoE,	EPC Contractor/ Developers, Migrant Worker and Labor, Local Community, Land owners and farmers, Sharecroppers and land users (illegal land owner)	Women, Vulnerable households
Secondary Stakeholder	-	Department of Education, Department of Public Health Engineering, Upazila Political Administration, Union leaders & local representatives	Department of Agriculture, Department of Fisheries, Department of Social Welfare (DSW)

0.7.3 Disclosure and Consultation

A number of consultations were conducted during this phase of ESIA preparation. A combination of methods of information disclosure and consultation process was adopted at this stage. The method selected for consultation was basically adopted keeping in mind the profile of the stakeholders, type of information desired and level of engagement required. The methods used in the consultation process were:

- Key In-depth Interview/discussion;
- Public Consultation
- Focus Group Discussion (FGDs)
- Consultations during Survey

The consultation and information disclosure were held in a free and fair environment with giving prior information about the same to the stakeholders. In all occasions the date, time and venue of the consultation was decided by the stakeholders keeping in view their prior engagement and availability.

0.7.4 Key Findings of Consultation

Broadly, the key findings and observations from the consultations process were:

Positive expectations from the project: it was conferred that most people saw the project as a positive development for the communities specifically in terms of employment and contracting opportunities, better infrastructure and electricity supply. It is also expected that the project will support additional industrial development in the surrounding area.

Land & Compensation related Issues: Acquired land was khas land and distributed to Landless people. However, complexity on ownership exists. Three types of affected persons have been identified i.e. Legal owners, sharecroppers and illegal land users. Compensation rate determined by the DC is higher than the current market price, will be known as replacement value, and people are willing to contribute for this development project if properly compensated.

Impact on Land Dependent Groups: livelihood of the landowners, sharecroppers and illegal land users will be partially impacted. Acquired land is single cropped with low productivity for high degree of salinity. Sole dependency on the acquired land is not found as most of the dependents have to rely on other jobs or other lands those are not being taken by the project intervention.

Adjacent Water bodies

Two Canals exist in the project site those are originated from the Choto Feni River and pass through the project site. If they are filled or blocked, adjacent communities and agricultural lands will be inundated during the wet season.

Existing Road Development

The existing road is not suitable for carrying construction and plant material. Therefore, a new road will be constructed or up-gradation of the existing road is required. Besides, proper traffic system will require to be adopted for the community safety.

0.7.5 Stakeholder Engagement

The effectiveness of the ESIA is directly linked to the degree of continuing involvement of those affected directly or indirectly by the project. The stakeholder engagement process is suggested to carry out at two levels, namely, local community and local governing bodies. Different communication methods and time period are also framed.

0.8 Conclusion

The ESIA study has been carried out based on the site visit, baseline environmental and social condition survey, stakeholder consultation, analysis of the possible project intervention and finally experts identified and evaluated potential environmental impact associated with all aspects of the proposed project.

The key environmental and social impact due to the project construction observed as an outcome of the ESIA study impacts on land use, loss of cultivable land, loss of livelihood, drainage pattern change, water quality, solid waste generation and disposal, increase traffic and transport and occupational health and safety. The economic opportunities in terms of

local employment during construction and operation phase are assessed as positive impact. During the operation of the proposed project, the key issues related to the environment have been identified from the ESIA study are hazardous waste generation and management, ecological, visual impact and occupational health and safety.

The Environmental and Social Management Plan (ESMP) describes mitigation measures for impacts specific to the project activities and also discuss implementation mechanism for recommended mitigation measures along with monitoring plan. Implementation of ESMP will help Electricity Generation Company of Bangladesh (EGCB) Limited to comply with the national regulatory framework as well as to meet IFC Performance Standard requirements.

The project should take structurally protective measures towards flood, cyclone and tidal surge as the site is located in the coastal region. Moreover, as per the loss of land and livelihood assessment this study also suggests preparing Resettlement Action Plan & Livelihood Restoration Plan and successful implementation, if required, in compliance with the relevant policy appropriate for the funding agency.

CHAPTER 1: INTRODUCTION

1. INTRODUCTION

1.1 Project Background

According to the Bangladesh Power Development Board, the per capita energy consumption in Bangladesh is 433 kWh. Non-commercial energy sources, such as wood fuel, animal waste, and crop residues, are estimated to account for more than 40% of the energy consumption. Electricity is the major source of power for most of the country's economic activities. About 90% of the population has access to electricity including about 13% from renewable energy. Total installed electricity generation capacity was 13, 846MW in March 2018. About 53.74% of generated power comes from natural gas and the rest is from liquid fuel, coal, and hydropower. The present share of renewable energy is only 3.10%. Bangladesh has 255.21 MW of solar energy capacity through the successful solar home systems that reached 4.8 million rural households (Source: BPDB and SREDA).

As per the National Renewable Energy Policy 2008, the plan is to add generation capacity of 800 MW by 2015 and 2,000 MW by 2020 from renewable sources. In addition, the Ministry of Power, Energy, and Mineral Resources has announced in 2013 to develop 500 MW of installed generation capacity from solar energy through Asia Solar Energy Initiative (ASEI).

The Electricity Generation Company of Bangladesh Limited (EGCBL) has acquired 999.65 acres land to establish 100 MW Solar and 100 MW Wind Power plant project at Sonagazi upazila of Feni district. The following **Figure 1-1** is showing the proposed project location. World Bank has shown their interest to finance EGCB Ltd for implementation of 50 MW Solar Power Plant on 165.5 acres land of that acquired land. Others renewable energy generating power plant will set up on rest of the acquired land based on the government mandate and suitable option outlined in feasibility study report. This ESIA report is prepared based on the solar and wind project following the relevant World Bank safeguard policies and GoB guidelines.

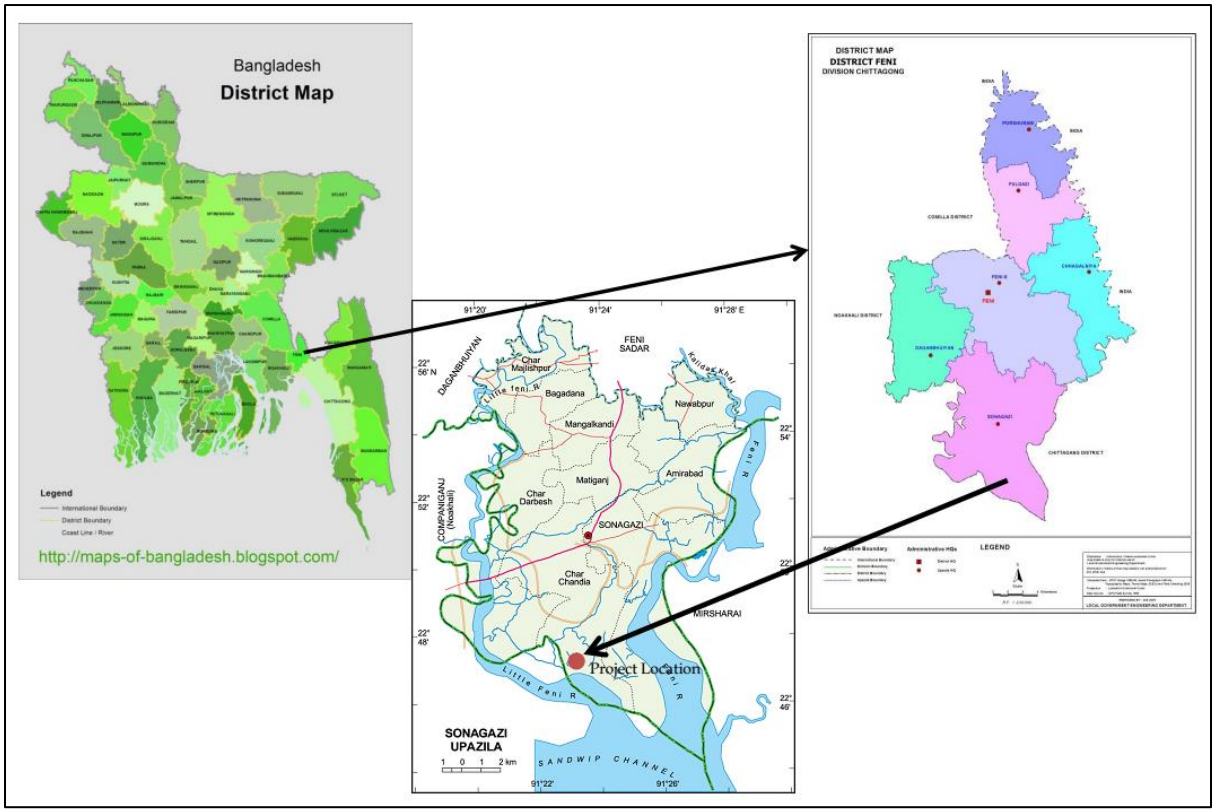


Figure 1-1: Project Location Map

1.2 Project Rationale

Power and energy are the main driving forces of country's economy and a prerequisite for development.. Per capita electricity generation is 433 KWh.[1] The GOB has given highest priority to power sector development in the country and has committed to making electricity available to all citizens by 2021. With this in mind, the government has initiated the implementation of reform measures in the power sector, including significant development programs of which this Project constitutes an important part.

1.2.1 Power Generation in Bangladesh

The total power generation capacity is 16,046 MW including captive and Solar Home System (SHS) till 20 March 2018. The highest generation stands 10,084 MW up to 19 March 2018. The Bangladesh Power Sector at a glance is shown in the following **Table 1-1**.

Table 1-1: Bangladesh's Power Sector at a Glance

Generation Capacity including captive and Solar Home System (SHS)	:	16,046 (20th March 2018)
Highest Generation	:	10,084 MW (19 March, 2018)
Total Consumers	:	28.2 Million (20th March 2018)
Transmission Line	:	10,622 CKt. Km (20th March 2018)
Distribution Line	:	4,34,000 Km (20th March 2018)

[1] Bangladesh Power Development Board

System Loss	:	12.19% (June 2017)
Distribution Loss	:	9.98% (June 2017)
Per Capita Generation	:	433 KWh (August 2016)

Source: Power Cell, Ministry of Power, Energy and Mineral Resources

Considering challenges of primary fuel, more emphasis has been given in power generation through renewable energy. This would especially meet the demand in areas where grid supply is not possible. According to the Renewable Energy Policy 2008, 10 percent of electricity is to be generated from renewable energy sources by 2021. The government has established Sustainable and Renewable Energy Development Authority (SREDA) in 2014 under Sustainable and Renewable Energy Development Authority Act, 2012.The achievement of renewable energy is shown in **Table 1-2.**

Table 1-2: Renewable Energy Contribution and Achievement (Up to March 2018)

Sl.	Technology	Off-Grid (MW)	On-Grid (MW)	Total (MW)
1.	Solar PV	255.21	16.64	271.85
2.	Wind	2	0.90	2.90
3.	Hydro	-	230	230
4.	Biogas to Electricity	0.68	-	0.68
5.	Biomass to Electricity	0.40	-	0.40
Total		258.29	247.54	505.83

Source: Sustainable and Renewable Energy Development Authority (SREDA)

Considering the Renewable Energy Policy 2008, GoB has planned to generate electricity from renewable sources. Besides the other power generation sources Government of Bangladesh has taken initiatives to install the renewable power generation plant by the public as well as privet sector for meeting the power demand in Bangladesh. The GOB has committed to attracting private sector investment to install solar power plant on a build-own-operate basis.

1.3 Purpose and Scope of the ESIA

1.3.1 Purpose

The proposed project has the provision of power generation from both solar and wind resources. As part of the World Bank funding requirement, the study is required to address the environmental and social issues related to the project. As per the Environmental Conservation Rules 1997, the proposed project falls under the RED category so the proposed project needs to be conducted EIA study for an approval from the Department of Environment (DoE). Besides the ECR, 1997 the EIA study needs to be followed the World Bank Operational Policies (OP 4.01 and others as applicable), OP4.03- Performance Standards for Private Sector Activities and World Bank's Environmental Health and Safety (EHS) guidelines. The applicable reference framework has been followed for the study is as follows:

- Applicable Bangladesh national and local regulatory requirement
- Applicable World Bank Operational Policies

  - ✓ Environmental Assessment (OP 4.01), Natural Habitat (OP 4.04), Involuntary Resettlement (OP 4.12), Physical Cultural Resources (OP 4.11), Indigenous People (OP 4.10)
- Performance Standards for Private Sector Activities (OP 4.03);
- The World Bank Group's General EHS Guidelines (2007);
- The World Bank Group's EHS Guidelines for Wind Energy (2015)

1.3.2 Scope

This feasibility study has identified and assessed all possible options of capacity mix at the site to meet different objectives of technology mix, costs of generation, sustainability etc. set by Power Cell and EGCB. Following are the identified and assessed options:

- Option 1 (reference case): it has 100 MWac (136.06 MWdc) solar PV with 24 MWac wind.
- Option 2: it has the reference case (100 MWac solar PV with 24 MWac wind) plus additional 54MWac solar PV in between shadow free area of WTGs.
- Option 3: it has only solar PV of 262 MWac (356.53 MWdc) at the entire site and no wind power system.
- Option 4: it has 172 MWac (234.050 MWdc) solar PV and 10 MWac wind power project with 262 acres (26% of entire land) for livelihood purpose like fishery and agriculture around WTGs area.
- Option 5: It has 166 MWac (225.85 MWdc) solar PV and 10 MWac wind power project with Fishery activity beneath the solar PV modules.
- Option 6: It has 182 MWac (247 MWdc) solar PV power project with Fishery activity beneath the solar PV modules.
- Option 7 (recommended option): It has 200 MWac (272 MWdc) solar PV power project with intensive fishery on around 25% land of the total area for livelihood purpose (no wind power project).

The project proponent (EGCB) will select the best option based on the suitability, techno-economic viability. This ESIA study report is prepared based on the option 5. EGCB is planning to establish first 50 MW solar project on 165.5 acres land. Solar and wind hybrid project along with aquaculture facility beneath the solar panel on rest 834.15 acres acquired land will come in later stage. A dike will be constructed around the project area to protect from flood hazard, which also consider in this report. This report is prepared based on the relevant World Bank safeguard policies and GoB guidelines.

The detailed scope of the ESIA study is as outlined follows:

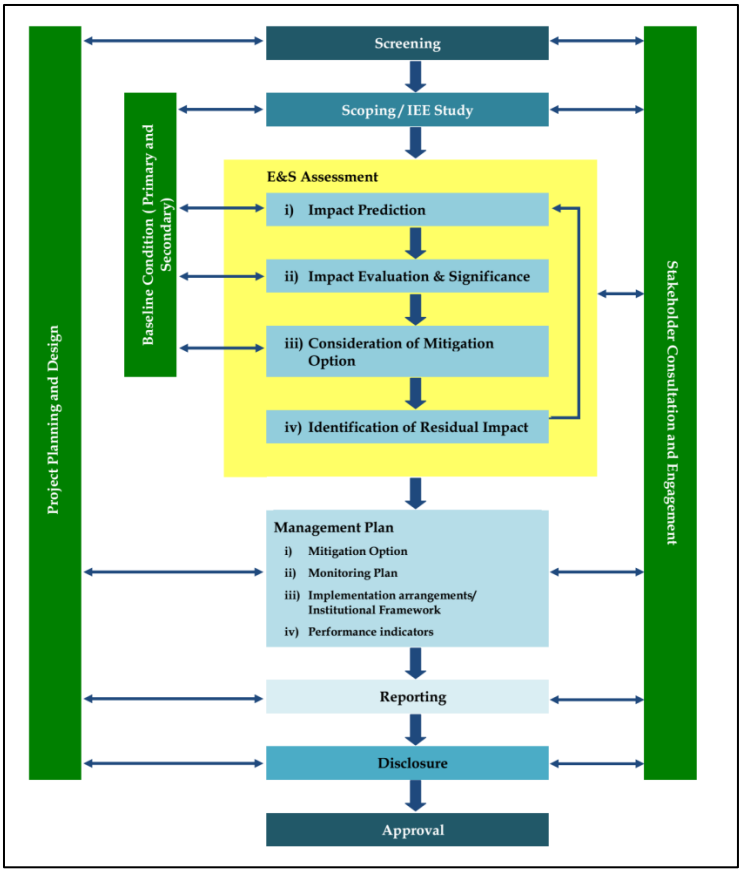
- Reconnaissance survey and identify the environmental and social receptor for primary field survey
- Development of an integrated project description from reviewing the feasibility study
- Development of a regulatory, policy and administrative framework related to the project
- Field survey, monitoring, analysis, and reporting of the environmental baseline of the study area including consultation with stakeholders;

- Assessment and evaluation of the environmental impact associated with the project;
- Preparation of Environmental and Social Management Plan (ESMP) based on the assessment and proposed specific mitigation plan for identified impacts
- Suggest appropriate institutional arrangement and capacity building needs for proper implementation of environmental management plan during all phases of the project

1.4 Approach and Methodology for the Study

The main focus of the ESIA will be 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 will consider all aspects and phases of the project and any indirect environmental and social effects, cumulative effects, and any environmental effects that may result from accidents or malfunctions.

The approach proposed for the ESIA study is presented in following ***Figure 1-2***:



Source: EQMS

Figure 1-2: Approach to the ESIA Study

The activities involved in conducting ESIA of a project are diverse and intensive efforts including field surveying are needed to prepare successful ESIAs. The procedure for conducting ESIA may be described in following steps.

1.4.1 Screening and Categorization

Screening

ESIA team reviewed the existing available data of the Project with the client and secondary information available in public domain with regard to the Project, Project location, and its

surroundings. The screening process was undertaken to identify environmental and other sensitivities associated with the Project. A review of the applicability of the reference framework with respect to the proposed project was also undertaken as part of this screening phase. The results of the screening exercise are reported in **Annex A** of this ESIA report.

Categorization

Based on the impact analysis and following the Environmental Conservation Rules, 1997, the is categorized as red (Item 6: Power Plant).

1.4.2 Scoping

The ESIA team had a brief introduction meeting with the World Bank, Power Cell and EGCB team in Dhaka prior to site reconnaissance visit. Consultants undertook a 2 days site visit to understand the site setting, environmental and social sensitivities and to identify the relevant local stakeholders as well as analyze the local requirements and national level stakeholders which would be important for secondary data generation and regulatory approval process of the project. The reconnaissance visit was conducted from 5th December – 6th December 2016.

Scoping was undertaken to identify the potential Area of Influence for the Project (and thus the appropriate Study Area), to identify potential interactions between the Project and resources/receptors in the Area of Influence and the impacts that could result from these interactions, and to prioritize these impacts in terms of their likely significance. The findings of the scoping exercise are reported in **Annex B** of this ESIA Report.

1.4.3 Environmental Baseline Data Collection

The baseline has covered a detail description of the physical environment, water resources, land resources, agriculture, fisheries, and eco-systems condition including identification of problems in respect of the resources. Field visits were carried out in the project site as well as in the whole study area. The main objectives of these visits were observation, assessment and professional justification. These have been conducted to identify the Important Environmental Components (IECs) through a scoping process including scoping sessions with the stakeholders. Primary data of surface and groundwater, noise level, air quality have been collected and analyzed for two periods (dry and wet). The secondary data have been generated from long-term data collected from different organizations like: Soil Resources Development Institute (SRDI), Bangladesh Water Development Board (BWDB), Department of Fisheries (DoF), Department of Public Health and Engineering (DPHE), Upazila Offices of different agencies, Bangladesh Meteorological Department (BMD) and Department of Environment (DoE).

1.4.4 Impact Assessment and Mitigation Measures

The key issues identified during the Scoping Phase have been analyzed upon 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 ESIA the significance of the potential impacts has been considered before and after identified mitigation is implemented, for direct, indirect, and cumulative impacts, in the short and long term.

The following criteria have been 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 will be classified as positive or negative, and direct or indirect.

Direct	Potential/ possible Impacts will be generated directly from the project activities and its associated facilities which are directly linked to the project. (e.g. loss of land due to project development or air emission from a power plant)
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 (which are not part of the Project) 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 1-3**).

Table 1-3: 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 1-4**).

Table 1-4: 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 construction period but 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 project but appropriate mitigation measures reduce the impact
Permanent – no mitigation	• Potential/ possible Impact will remain after an operational life of the 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 1-5**).

Table 1-5: 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 taken.
Medium	• Environment remarkably distorted/ disturbed/ impacted, still functions, if in a 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.

The potential for irreplaceable loss of resources: This is the degree to which the project will cause loss of resources that are irreplaceable (**Table 1-6**).

Table 1-6: 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 replace a particular/ vulnerable resource.

Probability: This is the likelihood or the chances that the impact will occur (**Table 1-7**).

Table 1-7: 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 historical 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.

E) 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
- 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.

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

		Probability of Impact				
		Unlikely	**Low**	**Medium**	**High**	**Definite**
Magnitude of	**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 1-8: 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. • 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.

1.4.5 Environmental and Social Management Plan (ESMP) and Environmental and Social Monitoring Plan

Put more attention to parameters producing negative impact and identify the mitigating measures to be incorporated in the planning and implementing stages of the project (ESMP) to eliminate, reduce and offset negative impacts and thereby enhance net positive impact i.e. benefit of the project. Plan a monitoring program to ensure the implementation of mitigating measures. The management and monitoring plans have been discussed in a chapter of ESIA report in detail.

Requirement and details of the controls measures have been suggested in the ESMP for implementation by Client during construction and operation phases of the Project. The ESMP comprises of the following aspects based on the impacts assessed for the Project:

- Introduction to the purpose of the ESMP;
- Institutional mechanism - roles and responsibilities for ESMP implementation;
- Summary of significant adverse impacts and potential hazards;
- Mitigation measures and control technologies, safeguards etc. to minimize adverse impacts on air, water, soil and biological environment, measures to minimize associated hazards and control 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.

1.5 Limitation

The ESIA report is prepared based on the technical document provided in the feasibility study report, field survey, consultation with stakeholders and local people. The Consultant assumes that the information provided is factual, accurate and accepts no responsibility for any deficiency, misstatement or inaccuracies contained in this report as a result of omission or misrepresentation of any person interviewed or contacted. However, the consultant notifies the contradictions and errors in the data, where it seems appropriate.

If the design of the Project changes from that assessed due to design development, the 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.

1.6 Content of the ESIA report

The content of the ESIA study has been structured based on DOE and World Bank Requirement. The structure of the ESIA report is as follows:

Chapter 1 describes the introduction containing background, purposed and scope, approach and methodology, limitations, and list of the members of ESIA study team.

Chapter 2 is on policy, legal and administrative framework describing the relevant policy and legal frameworks of national and international standard for the ESIA process.

Chapter 3 covers detailed project description of the proposed power plant comprising of project activities, project plan, design, specification, project schedule, resources and utilities demand.

Chapter 4 describes the environmental baseline condition with detail on the physical environment, biological environment, and environmental quality.

Chapter 5 Anticipated environmental impact and mitigation measures present all the predicted impacts of the project during pre-construction, construction and

post-construction phases and evaluates all the predicted impacts as well as suggest mitigation measures.

Chapter 6 describes the Analysis of Alternatives of the project.

Chapter 7 Information Disclosure, Consultation, and Participation, comprises public consultations and disclosures conducted at different sites of the study area.

Chapter 8 Grievance Redress Mechanism

Chapter 9 presents the Environmental and Social Management Plan (ESMP) with mitigation measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.

Chapter 10 is the concluding chapter of the ESIA report with conclusion and recommendations

CHAPTER 2: POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Introduction

This section focus on the environmental and social regulations applicable to the proposed solar and wind hybrid power plant project. The section mostly focuses on the institutional framework, applicable environment, health & safety and social legislation requirements, World Bank Operational Policies and IFC Performance Standards relevant to the proposed project.

2.2 Renewable Energy Policy of Bangladesh

The renewable energy policy of Bangladesh has been approved on December 18, 2008 with the target of developing renewable energy resources. This Policy laid out the target of meeting 5% of total power demand from renewable energy sources by 2015 and 10% by 2020. The policy provides an overall guidance of

- Institutional arrangements
- Resource, technology, and program development
- Investment and fiscal incentives
- Regulatory policy

The policy promotes the appropriate, efficient and environmentally friendly use of renewable energy. It also suggests that for large biomass electricity projects (i.e., greater than 1 MW) the project developer must demonstrate that the biomass is being sustainably harvested and that no adverse social impact will result from that development. It also restricted the larger scale production and use of biofuels which may jeopardize the existing crops.

2.3 Environment Related Policies in Bangladesh

The GOB has developed a policy framework that requires environmental issues to be incorporated into economic development planning. The Key tenets of the various applicable policies are detailed in the following subsections.

2.3.1 National Environmental Policy, 1992

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

- Maintaining ecological balance and ensuring sustainable development of the country through protection, 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 requires specific actions with respect to the industrial sector which are as follows:

- To phase-in corrective measures in polluting industries;
- To conduct EIAs for all new public and private industrial developments;
- To ban, or find environmentally sound alternatives for, the production of goods that cause environmental pollution; and
- To minimize waste and ensure sustainable use of resources by industry.

The policy also states that EIA's should be conducted before projects are undertaken and the DOE is directed to review and approve all Environmental Impact Assessments.

2.3.2 National Environmental Management Action Plan, 1995

The National Environmental Management Action Plan (NEMAP) is a wide-ranging and multi-faceted plan, which builds on and extends the statements, set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements related to the environment during the period 1995 to 2005; it also sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented. NEMAP was developed to achieve 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 attain the above-mentioned objectives, the plan groups all the relevant necessary actions under four headings, namely: *institutional, sectoral, location- specific* and *long-term issues.*

The *institutional* aspects reflect the need of intersectoral cooperation to tackle environmental problems which need new and appropriate institutional mechanisms at national and local levels. The *sectoral* action reflects the way the Ministries and agencies are organized and makes it easier to identify the agency to carry out the recommended actions. The *location-specific* action focuses particularly on acute environmental problems at local levels that need to be addressed on a priority basis. The *long-term* actions include environmental degradation to such degree that might become even more serious and threatening if cognizance is not taken immediately.

2.3.3 National Conservation Strategy, 1992

The National Conservation Strategy, 1992 provides recommendations for the sustainable

development of the industrial sector. The key aspects of the strategy are as follows:

- All industries shall be subject to an EIA and the adoption of pollution prevention/ control technologies shall be enforced;
- Hazardous or toxic materials/wastes shall not be imported as raw materials for industry;
- Import of appropriate and environmentally-sound technology shall be ensured; and
- Dependence on imported technology and machinery should gradually be reduced in favor of sustainable local skills and resources.

2.3.4 Other Policies relevant to the Project

Additional Bangladesh policies, their key features, and applicability to the subject Project are detailed in **Table 2-1**.

Table 2-1: Policies relevant to Environment

Policy	Key Features	Applicability
The National Water Policy, 1999	• Protection, restoration, and enhancement of water resources • Protection of water quality, including strengthening regulations concerning agrochemicals and industrial effluent • Sanitation and potable water • Fish and fisheries • Participation of local communities in all water sector development	Applicable for the preservation of water quality.
National Landuse Policy, 2001	• Deals with several lands uses including agriculture (crop production, fishery, and livestock), housing, forestry, industrialization, railways and roads, tea and rubber • Identifies land use constraints in all these sectors	Applicable, as land use change from seasonal cultivable land to power plant
Draft Wetland Policy, 1998	• Establishment of principles for the sustainable use of wetland resources • Maintenance of the existing level of biological diversity • Maintenance of the functions and values of wetlands • Promotion and recognition of the value of wetland functions in resource management and economic development	Not directly applicable, however, may be applicable once the draft policy is finalized
National Fisheries Policy, 1998	• Preservation, management, and exploitation of fisheries resources in inland open water • Fish cultivation and management in inland closed water. • Prawn and fish cultivation in coastal areas • Preservation, management, and exploitation of sea fishery resources	Not directly applicable

Policy	Key Features	Applicability
The Energy Policy, 1996	• Provides for utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy source and environmentally sound sustainable energy development programmes • Highlights the importance of EIA's for any new energy development project	Applicable as subject Project is a Power Plant
The Power Policy, 1995	• Is an integral part of the Energy Policy and deals with policy statement on demand forecast, long-term planning and project implementation, investment terms, fuels and technologies, load management, institutional issues, private sector participation, technology transfer and research programme, environmental policy, and legal issues	Applicable as subject Project is a Power Plant
Industrial Policy, 1999	• Deals with industrial development, direct foreign investments, investment by public and private sector, introduction of new appropriate technology, women's participation, infrastructure development and environmentally sound industrial development	Applicable to the Project is a public industrial development

2.4 Environment and Social Related Legislation in Bangladesh

The main Acts and Regulations guiding environmental protection and conservation in Bangladesh are outlined in the following subsections.

2.4.1 Bangladesh Environmental Conservation Act, 1995 (subsequent amendments in 2000 and 2002)

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

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

included many important environmental concerns such as conservation wetlands, hill cutting, ship breaking, and hazardous waste disposal.

- Affected persons were given provision for putting objections or taking legal actions against the polluters or any entity creating a nuisance for the affected person.

2.4.2 Environment Conservation Rules (ECR), 1997 (subsequent amendments in 2002, 2003 and 2010)

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

- The National Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities on the basis of actual (for existing industries/development projects/activities) and anticipated (for proposed industries/development projects/activities) pollution load;
- Procedure for obtaining environmental clearance;
- Requirements for undertaking IEE and EIA's as well as formulating EMP's 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.

Depending on the location, size and severity of pollution loads, projects/activities have been classified in ECR, 1997 into four categories:

Green, Orange A, Orange B and *Red* respectively as nil, minor, medium and severe impacts on important environmental components (IECs).

2.4.3 Acquisition and Requisition of Immovable Property Ordinance, 1982

The basic principles behind compensation of property in Bangladesh are founded in Articles 42 and 47 of the Constitution (1972). The current legislation for governing land acquisition in Bangladesh is the "Acquisition and Requisition of Immovable Property Ordinance (ARIPO), 1982 and amended in 1983, 1993 and 1994. Key features of the ordinance are as follows:

- This Ordinance provides the Deputy Commissioner (DC) with the power to initiate the acquisition of any property in any locality within his district that is likely to be needed for a public purpose or in the public interest.
- It also defines the process to claim compensation.
- It describes the entire procedure of notice and intimations prior to the acquisition of any property and process and timeframes for raising objections.
- It defines the role and authority of Divisional Commissioner in decision making, compensation issues and in case of dispute. Among the matters to be considered in determining compensation are the following:
    - ✓ The damage that may be sustained by the person interested, by reason of the taking of standing crops or trees which may be on the property at the time of taking possession thereof by the Deputy Commissioner,

- ✓ The damage that may be sustained by reason of the acquisition injuriously affecting his other properties, movable or immovable, in any other matter, or his earnings; and
- ✓ If in consequence of the acquisition of the property, the person interested is likely to be compelled to change his residence or place of business, the reasonable expenses, if any, incidental to such change; In terms of compensation, the Ordinance explicitly states that the DC, when determining compensation, shall neither consider any disinclination of the person to part with the property, nor any increase in the value of the property to be acquired likely to accrue from the use of it after it has been acquired.

- The Ordinance also covers the case of temporary acquisition of property for a public purpose or in the public interest

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.

The Acquisition and Requisition of Immovable Property Ordinance (ARIPO), 1982 is applicable for the project since the first notification was served before published of the latest law.

2.4.4 Framework for Leasing of Government (Khas) Agricultural Land

The rules for managing and leasing Government-owned (khas) land are framed in two notifications in the Bangladesh Gazette: (1) Notification: Bhumo/Sha-8/Kha-jo-bo/46/84/261, Bangladesh Gazette Extra Edition, 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. A landless family is defined as one that works in agriculture and may own a homestead, but has no arable land of its own. Given this basic definition, five groups of landless families are given priority in the allotment of leases:

- families of freedom fighters;
- families who have lost all their land due to erosion;
- widows with an adult son capable of working the land;
- farmers with homesteads but no land;' and
- farmers who have lost all their land due to land acquisition under the eminent domain laws.

The regulation further defines the structure and responsibilities for the management and leasing of Khas Lands at the National, District, and Thana levels.

2.4.5 Other Relevant National Legal Instruments for the Project

Table 2-2 presents an outline of other National legal instruments that will have relevance to the proposed Project with respect to the social and environmental considerations.

Table 2-2: National Legal Instruments relevant to the Project

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
The Environment Conservation Act, 1995 and subsequent amendments in 2000 2002 and 2010	Department of Environment Ministry of Environment and Forests,	• Define Applicability of environmental clearance • Regulation of development activities from environmental perspective • Framing applicable limits for emissions and effluents • Framing of standards for air, water, and noise quality • Formulation of guidelines relating to control and mitigation of environmental pollution, conservation, and improvement of environment • Declaration of Ecologically critical areas	Applicable as the proposed project activity associated with environmental issues
Environmental conservation Rules, 1997 and subsequent amendments in 2002, 2003 and 2010	Department of Environment Ministry of Environment and Forests	• Declaration of Ecologically critical areas • Requirement of environmental clearance certificate for various categories of projects • Requirement of IEE/EIA as per category • Renewal of the environmental clearance certificate within 30 days after the expiry • Provides standards for quality of air, water and sound and acceptable limits for emissions/discharges from vehicles and other sources	Applicable Projects falls under Red Category and require EIA approval prior to start construction and environmental Clearance Certificate prior to start of operation
Environment Court Act, 2000 and subsequent amendments in 2002	Ministry of Environment and Forests and judiciary	• GoB has given highest priority to environment pollution • Passed 'Environment Court Act, 2000 for completing environment-related legal proceedings effectively • Provides the Jurisdictions of environment court, the penalty for violating court's order, trial procedure in special magistrate's court, the power of entry and search, the procedure for investigation, procedure and power of environment court, the authority of environment court to inspect, appeal procedure and formation of environment appeal court.	Applicable for completing environmental legal requirements effectively

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
The Vehicle Act, 1927; The Motor Vehicles Ordinance, 1983; and The Bengal Motor Vehicle Rules, 1940	Bangladesh Road Transport Authority	• Exhaust emissions • Vehicular air and noise pollution • Road/traffic safety • Vehicle Licensing and Registration • Fitness of Motor Vehicles • Parking by-laws.	Applicable for proposed Project in relation to road transport
Water Supply and Sanitation Act, 1996	Ministry of Local Government, Rural Development, and cooperatives	• Management and control of water supply and sanitation in urban areas.	Not directly applicable, however, indirectly applicable when considering water usage management and sanitation facilities for the project
The Ground Water Management ordinance, 1985	Upazilla Parishad	• Management of groundwater resources • Installation of tube- wells at any place after licensing from Upazilla Parishad only	Proposed Project will use surface water as well as groundwater. Therefore, the license is required prior to installation of any tube-wells.
National Biodiversity Strategy and Action Plan (2004)	Ministry of Environment and Forest Bangladesh Wild Life Advisory Board	• Conserve, and restore the biodiversity of the country for well-being of the present and future generations • Maintain and improve environmental stability for ecosystems • Ensure preservation of the unique biological heritage of the nation for the benefit of the present and future generations • Guarantee the safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country • Stop introduction of invasive alien species, genetically modified organisms and living modified organisms	Applicable for conservation of bio-diversity in the study area including water body

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
National Water Bodies Protection Act, 2000	Town development authority/Municipalities	• The characterization of water bodies as rivers, canals, tanks or floodplains identified in the master plans formulated under the laws establishing municipalities in division and district towns shall not be changed without approval of concerned ministry	Applicable due to the proximity to and use of surface water bodies
The Protection and Conservation of Fish Act 1950 subsequent amendments in 1982	Ministry of Fisheries and Livestock	• Protection and conservation of fish in Government-owned water bodies	Applicable for the conservation of fish as the project construction activity may impact on natural water body
The Embankment and Drainage Act 1952	Ministry of Water Resources	• An Act to consolidate the laws relating to embankment and drainage and to make better provision for the construction, maintenance, management, removal and control of embankments and watercourses for the better drainage of lands and for their protection from floods, erosion and other damage by water	Applicable due to the site location and dike will be constructed to avoid flooding
The Acquisition and Requisition of Immovable Property ordinance 1982 and subsequent amendments in 1994, 1995 and 2004	Ministry of Land	• Current GOB Act and Guidelines, relating to acquisition and requisition of land	Applicable as the land acquisition has been carried out
The Building construction Act 1952 and subsequent amendments	Ministry of Works	• This act provides for prevention of haphazard construction of building and excavation of tanks which are likely to interfere with the planning of certain areas in Bangladesh	Applicable due to structure will be constructed in the project area
The Factories Act, 1965 Bangladesh Labour Law, 2006	Ministry of Labour	• This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions	Applicable as workers will involve during the construction and operation of the project

Act/ Rule/ Law/ Ordinance	Enforcement Agency - Ministry/ Authority	Key Features	Applicability to the Project
Noise Pollution (Control) Rules 2006	Ministry of Environment and Forests	• Prevention of Noise pollution • Standards for noise levels	Applicable Noise will be generated due to the construction activity
Bangladesh Labour Law, 2006, Bangladesh Labour Act, 2013 and Bangladesh Labour Rules, 2015	Ministry of Labour and Employment	• Provides health, safety, and well-being of workforce during project life cycle. In addition, it also stipulated that children under 18 years are not allowed to be employed during project life cycle and therefore, this law requires to be complied with	Applicable as skill, semi-skilled and day labor will be worked in the project
Disaster Management Act, 2012	Ministry of Food and Disaster Management	• To make the activities about disaster management coordinated, object-oriented and strengthened and to formulate rules to build up infrastructure of effective disaster management to fight all types of disaster	Applicable, as the project is located in a cyclone prone area
The Electricity Act, 1910 and Amendment and The Electricity Rules, 1937	Office of the Chief Electrical Inspector, Power Division	• Law relating to the supply and use of electrical energy	Applicable as the project is related to power generation

Source: Website of DoE, Legislative and Parliamentary Affairs Division: Bangladesh Laws and Bangladesh Board of Investment: Business Laws

2.5 Administrative Setup related to Environment in Bangladesh

The Ministry of Environment & Forest (MoEF) is responsible for overseeing all environmental matters relating to national environmental policy and regulatory issues in the country. The MoEF 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); and
- Bangladesh National Herbarium (BNH).

Other Related Organizations

There are several other organizations under the administrative framework which would govern social and environmental functions related to the proposed Project, namely:

- Ministry of Land: Land reform and land acquisition directorate;
- Ministry of water resources: Bangladesh Water Development Board; and
- Local Government Engineering Department (LGED).

2.5.1 Department of Environment (DOE)

The DOE has been placed under the MoEF as its technical wing and is statutorily responsible for the implementation of the Environment Conservation Act, 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 Ecologically Critical Areas (ECAs), where the ecosystem has been degraded to a critical state; and
- Review and evaluation of Initial Environmental Examinations (IEEs) and EIAs prepared for projects in Bangladesh.

Environmental Clearance Process

As mentioned in the *Section 3.3.2,* ECR has classified projects to be assessed by the DOE in four categories based on the severity of impacts on IECs:

- Green: Nil;
- Orange A: minor;
- Orange B: medium; and

- Red: severe.

The applicability of environmental clearance and the process in Bangladesh is described in **Figure 2-1.**

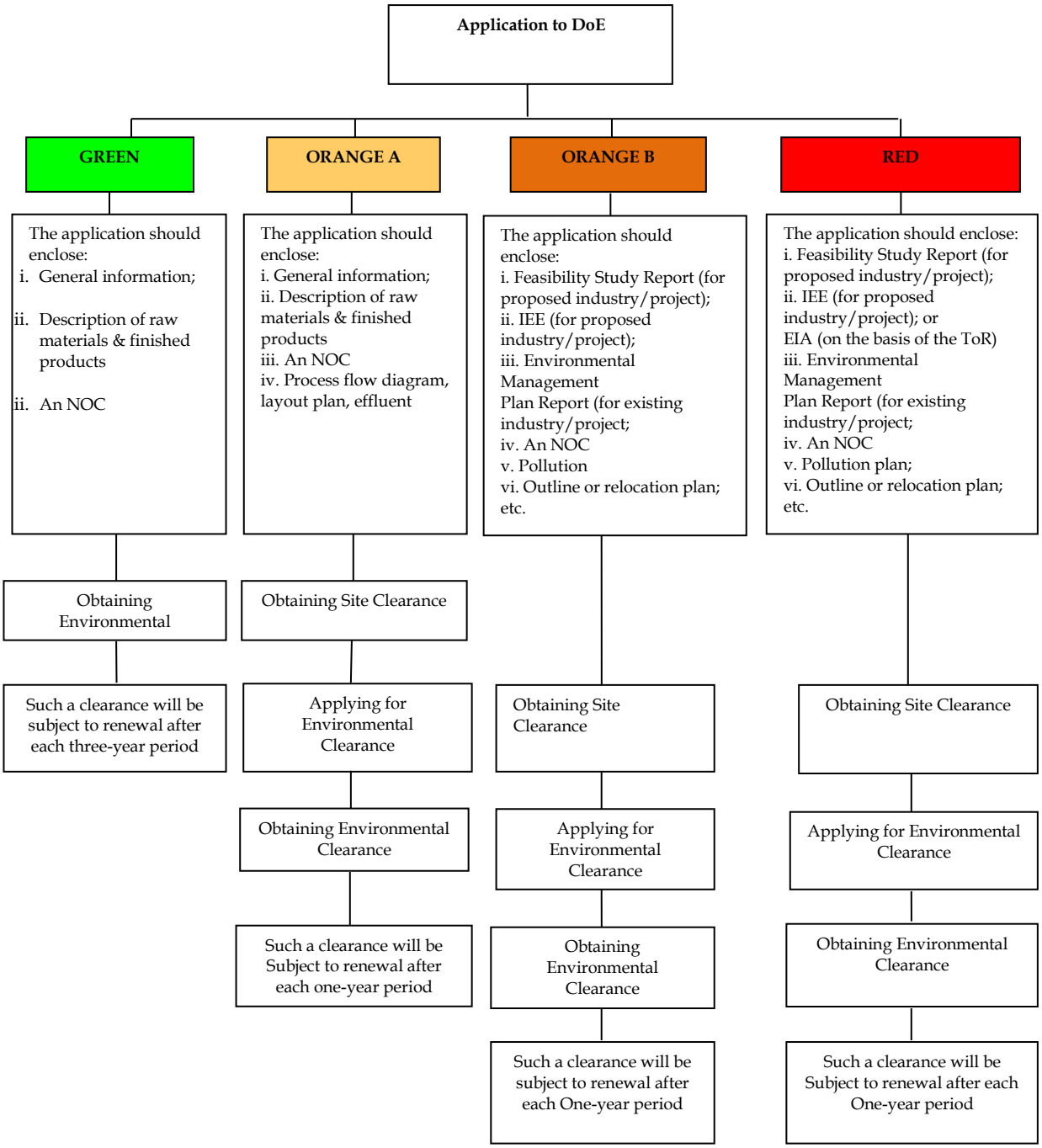
The EIA process consists of three stages, screening, IEE, and detailed EIA:

- Projects categorized as *Green* and *Orange-A* does not require IEE or EIA for environmental clearance, however, the proponent must 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 plants and the Sub Project fall under the Red category as referred below:

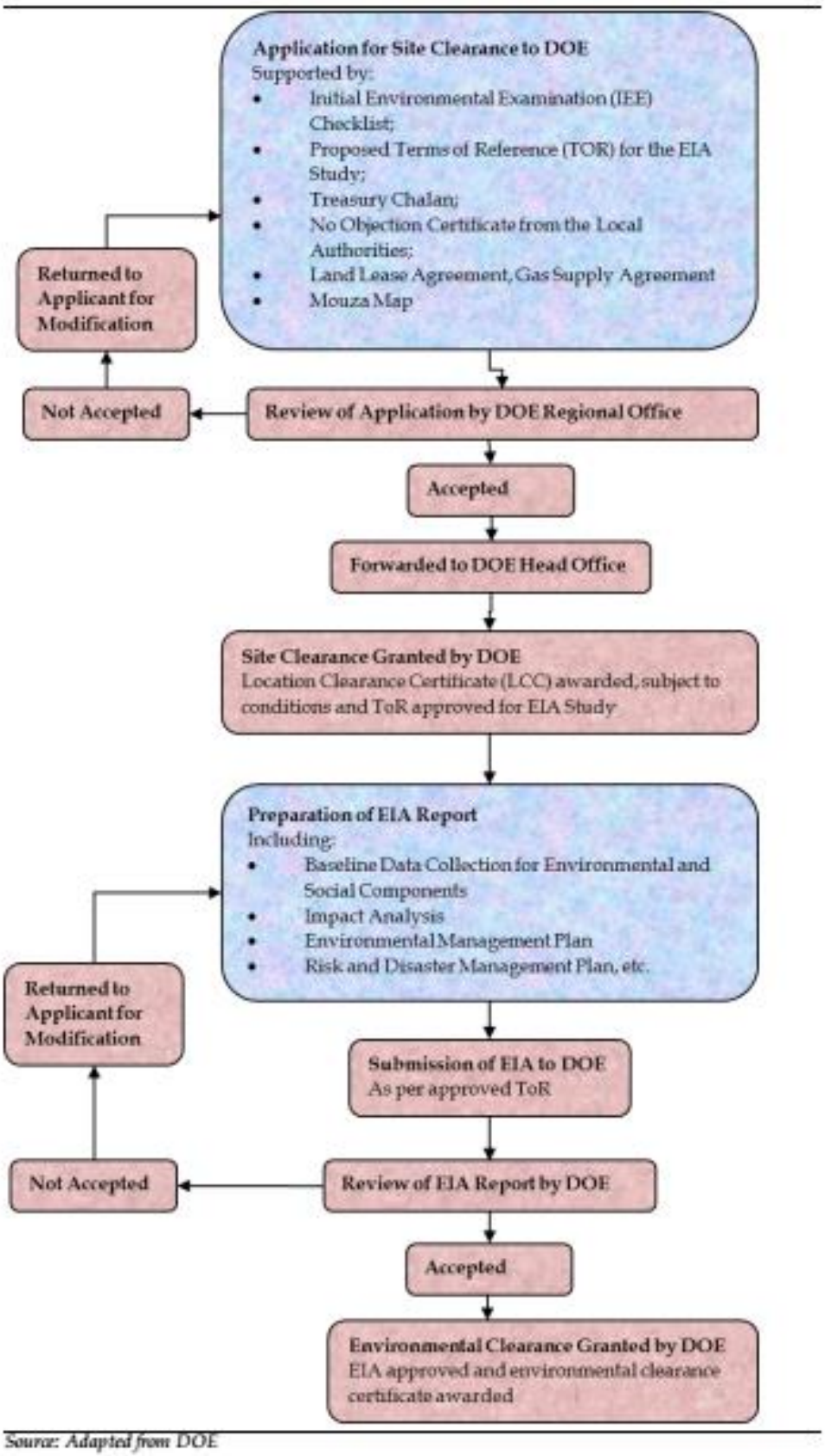
- Item 6: *power plants;*
- Item 64: Water, power, and gas distribution line laying/relaying/extension
- Item 66: Construction/reconstruction/expansion of flood control embankment, polder, dike etc

The process for obtaining an Environmental Clearance Certificate (ECC) for the proposed Project is outlined in **Figure 2-1**.



(Source: EIA Process, ESIA Guideline for Industries, Department of Environment, 1997)

Figure 2-1: DoE Environmental Clearance Applicability and Procedure



Source: Adapted from DOE

Figure 2-2: Flow Chart of EIA Process Applicable to the Project

2.6 Relevant International Treaties and Conventions

Bangladesh is party to a number (30)[2] of international environmental conventions, treaties, and agreements. The international treaties and conventions relevant to the Project and their status are detailed in **Table 2-3**.

Table 2-3: Project Relevant International Treaties and Conventions

Environment-related International convention and Treaties	Status	Applicability to Project
Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985)	02.08.90 (accessed) (entry into force)	Applicable
Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal 1987)	02.08.90(accessed) 31.10.90 (entry into force)	Applicable
London Amendment to the Montreal Protocol on substances that Deplete the Ozone Layer (London, 1990)	18.03.94 (accessed) 16.06.94 (entry into force)	Applicable
Copenhagen Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, Copenhagen, 1992	27.11.2000 (accepted) 26.2.2001 (entry into force)	Applicable
Montreal Amendment of the Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1997	27.7.2001 (Accepted) 26.10.2001 (Entry into force)	Applicable
Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989)	01.04.93 (accessed)	Applicable
United Nations Framework Convention on Climate Change, (New York, 1992)	09.06.92 (signed) 15.04.94 (ratified)	Applicable
Convention on Biological Diversity, (Rio De Janeiro, 1992)	05.06.92 (signed) 03.05.94 (ratified)	Applicable
Convention on Persistent Organic Pollutants, Stockholm	23.5.2001 (signed) 12.03.2007 (ratified)	Applicable and use of any persistent pollutants to be prohibited
Kyoto protocol to the United Nations Framework Convention on Climate Change	21.8.2001 (accessed)	Applicable

Source: DoE, Bangladesh

[2] Department of Environment (DoE)

2.7 World Bank Operational Policies

The World Bank follows an operational policy statement (updated in February 2011), which stipulates that all operations are carried out in an environmentally responsible manner and that projects must comply with all local environment legal obligations and appropriate World Bank guidelines[3]. The World Bank sets out its procedures and policies with regard to conducting environmental assessments on Operational Policy 4.01: Environmental Assessment (October 1991) and its updates and other pertinent Guidelines.

2.7.1 Applicability

Depending on the specific characteristics of the project, World Bank Environmental and Social Safeguard Policies provide ten potential issues that may need to be considered in an ESIA. The expected applicability of the potential safeguard policies for the proposed project has been summarized in the following **Table 2-4**.

Table 2-4: Potential World Bank Environmental Safeguard Policies and its Applicability to the Project

Safeguard Policy	Requirement	Policy Triggered	Applicability/Compliance
Environment Assessment (OP 4.01)	The Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making.	Yes	The proposed project involves setting up first 50 MWac solar power plants on acquired 165.5 acres land out of 999.65 acres land and rest of the land will be utilized for 122 MWac solar along with 10 MWac wind power generation facility including local community livelihood support purposes. All environmental and social aspects included in the proposed project are adequately examined. The project is likely to have some risks and potential adverse environmental impacts during the constructional and operational phases regarding the natural environment, water, human health, and safety.
Performance Standards for Private Sector Activities (OP 4.03)	This policy is aimed at facilitating World Bank financing for private sector led economic development projects by applying environmental and social policy standards that are better suited to the private sector, while enhancing greater policy	Yes	Applicable for this project The project is evaluated based on the performance standard to identify the impacts and affected stakeholders and lay down processes for management and mitigation of adverse impacts

[3] The World Bank Group General Environment, Health and Safety (EHS) Guidelines are expected to apply to the proposed project. The guidelines are available at www.ifc.org/ehsguidelines

	coherence and cooperation across the World Bank Group.		
Natural Habitats (OP 4.04)	The Bank requires borrowers to incorporate into their development and environmental strategies analyses of any major natural habitat issues, including identification of important natural habitat sites, the ecological functions they perform, the degree of threat to the sites, priorities for conservation, and associated recurrent-funding and capacity-building needs.	Yes	The project site is located in the medium high land where a single crop is cultivated during the post-monsoon season. The land has seasonal flood effect during the monsoon period. There are two canals inside the project area. Aquatic habitat present in these canals especially during the monsoon season. The impact due to the project development will be taken place on aquatic habitat in the canal.
Pest Management (OP 4.09)	In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management. As necessary, the Bank and the borrower incorporate in the project components to strengthen such capacity.	No	The proposed project involves generation of power from solar and wind energy which is the cleanest sources of energy. The project activity would not require the use of pesticides in any way.
Involuntary Resettlement (OP 4.12)	World Bank recognizes that Involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out.	Yes	Project will acquire total 999.65 acres land including government khas land, Allocated khas land to people, and private land
Indigenous People (OP 4.10)	The Bank recognizes that the identities and cultures of Indigenous Peoples are inextricably linked to the lands on which they live and the natural resources on which they depend. Hence, A the project proposed for Bank financing must be screened for the presence of indigenous people.	No	This policy does not get triggered as there are no indigenous people inside the project boundary
Forests (OP 4.36)	If a project involves significant conversion or degradation of natural forests or related natural habitats that the Bank determines are not critical, and the Bank	No	The proposed project does not consist of any kind of forest land

	determines that there are no feasible alternatives to the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially Outweigh the environmental costs; the Bank may finance the project provided that it incorporates appropriate mitigation measures.		
Physical Cultural Resources (OP 4.11)	The proponent needs to addresses impacts on physical cultural resources in projects proposed for Bank financing, as an integral part of the environmental assessment (EA) process.	No	No tangible forms of cultural heritage having archaeological, paleontological, historical, cultural, artistic and religious significance were observed or by the communities residing in the vicinity of the project area.
Safety of Dams (OP 4.37)	When the Bank finances a a project that includes the construction of a new dam, it requires that the dam be designed and its construction supervised by experienced and competent professionals.	Yes	The proposed project has a provision for constructing a dike to avoid flood in the project site
Project in Disputed Areas (OP 7.60)	Projects in Disputed Areas may affect the relations between the Bank and its borrowers, and between the claimants to the disputed area. Therefore, the Bank will only finance projects in disputed areas when either there is no objection from the other claimant to the disputed area, or when the special circumstances of the case support Bank financing, notwithstanding the objection.	No	The proposed project is not stipulated in a disputed area
Project on International Waterways (OP 7.50)	The Bank recognizes that the cooperation and goodwill of riparian's is essential for the efficient use and protection of the waterway. Therefore, it attaches great importance to riparian's making appropriate agreements or arrangements for these purposes for the entire waterway or any part thereof.	No	Not applicable

2.7.2 World Bank Categorization of Projects

The Bank screens the Private Sector Activity in order to determine the nature and extent of the environmental and social assessment needed, based on the type, location, sensitivity, and scale of the activity, as well as the nature and magnitude of its potential impacts. This screening also identifies any additional information required to complete the Bank's environmental and social review and determine whether to support the activity. The Project Activity is categorized by the Bank as Category A, B, C, depending on the nature of the activity and financing mechanism, as follows:

Table 2-5: World Bank's Categorization for Projects

Category	Justification
Category A	Projects are those whose impacts are sensitive, diverse, unprecedented, felt beyond the immediate project environment and are potentially irreversible over the long term.
Category B	Projects involve site specific and immediate project environment interactions, do not significantly affect human populations, do not significantly alter natural systems and resources, do not consume much natural resources and have adverse impacts that are not sensitive, diverse, unprecedented and reversible.
Category C	Projects are mostly benign and are likely to have minimal or no adverse environmental impacts.
Category FI	A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.

Source: World Bank Environmental and Social Safeguard Policy

2.8 Performance Standards for Private Sector Activities (OP 4.03)

The eight IFC Performance Standards have been adopted by the Bank as the World Bank Performance Standards for Projects Supported by the Private Sector ("**WB Performance Standards**") for application to Bank support for projects (or components thereof) that are designed, owned, constructed and/or operated by a Private Entity, in lieu of the World Bank's safeguard policies ("WB Safeguard Policies"). A list of the Performance standards is provided in ***Table 2-6*** and detail of all performance standards along with applicability with the project has been shown **Annex C**.

Table 2-6: IFC Performance Standards

Performance Standards	Specific Areas
Performance Standard 1	Assessment and Management of Environmental and Social Risks and Impacts
Performance Standard 2	Labor and Working Conditions
Performance Standard 3	Resource Efficiency and Pollution Prevention
Performance Standard 4	Community Health, Safety and Security

Performance Standard 5	Land Acquisition and Involuntary Resettlement
Performance Standard 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources
Performance Standard 7	Indigenous Peoples
Performance Standard 8	Cultural Heritage

Source: OP 4.03- Performance Standards for Private Sector Activities, July 2012

This OP sets forth the circumstances under which the WB Performance Standards may be applied, the roles and responsibilities of the Private Entity implementing the project, and of the Bank in supporting environmental and social sustainability aspects of the project.

2.9 Applicable Environmental Standard

The applicable environmental standards for the proposed project have been presented in Annex D. The ambient air quality standards will be applicable only during the construction phase of the project and the wastewater discharges from the project during both construction and operation phases shall be applicable as per the general discharge standards of Bangladesh as sector specific standards are not available for solar power project.

CHAPTER 3: DESCRIPTION OF THE PROPOSED PROJECT

3. DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Description

The proposed project involves setting up of 50 MWac solar power plant in Phase I and 122 MWac solar along with 10 MWac wind power generation facility in Phase II at Purbo Barodhuli mauza in Char Chandia union of Sonagazi Upazila under Feni District. Power generated from the proposed 50 MWac power plant of phase I will be evacuated in the national grid through a 33kv transmission line to the Barayarhat substation whereas another 132 MWac power which will be generated from both solar (122 MWac) and Wind (10 MWac) considered as phase II and evacuated using the 230/33kv transmission line to the Mirsari grid substation. The following Table presents the key project information.

Table 3-1: Key Project Information

Project at a glance – Solar PV	
The project	172 MWac grid-connected solar PV power project
Development	In two phases
Owner	EGCBL for Phase-1 and IPP/PPP in Phase-2
Location of plant	Sonagazi upazilla, Dist: Feni, Chittagong Divison, Bangladesh
Geo-coordinates of the site	22^0 47′ 13.19″ N Latitude and 91^0 21′ 59.46″ E Longitude
RE technology	Solar PV Plant
Solar technology	Earth mounted fixed structures for 172 MWac solar PV system
Intended application	Development of clean energy solutions for sustainability of the country in terms of environmental (reduction in GHG emissions), social (environmental and livelihood) and economic (reduction in fossil fuel import) benefits.
Expected project completion period	April, 2019
Project at a glance – wind	
The project	10 MWac grid-connected wind power project
Development	In Phase-2
Owner	EGCBL Or IPP/PPP
Location of plant	Sonagazi upazilla, Dist: Feni, Chittagong Divison, Bangladesh

Geo-coordinates of the site	22^0 47′ 13.19″ N Latitude and 91^0 21′ 59.46″ E Longitude
Rating of individual turbines	2 MW wind turbine generators of Class V as per IEC codes
Intended application	Development of clean energy solutions for sustainability of the country in terms of environmental (reduction in GHG emissions), social (environmental and livelihood) and economic (reduction in fossil fuel import) benefits.
Expected project completion period	April, 2020

Source: Feasibility Study Report, 2017

3.2 Project Location

The project site is located at Purbo Barodhuli mauza in Char Chandia union of Sonagazi Upazila under Feni District. The proposed power plant will be constructed on approximately 999.65 acres land. The proposed project is situated about 6.5 km south-west as well as ends of the Sonagazi Upazila and 175 km south-east zero point of Dhaka city. The site is located north-west side of the confluence of Feni and Choto Feni River. The site is situated beside the left bank of the Choto Feni River, Sandwip channel on the south, agricultural land and village on the north, Feni River on the east and existing road on the west. The site soil is primarily alluvial/loamy soil deposited by the river. It is mostly land deposited in the area by the rivers over a long period of time and changing course of the rivers has currently left this area available for cultivation and fishery. The project location is shown in the following **Figure 3-1**. The approximate project site coordinates are as follows:

NW- 22°47'40.00"N 91°21'52.32"E NE- 22°47'32.58"N 91°24'8.95"E

SE- 22°46'58.19"N 91°23'47.78"E SW- 22°46'50.78"N91°21'55.30"E

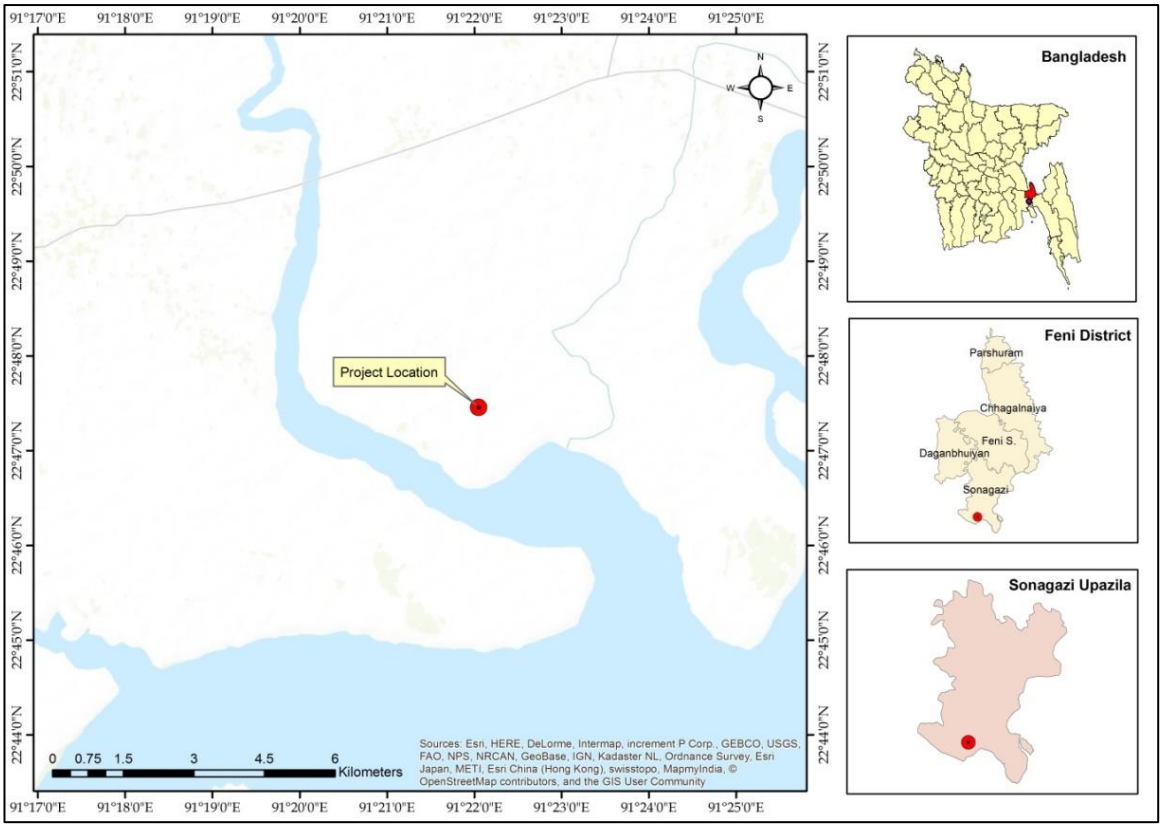


Figure 3-1: Location of the Proposed Solar and Wind Power Plant

3.3 Project Component

The feasibility study team analyzed four alternative options to finalize the project setting. This feasibility study has assessed all possible options of the capacity mix at the site to utilize the land in a sustainable manner to fulfill GOB' purpose of the environment, economy and social sustainability, following are the identified and assess options:

1. Option 1 (reference case): it has 100 MWac (136.06 MWdc) solar PV with 24 MWac wind.
2. Option 2: it has a base case (100 MWac solar PV with 24 MWac wind) plus additional 54MWac solar PV in between shadow-free area of WTGs.
3. Option 3: it has only solar PV of 262 MWac (356.53 MWdc) at the entire site and no wind power system.
4. Option 4 (base case): it has 172 MWac (234.050 MWdc) solar PV and 10 MWac wind power project with 262 acres (26% of entire land) for livelihood purpose like fishery and agriculture around WTGs area.
5. 166 MWac (225.85 MWdc) Solar PV with Semi-Intensive fishery activity beneath the Solar panels and 10 MWac Wind.
6. Only 182 MWac (247 MWdc) Solar PV with semi-intensive fishery activity beneath the solar panels with no Wind.

Based on the GOB's requirements and sustainable use of land the Option 4 has been recommended in the feasibility study. The proposed project will be installed in two phases.

Following **Table 3-2** shows the results of selected option (Solar PV wind hybrid project) for the proposed power plant.

Table 3-2: The Results of the Selected Option (Solar PV and Wind Hybrid) at the Proposed Site

Parameter	Unit	Phase-1	Phase-2	
		Solar PV	Solar PV	Wind
Technology		Fixed-tilt solar PV system based on central inverter and polycrystalline module technology	Fixed-tilt solar PV system based on central inverter and polycrystalline module technology	Gamesa G114 2.0MW Model
Capacity	MWdc	68	166	
	MWac	50	122	10
	Total MWac	**50**	**122**	**10**
Net Energy Yield	GWhr/yr	97.78	238.58	12.78
Total Area	Ha	67	164	7DX5D
CAPEX	m USD	72.59	137.07	13.71
OPEX	m USD	0.75	1.66	0.19
LCOE	USD cents / kWh	9.76	9.77	10.65
Weighted Average LCOE for PV		9.77		-
Weighted Average LCOE for PV and wind		9.80		

Source: Feasibility Study Report

3.4 Facilities

The project is planned to install 172 MWac (234.050 MWdc) solar PV and 10 MWac wind power project with 262 acres for livelihood purpose like fishery and agriculture around WTGs area. The major components of the proposed project include the following:

- PV module
- Wind Turbine
- Substation
- Transmission Line
- Access Roads
- Additional Project Infrastructure

The details of the facilities has been described as follows

3.4.1 PV Module

Polycrystalline modules of 315 Wp Canadian Solar CS6X-315P; 432,000 number of modules; 20 modules in series/string; 21,600 strings in parallel has been considered to install in the project area for getting the 172 MWac power generation from the solar PV.

3.4.2 Wind Turbines

The project is proposed to have five Wind Turbine Generators (WTGs) of the Gamesa G114 with a rated capacity of 2 MW each. The WTGs will be installed southern edge of the project boundary in Phase II of the project.

3.4.3 Transmission Line

Phase-1 of 50 MWac solar PV will be evacuated to 33 kV Bairiyarhat grid SS and Phase-2 (balance solar PV and wind) will be evacuated to 230 kV Mirsarai grid SS. Once both Phases will have been developed then entire project capacity will be shifted to 230 kV Mirsarai grid SS.

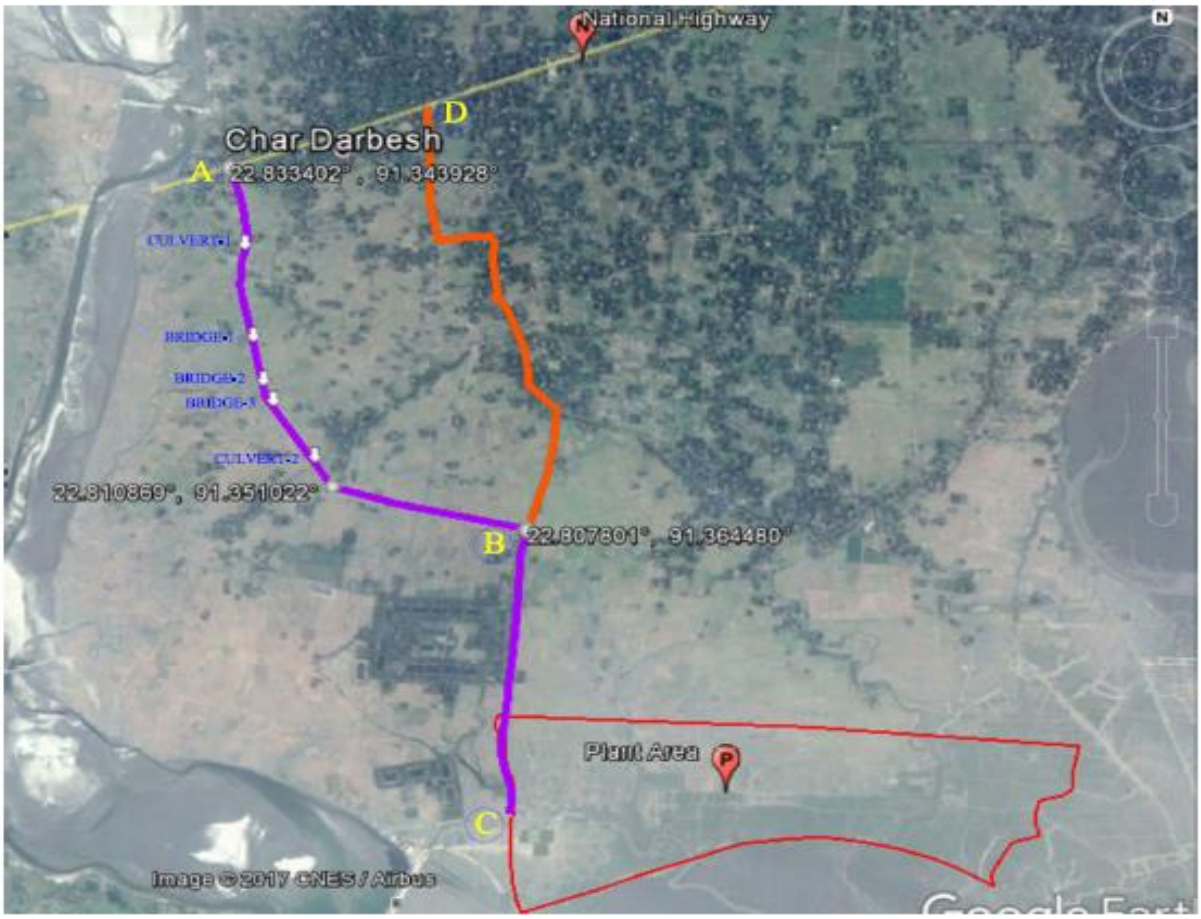
The pooling SS (two sets of 100 MWac capacity) will be developed in Phase-2, because in Phase-1 (50 MWac solar PV) the generated power will directly be injected to the Bairiyarhat grid SS through four pole structure and one 33 kV transmission line.

During first phase 33 kV one circuit txm line of 20 KMs; four pole structure with outdoor type gang operated isolator with earth switch, drop out fuse, LA whereas four 50/60 MVA, 230 kV / 33 kV, ONAN/ONAF Power Transformers; 8 bays; 230 kV two circuit txm line of 20 KMs; two additional bays at 230 kV grid SS; 10 numbers of VCBs will be required during the second phase.

3.4.4 Access Roads

The access road from the Sonagazi-Olamabazar to the proposed project site is not suitable for carrying out the construction materials. There is two alternative roads for accessing the proposed project site which is not suitable and need to be upgraded by the EPC. The following Figure 3-2 shows the proposed approach road plan as per the feasibility study.

PROPOSED APPROACH ROAD PLAN



LEGENDS :

SYMBOL	DESCRIPTION		WIDTH	LENGTH	AREA
	A TO B - PROPOSED ROAD (FROM NH [Z1434] TO POINT 'B' IN EXISTING ROAD)		9.8 MTR	4.2 KM	41160 SQ. MTR
	B TO C - EXISTING ROAD (FROM POINT 'B' TO 'C' ROAD TO BE RECONSTRUCTED. EXISTING ROAD IS 4 M WIDTH, 12M WIDTH TO BE RECONSTRUCTED[PROPOSED])		9.8 MTR	2.3 KM	22540 SQ. MTR
	B TO D - EXISTING ROAD		4 MTR	4 KM	
	NATIONAL HIGHWAY [Z1434]				
BRIDGE-1	COORDINATES	22.820945°, 91.345530°	9.8 MTR	8 MTR	78.4 SQ. MTR
BRIDGE-2		22.817844°, 91.346242°	9.8 MTR	30 MTR	294 SQ. MTR
BRIDGE-3		22.816405°, 91.346924°	9.8 MTR	20 MTR	196 SQ. MTR
CULVERT-1		22.827460°, 91.344967°	9.8 MTR	3 MTR	29.4 SQ. MTR
CULVERT-2		22.812440°, 91.349806°	9.8 MTR	3 MTR	29.4 SQ. MTR

Figure 3-2: Proposed Approach Road Plan

The existing road (from point D to B and B to C) is not that much strengthened to bear the load of project material transportation and does not have that much width, hence enhancing its existing width and capacity will cost almost equal to new road development

and it has some local people living around the road (from point D to B), therefore the development of new road (from point A to B) and strengthening the existing road from point B to C looks more viable.

3.4.5 Boundary Wall and Fencing

To protect from infiltration of animals, the unauthorized person inside site area, the periphery of Solar PV power plant has to be covered by prefabricated/modular concrete wall with elevated barbed wire fencing (concertina). Prefabricated/modular concrete boundary wall will be erected of height 1.8 m with elevated spiral type round barbed wire fencing with 150 mm spacing of 1 m height, the total height of the boundary wall will be 2.8 m above finished ground level. Boundary wall's bottom portion of 450 mm will be covered by random rubble or stone masonry to protect the intrusion of surface water from adjacent land. Galvanised Iron (GI) post or concrete post shall be provided at a spacing, not more than 3 m. Vertical bracings should also be provided at certain distances for the overall stability of the fence. Proper arrangements should be done to block outside water. Grills on inlet and outlet of drainage or waterways should be given as per executing agency.

It is suggested that the CCTV scheme should be implemented at the plant area, which as follows:

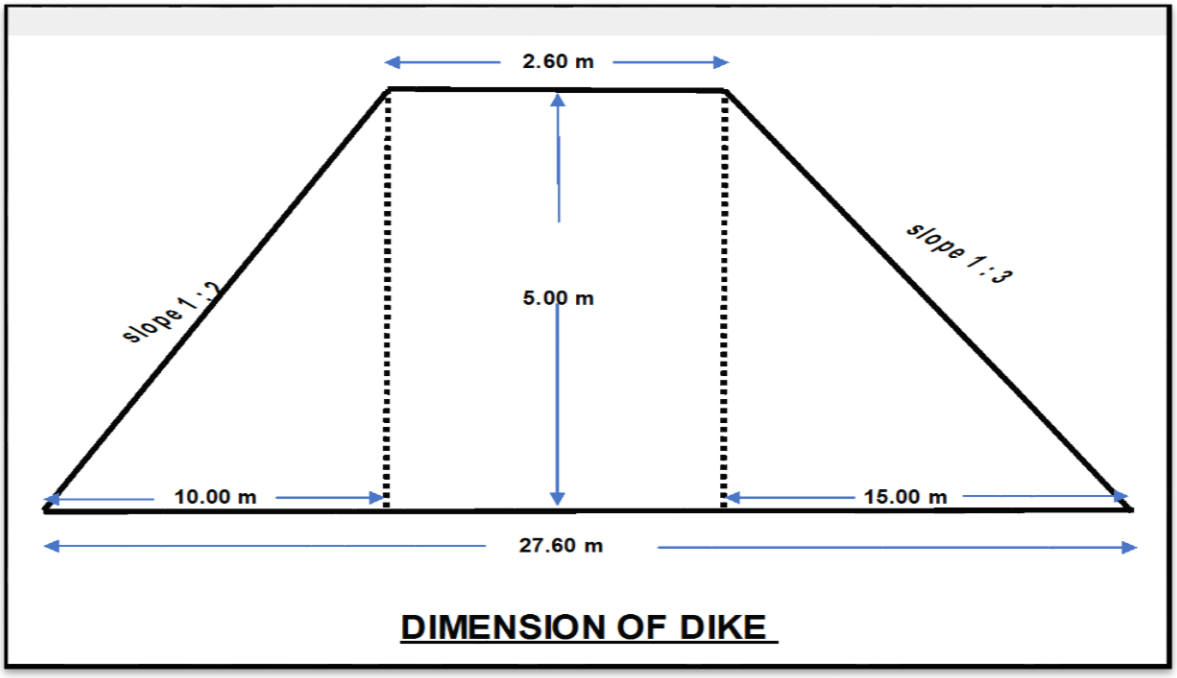
- 24/7 simultaneous coverage of the boundary and entire field (leaving no blind spots at any point of time) will be ensured through the installed CCTV systems.

3.4.6 Dike for Flood Protection

Dike system around the solar PV plant is considered as a preferred option for the project because of following reasons.

- The dike could be constructed along the borders of the site and be connected to the existing dike (elevated street) located at the western boundary of the project site.
- The dike would allow to design, construct and operate the solar PV plant on a dry area during the whole year. However, water entering the dike area during regular rainfall (in particular during monsoon season) and flooding events have to be considered for the design of the solar PV plant.
- The expected cost for the dike is considered as moderate compared to other options. As the first indication, the cost for a dike with a height of 5.0m is estimated to be around 2.2 m USD/km dike.

Prepared Cross section of the proposed dike is provided in Figure 3-3 below.



Source: Feasibility Study Report, 2017

Figure 3-3: Typical Cross Section of the Dike

3.4.7 Additional Project Infrastructure

Associated facilities of the proposed project are as follows:

- Intensive Fishery
- Transformer with WTG
- Inverter
- Foundation of the WTG
- Material storage yard and stores
- Scrapyard
- Central Monitoring Station building and facilities

3.5 Resources and Utility Demand

3.5.1 Land Requirement

The proposed project will be installed in two phases. Total 999.65 acres will be required for the proposed plant. Out of the total area, 165.5 acres land will be required in Phase I for 50 MW solar power plant and rest of the will utilize for Phase II as well as livelihood purposes. The land use breakdown of both phases is shown in the following Table 3-3.

Table 3-3: Land use Breakdown of the Proposed Project Area

Particulates	Phase I	Phase II
Solar including maintenance & equipment area	165.5	460.38
Wind		112.12
Livelihood		262
Total	165.5	834.5

Source: Feasibility Study Report, 2017

3.5.2 Water Requirement

Water will be required for both construction and operation phases. Water will require for foundation structure, office building construction approach road, culvert and bridge construction during the construction period. Water requirement for construction period will be estimated during the detail design stage. At the present stage, it has estimated that 31.5 million litres per annum will be required for cleaning the module. As per the feasibility study, the suitable source of water is underground aquifer as the water level present only 6 m below the surface. On the other hand, surface water also available as the Feni and Choto Feni Rivers are following close to the project area. Following table shows the water requirement calculation.

Parameter	Value	Unit
Capacity (Option 7)	272160000	Watt
Number of Modules	864000	Number
Per module water required	1.5	liters per module
Module cleaning cycle	15	in every 15 days
Total water required per annum	31.5	million liters per year

3.5.3 Raw Materials

During construction stage, cement, aggregates, steel, paints, solvents etc will be required. Besides these, other supplies required for the project are fuels and oils, drilling requirements, spare parts for construction machinery and food and supplies for construction workforce. Most of the raw materials will be sourced locally. A 5 meters height earthen dike will be constructed around the project site. The filling earth material and stone boulders quantities for the dike construction are provided in Table 3-4.

Table 3-4: Earth Material and Stone Boulders Quantities for Dike Construction

Phase	Length (km)	Quantity (m^3)	Total (m^3)
Earth Material Quantity			
Phase-1	5.50	426250.00	467050
	3.40	40800.00	
Phase-2	6.90	534750.00	563814
	2.42	29064.00	
Total	**18.22**	**1030864.00**	**1030864.00**
Stone Boulders Quantity			
Phase-1	5.50	31455.35384	36016.93
	3.40	4561.578674	
Phase-2	6.90	32729.57378	35976.34
	2.42	3246.770703	
Total	**18.22**	**71993.27**	**71993.27**

Feasibility Study Report, 2017

The EPC contractor will be responsible for obtaining the earthen materials to be used in the dike construction. Two options are possible in this respect:

Option 1: obtaining materials from already available legally dredged stock piles

The DC offices routinely tender out contracts for removal of soil and sand from river "islands" or river beds in order to ensure the navigability of the rivers; for those sites an impact assessment and mitigation measures would have been approved by the Department of Environment (DoE); the EPC could source the materials from those sites/sources. In this case, supporting EIA approval documents mentioned above would be provided to the Bank.

Option 2: EPC contractor selects during the implementation of the project to dredge the material from a nearby river

In this case, the contractor would be responsible for conducting an ESIA for the selected site and obtaining necessary related approvals from the DoE as well as respective authorities. To satisfy the Bank requirements in this regard, the EISA terms of reference (TORs) for river dredging has been prepared and is attached herewith (**Annex M**). The EGCB shall insure that the above TORs are included in the EPC contract and the bidding documents. The EIA report and the environmental and social management plan (ESMP) should be cleared with the Bank and approved/disclosed prior to the dredging of material and use for dike construction.

Aggregates will be sourced from Sylhet or imported from the neighboring country. Fuels and oils, spare parts will be required during the operation period. Beside these food supply is also required for the site staff.

3.5.4 Fuel Requirement

Fuel will be required for the machinery running as well as backup diesel generator during the construction period and it will be sourced from the local market. The fuel oil will be stored in the diesel drums in the storage yard.

Insignificant lubricating will be required during the operation period which will store in the designated storage area.

3.5.5 Power Requirement

A diesel generator will be used for the power generation during the construction period to meet the power requirement. The power requirement at the site office and monitoring building during operation phase will meet by the BPDB/PBS/Own generation.

3.5.6 Manpower Requirement

The labor requirement varies during the construction phase from the initial phase to the commissioning phase. Approximately 100 labor will be required during the construction of Phase I and 190 persons for Phase II whereas total 50 persons will be required during the operation and maintenance phase.

3.6 Project Phases and Activities

The proposed solar and wind hybrid project lifecycle can be divided into four phases as follows:

- Planning and Preconstruction Phase

- Construction Phase
- Operation and Maintenance Phase
- Decommissioning Phase

The detail work involves in these phases has been described in the following subsection.

3.6.1 Planning and Preconstruction Phase

The planning and pre-construction phase involves the conceptualization of the project and has following five components:

- Site Selection;
- Land acquisition process;
- Site surveys as topographic, geotechnical investigations, micro-siting studies, power evacuation arrangements;
- Approvals/clearances/ permits;
- Design and finalization of contractors;
- Mobilisation of contractors

3.6.2 Construction Phase

The proposed construction of solar and wind farm development involves the following activities:

- Site preparation activities such as clearance, excavation, filling, leveling etc.;
- Construction of external connecting road and internal access roads;
- Dike construction around the project area;
- Construction of labor camp, site office, equipment and supplies storage areas, fuel storage areas and waste pits;
- Construction of Foundation of the PV module
- Construction of turbine foundations at each WTG location;
- Transportation of equipment including PV module, mounting structure, towers, blades, turbines, supply materials, and fuels;
- Completing internal electrical connections of PV module and at each WTG location;
- Erection of internal electrical lines;
- Establishment of pooling sub-station; and
- Commissioning of the PV module and WTGs

3.6.3 Operation and Maintenance Phase

During the operation of the proposed solar and wind power plant involves the following activities:

- Obtaining the regulatory permit and approval from the Department of Environment prior start the operation
- Regular remote monitoring of PV module and WTG operation
- PV module washing
- Inverter maintenance

- Breakdown maintenance
- Changing the broken or disable PV module;
- Annual shut down for maintenance which will mostly include cleaning and greasing, change of parts etc of the WTG;
- Internal road repair as and when required
- Checking the electric connection

3.6.4 Decommissioning Phase

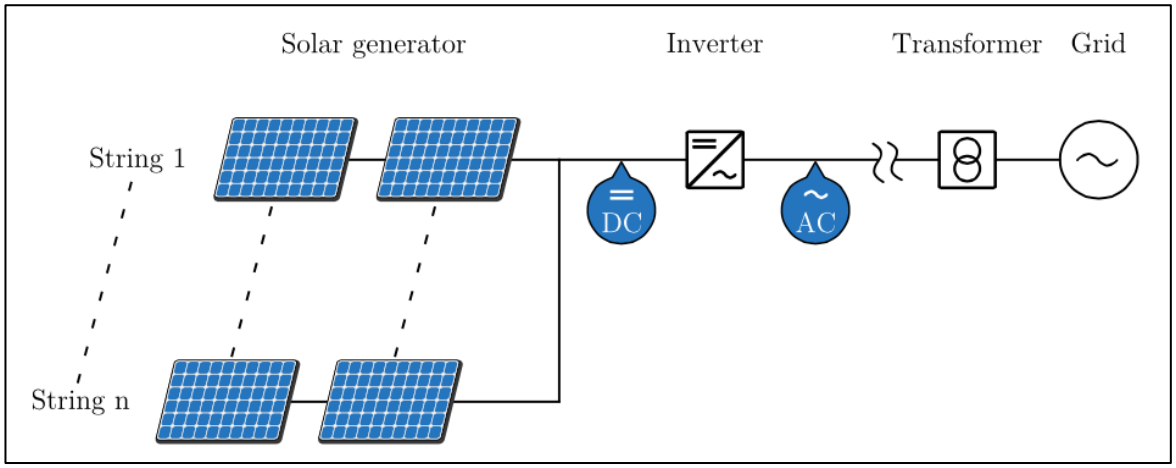
The solar and wind power plant site, after having remained in operation for the lifecycle estimated at 20 years, will not lose its value. However, it is not yet decided if the project would approach for upgradation/expansion, once this project life is completed.

3.7 Technology

Considering the renewable energy development program, EGCB has planned to construct solar power plant along with wind-based power generation which will be a hybrid power generation facility at Sonagzi upazila of Feni district. Solar energy systems produce energy by converting solar irradiation into electricity or heat. The proposed project will be utilized the photovoltaic (PV) technology to generate electricity. The 50MWac solar power plant will be installed in Phase I and during the Phase II, 122 MWac solar power along with 10MWac wind power generation facility will be set up. The basic technological description of solar and wind power plant has been described in the below section.

3.7.1 Basic of Solar PV Technology

Solar photovoltaic plants use the global irradiation (GI), which is converted into electric energy in the solar generator. The solar generator consists of PV modules connected in series to form strings, which are connected in parallel and deliver DC power to the inverters. The inverter converts the DC power to AC power before transforming to the required voltage level allowing evacuation of power to the grid as shown in Figure 3-4 below.

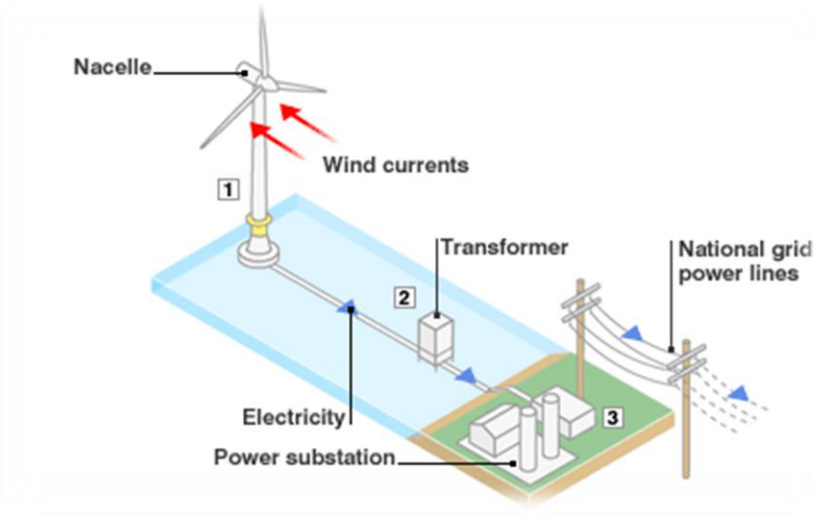


Source: Suntrace GmbH

Figure 3-4: General principle of a solar PV power system

3.7.2 Basic of Wind Technology

Wind power is the conversion of wind energy into electricity or mechanical energy using wind turbines. The power in the wind is extracted by allowing it to blow past moving blades that exert a torque on a rotor. The amount of power transferred is dependent on the rotor size and the wind speed. The typical diagram of wind technology has been shown in the following Figure 3-5.



Source: easy wind energy

Figure 3-5: Basic Working Principle of Wind Technology

3.7.3 Module Technology

Technology evaluation was performed by the feasibility study team. The main PV module technologies considering availability in the market at a commercial level were compared from a techno-economic point of view in order to find the technology that fits best the local ambient conditions found on the site. The polycrystalline module has been selected as the final option. For the feasibility study, polycrystalline modules from Canadian Solar with 315 Watt peak and the model number CS6X-315P have been applied reflecting state of the art module technology. The technical characteristics of the chosen modules are given in Table 3-5 below.

Table 3-5: Characteristics of CS6X-315P PV modules

Description	Value
Technology	Polycrystalline
Power output	315 W
Optimum operating voltage (@ STC conditions)	36.6 V
Current at Pmax (@STC conditions)	8.61 A
Open-Circuit Voltage	45.1 V
Short-Circuit Current	9.18 A
Temperature coefficient of Pmax	-0.41%/°C
Temperature coefficient of Voc	-0.31%/°C
Temperature coefficient of Isc	-0.053%/°C
Maximum System Voltage (DC)	1000 V (IEC) or 1000 V (UL)
Module efficiency; no. of cells	16.42%; 72

Description	Value
Power Tolerance	0 ~ + 5 W
Length	1954 mm
Width	982 mm
High	40 mm
Weight	22 kg

Source: Feasibility Study Report, 2017

3.7.4 Module Mounting System

The mounting structure plays an important role in supporting and securing the module. It also deals with the module alignment with the sun at a particular angle at a certain time to maximize the solar power generation. Mainly there are two modes of installation:

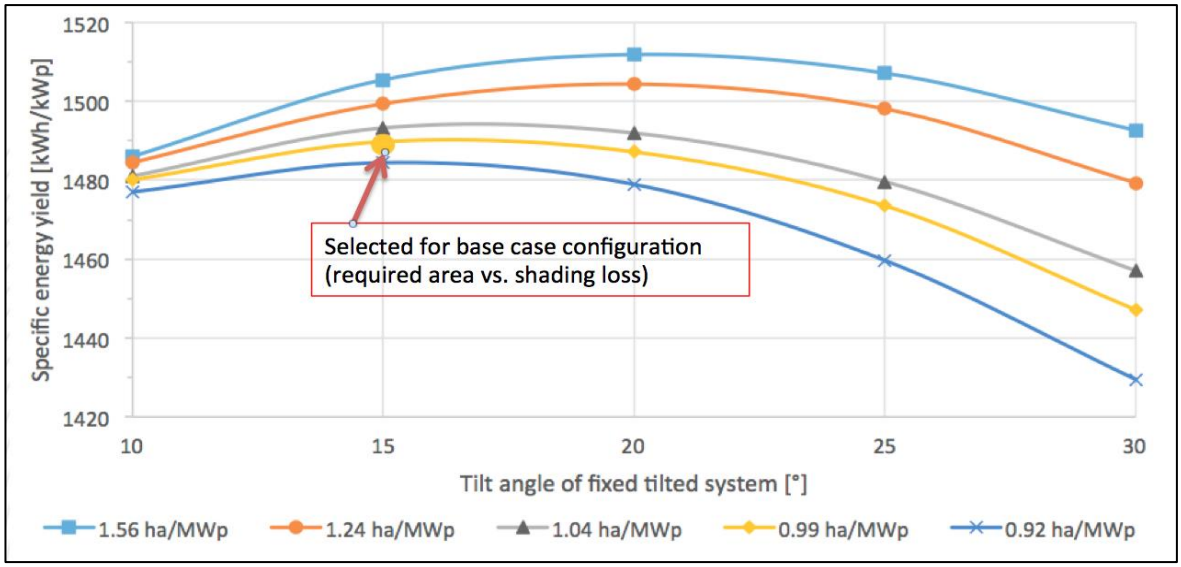
- Fixed-tilt system
- Single axis tracked system

These two options are analyzed to find out the suitable option for the proposed power plant. The single tracking systems can generate more energy compare to the fixed till system but it requires more space for the same power output. One of the most important aspects of tracking systems is the increased energy yield during the morning and evening hours, which helps to deliver a more constant electricity supply. Tracking systems are more susceptible to failure, due to the number of moving parts and therefore also require more maintenance and have around 15% higher maintenance costs. Trackers are more susceptible to high wind loads and in areas of high wind speeds the limited warranty for tracker systems may be reduced. Based on the site condition, area requirement and cost-benefit analysis the fixed-tilt system has been selected as per the feasibility study.

3.7.5 Module Tilt Angel

Module tilt angle decides the angle of incidence of solar radiation on the PV module to utilize maximum solar energy for generation of maximum possible energy. A PV would produce more power with lower reflection and incident angle losses when the solar radiation is normal to its surface as compared to solar radiation incident at any other angle. The most optimum angle of tilt of PV modules at any given location depends on its latitude and the variation of solar irradiation over the year. Since each site has its own characteristics, it is necessary to determine the most optimum tilt for the site.

By increasing the tilt angle and keeping the pitch (distance between two consecutive rows of PV modules) constant, the shadow created by one row of PV modules on the next row of PV modules increases. This decreases the output of the PV power plant. Hence, it is also important to check the most optimum tilt angle for different values of the pitch as shown in the Figure below.



Source: Feasibility Study Report, 2017

Figure 3-6: Annual energy yield respective to tilt angle and pitch

To account for an efficient land utilization, a specific land use of 1ha/MWp has been selected for the fixed-tilt system resulting in a tilt angle of 15° and a pitch of 8.9 m (GCR 65%). The resulting shading loss is below 2% compared to the case with 1.56 ha/MWp land use (GCR 40%).

3.7.6 Inverter Technology

The inverter technology is crucial for the plant layout and equipment requirements such as string combiner boxes, DC and AC cabling, distribution transformers and others. Typically, a central inverter concept is applied to large-scale PV plants having several MW of capacity, while the string inverter concept offers more flexibility often required for smaller installations.

The use of large turnkey central inverter station is proposed in order to maximize the performance and reduce investment cost. Special coating and/or sophisticated ventilation is likely to be necessary for various parts of the inverters and transformers. Additionally, official approvals from manufacturers for the installation of their products on the specific site with its challenging features (proximity to sea) are needed.

The ABB inverter station PVS800-MWS-2000kW-C with 2,000 kWac capacity has been applied during the conceptual engineering reflecting state of the art inverter technology. The inverter station comprises of 2 x 1000 kWac ABB inverters of model number PVS800-57-1000kW-C, a LV switchgear, transformer and MV switchgear. The output voltage of the inverter station is 33kV. The technical characteristics of the chosen inverter station are given in Table 3-6.

Table 3-6: Characteristics of ABB PVS800-MWS-2000kW-C inverter station

Description	Value
Nominal AC output power	2000 kW
Max. AC output power (@50 °C)	2400 kW

Description	Value
Max. DC voltage	1100 V
MPP DC voltage range	600 to 850 V
Max. DC current	2 x 1710 A
Max. DC input power	2400 kW
AC output voltage	33 kV
AC grid frequency	50 Hz./60 Hz.
Protection rating	IP54*
Ambient temperature range	-15 to +45 °C
Max ambient temperature	+50 °C
Efficiency Euro-eta (inverter only)	98.8%

3.7.7 Base case plant configuration

During the techno-economic optimization and technology selection described in the above sections, the concept design for the fixed-tilt system has been identified for the reference case based on 100 MWAC plant capacity.

A suitable plant capacity has further been developed by assessing different technology options, also taken into account wind turbines for power generation and other land utilization options, as discussed in section 5.2. The resulting base case scenario has a PV plant capacity of 172 MWAC being subdivided into Phase 1 with 50 MWAC and subsequent Phase 2 with 122 MWAC capacity. The technical parameters of the base case scenario reflect the concept design of the reference case developed during the initial investigations. A summary of the main plant characteristics of both cases is provided in Table 3-7 below.

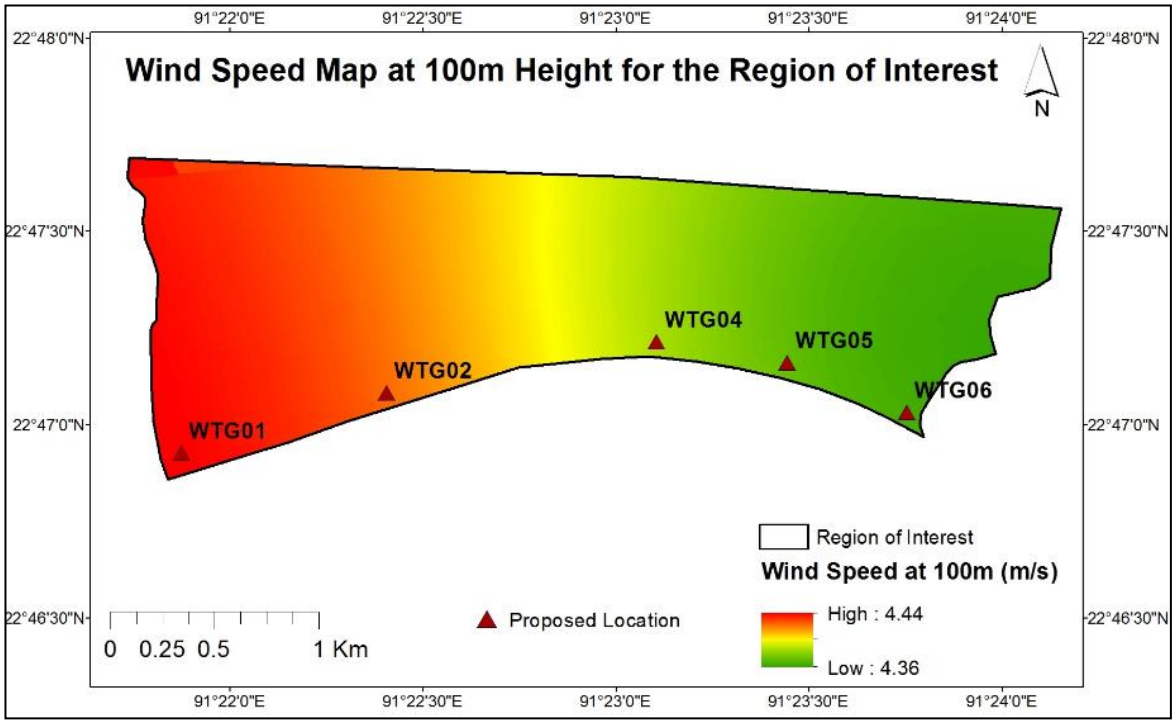
Table 3-7: Main characteristic of the fixed-tilt system for reference and base case scenario

Description	Reference case	Base case*	Unit
Plant capacity	100	172	MW_{AC}
Peak capacity	136	234	MW_{DC}
Number of modules	432000	743040	Number
Number of inverters	50	86	Number
Modules per string	20	20	Number
Number of strings	21600	37152	Number
Strings per string combiner box	24	24	Number
Combiner boxes per inverter station	18	18	Number
Tilt angle	15	15	Degree
Distance between rows	8.9	8.9	Meter
Table width	6	6	Meter
Modules per table width (portrait orientation)	3	3	Number

* The Final Selected Option 4 is applied in subsequent sections as "base case"

3.7.8 Technical Description of Suitable Wind Technology

This study shows the average wind speed for the Region of Interest (RoI) at a typical hub-height of 100 m above the ground (observing the long-term wind speed trends), as shown in the below map (base case):



Source: Simulation, Feasibility study report, 2017

Selected wind turbine generators (WTG) are known for operating in low wind regions with the capability of generating power at lower cut-in wind speeds. These wind turbine generators which have wider blades can reach rated power at wind speeds much lower than compared to other WTG models.

These WTG models are mainstream IEC-61400 fully certified turbine. The typical technological parameters of the WTG models have been tabulated below:

Technical Specification	Gamesa G114	Vestas V110	Suzlon S111	Unit
Rated Power	2	2	2.1	MW
Wind Class	IIIA	IIIA	IIIA	-
Rotor diameter	114	110	111	m
Hub Height	106	110	120	m
Swept Area	10,207	9,503	9,817	m^2
Generator type	Doubly Fed Generator	Doubly Fed Generator with slip rings	DFIG-Asynchronous with slip rings operated with rotor circuit	-

Technical Specification	Gamesa G114	Vestas V110	Suzlon S111	Unit
			inverter system	
Cut-in wind speed	3	3	3	m/sec
Cut-out wind speed	20	25	21	m/sec

It has been determined that the average wind speed at typical hub-height of 100 m is about 4.47m/s for the Region of Interest (RoI). Based on the selection of above WTG models, the wind energy estimation modeling has been carried out for base case considering 5 WTGs of 2 MW each at the 5D x 7D spacing criteria. The estimate accounts are shown below respect to gross and net PLF values:

WTGs Model	PoE	*Gross AEP (GWh/year)	*Gross PLF (%)	**Net AEP (GWh/year)	**Net PLF (%)
Gamesa G114-2MW	P50	16.62	18.97%	14.78	16.87%
	P75	14.36	16.40%	12.78	**14.59%**
Vestas G110-2MW	P50	15.68	17.90%	13.95	15.93%
	P75	13.36	15.48%	12.06	**13.77%**
Suzlon S111-2.1MW	P50	15.73	17.95%	13.99	15.97%
	P75	13.6	15.52%	12.09	**13.81%**

* Gross PLF is assessed using wind speed derived from mesoscale modeling at 100m hub height for the site.

** Net PLF after MA=0.96, GA=0.97 and TL factor = 0.965 and blade soiling = 0.99 has been considered as per industry practices

Considering 5 numbers of Gamesa 2 MW turbines model G114, and indexing costs based on sectoral experience, the LCOE for the wind power plant comes out to be 10.65 USD cents/ kWhr (at AEP of 12.78 GWh/yr, PLF of 14.59% and P75).

Parameter	Unit	Gamesa 2 MW (model G114)
Energy Yield (P75)	GWh/yr	12.78
Distance between two turbines	-	5D X 7D
AC Power	MWac	10
CAPEX	M USD	13.70
OPEX	M USD	0.19
LCOE (P75)	USD cents/kWh	10.65

3.7.9 Monitoring and Control Equipment

Solar PV plant should be equipped with an adequate SCADA system. The SCADA system needs a reliable communication design to monitor and fully control the plant as required by the grid code. The SCADA system enables to monitor and control the inverter stations

and substation allowing the constant measuring of the system performance and the recording of important system parameters, such as current, voltage, frequency, real and reactive power generation and power factor of the generated electricity.

A remote and local monitoring system will be installed. The remote monitoring system will facilitate monitoring of the plant through an Internet connection. Also, the solar PV plant will be monitored and controlled from the solar PV plant central control room located within the on-site control building. The control room will completely be equipped to allow for daily use as a workstation. In order to obtain a high availability and reliability of the solar PV plant, an Uninterrupted Power Supply (UPS) system should be installed in the Control Room, for providing power supply to the rest of equipment and preventing the loss of data in case of emergency.

CHAPTER 4: DESCRIPTION OF THE ENVIRONMENTAL AND SOCIAL BASELINE

4. DESCRIPTION OF THE ENVIRONMENT AND SOCIAL BASELINE

4.1 General

This section describes the existing environmental baseline status of Solar PV and Wind Project study area, covering both the natural and social environments. The analysis was completed through the use of a combination of secondary data sources in addition to extensive on-ground reconnaissance and baseline studies to establish an understanding of the environmental and social baseline of the Project area. Data for this chapter were collected from:

- Primary Sources: This included gathering information from field surveys, laboratory analysis and stakeholder consultations in the project area.
- Secondary Sources: This included data from literature reviews, maps and monitoring reports;

The baseline condition of environmental quality in the locality of project study area serves as the basis for identification, prediction, and evaluation of impacts. The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment such as air, noise, water, land and socio-economic etc.

Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, wind speed & direction and humidity), physiography, geology etc. Primary environmental and social baseline information was collected from the project site and surrounding area to know the current environmental and socio-economic condition of the project study area. Ambient air, noise and water quality samples were collected in terms of environmental quality to prepare a baseline database. The consultation was another source of information to explain local socio-economic conditions.

The following section describes the baseline environment into four broad categories:

- Physical Environment- factors such Geology, Topology, Land-use, Soils & Meteorology;
- Biological Environment- factors related to life such as habitats, aquatic life, fisheries, terrestrial habitats and flora, and fauna;
- Environmental Quality- Air, Noise level, Surface and Ground Water quality and
- Socio-economic Environment- demography, income, and infrastructure, sources of water supply and sanitation, electricity connection;

4.2 Area of Influence (AoI)

The Area of Influence (AoI) of the project comprises of the project site and the surrounding area, where the influence of the project activities is anticipated. The areas likely to be affected by the project and its associated activities include:

- The project activities and facilities that are directly owned operated or managed by the EGCB (including by contractors) and that are components of the project, such as the dike construction around the project boundary, solar modules, switchyard, control room and transmission line to power grid sub-stations;
- Impacts from unplanned but predictable developments caused by the project that shall occur later or at a related location such as increase in traffic on the approach road;
- Impacts on biodiversity or on ecosystem services upon which affected communities' livelihood are dependent;
- Associated facilities e.g. approach road construction and widening of existing road;

Further to this, the AoI with respect to the environmental and social resources was considered based on the following reach[4] of impacts:

Air Quality

- Impact on ambient air quality from vehicle exhaust;
- Impact of air pollutants emission from construction activities and
- Dustfall- typically up to 200 m from construction activities

Noise

- Noise impact area (defined as the area over which an increase in environmental noise levels due to the project can be detected) - typically 500 m from operations and 200 m from the access road

Water

- Surface water body- typically 500 m upstream and downstream of water intake point and downstream of discharge point
- Other surface water bodies within 1 km of the project footprint
- Groundwater in 1-2 km radius of project footprint

Flora and Fauna (Terrestrial and Aquatic)

- The direct footprint of the project comprising the project site
- The areas immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence and project related activities (e.g., trampling, water intake/outfall, transportation). This kind of disturbance has been estimated to occur within the project footprint and surrounding areas of about 500 m to 1 km from the activity areas.

Based on the above the AoI for environmental studies was limited to 5 km from the project site.

Socio-economic/Social

[4] Distance based on EQMS's experience with similar project

The AoI for social receptors was fixed to include 2 km radial zone which has been developed based on the reconnaissance site visits and stakeholder consultations with the local community.

The AoI for development of the social baseline comprises of two villages (Adorsho village and Purba Baradhali village) which according to the administrative structure falls in 2 Mauza (Char Darbesh and Purba Baradhali), 2 unions (Char Darbesh and Char Chandia) of Sonagazi upazila under Feni district.

The socio-economic information presented in this report has drawn from primary socio-economic survey and the Population and housing census 2011, Bangladesh Bureau of Statistics (BBS). The figure shows areas with 2 km and 5 km radius from the project periphery.

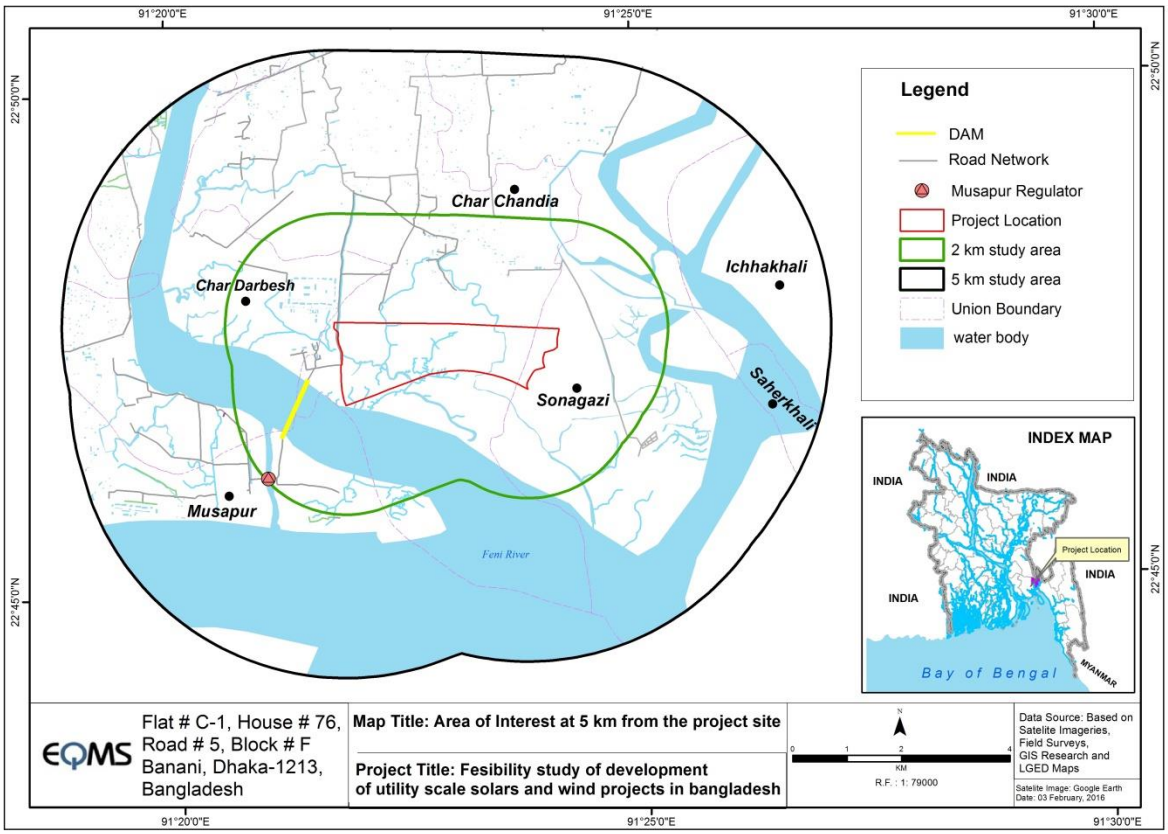


Figure 4-1: AoI at 5 km from the Project Site

4.3 Key Features of the Site and Surroundings

The Project site with key features in the surrounding areas is presented in **Figure 4-2**. The Project site is located on the north bank of the Small Feni River and falls within the Young Meghna Estuarine Floodplain. There is no large tree species and precious environmental component present in the project site. The project site is medium high land where only aman rice is cultivated seasonally. The site is almost flat; the land inundated for 4-5 months continuously at various depths up to 11 inches. The maximum historical high water level has been 5 meters during the super-cyclone of 1991. Rest four months the project site is used for cattle rearing during the dry season in the project site. There are two canals inside the project site and both the canals are connected with Choto Feni River. The access road

from the Sonagazi upazila to project site is not suitable for transportation of equipment and material for setting up the Plant. Musapur Dam on Small Feni River is close to the project site at 800m distance. The substation location is almost 20 km North East of project location at Baraiyarhat in Mirsharai upazila. The Musapur Regulator is 2.15 km south west of the project site. There is a forest cluster in Musarpur which is 1.40 km south west of the project boundary. There is no settlement as well as any utility in the project location.

In the close vicinity (within 2 km from the project boundary) of the Project site, habitation is only present in the western and northern parts and the nearest habitations are Purbo Barodhuli and Ashrayan/Adarsha villages of Purbo Barodhuli Union. The nearest residential, sensitivity and infrastructure properties in each compass direction are as follows:

- Purbo Barodhuli Village – Approximately 250 m north from the Project Site boundary;
- Ashrayan/Adarsha Village – Approximately 400 m west-north-west from Project Site boundary;
- Musapur Dam – Approximately 700 m south-west from Project Site boundary;
- Musapur Regulator – Approximately 2.15 km south-west from Project Site Boundary;
- Musapur Reserve Forest – Approximately 1.4 km south-west from Project Site boundary.

The project site is bounded by the following features:

- The northern part of the proposed project site is seasonally flooded land/seasonal cultivable land and Purbo Barodhuli village.
- Southern side is Small Feni River,
- At the western site the access road/embankment and
- The Feni River and tidal flat land are present.

The Project site is situated in Sonagazi Upazilla under Feni District of Bangladesh. The important feature located in the influence area has been shown in the following **Table 4-1** and depicted in **Figure 4-2**.

Table 4-1: Important Features of the Project Surroundings in accordance with Distance.

Sl.	Area/ village name	Direction	Distance (Km)	GPS Location	Features/ Remarks
1	Adarsho Village Bazar	North-West	0.94	22°47'58.1"N 91°21'31.9"E	SBE
2	Adarsho Village Jame Mosque	North-West	0.93	22°47'59.7"N 91°21'33.1"E	EHS
3	Adarsho Village Madrasha	North-West	0.90	22°47'59.7"N 91°21'34.3"E	EHS
4	Adarsho Village Graveyard	North-West	0.90	22°47'59.7"N 91°21'34.4"E	EHS

Sl.	Area/ village name	Direction	Distance (Km)	GPS Location	Features/ Remarks
5	Adarsho Village Govt. Primary School	North-West	1.01	22°48'01.2"N 91°21'30.1"E	EHS
6	Adarsho Village Police investigation Center	North-West	0.98	22°47'59.9"N 91°21'30.6"E	EHS
7	Nurani Bazar	North	3.06	22°49'14.0"N 91°21'51.4"E	SBE
8	Panjekhana Masque	North	3.08	22°49'14.6"N 91°21'52.0"E	EHS
9	Char Darbesh Community Clinic	North	3.08	22°49'14.6"N 91°21'52.5"E	EHS
10	ESG Model High School	North	2.94	22°49'10.01"N 91°21'58.36"E	EHS
11	Char Darbesh Primary School	North	3.00	22°49'11.75"N 91°22'1.33"E	EHS
12	Graveyard	North	2.98	22°49'12.7"N 91°21'52.0"E	EHS
13	Nurani Bazar Masque	North	2.99	22°49'12.7"N 91°21'52.1"E	EHS
14	Baitul Rahmat Masque	North	1.47	22°48'23.2"N 91°21'50.4"E	EHS
15	7 no union jame masque , Musapur	West	0.79	22°47'17.67"N 91°21'21.83"E	EHS
16	Panjekhana Masque	West	1.29	22°47'50.42"N 91°21'9.34"E	EHS
17	Rahamatpur Ahmadia Forkania Madrasha	North	3.90	22°49'42.1"N 91°21'42.9"E	EHS
18	Baitul Nur Jame Masque	North	4.07	22°49'46.9"N 91°21'56.3"E	EHS
19	East Boro Dholi Govt Primary School	North	1.97	22°48'34.5"N 91°22'45.0"E	EHS
20	Jele para, Musapur	West	2.33	22°46'50.02"N 91°20'31.08"E	SBE
21	Madina Bazar	North	3.14	22°48'37.62"N 91°22'37.78"E	SBE
22	Sultan Ahmed Primary School	North	4.54	22°49'32.2"N 91°21'44.2"E	EHS
23	Graveyard	North	2.19	22°48'39.9"N 91°22'37.5"E	EHS

Sl.	Area/ village name	Direction	Distance (Km)	GPS Location	Features/ Remarks
24	Madina Bazar Jame Masque	North	3.15	22°48'37.62"N 91°22'37.78"E	EHS
25	Baitul Nur Masque	North	1.51	22°48'23.0"N 91°22'29.5"E	EHS
26	Nur Jame Masque	North	2.20	22°48'29.0"N 91°23'05.0"E	EHS
27	Graveyard	North	1.83	22°48'19.1"N 91°22'55.5"E	EHS
28	Baitul Jame Masque, 6 no Char Chandina	North	1.45	22°48'09.8"N 91°22'54.7"E	EHS
29	Rice Research Institute (Regional)	North	2.40	22°48'31.1"N 91°23'14.5"E	EHS
30	Islamia Dakhil Madrasha	North	4.46	22°49'17.5"N 91°24'16.5"E	EHS
31	East Char Chandina Govt. Primary School	North- East	5.00	22°49'34.9"N 91°24'25.7"E	EHS
32	Jele Para, Char Khandakar	North- East	5.00	22°49'24.8"N 91°24'47.0"E	EHS
33	Musapur Reserve Forest	South-West	2.01	22°45'58.33"N 91°21'16.91"E	EHS

Note: HH- Households, SBE- Small Business Enterprise, EHS- Environmental Hotspots (mosque, madrasa, school, college etc.)

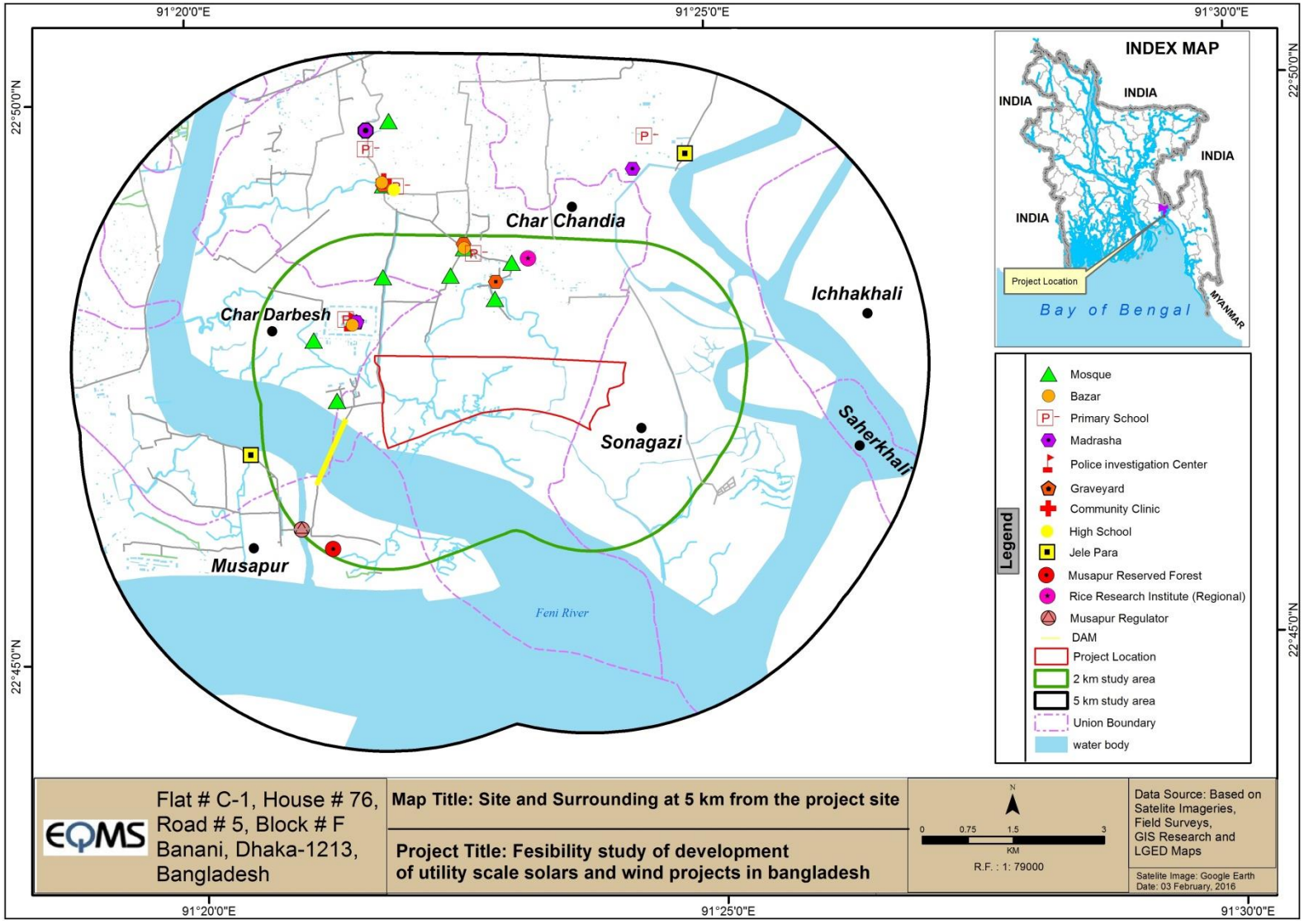


Figure 4-2: Key Feature in the Surroundings of the Project Site

4.4 Objective and Methodology

Objective of Baseline Study

The primary objective of the environmental and social baseline study is to provide an environmental and social baseline against which potential impacts from the construction, operational and decommissioning phases of the Project can be compared.

Methodology of Baseline Study

The methodology adopted for collecting the baseline data is as follows:

- Reconnaissance survey for scoping was carried out in February 2017 for the current study. The detailed environmental and social field monitoring and survey was carried out during the period of February 2017 and May 2017;
- 5 km Study area of the proposed Project location was selected for the baseline studies considering the location of project components, associated components, and nature of project activities;
- Primary environmental data collection was through monitoring and field survey for water, air, noise, traffic, and ecology;
- Social baseline of the study area was captured through field consultations, interviews, meeting with stakeholders, discussions with government departments and secondary data review etc; and
- Secondary data was collected from government reports, academic institutes, websites, published literature, interactions with government department and stakeholders etc.

4.5 Physical Environment

This section describes the major features of the physical environment of the project site. Information was gathered on the existing physical environment related to land use, geology, topography, climate, soils, surface water and groundwater quality, air quality and noise level.

4.5.1 Land use

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 5 km buffer was undertaken with the following objectives:

- To study the land use/cover in the 5 km radius areas of the proposed Solar PV and wind project site and provide inputs for environmental planning of the proposed plant 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 agricultural land, water bodies, tidal zone, settlements and forest area etc.

The evaluation of the existing environmental status of the study area was considered 0-5 km. This revealed that the land use/land cover consists mainly of a settlement with homestead vegetation, water bodies, agricultural land, forest, and tidal prone area. **Table**

4-2 shows the existing land use composition around 5 km of the project study area. **Figure 4-3** shows the Land use/Land cover map shows the land use pattern within 5 km of the study area.

Table 4-2: Land Use/Land covers statistics of the Project AOI

Name	Area(Hectors)	Percentage
Agricultural Land	12806.3	38.42
Homestead Vegetation	4005.03	12.02
Forest	1577.49	4.73
Tidal area	4193.52	12.58
Water	10749.6	32.25
Total	**33331.94**	**100**

Source: EQMS GIS database, Google earth, LGED

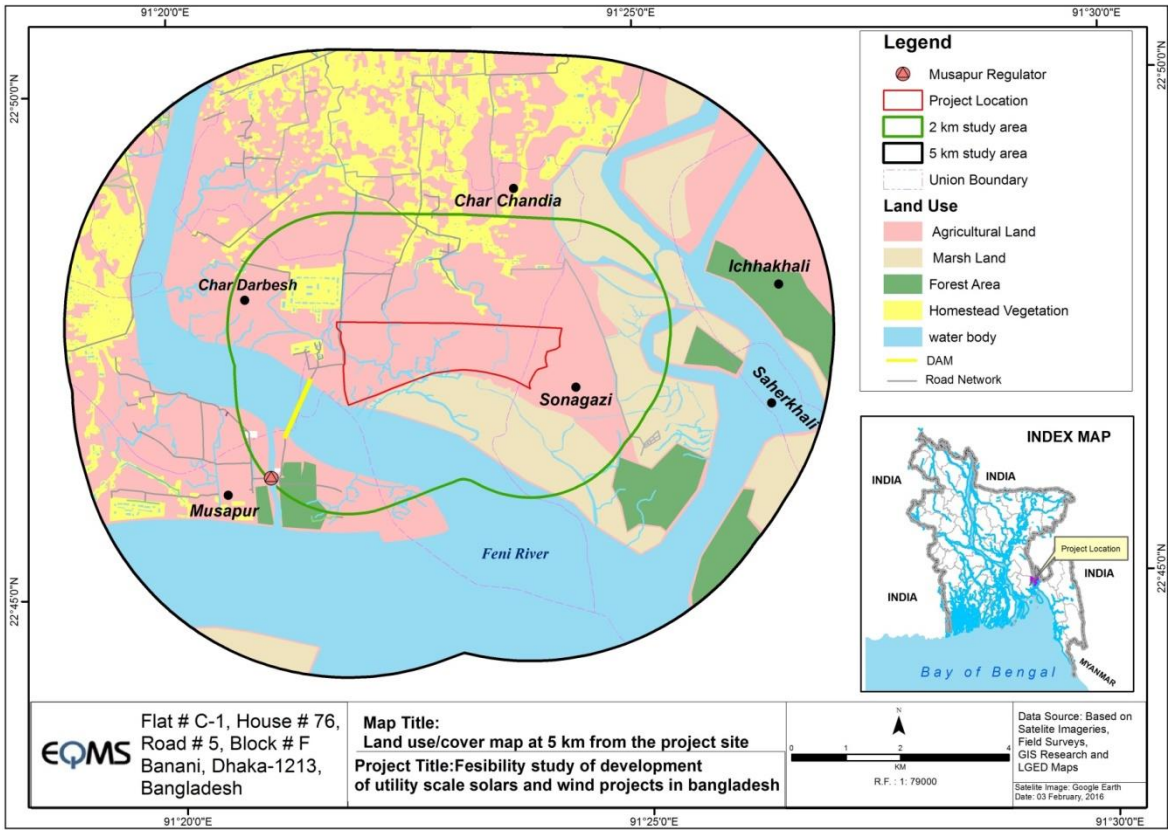


Figure 4-3: Land Use/ Land Cover Map of the Project AOI

4.5.2 Topography

A digital elevation model (DEM) or 3-D representation of the terrain surface of 5 km buffer study area is shown in **Figure 4-4.** The proposed Solar PV and Wind project location, its 5 km buffer area as well as the other liner feature is shown in the relief map with the height range.

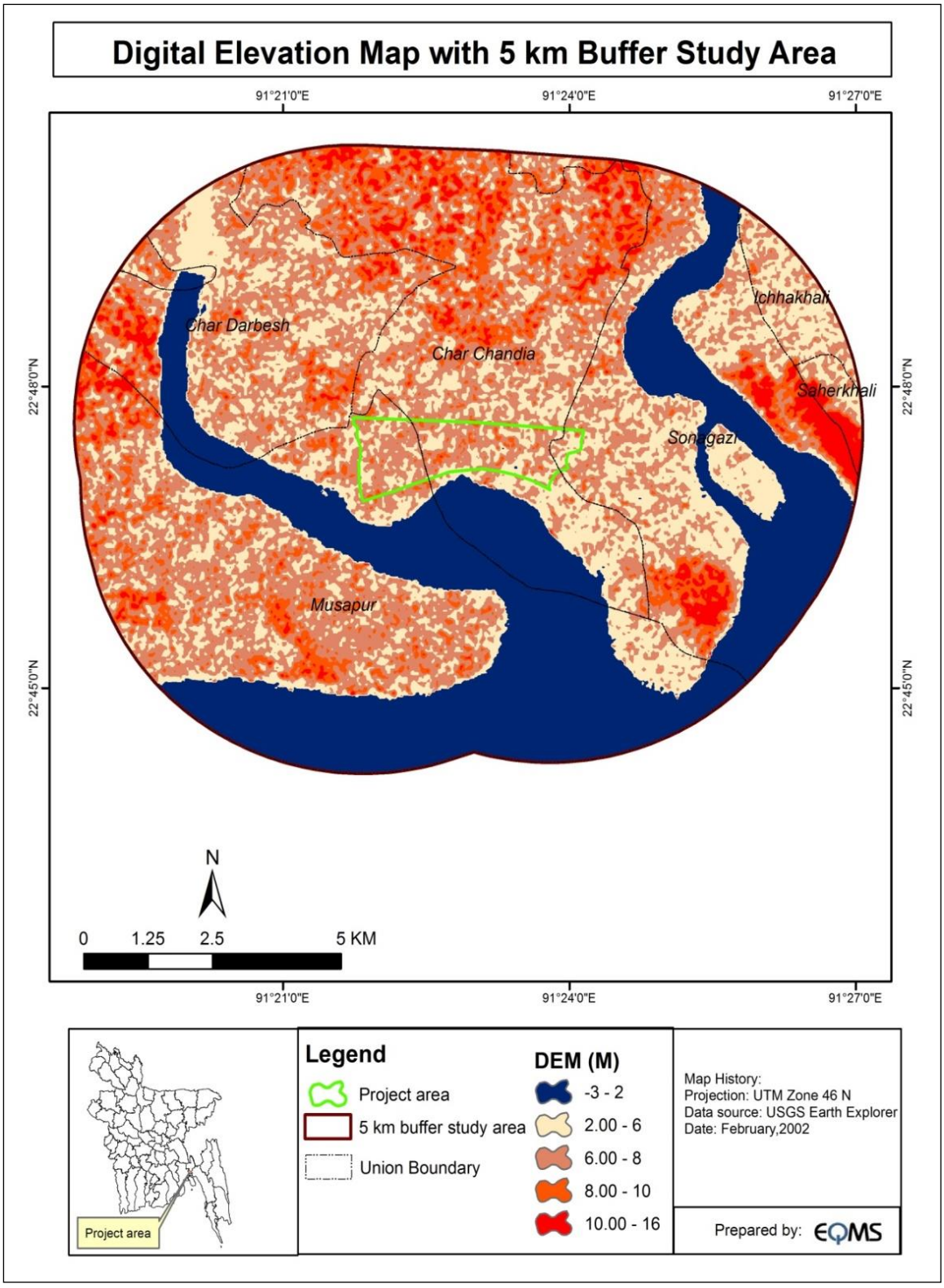


Figure 4-4: Digital Elevation Model of the 5 km Study Area

The study area is generate from the Advance Space-Borne Thermal Emission and Reflection Radiometer (ASTER) relief maps. Top sheet was not available for the study area and therefore all the relevant information are extracted from the Shuttle Rader Topography Mission (SRTM) DEM only. All the processing was done in the ARC GIS 10.4.1 software.

DEM shows that the topography of the 5 km study area is predominantly a medium terrain with maximum elevation in the northern part of the study area. The Elevation range of the study area is 2 to 16 m.

4.5.3 Geology

Geologically major portion of the study area dominantly consists of Tidal deltaic deposit, 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 contains some brackish water deposits. Numerous tidal creeks crisscross the area; large tracts are submerged during spring tides.

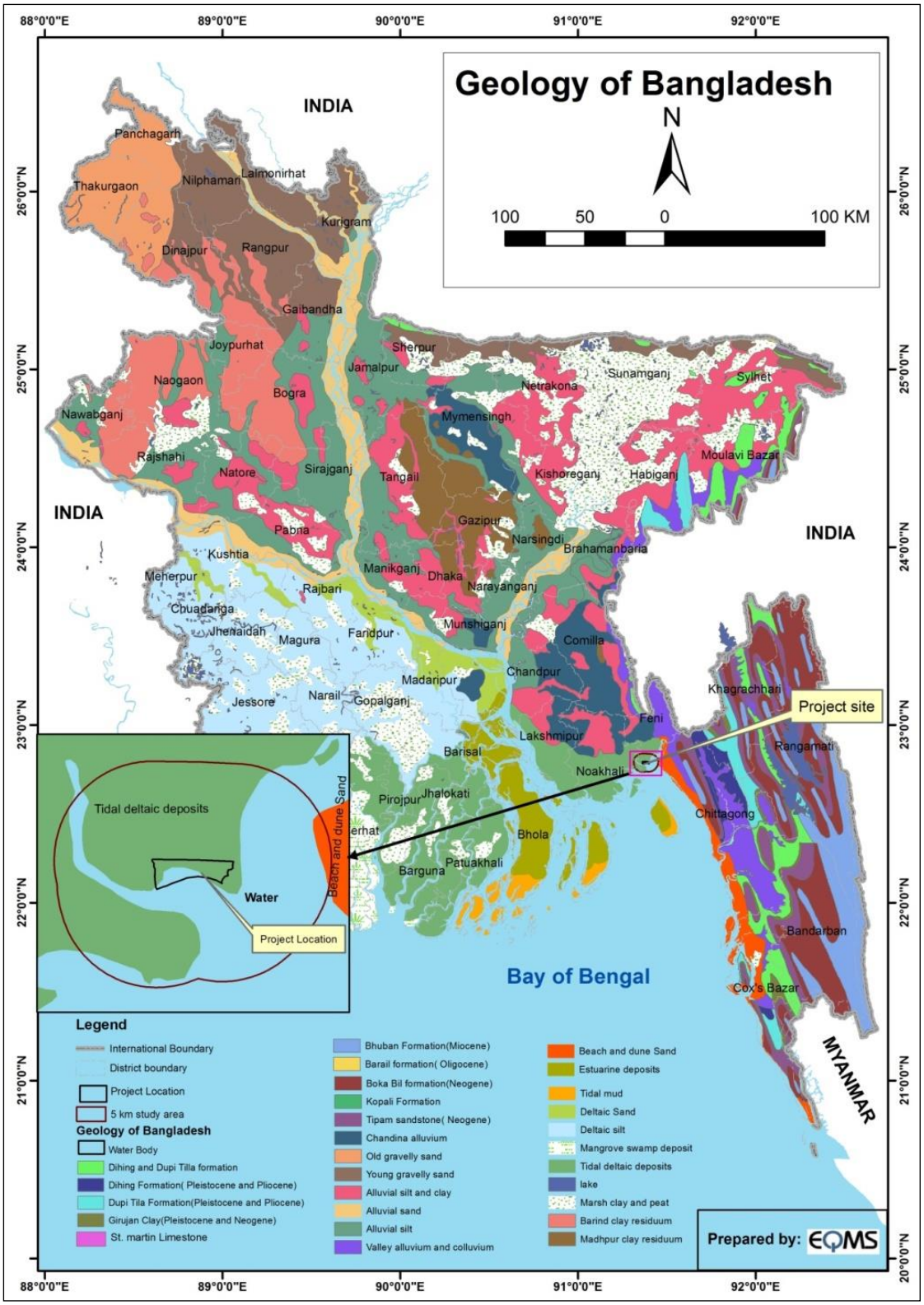


Figure 4-5: Project Study Area Shown in Geological Maps of Bangladesh

4.5.4 Soil

The soil of the Project area mainly "Calcareous Alluvium" Soils are stratified or raw alluvium throughout or below the cultivated layer. This alluvium on the active Ganges floodplain mainly comprises brownish grey to pale brown sandy and silty deposits, which are moderately calcareous.

Calcareous Alluvium on the active Ganges Floodplain mainly comprises sandy and silty deposits which are moderately calcareous and brownish-grey to pale olive-brown.

Most areas are moderately deeply or deeply flooded at the peak of Ganges floods and they are subject annually to the risk of bank erosion. Soils become slightly to moderately saline in the dry season. Risk of bank erosions alongside estuarine channels, exposure to cyclone and storm surges, the general lack of suitable water supplies for dry season irrigation as well as widespread salinity provide moderate or severe limitations on increased agricultural production.

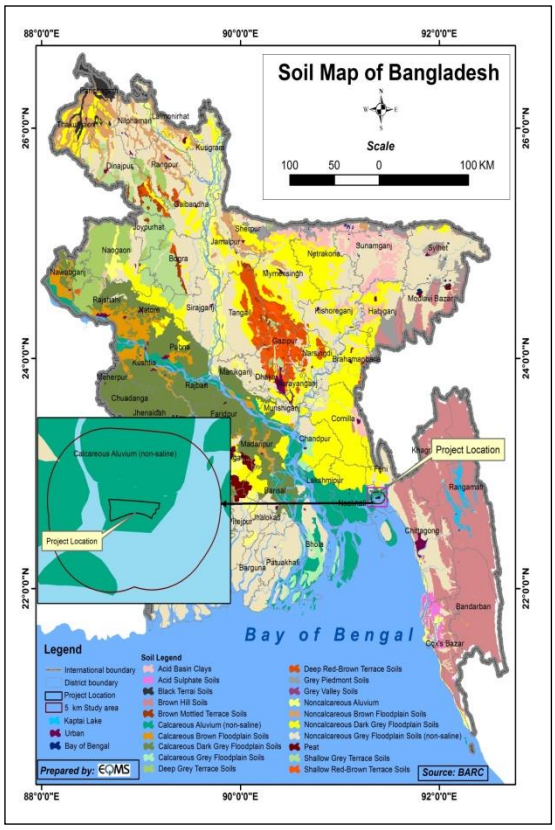


Figure 4-6: General Soil Categories of Bangladesh

4.5.5 Meteorology

Bangladesh has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures, and humidity. There are three distinct seasons in Bangladesh: a hot, humid summer from March to June; a cool, rainy monsoon season from June to October; and a cool, dry winter from October to March. In general, maximum summer temperatures range between 30°C and 40°C. April is the warmest month in most parts of the country. January is the coldest month when the average temperature for most of the country is about 10°C.

In order to investigate the climatic condition of the study area different meteorological parameters have been collected from multiple secondary sources. The proposed power plant area falls under tropical climate. Basically, this region has a distinct monsoonal season which influences all other climatic parameters. **Figure 4-7** shows the location of the study area in the climatic sub-regions of Bangladesh. The study area falls in the South-eastern climatic zone of Bangladesh.

Long-term Meteorological data for 30 years (1987-2016) was collected from the nearest BMD stations in Feni which is analyzed to get the overall micro-climatic conditions of the study area.

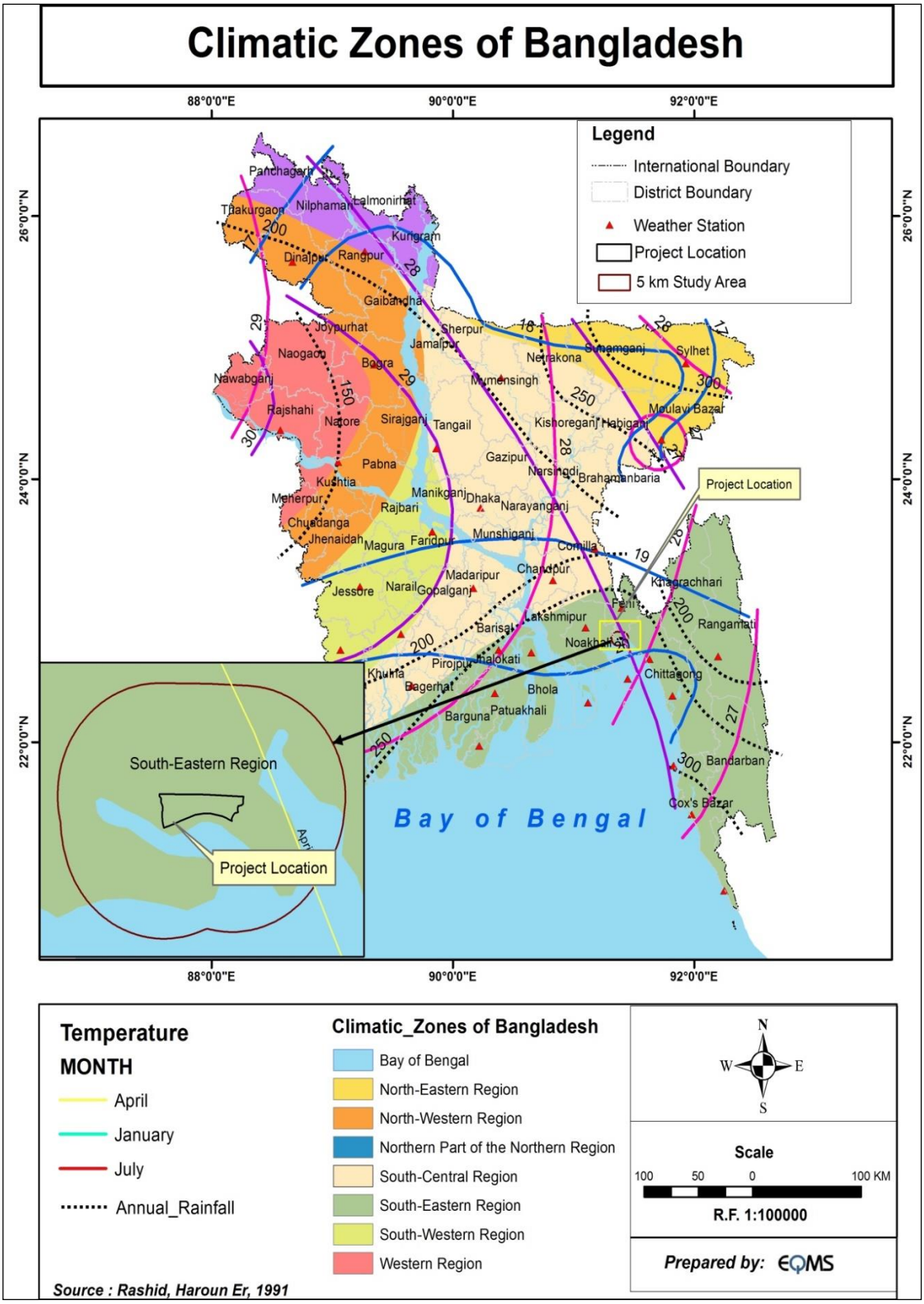
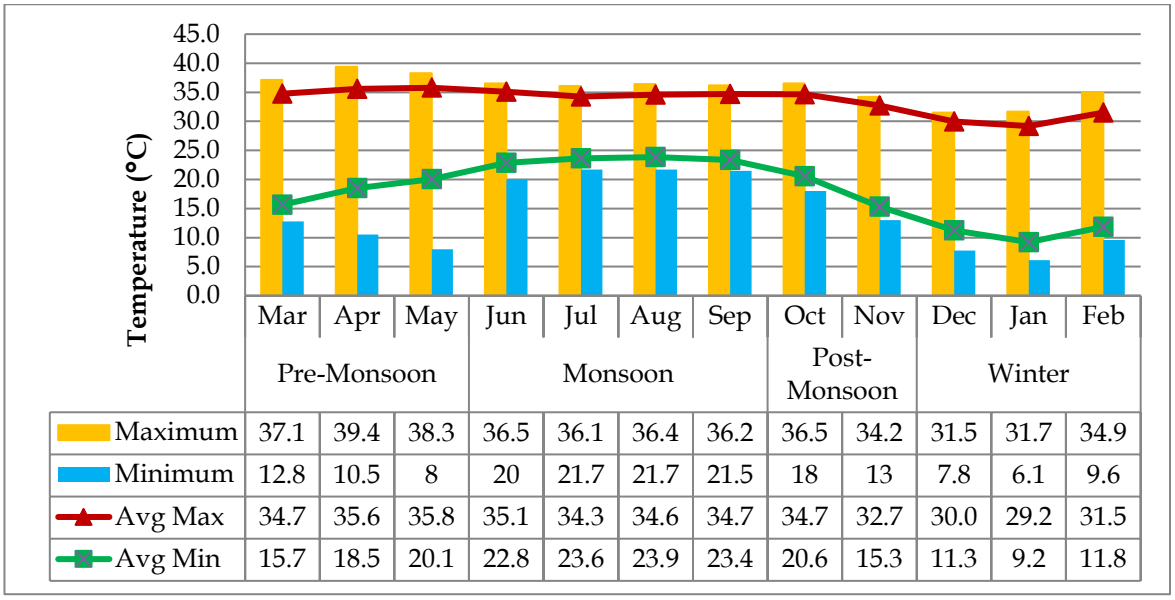


Figure 4-7: Climatic Zones of Bangladesh

4.5.5.1 Temperature

The maximum, minimum and average temperatures recorded at the Feni weather station are presented below in **Figure 4-8**. The data analysis of 30 years (1987-2016) shows that monthly maximum temperature varies from 31.5°C to 39.4°C whereas monthly minimum temperature varies from 6.1°C to 21.7°C. The lowest average temperature recorded in the past 30 years was in January 2013 (6.1°C). The highest temperature reached 39.4°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 4-8**).



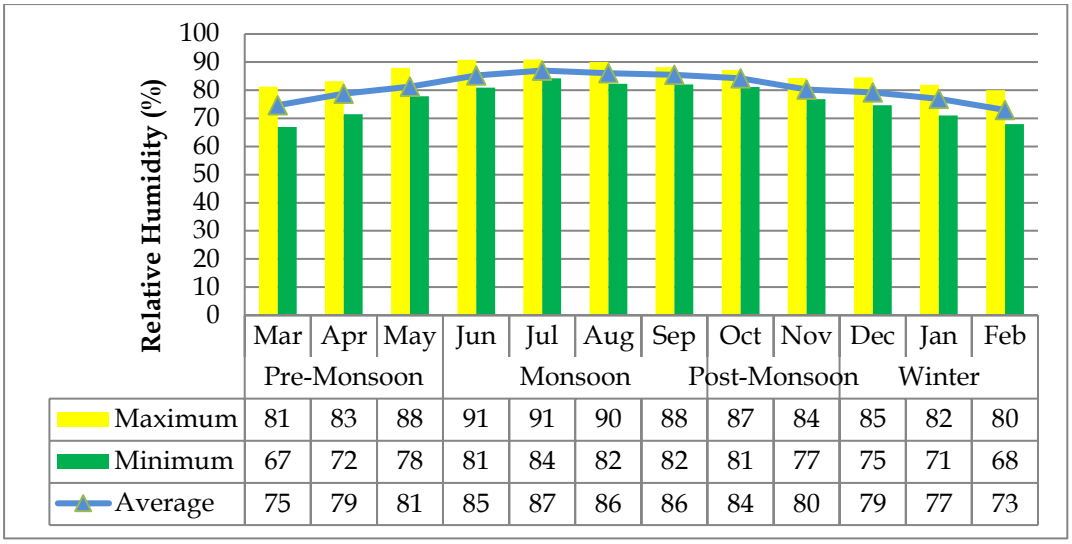
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Maximum	37.1	39.4	38.3	36.5	36.1	36.4	36.2	36.5	34.2	31.5	31.7	34.9
Minimum	12.8	10.5	8	20	21.7	21.7	21.5	18	13	7.8	6.1	9.6
Avg Max	34.7	35.6	35.8	35.1	34.3	34.6	34.7	34.7	32.7	30.0	29.2	31.5
Avg Min	15.7	18.5	20.1	22.8	23.6	23.9	23.4	20.6	15.3	11.3	9.2	11.8

Source: Bangladesh Meteorological Department, Dhaka.

Figure 4-8: Monthly Maximum, Minimum and Average Temperatures (1987-2016) of Feni Weather Station

4.5.5.2 Humidity

Due to the heavy rainfall and proximity to the Bay of Bengal, the humidity levels in the Bangladesh remains high. Average Relative humidity in the project area is generally above 80% during May to October. The month of February is the driest with the relative humidity around 73%. The monthly average relative humidity near the project area varies from 73% to 87% throughout the year. The monthly maximum, minimum and average humidity of the last 30 years (1987-2016) of Feni weather station is shown in **Figure 4-9**.



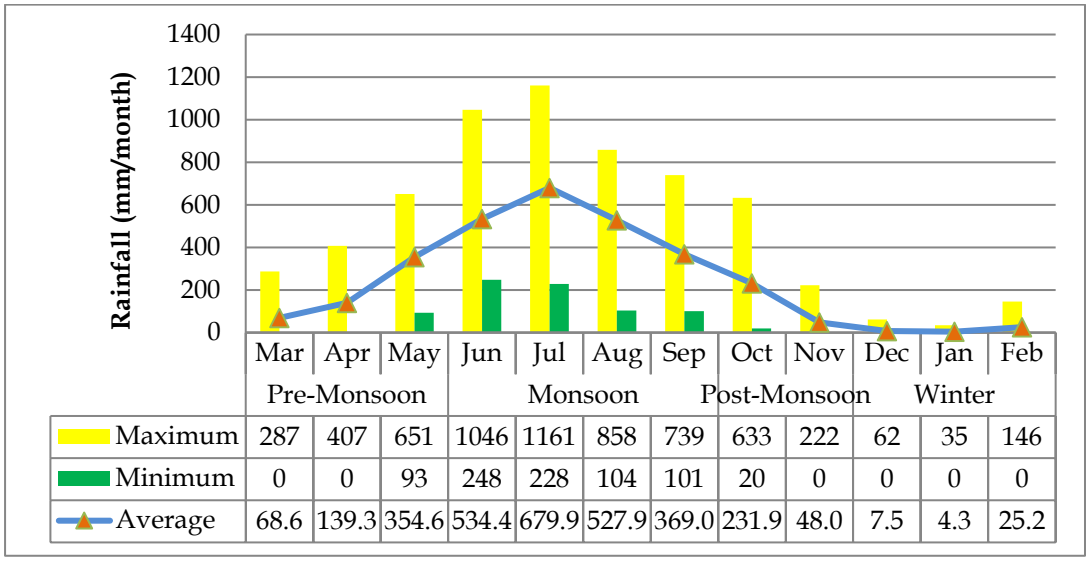
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon			Winter	
Maximum	81	83	88	91	91	90	88	87	84	85	82	80
Minimum	67	72	78	81	84	82	82	81	77	75	71	68
Average	75	79	81	85	87	86	86	84	80	79	77	73

Source: Bangladesh Meteorological Department, Dhaka.

Figure 4-9: Monthly Maximum, Minimum and Average Humidity (1987-2016) of Feni Weather Station

4.5.5.3 Rainfall

About 80% of the rainfall occurs during six monsoon months (May to October) with June and July getting the maximum rains. Minimum rains are reported during the months of November to February whereas average showering does occur in March, April, and November. The last 30 years data from the Feni meteorological station shows that the annual average of total rainfall is recorded as 2990.5 mm/year. According to the analysis of the historical data, a monthly highest average of total rainfall occurs in July 679.9 mm whereas monthly minimum rainfall recorded during the winter season (December and January). The monthly maximum, minimum and average rainfall of the last 30 years (1987-2016) of Feni weather station is shown in **Figure 4-9**.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon			Winter	
Maximum	287	407	651	1046	1161	858	739	633	222	62	35	146
Minimum	0	0	93	248	228	104	101	20	0	0	0	0
Average	68.6	139.3	354.6	534.4	679.9	527.9	369.0	231.9	48.0	7.5	4.3	25.2

Source: Bangladesh Meteorological Department, Dhaka

Figure 4-10: Monthly Maximum, Minimum and Average Rainfall (1987-2016) of Feni Weather Station

4.5.5.4 Sunshine

On average, the region experiences 6.38 hours of sunshine each day. The highest sunshine hours occur during November to February, which is the coolest and has low humidity. The lowest sunshine occurs from June to September, when the cloud cover is high.

4.5.6 Water Resources

The proposed project will be constructed at the left bank of Choto Feni River and a Right bank of Feni River in Char Chandia Union of Sonagazi Upazila.

The existing water resources system of the study area plays indispensable role in attenuating and regulating drainage in a controlled way, recharging the aquifer, and maintaining the environment for aquatic habitats.

4.5.6.1 Major Water Resources in the Study Area

There are two rivers and several canals are flowing in the study area. The proposed of projected located (22°47'21.13"N 91°22'39.21"E) besides the river Choto Feni River and right bank of the Feni River. The outfall of both rivers is the Sandwip Channel. Feni River and Choto Feni River profile has been shown in the following Table 4-3.

Table 4-3: Feni and Choto Feni River Profile

Sl.	Items	Feni River	Choto Feni River
1	Off take	India	Kakri Ricer
	Geographical Location	Matiranga, Khagrachari	Chauddagram, Comilla
2	Outfall	Sandwip Channel	Sandwip Channel
	Geographical Location	Sonagazi, Feni	Companiganj, Noakhali
3	River flow path		
	Upazila	Matiranga, Ramgarh, Fatikchari, Mirsharai, Chagalnaiya, Feni Sadar, Sonagazi	Chauddagram, Comilla Sadar South, Nagolcote, Feni Sadar, Dagonbhuya, Sonagazi, Companiganj
	District	Khagrachari, Feni, Chittagong	Comilla, Feni, Noakhali
4	Tributary/ Distributary/ Branch		
	Tributary river	Muhuri, Salonia	None
	Distributary	None	None
	Branch	None	None
5	Physical Setting		
	Length	153 km	112 km
	Width	Minimum 81 m, Maximum 291 m, and Average 159 m	Minimum 30 m, Maximum 438 m, and Average 147 m

Sl.	Items	Feni River	Choto Feni River
	Characteristics	Meandering, flood flow slope 15 cm/km	Meandering, flood flow slope 3 cm/km
5	Discharge		
	Seasonal/Perennial	Perennial	Perennial
	Months of Minimum discharge (dry season)	February – April	February – April
	Minimum Average discharge quantity (dry season)	1.35 m^3/sec	-
	Months of Maximum discharge (wet season)	July – September	July – September
	Maximum Average discharge quantity (wet season)	10800 m^3/sec	-
	Tidal	Yes, (Maximum Tidal effect difference 1.2 m)	Yes, (Maximum Tidal effect difference 2.5 m)
6	Measuring Station	SW84- Ramgarh (NTWL), SW84.1- Kaliachari (NTWL), SW85- Shovapur (TDWL), SW86- Dhumghat (TDWL), SW87- Sonapur (TDWL)	SW181- Gunaboti railway bridge (NTWL), SW181A- Salonia (TDWL), SW182- Companiganj (TDWL)

Source: Bangladesh Rivers, August 2011, BWDB

4.5.7 Agriculture Resources

The land of Sonagazi Upazila of Feni District is intensively used for agriculture, settlements, forest, shrimp, and fisheries for other infrastructural developments. The newly accreted Chars and Islands have special uses also. These diversified uses of land always creating problems in respect of its criteria based uses and creating conflicts among the users. The upazila is vulnerable to natural disasters like cyclone, storm surges, drainage congestion, salinity and land erosion, which are the main causes of land degradation and loss of biodiversity and human lives. These vulnerabilities, as well as opportunities, call for distinctive management for proper uses of land and other resources.

4.5.7.1 Agriculture Land Use

Char Chandia union where project site is located is comprised of five mouzas having an area of 3845 ha of land of which the net cultivable land is 2153ha (56%). The landscape is almost level. Creeks are found in different locations of the Char Chandia Union restricting crop cultivation. Dry season soil salinity results from the capillary rise of soil moisture to the surface causing from slightly to strongly salinity in soils thus limiting dry land crop cultivation in the area. The salinity starts from early dry season after harvesting of T.aman (HYV) which became strong in March-May. Tidal saline water sometimes enters into the crop fields and stands for several months causing soil salinity.

The project site is low to medium land and the land is inundated during the monsoon season. The land is used only for single crop agricultural land and rest of the time the land remains barren.

4.5.7.2 Land Type

Land type is the dominant factor guiding the choice of crops and cropping patterns in Bangladesh's as well as in the project area. Selection of crop/ cropping patterns largely depends on the topographic position of land in relation to seasonal flooding depth and its duration. Lands, which are above normal inundation level, can provide a wide range of opportunities for growing both perennial and year-round crops.The major land types of this union are medium high land (1483.00 ha) followed by Highland (25.00 ha). The high land is not inundated by flooding water but the medium high land inundated for 4-5 months continuously at various depths up to 90 cm.

Table 4-4: The present Cropping Patterns of Char Chandia Union

Name of the union	Net Cultivable area (ha)	Major Cropping Patterns		
		Cropping Patterns	Area (ha)	% of NCA
Char Chandia	2153	RC- T.aus (HYV) -T.aman (HYV)	450.00	20.90
		RC-Fallow-T.aman (HYV	273.00	12.68
		Fallow- T.aus (HYV) -T.aman (HYV)	330.00	15.33
		Veg-Fallow-T.aman (HYV)	250.00	11.60
		Boro (HYV)-Fallow-T.aman (HYV	550.00	25.55
		Fallow-Fallow-T.aman (HYV)	300.00	13.94
Total			**2153.00**	**100.00**

Source: Land Zoning Report; Sonagazi Upazila, Feni District, 2011

4.5.7.3 Crop Production

The union also faces various problems in respect of agricultural land uses and management. The valuable agriculture land is reducing every year due to constriction of the unplanned housing. Major crop production in the Char Chandia Union is aman rice followed by winter vegetable, potato, sweet potato, felon dal etc. The crop production of the Char Chandia Union is given in **Table 4-5.**

Table 4-5: Crop Production (2015-2016) of Char Chandia Union

Sl#	Crop name	Cultivated area (Hector)	Production year (Metric Ton)
1.	Aman Rice**	3400	8500
2.	Khesari dal	1700	2040
3.	Tomato	4	240
4.	Boro	35	210
5.	Long melon	5	150
6.	Radish	3	120
7.	Spinach	7	120
8.	Brinjal	2	100

Sl#	Crop name	Cultivated area (Hector)	Production year (Metric Ton)
9.	Sweet Potato	2	70
10.	Potato	2	60
11.	Bitter Gourd	2	30
12.	Lentils	20	28
13.	Coriander	5	12.5
14.	Onion	1	10
15.	Pea	5	7.5
16.	Green Chilli	5	7.5
17.	Felon dal	5	6
18.	Mug dal	5	5
19.	wheat	1	4.5
20.	Mustard	4	4
21.	Nuts	2	2.5

**Only Aman rice is cultivated on the project site

Source: Agricultural Department, Sonagazi Upazila, Feni District Date: 27 February 2017

4.5.8 Fisheries Resources

The fisheries of Sonagazi Upazila consist of inland open water fisheries and freshwater aquaculture. Like other parts fisheries sector of the country, particular fisheries of Sonagazi Upazila is a major source of nutrition, income, employment and livelihood support of the local people.

In Bangladesh, fish provides 60 percent of the national animal protein and this sub-sector contributes about 5 percent to the GDP and approximately 9 percent of the total foreign exchange earnings. Nearly, 1.2 million people directly employed in this sub-sector and another 11 million are indirectly engaged in activities related to this sector.

The Char Chandia union where project site is located has a total wetland area of about 437 ha of which under aquaculture were 118 ha used as a homestead fish culture in the homestead pond, 3 ha of land was under commercial fish culture and 162 ha was under shrimp culture. The union is suitable for brackish water fish & shrimp culture. Union wise fisheries land use has been shown in the following **Table 4-6**.

Two canals are crossing the project site where fish species are found especially during the high tide as well as monsoon season.

Table 4-6: Union-wise Fisheries Land Use of Sonagazi Upazila

Union	Pond	Total of Culture fisheries	Capture Fish/ Open Water	Total Wetlands	% of the total area of the Union	Remarks
Amirabad	107	110	607	717	17	Suitable for fish farming

Union	Pond	Total of Culture fisheries	Capture Fish/ Open Water	Total Wetlands	% of the total area of the Union	Remarks
Bagadana	98	99	-	99	8	Homestead pond culture
Char Majlishpur	118	124	23	147	9	Homestead pond culture
Char Chandia**	272	437	-	437	29	Suitable for shrimp farming & Brackish water aquaculture
Char Darbesh	181	30	810	1000	24	Suitable for fish farming
Mangalkandi	125	160	-	160	13	Suitable for fish farming
Matiganj	133	137	107	245	18	Suitable for fish with paddy
Nawabpur	84	189	283	472	18	Suitable for aquaculture
Sonagazi	224	283	607	890	23	Suitable for shrimp farming & Brackish water aquaculture

Note: Area in Hector

***Project site located in this union*

Source: Land Zoning Report; Sonagazi Upazila, Feni District, 2011

4.6 Environmental Quality

4.6.1 Air Quality

The objective of the ambient air quality monitoring program was to establish the baseline ambient air quality in the study area. The profile of the study area is rural, which has mix of scattered settlements, bazar and agriculture areas. Generally, air pollution sources in the Project study area consists of road dust, black smoke from diesel engine vehicles, construction dust, and windblown dust from agricultural lands, domestic heating and cooking.

The air quality monitoring locations were selected based on the locations of settlements and receptors within the study area. 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.

4.6.1.1 Methodology of Air Quality Monitoring

The ambient air quality of the study area was monitored at Four (4) locations once during the dry season (February 2017) and once during the wet season (May 2017). The monitoring parameters included Particulate Matter (SPM, PM10, and PM2.5), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO). All the parameters except CO and SPM were monitored on 24-hourly during the duration of the study.

Selection of Sampling Locations

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The ambient air quality monitoring locations were based on the following aspects covered in field survey plan developed prior to the field work:

- Meteorological conditions of the area based on information of BMD observatory at Feni;
- Topography of the study area; and
- Location of sensitive receptors such as major settlements;

The particulate and gaseous samples collected during the monitoring have been analyzed as per the procedures specified in **Table 4-7.** The geographical locations and setting of the ambient air quality monitoring locations have been presented in **Table 4-8** and **Figure 4-11**.

Table 4-7: Methodology for Analysis of Ambient Air Quality

Sl	Parameter	Analysis procedure
1.	SPM	Gravimetric method
2.	PM10	Gravimetric method
3.	PM2.5	Gravimetric method
4.	SO_2	Colorimetric method at 560nm using spectrophotometer (West-Gaeke method)
5.	NOx	Colorimetric method at 540 nm using spectrophotometer (Jacob and Hochheiser method)
6.	CO	Digital CO meter

Table 4-8: Ambient Air Quality Sampling Locations

Sl.	Sampling Station	Station Code	Geographic Location
1.	Project area	AQ1	22°47'27.42"N 91°21'56.19"E
2.	Adarsha village	AQ2	22°48'09.5"N91°22'55.4"E
3.	Purbo Barodhuli village	AQ3	22°47'50.5"N91°21'43.4"E
4.	Musapur Civic	AQ4	22°46'24.0"N91°21'07.3"E

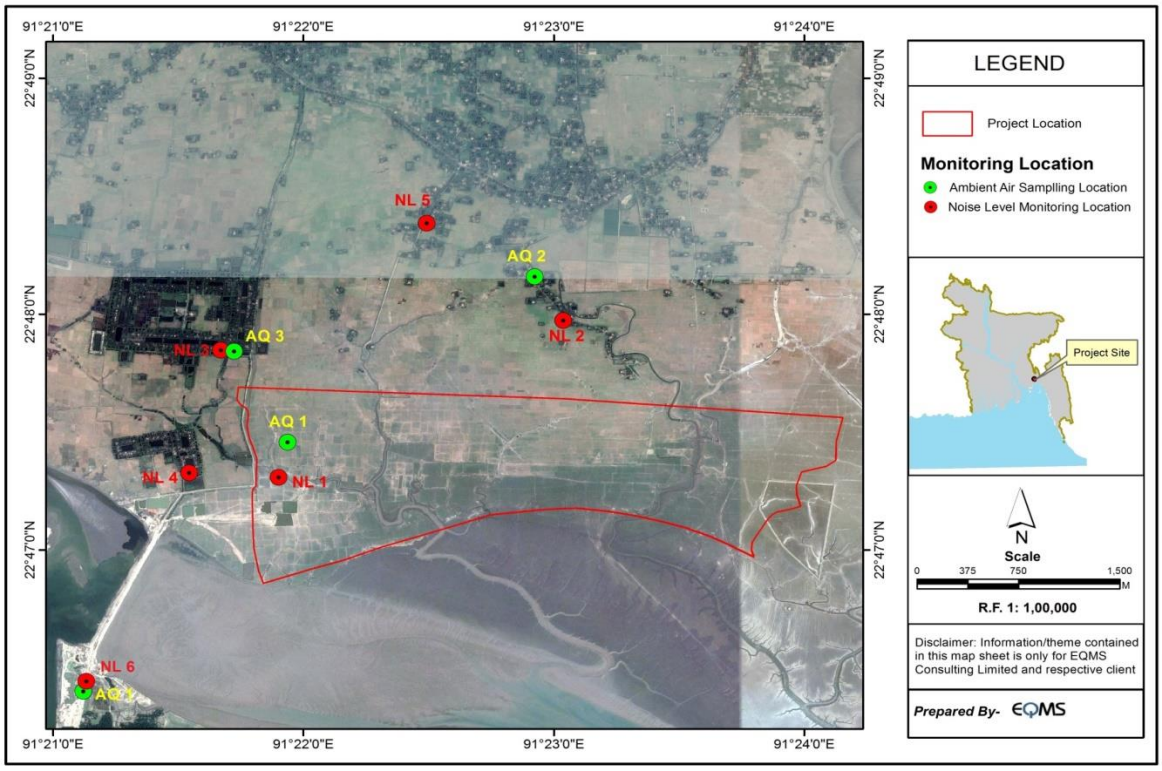


Figure 4-11: Air Quality and Noise Level Monitoring Location

4.6.1.2 Ambient Air Quality in the Study Area

The monitored ambient air quality is summarized in **Table 4-9.**

Table 4-9: Ambient Air Quality in the Study Area

Location	Sampling Date	Concentration (µg/m³)					PPM
		$PM_{2.5}$	PM_{10}	SPM*	SO_2	NOx	CO*
Project area	25.02.2017 (Dry)	18.3	47.4	85.4	3.8	7.8	<1
	2.05.2017 (Wet)	16.8	35.4	73.5	3	68	<1
Adarsha VIllage	26.02.2017 (Dry)	22.5	56.2	98.5	6.7	11.3	<1
	3.05.2017 (Wet)	19.5	46.8	84.2	5.7	8.4	<1
Purbo Barodhuli village	27.02.2017 (Dry)	24.5	50.1	90.8	6.2	8.6	<1
	4.05.2017 (Wet)	21.6	40.1	79.8	5.0	7.3	<1
Musapur Civic	28.02.2017 (Dry)	34.1	66.8	120.4	9.4	18.9	1
	5.05.2017 (Wet)	25.8	58.4	97.5	8.3	12.3	<1
Bangladesh Standard (ECR'97)**		**65 (24 hr)**	**150 (24 hr)**	**200 (24 hr)**	**365 (24 hr)**	**100 Annual**	**9 (8hr)**
Duration (hr)		**24**	**24**	**8**	**24**	**24**	**8**

Source: Air quality analysis done by EQMS Consulting Limited, 2017

Date of analysis: 2nd March to 10th March, 2017and 7th May to 16th May 2017

Note:

* SPM and 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.

4.6.1.3 Analysis and Discussion of Result

SPM

The 8-hourly SPM concentration in ambient air in the study area was recorded in the range of 85.4-120.4 µg/m³ during the dry season and 73.5-97.5 µg/m³ during the wet season. During the monitoring period, the maximum SPM concentration was reported (Dry Season) from Musapur Civic as 120.4 µg/m³. SPM concentrations at this location are primarily due to traffic movement. SPM level of all locations was reported below the National Ambient Air Quality Standards of Bangladesh. The SPM concentration of the project study is shown in **Figure 4-12**.

	AQ1	AQ2	AQ3	AQ4
Dry	85.4	98.5	90.8	120.4
Wet	73.5	84.2	79.8	97.5
Standard	200	200	200	200

Figure 4-12: SPM Concentration in the Project Study Area

PM_{10}

The 24-hourly PM10 concentration in ambient air in the study area was recorded in the range of 35.4 – 66.8µg/m³. During the monitoring period, the maximum PM10 concentration was reported (Dry Season) from Musapur Civic as 66.8 µg/m³. PM10 level at all monitoring locations was reported below the NAAQS. The PM_{10} concentration of the project study is shown in the following **Figure 4-13**.

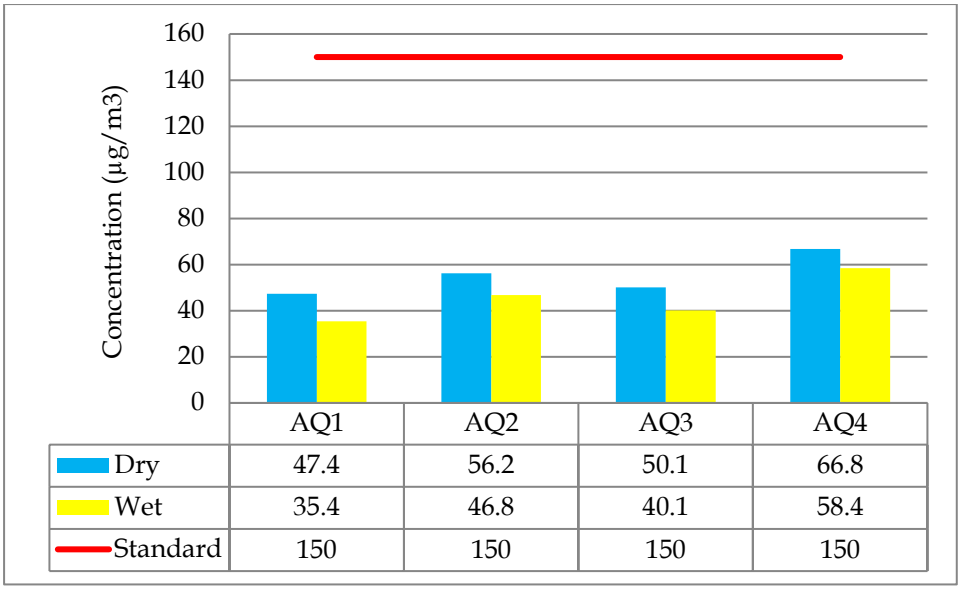


Figure 4-13: PM_{10} Concentration in the Project Study Area

$PM_{2.5}$

The 24-hourly PM2.5 concentration in ambient air in the study area was recorded in the range of 16.8 – 34.1µg/m³. During the monitoring period, the maximum PM2.5 concentration was reported at Musapur Civic as 34.1µg/m³ during the dry period. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ in Bangladesh. The $PM_{2.5}$ concentration of the project study is shown in the following **Figure 4-14**.

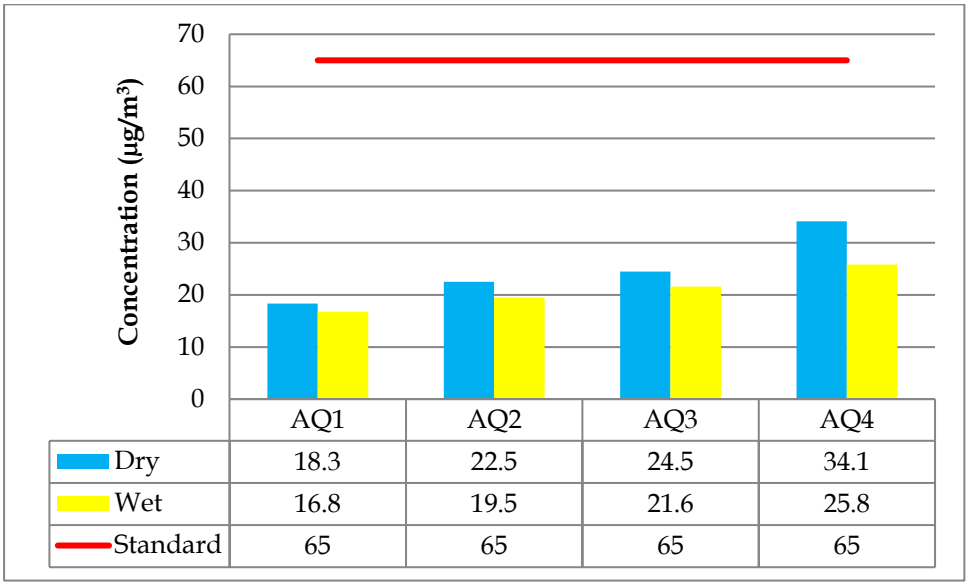


Figure 4-14: $PM_{2.5}$ Concentration in the Project Study Area

SO_2

The 24-hourly SO_2 concentration was recorded in the range of 3.0 – 9.4 µg/m³. During the monitoring period, the maximum SO_2 concentration is reported at Musapur Civic as 9.4µg/m³ during the dry period due to the vehicle movement. SO_2 concentrations at all the

monitoring locations were reported well below 365µg/m³, which is National Ambient Air Quality Standard (NAAQS) for SO_2 in Bangladesh.

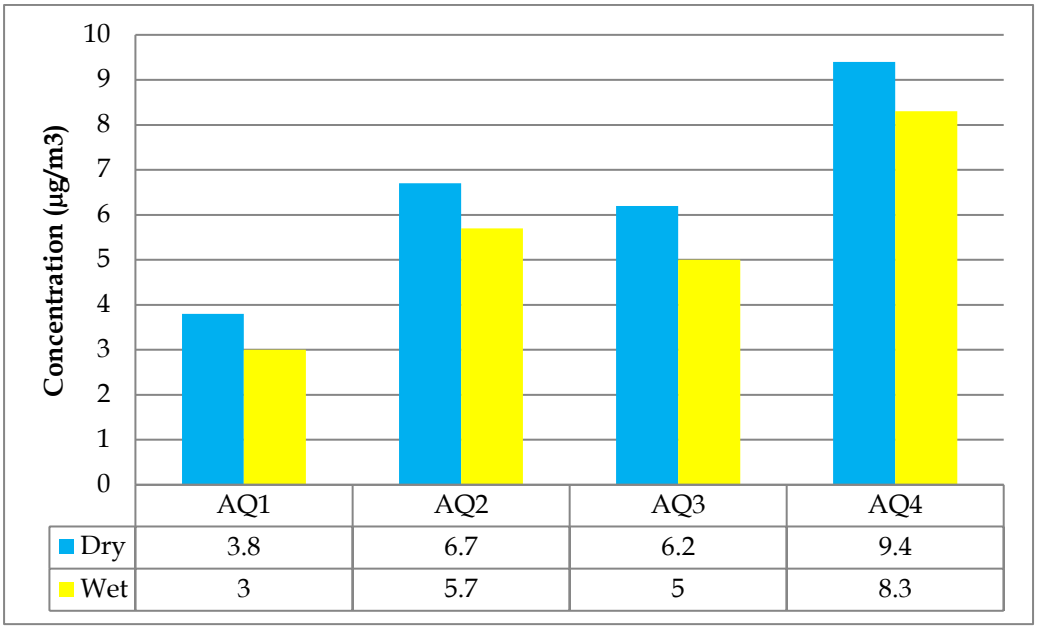


Figure 4-15: SO_2 Concentration in the Project Study Area

NOx

The 24-hourly NOx concentration was recorded in the range of 6.8 – 18.9µg/m³. During the monitoring period, the maximum NOx concentration is reported at Musapur Civic as 18.9µg/m³ during the dry period. There is no stipulated standard for 24-hourly NOx concentration in Bangladesh. The annual Bangladesh standard values for NOx are 100µg/m³ and present concentrations at all the locations are well below these values. The NOx concentration in the project study area is shown in **Figure 4-16**.

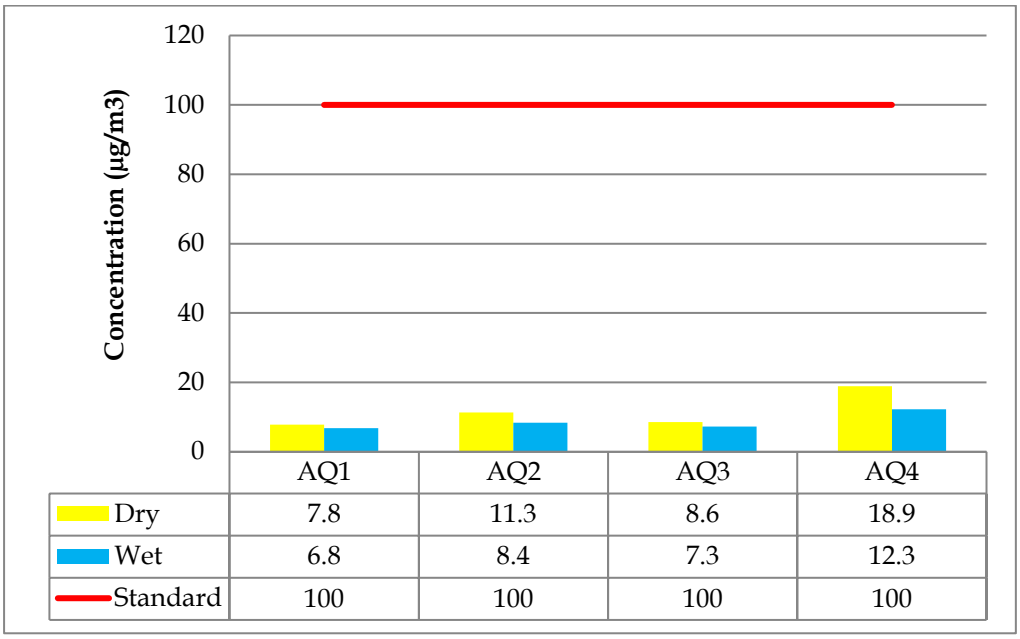


Figure 4-16: NOx Concentration in the Project Study Area

CO

The 8-hourly CO concentration in ambient air in the study area was recorded below the national standard level. Only the CO concentration is found 1 ppm in the Musapur Civic location whereas rest of the locations found less than 1 ppm. Present CO concentration is low at all the monitoring locations while comparing with the Bangladesh Standard (9 ppm).

4.6.2 Noise Level

Noise levels were recorded at six (6) locations in the study area during the monitoring period. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The details of noise monitoring locations are given in **Table 4-10** and shown in **Figure 4-11** .The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations are chosen in such a way that a representative data could be recorded all over the project site. The sound level is recorded in form of A-weighted equivalent continuous sound pressure level values with the use of A-weighting filters in the noise measuring instrument. The noise level of the project site and surrounding study area is shown in **Table 4-10.**

Table 4-10: Details of Ambient Noise Monitoring Locations

Sl.	Code	Location	Geographic location	Location Setting
1.	NL1	Project area	22°47'18.46"N 91°21'54.04"E	Silent area
2.	NL2	In front of Abdul Sukkur House	22°47'58.4"N 91°23'02.2"E	Residential Area
3.	NL3	In front of Mosaraf Hossain House	22°47'50.8"N 91°21'40.2"E	Residential Area
4.	NL4	In front of Yaseen house	22°47'19.6"N 91°21'32.6"E	Residential Area
5.	NL5	In front of South char chandina Mosque	22°48'23.1"N 91°22'29.5"E	Silent area
6.	NL6	Musapur bazar	22°46'26.6"N 91°21'08.0"E	Commercial Area

Noise level monitoring was carried out for 24 hours during monitoring period with 1-min equivalent sound pressure levels. At all the locations, measurement was taken at 1-min intervals over a 24 hour period. The equivalent noise levels have been converted to hourly equivalent noise levels. Finally, the measurements were carried out by dividing the 24 hours into two parts, i.e. daytime, which is considered from 0600 to 2100 hours and night from 2100 to 0600 hours. At each location, daytime Leq has been computed from the hourly sound pressure level values measured between 0600 to 2100 hours and nighttime Leq has been computed from the hourly sound pressure level values measured between 2100 to 0600 hours.

Observation

The recorded noise level in the project study area during the monitoring period is summarized in **Table 4-11**. The equivalent sound pressure level during day and night time measured during the monitoring period is presented in **Figure 4-17**.

Table 4-11: Noise Levels in the Study Area

Sl.	Location	Noise Level dB (A)				Location Setting*	Bangladesh Standard dB (A)**	
		Leq_{day}	Leq_{night}	L_{max}	L_{min}		Day	Night
1.	Project area	45.8	38.4	52.1	36.7	Silent Area	50	40
2.	In front of Abdul Sukkur House	48.9	40.4	59.1	37.2	Residential Area	55	45
3.	In front of Mosaraf Hossain House	46.7	40.8	57.1	37.5	Residential Area	55	45
4.	In front of Yaseen house	45.5	41.1	60.1	36.3	Residential Area	55	45
5.	In front of South char Chandina Masque	42.5	39.3	59.2	37.8	Silent Area	50	40
6.	Musapur bazar	53.6	47.2	65.3	44.3	Commercial Area	70	60

Source: Field Survey by EQMS 24th to 28th February, 2017, Data analysis: 1st March to 7th March

*Location setting (according to Environmental Quality Standard 1997 and subsequent amendment in 2006)

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

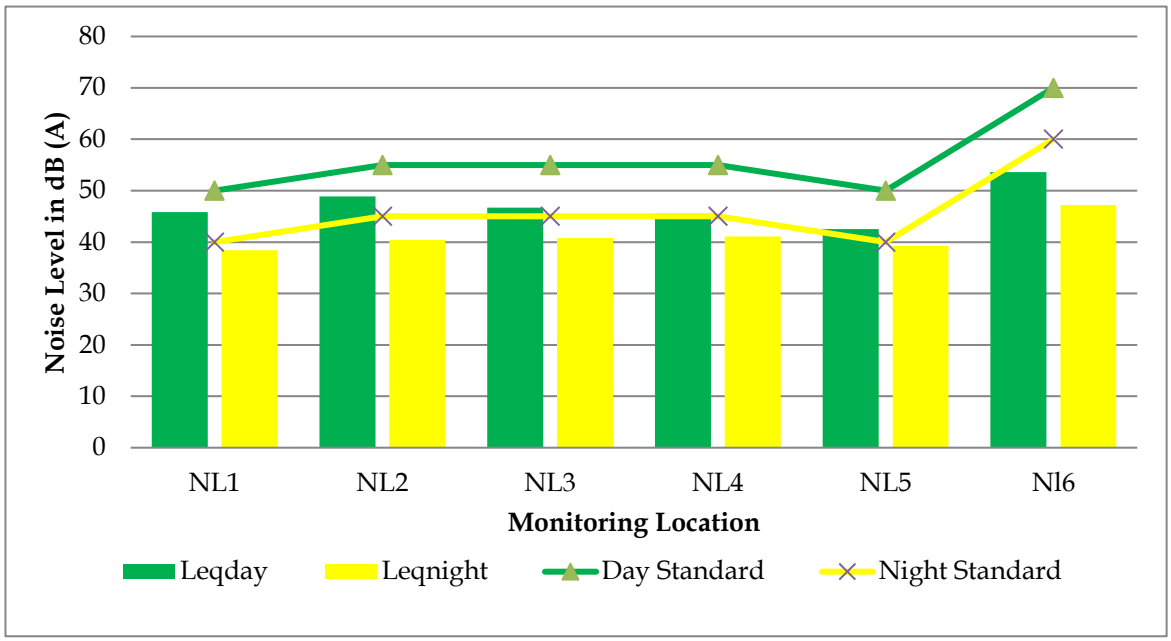


Figure 4-17: Noise Level Recorded in the Study Area

Ambient daytime noise level **(Leq_{day})** was recorded in the range of 42.5 to 53.6 dB (A). Whereas, ambient night time noise level (**Leq_{night}**) in the study area varied in the range of 38.4 to 47.2 dB (A). Maximum noise levels (**L_{max}**) at the monitoring locations were recorded in the range of 52.1 to 65.3 dB (A) and the minimum noise levels (**Leq_{min}**) at the monitoring locations were recorded in the range of 36.3 to 44.3 dB (A). All noise levels were within the standard limit of ECR'97.

4.6.3 Water Quality

Water sampling and analysis were undertaken to understand the overall baseline water quality characteristics of the surface water and groundwater in the study area. Samples were taken from representative selected water bodies and groundwater sources representing different parts of the study area. The surface water sampling was based on the identification of major surface water bodies. Groundwater sampling locations were selected to obtain a representative water sample from within the study area. The samples were collected from existing tube wells (hand-pumps) being used by the villagers. A total of 4 samples, Two (2) surface water and two (2) groundwater samples were collected. Detail of the sampling location is provided in **Table 4-12** and shown in **Figure 4-18 .**

Table 4-12: Details of Surface and Ground Water Sampling Locations

Sl.	Sampling location	Sampling Code	Geographic location	Type of Source
1.	Project area	SW1	22°47'06.0"N 91°21'53.4"E	Pond
2.	Feni River (Near Char khandakar Jele para)	SW2	22°49'23.1"N 91°24'47.7"E	River
3.	Abul khayer house (Adorsho village)	GW1	22°47'51.7"N 91°21'46.5"E	Tubewell
4.	Abdul Haque house (Purbo Baradholi)	GW2	22°47'51.6"N 91°23'12.3"E	Tubewell

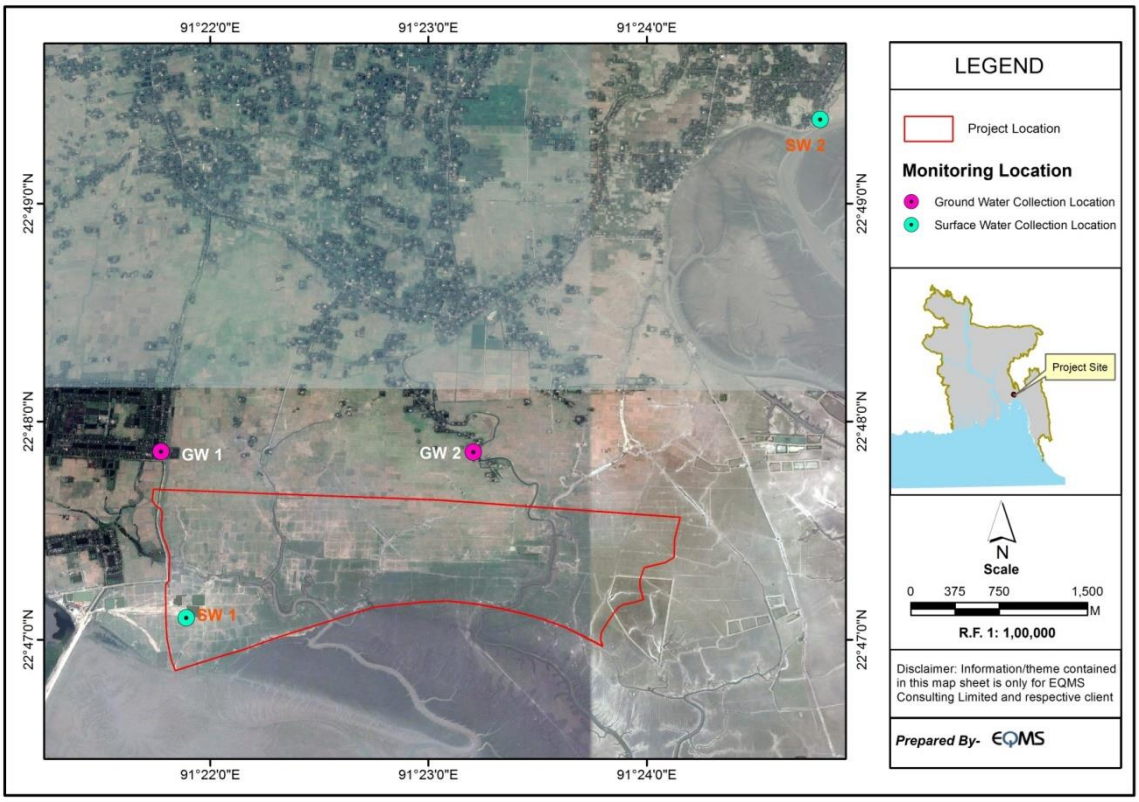


Figure 4-18: Surface Water and Ground Water Sampling Location

The samples were analyzed for parameters covering Bacteriological and physicochemical characteristics which include certain heavy metals and trace elements.

Water samples were collected as grab water sample in a pre-washed 5-liter plastic jerry can 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. Details of the analysis method are presented in **Table 4-13.**

The quality of surface water was compared with the standards for Inland Surface Water, Environment Conservation Rules (ECR), 1997-Schedule 3 (a) whereas the groundwater was compared with the Drinking Water Standard ECR-Schedule-3 (b), 1997. The standards have been presented along with the monitoring results of surface water and groundwater for comparison.

Table 4-13: Method for Water Analysis

Sl.	Parameter	Analysis Method
1.	Temperature	Digital Thermometer
2.	pH	pH meter
3.	Dissolved Oxygen (DO)	Digital DO Meter
4.	Total Dissolved Solids	Digital TDS meter
5.	Alkalinity	Titrimetric
6.	Electrical Conductivity (EC)	Digital EC meter

Sl.	Parameter	Analysis Method
7.	Chemical Oxygen Demand (COD)	CRM
8.	Biological Oxygen Demand (BOD)	5 days Incubation
9.	Nitrate	Spectrophotometer
10.	Nitrite	Spectrophotometer
11.	Salinity	Digital Salinity meter
12.	Fecal Coliform	Membrane Filtration Procedure
13.	Total Coliform	Membrane Filtration Procedure
14.	Iron as Fe	Atomic Absorption Spectrophotometer
15.	Total Hardness	Titrimetric
16.	Chloride	Titrimetric
17.	Fluride	UV-Visible Spectrophotometer
18.	Arsenic	Atomic Absorption Spectrophotometer

4.6.3.1 Surface Water Quality

The surface water Quality was compared with the Bangladesh ECR standard for best practice based classification criteria. **Table 4-14** shows the analysis results. Some of the water analysis parameters are discussed below in detail:

pH

All results for pH in surface water were within the permissible limits of 6.8-8.2.

Dissolved Oxygen (DO)

The DO of all samples range in between station is 5.2-6.7 mg/l that meet the criteria of inland surface water quality standard of Bangladesh. The water is usable for fisheries.

Biological Oxygen Demand (BOD)

The BOD levels range between is 3-7 mg/l which is usable for fisheries. DO level was less during the dry period than the wet season.

Table 4-14: Surface Water Quality Analysis Result

Parameter	Unit	Sampling Location				Bangladesh Standard*					
		SW1		SW2		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
		22°47'06.0"N 91°21'53.4"E		22°49'23.1"N 91°24'47.7"E							
		Dry	Wet	Dry	Wet						
Temperature	°C	27.5	34.3	27.6	32.2	--	--	--	--	--	--
BOD_5	mg/l	4	3	7	5	2 or less	3 or less	3 or less	6 of less	10 or less	10 or less
COD	mg/l	9.5	6.4	5.6	2.6	--	--	--	--	--	--
DO	mg/l	5.2	5.4	6.3	6.7	6 or above	5 of more	6 or more	5 or more	5 or more	5 or more
EC	µS/cm	876	287	200	158	--	--	--	--	--	--
pH	--	7.8	7.4	7.7	6.8	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5
TDS	mg/l	4400	2400	6500	5200	--	--	--	--	--	--
Salinity	ppt	3.3	0.16	9.8	6.07						
Nitrate	mg/l	0.04	0.08	0.12	0.09						
Nitrite	mg/l	0.56	0.023	0.017	0.027	--	--	--	--	--	--
Phosphate	mg/l	2.93	6.45	0.714	6.48	--	--	--	--	--	--

Source: Sampling Date: 27th February and 13th May

Temperature, DO, EC, pH, TDS and Salinity parameters tested in field by EQMS Personnel dated on 27th February & 13th May

BOD_5, COD, Nitrate, Nitrite and Phosphate parameters tested in DPHE central laboratory from 1st March-15th March and 14th May -28th May 2017

* Bangladesh Environment Conservation Rules, 1997- Schedule 3 (Standards for inland surface water)

4.6.3.2 Ground Water Quality

The results of two groundwater samples collected from the Abul khayer house (Adorsho village) and Abdul haque house (Purbo Baradholi) is shown in **Table 4-15**.

In 1993, Department of Public Health Engineering (DPHE) first detected arsenic in hand tube wells (HTWs) and arsenic contamination has become one of the most pressing environmental issues in Bangladesh. The World Health Organization has defined the tolerance limit of arsenic for drinking water as 0.01mg/L, while the Bangladesh standard for arsenic in drinking water is 0.05mg/L. The arsenic content of the project site is <0.01 mg/l which is within the Bangladesh Standards (0.05mg/l).

Peoples in this area use surface water for their domestic purposes and use deep tube wells (900-1200 feet) water for drinking.

In February & May 2017, Groundwater samples were collected by EQMS from deep tube wells in the project area surrounding the area. The result of the groundwater and the GoB standards for potable water (ECR, 1997) are shown in **Table 4-15**. The concentration levels of pH, Temperature, Electrical conductivity, Total dissolved solids, Salinity, Total Hardness, Total Alkalinity, Chloride, Arsenic, Fluoride, Fecal Coliform and Total Coliform for tube well were found within the acceptable limit set by the DOE, GoB for drinking water. According to the overall water quality data, practically good quality and quantity of groundwater are available in and around the project site.

Table 4-15: Groundwater quality analysis

Parameter	Unit	Concentration				Standard (ECR, 1997)
		GW1		GW2		
		Dry	Wet	Dry	Wet	
Temperature	°C	27.3	27.5			--
pH	-	7.10	7.12	7.04	7.09	6.5-7.5
EC	µS/cm	301	390	400	410	--
TDS	mg/l	200	190	150	130	1000
Salinity	ppt	0.12	0.16	0.11	0.19	--
Fluride (F)	mg/l	0.30	0.31	0.26	0.28	1.0
Total Alkalinity	mg/l	180	170	175	190	--
Chloride (Cl)	mg/l	10	12	13	15	150-600
Arsenic (As)	mg/l	0.001	0.001	0.002	0.002	0.05
Total Hardness	mg/l	180	190	200	230	200-500
Fecal Coliform	n/100L	0	0	0	0	0
Total Coliform	n/100L	0	0	0	0	0

Source: Sampling Date: 27th February and 14th May

Temperature, EC, pH, TDS and Salinity parameters tested in field by EQMS Personnel dated on 27th February & 13th May

Fluride, Total Alkalinity, Chloride, Arsenic, Total Hardness, Fecal Coliform and Total Coliform parameters tested in DPHE Central Laboratory from 1st March-15th March and 14th May -28th May 2017

The key parameters in groundwater are discussed below, compared with the Bangladesh ECR Standards for drinking water.

pH

The pH of all samples ranges 7.04 - 7.12, which is well within the standard range of 6.5 to 8.5.

Total Dissolved Solid (TDS)

The TDS contain the range 130-200 mg/l, which is within the range of Bangladesh Standard (ECR'97).

Chloride

The chloride contains in the range 10-15 mg/l. which is below the permissible standards of 150-600 mg/l.

Arsenic

The Arsenic content of both the samples is <0.01 mg/l which is below the Bangladesh Standard (ECR'97).

Coliform

Both Fecal and Total Coliform are absent in both the samples.

4.7 Traffic

Total tree primary traffic surveys were conducted during 27th – 28th February 2017 of which one was on the access road and other two were river traffic for Choto Feni River and Feni River. The traffic surveys were conducted for 24 hours. Road traffic survey was conducted during the survey period on the Musapur civic road that is passed western side of the project site and connected with Musapur closer. Musapur civic road is selected for the road traffic survey to understand the traffic load as the road will be used for carrying the construction material. River traffic survey was also conducted at two locations; near Char Khandakar Jele para (Feni River) and near Musapur Regulator (Choto Feni River). The details of the road and water traffic have been shown in the following **Table 4-16** and depicted in **Figure 4-19**.

Table 4-16: Details of Road and River Traffic Survey

Sl.	Location	Code	Geographic Location
1.	Musapur civic road (Near Project Location)	RT1	22° 47.795'N 91° 21.789'E
2.	Near Musapur Regulator (Choto Feni River)	WT1	22° 46.134'N 91° 21.027'E
3.	Char khandakar Jele para (Feni River)	WT2	22° 49.330'N 91° 24.733'E

Source: EQMS Field Survey

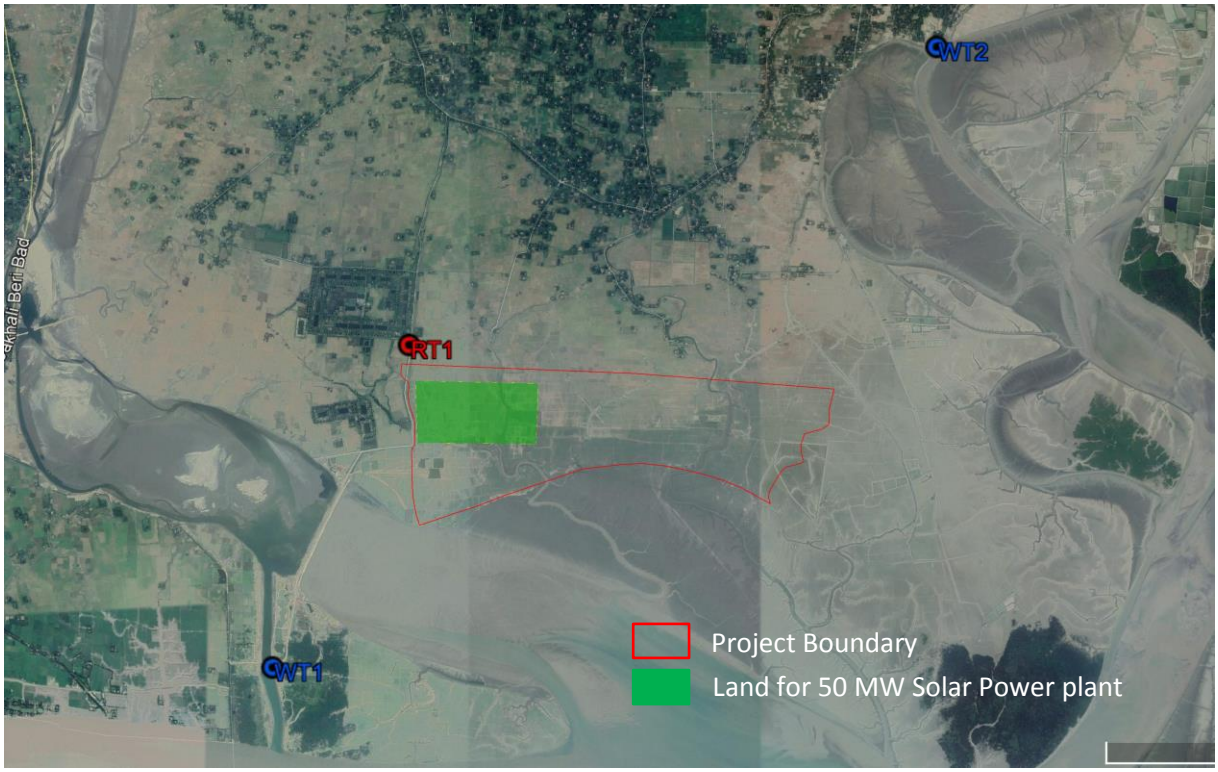


Figure 4-19: Road and River Traffic Survey Locations

4.7.1 Road Traffic

The road traffic survey was conducted for 24 hours, once during the study period at one location at the approach road to the proposed project. The traffic survey was conducted for both way movement of vehicles and categorization as a Medium vehicle (tractor/power tiller), light vehicle (private car, auto rickshaw, CNG, motorcycle) and non-motorized vehicle (rickshaw, cycle etc.).

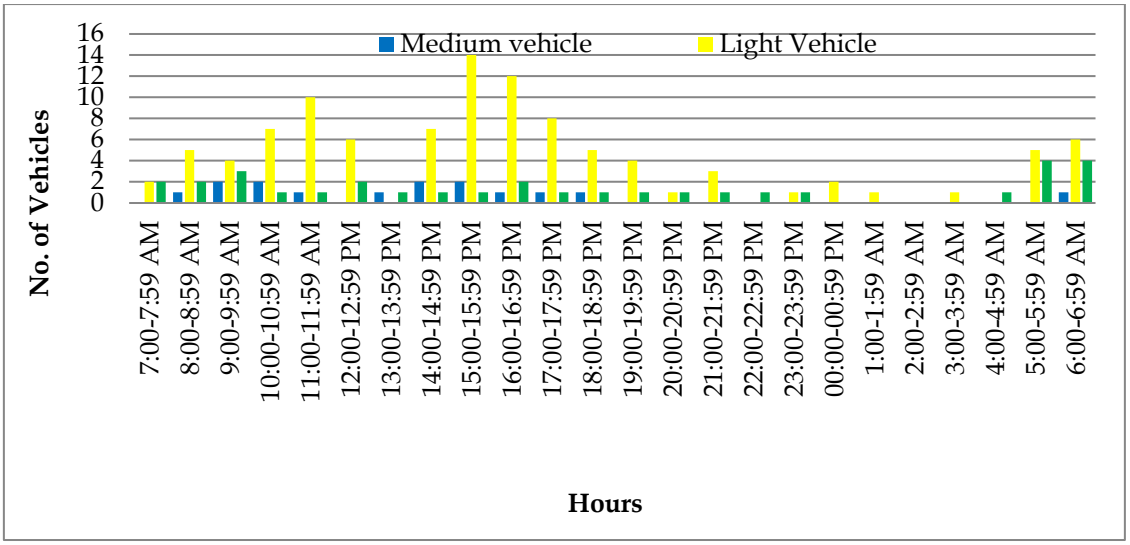
Total no. of vehicles recorded on the road for 24 hours are 151 including 15 medium vehicles, 104 light vehicles, and 32 non- motorized vehicle. Maximum traffic volume of 17 vehicles in an hour was recorded between 3.00 pm to 4.00 pm. The frequency of the medium vehicle (9.93%), light vehicle (68.87%) and non-motorized vehicle (21.19%) respectively.

A summary of traffic survey results is presented in **Table 4-17** and hourly movements of vehicles are presented in **Figure 4-20.**

Table 4-17: Status of Road Traffic

Sl#	Vehicle type	Numbers/Time
1.	Total traffic volume (Nos)/24 hr	151
2.	Average traffic volume/hr	6
3.	Max Traffic volume (Nos)/hr	17
4.	Min traffic volume (Nos)/hr	0
5.	Minimum traffic flow hours	2.00 am to 2.59 am
6.	Maximum traffic flow hours	15.00 pm to 15.59 pm

Source: Field Survey, February 2017



Source: Field Survey, February 2017

Figure 4-20: Hourly Road Traffic Volume

Movement of man, material, and machinery to the site is expected during the construction and operation stages of the project. This is likely to result in an increase in traffic movement on the project surrounding the area. It is understood that equipment can be transported to the project site by road after improvement of the existing road.

4.7.2 River Traffic

The river traffic survey was conducted continuously for 24 hours, once during the study period at two locations in Feni River near Char khandakar Jele para and near Musapur Regulator (Choto Feni River). The river traffic survey was done for both way movement of river traffic and categorized as a fishing boat (motorized), trawler (goods carrying), passenger service boat (large), fishing boat (Non- motorized).

A total number of vessels recorded in 24 hours, details status shows in **Table 4-18** and depicted in **Figure 4-21** and **Figure 4-22.**

Table 4-18: Status of River Traffic

Sl#	Vehicle type	Char Khandakar Jele para (Feni River)	Musapur Regulator (Choto Feni River)
1.	Total river traffic count (Nos)/24 hr	326	77
2.	Average Vehicle count /hr	26	6
3.	Max Vehicle count (Nos)/hr	38	7
4.	Min Vehicle count (Nos)/hr	0	0
5.	Min Vehicle Movement Hours	9:00 am – 9:59 am, 16:00 pm -17:59 pm	1:00 pm -1:59 pm
6.	Max Vehicle Movement Hours	12:00 pm -12:59 pm	10:00 am -10:59 am

Source: Field Survey, February 2017

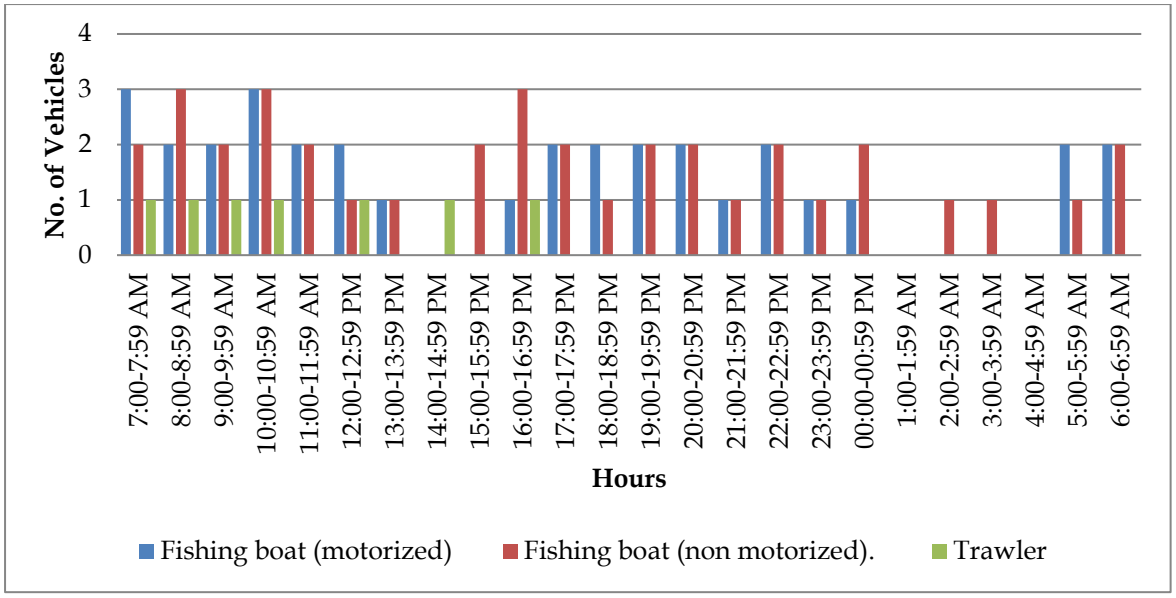


Figure 4-21: Hourly movement of River Traffic at Musapur Regulator

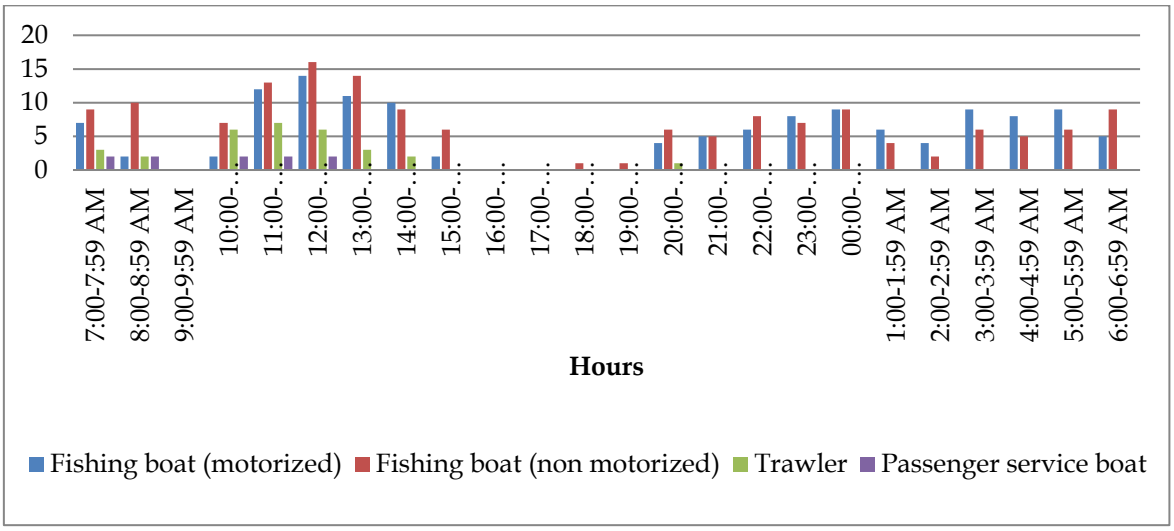


Figure 4-22: Hourly movement of River Traffic at Khandakar Jele para

4.8 Biological Environment

4.8.1 Introduction

This section deals with the methodology for biodiversity assessment of Flora (tree, shrubs, herbs) and Fauna (birds, reptiles, amphibians, mammals) as well as the surrounding ecosystems. Most of the field work within the Project study area addressed these groups although each group was dealt with different approaches and requirements. A four-person multidisciplinary team was organized to deal with these various aspects (Table 4-19). A 5 km radial zone around the Project site has been taken into consideration to establish the representative baseline in the study area.

Table 4-19: List of Ecological Team

Sl.#	Name	Field of Expertise
1	Mirza Shamim Ahsan Habib	Wild Life Expert
2	Md. Karimul Islam	Botanist

Sl.#	Name	Field of Expertise
3	Jahangir Alam	Fisheries Expert
4	Abdullah Sadique	Wild Life Expert / Bird expert

4.8.2 Ecology and Biodiversity

The biodiversity component of the study focused on a few groups of biological components comprising of flora, birds, reptiles, amphibians, mammals, Butterflies, Fisheries as well as the surrounding ecosystems. The overall objective of this study is to establish the baseline data for flora and fauna of this proposed project study area. A multidisciplinary team related to ecology (terrestrial & aquatic) has been engaged in order to conduct the study profoundly.

4.8.3 Objectives of Ecological Study

The study was undertaken with the following broad objectives:

- Assess the status of major floral and faunal components of all the terrestrial habitats (forest, grassland, fallow land, riverine land, agro-ecosystem and homestead plantation) present in the Project AOI (including the project site) adopting different standard techniques;
- Collection and compilation of secondary information on the status of floral and faunal components and habitats from the concerned stakeholders – Forest Department and others;
- Provide quantitative information on different floral and faunal components: using statistical analysis and derive diversity indices;
- Identification and listing of floral and faunal species of conservation significant (CR, EN, VU and threatened and endemic species in accordance with the International Union of Conservation for Nature - IUCN RED List/ MoEF) in the Project AOI;
- Identification of areas of conservation significance (Protect Areas: Sanctuary, National Parks, Biosphere Reserve, landscape and Sacred grows- pertaining to Floral diversity) areas in the vicinity of the (within 5 km Radius) Project AOI; and
- Assess the status of floral and fishes of perennial aquatic habitats (ponds and rivers) present in the Project AOI (Including the project site).

4.8.4 Flora

Ecological surveys were undertaken in May 2017 in the project area using quadrate sampling method for different habitats. Different quadrate sizes for a different type of vegetation were taken. It has been done quadrates study in the project area of different floral aspects. The ecology team has been counted the different floral species in the project area. The floral quadrates study has been included homestead plantation; agricultural crops species, fallow land species, grassland species and so on. But, there is no any existing homesteads as well as a natural plantation in the project site except grassland. The team has been taken three blocks for grassland species in the project site, homestead plantation and forest land plantation in the project study area. The Quadrates study details have been provided in **Table 4-20**.

Table 4-20: Quadrates Study of Flora Species

Vegetative types	Area	Quadrates	GPS coordinates
Grass Land (3 Quadrates each of size 1 m X 1 m)	Southern part of the project site	GLQ1	22°47'27.09"N 91°21'55.99"E
	Sothern part of the project	GLQ2	22°47'26.08"N 91°22'22.85"E
	South-Eastern part of the project	GLQ3	22°47'16.77"N 91°22'27.01"E
Homestead Plantation (3 Quadrates each of size 10mX10m)	Adarsha Village	HP1	22°47'50.88"N 91°21'46.61"E
	Purbo Barodhuli village	HP2	22°48'27.51"N 91°22'31.34"E
	Purbo Barodhuli village	HP2	22°48'40.99"N 91°22'34.19"E
Forest land Plantation (3 Quadrates each of size 10mX10m)	Musapur Reserve Forest	FP1	22°46'13.88"N 91°21'7.79"E
	Musapur Reserve Forest	FP2	22°46'6.51"N 91°21'22.79"E
	Musapur Reserve Forest	FP3	22°46'0.32"N 91°21'22.41"E

The Primary data collection of different components of the project area conducted by using well established and accepted ecological methods in the different habitats. The field data collection was mainly based on biodiversity assessment of different floral elements such as trees, shrubs, climbers, herbs, and grasses.

Project site

Aquatic body at the project site

Grassland quadrates in the project site

Grassland on the project site

4.8.5 Fauna

The fauna survey mainly covers:–

- Birds
- Mammals
- Amphibians and Reptiles
- Butterflies
- Fisheries

4.8.5.1 Birds

The basic methods have been chosen called a "transect". The birds were identified either visually, by their calls or digitally recorded. This method involves identifying all the birds; it has been seen or heard while standing at a series of points along transects (Straight line through the site). Bird's counts were conducted at the start of first light which is before sunrise. It is also a time for maximum bird movement as birds through the bush to begin feeding. A systematic search in the project impact area (over a fixed area and/ or for a fixed time) such as the method specified here has been the added advantage of providing an index of the abundance of individuals and species. Nesting also considers during the survey tenure in the order identified the taxon. The reliability of the abundance index can be reduced by either overestimates or underestimates of bird numbers. To reduce overestimates, particularly when a member is observing, try to ensure that each individual bird is recorded only once. Hence, ensure that a least one member of the team was watching at all times. Focus Group Discussion (FGD) with local people (including villagers, school teachers, Mosque Imam, help us to get information of the local species available in the project area.

Digitally recorded Birds in the project area

Digitally recorded Birds in the project area

4.8.5.2 Amphibians and Reptiles

Amphibians and Reptiles have been assessed on an opportunistic basis by the team. For this inventory, it has been used a combination of diurnal and nocturnal time-recorded visual encounter surveys ("general surveys"), road driving with capturing digital image from the spot. Interviews were held with local people in the area to assess the presence of game species. Focus Group Discussion (FGD) with local people (including villagers, school teachers, Imam, help us to get information of the local species available in the project area).

4.8.5.3 Mammals

For mammal's inventory, it is generally huge challenging, time-consuming as well as costly. During the inventory of this project area with the stipulated short time, it has been followed "Observational methods" including imaging record by the digital camera, identification of dung or feces, footprint, tracks and others signs, night walks. Focus Group Discussion (FGD) with local people also consider this inventory of the project area.

4.8.5.4 Butterflies

Butterflies had been assessed during the walk-over surveys. Identification of butterflies was done by both visual characteristics. During the identification of the survey, priority had given to record the species presence through a digital medium. All Photographs with each species had reconciled in order to avoid duplications of species records.

4.8.5.5 Fisheries

The fish survey has been conducted based on FGD to the Fishermen and fish market, local people and secondary information for fish species in the project area. It has been considered different water body in the project area.

Fish species survey

4.8.6 Bio-Ecological Zone

Twenty-five bio-ecological zones have been delineated within Bangladesh by the IUCN. Six parameters were used to determine the areas including physiography, soil, rainfall and temperature, floral distribution, faunal distribution and flood depth (IUCN 2002). The project site covered Meghna Estuarine floodplain and Coastal and Marine water of bio-ecological zone (**Figure 4-23**).

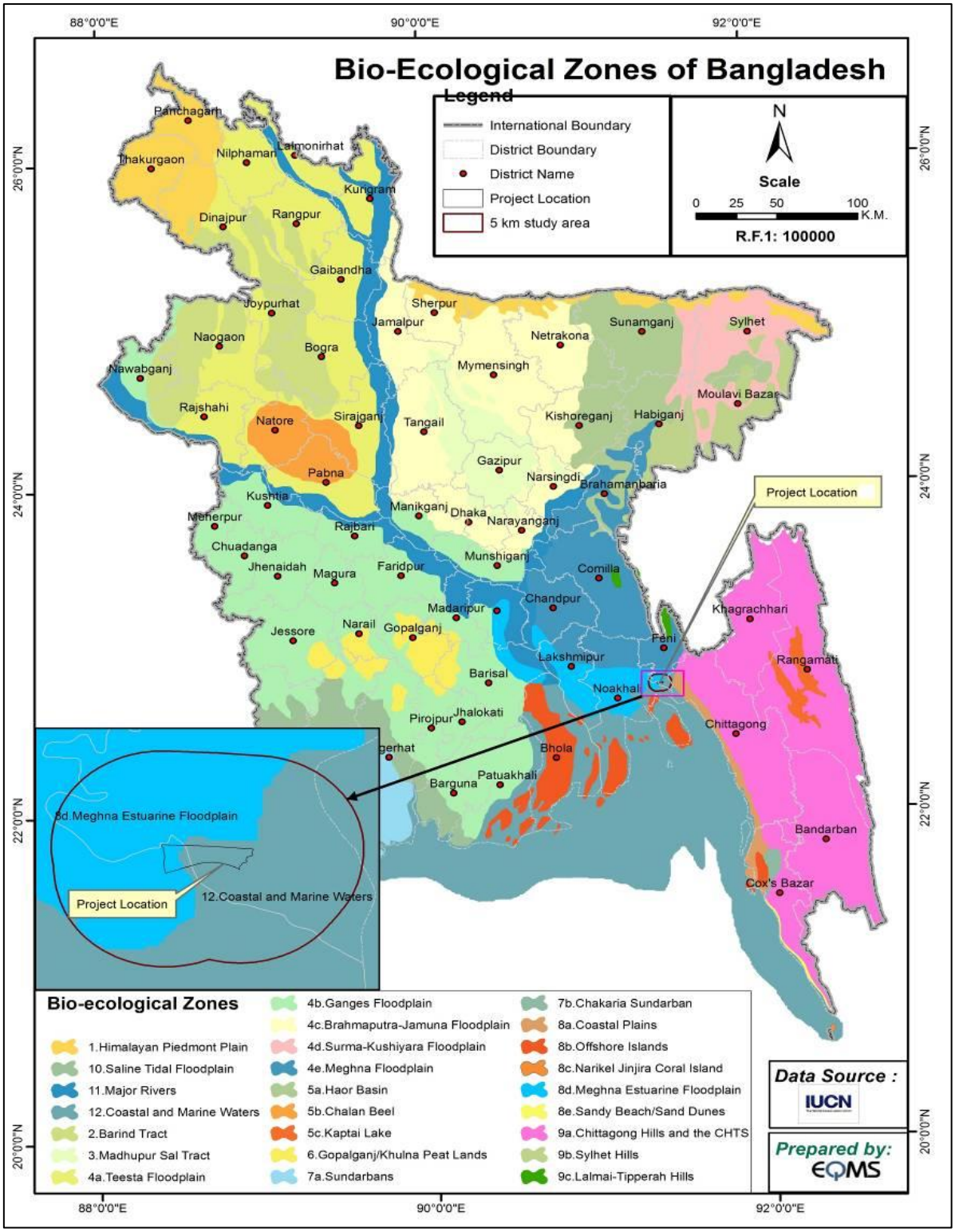


Figure 4-23: Bio-ecological Zone of the Project area

a. Meghna Estuarine Floodplain

Location : 22°45′-23°20′ N and 90°20′-91°27′ E
Relevant adm hq : Noakhali, Laxmipur, Barisal, Bhola
Physiography : Young Meghna estuarine floodplain
Soil : Calcareous alluvium (saline)

Rainfall : 2030-2790 mm
Temperature : Maximum 340 C, Minimum 120 C
Flooding depth : MH; H-MH
Land use : Fallow-Fallow-T. aman (5b); Boro-Fallow-T. aman (4a); Rabi-Aus- T. aman (2b).

A huge newly accreted mudflat is the main physiographic feature of the Meghna estuarine floodplain, which is mainly situated in the districts of Noakhali and Lakshmipur. Depositions and erosions are constantly taking place on the land margins, thereby continuously altering the shape of the land. During the dry season, in many, but not all, parts of the zone, the soil surface becomes saline in varying degrees. Flooding by salt water occurs primarily on the land margins during exceptionally high tides in the monsoon season and when storm surges associated with tropical cyclones occur. On the other hand, seasonal flooding, usually by rainwater or nonsaline river water, is mainly shallow but fluctuates tidally (Brammer, 1996).

Floral Diversity

Trees: Narikel (*Cocos nucifera),* Supari (*Areca catechu*)

Trees near water: Bhui dumur (*Ficus heterophyllus*), Pitali (*Trewia nudiflora*), Barun (*Crataeva nurvala)*

Aquatic plants: Binna ghash (*Vetiveria zizanioides*), Chechra (*Schenoplectus articulatus),* Hogla (*Typha angustata*)

Fauna diversity

Mammals: Jackal *(Canis aureus),* Common mongoose *(Herpestes edwardsi)*, Tickellos bat *(Hesperoptenus tickelli)*

Birds: Swamp francolin *(Francolinus gularis),* Indian skimmer *(Rynchops albicollis),* Black-headed ibis *(Threskiornis melanocephalus)*, Eurasian spoonbill *(Platalea leucorodia)*

Reptiles: Ring lizard (*Varanus salvator*), Bengal monitor (*Varanus bengalensis*), Copper head trinket snake *(Elaphe radiata)*

Amphibians: Maculated tree frog *(Polypedates maculatus)*, Boulengeros frog *(Rana alticola)*

b. Coastal and Marine Waters

There are over 25 million acres of marine area, which comprise the territorial waters and the Exclusive Economic Zone (EEZ) of Bangladesh. The coastline along the Bay of Bengal is 1200 kilometers 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.

The knowledge base on the status of the biological wealth, both in terms of floral and faunal, is very rudimentary of this zone. Nonetheless, some of the faunal species which are known to

occur in this zone include the Fin whale (*Balaenoptera physalus*), Humpback whale (*Megaptera novaeangliae*), various species of dolphins: e.g. the Ganges river dolphin (*Platanista gangetica*), Irrawaddy dolphin (*Orcaella brevirostris*), Indo-Pacific hump-backed dolphin (*Sousa chinensis*), all five species of marine turtles: the Loggerhead turtle (*Caretta caretta*), Green turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricata*), Olive ridley turtle (*Lepidochelys olivacea*), Leatherback turtle (*Dermochelys coriacea*), snakes, numerous migratory waterfowl, marine fishes, echinoderms, mollusks, etc (IUCN, 2000).

4.8.7 Biodiversity of Flora

4.8.7.1 Terrestrial Ecosystems

The quantitative surveys of plant ecology were conducted in different habitats to describe the vegetation availability within of the project study area. Both the floral and faunal survey had been conducted here to understand the overall terrestrial ecosystem prevails here. The Floral habitat has been described below.

a. Homestead Plantation

There is no any plantation species in the project area. The Ecology team has been considered homestead plantation and mangrove species for plant species survey.

It has been recorded 12 different plant species from 3 homestead plantation blocks and under the 8 families. Arecaceae family has been found maximum 3 times as well as Fabaceae, Myrtaceae families have been found two times among these 8 families.

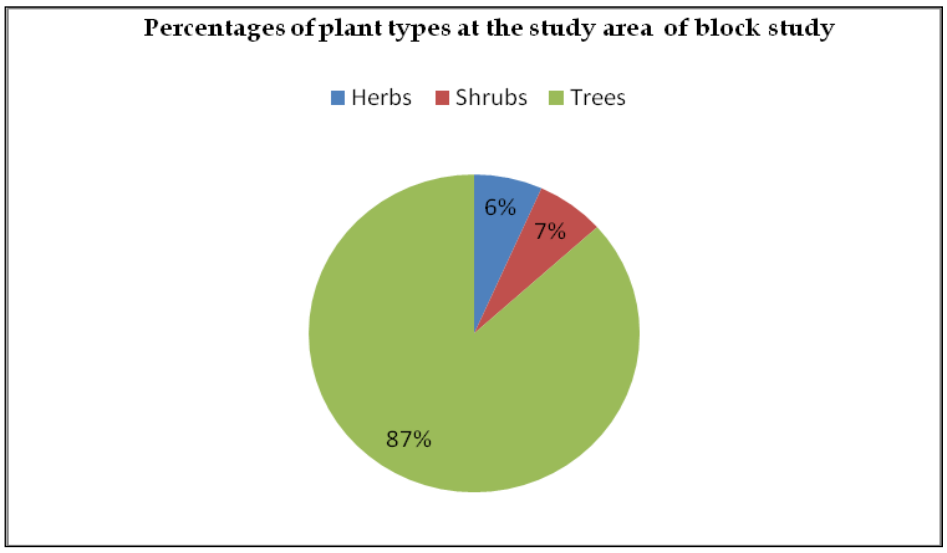


Figure 4-24: Types of plants species of Block study

Furthermore, maximum 87% has been found tree and rest of the 7% Shrubs and 6% Herbs in the study area block survey.

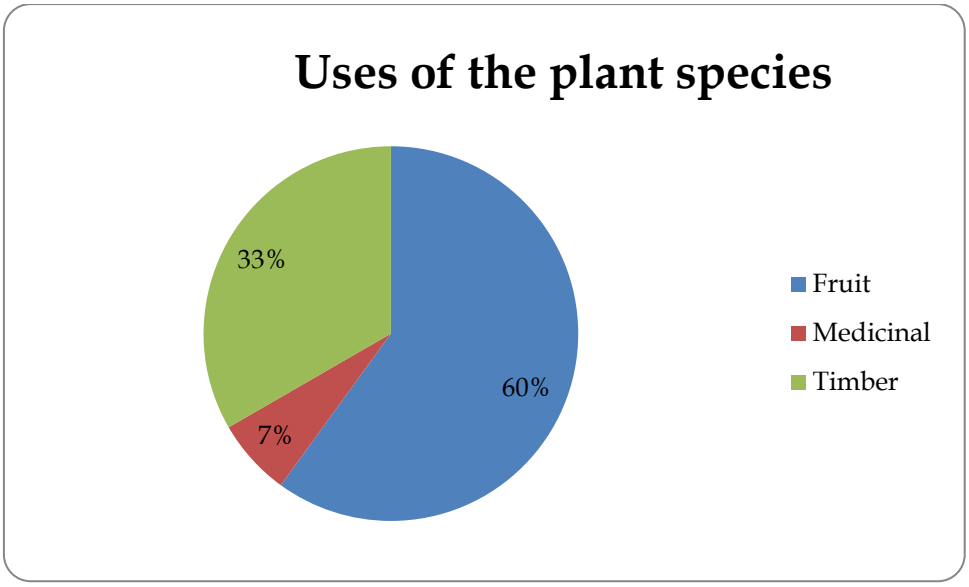


Figure 4-25: Uses of the plant species at study area block survey

In terms of use of plant species in a block, it has been found that maximum 60% fruits species, 33% timbers, and 7% Medicinal plant species. In the study area block survey, mostly dominated species are Mahagoni (*Swietenia mahagoni*), Rain tree (*Samanea saman*), Banana (*Musa sapientum*), Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*), and Rain tree (*Samanea saman*). The checklist of homestead plantation according to the block study has been provided in **Annex E**.

b. Forest Land Plantation

Three quadrates have been taken in the Musapur reserve forest for identifying the tree species. The Musapur reserve forest is a planted forest by the forest department of Bangladesh. Total tree species are found in the forest land. Gewa is the dominant species followed by Hargoza and Babla. The details of the forest land plantation according to the quadrate survey are presented in **Annex F**.

c. Agricultural land

There is no any existing agricultural crops in the project site but the ecology team has been conducted FGD with local people for the agricultural survey. According to the local people, the project site is a medium high land where only aman rice is cultivated during monsoon season. The project site has become inundated during the rainy season and rest of the time pasturing by a domestic animals like cow, buffalo, goats, and sheep's and so on.

d. Grassland

Three quadrates of grassland (each of size 1 m x 1 m) were studied in this project area. During study period 5 families have been recorded with 9 different species and Cyperraceae family has been found maximum three times among those species. The second dominating family was 'Poaceae 'which has been found twice during the survey tenure. Among the common grasses species *Cyperus rotundus*, *Cynodon doctylon*, *Amaranthus philoveroides*, *Alternanthera sessilis*, *Alerodendron viscosum* and *Eurena loba* were notable. The checklist of grassland species has been provided in Annex G.

4.8.7.2 Aquatic Vegetation

There are two canals in the proposed plant location and it has been considered for aquatic vegetation survey. A visual observation study has been conducted for the aquatic vegetation survey of this area.

Water bodies of the project site

Choto Feni River at the Southern edge of the project site

A total of 10 aquatic vegetation species belongs to 7 families have been found at the project site. Among them, Lemnaceae families have been seen maximum three times. The checklist aquatic vegetations have been shown in Annex H.

4.8.8 Biodiversity Index of study area

It has been considered 3 homestead and forest land plantation blocks in the proposed project study area to determine the biodiversity index. During the survey, it has been estimated the Simpson index diversity, Simpson reciprocal index, richness, abundance of the floral species (**Table 4-21**). Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

Shannon Weiner Diversity: On the diversity scale, biologically realistic H' values range from 0 (only one species present 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 highest H' value was recorded for Mangrove plantation in Block 2(value 0.82), for homestead plantation Block1 (1.87,) which possesses moderate diversity on the H' scale in the project area.

Simpson's Index (D): Simpson's Index (D) value of ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. The highest Simpson's diversity (0.90) for homestead plantation was recorded at Block 1, 3 and for Mangrove species it has founded highest index Block 2 (0.75).

Simpson's Index of Diversity (1-D): The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different

species. The highest diversity values Block 3 (0.37). For Mangrove species highest values have been recorded Block 2 (0.37).

Simpson's Reciprocal Index (1/D): The value of this index starts with 1 as the lowest possible figure. The lowest Simpson's reciprocal index represents the highest diversity index and higher reciprocal index represent the lower diversity index. The highest value of the reciprocal index for homestead plantation was recorded in Block 2 (value 1.16), for mangrove species was recorded in Block 3 (1.58).

Species Richness: Plot 1,2 recorded the highest number of species richness 8 and thus showed higher species richness with respect to other sampled homestead plantation plots and for Mangrove species, it has been recorded in all plot richness 3.

Total Abundance: Total abundance represents the highest number of individuals recorded per sample which was recorded highest in Block 2(value 34), for Mangrove species Block 3 (32) in the study area.

Table 4-21: Biodiversity index of floral species at study area

	Mangrove species			Homestead Species		
Parameter	Blodk#1	Block#2	Block#3	Block #1	Block #2	Block #3
Shannon-Wiener Diversity Index(H)	0.77	0.82	0.69	1.87	1.80	1.62
Species Richness (S)	3.0	3.0	3.0	8.0	8.0	6.0
Total Abundance	30	26	32	27	34	29
Simpson's Index (D)	D: 0.70	D: 0.75	D: 0.63	D: 0.90	D: 0.86	D: 0.90
Simpson's Index of Diversity(1-D)	1-D: 0.30	1-D: 0.25	1-D: 0.37	1-D: 0.10	1-D: 0.14	1-D: 0.1
Simpson's Reciprocal Index (1/D)	1/D: 1.42	1/D: 1.33	1/D: 1.58	1/D: 1.11	1/D: 1.16	1/D: 1.11

4.8.9 Biodiversity of Fauna

During the Fauna survey of the study area mainly covered:-

- Birds(Avifauna)
- Amphibians
- Mammals
- Butterflies
- Fishes
- Crabs

4.8.9.1 Birds (Avifauna)

During the survey tenure, a total of 23 species belongings to 15 families have been founded in the project area.

The highest number of families has been found three times of Sturnidae, Ardeidae, and Corvida among the families. Different aquatic bodies, near homestead vegetation, different shrubs of the study area have supported the wild birds for feeding and roosting.

All species are the least concern (LC) according to IUCN Red List 2015. The checklist of bird's species has been shown in Annex I.

4.8.9.2 Amphibians & Reptiles

During field investigation, a total 4 species belong to 4 families have been recorded in the Project area. Species are Bengal Monitor (*Varanus bengalensis),* Asian common toad, Rana Tigrina*(Hoplobatrachus tigerinus*), Checkered keel back (*Xenochrophis piscator)*. Only Bengal Monitor (*Varanus bengalensis)* has been found as Near Threatened and rest of the species are Least Concerned according to the IUCN red list status 2015. The List of Amphibian and reptiles are presented in following **Table 4-22**.

Table 4-22: List of Amphibian and Reptiles in the Project Area

SL#	Local Name	English Name	Scientific Name	Family	IUCN Red List Status (Regional)
1.	Gui shap	Bengal Monitor	*Varanus bengalensis*	Varanidae	NT
2.	Kono bang	Asian Common Toad	*Duttaphrynus melanostictus*	Bufonidae	LC
3.	Borsa bang	Rana tigrina	*Hoplobatrachus tigerinus*	Dicroglossidae	LC
4.	Dhura sap	Checkered keel back	*Xenochrophis piscator*	Colubridae	LC

Note: LC-Least Concern, NT- Near Threatened

4.8.9.3 Mammals

It has been recorded 3 mammal's species belonging three families in the project area. Mammals that were found in the project area are Golden Jackal (*Canis aureu*), Little Indian field mouse (*Mus booduga*), and House mouse (*Mus musculus*). According to the IUCN red list status 2015, all species are least concern status. The checklist of Mammals has been provided in **Table 4-23**.

Table 4-23: List of Mammals in the Project Study Area

Sl.#	English Name	Scientific Name	Family	IUCN Red List Status 2015 Bangladesh
1.	Golden Jackal	*Canis aureus*	Canidae	LC
2.	Little Indian field mouse	*Mus booduga*	Muridae	LC
3.	House mouse	*Mus musculus*	Muridae	LC

Note: LC-Least Concern

4.8.9.4 Butterflies

There is no any host plant on the project site. The ecology team does not found remarkable butterflies in the project area. A total of 3 species belongs to 3 families have been identified during the survey tenure. List of Butterflies has been incorporated in **Table 4-24.** All species are Least Concerned (LC) according to the IUCN red list status 2015.

Table 4-24: List of Butterflies in the Project Site

Sl. #	English Name	Scientific Name	Family	IUCN Red List Status 2015 (Bangladesh)
1.	Tiny Grass Blue	*Zizula hylax*	Lycaenidae	LC
2.	Grey Pansy	*Junonia atlites*	Nymphalidae	LC
3.	Common Grass Yellow	*Eurema hecabe*	Pieridae	LC

Note: LC- Least Concern

4.8.9.5 Fisheries

A good number of aquatic bodies are available in the project area and during the rainy seasons, the project site has become inundated. The fishermen catch fish all around the year in the canal and River. Fish species are mostly found in the canal during the high tide. This aquatic body directly link up with the Bay of Bengal.The total 32 fish species in 19 families have been reported to found by the local people followed by FGD. Fishermen observation also considered during the data collection process. Among them, Cyprinidae family has been found highest 10 times. Only one species (*Cirrhinus reba*) is near threatened whereas rest of the species are "least concerned" according to the IUCN red list status 2015. The checklist of the project area fish has been provided in Annex J.

Fish market survey near project area

Fishing net used in the project area

Local Fish market survey

Fishing boat

Fishing net used in the project area

Fishing net used in the project area

4.8.9.6 Crabs

It has been found few crabs in the project area. During the survey, the ecology team has been observed crabs in the project area and recorded four different crabs in the project area. Mud Crab -*Scylla olivacea,* Red Ghost Crab -*Ocypode macrocera,* Giant mud crab -Scylla serrata, Red Claw Crab -*Perisesarma bidens* , all are least concerned according to the IUCN red list status 2015.

Table 4-25: Checklist of Crabs in the project area

SL#	Local Name	Common Name	Scientific name	Family	IUCN status Bangladesh 2015
1.	Jati Kakra	Mud Crab	*Scylla olivacea*	Portunidae	LC
2.	Lal Kakra	Red Ghost Crab	*Ocypode macrocera*	Ocypodidae	LC
3.	Shila Kakra	Giant mud crab	Scylla serrata	Portunidae	LC
4.	Unknown	Red Claw Crab	*Perisesarma bidens*	Sesarmidae	LC

4.9 Socio-Economic Environment

4.9.1 Population

4.9.1.1 Demography

In the 5 kilometer study area, there are 76163 households (HHs) including squatters with a total population of 402157 that will be somehow affected (directly or indirectly) by the implementation of the Project. Population density per square km of the study area is 594.2. The average sex ratio is 85.5 and the average household size is 5.3. **Table 4-26** shows the Demography of the project study area.

Table 4-26: Demography of the project area

District Name	Upazila Name	Union	Total population	Total HHs	Average HH size	Sex Ratio	Population density (Sq. Km)
Feni	Sonagazi	Char Darbesh	32145	6193	5.2	89	653

District Name	Upazila Name	Union	Total population	Total HHs	Average HH size	Sex Ratio	Population density (Sq. Km)
		Sonagazi	262547	50167	5.2	90	922
		Char Chandia*	40592	7276	5.5	93	703
Noakhali	Companiganj	Musapur	21981	4273	5.2	94	363
Chittagong	Mirsharai	Ichhakhali	27980	5205	5.4	84	439
		Saherkhali	16912	3049	5.5	81	485
Project Study Area			402157	76163	5.3	88.5	594.2

**Project site located in this union*

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

4.9.1.2 Ethnic Composition

According to population and housing census (2011), among the selected Unions only 1 ethnic households consisting a total of 3 populations are found in the Unions lied within the 2km radius boundary from the project site. The ethnic group is Chakma.

4.9.1.3 Religion

As per BBS, Population and Census (2011), the population of the project study area primarily consists of Muslims constituting almost 92% of the total population. The remaining 8% is primarily constituted by Hindus with Christians, Buddhists and others comprising an insignificant percentage. The following **Table 4-27** indicates the various religious profiles of the project study area.

Table 4-27: Religion Profile of Project Area

District Name	Upazila/Thana Name	Union	Total pop.	Muslim		Hindu		Christian		Buddhist		Others	
				Pop.	%	Pop.	%	Pop.	%	Pop.	%	Pop.	%
Feni	Sonagazi	Char Darbesh	32145	29240	91.0	2900	9.0	4	0.01	0	0	1	0.003
		Sonagazi	22164	20913	94.4	1250	5.6	0	0	1	0.005	0	0
		Char Chandia*	40592	37889	93.3	2702	6.7	0	0	1	0.002	0	0
Noakhali	Companiganj	Musapur	21981	20756	94.4	1225	5.6	0	0	0	0	0	0
Chittagong	Mirsharai	Ichhakh ali	27980	24594	87.9	3326	11.9	2	0.01	51	0.18	7	0.03
		Saherkhali	16912	15405	91.1	1506	8.9	0	0	1	0.006	0	0
	Project Study Area		161774	148797	92.0	12909	7.9	6	0.003	54	0.033	8	0.005

**Project site located in this union*

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

4.9.2 Education

According to the population and housing census (2011) shows that concentration of literate people in underlying unions of selected Upazilas is 48.7% which is lower than the national average of 51.8%. Female literacy is lower than the male counterpart its 47.9% where male literacy is 49.6%. Figure 4-26 shows the Literacy rate of the project area.

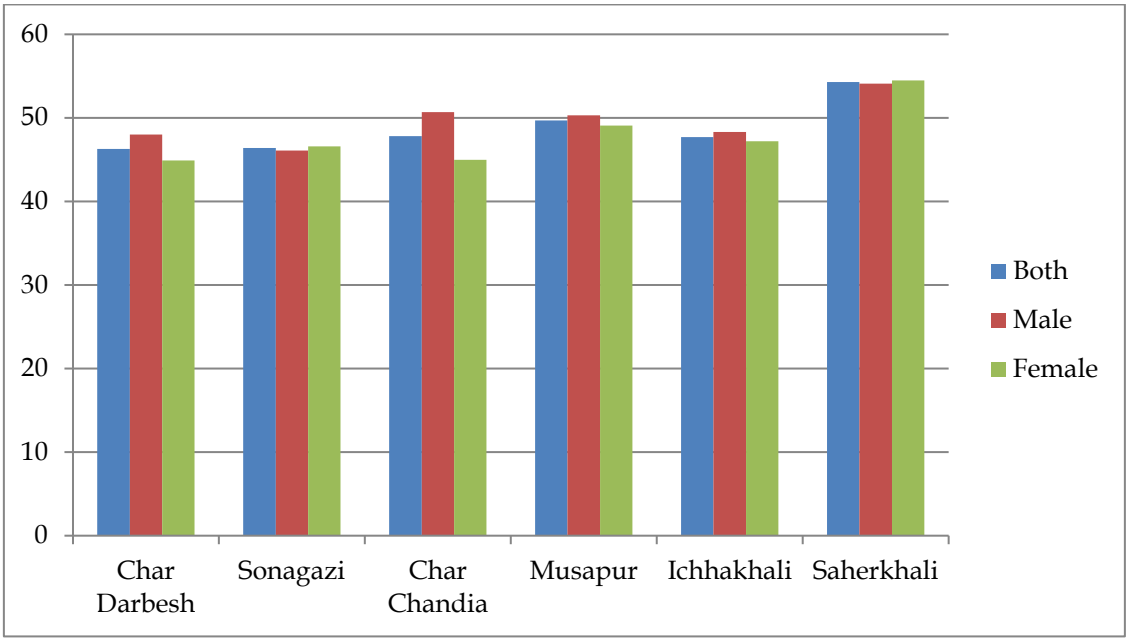


Figure 4-26: Literature Rate of the Project Area

4.9.3 Settlement and Housing

According to population and housing census (2011), total households of the project study area is 30255. Predominant structure of this study area is kutcha (85.9%) followed by Semi-pucka (5.3%), Pucka (6.1%) and Jhupri (2.8%). Housing tenancy of the study area is owned by (96.98 %), rented (0.75 %) and Rent free (2.28%). **Table 4-28** and **Table 4-29** show the Type of structure and Housing tenancy in the project study area.

Table 4-28: Type of Structure in the Project Area

District Name	Union/Thana Name	Union	Number of Households	Type of Structure (%)			
				Pucka	Semi-pucka	Kutcha	Jhupri
Feni	Sonagazi	Char Darbesh	6193	5.1	3.2	87.9	3.8
		Sonagazi	4296	7.1	5.7	87.1	0.1
		Char Chandia*	7269	8.1	4.5	85.5	1.9
Noakhali	Companiganj	Musapur	4263	5.9	3.7	85.6	4.9
Chittagong	Mirsharai	Ichhakhali	5196	5	7.5	83.4	4.1
		Saherkhali	3038	5.1	7.1	85.9	1.9
Project Study Area			30255	6.1	5.3	85.9	2.8

**Project site located in this union, Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

Table 4-29: Housing Tenancy in the Project Area

District Name	Union/Thana Name	Union	Number of Households	Housing Tenancy (%)		
				Owned	Rented	Rent free
Feni	Sonagazi	Char Darbesh	6193	97.8	0.3	2
		Sonagazi	4296	98.5	0.2	1.2
		Char Chandia*	7269	97.6	0.5	2
Noakhali	Companiganj	Musapur	4263	93.9	2	4.1
Chittagong	Mirsharai	Ichhakh ali	5196	95.9	0.8	3.3
		Saherkhali	3038	98.2	0.7	1.1
Project Study Area			**30255**	**96.98**	**0.75**	**2.28**

**Project site located in this union*

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

4.9.4 Public Utilities

4.9.4.1 Water Supply

At the project study area, the major source of drinking water is tube-well where about (91.18%) population use tube-wells water. About 0.37% people have access to tap-water. Other 8.4% people have access neither tube-well nor tap water. An overview is depicted in **Table 4-30** below.

Table 4-30: Sources of Drinking Water and Electricity Facility of the Project Area

District Name	Upazila Name	Union	No. of HHs	Source of Drinking Water (%)			Electricity Connection (%)
				Tap	Tube-well	Other	
Feni	Sonagazi	Char Darbesh	6193	0.3	89	10.6	23.8
		Sonagazi	4296	0.3	92.9	6.8	29.6
		Char Chandia*	7269	0.2	89.6	10.2	31.9
Noakhali	Companiganj	Musapur	4263	0.7	87.8	11.6	56.1
Chittagong	Mirsharai	Ichhakh	5196	0.6	91.2	8.1	38
		Saherkhali	3038	0.1	96.6	3.3	32.5
Project Study Area			30255	0.37	91.18	8.43	35.32

**Project site located in this union*

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

4.9.4.2 Electricity

Electricity is an important indicator for measuring the quality of life in the study area. In the project study area, 35.32% of the households have grid electricity connection. However, households mostly use the electricity for lighting and fanning purposes. Electricity connection of the study area shows **Table 4-30.**

4.9.4.3 Sanitation

In the Project area only about 8.22% and 66.02% of households use respectively water sealed and non water-sealed sanitary latrine facility which represents the 74.24% households of the study area. 21.23% households use non sanitary facilities. On the contrary, 4.47% households defecate in open places with no access to hygienic latrine facilities. **Table 4-31** shows sanitation facility of the project area.

Table 4-31: Sanitation Facility of the Project Area

District Name	Upazila Name	Union	Number of Households	Type of Toilet Facility (%)			
				Sanitary (water-sealed)	Sanitary (non water-sealed)	Non-sanitary	None
Feni	Sonagazi	Char Darbesh	6193	2.5	72.2	20.4	4.9
		Sonagazi	4296	7.5	62.1	27.2	3.2
		Char Chandia*	7269	3.1	74.5	16.9	5.5
Noakhali	Companiganj	Musapur	4263	16.9	57.3	19	6.8
Chittagong	Mirsharai	Ichhakhali	5196	10.9	57.5	26.7	4.9
		Saherkhali	3038	8.4	72.8	17.2	1.5
Project Study Area			**30255**	**8.22**	**66.07**	**21.23**	**4.47**

**Project site located in this union*

Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)

4.9.4.4 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 diseases. 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.

4.9.5 Agriculture

In the selected study area, it is found that 18.91% of total agricultural farm families are landless and marginal. High number of landless farm families signifies the high pressure on productive land for livelihood. Moreover, 24.19% is small scale farm families. On the contrary, only 10.53% is medium and large scale farm.

Table 4-32: Agricultural Farm Families in the Project Area

District Name	Upazila/Thana	Union	Farm Family (in nos)	Farm Family Distribution*									
				Landless	%	Marginal	%	Small	%	Medium	%	Large	%
Feni	Sonagazi	Char Darbesh	3800	974	25.63	1237	32.55	1414	37.21	131	3.45	44	1.16
		Sonagazi	3041	845	27.79	1226	40.32	497	16.34	427	14.04	46	1.51
		Char Chandia*	4800	700	14.58	2050	42.71	1300	27.08	650	13.54	100	2.08
Noakhali	Companiganj	Musapur	0	0	0	0	0	0	0	0	0	0	0
Chittagong	Mirsharai	Ichhakhali	5748	575	10.00	3161	54.99	1437	25.00	517	8.99	58	1.01
		Saherkhali	3322	550	16.56	1800	54.18	510	15.35	420	12.64	42	1.26
Project Study Area			**20711**	**3644**	**18.91**	**9474**	**44.95**	**5158**	**24.196**	**2145**	**10.532**	**290**	**1.40**

**Project site located in this union*

Note: Landless (0.0-0.049 acre), Marginal (0.05-1.49 acre), Small (1.50-2.49 acre), Medium (2.50-7.49 acre), Large (7.50 acre or above)

4.9.6 Livelihood

In the study area about 340 women are engaged directly and indirectly in agriculture activities. Additionally, 8520 share cropper and 4100 agriculture labors are available in the study area. Moreover, 1850 absentee land owner are available.

4.9.7 Socio-Economic Study

4.9.7.1 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 plant within 2km radius were surveyed for intense socio-economic assessment. Villages, Adarsha Gram, Purba Baradhali, Dashkkhin Char Chandia and Bara Char Dhali, are so close to proposed project and communities of the villages are rigorously connected in their daily life to the proposed project area.

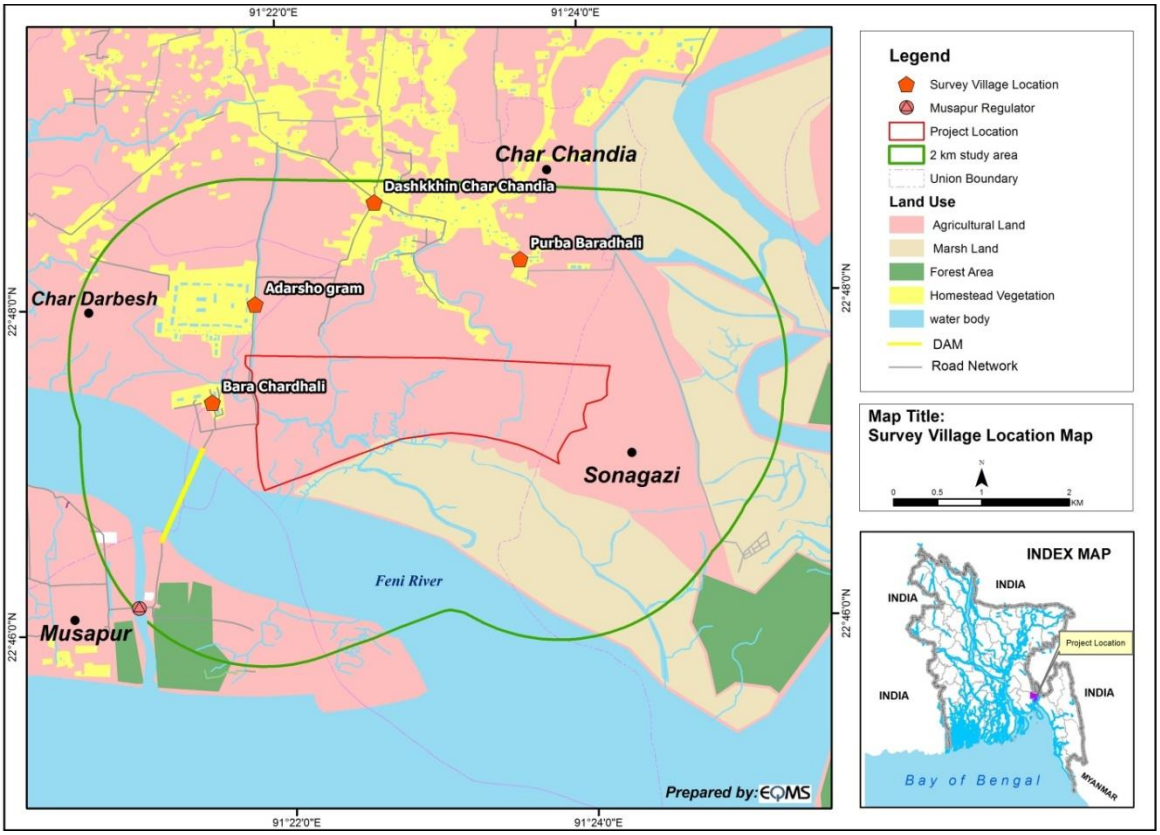
Villages situated within the 2km radius from the proposed project were considered for conducting socio-economic survey (SES). To get the actual population/households of the studied villages, secondary sources such as Population and Housing Census, District Statistics and District Web Portal have been used. When total numbers of the households/populations had been confirmed, considering all villages as cluster 5% households were finalized for random sampling along with specific interval. Total population of the selected villages are presented in the following **Table 4-33**

PHC 2011, suggests that a total of 1754 households with average 5.2 household size lie within four selected villages. Average population density of these areas is found 573 only which is almost half of the national score 976. Therefore, 5% (n-88) of total households were surveyed randomly from each selected villages following specific proportionality and interval.

Table 4-33: Numbers of Households Surveyed in the 2 km Study Area

Union	Villages	Total Population*	n	Proportional Percent
Char Darbesh	Adarsha Gram	540	27	30.7
Char Chandia	Purba Baradhali	377	19	21.6
	Dashkkhin Char Chandia	610	31	35.2
Musapur	Bara Char Dhali	227	11	12.5
Total		1754	88	**100.0**

* *Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*



Source: EQMS

Figure 4-27: Surveyed Villages' Locations

4.9.7.2 Basic Demographical Characteristics of the Households

Basic demographic characteristics include total population, gender, age, marital status, and health status. Table 4-34 illustrates the basic demographical characteristics of the households. Survey result has found about a total number of 415 population are living within the 88 households, whereas about 60.5% are male and rest 39.5% are female. Average family size is 4.7. On the other hand, 1-86 age range has been found within the selected households of specific villages. Importantly around 78.6% population belongs to 14-64 age range which signifies that most of the populations are eligible for being active in economic activities. Contrary, only 21.4% population is found depended. Additionally, 52.5% population is married. Allover health status among the households has been found quite well. Around 99.8% populations are found healthy and only .2% are found handicapped by birth. Study area is found Muslim dominated where about 97.7% surveyed households were found Muslims and rests were found Hindu.

Table 4-34: Basic Demographic Characteristics of the Selected Villages

Sl.#	Details		Frequency	Percent
1.	Total Population	Male	251	60.5
		Female	164	39.5
		Total	**415**	**100.0**
2.	Age	1-13	72	17.3

Sl.#	Details		Frequency	Percent
		14-27	148	35.7
		28-41	107	25.8
		42-64	71	17.1
		65-65+	17	4.1
		Total	**415**	**100.0**
3.	Marital Status	Married	218	52.5
		Unmarried	192	46.3
		Divorced/Widowed	5	1.2
		Total	**415**	**100.0**
4.	Health Status	No disease	414	99.8
		Handicapped	1	0.2
		Chronic Health Problem	0	0.0
		Total	**415**	**100.0**
5.	Religion	Muslim	86	97.7
		Hindu	2	2.3
		Total	**88**	**100.0**

Source: SES, December 2017

4.9.7.3 Households Structures and Sanitation and Other Utilities

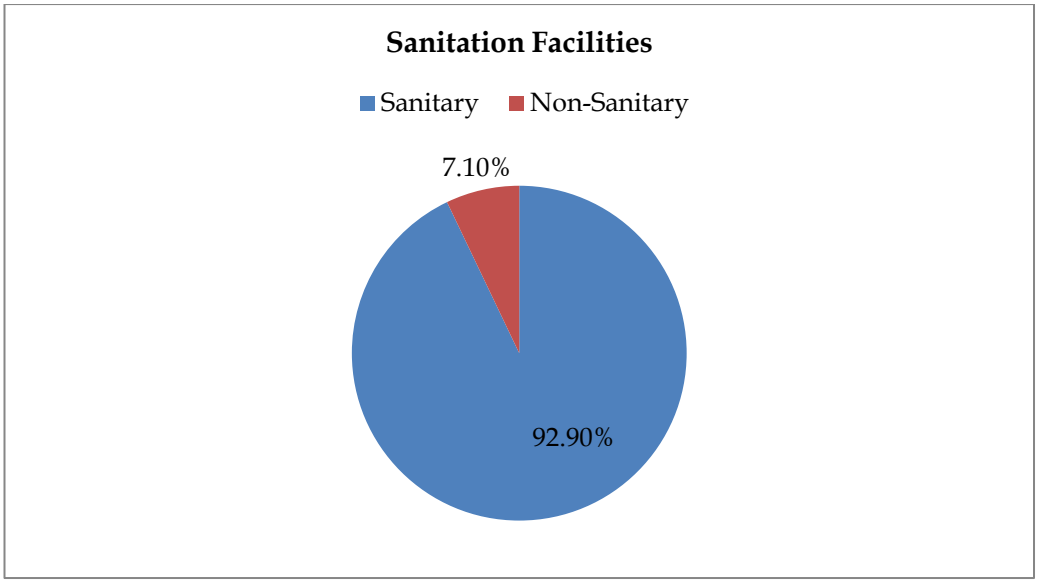
Predominating household structures are Tin made. Survey finds that among the all surveyed households only about 2.3% households' structure is Building and 4.5% is semi-building. Moreover, about 69.3% households' structure is Tin made. On the other side, about 23.9% households' structure is found thatched.

Table 4-35: Structures of the Studied Households

Building	%	Semi-Building	%	Tin Made	%	Thatched	%
2	2.3	4	4.5	61	69.3	21	23.9

Source: SES, December 2017

Among the surveyed households about 92.9% have sanitary toilets and rest 7.1% have Non-sanitary toilets. No open defecation has been found around the 2km radius villages. Sanitation facility of the study area is shown in following **Figure 4-28**.



Source: SES, December 2017

Figure 4-28: Sanitation facilities of the Study Area

Utilities available in the surveyed households are Tube-well, Water Pump and Water Tank with average of 0.75, 0.03 and 0.01 respectably. Cow rearing is a very common practice in all households and this study finds that average 3.13 Cow followed by 0.59 Buffalo, 0.14 Goat and 0.11 Sheep.

Table 4-36: Households' Utilities and Domestic Animals

	Tube-well	Water-pump	Water-tank	Cattle-shed	Cow	Buffalo	Sheep	Goat	Poultry
Mean	0.75	0.03	0.01	0.44	3.13	0.59	0.11	0.14	0
Median	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0
Std. Deviation	0.435	0.183	0.107	0.499	4.296	2.365	1.066	.809	0

Source: SES, December 2017

4.9.7.4 Education

Study finds that about 88.2% of total population is literate. About 11.8% and 33.3% populations are found underlie within the Illiterate and primary level education category. About 42.4% and 10.1% populations are found who completed Secondary and Higher Secondary level. On the other hand, only 2.4% have graduation or higher educational attainment.

Table 4-37: Educational Attainment of the Population

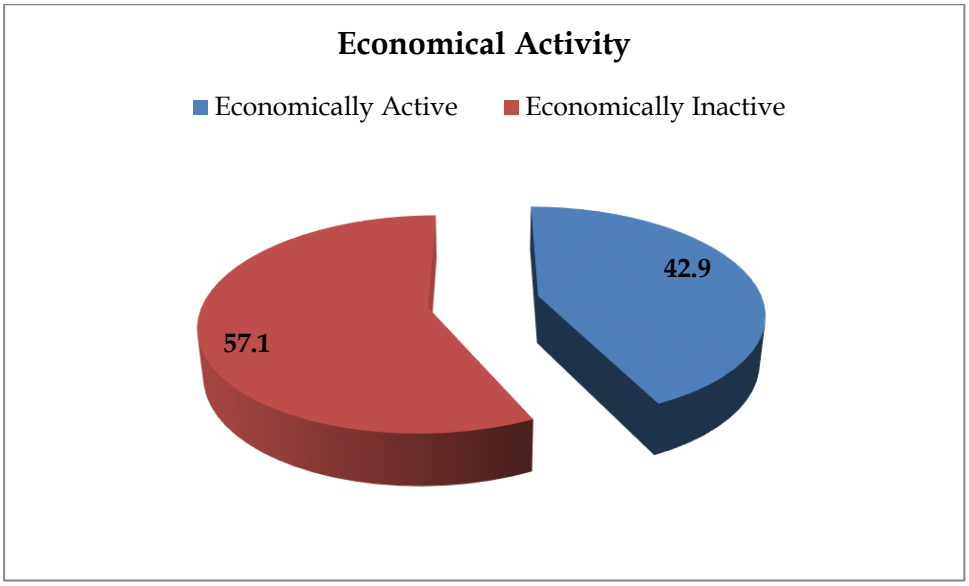
Sl#	Details	Frequency	Percent
1.	Illiterate	49	11.8
2.	Primary	138	33.3
3.	Secondary	176	42.4

Sl#	Details	Frequency	Percent
4.	Higher Secondary	42	10.1
5.	Graduation or Higher	10	2.4
Total		**415**	**100.0**

Source: SES, December 2017

4.9.7.5 Occupation and Income

Among the total surveyed population 42.9% are economically engaged by engaging in varies occupations. Like other parts of the rural Bangladesh, occupations within the selected villages are found agriculture based. Majority (36.1%) of total population are engaged in agriculture including fish culture. Moreover, 2.9% populations are engaged in business activities. Non Agricultural labor (0.7%) and private job (0.7%) are also common in the study area as this area is well known for different types of industries. Others activities (1.4%) include driving, working in bakery etc.



Source: SES, December 2017

Figure 4-29: Economically Active Population of the Surveyed Population

Table 4-38: Occupational Profile of the Surveyed Household

Occupations	Frequency	Percent
Agriculture	93	22.4
Agriculture Labor	56	13.5
Non Agriculture Labor	3	.7
Business	12	2.9
Fishing/ Fish culture	1	.2
Govt. Job	2	.5
Private	3	.7

Occupations	Frequency	Percent
House Made	2	.5
Others	6	1.4
Total	178	42.9
Not Working	237	57.1
Total	**415**	**100.0**

Source: SES, December 2017

Table 4-39: Occupation and Yearly Income of the Households

Occupations		Number	<5 Thousand	5 -10 Thousand	10 -15 Thousand	15-20 thousand	>20 Thousand
Agriculture	N	93	40	40	13	0	0
	%	52.8%	22.7%	22.7%	7.4%	0.0%	0.0%
Agriculture labor	N	55	4	33	13	5	0
	%	31.2%	2.3%	18.8%	7.4%	2.8%	0.0%
Non Agriculture labor	N	3	0	1	1	1	0
	%	1.7%	0.0%	0.6%	0.6%	0.6%	0.0%
Business	N	12	0	5	3	2	2
	%	6.8%	0.0%	2.8%	1.7%	1.1%	1.1%
Fishing/Fish culture	N	1	0	0	1	0	0
	%	0.6%	0.0%	0.0%	0.6%	0.0%	0.0%
Govt. Job	N	2	0	0	2	0	0
	%	1.1%	0.0%	0.0%	1.1%	0.0%	0.0%
Private Job	N	3	0	1	1	1	0
	%	1.7%	0.0%	0.6%	0.6%	0.6%	0.0%
House Made	N	1	0	1	0	0	0
	%	0.6%	0.0%	0.6%	0.0%	0.0%	0.0%
Others	N	6	0	0	4	1	1
	%	3.4%	0.0%	0.0%	2.3%	0.6%	0.6%
Total		178	44	81	38	10	3
Total Percentage		100.0%	25.0%	46.0%	21.6%	5.7%	1.7%

Source: SES, December 2017

Occupation based monthly income has also been considered during survey. It is found that 46.0% of total occupations' (Agriculture, non-agriculture labor, private job and house made occupations) incomes lie within 5-10 thousand BDT monthly. Secondly, 21.6% Occupations' income is between 10-15 thousand followed by 5.7% occupations have 15-20 thousand monthly income. On the other hand, only 1.7 % occupations have more than 20 thousand monthly income.

Agricultural dependency is prevalent in the study area. Among the studied area, 85.2% have ownership on agriculture land followed by 21.6% garden, 76.1% pond.

Table 4-40: Agriculture and Types of Ownership of Land

Ownership Types	Ownership Types*			
	Agriculture land	Garden	Pond	Open land
Self-owned	33	17	49	0
%	37.5	19.3	55.7	0
Sharecropping	16	2	17	0
%	18.2	2.3	19.3	0.0
Self owned and Sharecropping	22	0	0	0
%	25	0	0	0
Lease	4		1	0
%	4.5	0.0	1.1	0.0
Total	75	19	67	0
%	85.2	21.6	76.1	0.0

*Multiple responses allowed, Source: SES , December 2017

Survey has found the land types and cropping patterns of the villages around the 2km radius from the proposed project. Most of the land is used for only once aman rice cultivation. Rice is the only sessional products. Average production rate per decimal is 15.27 Kg.

Table 4-41: Agricultural Cropping Pattern

Agriculture Products	Frequency	Percent
Not used for Agriculture purposes	13	14.8
Rice	75	85.2

Source: SES, December 2017

About 13.6% households were found who are engaged in Business. Common businesses are found Tea Stall 6.8%, Grocery shop 3.4%, Medicine Shop 3.4% and electric shop 1.1%. Average capital of these businesses is 30450 BDT.

Table 4-42: Business types

Type	Frequency	Percent
No Business	76	86.4
Electric Shop	1	1.1
Grocery Shop	3	3.4
Medicine Shop	2	2.3
Tea stall	6	6.8

Total	88	100.0

Source: SES, December 2017

4.9.7.6 Energy Access

Lighting and cooking sources are the very important needed energy for any households and higher quality and easy access to quality energy can ease household's daily life. Results have found that 76.1% of the total households have access to electricity followed by 21.6% solar.

Table 4-43: Different Energy Access by the Households

Sl#	Details		Frequency	Percent
1.	Lighting Source	Electricity	67	76.1
		Electricity and Kerosene	1	1.1
		Electricity and Solar	1	1.1
		Solar	19	21.6
		Total	**88**	**100.0**
2.	Fuel/energy used for Cooking	Gas/LPG	3	3.4
		Crop Residue, Firewood, Cow-dung Cake	85	96.6
		Total	**88**	**100.0**

Source: SES, December 2017

In the case of cooking fuel it is found that all the households are relying on the conventional ways of cooking. Firewood, crop residue and cow-dung cake are used for cooking fuel. 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 96.6% households are relying on natural fuels (Firewood, crop residue and cow-dung cake) where rests 3.4% use LPG gas for cooking.

4.9.7.7 Access to Social Market and Medical Services and Other Facilities

Convenient and easy access to market and medical services help households get basic needs and health services when it's necessary or urgent. Distance may barrier from easy access to these services. Survey results have found that 50% households have easy access to main markets and they lie less than 1km followed by 50% lie more than 3km from the market. They can get all sorts of amenities from the markets. Each studied village people use separate market for daily life shopping.

Table 4-44: Access to Social Market

Sl #	Main Market	Village Name	Distance						Total	%
			<1km	%	1 to 2km	%	>3km	%		
1.	Choudhury Bazar	Bara Char Dhali	0	0	0	0	17	19.3	17	19.3
2.	Dhan Gobesona Bazar	Dashkkhin Char Chandia	22	25.0	0	0	0	0	22	25.0
3.	Modina Bazar	Purba Baradhali	22	25.0	0	0	0	0	22	25.0
4.	Sonagagi	Adarsha Gram	0	0	0	0	27	30.7	27	30.7
Total			44	50.0	0	0	44	50.0	88	100.0

Source: SES, December 2017

Easy access to hospitals enhances the frequency of health services taking frequency. Higher distance may hinder taking health services which ultimately increase the health risk. Survey results have found that only 10.2% households are staying less than 1km distance from the health service point. Conversely, significant numbers of the households (89.8%) are residing more than 3km distance from the hospitals. It will be clear if you look individual village separately. Major preferred area for taking health services is Sonagazi Govt. Hospital 70.5% followed by Basurhat Hospital 19.3% and Community clinic 10.2%.

Table 4-45: Access to Medical Services

Sl #	Hospital Name/Location	Village	Distance						Total	%
			<1km	%	1 to 2km	%	>3km	%		
1.	Bosurhat Hospital	Bara Char Dhali	0	0	0	0	17	19.3	17	19.3
2.	Community clinic	Dashkkhin Char Chandia	9	10.2	0	0	0	0	9	10.2
3.	Sonagagi Govt. Hospital	Adarsha Gram	0	0	0	0	27	30.7	27	30.7
		Dashkkhin Char Chandia	0	0	0	0	22	25.0	22	25.0
		Purba Baradhali	0	0	0	0	13	14.8	13	14.8
Total			9	10.2	0	0	79	89.8	88	100.0

Source: SES, December 2017

Study finds that about 55.7% households have access in primary school within less than 1km followed by 19.3% have access within 1-2km. On the other hand, 25% have access more than 3km distance.

Table 4-46: Access to Primary School

Sl #	Primary School	Village	Distance						Total	%
			<1km	%	1 to 2km	%	>3km	%		
1.	Adarsha Gram Primary School	Adarsha Gram	27	30.7	0	0	0	0	27	30.7
2.	Dhokkin char chandia Primary School	Bara Char Dhali	0	0	17	19.3	0	0	17	19.3
		Dhokkin char chandia	0	0	0	0	22	25.0	22	25.0
3.	Madina Bazar Primary School	Purba Baradhali	9	10.2	0	0	0	0	9	10.2
4.	Purba Baradhali Primary School	Purba Baradhali	13	14.8	0	0	0	0	13	14.8
Total			**49**	**55.7**	**17**	**19.3**	**22**	**25**	**88**	**100**

Source: SES, December 2017

High school lies more than 3km distance for most of the households. 77.3% households have more than 3km distance from the secondary high school.

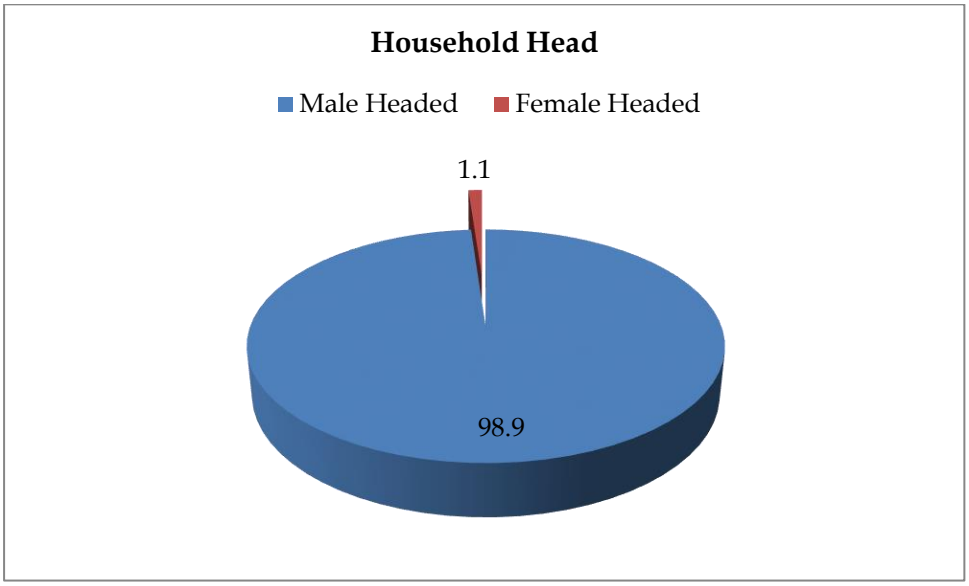
Table 4-47: Access to High School

Sl #	High School	Village	Distance						Total	%
			<1km	%	1 to 2km	%	>3km	%		
1.	Choudury Bazar High School	Bara Char Dhali	0	0	7	8.0	10	11.4	17	19.3
		Dashkkhin Char Chandia	0	0	0	0	22	25.0	22	25.0
2.	Dokkhin Chor Dor.High School.	Adarsha Gram	0	0	0	0	27	30.7	27	30.7
3.	Haji Tofael High School	Purba Baradhali	0	0	13	14.8	9	10.2	22	25.0
Total			**0**	**0**	**20**	**22.8**	**68**	**77.3**	**88**	**100**

Source: SES, December 2017

4.9.7.8 Gender Analysis

Study finds the common patriarchic scenario in the study area. Among all the surveyed households only 1 household has been found female headed.



Source: SES, December 2017

Figure 4-30: Gender based Economic Activity

Education and Occupation

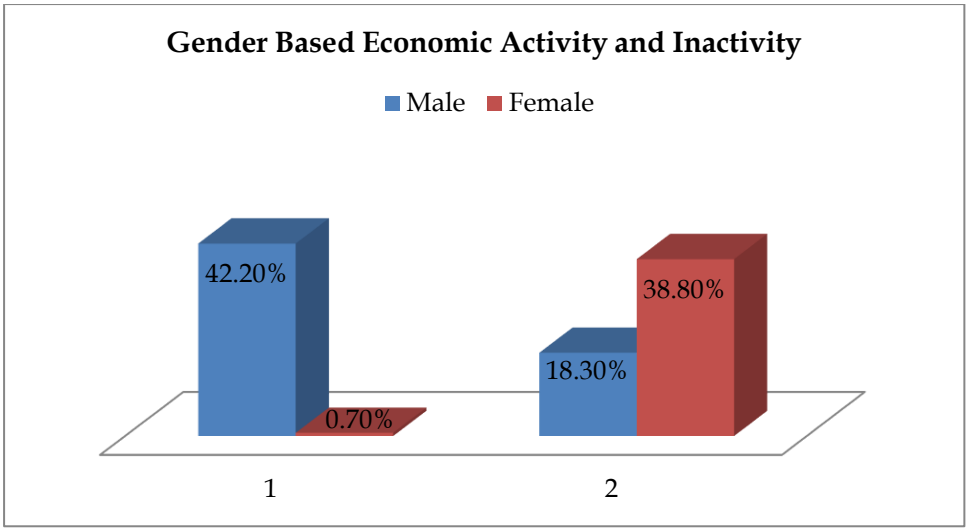
Study finds that female populations are lagging behind in education compared to the male counterpart. Among the whole population, 27.5% male have secondary education followed by 7.2% Higher secondary and 2.2% graduation or higher education. On the contrary, only 14.9% female have secondary education followed by 2.9% Higher secondary and only 0.2% graduation or higher education.

Table 4-48: Educational Attainment based on Gender

Gender		Education					Total
		Illiterate	Primary	Secondary	Higher Secondary	Graduation or Higher	
Male	Count	22	76	114	30	9	251
	% of Total	5.3%	18.3%	27.5%	7.2%	2.2%	60.5%
Female	Count	27	62	62	12	1	164
	% of Total	6.5%	14.9%	14.9%	2.9%	0.2%	39.5%
	Total	49	138	176	42	10	415
	%	11.8%	33.3%	42.4%	10.1%	2.4%	100.0%

Source: SES, December 2017

Like the education attainment, female populations are also found lag behind in economic activities. It is found that, only 0.3% female of total population are engaged in economic activities.



Source: SES, December 2017

Figure 4-31: Gender based economic activity

Study finds that in the study area there is very limited scope of economic opportunity. Male populations have some moderate occupational diversity though. Most common occupational activity is Agriculture 51.7% followed by agriculture labor 30.9%, business 6.7%, non-agricultural labor 1.7% etc. Unlike the male population, female occupational diversity is very limited. Among them, .12% females are engaged in agriculture and agricultural labor activities. Moreover, Only .6% female has found who works in govt. sector.

Table 4-49: Occupations based on Gender

Gender		Occupations									Total
		Agriculture	Agriculture Labor	Non Agriculture Labor	Business	Fishing/ Fish culture	Govt. Job	Private	House Made	Others	
Male	N	92	55	3	12	1	1	3	2	6	175
	%	51.7%	30.9%	1.7%	6.7%	0.6%	0.6%	1.7%	1.1%	3.4%	98.3%
Female	N	1	1	0	0	0	1	0	0	0	3
	%	0.6%	0.6%	0.0%	0.0%	0.0%	0.6%	0.0%	0.0%	0.0%	1.7%
Total	N	93	56	3	12	1	2	3	2	6	178
	%	52.2%	31.5%	1.7%	6.7%	0.6%	1.1%	1.7%	1.1%	3.4%	100.0%

Source: SES, December 2017

4.9.7.9 Vulnerability Analysis

According to the head count rate of HIES (2010), it has been found that about 2.3% households are underlying below the poverty line. Additionally, 0.2% households were found women headed. No ethnic households have been found.

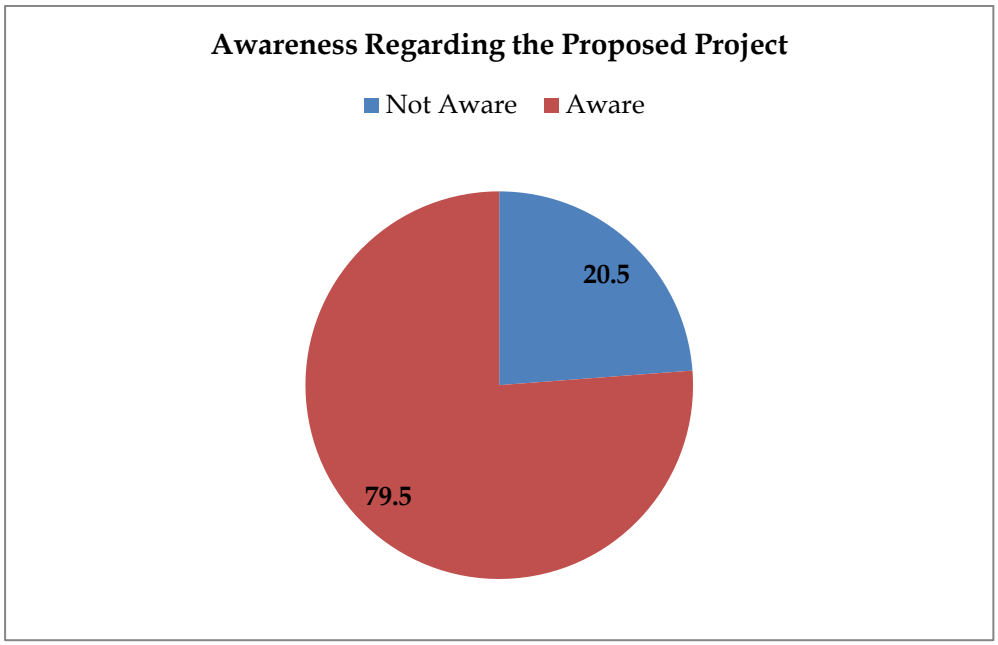
Table 4-50: Vulnerability of the Study Area

Sl#	Vulnerabilities	Percentage
1.	Below Poverty Line (head count rate 2151)	2.3%
2.	Women headed Households	.2%

Source: SES, December 2017

4.9.7.10 Project Awareness

Project awareness and perception may hinder or facilitate any project work's successful implementation. Survey result shows that 79.5% of total households are completely aware of this proposed project. Conversely, 20.5% of total households are found indifference and know nothing regarding this project.



Source: SES, December 2017

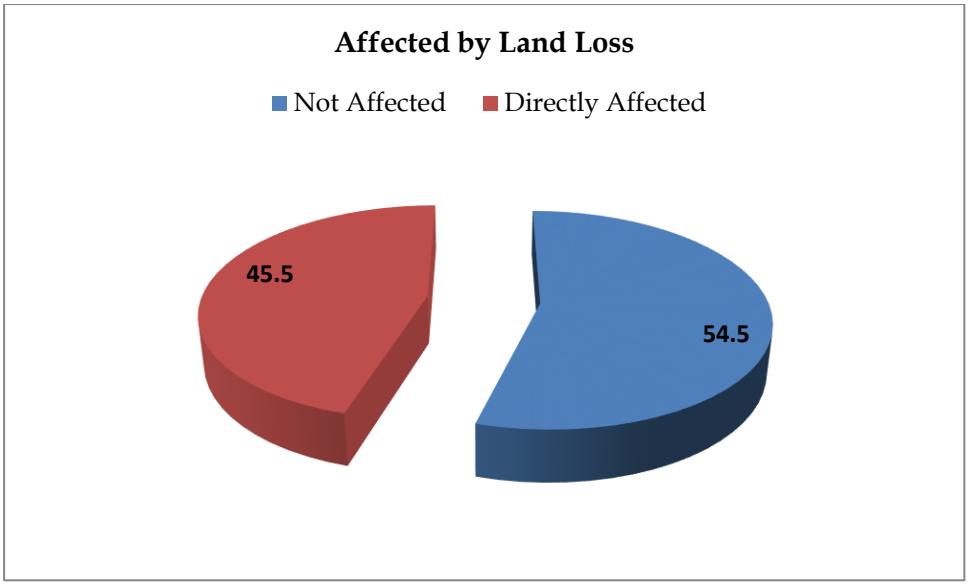
Figure 4-32: Project Awareness

4.9.7.11 Perceived Impacts

a. Negative Impacts

Land Loss

It is found that about 45.5% households will be directly affected (structure/land) by the proposed project. Affected persons have been found in all surveyed villages. Major affected households were found in Dashkkhin Char Chandia where about 17 households claimed that they will loss agricultural land. In Purba Baradhali 11, Bara Char Dhali 8 and Adarsha Gram 4 households claimed similarly.



Source: SES, December 2017

Figure 4-33: Affected by land and structure loss

Table 4-51: Types of Land Ownership

Types of Land Ownership	Frequency	Percent
No land	48	54.5
Private Land	31	35.2
Sharecropping	4	4.5
Both Private and Sharecropping	5	5.7
Total	**88**	**100.0**

Source: SES, December 2017

Study finds major two types of land ownerships pattern in the project site area. About 35.2% of total households claimed that they have private land on this this proposed project site followed by 4.5% claimed sharecropping ownership.

Table 4-52: Total land ownership

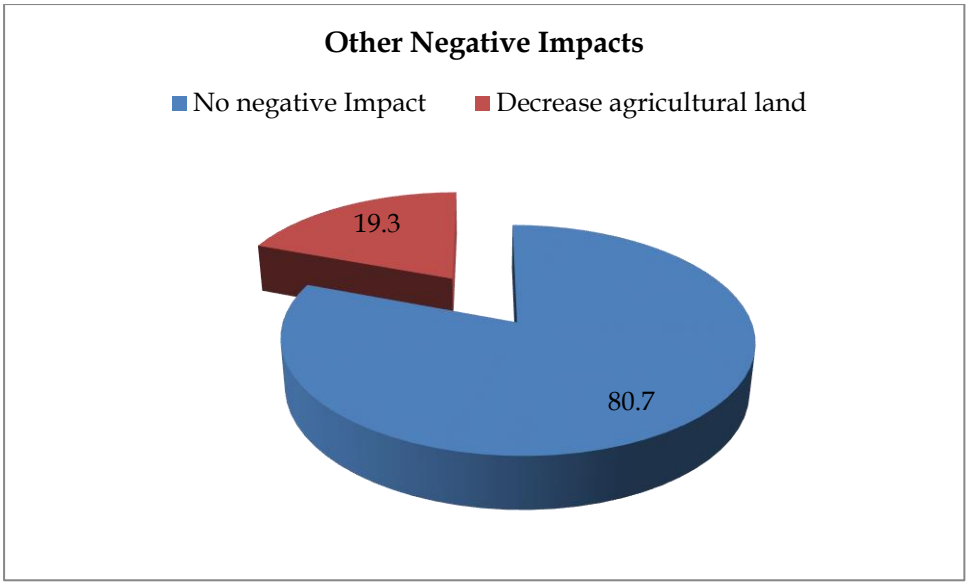
Total ownership of land (in decimal)	Frequency	Percent
no land	48	54.5
1-119	6	6.8
120-239	22	25.0
240-359	4	4.5
360-479	7	8.0
480-600	1	1.1
Total	88	100.0

Source: SES, December 2017

Survey result shows that land ownership/usage per households varies 1-600 decimal. About 25% of total households claimed that they have 120-239 decimal land in the proposed project site area. Moreover, 8%, 6.8% and 4.5% households have been found who have respectively 360-479, 1-119 and 240-359 decimal land.

Other Community Problems

Study finds that, about 90.8% believe that there will be no harm on the local community as the consequence of the project establishment. On the contrary, 9.2% believe that local community will be affected by the consequences of the project development. Among them, 2.7% identifies security problem, 3.7% transportation problem, 2.0% increase of traffic accident, .3% increase the health risk and garbage. They suggest to take necessary measures to mitigate these problem.



Source: SES, December 2017

b. Positive Impacts

Among the surveyed population about 68.4% believe that this project will bring positive impacts on the development of the local community. Rest 31.6% believe that the community will not be benefitted by the intervention of the project.

Table 4-53: Positive impacts

	Frequency	Percent
No positive Impacts	17	19.3
Positive Impacts	71	80.7
Total	88	100.0

Source: EQMS Survey, **December 2017**Among the positive believers majority think (37.1%) that market will be developed and business opportunity will increase. Besides this, People think that other infrastructural developments like educational institute, residence, theater, park and hospital will be developed. Some believe that basic services and quality of life will be enhanced.

Table 4-54: Perceived Positive Impacts

Types of Positive Impacts	Frequency	Percent
No Positive Impacts	17	19.3
Employment creation	62	70.5
Social development	3	3.4
Infrastructural development	4	4.5
Economic solvency	2	2.3
Total	**88**	**100.0**

Source: EQMS Survey, December 2017

4.9.8 Findings of Social Analysis:

Both Secondary sources and primary survey data have been analysed to get the pictures of the socio-economic conditions of the project study area. All results have been cross validated with secondary and primary sources. When there is dissimilarity found qualitative tools; FGD, KII etc., have been used to get the real scenario. All social findings are applicable for 2km surround area from the 999.65 acres project site including first 50 MW solar power plant area. Four villages Adarsha Gram, Purba Baradhali, Dashkkhin Char Chandia and Bara Char Dhali lie within the 2km radius from the project site. It is mentionable that Dashkkhin Char Chandia village fall partially within 2km study area. Thus, primary survey was conducted within the area that falls within defined boundary.

4.9.8.1 Demographic Details

According to PHS 2011, average household size is 5.3 of the households falling within 5km study boundary. But primary survey within 2 km boundary, average households size is found 4.7. Converse relations found in the case of sex ratio, where secondary study suggests 88.8 (88.8 male against 100 female), primary study suggests 153 (153 male against 100 male). However, this may has been happened for sampling limitation as only 5% households were surveyed. Besides this, most of the cases the respondents were male, and thus female names of the households may have been unreported during the survey.

Population density of the primary study area was found less than the secondary study findings.

Secondary findings suggest that only one Chakma (Ethnic group) household is living within the 5km secondary study area. On the other hand, primary study conducted within 2km radius area does not suggest similar. However, it was cross verified from the Consultation and FGDs findings that there are no ethnic communities living in and around the primary study area.

Secondary findings depict religious views of the 5km surrounding area from the project site where 92% is Muslim and 7.9% is Hindu. But primary study suggests the proportion of Hindu is 2.3% only. However, from KII and other informal interview, it was known that the proportion of Hindu community of the 2km surrounding study area may lie within 8-12%.

Demographic Character	Secondary Data (5km)	Primary survey Data (2km)
Average Household size	5.3	4.7
Sex Ratio	88.5	153
Population Density	594	573
Ethnic Community	1 Chakma household	-
Religion	92% Muslim, 7.9% Hindu, .33 Buddhist	97.7% Muslim, 2.3% Hindu

4.9.8.2 Education

Secondary study shows that only 49.6% male and 47.9% female are literate within the 5km study area, but secondary study shows higher literacy rate of the 2km study area. Instead of dissimilarity in the percentage, both findings suggest that females lag behind in accessing educational service.

Literacy	Secondary Data (5km)	Primary survey Data (2km)
Male literacy	49.6%	91.24%
Female literacy	47.9%	83.54%

4.9.8.3 Housing Structure, Sanitation and Electricity Access

With the cross verification it is found that most of the housing structure of the 2km study area are Tin made and Jhupri. Besides this, both secondary and primary study results are indicating same about the sanitation practices. Access to electric services is higher (76.1%) in 2km study area than that of (35.32%) in 5km study area.

	Secondary Data (5km)	Primary survey Data (2km)
Housing	Pucka -6.1 Semi Pucka-5.3 Tin Made-85.9 Jhupri-2.8	Pucka-2.3 Semi Pucka-4.5 Tin Made-69.3 Jhupri-23.9
Sanitation	Sanitary-74.29 Non-sanitary-21.23 Open-4.47	Sanitary-92.90 Non-sanitary-7.10 Open-0.00
Electricity	35.32%	76.1%

4.9.8.4 Occupational Engagement

Secondary study suggests that among the total population of the 5k area, 30.3% population is employed in economic activities. Whereas, primary study within the 2km study area suggest higher participation (42.9%) in economic activities. Instead of this, both studies indicate that female's participation is very meager and has very low representation on total economic activities.

Both secondary and primary studies suggest almost similar mentioning agriculture is the major economic activities. Primary study shows that 84.40 populations are engaged with agricultural activities while female's contribution is only 1.20%.

Service is the second major economic activity in the study area and both secondary and primary studies support that. On the other hand, both studies indicate that engagement in industry is very limited in the study area. Female's participation is very low in these two sectors.

Employment status	Secondary Data (5km)	Primary survey Data (2km)
Employed	30.3%	42.9
Male Employed	29.3	42.2
Female Employed	1.0	.7
Specified Field	**Secondary Data (5km)**	**Primary survey Data (2km)**
Agriculture	Male-70.42 Female-1.95	Male-83.20 Female-1.20
Industry	Male-3.39 Femal-0.17	Male-1.7 Femal-0.0
Service	Male-22.73 Female-1.35	Male-13.50 Female-0.60

4.9.9 Extent of Impacts

All potential impacts have been identified and extents of impacts have been cross verified in all steps of the study.

Type of Loss	Nature/scope of impacts	Secondary Data	Primary Data	Cross Validation
Agricultural Production Loss	Agricultural production of 999.65 acres single cropped	80% productive land of Char Chandia Union Is double and	Average Paddy production rate is 1.01 metric Ton	During the FGDs Farmers stated that not all land is cultivated during the Aman

Type of Loss	Nature/scope of impacts	Secondary Data	Primary Data	Cross Validation
	land will be hampered permanently for the projects including 165.5 acres for first 50 MW solar power plant.	triple Cropped. Thus, it will impact on only 20% single cropped production rate. Cropping intensity of the Char Chandia Union is 215 which is lower than the average cropping intensity rate of total Sonagizi Upazila. (Source: NLZR 2017)	per acre. Total production loss for 999.65 acre will be 1011.79 (11.9%) Metric Ton and for 165.5 acre will be 167.5 (2%) Metric Ton of total yearly Aman production 8500 Metric Ton. (Source: Agricultural Department, Sonagazi Upazila)	cultivation for high degree of salinity. Among the 999.65 acres highest 60-70% area is cultivated. They also confirmed that production rates off all cultivated land are not same. Thus it is found that the loss off production will be less than 11.9% or 2% (for first 50 MW solar plant) of total Aman production.
Land Loss	Land owners will lose ownership of 999.65 acres single cropped land including 165.5 acres for first 50 MW solar power plant	According to NLZR (2017), In Char Chandia among the total 4800 farm families 57.3% households belong to landless and marginalized group who usually no or minimum land ownership. Moreover, 1850 absentee land owners are available in the Char Chandia Union which refers the high participations of	According to Feni, DC office list a total of 392 persons will lose their right of land ownership for total 999.65 acres including 165.5 acres required for first 50 MW solar project. RAP study for first 50 MW solar project states that 165.5 acres consists 139 sub-plot where 61	From the FGDs with the local communities it was known that there is complexity on land ownership. Acruired land for the proposed project was govt. Khasland and distributed to the landless people. Many land allottes could not hold the land ownership for various reasons. Thus numbers of total legal land owners may vary 150-200 persons for 999.65 lands.

Type of Loss	Nature/scope of impacts	Secondary Data	Primary Data	Cross Validation
		sharecroppers (8520) and agriculture labors (4100) in the agriculture activities. It suggests that land holding density (land ownership per household) is low in the project area. (Source: NLZR 2017)	legal land owners will lose the right of land ownership.	On the other hand, RAP report for first 50 MW solar project identifies only 18 legal households who will lose the right of land ownership.
Livelihood Loss	Land owners, sharecroppers and other land user (illegal land holders) will lose livelihood earning from 999.65 acres single cropped land including 165.5 acres for first 50 MW solar power plant	From 4800 farm families 57.3% households belong to landless and marginalized group who usually no or minimum land ownership. Moreover, high numbers of sharecroppers (8520) and agriculture labors (4100) suggests that project will impact on the livelihood of landowners, sharecroppers, agriculture labor or other land user (illegal land holder) As the land is single cropped with low productivity, it	DC office only recognizes the legal land owners. Thus it is found that 392 persons' livelihood will be affected as the result of land acquisition. On the other hand, for 50 MW solar project 61 APs' livelihood will be affected. RAP study report states that 22 sharecroppers and some other land users' (illegal) livelihood will be affected.	150-200 legal owners and 60-80 sharecroppers along with some other users' (illegal) livelihood will be affected from the land acquisition of 999.65 acres known from FGDs with legal land owners, sharecroppers and other land users (illegal). From the FGDs with legal land owner group, it was known that some owners have double or triple cropped land outside of proposed project site. Some owners stated that they don't have additional land but they do sharecropping

Type of Loss	Nature/scope of impacts	Secondary Data	Primary Data	Cross Validation
		is assumed from that the degree of livelihood impacts would not be severe. (Source: NLZR 2017)	Average Paddy production rate is 1.01 metric Ton per acre, suggests minimum dependency on the livelihood from the affected land.	other double/triple cropping lands for their livelihood. Thus, it is confirmed that affected different groups are not solely dependent on the affected land for their livelihood.
Structure Loss	No Structures including homestead, business structures will be affected	Not required	No structures were observed during field visit and survey.	Not required
Trees Loss	No trees will be affected from the intervention of the project	Not required	No trees were observed during field visit and survey.	Not required
Community Resource Loss	No community resources will be affected from the intervention of the project	Not required	No community resources were observed during field visit and survey.	Not required
Major Fishing Source Loss	No fishing resources are available within the proposed project area	Not required	Two separate canals go through the proposed project site and fall to Bara Feni River. No major fishing resources observed within the project site.	FGDs with the communities and other groups, it was confirmed that no major fishing activity is done within these Canals.

Type of Loss	Nature/scope of impacts	Secondary Data	Primary Data	Cross Validation
			One canal goes besides the 165.5 acres land acquired for first 50 MW solar project.	
Vulnerability	Income, gender and age based vulnerability may exists among the Ahs which leads incapability to cope up with the direct impacts generated from the project intervention.	According to the head count rate of Chittagong Division has recorded the lowest HCR of incidence of poverty in rural area at 16.2%. It also suggests that The highest average monthly household nominal income was recorded at Tk. 14092 for Chittagong Division. (Source: HIES, 2010)	Primary survey conducted within the 2km boundary area from the project site found that 2.3% households are underlying below the poverty line. Additionally, 0.2% households were found women headed.	Actual numbers of vulnerable households will not be known unless census is conducted among all the Ahs. However, consultation and FGDs with the local communities, it was found that among the affected households significant numbers may fall into the vulnerable categories. RAP report for the first 50 MW solar power plant suggests that among the 18 legal land owners 11 households are found vulnerable.

CHAPTER 5: IDENTIFICATION, PREDICTION AND EVALUATION OF POTENTIAL IMPACTS

5. IDENTIFICATION, PREDICTION AND EVALUATION OF POTENTIAL IMPACTS

5.1 Introduction

The proposed project may have an impact on the environment during construction and operation phases. During the construction phase, the impacts may be regarded as temporary or short-term; while long-term impacts may be observed during the operation stage. Spatially the impacts have been assessed over the study area of 5 km radius of the project site.

5.2 Impact Identification

Based on the activities involved, an impact interaction matrix for construction and operation phases has been prepared for the project. Impacts have been categorized based on only Environment aspect. The Impacts of the proposed project are covered mainly three phases are followed:

1. Pre-Construction and Construction Phase
2. Operation Phase
3. Decommissioning Phase

The impact identification matrices based on the activities involved in the different phases are presented below in the respective sections.

5.3 Impact during Construction Phase

During the construction phase, the following activities may have impacts on the environment:

- Site preparation
- Minor excavation and leveling
- Hauling of earth materials and wastes
- Cutting and drilling
- Concrete work, erection of concrete and steel structures
- Material handling and storage
- Approach road and internal service road construction
- Painting and finishing
- Dike Construction for flood protection
- Transmission line construction
- Construction Demobilization

Potential environmental impacts are identified and predicted for both negative and positive impacts in terms of ecological and environmental parameters for the construction phase. Assessment of impacts and possible mitigation measures are described in this section mentioning the sources and characteristics of impacts. An activity – impact interaction matrix for the pre-construction and construction phase of the project is presented in **Table 5-1.**

Table 5-1: Activity–Impact Interaction Matrix for Pre-construction and Construction Phase of the Project

Sl. #	Potential Impacts/ Risks Activity	Land Resources	Soil Resources	Sediment Quality	Water Resources	Air Quality	Noise Level	Drainage Pattern	Traffic/Transportation	Terrestrial Ecology	Aquatic Ecology	Visual/Aesthetics	Occupational Health	Community Health and Safety	Employment	Land loss	Gender	Vulnerable Group	Livelihood
A	**Site Preparation**																		
A1	Land Acquisition	■														■	■	■	■
A2	Site Cleaning, Leveling (cutting, stripping, excavation, earth movement, compaction)	■	■	■				■		■	■								
A3	Staging Area	■	■																
B	**Labour Engagement**																		
B1	Migrant Labour Influx								■				■	■					
B2	Employment of Workers								■				■	■	■	■	■	■	■
B3	Water Requirement																		
B4	Power Requirement					■													
B5	Waste Handling and Disposal		■		■														
B6	Sewage Disposal		■		■														
C	**Material Handling and Storage**																		
C1	Transportation and Unloading of Construction Material		■			■	■		■				■	■					
C2	Transportation of Plant Component		■			■	■		■				■	■					
C3	Storage and Handling of Plant Components	■	■			■	■		■				■						
C4	Storage and Handling of Construction Material, Hazardous Materials etc		■		■	■	■		■										
D	Construction Activities																		

Sl. #	Potential Impacts/ Risks Activity	Land Resources	Soil Resources	Sediment Quality	Water Resources	Air Quality	Noise Level	Drainage Pattern	Traffic/Transportation	Terrestrial Ecology	Aquatic Ecology	Visual/Aesthetics	Occupational Health	Community Health and Safety	Employment	Land loss	Gender	Vulnerable Group	Livelihood
D1	Preparation/Mixing of Construction Material	■			■	■	■												
D2	Supply of Water, Power, Sanitation etc.		■		■	■	■												
D3	Operation of Construction Machinery, Foundation, Pads, Office Building					■	■		■				■						
D4	Construction of Access Road and Widening of Existing Road	■	■	■	■	■	■			■	■		■	■	■	■	■	■	■
D5	Internal Access Road Construction	■	■		■	■	■	■					■	■	■	■	■	■	■
D6	PV Mounting and Foundation Excavation and Construction of each WTG Sites	■	■		■	■	■						■						
D7	Transmission Line Erection	■	■			■	■			■	■								
D8	Dike Construction around the Project Site	■	■	■	■	■	■	■		■	■				■	■	■	■	■
D9	Handling and Disposal of Construction Wastes		■		■	■				■	■								
E	De-Mobilization of Construction Equipment																		
E1	Dismantling of Temporary Support Construction Structures/equipment		■										■						
E2	Removal of Construction Machinery									■									
E3	Transportation of Construction/Dismantled Wastes		■		■	■	■		■				■						

The dike will be constructed using river dredged sand material. The location of sand sourcing not yet decided. It will be selected by the EPC contractor prior to start the construction. Possible options of sand materials sourcing and regulatory requirement have been presented in section 3.5.3. The possible impacts during the dredging activity on the following aspects would be generated.

- Air quality impact
- Impact on Noise level
- Water Quality
- Sediment Quality
- Impact of dredging and excavation and spoil disposal
- Impact of spoil plumes generated by dredging
- Impact on Geomorphology and Bathymetry
- Impact on River erosion
- Impact on River ecosystem including dolphin
- River traffic and collision risk
- Occupational health and safety
- Community health and safety
- Socio-economic impact

Impacts associated with pre-construction and construction activities are discussed and mitigation measures are also suggested in the following sections.

5.3.1 Land loss

a. Sources of Impact

Acquisition of 999.65 acres land will cost land loss. According to the land office record it is envisaged that approximately 392 households will lose their land. Moreover, RAP study for first 50 MW solar power plant identifies 18 land owner households among 61 persons listed by DC office, Feni.

- Land acquisition and ownership transfer
- Land development and changes of the land modalities
- Restriction in usage of land

b. Receptor

Primary study suggests that villagers of four villages within 2km radius from the proposed project site are the land users/owners. Thus it is expected that the impact will be bounded in local area only.

c. Impact Assessment

A total of 999.65 acres land acquisition including 165.5 acres for first 50 MW solar power plant will definitely impact on the land owners/users. Due to its permanent, irreplaceable loss and severity, this land loss impact is considered as **Medium High**.

Impact	Land Loss		
Impact Nature	Direct	Indirect	Induced
Impact Scale	Approximate 837 households residing local area		

Frequency	Permanent and covers all the phases					
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 *as* ***Medium-high***					

Land loss impacts have been assessed and it is assessed that impact is Medium-high in nature which is characterized by;

- Potential/possible impacts are significant and required attention;
- Mitigation measures are required to reduce the negative impacts to acceptable levels;
- Potential/possible impacts are localized but irreversible loss and long-term effects

Mitigation Measures

Potential impacts due to loss of land are attributed to land title ownership transfer of the land owners, loss of earning for land owners. These impacts are expected to be **low** with the implementation of the following mitigation measures.

- Payment of replacement value of land
- Payment of transitional assistance to support economic loss;
- Payment of severity allowance for fragmentation of land. Where the remaining land becomes unviable in case of fragmentation, the Project to compensate for the full land parcel;
- Livelihood restoration measures for severely affected households;
- Reimbursement of registration cost for purchase of land (up to the land lost to the project) within a specified period to encourage usage of compensation amount for building productive asset;
- Establishing a grievance redress mechanism;
- prioritization for work during project construction period;
- Prior notification before land development as crops harvesting not get impacted.

RAP and LRP study addresses all the mitigation measures, thus RAP & LRP study and successful implementation is required. Lately, RAP study for first 50 MW solar power plant has been done addressing all required measures. These mitigation measures will be supposed to reduce the land loss impact if these are implemented. Taking these measures into account, the land loss social impact will be reduced at the level of **low** significance.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance

Land Loss	Without Mitigation	Project Site	Permanent-Mitigated	Low	Medium-Low	Definite	Medium-High
	With Mitigation	Project Site	Medium term	Low	Low	Medium	Low

5.3.2 Livelihood Loss

a. Sources of Impact

The project will result in permanently change in land use of the project site from agricultural to industrial. The direct resultant impact (adverse) of land use change in the project area (and the other planned components) is the reduction in land area available for cultivation and resultant livelihood impacts on land owners, share croppers and illegal users.

- Land acquisition and ownership transfer
- Land development and changes of the land modalities
- Restriction in usage of land

b. Receptor

Primary study finds different land based livelihood patterns such as farmers, s, sharecroppers and illegal users. The number of the affected users may be varied (300-350) including legal land owners, sharecroppers and illegal land users. Where RAP for first 50 MW solar power plant identifies 18 legal land owner households, 22 sharecroppers and illegal land users.

c. Impact Assessment

It is envisaged that affected peoples will be partially impacted in the change of land use as they have other livelihood dependency. Affected persons do agricultural activities only in wet season. Production rate is very low and contributes only 3-4 months on livelihood. Thus the dependency is limited to only 3-5 months. Farmers, sharecroppers and illegal users will lose their livelihood as agricultural activities will be stopped permanently. Resource users and population residing on the land can't continue grazing their cattle in the land area thus they will lose livelihood in some extent too. So the impact has been assessed as Medium High.

Impact	Livelihood Loss					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Approximately (900-1000 including agricultural labor) households will be affected					
Frequency	Permanent and covers all the Phases					
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	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 is considered as ***Medium-High***					

In pre-construction and construction phases livelihood loss impacts have been assessed and it is assessed that impact is Medium-High in nature which is characterized by;

- Potential/possible impacts are significant and required attention;
- Mitigation measures are required to reduce the negative impacts to acceptable levels;
- Potential/possible impacts are localized but irreversible loss and long-term effects

Mitigation Measures

Potential impacts due to loss of livelihood are attributed to loss of earning for land owners, loss of livelihood for the sharecroppers, loss of employment for agriculture laborers, loss of grazing land for the community. These impacts are expected to be Medium-High with the implementation of the following mitigation measures

The following measures will be implemented to mitigate impact on farmers and sharecroppers:

- Prior information to harvest the crops or compensation for loss of crop;
- Payment of transitional allowance to support economic loss;
- Livelihood restoration measures for severely affected households;
- Establishing a grievance redress mechanism;
- Prioritization for work during project construction period or skill improvement training.

The impact on resource users from project activity is expected to be significant, as the land parcel acquired for the project large and there is no additional such place to graze cattle in the vicinity. The following measures will be implemented to mitigate impact on resource users:

- Livelihood restoration measures;
- Manage proper training by proponent for the resource users for using alternative resources;
- Proponent may keep a significant portion of the land unused for the usages of grazing land;
- Manage alternative grazing lands for the resource users;
- Establishing a grievance redress mechanism;
- Prioritization for work during project construction period or skill improvement training

Mitigation measures will be supposed to reduce the social impact during construction. Taking these measures into account, the social impact will be reduced at the level of low significance.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Livelihood Loss	Without Mitigation	Project Site	Permanent-Mitigated	Low	Medium-Low	Definite	Medium-High
	With Mitigation	Project Site	Medium term	Low	Low	Medium	Low

5.3.3 Gender Impact

Gender Impacts assessment highlights the potential impacts on women due to the proposed project activities. In this project, women may get affected directly by losing land and livelihood. Thus this section will assess the impacts on women due to land acquisition.

a. Sources of Impact

The sources of impact on the health and safety of the Project construction workforce are listed below.

- Land acquisition that causes land loss
- Livelihood loss after the Land Acquisition
- Transitional livelihood loss during Land acquisition

b. Receptor

The receptors of the gender impacts are specially those women who will lose land and livelihood due to land acquisition.

c. Impact Assessment

Land loss and livelihood loss will be incurred as the consequence of the Land Acquisition. Primary survey suggests that 83.20% Male and 1.20% Female involve with agriculture activities within 2km radius from the project site. Hence, it suggests that the potentiality of being directly affected of women by losing land and livelihood is lower than that of male. RAP report for first 50 MW solar project suggests that no women headed household will be directly affected due to land acquisition. According to the RAP report, lands are owned and ploughed by male head of the household. Therefore it suggests that no direct impact is envisaged on women as the consequence of the land acquisition.

Data, found from RAP report and primary survey, suggest that the impacts on women due to land acquisition will be **Very Low**.

Impact	Occupational Health and Safety				
Impact Nature	Direct	Indirect	Induced		
Impact Scale	Women who will lose land and livelihood due to land acquisition				
Frequency	Permanent				
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**					

5.3.4 Vulnerable Group

Vulnerable groups are those who are underlying below the poverty line, women/elderly/handicapped headed households. It is experienced that vulnerable groups are incapable to coup up with the changes incurred by the land acquisition and land use pattern. According to the primary study, significant number of vulnerable households may be affected in consequence of land acquisition.

Mitigation Measures

Along with the abovementioned measures following measures need to be implemented to mitigate impact on vulnerable groups:

- Additional cash/ other assistance
- Livelihood restoration measures;
- Establishing a grievance redress mechanism;
- Prioritization for work during project construction period or skill improvement training.

5.3.5 Unforeseen Impact

Primary study suggests that this affected community is agricultural based. About 70-85% of the total households somehow depend on agriculture. This intense and unilateral dependency on agricultural land of the community constructs its own social structures and other institutions. When agriculture gets affected then social structure and other social structures may get affected indirectly. Proper RAP and LRP implementation may reduce the chance of impacts on other related institutions.

5.3.6 Land Use Change

d. Sources of Impact

After land acquisition total 999.65 acres land which is used for only aman rice cultivation followed by grazing land will be changed to the industrial area. Following activities will lead to change the land use of the proposed project site during the construction phase.

- Construction of temporary structure such as construction site office, labor camp, store yard;
- Construction of internal access road
- Vehicular movement for carrying out the plant component and construction materials;
- Movement of construction equipment like cranes, excavators, dumpers, trucks;
- Construction of dike around the project site for flood control and
- Erection of PV mounting and WTGs as well as associated transformer yard and permanent site office.

e. Receptor

The impact will be bounded in the project location only.

f. Impact Assessment

A total of 999.65 acres of land has been identified for the proposed project comprising of government land that has been leased to the landless people and private land. The land use of the project area classified as seasonal aman rice cultivation during post monsoon grazing land during the pre-monsoon season. Proposed land is inundated during the monsoon season. The land acquisition has been completed and handed over to the Electrical Generation Company Bangladesh Limited (EGCB).

The agricultural activities, as well as grazing land, will be changed as industrial land. Approximately 5 m height dike will be constructed around the project site for flood control. Total 1,030,864 m^3 earth material will be required for dike construction around the project boundary of both phases. Approximately 467,050 m^3 will be required for dike construction of Phase 1 project whereas 563,824 m^3 for Phase 2. Furthermore, total 71993.27 m^3 stone boulders shall be required for dike protection of which 36,016.93 m^3 and 35,976.34 for Phase 1 and Phase 2 projects respectively. Due to the dike construction, the present land use will be changed.

The establishment of the solar plant will convert cultivable land to industrial use for long-term (25 years). Changes in land use are also envisaged for the development of the associated facilities such as storage yard, offices, switchyard etc. however, the impact on land use will only be within the project boundary and will not affect any of neighboring areas. Furthermore, the changes to the land use will be reversible and can be used for agricultural purposes after decommissioning of the project. Thus the overall impact significance without mitigation measures of the PV power plant on the areas land use/landscape assessed as ***medium-high***.

Impact	Land use change					
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 *as* ***medium-high***					

g. Mitigation Measures

The **land use change** can be minimized by implementing the following mitigation measures:

- EGCB has considered all aspects of siting and design prior to selection of the proposed site. The construction activities will be restricted within the boundary of the proposed plant and will not alter the land use of the adjacent areas;
- Construction activities should be restricted to designated areas;
- Proponent should take tree plantation program whereas possible in the plant boundary or along the road/embankment side
- Waste should not be allowed to litter in and around the project area;
- On completion of construction activities, land used for temporary facilities will be restored to the extent possible;
- The land should be restored back to the original state to the extent possible after completion of the life cycle of the project and in case there are plans not to continue further at the site.

The impact on land use will have a high intensity within the project site for a permanent duration which will result in an overall medium-high impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***Medium-low***.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Land use change	Without Mitigation	Project site	Long Term	High	Medium-High	High	Medium-High
	With Mitigation	Project site	Long Term	Medium	Medium Low	Medium	Medium Low

5.3.7 Impact on Land Resources

a. Source of Impact

The potential source of impact on land resources during the construction phase activities includes:

- Topsoil removal
- Site Cleaning, Leveling (cutting, stripping, excavation, earth movement, and compaction)
- Construction of Dike
- Transportation and storage of construction materials/equipment
- Storage, Transportation, and Disposal of Construction debris
- Influx of labor and construction of temporary houses
- Waste disposal from construction camp
- Civil construction activities

b. Receptor

The total 999.65 acres land using for seasonal low yielding variety aman rice and grazing land, which will be changed from agriculture to industrial land. This will boost the price of the land in the region.

The soil of the project area is not suitable for crop cultivation. Project site land inundated during the monsoon season and stands for several months causing soil salinity. The range of soil salinity 4-12 dS/m. Soils are imperfect to poorly drain in rabi season, surface water drained out by December. Cracks in surface soil and salinity create problems to the normal cultivation of land.

c. Impact Assessment and Mitigation Measures

i. Loss of Top Soil

During the site preparation, 200-300 mm top soils will be stripped out and these spoils will be used to fill up the low land in the project boundary. During the site preparation, top soils will be stripped out and leveling the land. The proposed project site is medium high land where only low yielding variety aman rice is cultivated during the post monsoon. As the topsoil removal activity will be restricted within the project boundary and will not have off-site impacts, so the significance of an impact is assessed as ***Low***.

Impact	Loss of Top Soil					
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 **Low**					

Mitigation Measures

The potential **loss of topsoil** impacts will be minimized by the implementation of the following measures:

- The removal of vegetation and soil cover will be restricted to only those areas necessary for the development. All topsoil will be retained and reused;
- Stockpiles will be vegetated or appropriately covered to reduce soil loss as a result of wind or water erosion;
- Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds;

- All construction plant and equipment will utilize approved access routes
- Minimizing the amount of soil handled;
- Stabilizing exposed areas; and
- Covering or spraying water on stockpiles of excavated material

The impact on topsoil loss will have a medium intensity within the project site for a short duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***Very Low.***

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Loss of Top Soil	Without Mitigation	Project site	Short term	Medium	Low	Medium	Low
	With Mitigation	Project site	Short term	Low	Insignificant	Low	Very Low

ii. Soil Compaction and Erosion

Site preparation for the establishment of ***wind and solar PV hybrid power plant***, Dike construction, internal access road(s), temporary laydown area and buildings (accommodation and control) during the construction phase will require vegetation clearance, some site leveling and grading and soil compaction. The area required for the PV array locations and foundations for the wind turbine, buildings and access tracks linking infrastructure is considerable which approximates to 738 acres. The construction activities will result in loss of topsoil within the site boundary and will not affect adjoining land.

The soil compaction would lead to impact on the soil physical properties such as reduction in pore spaces, water infiltration rate, and soil strength etc. However, it should be noted that 262 acres of land will be used for the agriculture and aquaculture activities whereas 738 acres land is designated for plant construction. Total 28 meters base width and 18.22 km dike will be constructed around the project site of which 8.90 km dike will be constructed for first 50 MW project.

Further, the transport of materials and equipment will involve the additional movement of vehicles; construction machinery which will also lead to some degree of compaction within the site premises. No adverse impact on the soil in the surrounding area is anticipated. However, in order to minimize such impacts, appropriate soil erosion control measures would be undertaken by Developers of Modules and associated structure to appease the chances of soil erosion. As the soil compaction will be restricted within the project boundary and its extent is expected to be limited to the impact significant due to the soil compact is considered as ***Low***.

Impact	Soil Compaction and Erosion				
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 **Low**					

Mitigation Measures

The following measure will be implemented to mitigate the Soil Compaction and Erosion:

- The area to be cleared must be clearly demarcated and this footprint strictly maintained;
- Soil conservation measures will be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas.
- Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds;
- Work areas will be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint;
- It is recommended to grow turf grass beneath solar panels to avoid soil erosion
- Construction vehicles will remain on designated and prepared compacted gravel roads;

The impact on topsoil compaction and erosion will have a medium intensity within the project site for a short duration, which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***very low***.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Soil Compaction and Erosion	Without Mitigation	Project site	Short term	Medium	Low	Medium	Low
	With Mitigation	Project site	Short term	Low	Insignificant	Low	Very Low

iii. Soil Contamination

The project will also involve the use of paints for solar PV and wind hybrid power plant and switchyard structures during construction which if not handled and used properly, may lead to contamination of soil. Improper disposal of hydraulic fluids, diesel, lubricating oils and other used oils can also result in contamination of soil. Improper storage of construction material can also result in the unwanted dispersal of contaminants into adjoining areas.

Spills could have a long-term impact on soil quality, but are expected to be localized in nature. Spill control measures such as the storage and handling of chemicals and fuel in concreted areas will be implemented to minimize impacts in the event of a spill. Liquid effluents arising from construction activities will be treated to the standards specified in Schedule 9 and 10 of ECR, 1997 of the GOB.

The soil in the Project area is not contaminated as there is no anthropogenic activity in the project area. No assessment or testing of the imported fill material for the dike construction and site preparation has been carried out as the source of the fill material has not been finalized at the time of writing. Therefore the assessment of potential soil contamination from site preparation will need to be finalized once details of the imported fill material are available. Once the nature of the soil is known, sufficient controls will be implemented to ensure that any impacts to existing soil quality will be ***low***.

Impact	Soil Contamination					
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 as ***low***					

Mitigation Measures

The following measure will be implemented to mitigate the **Soil contamination:**

- Earth material should be tested at source prior to fill the land for dike construction;
- Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area.
- Sewage generated from the project site will be treated and disposed of through septic tank and soak pits;
- Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of.
- Construction vehicles and equipment will be serviced regularly
- The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals;
- Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system;
- A site-specific Emergency Response Plan will be prepared by the contractor for soil clean-up and decontamination;

- Any loading and unloading protocols should be prepared for diesel, oil and used oil respectively; and
- The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination events

The impact on topsoil contamination due to spills and leaks will have a medium intensity within the project site for a short duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***very low.***

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Soil Contamination	Without Mitigation	Project site	Short term	Medium	Low	Medium	Low
	With Mitigation	Project site	Short term	Low	Insignificant	Low	Very Low

iv. Impact on land due to the improper waste disposal

General construction waste generated onsite will comprise of surplus or off-specification materials such as concrete, wooden pallets, steel cuttings/filings, packaging paper or plastic, wood, metals etc. Municipal domestic wastes consisting of food waste, plastic, glass, aluminum cans and waste paper will also be generated by the construction workforce at any canteen facility/ rest area which shall be constructed for them. A small proportion of the waste generated during construction phase will be hazardous and may include used oil, hydraulic fluids, waste fuel, grease and waste oil containing rags. If improperly managed, solid waste could create impacts on the land. A considerable amount of solid and liquid waste will be generated during the construction phase that will be managed by the contractor however improper management of these waste may impact on the soil quality which has been accessed as *low* impact.

Impact	Impact due to waste generation					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Within the project boundary					
Frequency	Limited to construction Phase					
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	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 as ***low***					

Mitigation Measures

The following measure will be implemented to mitigate the **Waste Generation:**

- The construction contractors will have control over the amount and types of waste (hazardous and non- hazardous) produced at the site. Workers will be strictly instructed about random disposal of any waste generated from the construction activity;
- Construction contractor should ensure that no unauthorized dumping of used oil and other hazardous wastes is undertaken from the site;
- Municipal domestic waste generated at site to be segregated onsite;
- Ensure hazardous waste containers are properly labelled and stored onsite provided with an impervious surface, shed and secondary containment system;
- Ensure routinely disposal of hazardous waste through approved vendors and records are properly documented;
- Construction contractor should ensure daily collection and periodic (weekly) disposal of construction waste generated debris, concrete, metal cuttings wastes, waste/used oil etc.;
- Ensure hazardous waste is properly labeled, stored onsite at a location provided with impervious surface, shed and secondary containment system and;
- The municipal waste from the labor camp will only be routed through proper collection and handover to the local municipal body for further disposal. The hazardous wastes will be temporarily stored in labeled drums on the impervious surface at designated area onsite and will be disposed of through approved vendors.

The impact on soil quality due to the waste generated during the construction will have a medium intensity within the project site for a short duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***very low.***

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Impact on land due to waste	Without Mitigation	Project site	Short term	Medium	Low	Medium	Low
	With Mitigation	Project site	Short term	Low	Insignificant	Low	Very Low

5.3.8 Agricultural Resources

a. Sources of Impact

The proposed project will be set up on 999.65 acres land of which 738 acres land is designated for plant development and rest 262 acres for aquaculture activities. The project site is medium high land where only aman rice is cultivated during monsoon season. The land is also used for grazing purpose. During the monsoon season, the land gets inundated approximately 12-15 inch. The agricultural production will be lost due to the project development.

b. Receptor

Most of the lands are government land that was leased to the people. There are some private lands as well. The ratio of public and private land is unknown as the information is not available during the writing of the report. The seasonal low yielding variety cultivable land

will be turned into an industrial area. The landowner and sharecropper will be affected due to the project development.

c. Impact Assessment

The main agricultural practice in the project and surrounding area is mainly seasonal low yielding variety aman rice cultivation land. According to the Sonagazi upazila Agriculture office, 2.5 metric ton per hectares rice is growing in the Char Chandia Union. The production loss of the land will be almost 1000 metric ton rice. The project area will be confined to the respective location and will not hamper surrounding agricultural land. Approximately 262 acres land out of 999.65 acres of the total land has been designated for the fisheries. The project site will be bounded by 5 m height dike to protect from the flood, therefore, the designated land for livelihood purposes will be utilized throughout the year. So the impact due to the project development on agricultural land will be minimized. The intensity of the impact is high for the permanent duration so the impact significance has been assessed as **Medium High.**

Impact	Agricultural Production Loss					
Impact Nature	**Direct**		Indirect		Induced	
Impact Scale	Production loss of the 300 hectares agricultural land within the project boundary					
Frequency	Permanent loss					
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	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**					

d. Mitigation Measures

The following mitigation will be taken to reduce the agricultural production loss;

- Inform the landowner prior to start land development work so they can harvest the standing crop;
- Best utilize the designated land area for fisheries

The impact on agricultural resources due to the project construction will have a high intensity within the project site for permanent loss which will result in an overall Medium high impact

without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***Medium-low.***

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Agriculture production loss	Without Mitigation	Project site	Permanent -Mitigated	High	High	Definite	Medium-High
	With Mitigation	Project site	Permanent -Mitigated	Medium	Medium-High	Medium	Medium Low

5.3.9 Water Resources

a. Source of Impact

The potential sources of impact on surface and groundwater resources are as follows:

- Surface and groundwater abstraction for construction work and domestic purposes;
- Earthworks in the project area may increase the erosion, especially during rainfall events, which may increase the suspended sediment concentrations and pollute water sources;
- Sewage will generate from the construction workforce (toilets and washing facilities) and from drainage from cooking activities.
- Liquid effluents will also arise from washing of construction equipment and vehicles; and
- Inappropriate storage of construction waste, material storage that leading to water quality impacts from runoff entering the Choto Feni River, Canal inside the project area.

b. Receptor

The Choto Feni River and Feni River are the major surface water body in the 5 km study area which flows adjacent to the project site. During the project construction, ground water or Choto Feni River water will be used. Two Canal also exist in the project site which is originated from the Choto Feni River and pass through the project site.

The primary analysis result of both the surface and groundwater quality of the project study area are well within the ECR, 1997 standard limit. During the monsoon season, remarkable fish species of Bangladesh are found in the Feni and Choto Feni River as well as in the canal. The groundwater is the main source of drinking water in the project study area.

c. Impact Assessment

i. Water Abstraction

During the construction phase, the primary water use requirement will be for dust control. However, water may also be required to moisture condition the soils for proper compaction of internal roads and foundations within the site premises. Temporary ablution facilities will be required during construction (i.e. portable toilets). Water will be required for foundation work and domestic requirement of workers. Water will be sourced from Choto Feni or Feni River. Borewell(s) will also be constructed within the site premises to cater to the domestic water requirement during the construction phase.

Water is available in both the River which can meet the water requirement during the construction phase. The water abstraction rate will be less compared to the available water flow of the River therefor the impact due to the water abstraction from the River will be low.

The groundwater table in and around the project area is shallow (around 6 meters). The local people are using the groundwater for drinking and domestic purposes. Water abstraction for domestic as well as construction activities will not create the water scarcity for the local people as the water table is shallow.

So the impact on water resources due to the water abstraction during the construction period has been assessed as ***low***.

Impact	Water Abstraction					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Water abstraction from Feni/Little River and groundwater					
Frequency	Limited to construction Phase					
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	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**					

Mitigation Measures

The following measure will be implemented to mitigate the **water consumption:**

- The effect of groundwater or surface water abstraction for project activities will be assessed in detail using field testing and modeling techniques, and accounting for seasonal variability and projected changes in demand in the Project area;
- Periodical training need to provide to workers for best utilization of water;
- Keep provision for rainwater harvesting;
- Take permission for installation of bore well from Upazila Parishad;
- Recycle/reusing to the extent possible

The impact due to water abstraction from Feni River/Choto Feni River and the ground level will have low intensity with locally extent for a short duration which will result in an overall

low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***very low.***

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Water Abstraction	Without Mitigation	Project site	Short term	Low	Low	Medium	Low
	With Mitigation	Project site	Short term	Low	Insignificant	Low	Very Low

ii. Water Quality

There are two canals are following on the project site which is the major receptor of water pollution due to the construction work. As the construction camp will be set up in the project premises and sanitary facilities including toilets and showers will be provided for the use of the construction workforce both on-site and at the worker's accommodation. Such liquid effluent streams are likely to be high in organic matter, suspended solids, bacterium and other pollutants. Septic tanks will be provided to treat sanitary wastewater. Surface water quality might be contaminated due to the accidental spills/leaks at the storage areas. A small volume of wastewater from the washing of equipment and machinery may also be generated. This wastewater may contain concentrations of suspended solids and traces of hydrocarbon. The contractor will be responsible for ensuring that any wastewater discharges meet the standards stipulated in Schedule 9 and 10 of ECR, 1997. Potential impacts are expected to be short-term and extent will be localized. Therefore, the impact to surface water from wastewater discharges during construction is assessed to be ***low***.

Impact	Waste Water Discharge					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Wastewater discharge in water body					
Frequency	Limited to construction Phase					
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	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***					

Mitigation Measures

The following measure will be implemented to mitigate the wastewater discharge:

- Fuel, oil and used oil storage areas will be contained in bunds of 110 percent capacity of the stored material;
- Refueling will be carried out in designated areas using strict protocols;
- Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a bound landfill site;
- Project staff will not be permitted to utilize any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing;
- Construction vehicles and equipment will be serviced regularly at off-site location;
- Ensure that all construction plant and equipment is maintained in a good state of repair with minimal leaks;
- Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal;
- Oil and grease separator shall be used for wastewater generated from cleaning activities;
- Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce;
- Workers will be trained in the use of designated areas/bins for waste disposal and encouraged to use toilets;
- Septic tanks will be provided to treat sanitary wastewater
- Use of licensed contractors for management and disposal of waste and sludge and
- All sewage and liquid effluent will be treated to meet the standards specified in Schedules 9 and 10 of the ECR, 1997.

The impact due to wastewater discharge will have low intensity with short-term duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **Very low.**

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Wastewater Discharge	Without Mitigation	Project site	Short term	Low	Low	Medium	Low
	With Mitigation	Project site	Short term	Low	Low	Low	Very Low

iii. Increased Sediment Content of Surface Water

Soil compaction and vegetation clearance may increase the intensity and volume of surface water runoff as a result drainage lines within the site will be impacted by the increase of sediment load. There will be heavy equipment and machinery that will be used for the construction of the access roads, site preparation as well as foundations for the solar PV & wind turbines foundation. As there is a provision for embankment construction around the project site that will lead to increase the sediment load in the Canal and River water. If this equipment is not maintained in a good state of repair, hydrocarbon-related leaks from construction plant and equipment could be part of the surface water run-off leading to water pans thus adversely affecting surface water quality. Besides the above-mentioned sources of impact there are some additional source e.g Runoff and erosion of exposed bare soil, slopes

and earth, and stockpiles; Release of cement materials with rain wash; and washing water from dust suppression sprays and vehicle wheel washing facilities. The extra sediment loads in the canal and River water also lead to an impact on the aquatic environment. The impact is direct in nature for short duration and localized. Taking into consideration the earthwork control measures that will be in place, the potential impact from construction activities on sediment content of the water body is assessed to be **Low.**

Impact	Increased Sediment loading in surface water body					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Impact on canal and Choto Feni River water					
Frequency	Limited to construction Phase					
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	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**					

Mitigation Measures

The following measure will be implemented to mitigate the sediment content in the water body:

- The drainage pattern of the site will not be altered and the natural slope of the site will be maintained;
- Flow of two canals as passing through the site should be maintained as per present scenario;
- Special care needs to be taken during the road construction to maintaining the standard slop as the soil cannot wash out in the water body. As well as need proper compaction of the road structure;
- Cover all slopes of the road and embankment by first growing grass;
- Adequate arrangement for stormwater management during construction period will be made to avoid sediment runoff from the site;
- During construction, it should be ensured that no run-off from construction area merges with the existing canals
- Stormwater flow should be directed to the existing canals/River with silt trap to

avoid sedimentation of the canals/River or the receiving water body

The impact due to increase sediment load in a water body will have medium intensity with locally extent for a short duration which will result in an overall Medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures has been provided above the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Wastewater Discharge	Without Mitigation	Local	Short term	Medium	Medium-Low	High	Medium-Low
	With Mitigation	Local	Short term	Low	Low	Medium	Low

iv. Groundwater Contamination

Vegetation clearance and soil compaction may increase the intensity and volume of surface water runoff as a result of a decrease in water infiltration recharging the groundwater. Improper disposal of sewage and wastewater from a labour camp and construction debris can contaminate the groundwater resources in the area. The hydrogeology of the project area could potentially be affected if any leaked hydrocarbons permeate into the sub-surface and through cracks in the bedrock geology come into contact with the groundwater. Groundwater contamination during the construction phase may occur from unplanned events such as leaks and spills of oil, lubricants, fuel from heavy equipment, improper handling of sewage. Mitigation measures such as storage of oil, lubricants, fuel at concreted laydown areas will be implemented to minimize contamination in the event of a spill. Septic tanks will be provided to treat sanitary wastewater. As stated above, all wastewater discharges will meet the standards stipulated in Schedule 9 and 10 of ECR, 1997 prior to discharge. While there is a potential for long-term direct impacts to groundwater quality from construction, proper handling of fuel, waste and liquid effluents, the impact to groundwater from spills and leaks is assessed to be **low.**

Impact	Groundwater contamination from spills and leaks				
Impact Nature	Direct	Indirect	Induced		
Impact Scale	Groundwater in the project site and surrounding				
Frequency	Limited to construction Phase				
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	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**					

The impact on groundwater contamination will have low intensity with locally extent for a long duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to **very low.**

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Groundwater contamination	Without Mitigation	Local	Long-term	Low	Low	Medium	Low
	With Mitigation	Local	Long-term	Low	Low	Low	Very Low

5.3.10 Impact on Drainage Pattern

a. Source of Impact

There is a provision of embankment construction around the project site for flood water control. The drainage pattern of two canals which are passing through the project site might be blocked or change due to the embankment construction.

b. Receptor

The project site is located adjacent to the left bank of Choto Feni River as well as right bank of Feni River which is following approximately 3.5 km eastern side of the project area. There are two canals passing through the project site. Western side canal is connected with both Choto Feni River and eastern side canal. Eastern canal flows long distance and connected with both Feni River and Choto Feni River. Both the canals get water during high tide and act as drainage of upstream rainwater/flood water.

c. Impact Assessment

A 5 meter high embankment will be constructed around the 999.65 acres land to protect the floodwater enter in the project area through the two canals. If there is no regulator in the dike design, therefore, the canals will be disconnected with the River as a result upstream water could not drain out to the River. Therefore waterlogging may be taken place in some places on the northern side of the project boundary. Improper design of the dike may impact on the natural drainage pattern in and around the project site. The impact extent will be local and long-term duration so the impact on drainage pattern assessed as ***medium-high***.

Impact	Impact on drainage pattern				
Impact Nature	Direct	Indirect		Induced	
Impact Scale	Waterlogging				
Frequency	Construction and Operation Phase				
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	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***					

d. Mitigation Measures

The following measure should be implemented to mitigate the change of drainage pattern:

- Detail hydrology study should be carried out prior to design the dike;
- Appropriate number of cross drainage channels should be provided during access road construction to maintain flow in existing natural channels
- Keep both the canals functional
- Design the dike and plant considering the normal functioning of the canals

The impact on the hydrological pattern will have high intensity with locally extent for a long duration which will result in an overall medium-high impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to **low.**

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Drainage Pattern	Without Mitigation	Local	Long-term	High	Medium-High	High	Medium-High
	With Mitigation	Local	Long-term	Medium	Medium-Low	Low	Low

5.3.11 Air Quality

a. ***Source of Impact***

The main impacts associated with construction activities will be:

- **Dust Generation:** Resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions, construction of approach road, construction of WTG and PV module foundation, construction of building, loading and unloading equipment, dust generated from stockpiles of waste, topsoil handling and moving excavated material and transporting wastes on vehicles.
- **Exhaust Emissions:** Exhaust emissions of SO_2, NOx, CO, CO_2, and PM_{10} will be attributed predominantly to the construction of the plant, DG set operation and road vehicles such as movement of trucks and vehicles during construction work.

b. Receptor

The project site is surrounded by Choto Feni River in South; agricultural land in north and east, road/embankment in the west. There is no settlement adjacent to the project site. The nearest settlement is located 250 m northern side of the project which is scattered household with homestead plantation. Major settlement around the project site is adorsho village which is located approximately 275 m west and 265 m north-west from the project site.

c. Impact Assessment and Mitigation Measures

i. Dust from Construction Activities

The presence of dust can be a nuisance to Site users, including construction workers and other nearby receptors. The levels of dust at the site are expected to be variable and dependent on the time of year, the intensity of the activity and the prevailing winds. During the construction phase, dust will be generated from increased vehicle movements from trucks driving on unpaved roads and from activities that cause disturbance of the soil.

Dust becomes airborne due to the action of winds on material stockpiles and other dusty surfaces, or when thrown up by mechanical action, for example, the movement of tyres on a dusty road or activities such as excavating. The quantity of dust released during construction depends on a number of factors, including:

- the type of construction activities occurring;
- the area of exposed materials;
- the moisture and silt content of the materials;
- distances traveled on unpaved surfaces; and
- the mitigation measures employed.

The key construction activities likely to result in increased dust levels are site cleaning, excavation work, cutting and levelling work, movement of trucks transporting solar and WTG infrastructure to the site, movement of construction vehicles along dusty roads, clearance of vegetation, trenching, burial of cables and screwing/ piling support poles of structures into the ground. Dust emissions are exacerbated by dry weather and high wind speeds. The impact of dust also depends on the wind direction and the relative locations of dust sources and receptors.

The nearby resident will be affected by construction dust as well as the people living near the site of the approach road. All of these residential settlements are however surrounded by thick homestead plantation which will act as a barrier reducing the magnitude of any dust impacts. On the basis of the above factors, the magnitude of the impact associated with the emission of dust during construction activities is predicted to be low as the settlement is located more than 200 m far from the project site. Traffic movement for carrying out construction materials and infrastructure of PV and WTG will generate dust to the local resident due to the presence of household close to the approach road. However, the significance of the impacts is assessed to be **medium-low.**

Impact	Dust from Construction Activities		
Impact Nature	Direct	Indirect	Induced
Impact Scale	Settlement within the 100 m of the project boundary and along the approach road		
Frequency	Limited to construction Phase		

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	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*					

Mitigation Measures for dust control

To reduce dust impacts, the following measures will be put in place:

- Implementation of a regular watering and sprinkling dust suppression regime, during the dry season;
- Stockpiles of dusty materials will be enclosed or covered by suitable shade cloth or netting to prevent the escape of dust during loading and transfer from Site.
- No stockpiles will be maintained outside, and maximum Possible distance between the stockpiles and receptors will be maintained;
- Covering and/or watering of all stockpiles of dusty materials such as excavated spoils to avoid fugitive dust emissions;
- During construction, the approach road will be kept clean, free from mud and slurry;
- Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site;
- Speed of vehicles on site and approach road will be limited to 15-20 km/hr which will help in minimizing fugitive dust emission due to vehicle movement
- Idling of vehicles and equipment will be prevented and
- Waste from construction will not be burned.

The impact due to dust generation will have medium intensity with locally extent for a short-term duration which will result in an overall **medium-low** impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Dust from construction activities	Without Mitigation	Local	Short term	Medium	Medium Low	Medium	Medium Low
	With Mitigation	Local	Short term	Low	Low	Low	Low

ii. Exhaust Emissions

In addition to dust generation, construction vehicles and other construction equipment will generate exhaust emissions. Heavy equipment such as bulldozers, excavators, dump trucks, and compactors will be used onsite. Emissions from this equipment and from diesel generator sets used to generate power will cause impacts to ambient air quality. It is not anticipated that large volumes of exhaust emissions will be generated during the construction phase of the ***solar PV and wind hybrid plant*** facility.

The implementation of the good site practices, such as the regular maintenance of vehicles and equipment, using cleaner fuels and switching of vehicles when not in use will be used to reduce exhaust emissions from the operation of the diesel-powered construction equipment and therefore minimise adverse air quality impacts. However, the air quality impacts associated with the vehicular and equipment emissions during construction activities are assessed to be of **low** potential significance. This implies the effects to be of localized nature and temporary which indicates that any deterioration in air quality at project location is unlikely to be significant and is expected to be transient. The impact due to the exhaust emission from the vehicle is assessed to be **Low.**

Impact	Exhaust Emission					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Settlement within the 100 m of the project boundary and along the approach road					
Frequency	Limited to construction Phase					
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	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***					

Mitigation measures for exhaust emission

Exhaust emissions will be minimized by following mitigation measures:

- The movement of construction vehicles will be minimized and a 20 km/hr speed limit will be enforced in the project site as well as approach road;
- Vehicles traveling on gravel roads will not exceed a speed of 30 km/hr;

- All diesel-powered equipment will be regularly maintained and idling time reduced to minimise emissions;
- Low sulfur diesel (S<O.5%) will be used in diesel-powered equipment in collaboration with best management practices;
- Vehicle/equipment air emissions will be controlled by good practice procedures (such as turning off equipment when not in use);
- Vehicle/equipment exhausts observed emitting significant black smoke in their exhausts will be serviced/ replaced; and
- Solid waste burning in the project site is strictly prohibited

The impact of exhaust emission will have high intensity with locally extent for a short-term duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **very low.**

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Exhaust Emission	Without Mitigation	Local	Short term	Low	Medium Low	Low	Low
	With Mitigation	Local	Short term	Low	Low	Low	Very Low

5.3.12 Impact on Noise

The proposed solar and wind energy facility will be located in an area with a rural character which is fairly remote. Increased noise levels are directly linked with various activities associated with the construction phase.

a. Sources of Impact

Following project activities were considered for the purpose of impact assessment on ambient noise levels during the construction phase:

- Construction activities including site preparation, construction of PV and WTG foundation, operation of earthmoving and excavation equipment, building, and substation construction;
- Transportation of PV module, PV module mounting structure, WTG components, construction material, construction machinery, and personnel;
- Operation DG sets;
- Operation of batching plant
- Digging of trenches to accommodate underground power cables,
- The equipment likely required to complete the above tasks will typically include Excavator, Graders, bulldozers, dump trucks, vibrating roller, wheel loader, rock breaker, flatbed trucks, concrete trucks, cranes, forklifts and various four-wheel drive and service vehicles.

b. Receptor

The nearest settlement is 250 m of the northern boundary and 275 m and 265 m of the western and north-western boundary. The sensitive receptor is located approximately 720 m North-Western side of the Project location. The closest reserve forest is located 1.30 km from the

south-west corner of the project boundary. The household is located within the 200m of the access road, as a result, they will be affected by the movement of the vehicle.

c. Impact Assessment

A significant source of noise during the construction phase is additional traffic to and from the project site as well as traffic on the site. The use of borrow pits and a concrete batching plant will significantly reduce heavy traffic vehicle movement to and from the site. Construction traffic is expected to be generated throughout the entire construction period; however, the volume and type of traffic generated will depend on construction activities being conducted which will vary during the construction period. There is potential for disturbance to habitations in the proximity to construction site. Movement of traffic during night hours can also disturb the local community. Approximately 90-92dB (A) of noise is expected to be generated from construction activity which will attenuate to less than 45dB (A) i.e. night time prescribed noise level at about 100 m. As the closest receptor present more than the 100m from the project site as well as there is a road on the western boundary that is elevated than the project site. The road will act as a barrier for dispersing the construction on the western side. The traffic movement will generate noise on the access road as well as along the roadside. Peoples who are living near to the roadside will be get affected by the traffic movement so the impact assessment has been considered as **low.**

Impact	Noise from construction activity					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	NSR is adjacent to the plant boundary and within the 200 m					
Frequency	Limited to construction Phase					
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	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**					

d. Mitigation Measure

The following mitigation measures will be implemented to minimize potential noise impacts during the construction phase in all periods:

- The contractor should ensure that all construction equipment and vehicle is fitted with

silencers (where possible);

- The contractor should consider the noise emission characteristics of equipment when selecting equipment for the project and select the least noisy machine available to perform the specific work (this is a requirement of OSHA 2007);
- The contractor should undertake additional post development noise monitoring in accordance with National and International noise standards.
- Mobile noise sources such as cranes, earth moving equipment shall be routed in such a way that there is minimum disturbance to receptors;
- Developer shall instruct their Safety Officers to arrange for inherently quiet construction equipment and machines to maintain the noise level to minimum;
- Only limited construction activities shall be carried out during night-time;
- Restrict the night time vehicle movement through the access road;
- Adopt the vehicle speed limit in the access road
- It is also to be ensured that no village road will be utilized for movement of equipments except the designated access road;
- The number of equipment operating simultaneously should be reduced as far as practicable;
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable;
- All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50m away from the site boundary;
- Rubber padding/noise isolators will be used for construction equipment
- Temporary noise barriers shall be provided surrounding the high noise generating construction equipment;
- The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels;
- Construction vehicles and machinery will be well maintained and not kept idling when not in use;

The impact of noise will have low intensity with locally extent for a short-term duration which will result in an overall **low** impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **Very-low.**

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Noise generation	Without Mitigation	Local	Short term	Low	Medium Low	Low	Low
	With Mitigation	Local	Short term	Low	Low	Low	Very Low

5.3.13 Traffic and Transport

a. Sources of Impact

The construction phase shall involve transportation of construction materials, solar PV modules, wind turbine equipment and mounting structures. The existing road is not suitable for carrying construction and plant material, therefore, a new road will be constructed and upgrade the existing road according to the section 3.5.4. The access road plan is not finalized

yet and it will finalize during the detail design stage. The construction workforce will travel to the site over the road, and will, therefore, have an impact on local traffic and transportation.

b. Receptor

Local people mainly used the Feni – Sonagazi roadway for movement to town area whereas the existing access road from the Sonagazi-Olamabazar-Chardarbesh-Companiganj road to the project site is used by the villagers. No major vehicle is running on the road only auto rickshaw, CNG, motorcycle, and bicycle are using the access road. Local people will be affected due to the additional traffic movement on the access road. The receptors exposed to impacts from construction phase movements and personnel are the existing users of the road as well as nearby residents. The Feni – Sonagazi (Char Chandia) roadway and local user are the main receptors considered in this assessment. This road is used by the local people to go to the resident and Musapur closer for recreation purpose.

c. Impact Assessment

The construction activities will require transportation of construction material, PV module, WTG component, PV module mounting structure and construction material to the site. The project construction activities will lead to additional traffic and increased risk of traffic-related accidents and injuries to the community and to workers. Such impacts arise almost entirely during the construction period. The increase in traffic due to the project is, however, going to be marginal. Transportation of construction material in open trucks /tippers can also lead to dust generation along the route. Excess traffic on the road will create discomfort for locals due to increment in noise level and fugitive dust and gaseous pollution expected to exhaust from the vehicles. The impact due to the traffic movement is assessed as **Medium-low**.

Impact	Increased traffic movement					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Impact on local community					
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**

d. Mitigation Measures

The following mitigation measures will be taken to mitigate the traffic and transportation impact:

- The contractor should ensure that all WTG, PV module and mounting structure components are transported in appropriate vehicles that adhere to the axle load limits.
- Only trained drivers with valid license shall be recruited by the construction contractor.
- Training programs shall be conducted at regular intervals for all the drivers for raising awareness about road safety and adopting best transport and traffic safety procedures once in every month.
- Additionally, speed limits for all construction related vehicles shall be adhered to at all times to prevent damage to roads and other infrastructure
- Mitigation measures such as emphasizing on safety amongst drivers, adopting limits for the trip duration and arranging driver roster to avoid overtiredness and avoiding dangerous routes and times of day to reduce the risk of the accident shall also be implemented.
- High visibility colors should be used during the transportation of the wind turbines to the project site.
- Regular maintenance of vehicles and use of manufacturer approved parts should be adopted to minimize potentially serious accidents caused by equipment malfunction or premature failure.
- The villagers will be made aware of the schedule prior to the movement of trucks and transportation of power plant equipments in the project area.
- Collaboration with local communities and responsible authorities to improve signage, visibility, and awareness of traffic and pedestrian safety;
- Notify the school governing body and local area responsible person prior to start the construction work and put signage before the school, mosque and madrasah on both way and instruct the driver for carefully driving in close to the sensitive area;
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents.
- The existing earthen road should keep functional as the local people can use the road;
- Movement of the project traffic should be limited to the planned route only and;
- The traffic movement in the settlement areas should be limited for the daytime only

The impact due to traffic and transport will have medium intensity with a local extent for a short duration which will result in an overall Medium-low impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **Low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance

Traffic generation during construction phase	Without Mitigation	Local	Short term	Medium	Medium Low	Medium	Medium-Low
	With Mitigation	Local	Short term	Low	Low	Low	Low

5.3.14 Solid and Liquid Waste Generation, Storage and Disposal

a. Sources of Impact

The construction of solar PV and Wind hybrid power plant activities such as site clearance, excavation works, setting up of labor camps, installation of modules will generate different types of solid and hazardous wastes. The construction demobilization which will entail removal of machinery, workers, campsite and other temporary structures will also result in the generation of waste. The following types of wastes will be generated due to the construction of the project:

- Domestic solid waste and sewage from labor colonies;
- Waste oil from generator and other construction machinery;
- Packaging waste such as gunny bags, plastics, etc.;
- Empty paint containers, metal scrap, etc.; and
- Construction debris

b. Receptor

Improper management of solid and liquid waste may lead to air, water, soil pollution and odor problem in and around the project site.

c. Impact Assessment

The construction debris generated due to the construction activities may spread out in nearby areas with wind and run-off during the rainy season. This may lead to the soil and water contamination. The dust particles from debris generated during construction activities can be carried along with the wind into nearby areas, thereby increasing the particulate matter in the area. However, this will happen only for a temporary period as the construction activities will be of short duration only.

Improper disposal of solid waste from the labor camps at the site and lack of proper sanitation facility for labor can lead to unhygienic conditions due to open defecation and spread of diseases in the area. It can also lead to the discontent of the local community and result in conflicts with the labor engaged at the site.

Improper disposal of packaging materials, boxes, plastics, ropes etc. can lead to littering in the construction site and surrounding areas. Hazardous wastes such as waste oil, lubricants, hydraulic oil etc. can cause contamination of soil and water bodies if adequate precautions for management and handling are not undertaken. Use of chemicals such as paints, curing chemicals can lead to contamination of soil. Impact due to the solid waste generation has been assessed as **Medium-Low**.

Impact	Solid and Liquid waste generation, storage and disposal		
Impact Nature	**Direct**	Indirect	Induced
Impact Scale	Impact on air, soil and surface water		
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**					

d. Mitigation Measures

The following mitigation measures will be taken to mitigate the waste generation impact:

- The quantity of domestic waste generated daily from the labor camps will be small and limited as most of the workers will be hired locally. However, the construction contractor shall ensure that the camp sites provided at the site have adequate waste disposal facilities. Arrangements for collection of garbage in dustbins and daily disposal to the nearest dump site shall be made. Provision of segregated toilets for male and female workers (if any) in the ratio of 1:15 and 1:10 (toilet to workers) respectively shall be made at the campsites in order to maintain hygienic and clean surroundings;
- Effort should be made to use the locally available labor for unskilled work purpose;
- Construction contractor will be followed the 3R policy to manage the solid waste management;
- Nearby municipality may also be contracted for regular disposal of the labor camp waste;
- Washing and bathing areas will be provided with a proper drainage system so that wastewater is not accumulated in the campsites. Disposal of sewage shall be made through a septic tank – soak pit arrangement;
- Used or waste oil generated from generators and construction machinery and equipment will be stored on a paved surface in a secure location at the project site. Appropriate secondary containment capable of containing the 110 percent of the largest tank is to be provided;
- The waste oil, which is characterized as hazardous will be sold to authorized vendors at frequent intervals;
- Empty fuel containers will also be stored at a secured area designated for scrap and sold to authorized vendors. All packaging material will also be collected at the

storage area and sold to scrap dealers;
- Construction debris and excavated material will be stored in a confined area to prevent spread by wind or water;
- The construction debris will be used for backfilling of excavated areas and for foundation works at site.

The impact due to waste disposal will have medium intensity with a local spread for a short duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Solid and Liquid waste generation, storage and disposal	Without Mitigation	Local	Short term	Medium	Medium Low	Medium	Medium-Low
	With Mitigation	Local	Short term	Low	Low	Low	Low

5.3.15 Impact on Ecology

a. Sources of Impact

The potential sources of impact on ecological resources during the construction phase of the Project will be mostly from the following activities:

- Project site clearance;
- Project site leveling;
- Construction activities at site;

b. Receptor

The project site is medium high land where only aman rice is cultivated during monsoon season. There are no trees on the project site. During the pre-monsoon season, the project site used as grazing land. Removal of vegetation may result in loss of habitat for small mammals and birds. Construction activities will result in noise generation, which will impact on avifauna. Wastewater discharge in the existing canal may impact the fish species and other aquatic species.

c. Impact Assessment

The construction period will be short duration. There is no critical habitat in and nearby the project site. The Musapur reserve forest is located approximately 1.40 km south of the project site. No significant impact on this forest is expected due to noise from the construction activities. Removal of vegetation from the project site may result in loss of small mammals, insects, and birds. Construction activities will result in noise generation which will ward-off the avifauna from the nearby habitats of homestead plantation and water bodies. Sediment load may increase in the existing canals of the project site due to improper management of soil, which will lead to an impact on aquatic fauna. Considering duration and size of construction activities impact on the ecological environment is assessed to be **medium-low**.

Impact	Impact on ecology		
Impact Nature	**Direct**	Indirect	Induced
Impact Scale	Impact on terrestrial, aquatic flora and fauna		
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**					

d. Mitigation Measures

Mitigation measures to minimize impact to the ecology from construction activities will be as follows:

- The noise generating activities should be scheduled during daytime only.
- Movement of construction and transport vehicles should be restricted to dedicated paths to minimise any harm to small mammals near to the proposed site.
- Construction activities should be planned and undertaken in a phased manner
- Project related activities should be avoided during the night time;
- Damage to the natural topography and landscape should be minimized;
- Strict prohibition should be implemented on trapping, hunting or injuring wildlife within the subcontractors and should bring a penalty clause under contractual agreements;
- A minimum possible number of routes should be authorized for use during construction by the laborers and staff, speed limit of the vehicles plying in these routes should be kept 20-25 km/hr to avoid road kill;
- Keep functional as present condition of the canals in project site for fish and herpetofauna species
- Follow the proposed mitigation measure for the water resources (section 5.3.8)

The impact on ecology will have medium intensity with a local spread for a short duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Impact on ecology	Without Mitigation	Local	Short term	Medium	Medium Low	Medium	Medium-Low

	With Mitigation	Local	Short term	Low	Low	Low	Low

5.3.16 Occupational Health and Safety Hazard

The development of the proposed Solar PV and wind energy facility will involve a range of activities that could potentially be unsafe to workers and the local community without mitigation measures. Examples of such activities include excavation for solar PV and wind turbine foundations, use of drills for cutting, working at heights, trenching, etc. Such activities require the use and operation of heavy-duty earth moving equipment, machinery and vehicles.

d. Sources of Impact

The sources of impact on the health and safety of the Project 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 of air, water pollution and noise generation from construction activities as well as from storage and handling of waste, particularly hazardous waste.
- Loading and unloading activities of the construction materials
- Working at height, working with rotating machinery and falling objects

e. Receptor

The receptors of the impacts on occupational health and safety include the workers, both regular and contractual working on the project. The construction workforce of 290 workers during construction (Phase-1 = 100; Phase-2 = 190) phase will be exposed to occupational health and safety impacts arising from construction activities of solar PV and wind hybrid plant.

f. Impact Assessment

The construction activities include site preparation, infrastructure utilities installation and building structures. Loading and unloading operation of the construction material may cause an injury if not handled properly. During construction works, physical injury result due to road accidents, construction accidents, and other occupational hazards. Overexertion injuries and illness are potentially the most common health hazards associated with construction activities. Further, there is potential for slips and fall on the same elevation associated with poor housekeeping, such as excessive waste debris, loose construction material, liquid spills and uncontrolled use of electrical cords and ropes on the ground which results in injuries and time loss during construction.

Hazards associated with fall of construction material or tools, as well as the collapse of constructed slabs, walls and roofs can result in injury to head, eyes, and extremities. Transportation and movement of vehicles are associated with road accidents and related hazards, which can lead to injuries and fatalities.

Therefore, there will be potential impacts on worker's health and safety due to exposure to risks through construction activities that lead to accidents causing injuries and death. The most frequent risks causes of accidental death and injury are:

Safety Risks:

- Tripping due to uneven surfaces, obstacles, trailing cables;
- Falling during working at height due to fall from fragile surfaces, roof edges, and ladders;
- Fire due to hot works, smoking, failure in electrical installations;
- Mobile plant and vehicles; and
- Electrical shocks.

Health Risks:

- Manual handling and musculoskeletal disorders: typical construction activities that can cause injury such as lifting, lowering, pushing, pulling and carrying
- Hand-arm vibration: people work with hand-held or hand-guided power- tools and machines, such as concrete breakers, pokers and compactors, sanders, grinders and disc cutters, hammer drills, chipping hammers, chainsaws, scrabbles and needle guns.
- Temporary or permanent hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc.
- Heat stress and working at high temperatures.

These risks could create long-term impacts to the health and safety of the construction workforce and therefore the impact severity is assessed to be high without mitigation measures. So the impact on occupational health and safety during construction phase has been assessed as **Medium-High** without taking mitigation measures.

Impact	Occupational Health and Safety				
Impact Nature	Direct	Indirect	Induced		
Impact Scale	Expose to permanent and temporary worker				
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-High**					

g. Mitigation Measures

Following measures will be taken to minimize the health impact during construction phase:

- The workers (both regular and contractual) on the project will be provided with training on the Health and Safety policy in place, and their role in the same and refresher courses will be provided throughout the life of the project;
- Establish a grievance redressal mechanism in place, to allow for the employees and workers to report any concern or grievance related to work activities;
- Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional;
- The contractor should ensure that no person is engaged in driving or operating construction machinery unless he/she is sufficiently competent and reliable, possess the knowledge of risks involved in the operation and is medically examined periodically.
- Child labor during the project construction should be prohibited;
- Contractor should prepare a site Emergency Preparedness and Response Procedure, which should be followed for the subjected project;
- Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures;
- Job responsibility and shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries;
- Safety sign should also be marked at appropriate places.
- It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls.
- Excessive waste debris and liquid spills will be cleaned up regularly, while electrical cords and ropes will be placed along identified corridors marked for the attention of everyone at the site.
- Use of personal fall arrest system, such as full body harnesses as well as fall rescue procedures to deal with workers whose fall has been successfully arrested shall also be carried out.
- Dropping/lowering of construction material or tool will be restricted and undertaken only under strict supervision if required. PPEs such as safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas.

The health and safety impact will have high intensity with a local spread for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **Medium-low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance

Occupational health and safety	Without Mitigation	Local	Long-term	High	Medium-High	High	Medium-High
	With Mitigation	Local	Long-term	Low	Low	Low	Low

5.3.17 Impacts from the Influx of Migrants Workers

The construction phase for the Project is scheduled to be undertaken under two phases. The first phase will include civil construction work, whereas the second phase which accounts for set up of PV panel. The approximate working population for both civil and mechanical work is expected to be around 100 during the Phase I and 190 persons for Phase II. The entire construction phase is expected to continue for about 1-1.5 years. This will require labour of unskilled, semi-skilled, skilled and highly skilled nature. However, it is envisaged that outsourced personnel will comprise mostly of skilled labourers and workers.

The Construction Contractor will be responsible for the construction of temporary labour camps and provide the workers with water supply, electricity, sanitary facilities, medical aid and other basic amenities. It is assumed that the camps would be constructed in-situ. Following impacts are envisaged due to influx of migrant workers.

i. Social Impacts of Migrant Workers

Due to the migrant worker influx in the project area the following impact may arise:

- Increased community conflicts due to increased interface between migrants and locals;
- Frequent movement of vehicles may increase accidents;
- Sharp increase in daily wage rates for labour, impacting the availability of agriculture labour for cultivation activities; and
- On the contrary, there could be an enhancement of local skills and skill sets through interaction of local unskilled or semi-skilled labourers with the skilled migrant workers.

ii. Community Health Impacts from Migrant Workers

As the project worker will live in the temporary construction camp and surrounding area in a rental basis. The following health risk may be brought out due to the migrant worker:

- Spread of communicable diseases, especially sexually transmitted diseases, which accompany many major constructions;
- Poor health infrastructure in the Project area may worsen the spread of any disease; and
- Lack of hygiene and adequate sanitation facilities would create health ailments related to food poisoning or diseases like malaria, viral fever, gastroenteritis which could spread within the community.

As most of the unskilled worker will be recruited from the local community therefore migrant worker will less. So the impact due to the labor influx during the construction phase on community people has been assessed as **Low** without taking mitigation measures.

Impact	Influx of the migrant worker and labour		
Impact Nature	Direct	Indirect	Induced

Impact Scale	Community close to the project footprint area				
Frequency	Limited to construction Phase				
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	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 is considered as ***Low***					

Mitigation Measures

Potential impacts during construction period include impact due to the influx of migrants and associated health related risk to the community. These impacts are expected to be low and with the implementation of the following mitigation measures the potential impact due influx of migrant workers will be further minimised.

- Engage as many locally available unskilled, semi-skilled and skilled human resources as practically possible to avoid large scale in migration of labour force;
- Provision of infrastructure and amenities for migrant labour in construction camp to avoid dependence on limited local resources;
- Adequate sanitation facility at labour camps to maintain hygiene and minimise spread of diseases;
- Creating awareness about local tradition and culture among outside migrant and encouraging respect for same;
- Providing awareness training regarding sexually transmitted diseases among the migrant population;
- Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area;
- Avoid unnecessary movement of vehicles through settlement areas to avoid disturbance and traffic safety related issues.

The impact due to influx of migrant worker will have medium intensity with a local spread for a short duration which will result in an overall **low** impact without mitigation. However, with proper implementation of suggested mitigation measures the overall impact will be ***very low***.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Community health impact from migrant worker	Without Mitigation	Local	Short term	Medium	Medium-Low	Low	Low
	With Mitigation	Local	Short term	Low	Low	Low	Very Low

5.3.18 Employment Opportunity

a. Source

The project is likely to create a range of avenues for direct and indirect employment opportunities.

- The requirement for around 290 laborers in the construction phase can spur local labor contracting activities as well as avenues of unskilled labor;
- Self-employment options for individuals possessing vocational or technical training skills like electricians, welders, fitters etc, which are likely to be sourced locally;
- Contracting opportunities for locals possessing tractors, trucks or other vehicles which would be needed during construction phase for material and personal transportation;

b. Receptor

Local villagers living near to the project site as well as Sonagazi upazila or surrounding upazila will be benefited.

c. Impact Assessment

The construction phase activities of the project including construction of access road, civil works, foundation activities, site clearance and security will involve semi-skilled and unskilled workers, who are likely to be recruited from the local community.

Furthermore, the community has benefited from the project in terms of the cars and drivers hired by the project, with only local cars being used in the project. The project is also likely to create a number of indirect economic opportunities in terms hiring tractors, setting up of tea shops etc. As the project development will generate the employment opportunity so it is assessed as the positive impact.

Impact	Local Employment					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Sonagazi and extended to Feni and Companiganj					
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**					

d. Mitigation Measures

The project is recommended to have the following mitigation measures in place:

- The local community is preferred by the project for the requirement of semiskilled and unskilled workers to the extent possible;
- The sourcing of local labor wherever possible should be made obligatory for the sub-contractors and in all major procurement activities;
- Preference should be given to the vulnerable population in the AoI;
- EGCB will establish a mechanism to audit subcontractors and suppliers with respect to compliance of utilizing local labor and resources.

5.4 Impact during Operation Phase

Due to increased activities and efficient operational systems, there will be some impacts on the environmental set-up in the project area, which are discussed hereunder. In order to achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, in order to reap the full environmental benefits of the activities and ensure environmental enhancement, it would be necessary to implement the following which is beyond the purview of this project. An activity – impact interaction matrix for operation phase of the project is presented in **Table 5-2**.

Table 5-2: Activity–Impact Interaction Matrix for Operation Phase of the Project

Sl.	Potential Impacts/ Risks Activity	Land Resources	Soil Resources	Waste Generation	Water Resources and Quality	Air Quality	Noise Level	Drainage Pattern	Traffic/Transportation	Ecology	Visual/Aesthetics	Occupational Health & safety	Employment
1.	Power Generation process												
2.	Surface Runoff												
3.	Transportation during operation and maintenance												
4.	Material Handling and Storage												
5.	Hazardous and Non-Hazardous Material and Waste Management												
6.	Water use/demand for Solar Panels cleaning												
7.	Schedule maintenance activities (PV module,												

Sl.	Potential Impacts/ Risks Activity	Land Resources	Soil Resources	Waste Generation	Water Resources and Quality	Air Quality	Noise Level	Drainage Pattern	Traffic/Transportation	Ecology	Visual/Aesthetics	Occupational Health & safety	Employment
	WTGs, Sub-station, electrical lines, storage yard, SCADA building)												

5.4.1 Impact on Land and Soil Environment

a. Sources of Impact

The following activities will lead to an impact on soil quality:

- Monitoring of solar PV and WTG operation;
- Routine maintenance activities at PV module and WTG locations;
- Material Handling and Storage;
- Hazardous and Non- Hazardous Material and Waste Management during maintenance activity

b. Receptor

The operational phase of the project will have limited impacts on the soil in form of waste generation and soil contamination due to accidental spillages/leakage.

c. Impact Assessment

i. Impact on Land due to Improper Waste Disposal

During operation phase, the waste generated from the project will include domestic solid waste at SCADA building, Central Monitoring Station (CMS) and substation, and hazardous waste like waste oil and lubricants and oil containing jute and rags will be generated during maintenance activities. Operation of solar photovoltaic panels for power generation will not have a direct impact on soil. However, the water as may use for washing activities may contaminate the soil if the chemical is used for washing. The quantity of hazardous waste generated will be much lesser quantity than during the construction stage. The PV module will be set on a fixed tilled angle and no tracking system will be used so no gear oil/hydraulic oil shall be required for the purpose. As the waste will be generated fewer amounts so the impact has been assessed as **Low**.

Impact	Improper waste disposal (hazardous and non-hazardous)				
Impact Nature	Direct		Indirect		Induced
Impact Scale	Limited to project footprint 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 **Low**					

Mitigation Measures

The following mitigation measures will be taken to manage the waste:

- The waste generated during operation phase will be disposed of through approved vendors;
- The hazardous wastes will be stored onsite at separate designated covered area provided with impervious flooring and send for disposal to nearest designated dumping site;
- During the operation phase, the quantity of municipal waste and hazardous waste generated is less and probability of the hazardous waste generation is only during WTG maintenance and therefore occasional. The waste generated would be routed through proper collection and containment;
- The water for cleaning purpose of the solar PV modules t remove dust from it is likely to get evaporate or absorbed by the vegetation and soil underneath the solar panel;
- The proponent should make a MoU with the local municipality to collect the daily domestic for disposing of in the designated dumping site.

The impact on soil environment due to waste generation will have medium intensity with a local spread for a long duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **very low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Impact on land due to improper waste disposal	Without Mitigation	Local	Long-term	Medium	Medium Low	Low	Low
	With Mitigation	Local	Long-term	Low	Low	Low	Very Low

ii. Soil Contamination due to Leaks/Spills

There are chances of spillage of oil during maintenance work such as lubricating oils from gearbox systems, hydraulic systems of the turbine etc. The accidental spillages at oil/lubricants and hazardous waste storage areas may cause contamination of soil and groundwater. The probability of the impact is only during the maintenance and therefore occasional. In case of accidental spillage, the impacts will be confined to the maintenance area and storage area. The impact on soil due to leaks/spills has medium intensity with low probability and assessed as low significance without mitigation measures.

Impact	Leaks/Spills					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Limited to WTG locations, sub-station and storage yard					
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**					

Mitigation Measures

The following mitigation measures will be taken for controlling the leaks/spills of liquid effluent.

- Ensure oil/ lubricants are stored on impervious floor in the storage area having secondary containment;
- Use of spill control kits to contain and clean small spills and leaks during O&M activities; and
- The guidelines and procedures shall be prepared and followed for immediate clean-up actions following any spillages.

The impact on soil environment due to spills/leaks of liquid effluent will have medium intensity with a local spread for a long duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **very low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Impact on soil due to spills/leaks	Without Mitigation	Local	Long-term	Medium	Medium Low	Low	Low
	With Mitigation	Local	Long-term	Low	Low	Low	Very Low

5.4.2 Waste Generation

a. Sources

- Wastes likely to be generated during routine operations are dielectric fluids, clearing agents and solvents etc;
- Repair and maintenance of underground cables and associated utilities will lead to generation of hazardous wastes as used oils;
- Wastewater from PV module cleaning;
- Hazardous waste generated from operation and maintenance of wind farms is limited to small quantities of waste oil from use of lubricant oil and transformer oil;
- The defunct / damaged photovoltaic cells will also be generated;
- Domestic liquid and solid waste

b. Receptor

Improper disposal and maintenance of waste may lead to contamination of soil, surface and groundwater environment, which could result in indirect impacts to humans, flora, and fauna.

c. Impact Assessment

Once the plant is commissioned there will be limited waste generation, however different hazardous and non-hazardous waste will be generated from PV module cleaning, maintenance of WTG, used oil from substation, broken PV module. These wastes typically would be put in containers, characterized and labeled, possibly stored briefly, and transported by a licensed hauler to an appropriate permitted off-site disposal facility as a standard practice.

Hazardous waste generated from operation and maintenance of wind farms is limited to small quantities of waste oil from the use of lubricant oil and transformer oil. Improper disposal of hazardous waste can lead to contamination of soil and groundwater, which could result in indirect impacts to humans, flora, and fauna.

Operations and maintenance of the PV power plant are not expected to require hazardous materials to be present and used on Site or to generate hazardous waste. PV panels, array enclosures, and inverter/transformer enclosures will not produce waste during operation. The PV panels contain micron-sized amounts of cadmium telluride (CdTe) which is classified as hazardous waste.

Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer. This reduces the risk of the CdTe impacting on human health or the environment.

The PV panels will possibly be cleaned twice a month to remove dust accumulated on the surfaces of the modules during the operational phase of the project. The water used for cleaning will not contain any harmful chemicals or additives and will not be heated. Therefore the water is not regarded as wastewater and the water will be allowed to percolate into the

soil. As the impact severity is medium from waste and effluent generation from operation phase the significance of impact assessed as **Medium Low**.

Impact	Waste Generation				
Impact Nature	Direct		Indirect		Induced
Impact Scale	Soil, surface and groundwater contamination				
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**				

d. Mitigation Measures

- The separate designated area should be earmarked for storage of hazardous waste like waste oil, transformer oil. These wastes shall be given to the DoE approved recyclers.
- Operation waste management will be governed by an Environmental Management Plan (EMP) and will incorporate reduction, recycling, and reuse principles.
- Material Safety Data Sheets for all applicable materials present on Site will be readily available to on-site personnel.
- All wastes produced from project activities on site will be transferred to designated temporary storage areas and where possible into secure containers.
- Solid wastes will be segregated to facilitate reuse and recycling of specific materials.
- All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal.
- First of all, inspection of PV modules for defects that can appear in the form of burn marks, discoloration, or broken glass is to be undertaken. An authorized person will walk the site to confirm that there are no broken modules (shattered glass) and broken modules should not be sprayed with water.
- Broken or damaged solar panels are required to be immediately shifted to a designated area in a scrap yard to avoid any type of land contamination. A photograph is to be taken of the broken panel at the site to cater to Insurance settlement claims.

- Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer.
- Use the soak pit and septic tank in the office building and guard room for sewage.

The impact of waste and effluent from the operation of the project will have medium intensity with locally extent for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Waste and Effluent from operation phase	Without Mitigation	Local	Long-term	Medium	Medium-High	Medium	Medium Low
	With Mitigation	Local	Long-term	Low	Medium Low	Low	Low

5.4.3 Impact on Water Resources and Quality

a. ***Sources of Impact***

The impacts of the proposed project on water environment are assessed with respect to following:

- Water use for PV module and wind turbine rotor blades cleaning;
- Water Consumption for domestic use;
- Possibility of groundwater level reduction due to compacted soil and covered by PV module;
- Surface water pollution due to the surface runoff from the project to the drainage network passing through the project site and Choto Feni River;
- Surface and groundwater pollution due to the accidental leakage and spills of oil

b. ***Receptor***

Surface and groundwater might be polluted and shortage due to the withdrawal of water for PV module and turbine rotor blades cleaning as well as the possibility of surface water pollution from surface runoff from the site.

c. Impact Assessment

i. Water Availability

During the operation phase, the water requirement will be for domestic as well for cleaning of modules and wind turbine rotor blades. The operation phase water requirement of the project will be approximately 31.5 million liters per year for module cleaning. Module cleaning needs to be carried out periodically (per module 2 times in one month) to remove dust, bird dropping etc. On the other hand, it is estimated that about 2 m3 of water will be required for cleaning of each turbine to avoid deformation the shape of airfoil and degradation of performance as per the annual maintenance schedule. During operation of the whole project, approximately 50 persons will work on the project site and they will consume approximately 50-litre water per person per day. The source of water has not been finalized yet. There is both surface and ground water source to meet up the water requirement during

operation. Feni and Choto Feni River are following close to the project site as well as groundwater can be found only 6m below from the surface level. As there is the availability of water in the project site so it would not be a major problem due to the abstraction of surface and groundwater. Surface water will more convenient as two Rivers are following close to the project. Groundwater uses also a good option for module cleaning during the operation phase. In this context, a detail groundwater study needs to be carried out for better understanding the aquifer recharge rate. Therefore impact due to water abstraction during operation phase has been assessed as **Medium Low**.

Impact	Impact on water availability					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Impact on surface and groundwater resources in the project site and surrounding					
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**					

Mitigation Measures

The following measure will be implemented to mitigate the water consumption:

- The effect of groundwater water abstraction for project activities will be assessed in detail using field testing and modeling techniques, and accounting for seasonal variability and projected changes in demand in the Project area;
- Periodical training should provide to workers for best utilization of water;
- Bore-wells should be established after requisite permission from the regulatory authority. Meters should be installed at the bore-wells to monitor the abstraction of water and using low flush urinals;
- Wastage of water during cleaning of panels should be avoided;
- Drinking water demand should be met by bottle potable water purchased

- The wastewater emanating from cleaning operations shall be used for the agriculture and aquaculture pond in the project site and excess water shall be discharged after settling of the sediment;
- Appropriate drainage network should be planned in the project site;

The impact due to water abstraction from River and ground will have Medium intensity with locally extent for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Water Abstraction	Without Mitigation	Local	Long-term	Medium	Medium-Low	Medium	Medium-Low
	With Mitigation	Local	Long-term	Low	Low	Low	Low

ii. Impact on Water Quality

Run-off from the plant site may carry waste oil from plant area to the nearest drainage system. This may affect the water quality of the drainage passing through the site and River water adjacent to the project site. Due to proposed hard standing areas (lay down areas, building foundations, compacted gravel roads), compacted soil (rows between arrays) and PV panels covering large parts of the Site, recharge to groundwater from rainfall is expected to be reduced on the site. Sewage would be generated from substation and CMS building and this will be of negligible quantity. Based on the above possibility of impact, the impact has been assessed as low due to the plant operation.

Impact	Decreased water quality					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Impact on surface and groundwater resources					
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**					

Mitigation Measures

- The drainage and sewerage system will be provided for the collection and treatment of wastewater at SCADA building/ CMS and substation areas.
- No wastewater discharge on open land will be practiced;
- The plant site should be provided with adequate drainage facility to drain-off the rainy water and prevent any waterlogging at site or in the surroundings;
- No careless attitude in the handling of hazardous waste and oil should be tolerated during plant operation. If any oil spilled out accidentally, it should be cleaned and stored appropriately.
- Fuel, oil and used oil storage areas will be contained in bunds of 110 capacity of the stored material.

The impact due to water abstraction from River and ground will have low intensity with locally extent for a long duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **very low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Water Abstraction	Without Mitigation	Local	Long-term	Low	Medium-Low	Low	Low
	With Mitigation	Local	Short term	Low	Low	Low	Very Low

5.4.4 Impact on Air Quality

a. ***Sources of Impact***

The impacts of the proposed project on air quality are assessed with respect to following:

- Maintenance of vehicles
- Transportation during operation and maintenance of the power plant

b. ***Receptor***

As the project is a renewable and clean energy development project, the operation will be largely free from air emissions. The only limited vehicle will move through the access road and within the project site for maintenance activities so dust and emission will be generated. There are no major settlements close to the project site. The local people who are living close to the access road will feel discomfort.

c. Impact Assessment

No emissions are expected to be released during the operation phase, due to the fact that solar PV and wind power plants do not release greenhouse gases or any toxic pollutants during their operation as solar and wind power plants do not involve combustion processes. Dust will be generated during the movement of the vehicle during maintenance of power plant which is very limited scale. Limited exhaust will be emitted from the vehicle during the operation phase. Therefore, the impact of dust and emissions generated during the operation phase is not considered as **very low**.

Impact	Impact on air quality

Impact Nature	Direct		Indirect		Induced	
Impact Scale	Limited due to the traffic movement					
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**					

d. Mitigation Measures

- Vehicles traveling on gravel roads should not exceed a speed of 30 km/hr.
- Regular water spray is required on unpaved road as the dust not move during heavy wind;
- Use clean fuel in vehicle as the exhaust emission will be low

5.4.5 Impact on Ambient Noise Levels

a. Sources of Impact

Noise will be generated from the following activities during operation phase:

- WTG Operations
- Vehicular movement
- Noise from inverters and transformers
- Repair and Maintenance Works of solar panels

b. Receptor

No major noise will be generated from the solar power plant whereas WTGs will generate noise during the operation period. Peoples are living along the access road and traffic movement during the operation and maintenance period will make discomfort to the settler.

The closest settlement is 900 m away from the WTG location. No noise modeling was carried out as there are no closest receptors that would get impacted by the operation of the WTGs.

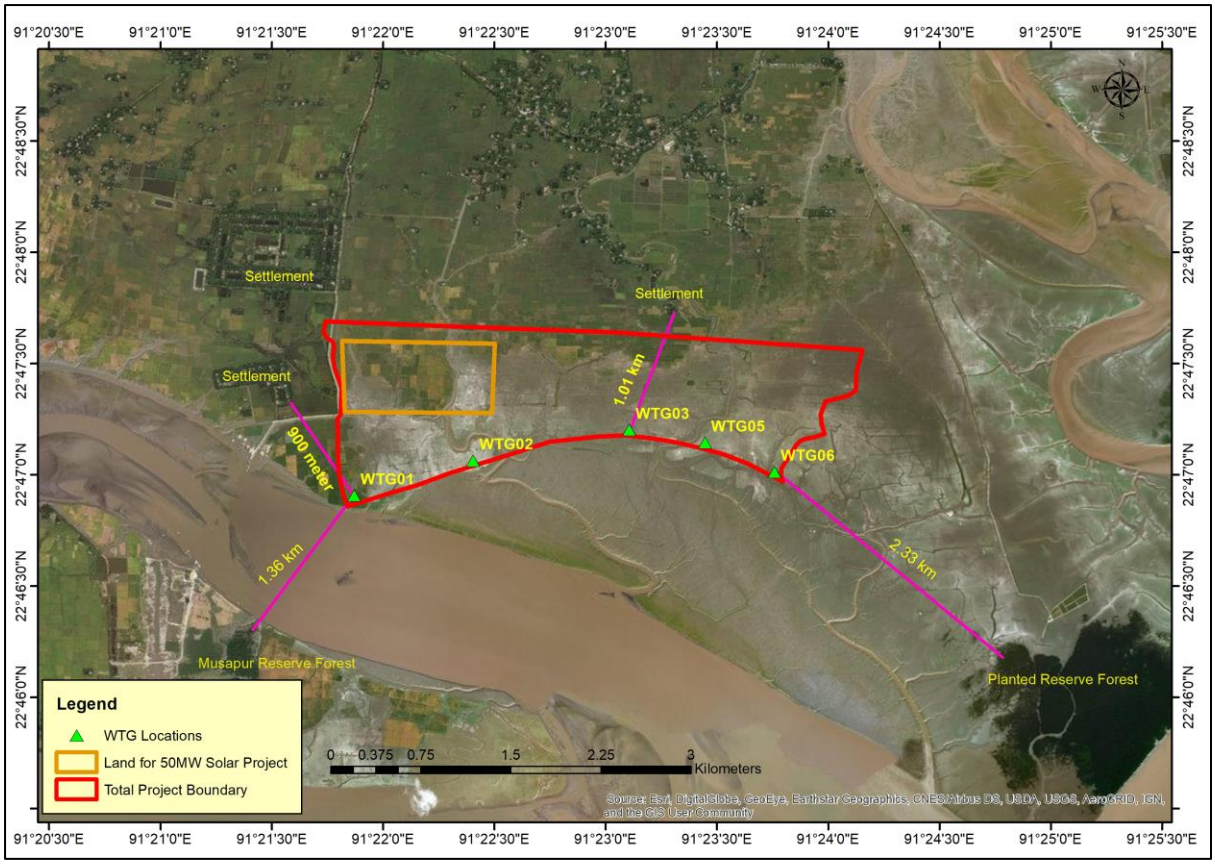


Figure 5-1: Distance of Receptor Locations with Respect to WTGs Location

c. ***Impact Assessment***

During the operation phase of the project, the limited vehicle will move on the access road and within the project site for maintenance activities as a result dust generation and exhaust emission will be a negligible amount.

The emanation of noise from the operation of WTGs is of the following two types: (a) Mechanical noise, from the interaction of turbine components; and (b) Aerodynamic noise, produced by the flow of air over blades. Mechanical sounds originate from the relative motion of mechanical components and the dynamic response among them. Sources of such sounds include:

- Gearbox
- Generator
- Yaw drives
- Cooling fans
- Auxiliary equipment (e.g. hydraulics)

The aerodynamic sound is typically the largest component of wind turbine acoustic emissions. It originates from the flow of air around the blades. Aerodynamic sound generally increases with rotor speed.

The Project will have only 5 WTGs of 2 MW each with 114 m rotor diameter and 106 m hub height. As there is no settlement close to the project site, therefore, the noise generation from

the WTGs will not create any disturbance to the community. So the noise generation due to the WTG operation has been assessed as **low**.

Impact	Higher ambient noise during operation of WTGs					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Limited to within 300-500 m of WTGs					
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**					

d. ***Mitigation Measures***

- The wind turbines shall be maintained in good running conditions throughout the operational life of the project through routine maintenance;
- Periodic monitoring of noise near to the sources of generation to ensure compliance with design specification;

The impact due to WTG operation will have low intensity with locally extent for a long duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be very **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Noise Generation	Without Mitigation	Local	Long-term	Low	Medium-Low	Low	Low
	With Mitigation	Local	Long-term	Low	Low	Unlikely	Very Low

5.4.6 Impact on Ecology

a. Sources of Impact

The following ecological impacts are envisaged due to the operation of the project:

- Glare/Reflection from solar module;
- Fatalities of birds and bats due to possibility of collisions with wind turbines blades and electrocution from transmission line;

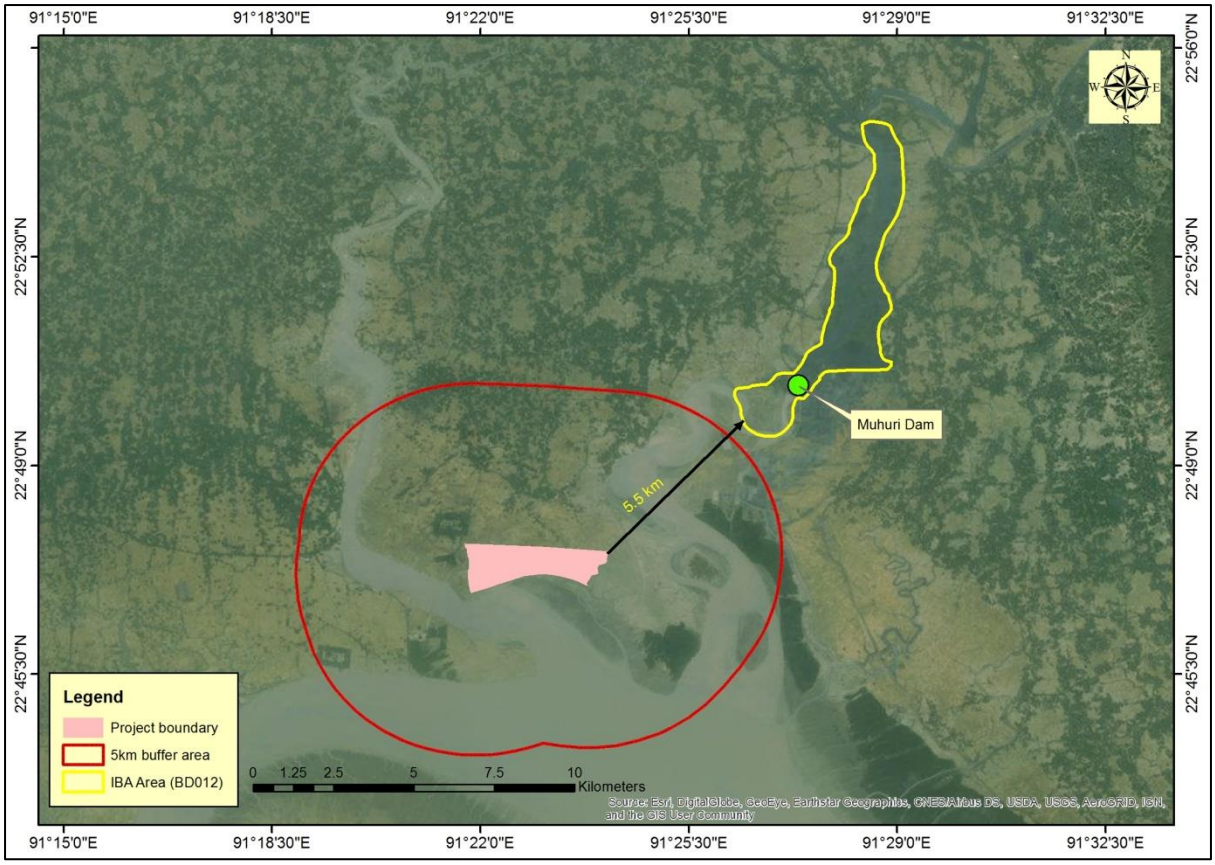
- Barrage effect for migratory birds causing a chance of flight route;
- Hunting and Poaching of mammals and avifauna by the labors or project employees;
- Increased risk of fires at the site due to failure of machinery or transmission line

b. Receptor

Local and migratory bird species mortality will be increased due to the glare/reflection from solar module and collision with the blade of WTG.

c. Impact Assessment

Bird survey was carried out (9th to 15th February) during the ESIA study. During the study period total 23 birds' species were found of which all were the least concern according to the IUCN red list 2015. No migratory bird was found during the study period. According to the BirdLife International, the Muhuri dam and its surrounding 500 ha area is a migratory staging ground (Figure 5-2) which is located approximately 5.5 km north-east of proposed project boundary. As the study was not cover full winter season, therefore, birds and bat survey need to be conducted during winter season prior to the establishment of WTGs.



Source: Birdlife International

Figure 5-2: Nearest Important Bird Area (IBA) in Sonagazi

The principal risk to birds believed to be posed by turbines is the potential to be killed as a result of a collision with moving rotors. There is a probability of a bird hit when making a transit through a rotor, depends on the size of the bird (both length and wingspan), breadth and pitch of the turbine blades, the rotation speed of the turbine, and the flight speed of the

bird. Glare / Reflection from solar modules may distract the avian fauna flying over the solar panel area.

In the proposed project site no "Critically Endangered" or "Endangered" bird & bat species were recorded. Moreover, the proposed site does not form part of any critical habitat, IUCN protected area, Important Bird Area and Ramsar Wetland Site but the project site is located close to the IBA area. The anticipated impact identified due to the project are general in nature common with windmill projects like mortality due to collision with turbine rotor or accidental body touch with high tension transmission line or in a general disturbance in the site due to the operation of the project so the impact has been assessed as medium-high considering no mitigation measures.

Impact	Bird collision risk and electrocution					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Limited to 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**					

d. Mitigation Measures

Following appropriate mitigation measures should be undertaken for a reduction in bird and bat collision:

- Solar panels will absorb most of light falling on them which will be then converted to electricity. Thus there will be very less impact due to glare from the panels. The glare is reported to be similar to that of a small water body, which implies insignificant distraction for the avifauna;
- Carry out detail birds and bat survey covering the full winter season to understand whether the project site is staging ground for migratory bird;

- Marking overhead cables and transmission poles using detectors and avoiding the use of areas of high bird concentrations, especially IBA area located close to the project site and for species vulnerable to collision.
- Where possible, installing transmission cables underground in accordance with existing best practice guidelines for underground cable installation. Otherwise if possible, install overhead cables with proper insulation to avoid bat and bird electrocution through body touch. Install bird detectors on overhead transmission cables at selected points wherever possible.
- Some bird reflectors can be fitted at relevant places to divert low-medium and medium-high flying bird species during daytime.
- Feasibility of fixing of bird detector on the turbine to avoid perching of birds near blades can be worked out, especially raptor species which prefer to perch at higher points.
- To reduce collision risk, livestock carcass management is to be undertaken in the wind farm area. All carcasses detected inside the wind farm area are to be removed and dumped at designated livestock dumping locations. This will reduce the probability of predator birds occurring in the wind farm area, thereby reducing the risk of collision with operating WTGs.
- Identify the bird species and maintain documented record of the birds hit;
- Staff will be trained to handle the hurt/hit bird and take it to nearest Veterinary hospital.
- Post-operational Monitoring: Post-operational monitoring of the wind farm area should be undertaken through independent third-party organizations to assess the efficacy of carcass management practices for a period of two years. Additional surveys are also recommended to monitor bird carcasses during the migratory season.

The impact on avifauna due to the operation of the plant will have high intensity with locally extent for a long duration which will result in an overall Medium High impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **Medium-Low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Bird collision risk and electrocution	Without Mitigation	Local	Long-term	High	Medium-High	High	Medium-High
	With Mitigation	Local	Long-term	Medium	Medium-Low	Medium	Medium Low

5.4.7 Visual Impact

a. Sources of Impact

As total 7, 43,040 Nos of the module and 5 wind turbine generator (WTG) will be set up in the proposed project area so the presence of a large area of PV panels is expected to constitute a risk for glare. Besides this, lighting in the power plant area and building structure also sources of visual impact. The reflection from the PV panels may create a visual impact on local community.

b. Receptor

The landscape of the project area is fallow land followed by seasonal low yielding variety aman rice cultivable land. All these land will be altered by setting up the solar and wind hybrid power plant. The Choto Feni River is flowing South Western part of the project boundary. The Musapur closer and Regulator are located 700 m and 2.15 km away from the southern boundary of the project site. Embankment located western boundary of the project site is used for the communication of the local community as well go to the Musapur regulator area for recreation purposes. Nowadays the Musapur dam and regulator area become a tourist spot. Sunlight reflection from the solar panel may impact local community who live in the nearby project site and use the road for communication purposes.

c. Impact Assessment

The visual impacts will be perceived by two types of receptors, namely:

- Receptors located at a fixed point, i.e. dwellings on the Site and surrounding areas; and
- Receptors who will temporarily come into contact with the solar PV and wind power facility, such as passing motorists and tourists in the area.

The closest settlement located the western and northern side of the project boundary. The PV module will set as southern facing and settlement located at the western side will not come in contact with a glare as the road will act as a barrier whereas northern settlement will present behind the PV plant as a result reflection from solar PV panel will not cause any visual impact on the settlement area. Only the road user will be affected due to the glare from the PV power plant. From the field survey, it has been stated that the road is less used by the local people as the project site is located the last end of the road so the visual impact due to the solar and wind hybrid power plant considering without mitigation measures has been assessed as **Medium Low**.

Impact	Visual Impact					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Community close to the project footprint area and road user					
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**					

a. Mitigation Measures

- The solar panels will be installed at a low height and will be kept closer to the ground so that it does not prop out of the general landscape of the area;
- The panels will be arranged in a systematic manner which will give an aesthetic sense to it;
- The proposed solar PV and wind hybrid power project would include a boundary wall around the perimeter of the project to further obscure the peripheral view of the project and any indirect reflection. Impacts from glare would be minor;
- All cables and power lines will be located underground as far as possible;
- The substations, gatehouses and maintenance and storage buildings will be grouped as far as possible to avoid the scatter of buildings in the open landscape;
- The design of the buildings will be compatible in scale and form with rural buildings, such as farm barns, in the surrounding area;
- All yards and storage areas to be enclosed by masonry walls or screens;
- Design of wind farm according to the landmark of the site and with sensitivity to the surrounding landscape
- Locate the wind farm at least a certain distance from dwellings
- Selection of wind turbine design (tower, color) according to landscape characteristics;
- Selection of neutral color and anti-reflective paint for towers and blades
- The color of the solar array and wind structures, such as the supports and the rear of the panels, will be carefully selected, and to be in the light grey or white colors on turbine, to minimize visibility and avoid reflectivity;
- Maintain uniform size and design of turbines (e.g. direction of rotation, type of turbine and tower, and height)
- Avoid steep slopes and flat landscapes fit well with turbine distribution in rows,
- Low number of large turbines is preferable to many smaller wind turbines
- External lighting will be confined to the substations and maintenance areas. Lights will be low-level and fitted with reflectors to avoid light spillage;
- Signages related to the enterprise are to be discrete and confined to the entrance gates. No other corporate or advertising signage, particularly billboards or flags, to be permitted;
- All lighting will be kept to a minimum within the requirements of safety and efficiency;
- Where such lighting is deemed necessary, low-level lighting, which is shielded to reduce light spillage and pollution, will be used;
- No naked light sources will be directly visible from a distance. Only reflected light will be visible from outside the Site;
- External lighting will use down-lighters shielded in such a way as to minimize light spillage and pollution beyond the extent of the area that needs to be lit;

- Security and perimeter lighting will also be shielded so that no light falls outside the area needing to be lit. Unnecessarily tall light poles are to be avoided;
- Retain the agricultural use of the area for grazing of livestock as much as possible;
- Warning signs at appropriate distances indicating solar power plant location should be placed to alert road users.

The visual impact will have medium intensity with a local spread for a long duration which will result in an overall Medium Low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Visual impact	Without Mitigation	Local	Long-term	Medium	Medium-Low	Medium	Medium Low
	With Mitigation	Local	Long Term	Low	Medium-Low	Low	Low

5.4.8 Occupational Health and Safety

a. Sources of Impact

There are many hazards associated with a solar PV and wind power plant if sufficient precautions are not taken during the operation stages. The impact origins are in the following sectors:

- Leaching of materials from broken or fire damaged PV modules
- Vehicle accidents, replacement of components/parts
- Emergency Fire Hazard
- Electrocution of workers
- Electromagnetic radiation from PV modules
- Working at height for WTGs maintenance

b. Receptor

The main receptors are workers of the power plant and nearby dwellers who are living close to the project site.

c. Impact Assessment

Leaching of materials from broken or fire damaged PV modules The potential for chemical releases appears to be small since the chemicals are present in the sealed PV modules when completed installations of photovoltaic systems for power generation. Releases are likely to occur only due to fires or other unusual accidents. Cadmium could be a potential concern in this setting with thin-film technologies, as would arsenic and zinc to a lesser extent. Other chemicals that have inhalation toxicity factors are present only during the manufacturing process. Solar PV modules may contain heavy metals like lead, mercury, cadmium, chromium, polybrominated biphenyls (PBBs), or brominated diphenyl ethers (PBDEs) etc. Leaching of metals from the installed modules is not likely to be a concern, as documented in a study by Steinberger (1998). Leaching from small cells used in electronic devices is also unlikely to be a concern, given the small amounts of chemicals present and the sealed nature of the devices.

Vehicle accidents, replacement of components/parts: The potential occupational safety and health risks include injuries to workers from routine monitoring and maintenance activities (vehicle accidents, replacement of components/parts, etc.) and emergencies such as equipment malfunction, fires, etc.

Emergency Fire Hazard: Since this is a solar PV and wind hybrid power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. In the event of fire catching a solar module, it is theoretically possible for hazardous fumes to be released and inhalation of these fumes could pose a risk to human health. However, researchers do not generally believe these risks to be substantial given the short-duration of fires and the relatively high melting point of the materials present in the solar modules. Moreover, the risk of fire at ground-mounted solar installations is remote because of the precautions are taken during site preparation including the removal of fuels and the lack of burnable materials mostly glass and aluminum contained in a solar panel.

Electrocution of Workers: Risk of electrocution of workers during performing duties in a power plant is always present. Faulty electrical equipment, electric short circuits, exposed electrical wires may be the chief sources of electrocution. Damaged PV modules with exposed high voltage conductor also present high risk of electrocution.

Electromagnetic radiation from PV modules: The strength of electromagnetic fields produced by photovoltaic systems do not approach levels considered harmful to human health established by the International Commission on Non-Ionizing Radiation Protection. Moreover, the small electromagnetic fields produced by photovoltaic systems rapidly diminish with distance and would be indistinguishable from normal background levels within several yards.

Working at height for WTGs maintenance: Periodic maintenance will be required for proper functioning of the WTGs. Maintenance worker may fall down from the height during the maintenance work. Beside this, there is a possibility of electrocution during the maintenance work of WTGs.

As the above mention impact may happen during the operation phase but the probability of the impact occurrence is Medium. The impact may cause serious damage if the proper mitigation measures do not take properly. So the impact on health and safety during operation phase has been assessed as **Medium Low**.

Impact	Impact on health and safety during operation phase				
Impact Nature	Direct		Indirect		Induced
Impact Scale	Power Plant worker				
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**					

d. Mitigation Measures

The following mitigation measures will be taken to minimize the health impact during operation phase:

- Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears.
- Adequate training regarding health and safety will be provided to the workers.
- A health, safety, and environment (HSE) management system will be developed, rolled out and implemented. This system which will be reviewed annually or after a major accident or incident
- The switchyard building will be provided with fire extinguishers and sand buckets at all strategic locations to deal with any incident of fire.
- Safety incidents will be recorded and monitored with an aim that numbers are never significant, and gradually reduce.
- Workers at site handling broken solar panels shall be provided with adequate PPEs (safety gear, goggles, and gloves).
- The workers at the site are also on regular basis shall be appraised about the potential health risks associated with the handling of solar panels.
- WTGs supplier shall provide instructions and procedures to all the workers involved in service repair of wind turbines, which will consider wind speeds and other external conditions in such a manner that service, maintenance, and repair work on the wind turbine can be performed safely;
- Ensure use of safety belt and need for safety net as required;
- All work at height to be undertaken during daytime with sufficient sunlight except emergency (with proper illumination arrangement);
- Fixtures shall be installed on tower components to facilitate the use of fall protection systems;
- Only workers trained in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment shall be engaged for work at height;
- Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. Adequate training regarding health

and safety will be provided to the workers;

- Wind turbines shall be equipped with an earthing system;
- Access to areas containing exposed electrical equipment (such as transformers) shall be fenced and locked. Warning signs shall be posted at hazardous locations;
- Firefighting equipment such as fire extinguishers and sand buckets shall be provided at appropriate locations;
- Workers involved in electric operations shall be provided with Protective Equipment such as rubber gloves etc;
- Employees involved in electrical works shall be trained in and familiar with the safety-related work practices, safety procedures, and other safety requirements that pertain to their respective job assignments.
- First aid box/ arrangement to be ensured

The impact on health and safety from the operation of the project will have medium intensity with locally extent for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **low**.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Occupational Health and Safety	Without Mitigation	Local	Long-term	Medium	Medium-Low	High	Medium Low
	With Mitigation	Local	Long Term	Low	Medium-Low	Low	Low

5.4.9 Traffic and Transport

a. Sources of Impact

During the operation phase, only limited person will be involved with the power plant. Minimum transportation will be required for maintenance of the power plant.

b. Receptor

Limited traffic will be run on the access Road.

c. Impact Assessment

A limited number of people will be employed permanently at the power plant during the operation phase of the Solar PV and wind hybrid power facility and these employees will reside in on-site accommodation. Infrequent deliveries of replacement parts may be made during the lifespan of the solar PV power facility. Traffic impacts associated with the operation of the facility will be minimal and therefore traffic impacts associated with the operation are not considered any further. The impact due to the traffic movement during operation phase will be **very low**.

Impact	Traffic and transport				
Impact Nature	Direct	Indirect	Induced		
Impact Scale	Increase traffic volume on the access 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 **Very Low**					

d. Mitigation Measures

During operation, if abnormal loads are required for maintenance, the appropriate arrangements will be made to obtain the necessary transportation permits and the route agreed with the relevant authorities to minimise the impact of other road users.

5.4.10 Impact on Climate Change

The project is based on the power generation through Solar PV Technology and WTGs. The Solar PV technology and WTGs is environment-friendly in terms of GHGs emission. Levels of carbon dioxide (CO2) and other greenhouse gases (GHG) in the atmosphere have increased dramatically in the past few decades. Solar and wind energy is a Renewable resource available with the great potential to significantly reduce GHG emissions. The technology of electricity generation from Solar PV and wind turbine generator Plant is environment-friendly as it does not use any fossil fuel. It thereby reduces the greenhouse gas emissions associated with fossil fuel-based electricity generation system. The availability and reliability of solar power depend largely on current and future climate conditions, which may vary in the context of climate change.

The comparison of the GHGs emission caused by solar and wind power plant with the GHGs emission that would have been caused by fossil fuel burned to make the same amount of electricity has been made. Thus the purpose of the project activity is to generate power from zero emissions Solar PV and WTGs based power project and thereby reduce the emissions associated with the grid. According to the feasibility study, the calculation of the total GHGs emission reduction as 4601362 tCO_2e/year.

The proposed power plant is based on Photovoltaic technology and WTGs which generates electricity using solar energy and wind which depends upon solar flux and wind speed of the area. It is defined by the Global Horizontal Irradiance (GHI) of the area, wherein shortwave radiations received by the surface at a high temperature get absorbed and individual electrons in bonds move into a higher energy level. This absorption of energy does not cause any

change in temperature of the area. It is also very well understood that there can be an increase in temperature, which will be confined only to the site.

Climate change is a burning issue now a day. The project will help in reduction of GHG emission with the use of environment-friendly technology of power generation. So it would be a long-term beneficial impact of the project.

Impact	Impact on Climate Change					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Reduce the greenhouse gas emission (positive impact)					
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**					

5.5 Impact during Decommissioning Phase

a. Sources of Impacts and Receptor

The key issues associated with the demobilization phase will include:

- Issue of loss of job when the workers will be asked to leave;
- Improper disposal of demolition waste and obsolete machinery will lead to contamination of soil, water, and discontent of community;
- Demolition activity is anticipated to generate dust and exhaust emissions which can be carried downwind to habitations;
- Risks associated with health and safety issues such as trip and fall, electrical hazard etc.;
- The decommissioning activities of dismantling or removing the solar PV and wind power plant and removing the ancillary facilities can lead to increased noise levels;
- Generation of broken panels which is hazardous waste;
- Contamination of drainage channels due to release of hazardous waste; and
- During the dismantling or removing of the solar PV and wind power plant, with the removal of ancillary facilities, visual intrusions will be likely but their consequence

will be negligible due to the fact that such impact would be temporary (over a short period).

b. Impact Assessment

Damage to Solar Panels:

Depending on the type used, photovoltaic cells may contain toxic substances such as gallium arsenide, copper-indium-gallium-diselenide and cadmium telluride. If any solar panel is damaged during the dismantling of the facility, these toxins are likely to spill and leach into the soil and water of the area, posing a serious threat to environmental and public health.

Unsafe Disposal of Solar Panels:

If the solar panels are not handled or disposed of properly during the decommissioning phase, any toxic substances contained within them are likely to escape into the surrounding air, water or soil, creating serious environmental and public health risks.

Wind power plant removed

Decommissioning of the WTGs structure and foundation will lead to increase the soil, air and noise pollution as well as occupational health impact.

Considering the above mention fact, the impact due to the decommissioning of the power plant has been assessed as **Medium Low**.

Impact	Decommissioning of the power plant					
Impact Nature	Direct		Indirect		Induced	
Impact Scale	Impact may be into the surrounding air, water, noise, soil environment and public health					
Frequency	During the decommissioning period					
Extent and location	Project Site	Local	Regional		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**					

c. Mitigation Measures

Demobilization will require removal of machinery, workers, and other structures. The mitigation measures for decommissioning shall include:

- The proponent/developer shall inform the workers and local community about the duration of work;
- Dismantling activities will take care of experienced professionals under the guidance of plant EMS Head.
- All the dismantled infrastructures and debris shall be segregated and stored separately with cover facility to negotiate with contamination effects of such wastes;
- The metal structure will be sold out to the approved recyclers, whereas, debris will be disposed-off as per their characteristics.
- The workers shall be clearly informed about the expected schedule and completion of each activity;
- All waste generated from decommissioning phase shall be collected and disposed of at the nearest identified disposal site;
- All necessary Personal Protection Equipment (PPE) shall be used by the workers during demolition work;
- Solar Panels as utilized for the project even after 20 years will have the 70 – 80% power generation capacity. Due to technology improvement, after 20 years recycling or re-utilisation of these panels are very much likely;
- During decommissioning phase proponent should follow mitigation measures depicted in the section 5.3.6, 5.3.7. 5.3.9 and 5.3.11 for air, noise, solid & liquid waste and Occupational health and safety respectively;
- Water sprinkling would be the regular practice to reduce the dust generation from the plant decommissioning activities.
- Disposal panels will be disposed of off to authorized vendor through buyback agreements;
- It is to be ensured that dismantling is carried out during the non-monsoon season and all the drainage channels will keep intact by creating bunds around them. and
- EGCB will be committed to ensuring that all health and safety measures are in place to prevent accidents and reduce the consequences of non-conformance events;
- After decommissioning project authority will weed out the seeds of *Leucaena leucocephala* and *Prosopis Juliflora* to make the land fertile in few years.

Impact value for decommissioning is assessed to be medium-low without mitigation and low with preventive measures.

Aspect	Scenario	Extent	Duration	Severity	Magnitude	Probability	Significance
Impact during decommissioning phase	Without Mitigation	Local	Long-term	Medium	Medium-High	Medium	Medium Low
	With Mitigation	Local	Long Term	Low	Medium-High	Low	Low

CHAPTER 6: ANALYSIS OF ALTERNATIVES

6. ANALYSIS OF ALTERNATIVES

6.1 Site Selection

Solar projects are non-polluting energy generation projects which are site-specific and dependent on the availability of solar irradiance resource.

EGCB was identified two locations for the proposed solar project and the final selection of the site was based on the availability of a contiguous patch of land and no settlement on the same. Further details on the other locations identified were not available.

- No settlement present in the project site;
- The project site land is predominantly government land;
- The project site land is medium highland and only single crop is cultivated during the post-monsoon season;
- The proposed project site has the following location advantages:
- Site with high solar irradiation;
- No ecological sensitive receptor such as national parks, Wildlife Sanctuary within 10 km radius;
- No cultural property of archeological importance within 5 km radius and
- Power evacuation infrastructure i.e national grid substation is located at a distance 20 km from the proposed site.

6.2 Transmission Line RoW

The project requires the injection of generated power into a grid Sub-Station (SS), therefore all possible options for power evacuation have been assessed.

Based on the information gathered during the site visit and subsequent discussions with officials, following three interconnection options were considered for this project:

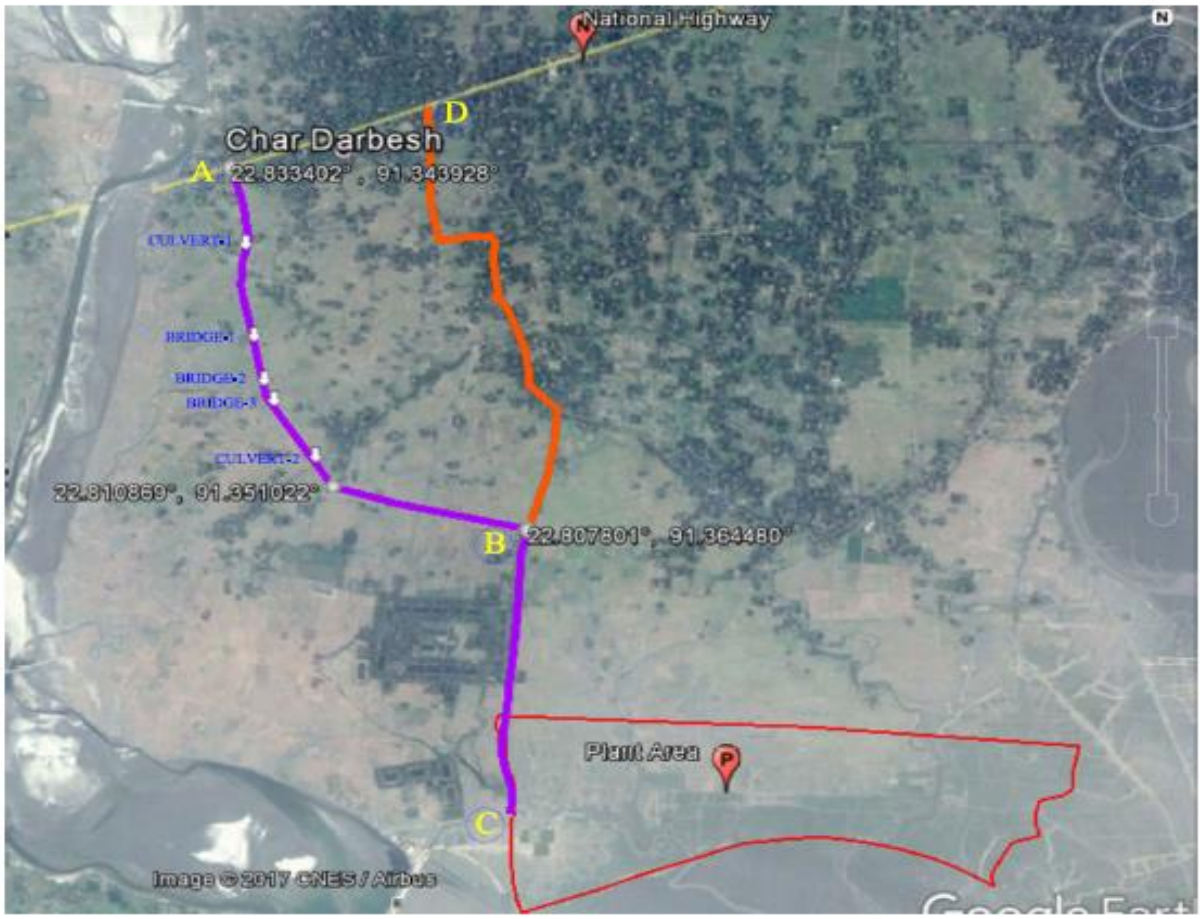
1. Feni 132 kV Sub-Station of PGCB (existing one)
2. Baraiyaarhaat 132 kV Sub-Station (under construction)
3. Mirsharai 230 KV SS

As per the assessment of the feasibility team, it has been proposed that the 50 MWac solar PV power will be evacuated through 33 kV one circuit transmission line of 20 km to the Baraiyaarhaat 33 kV substation.

6.3 Approach Road to the Project Site

Two alternatives option were considered for the approach road (refer Figure 6-1). The access road from the Sonagazi-Olamabazar to the proposed project site is not suitable for carrying out the construction materials. There is two alternative roads for accessing the proposed project site which is not suitable and need to be upgraded by the EPC.

PROPOSED APPROACH ROAD PLAN



LEGENDS :

SYMBOL	DESCRIPTION		WIDTH	LENGTH	AREA
	A TO B -	PROPOSED ROAD (FROM NH [Z1434] TO POINT 'B' IN EXISTING ROAD)	9.8 MTR	4.2 KM	41160 SQ. MTR
	B TO C -	EXISTING ROAD (FROM POINT 'B' TO 'C' ROAD TO BE RECONSTRUCTED. EXISTING ROAD IS 4 M WIDTH, 12M WIDTH TO BE RECONSTRUCTED[PROPOSED])	9.8 MTR	2.3 KM	22540 SQ. MTR
	B TO D -	EXISTING ROAD	4 MTR	4 KM	
		NATIONAL HIGHWAY [Z1434]			
BRIDGE-1	COORDINATES	22.820945°, 91.345530°	9.8 MTR	8 MTR	78.4 SQ. MTR
BRIDGE-2		22.817844°, 91.346242°	9.8 MTR	30 MTR	294 SQ. MTR
BRIDGE-3		22.816405°, 91.346924°	9.8 MTR	20 MTR	196 SQ. MTR
CULVERT-1		22.827460°, 91.344967°	9.8 MTR	3 MTR	29.4 SQ. MTR
CULVERT-2		22.812440°, 91.349806°	9.8 MTR	3 MTR	29.4 SQ. MTR

Figure 6-1: Approach Road Options under Consideration

The existing road (from point D to B and B to C) is not that much strengthened to bear the load of project material transportation and does not have that much width, hence enhancing its existing width and capacity will cost almost equal to new road development and it has

some local people living beside the road (from point D to B), therefore the development of new road (from point A to B) and strengthening the existing road from point B to C looks more viable.

6.4 Alternative Method of Power Generation

Harnessing solar energy is an eco-friendly process, with an inexhaustible solar resource and minimal pollution. There are minimal fuel requirements for operational activities. Solar energy has a short development timeframe, more predictable energy output and low maintenance costs as compared to some other forms of renewable energy sources. Table 6-1 elaborates upon the environmental advantages and disadvantages of various power generation systems.

Table 6-1: Advantages and Disadvantage of Power Generation Systems

System	Advantage	Disadvantage
Thermal Power	• Large-scale production potential • Moderate gestation period • Wider distribution potential	• High fossil fuel consumption • Large quantities of water required for cooling • High volume of emissions from operation • Accumulation of fly ash (in case of coal powered installations) • The upstream impact from mining and oil exploration. • GHG emissions estimated as 228gCeq/kWh
	• GHG emission estimated as low as 1.1gCeq/kWh for run of river projects • Do not create any waste by-products during conservation process. • Some hydropower facilities can quickly go from zero power to maximum output because hydropower plants can generate power to the grid immediately, they provide essential backup power during major electricity outages or disruptions	• Site-specific, dependent on reservoir/river etc. • Long gestation period • Alteration of river flow regime • Adverse social and ecological impacts due to inundation and downstream effects.
Nuclear Power	• GHG emissions as low as 2.5gCeq/kWh. • Low fuel cost • The production of electric energy is continuous. A nuclear power plant generates electricity for almost 90% of the annual time. It reduces the price volatility compares to other fuels;	• Availability of fuel source; • Hazards associated with radioactive materials • Disposal of waste is expensive as wastes are radioactive in nature • High cost of project; • Long gestation period;

System	Advantage	Disadvantage
	• Do not emit smoke particles or gases.	• Risk of fallout and meltdown scenarios and its impacts on the local population and environment
Wind Power	• Pollution levels are insignificant; • Inexpensive power generation; • Inexhaustible wind resource; • GHG emissions as low as 2.5Ceq/kWh for the production chain	• Bird and Bat hit issues in certain areas; • Site-specific, dependent on wind pattern; • Expensive installation
	• Pollution levels are insignificant; • Inexpensive power generation; • Inexhaustible solar resource; • GHG emissions as low as 8.2gCeq/kWh for the production chain.	• Large land requirement; • Site-specific, dependent on solar insolation

Source: International Atomic Energy Agency (IAEA)

6.5 No Project Scenario

The total power generation capacity is 16,046 MW including captive and Solar Home System (SHS) till 20 March 2018[5] and the demand is for 24000 MW in 2021. To meet the demand and supply gap BPDB has taken a massive capacity expansion plan to ass about 11600 MW generation capacities in next 5 years to achieve 24000 MW capacities by 2021.

GoB has set up the goal of electricity to all in Bangladesh by 2020 and to ensure reliable and quality supply of electricity at a reasonable and affordable price. Sustainable social and economic development depends on adequate power generation capacity of a country. There is no other way for accelerating development except to increase the power generation by fuel diversification.

In line with the Renewable Energy Policy 2008, the GoB is committed to facilitate both public and private sector investment in Renewable Energy projects to substitute indigenous non-renewable energy supplies and scale up contributions of existing Renewable Energy based electricity productions.

The No Action Alternative would have no negative impacts on the existing environmental and social resources but the positive socio-economic and beneficial commercial impacts would also not be realized as well. No additional megawatts of electricity would be added to the national grid and the associated benefits of increased electricity availability will not be realized. Considering the country's national goals related to Vision 2021 and power systems master plan 2010, halting this project would mean a step in the backward direction.

[5] http://www.bpdb.gov.bd/bpdb/

CHAPTER 7: INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

7. INFORMATION DISCLOSURE, CONSULTATION AND PARTICIPATION

7.1 Introduction

Participation is a process, through which stakeholders influence and share control over development initiatives, the decisions and the resources, which affects them. The effectiveness of environment and social management plan is directly related to the degree of continuing involvement of stakeholders in the project development process. Participation of stakeholders in the projects is also a primary requirement in developing an appropriate ESMP that addresses project's requirement and suited to the needs of the stakeholders. Stakeholder's involvement also vastly increases the probability of successful implementation of the management plan. In order to make consultation and disclosure process effective and fruitful, comprehensive planning is required to assure that local government, host population and project staff interacts regularly and purposefully, throughout all stages of the project and contribute toward a common goal.

7.2 Approach and Methodology for Consultation

The approach undertaken for information disclosure and consultation involved the following key processes.

- Mapping and Identification of key stakeholders such as primary (direct project influence) and secondary (indirect project influence) stakeholders;
- Undertaking expert consultations, interviews 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 more detailed assessments at a microscopic level taking into account the various project lifecycle phases and their implications on the stakeholder.

7.3 Stakeholder Assessment

A stakeholder is defined as "a person, group, or organization that has a 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 has 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 on the project as well as their priority to the EGCB 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 the EGCB 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 EGCB to engage the stakeholder who is 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 EGCB to engage that stakeholder.

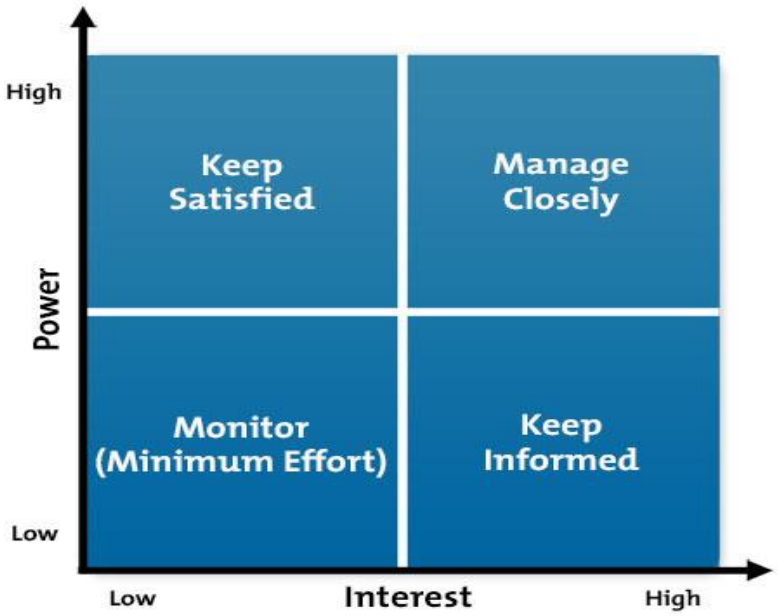


Figure 7-1: Power/Interest Grid for Stakeholder Prioritization

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 to following questions;

- What financial or emotional interest do they have in the outcome of your work? Is it positive or negative?
- What motivates them 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 7-1: Stakeholder Mapping for the Project

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Project Management				
Electricity Generation Company of Bangladesh (EGCB) Ltd	Primary	• EGCB Ltd. is the primary project proponent own a controlling stake of 100% in the project	Highest	• Primary project proponents • Primary financial beneficiaries • Responsible for all the project risks and impact liabilities • Responsible for establishment and operation of this project.
Project Financiers	Primary	• Financiers at the corporate and project level of EGCB for the project. • May include local and regional bank, national and international banks as well as development organization.	Highest	• Engagement is limited at the corporate management level. • Key participants in the decision making process • Compliance to funding agencies' safeguards/operation policies and other policies.
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

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Power Grid Corporation of Bangladesh (PGCB)	Primary	• PGCB has the primary objective of managing, operating and expanding the national power grid of Bangladesh.	High	• Responsible for constructing transmission line corridor for the project and connecting it to the regional power grid system. • Engagement level during construction period for setup transmission corridor.
Migrant Worker and Labor	Primary	• Labors and workers arriving from outside of Feni for participating in construction activities	Medium	• Responsible for undertaking mostly skill based work during construction phase • Engagement level during both civil and mechanical phases of work
Community				
Local Community	Primary	• Primarily includes adjacent community to the project site	Medium	• No major restrictions around the project site especially with respect to grazing land • Improvement in infrastructure in the area. • Project will bring development to the area • Increase in employment opportunities and preference in job. • Approach road will be used/developed during construction and operation period. • Business/Economic condition will be improved. • High interest with low influence.
Land owners and farmers	Primary	• Primarily includes land owners and farmers who are currently enjoying the right of land ownership	Medium	• Land owners will lose their right of land ownership. Land owners may vary 150-200 persons for 999.65 lands. On the other hand, RAP report for first 50 MW solar project identifies only 18 legal households, among

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
		and farming within the proposed project site.		61 listed persons by DC office, who will lose the right of land ownership. • Households' livelihood and quality of life will be partially hampered as this land is single cropped as well as less productive for high degree of salinity. • Right of land ownership and partial livelihood loss signifies high degree of interest. • Compensation for land, crops, employment and other assistance opportunities. • High interest with low influence.
Sharecroppers and land users (illegal land owner)	Primary	• Primarily includes the sharecroppers and agricultural labor and other users (illegal land owner) who do farming in the proposed project area	Medium	• 999.65 acres acquired land is currently being used for agricultural production once in a year. • Significant numbers of landless, marginalized sharecroppers as well as land users (illegal land owners) are currently involved with agricultural activities in the proposed project site. • Landless/marginalized farmers usually do sharecropping activities with the agricultural land owners. These sharecroppers also work as a labor in other agriculture land. RAP study for 50 MW solar power plant states that 22 sharecroppers will be affected due to the proposed project.

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
				• Land users (illegal land owners) are those who bought the khas land from the allottes by breaching the khas land distribution conditions. After buying from the allottes they are by now enjoying the right of land use and doing agricultural activities. • Sharecroppers and land users' income and livelihood will be partially affected. • Employment and other assistance opportunities from the project company • High Interest with low influence
Women	Primary	• Include women land losers; family members of land losers, sharecroppers and other land users	Low	• Compensation paid to male member of the family • Little control over compensation amount • Employment and other assistance opportunities from the project company.
Vulnerable Households	Primary	• Primarily includes those households who underlie in low yearly income and female / elderly person headed	Low	• Vulnerable households have common tendency to fail cope up with the drastic change of the existing settings. It results impoverishment of the vulnerable households. • Vulnerability can be defined by who underlies below poverty line, elderly, women and handicapped headed households. RAP report for first 50 MW solar power plant identifies 11 vulnerable households.

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
				• Assistance opportunities from the project company • Interest is low (for no legal provision to get extra benefits) with low influence
Regulatory/Administrative Authorities & Agencies				
Dept. of Environment, Bangladesh, DoE	Primary	• The Department of Environment is the primary government regulatory authority for Environmental protection in Bangladesh.	High	• Government Regulatory agency to provide Environmental Clearance (EC) to the project based on evaluation and approval of Environmental Impact Assessment (EIA) study • Responsible for monitoring project's Environmental compliance throughout the project lifecycle. • High influence and high interest
Department of Agriculture	Secondary	• Local governmental agency responsible for implementation of governmental agricultural activities.	Low	• Very marginal impact on total Upazilas' agriculture land and agricultural production. • Interest level is low with low Influence level.
Department of Fisheries	Secondary	• Local governmental agency responsible for implementation of governmental fisheries activities.	Low	• No major fishing resources will be affected by the proposed project. • Water body and fisheries will not be affected. • Fish Culture activities will be continued in designated places within the project site.

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
				Fisheries Department may contribute designing specific plan for it. • Interest level is low with low influence.
Department of Education	Secondary	• Local governmental agency responsible for implementation of governmental educational activities.	Medium	• Dust and heavy vehicle during construction period may create obstacle for students for going educational institute. Thus, proper mitigation measures should be employed on traffic and transport by the proponent. • Interest high with low influence
Department of Public Health Engineering	Secondary	• Local governmental agency responsible for implementation of governmental public heath activities.	Medium	• Accidental spillage during construction period may pollute soil as well as ground water that causes public health vulnerable. • Interest high with low influence
Department of Social Welfare (DSW)	Secondary	• Local governmental agency responsible for implementation of governmental social welfare schemes and activities	Low	• No major influence on project related activities • However participation level and influence may increase in case community welfare activities proposed by the project proponent are implemented in coordination with this agency
Political Administration				
Upazila (Sub District Level) Political Administration	Secondary	• Elected representative of people at sub-district level for a fixed tenure	Medium	• Key linkage between the community and the project proponent. • Low interest with high influence

Stakeholders	Category of stakeholder	Brief profile	Overall influence on the project	Basis of Influence Rating
Union leaders & local representatives	Secondary	• Elected representative at ward level i.e. village level for a fixed tenure	Medium	• 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 • Low interest with high influence
Other Institutional Stakeholder Groups				
Local NGOs and Community & Social Welfare Groups (CSWG)	Secondary	• Microfinance agencies, social welfare groups and charitable organizations working in the area		• No major involvement in the project as per today • Possible inclusion during future stages of the project with respect to project related community welfare activities

7.4 Information disclosure and consultation

A number of consultation exercises were conducted during this phase of ESIA preparation. The stakeholders consulted include local People, a community in the vicinity of the 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 **Table 7-2**. Photographs of the stakeholder meeting are shown in **Annex K** .

A combination of mixed methods of information disclosure and consultation process was adopted at this stage of ESIA 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 methods used in the consultation process were:

- Key In-depth Interview/discussion;
- Public Consultation
- Focus Group Discussion (FGDs)
- Consultations during Survey

The consultation and information disclosure were held in a free and fair environment with giving prior information about the same to the stakeholders. In all occasions the date, time and venue of the consultation was decided by the stakeholders keeping in view their prior engagement and availability.

Table 7-2: Details of Consultations Held for the Project

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Outcomes of the Brief
27.2.17	Department of Fisheries	Nurul Amin, Fisheries Field Assistant, Sonagazi Upazila	• Role and responsibility of the local fisheries departments • Where are the primary fishing point located in and around in Sonagazi and Char Chandia union, • Details of Fishing production in Sonagazi and Char Chandia • Details on the key species of fishes observed in Feni River, • Understanding of the Fishermen community and their practices, • Fish varieties in the Feni River • Total number of fisherman • Critically endangered fish species • Type of fishing activity • Type of fishing boat • Number of fishing boats • Type of fishing gear • Fish landing site • Commercial fish drying activity	• The Department of Fisheries (DoF) is under the administrative control of the Ministry of Fisheries and Livestock. It is headed by a Director General, who is assisted by four Directors (one reserve) and 2 Principal Scientific Officer (equivalent to Director). There are administrative set-ups at the division, district and Upazila (sub-district) levels headed by Deputy Director, District Fisheries Officer, and Senior/Upazila Fisheries Officer respectively. • Upazila Fisheries office renders its services to achieve the mission and vision of the DoF. • Total areas of capture and culture fisheries in Sonagazi are 1999.17 hectares and 1410.17 hectares respectively where the average fish production capture fisheries are 903.36 kg/ha and culture fisheries (pond aquaculture) is 4189.94 kg/ ha. • The Char Chandia Union contributes only 6.59%, 282.36 ha pond, and 98.46 ha capture, of total fish production of Sonagazi Upazila. • No major fishing sanctuary is located in project surrounding area. • Fish capture in the Char Chandia Union is very limited because of Musapur Closer and Regulator situated on the Southern West side from the proposed project location. Musapur Closer and Regulator hinder the tidal water entering into the Choto (small) Feni river which goes through the Western side from the proposed project. • No fishing community lives within the 2km radius from the proposed project. Impact due to the project activities to the surface water bodies is considerable.

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Outcomes of the Brief
				• Both mechanized, as well as non-mechanized boats, are used during fishing. (Approx. 100-120 boats) • Fisherman use push net, shrimp net etc. for fishing. • No major fish landing site is situated adjacent to project site but out of 5 km radius in Northern East side, there is a fish landing site named Jele Para, in the bank of the Boro (Big) Feni River. • No Commercial fish drying activities are carried out.
27.02.17	Department of Agriculture	Md. Shariful Islam, Agriculture Officer, Sonagazi Upazila	• Understanding and Broad overview of the agricultural sector in Sonagazi Upazila, • Information on the cropping pattern in the area and agricultural practices, • Wage rate in agricultural labor (with food and without food), • Crop varieties in the Char Chandia Union, • Agricultural production per acre • Price of paddy and Mustard	• Total agriculture land of the Sonagazi Upazila is 15,641.23 hector wherein Char Chandia union is 3112.72 hector represents 20% of the whole Upazila. • In the Char Chandia Union, Single cropped area is 692 ha, Double-cropped area is 1556 ha and the triple cropped area is 1211 ha. • Common agricultural products are Paddy, Grass pea, Mustard, Tomato and other vegetables. • Maximum production (paddy) 1200kg per acre and (Mustard) 400 kg per acre. • (Paddy) BDT 600-700 per 40 kg and (Mustard) BDT 2000 per 40 kg. • Wage rate in agricultural labor varies from season to season 400-500 tk. • There is a Canal goes through the proposed project site. It works to drain up the excess water during the rainy season. This Canal should be kept as it is otherwise adjacent agricultural land will be inundated.
27.02.17	Department of Public Health Engineering	Abdul Wahab, Assistant Sonagazi Upazila	• Number of deep tube-well and shallow tube-well number in project area, • Arsenic and Iron concentration of the project located union and upazila	• No deep tube-well and shallow tube-well is installed in the project area, • Arsenic and Iron level within the project location is in the standard limit.

Date	Stakeholder Details	Details of participants	Issues discussed/raised	Outcomes of the Brief
			• Source of water for drink and agriculture, • Testing water quality when installed the tube-well.	• Tube-well is used for drinking and cooking purpose and deep tube-well, pond, and channel are used for agriculture production purposes. • Test for Arsenic and Iron contamination has been considered before tube-well installation.
27.02.17	Upazila Forest Bit/ Range office	Babul Chandra Bhumik, Range officers, Sonagazi Upazila	• Available tree, herbs, Bird species, wildlife, reptile. • Any protected area or Sanctuary project surrounding the area. • The project has any impact on the forestry mainly social forestry. • Future social forestry program of the forest department.	• No protected area present in and around the project area. • Southern East part from the project site has a forest bit in Char Balua (2.45 km away from the project site) • No major influence/impact on project related activities. • There is no tree in the project area. Therefore, no trees need to be cut in the project area.
28.02.12	Char Chandia Union Parishad	Md. Mosharef Hussain Milon, Chairman, Char Chandia Union	• Understanding and awareness about the project. • Expectations from the project. • Key issues rising from the land acquisition process and are there any major oppositions sighted with respect to the project. • General questions on the social structure of Char Chandia, role of marginalized groups such as women, primary work profiles.	• Knowledge about the project is limited. • The project will create employment and contracting opportunities for the local population. Also, a significant need from the project is better electricity supply. • Some people have right of land usage in absence of legal landownership. They bought the land from the allotted persons. They must be compensated too. • Char Chandia Union is mostly agriculture based where mostly 90% households are engaged directly and indirectly with agricultural activities. Women are generally housewife. But now-a-days girls' participation in educational attainment is growing. Few young females are now working in different NGOs and other institutions.

7.5 Public Consultation Meeting

The Public discussion meeting was held on 22nd January 2018 at Char Chandia Union Parishad, Char Chandia. Affected persons, local community and relevant stakeholders including both govt. and private sector representatives were participated in this Public Consultation Meeting. The proceedings commenced at 10:00 am. The meeting was attended by a total of 22 people. The list of participants and attendance sheet has been provided as **Annex L**. Public Consultation meeting outcome has been given in Table 7-3.

Table 7-3: Brief overview of the Public Consultation Meeting

Sl	Issues	Concern	Replies
	Compensation for affected properties	• Mood of compensation, Compensation rate	• A total of 999.65 acres of land is going to be acquired by EGCB with the intervention of DC office, Feni. Compensation will be paid by DC in case of titled holder. Dc already has assessed the compensation rate and its BDT 934076/per acre. It is confirmed from the local people that this rate is much higher than the current market price of the affected land. Thus, this rate is applicable for all 999.65 acre land acquisition including 165.5 acres land required for first 50 MW solar power plant. First 50 MW solar plant will be funded by World Bank. According to the WB policy, compensation rate must be given at replacement cost. DC's assessed rate can be deemed as replacement cost since it is much higher than the current market price. • DC will also assess the market rate of standing crops and pay it.
	Identification of affected persons	• Bar of getting the compensation	• Any land owners who have legal documents testifying his/her ownership will be compensated by DC. Besides this, in absence of legal owner, Successors can apply for the DC's compensation with succession certificate. This is applicable for all 999.65 acres land acquisition. No illegal owners, informal sharecroppers will be compensated.
	Adjacent Water bodies	• Two Canals exist in the project site those are originated from the Choto Feni River and pass through the project site. If they are filled or blocked, adjacent communities will be inundated	• Appropriate measures will be taken after rigorous study and analysis. Consultant will propose to keep these canals alive for minimizing potential inundation problem.

Sl	Issues	Concern	Replies
		during the wet season. Will any measures be taken?	
	Traffic System	• Traffic will be increased during the construction period. Existing road is narrow and may not be capable to resist against the heavy vehicle. Will Project Company use this existing road?	• The existing road is not suitable for carrying construction and plant material, therefore, a new road will be constructed 0r upgrading the existing road will be required • Better/improved traffic system will be proposed to develop so that local community including students, elder persons, women etc. can move more conveniently.
	GRM procedure	• What if the promises are not kept and if someone wants to complain, where and how can they complain?	• Any person as a part of community can complain at community level GRM. • Any person as a local worker can complain at Worker Level GRM • Any person as a direct affected person form land acquisition can complain at specific GRM developed in accordance to RAP study. • These three types of GRM will be proposed to develop and share with the communities. • To keep the GRM transparent, involvement of local stakeholders will also be proposed and designed as well.
	Employment Opportunity	• Will there be any job opportunities for the APs and the community people?	• It is the responsibility of the contractors. Contractors require lots of skilled and unskilled labors. However, consultants will propose to create provision for the local labors. In that case, APs and local community will get priority.

7.6 Focus Group Discussion

Discussion was held with the local people at near the proposed project site. Date, location and the number of participants of each discussion is listed in Table 7-4**Error! Reference source not found.**. Different categories of local people were grouped and discussed with many issues to capture their perceptions. The summary of focus group discussion (FGD) is shown in Table 7-5, Table 7-6, Table 7-7 and Table 7-8. List of participants and photographs of focus group discussion are shown in **Error! Reference source not found.** and **Error! Reference source not fo und.**.

Table 7-4: Details of Focus Group Discussion (FGD)

Sl.	Date	Location of the FGD	Participants	Category of participants
1.	22.01.2018	Modinar Bazar	10	Local Community

Sl.	Date	Location of the FGD	Participants	Category of participants
2.	22.01.2018	Purbo Borodhuli	7	Land Owners and Farmers
3.	23.01.2018	Char Chandia Bazar	6	Sharecroppers and Land User (illegal land owner)
4.	23.01.2018	Modinar Bazar	4	Women (affected households' members)

Table 7-5: Summary of Focus Group Discussion with Local Community

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through the various surveys that have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project as this project will create employment opportunities and infrastructural development. All advised the Consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project.	The Consultants informed that during the design and layout of all infrastructures all the adverse impacts have been anticipated.
Does the proposed Project create any problem with ambient air, noise quality or water quality?	Most of the Participants don't have proper knowledge regarding this issue. Few emphasized that "Project company should take care the surrounding environment of the proposed project"	Impact of the project upon ambient air, noise quality, water quality will be assessed during ESIA study.
Any critical issue or concern by the local people regarding the project? Or Any criteria you would like to see considered during project design, construction and operation stage?	Participants requested that environmental hotspots (like school, hospital, graveyard etc.) should be avoided as much as possible. Moreover, dust suppression, noise mitigation must be considered.	Dust suppression measures and noise mitigation will be considered in the ESMP.
Is the proposed project going to	All the participants assumed that traffic will be increased after the	Design measures such as increased number of sign

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
provide better traffic system?	proposed project starting its construction. Participants came to the consensus that better traffic system should be developed by the proponent.	board, road mark, bump etc. will be proposed to develop.
Protected areas (national parks, protected forest, religiously sensitive sites, historical or archaeological sites) if any	There is no such kind of protected area in proposed project construction site.	No concerns over the park, the nearest sites with terms of cultural or religious significance are far from the project area. Project is designed to avoid most of those structures.
Does any indigenous or tribal community live in and around the project site who may be affected by the project intervention?	Around community consists people with Muslim and Hindu population. Hindu community contributes almost 8-12% of total population. Besides this, there are no tribal communities around the project site.	No tribal communities are found during various survey and FGDs. Thus no Action Plan for indigenous/tribal people is required.
Employment Status: Percentage of employment/unemployment/ underemployment	Employment opportunity is expected to increase in the project area. Participants expected that local people will be given priority for employing in the required fields.	Job chance and employment will be enhanced and promoted once the construction is started. Will propose to pay extra priority for the local people.
Others Benefits	Most of the participants believed that infrastructural development will be accelerated. Secondly, majority also believed that basic services and business opportunity will also be increased.	
Other Negative Impacts	This proposed project will produce a large amount of waste periodically. Most of the participants believed that in absence of proper waste management plan and proper implementation, living standards of surrounding community will be hampered.	Proper waste management plan and implementation will be proposed.

Table 7-6: Summary of Focus Group Discussion with Land Owners and Farmers

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through the DC's notice and various survey those have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project and advised the Consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during the various stages of the project.	The Consultants informed that during the design and layout of all infrastructures all the adverse impacts have been anticipated.
Perception regarding the land acquisition	Most of the participants have positive perception regarding the land acquisitions. Though, this land acquisition will create landlessness for the limited affected peoples but for the national development it can be considered if properly compensated.	All development projects require land acquisition which causes land loss. But in compared to national development this loss is very negligible.
What are the characteristics of the lands those are going to be taken for the proposed project?	Proposed land is medium low with high salinity in nature. Therefore, during wet season only agricultural activities can be done. But all the acquired land is not cropped. Some parts of and are not be harvested. 165.5 acres land required for first 50 MW, is harvested once in a year. Lands are used for paddy production only. Production rate is very low in these lands. Paddy produced approximately 10-12kg per decimal.	Depending on the productivity DC will pay the value of standing crops.
How do the land owners and farmers depend on the lands those are going to be	Paddy that produced from the land is mostly used for daily life consumption. Production rate of the acquired land is very low. Sole dependency on this kind of	Detailed RAP along with proper compensation packages and livelihood assistance will be proposed to prepare for all affected persons respective to all

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
taken for the proposed project? How does this dependency contribute to the livelihood?	land is not possible. Land owners/farmers who have additional land in other mouza with multiple cropping ability, they also harvest there for livelihood. Some affected persons have other job or business too. Agricultural production contributes to enhance the food availability and solvency for these affected households.	dependencies so that all affected persons can restore their livelihood after the land acquisition.
How do other people who are not land owners depend on the acquired land? What are the common practices for renting lands to the sharecroppers?	Some people do sharecropping production. These people are usually landless. They don't have land but they rent this land for specific time duration to produce crop for their livelihood. No formal agreement is done for sharing lands. Common practice prevailing in this area is sharecropper will not give any rent but share the yields in 50:50 ratio.	Informal sharecropper will be identified and also included for livelihood support.
What should be done to minimize the livelihood impacts on the land users? (land owners, sharecroppers)	Land compensation should be compatible to market price so that land owners can buy land in adjacent area. Some believed that land availability is another challenge for the affected farmers. Sometimes farmers may not be able to buy land in the adjacent area, in that case it won't be possible to go miles for doing agricultural production. Moreover, sharecropper will not get any land compensation but they will be affected. So, affected persons should be given priority when job opportunity creates in the proposed project site.	Provision of extra privileges for the affected persons in getting job respective to their skills will be proposed.

Table 7-7: Summary of Focus Group Discussion with Sharecroppers and Land User (Illegal Land owners)

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through the DC's notice and various survey those have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Support of local people for the proposed project	Almost everybody said that they will support the project and advised the Consultants to take precautions in the environmental and social mitigations to avoid the various impacts anticipated during the preconstruction, construction and operation stages of the project.	The Consultants informed that during the design and layout of all infrastructures all the adverse impacts have been anticipated.
Perception regarding the land acquisition	Most of the participants have positive perception regarding the land acquisitions. Though, this land acquisition will create landlessness for the limited affected peoples but for the national development it can be considered if properly compensated.	All development projects require land acquisition which causes land loss. But in compared to national development this loss is very negligible.
How much are the sharecroppers/Land Users depended on the lands those are going to be acquired?	Most of the sharecroppers are landless or marginal landowners. Due to lack of agricultural land ownership, they have to depend on other land owners for continuing their agricultural activities. Land users (Illegal land owners) are those who bought land from the allottes by breaching the khas land distribution conditions. Their livelihood is partially depended on the acquired land. They usually do sharecropping all the year. They also sharecrop in other mouza where multiple cropping land is available. Land acquisition will impact partially on their livelihood as during wet season they can't continue sharecropping. Other time, they already have other	Propose to identify the sharecroppers and land users and include them into livelihood assistance program after assessing their severity of impacts.

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
	options to continue sharecropping in other mouza.	
How does land sharing happen between the land owners and the sharecroppers?	Sharecropping happens on the basis of personal relationship. Landowners give the land to those sharecroppers whom they personally know and have trust on them. Barely written deed is incurred between the landowners and the sharecroppers. In that case, how would the sharecroppers' number be confirmed?	Proper guideline will be proposed to confirm the exact numbers of the sharecropper.
What are the common practices for renting lands to the sharecroppers?	Sharecroppers harvest the land and share the yields in 50:50 ratio.	
What should be done to minimize the livelihood impacts on sharecroppers and land user?	If land owners lost their land, sharecroppers won't manage to cultivate on other land owners' land as sharecropping is incurred on the basis of personal relationship. They assumed that permanent seasonal inactivity will be happened as a result. Land users bought the land from the actual land allottes and got the right of land usage. But such selling/purchase is not allowed for distributed khas land. Thus, the land users (who bought and are currently using the land as an owner) will not be legally recognized by Law. But their livelihood will be also partially affected by the land acquisition. They think that if project proponent considers employing them in the project works based on their skills or assisting them to get alternative occupations, this will help them to restore their livelihood.	Study will propose to design and implement proper livelihood restoration plan for the affected persons.

Table 7-8: Summary of Focus Group Discussion with Woman Group (affected households' members)

Issues discussed	Participant's Opinion, comments and Suggestions	Response to Questions/Action Point
General perception and awareness about the proposed project	Most of the participants are in favor of the project and have been made aware through various survey those have been taken place.	Consultants made a clear description about the proposed project. People are aware about the project in project study area.
Livelihood pattern of women in the study area	Women are usually engage in households work. However, during the harvesting period women sometimes help but its limited to in house. They don't engage in field work.	
How will woman group be affected by the project intervention?	Yields of acquired land help to meet daily needs of households for 3-5 months. This will come to end and impact on livelihood.	
What measures can be taken to minimize the impacts on livelihood?	They are not clearly confirmed what measures will minimize the impacts most. But they suggest taking necessary measures so that their daily need for 3-5 months can be met like before.	Study will propose to design and implement proper livelihood restoration plan for the affected persons.

7.7 Community/Stakeholder Engagement

Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. They can comprise individuals, communities, social groups, organizations etc. It is often observed that the poor and the marginalized are often ignored either due to the fact that they are unaware or do not have a forum to voice their opinion.

The purpose of the Stakeholder Engagement Plan (SEP) is to ensure that the direct and indirect impacted stakeholders of the project are regularly apprised of the project activities. The plan has been developed in order to draw out an outline wherein the communication process associated with the activities of the project cycle is to be undertaken.

Communication Methods

Stakeholder engagement becomes a successful exercise when proper and participatory communicative methods are used. This ensures that the stakeholders are kept engaged and well informed of the project development at every stage. A combination of communicative methods is usually used to engage with the stakeholders. To determine which option is best

suited to the various stakeholders, a benefit analysis of each option has been carried out. The communicative methods are:

- General Information consisting of the project's various activities, the operation stage and impacts that might arise shall be made available:
    I. on information board of EGCB's site office
    II. on EGCB's website
    III. in local newspaper
- Detailed information including documents like ESIA report; Environment, Health & Safety and Social Policy, Environment Management Plan, Social Management Plan including environmental decisions shall be in hard copies and disseminated to:
    I. EGCB's site office
    II. Electronic version of these documents will be made available at EGCB's website.
- In addition to this, a host of tools and techniques can be adopted to engage with the stakeholders in a transparent and accountable manner. Below a list of the tools and techniques which can be adopted are mentioned:
    - Public Meeting: This tool can be used to disclose information on a large scale involving the stakeholders of a particular village. A schedule of the meeting can be circulated well in advance and discussions can involve feedback session from the stakeholders. The meeting can be conducted in the premise of the village school for proximity and familiarity purposes.
    - Focus Group Discussion (FGDs): FGDs are important when gauging with a particular group of stakeholder on issues related to the project activities. It can be used to understand the needs, perceptions and concerns of the group. The discussion will give space for the members to voice their concerns and suggestions.
    - Participatory Workshops: Participatory workshops are meetings which enable local people to analyze, share and enhance their knowledge to plan, manage and evaluate development projects and programs. Visual aids – such as mapping, videos, illustrations, timelines, card sorting and ranking, Venn diagrams, seasonal calendar diagramming and body maps are often used in participatory workshops to engage participants and capture knowledge.
    - Participatory Rural Appraisal (PRA) Techniques: PRA techniques are usually adopted to emphasize local knowledge by enabling local people to make their own appraisal, analysis and plan. PRA uses group animation and exercises to facilitate information sharing, analysis and action among stakeholders. This process can be useful when the project proponent initiates any developmental activities in the area and uses the local knowledge to plan and strategies so that they feel responsible for delivery of the objectives.

The communicative methods that shall be adopted for each stakeholder have been provided below,

Sl No	Stakeholder	Communication Methods
1.	**Community** (Land owners and farmers; Sharecroppers and land users (illegal land owner); Women; Vulnerable Households and community adjacent project site)	• Verbal Communication • Information Board of EGCB's site office • On EGCB's website • Local Newspaper • Public Meeting/FGD
2.	**Government Authorities** (DoE, Department of Agriculture, Department of Education, DPHE, DSW)	• Information meetings and consultations • Permits and Approvals
3.	**EPC/Developers**	• Meetings with contractors and their respective managers • Trainings/ Workshops
4.	**Financiers**	• Reporting • Direct Meeting
5.	**Migrant and Local Worker & Labors**	• Internal meetings of direct employees and managers • Day to day contact • Trainings/Workshops

7.8 Stakeholder Engagement Program

The consultation with the stakeholders will be conducted with the Admin Officer who will also look at the social aspects and work in collaboration with the nominated (Grievance Officer) and Site Supervisor (Developer) and at the site level. Any grievances from the community relating to any issues that might arise from the project activities will be managed by the nominated Grievance Officer based at the Site Office. All grievances will be addressed to the developers during the construction and operation phase. For any unresolved grievances and grievances related community health and safety, livelihood status of the affected persons, the developer will forward the grievances to EGCB who in turn will subsequently forward them to appropriate authority for redress.

Consultations with the government agencies will be conducted as per the schedule that will be created with the Site Supervisor of the Developer and Project Manager of EGCB. These stakeholders will be informed in advance of the planned project activities. The development of the facilities will be based on the ESA procedures and mitigation issues once an ESA study has been completed.

Consultations with the primary stakeholders will involve meetings, information boards announcements and an Intranet system to apprise the direct employees of Developers

regarding the procedures of emergency response system, incident/accident reporting, grievance redress mechanism, Human Resources Policies and Procedures, welfare measures etc. In addition, communication of general employment conditions, company's code of conduct for work site, EHS concerns, use of PPEs, information and awareness about the requirements of labor laws and minimum wages, working hours, grievance redress, retrenchment process etc. should be also be conducted with workers engaged with contractors.

Project related information will be posted on the informational boards at the site office as well as at the Corporate Level. Information on the project milestones will be published in advance on the company's website to be available for the public and non-governmental organizations in the area to comprehend the attitude of the secondary stakeholders. In addition, the company will publish information on the project in the local newspapers.

In turn, if any issues are raised by the stakeholders, the project proponent management comprising of the Grievance Redress Committee at the Site Level will respond accordingly in the shortest possible time. Details of which have been provided in the Grievance Redress Mechanism section of the report.

The responsibility for the SEP implementation will be held by the Admin Officer and he will be supported by Project Manager (EGCB), Site Supervisor (Developer) and EHS Manager (Developer) and nominated Grievance Officer at the site level.

A summary of the consultation activities that the project proponent shall undertake as part of the Engagement Plan pertaining to the villages around the project area and other stakeholders have been provided in Table 7-9**.**

Table 7-9: Consultation Activities Summery

Stakeholder	Information to be shared	Proposed timeline	Responsibility
Land owners and farmers; Sharecroppers and land users (illegal land owner); Women; Vulnerable Households and community adjacent project site	• Progress of the work under each phase. • Information on job opportunities • Tenders for petty contractors and vendors • Local Area Development Activities • Grievance Mechanism	Quarterly (Ongoing process throughout the Project)	Project Manager and Local Leaders (chairman/ word members) of the villages.
Government Authorities	• Permits and Approvals • Grievances related to land issues and unresolved grievances • Environment Monitoring reports	Need Basis (Ongoing process throughout the project)	Project Manager

Migrant and Local Worker & Labors	• Trainings on dealings with local communities (for migrant workers only) • Training on Health and Safety • Grievance Mechanism	Quarterly (Ongoing process throughout the project)	• Developers: Site Supervisor • EHS Manager &Admin Officer
Contractors (Third Party)	• Trainings on dealing with local communities • Other EHS trainings	(Need Basis) Ongoing process throughout the project	EHS Manager & Site Supervisor
Lenders	• Information on project status • Submission of annual reports, information on any project-related events that could potentially create an increased risk of the project	(Need Basis) Ongoing process on a permanent basis	Project Manager and designated person from EGCB

The stakeholder engagement process should be carried out at two levels, namely, local community and local governing bodies. A summary of the proposed plans that is to be initiated by the developer(s) and EGCB have been described below in Table 7-10 below.

Table 7-10: Proposed Plan Activities Summery

Sl. No	Key Stakeholders	Proposed Plan of Activities
1.	Positively Influenced Stakeholders/ Local Communities	• Announcement of vacancies (skilled/unskilled) at proposed site; • Announcement of contract work for small scale work associated with the proposed project; • Local Area Development Activities as per EGCB of Action for Community Development; • Consultation with village people/local government about movement of heavy vehicles; • Information on route and timing of vehicle movement to be provided to village administrations; • Set up a grievance redress mechanism and inform the community about the procedure; and • Discuss the management plan with the community and incorporate the comments.
2.	Local Governing Bodies	• Compliance with legal requirements; and • Involvement of various Local Area Development Activities.
3.	Lenders	• Compliance with International Guidelines (World Bank Operational Policies, IFC Sustainability Framework& other national and local legal requirements) • Regular Reporting

It is to be noted that the proposed plan of activities relating to the stakeholder engagement can change as per the future planning of activities by Developer(s) and EGCB.

7.9 Monitoring and Reporting

7.9.1. Monitoring

Monitoring of project activities is necessary to cater the stakeholder's concerns by ensuring transparency in guaranteeing the project proponent's commitment in implementing the mitigation measures that addresses the environmental and social impacts arising from the project.

Through this information flow, the local stakeholders will feel the sense of responsibility for the environment and welfare in relation to the project and feel empowered to act on issues that might affect their lives.

Internal monitoring of project related activities as well as associated activities involving the local communities should be contemplated upon on a regular yearly basis (by identified staff from the Corporate level) to bring in openness in EGCB's commitment. In addition, external monitoring of a company's environmental and social commitments can strengthen stakeholder engagement processes by increasing transparency and promoting trust between the project and its key stakeholders.

EGCB should undertake a commitment in undertaking internal audits once every quarter. All related information shall be readily maintained at the site office and produced at the time of the audits.

Audit reports shall be accordingly created after every quarterly audit and submitted to Project Manager of EGCB. All records of these reports shall be maintained at the site office as well as the Corporate Office. In addition, an external auditor shall be engaged every biannually to assess the activities of the project and its mitigation measures. The auditor shall accordingly submit a report to the company for review and this should be forwarded to the lender financing the project as well.

7.9.2. Reporting

Performance of Developers and EGCB will be reviewed yearly against the Stakeholder Engagement Plan. The report will include, but not be limited to, the following:

- Informative materials disseminated, its types, frequency, and location;
- Place and time of formal engagement events and level of participation;
- Activities of community welfare undertaken;
- Feedback on Local Area Development initiatives;
- Other interactions with the community; and
- Numbers and types of grievances (both from the community and workers) and the nature and timing of their resolution.

CHAPTER 8: GRIEVANCE REDRESSAL MECHANISM

8. GRIEVANCE REDRESSAL MECHANISM

This section describes the need of establishment of a grievance redress mechanism to receive and facilitate resolution of complainants (project affected people, local community and workers) concerns and grievances regarding the project's performance in the constructional, operational and decommissioning phases. The mechanism should be able to address the aggrieved parties concerns and complaints promptly by using an understandable and transparent grievance addressing process which is readily accessible by all segments of the population including workers in a workplace environment.

The GRM has been developed with an intention of it being an effective tool for early identification, assessment and resolution of complaints during project entire life cycle. It is a means through which acceptance, assessment and resolution of community and workers complaints concerning the performance or behavior of EGCB are ascertained and addressed.

There can be range of issues arising during a project phase. Some of these issues could be related to

- Compensation payment,
- Failure to fulfill commitments,
- Poor management of construction activities,
- Accidents due to inappropriate planning of vehicle movement,
- Cultural conflicts between migrant workers and local communities,
- Disturbance due to excessive noise or other nuisance during construction or operation to unfair treatment of workers or unsafe working conditions.

Hence, a robust GRM is required that is gender responsive, culturally appropriate and readily accessible to the affected persons at no costs and without retribution.

8.1 Grievance Mechanism Development and It's Requiring Steps

The Developers/EPC while developing the Grievance Mechanism are required to adhere to the following steps:

8.1.1 Development of Procedures

The developers/EPC should ensure that procedures for lodging and registering of grievances are in place before the plan is implemented at the site level. The procedures of Grievance Mechanism should comprise of identifying the personnel (Grievance Officer at Site level) who will be responsible for receiving and addressing the grievances at the site level and handle the cases at the escalation level. The procedures to be developed should include assessment procedures, procedure to determine the appropriate resolution process, procedures for making decisions on proposed settlements, appropriate time frames for each step in the grievance resolution process and notification procedure to the complainant about eligibility, assessment results, proposed settlements and the like.

8.1.2 Develop Resolution Options and Response

Once Developers/EPC developed procedures, formal and informal resolution options should also be developed along with preparation of formulating a response. General approaches to grievance resolution many include proposing a solution, reaching a resolution through discussion or negotiation, using a third party to either informally or formally resolve the matter through mediation and through traditional and customary practices.

8.1.3 Publicize the Grievance Mechanism

Once the procedures for Grievance Mechanism have been developed by the developers/EPC, it has to be publicized through various stakeholder engagement activities as detailed out in the Stakeholder Engagement Plan and should be disseminated to the developer(s) as well. The Developers/EPC should inform the local community in the first instance and then on remind them of this mechanism on a regular basis during the project construction and operation phases. Various communicative methods can be adopted in disseminating the information like printed materials, displays, face to face meetings and website updation. The grievances redress mechanism (GRM) shall be documented in English and Bangla and copies shall be kept at the project site office and corporate office. The GRM is also to be displayed at notice board at the project site office and training on the GRM shall also be provided during orientation. Developer(s) is to ensure that the contractor would keep the workers informed about the grievance mechanism at the time of recruitment and make it easily accessible to them. All the relevant contact numbers to be made available to them.

8.1.4 Training/ Workshops on Grievance Redress Mechanism

A separate training/ workshop should be undertaken by the Developers/EPC at the community and worker level to discuss the process of how a grievance gets registered, the local contact person's/grievance officer details of receiving grievances, the significance of grievance boxes, the timelines for addressing the grievances and the personnel's involved in the redressal process.

These trainings should be held every half yearly and feedback/suggestions from the community should be acknowledged and changes to the GRM should accordingly be undertaken to make it more user friendly.

8.1.5 Recording of Grievances

Once the stakeholders are aware of the mechanism and access it to raise grievances, developer(s) is required to acknowledge the same and keep the complainant's identity anonymous. Consequently, developer(s) is required to collect grievances by checking the grievance boxes once every fifteen days, record and register the grievances that have come in as per the identified formats and track them throughout the redressal process to reflect on their status and important details. A Grievance Log or database emphasizing the records and status of the grievance is to be maintained by the identified Grievance Officer at the site level. The Grievance Log can be used to analyze information about grievance and conflict trends, community issues and project operations to anticipate the kinds of conflicts that EGCB might expect in the future both to ensure that the grievance mechanism is set up to handle such issues and to propose organizational or operational changes.

8.1.6 Appeal

If the grievance redressal solution is not acceptable or agreed by the complainant, the complainant should be offered to an appeal process. Circumstance revolving around when an appeal can be made should be set by the developers/EPC so that accountability and transparency is promoted by them in every step.

8.1.7 Resolve and Follow Up

Once the corrective action has been agreed upon, a good practice is to collect proof of those actions in terms of taking photographs, documentary evidence, getting confirmation from the complainant and filing the same within the case documentation. In addition, monitoring and follow up on the resolution agreed upon should be conducted once to close the case accordingly. Developers/EPC are required to provide regular (yearly) reports to EGCB that track the number of complaints received, resolved, not resolved and referred to a third party. In addition, the funding agency also needs to be constantly apprised of the yearly reports in order to support identification of developing risks.

8.2 Proposed Grievance Redress Mechanism for EGCB /Developer

The Grievance Redress Mechanism outlines the process for lodging of grievances, steps to be taken for subsequent action and the time limit within which the issue would be resolved to the satisfaction of the complainant (community members, project affected persons and workers). All complaints shall be recorded and addressed in a uniform and consistent manner. The GRM for the proposed project is presented below with time bound schedules and specific persons to address grievances.

8.2.1 Grievance Redress Committee

A site level approach is proposed to be developed for redressing of all cases of grievances. All grievances are to be redressed at this stage. The representatives proposed for the grievance committee is provided below,

- Site Supervisor
- EHS Manager
- Admin Officer and
- Safety Officer.

The functions of GRC are as follows:

- To provide support to affected communities on problems arising from environmental or social impacts;
- To record grievances of the affected community by categorizing and prioritizing them, and provide solutions within a stipulated time period; and
- To report to the aggrieved parties, developments regarding their grievances and decisions of the GRC.

The steps of grievance redressal for Developer have been provided below:

8.2.2 Receive and Register a Complaint

The developers/EPC in order to implement the Grievance Redress Mechanism is required to nominate a Grievance Officer for registering the grievances, initiating the process of registering and action taken thereon for the resolution of the grievance and the timeline required in each step. The contact details of the Grievance Officer shall be maintained and updated in the following format displayed at prominent places available to public and the project area.

Table 8-1: Contact Details of Grievance Officers

Sl. No	Name of the Grievance Officer	Telephone No.

- Any stakeholder such as worker, person from local community or any other stakeholder, with concerns pertaining to onsite work such as community health and safety, local employment, community risk, migrant labor or any issues etc., may register their complaint in writing to the nominated person/grievance officer at site level. ;
- All grievances will be addressed by the developers/EPC during the construction and operation phase. For any unresolved grievances or any grievances related to land(N/A for this project as land is acquired voluntarily), the developer/EPC will forward the grievances to EGCB who in turn will subsequently forward them to appropriate authority for redressing;
- Secured grievance boxes shall be placed at the entrance of the site office ;
- If any stakeholder or community member wishes to remain anonymous, he/she can write down the grievances and drop in the available complaint box; and
- Once a complaint has been received it shall be recorded in the grievance log register or data system.

Details of grievance received shall be maintained by the Grievance Officer in a register as per the following format.

Table 8-2: Records of Grievance Received

Sl. No.	Date of Receipt	Particulars of Complainant				Particulars of Grievance			
		Name	Address	Contact No	Whether acknowledgement given at time of receipt	Subject of the Grievance	Office	Brief Description	Date of acknowledgement/ Date of redress

8.2.3 Assessment and Addressal of Complaint

- The Grievance Officer will open the grievance boxes once every week and register the grievance in the Grievance Log Register as per the format provided above;

- The Grievance Officer will then forward the grievances after registration to the Site Supervisor for further action;
- The grievance will be assessed by the Site Supervisor within two (2) working days to determine if the issues raised by the complaint fall within the mandate of the grievance mechanism or not;
- During the assessment of complaints, the GRC team (EHS Manager Admin Officer, Site Supervisor &Safety Officer) will gather information about the key issues and concerns and helps determine whether and how the complaint might be resolved;
- The grievances will be redressed at the Site Level by the GRC within seven (7) working days;
- If the grievance fails to be addressed at this level the complainant will have the option to approach the appropriate court of laws for redress; and
- The complainant will have the opportunity to be present at the committee meetings and discuss the grievance faced by him/her.

The Grievance Mechanism proposed for Developer to consider and implement has been provided in Figure 8-1below.

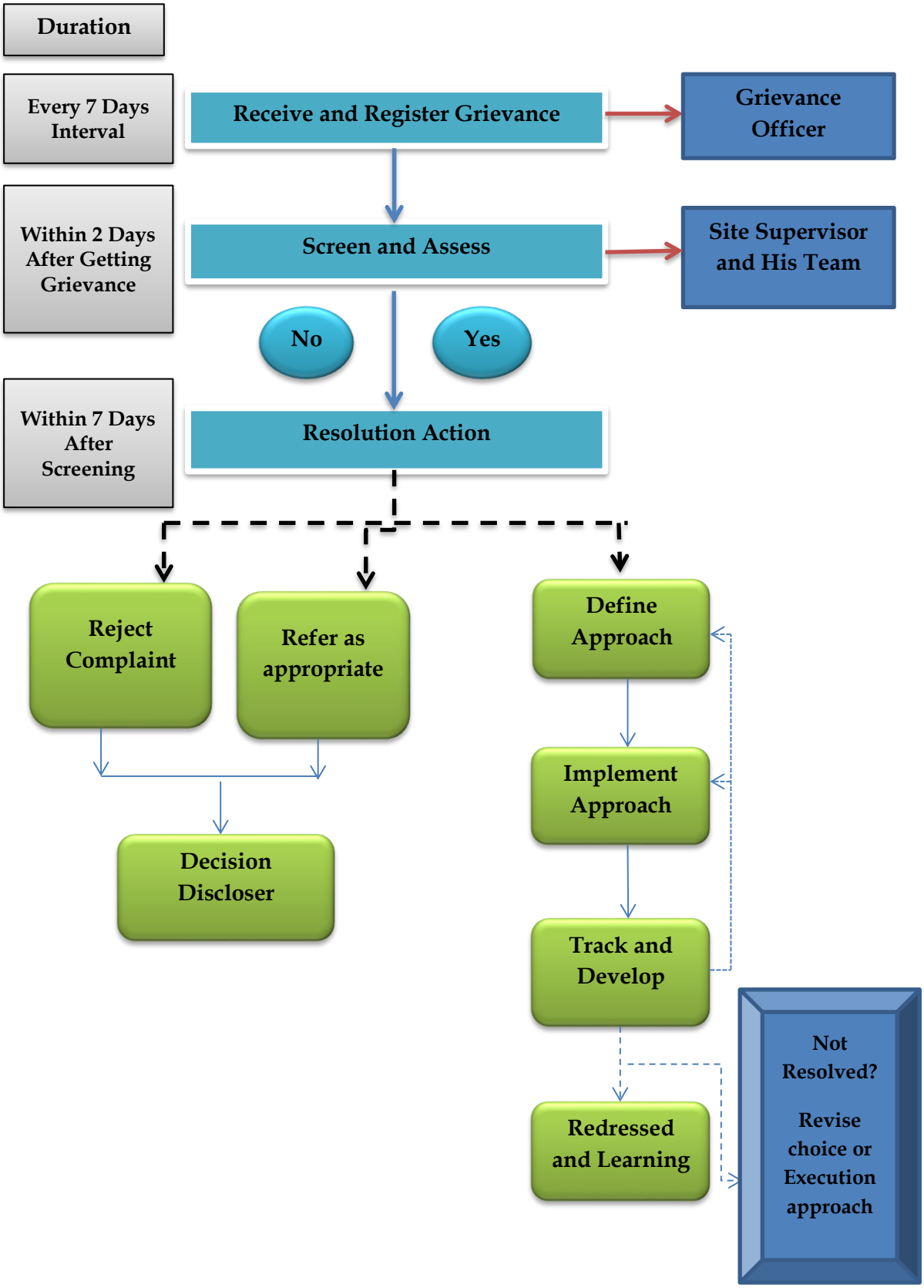


Figure 8-1: Proposed Grievance Mechanism for Developer

8.2.4 Documentation

- The Grievance Redress Mechanism will be documented in English and Bangla and copies will be kept at the project site office;
- The GRM will also be displayed at notice board at the project site office and labor camp sites and will be included in worker documentation;
- The developers/EPC should inform the local community and workers about Grievance Redress Mechanism during the project construction and operation phases. Various communicative methods can be adopted in disseminating the information like printed materials, displays and face to face meetings;
- The Contractor or Admin Officer will inform the workers about the grievance mechanism at the time of recruitment or induction training and make it easily accessible to them;
- The Grievance Officer's contact number will be made available to them. The project office phone number will be posted in public areas within the project area;
- The mechanism will address concerns promptly, using an understandable and transparent process and provide timely feedback to the concerned stakeholder;
- Verifiable records of implementation of corrective action like dated photographs, documentary evidence, getting confirmation from the complainant and filing the same within the case documentation should be kept;
- A Grievance Log or database emphasizing the records and status of the grievance shall be maintained by the Grievance Officer at the site level.

8.3 Resources Required for Grievance Mechanism Implementation

A Grievance Mechanism becomes successful if adequate resources are assigned in its implementation. Adequate resources here refer to people, systems and processes and associated financial resources. In order to incorporate the responsibility of designing, implementing and monitoring the grievance mechanism, the senior management of the Developers/EPC at the corporate level should be involved in executing the various tasks. For a grievance mechanism to function effectively, it is important to establish a governance structure and assign responsibilities for the mechanism's implementation. The following roles and responsibilities have been identified for grievance mechanism implementation:

8.3.1 Nominated Grievance Officer

Admin Officer based at the Site Level is to be nominated as the Grievance Officer. The incumbent is to work in tandem with the Site Supervisor, EHS Manager and Safety Officer. They cumulatively form the Grievance Committee at the site level.

8.3.2 Engagement of Third Party

To maintain ultimate transparency and accountability for the grievance mechanism process, third parties such as local governments, local community etc. can at times be involved in the grievance redress process. These parties can serve as process organizers, places to bring a complaint to be passed on to the company or as facilitators, witnesses, advisors or mediators. Third parties can assist in enhancing the trust level from communities as well as overcome limitations of project-level mechanism.

Through the involvement of third parties as facilitators, the community's confidence in project level grievance mechanism can be increased and EGCB can gain a better reputation with and greater trust from stakeholders. In addition, cost-efficiency and supplement of internal resources can also be achieved if this step is contemplated upon.

8.3.3 Monitoring and Reporting

Monitoring and reporting are requisite tools of measuring the effectiveness of the grievance mechanism, the efficient use of resources, determining broad trends and acknowledging recurring problems so that they can be resolved before they reach a higher level of contention. They also create a base level of information that can be used by EGCB to report back to the stakeholders.

8.3.3.1 Monitoring

Depending on the extent of project impacts and the volume of grievances, monitoring measures like internal (by identified Developers Corporate level staff) and external audits (third party consultants) every once in a year based on the complexity of the nature of grievances can be adopted by the Developers/EPC. Grievance records maintained should provide the background information for these regular monitoring exercises. Through the review of each grievance and analysis of its effectiveness and efficiency, Developers/EPC can draw on the complaints to evaluate systematic deficiencies. In addition, monitoring of the grievance mechanism helps to ensure that the design and implementation of the mechanism is adequately responding to stakeholder's comments in a cost effective manner.

8.3.3.2 Reporting

All grievances registered have to be recorded and regularly updated. The site management or Grievance Officer is responsible to discharging this responsibility and he should be able to produce this document whenever any audits take place. All minutes of meetings with stakeholders, complainants and Grievance Committee are to be recorded and documented regularly for reference purposes. In addition, through the process of monitoring and the reports produced thereafter, assurance of continual improvement of the company's operations is guaranteed. The company can also use these monitoring reports to report back to the community on its implementation of the mechanism and the modification/ changes proposed to make it more user-friendly.

CHAPTER 9: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

9. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

This section presents the Environmental and Social Management Plan (ESMP) for the project. The purpose of this ESMP is to specify the standards and controls required to manage and monitor environmental and social impacts during construction and operation phase. To achieve this, the ESMP identifies potential adverse impacts from the planned activities and outlines mitigation measures required to reduce the likely negative effects on the physical, natural and social environment.

The purpose of ESMP is as follows:

- Provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified in ESIA designated to mitigate potentially adverse impacts are implemented;
- List of all suggested mitigation measures and control technologies, safeguards identified through the ESIA process;
- Provide project monitoring program for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and risk control systems in place;
- Assist in ensuring compliance with all relevant legislation at local, state and national level for the projects

9.1 Environmental and Social Management Plan

In order to minimize adverse impacts during different phases of project lifecycles, mitigation measures and responsibilities for its implementation during construction, operation, and decommissioning phase are given in **Table 9-1**, **Table 9-2** and **Table 9-3**.

Table 9-1: Environmental and Social Management Plan (ESMP) for Construction Phase of the Project

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
A	**Social Impact during Pre-Construction Phase**								
1.1	Landloss	Land acquisition	Land owner will lose land due to acquisition	• Periodical consultation with the land owners during the land acquisition; • Payment of replacement value of land; • Payment of severity allowance for fragmentation of land. Where the remaining land becomes unviable in case of fragmentation, the Project to compensate for the full land parcel; • Establishing a grievance redress mechanism; • Redressing grievances according to the established GRM; Prioritization for work during project construction period;	EGCB	RAP Implementation Agency	Throughout the Implementation period	Report to proponent and lenders	Total cost 164,519,495 BDT including land and crop compensation (RAP implementation cost)
1.2	Livelihood loss	Land acquisition	Land owners, share croppers and resource users will lose their livelihood from the land	• Prior notification before land development as crops harvesting not get impacted; • Payment of transitional assistance to support economic loss; • Livelihood restoration measures for severely affected households or skill improvement training; • Establishing a grievance redress mechanism; • Redressing grievances according to the established GRM;	EGCB	RAP Implementation Agency	Throughout the Implementation period	Report to proponent and lenders	15,500,000 BDT Including transitional grant, training and after training grant (RAP implementation cost)

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				• Prioritization for work during project construction period.					
1.3	Vulnerable Group	Land acquisition	Vulnerable group will be impacted due to loss their land or livelihood	• Additional cash/ other assistance; • Livelihood restoration measures or skill improvement training; • Establishing a grievance redress mechanism; • Redressing grievances according to the established GRM; • Prioritization for work during project construction period	EGCB	RAP Implementation Agency	Throughout the Implementation period	Report to proponent and lenders	110,000 BDT (RAP implement ation cost)
B	**Environmental Issue Associated with site Preparation and Construction**								
1.1	Land Use	Construction of temporary structure, approach road & internal access road, dike around the project boundary, installation of PV module and WTGs	Permanent and temporary changes in land use	• EGCB has considered all aspects of siting and design prior to selection of the proposed site. • The construction activities will be restricted within the boundary of the proposed plant and will not alter the land use of the adjacent areas; • As there is a provision of farming practice in the project area so proponent should continue the farming practice to reduce the crop production loss due to the project; • Proponent should take tree plantation program whereas possible in the plant boundary or along the road/embankment side	EPC Contractor	On-site project management team of EGCB	Site inspection Upon completion of work	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				• Waste should not be allowed to litter in and around the project area; • On completion of construction activities, land used for temporary facilities will be restored to the extent possible; • The land use in and around the permanent project facilities will not be disturbed					
2.1	Land Resources	• Topsoil removal	Loss of topsoil	• The removal of vegetation and soil cover will be restricted to only those areas necessary for the development. All topsoil will be retained and reused; • Stockpiles will be vegetated or appropriately covered to reduce soil loss as a result of wind or water erosion; • Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds; • All construction plant and equipment will utilize approved access routes • Minimizing the amount of soil handled; • Stabilizing exposed areas; and • Covering or spraying water on stockpiles of excavated material	EPC Contractor	On-site project management team of EGCB	Site inspection Upon completion of work	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
2.2	Land Resources	• Site cleaning, leveling, compaction • Civil construction activities	Soil compaction and erosion	• The area to be cleared must be clearly demarcated and this footprint strictly maintained; • Soil conservation measures will be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas. • Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds; • Work areas will be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint; • It is recommended to grow turf grass beneath solar panels to avoid soil erosion • Construction vehicles will remain on designated and prepared compacted gravel roads;	EPC Contractor	On-site project management team of EGCB	Site inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost
2.3	Land Resources	• Empty paint container • Improper disposal of hydraulic fluids, diesel, lubricating oils and other used oil	Soil Contamination	• Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area. • Sewage generated from the project site will be treated and disposed of through septic tank and soak pits; • Spill containment and clean up kits will be available onsite and	EPC Contractor	On-site project management team of EGCB	Site inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
		• Improper storage of construction materials		clean-up from any spill will be appropriately contained and disposed of. • Construction vehicles and equipment will be serviced regularly • The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals; • Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system; • A site-specific Emergency Response Plan will be prepared by the contractor for soil clean-up and decontamination; • Any loading and unloading protocols should be prepared for diesel, oil and used oil respectively; and • The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination events					
2.4	Land Resources	• Construction waste; • Wooden crates, cartons, plastic wrapping sheets	Land contamination due to waste disposal	• The construction contractors will have control over the amount and types of waste (hazardous and non- hazardous) produced at the site. Workers will be strictly instructed about random	Appointed EPC Contractor	On-site project management team of EGCB	Site inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
		from solar panel packaging; • Municipal solid waste produced at the temporary site office; • Hazardous materials and waste including oil, used oil, oil containing rags etc.; • Leakage/spillage from construction equipment and vehicles, DG sets and storage areas; • Improper disposal of sewage;		disposal of any waste generated from the construction activity; • Construction contractor should ensure that no unauthorized dumping of used oil and other hazardous wastes is undertaken from the site; • Municipal domestic waste generated at site to be segregated onsite; • Ensure hazardous waste containers are properly labeled and stored onsite provided with impervious surface, shed and secondary containment system; • Ensure routinely disposal of hazardous waste through approved vendors and records are properly documented; • Construction contractor should ensure daily collection and periodic (weekly) disposal of construction waste generated debris, concrete, metal cuttings wastes, waste/used oil etc. • Ensure hazardous waste is properly labeled, stored onsite at a location provided with impervious surface, shed and secondary containment system and; • The municipal waste from the labor camp will only be routed through proper collection and handover to the local municipal				EHS person of EGCB	

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				body for further disposal. The hazardous wastes will be temporarily stored in labeled drums on the impervious surface at designated area onsite and will be disposed of through approved vendors.					
3.1	Agricultural Resources	Project will be set up on medium high land where only aman rice is cultivated during the post monsoon season	Loss of agricultural production	• Inform the landowner prior to starting land development work so they can harvest the standing crop; • Best utilize the designated land area for fisheries/livelihood purposes	EGCB	EHS person designated by EGCB	Site inspection During the site preparation	Report to project management	EPC Contractor Cost
4.1	Water Resources	Water demand for construction work	Surface and groundwater quantity	• The effect of groundwater or surface water abstraction for project activities will be assessed in detail using field testing and modeling techniques, and accounting for seasonal variability and projected changes in demand in the Project area; • Periodical training need to provide to workers for best utilization of water; • Keep provision for rainwater harvesting; • Take permission for installation of bore well from Upazila Parishad; • Recycle/reusing to the extent possible	EGCB	EHS person designated by EGCB	Permission letter (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	Project Development Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
4.2	Water Resources	• Sewage from labor camp • Liquid effluent from washing of equipment and vehicles • Storage of hazardous waste onsite	Water contamination	• Fuel, oil and used oil storage areas will be contained in bunds of 110 percent capacity of the stored material; • Refueling will be carried out in designated areas using strict protocols; • Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a bound landfill site; • Project staff will not be permitted to utilize any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing; • Construction vehicles and equipment will be serviced regularly at off-site location; • Ensure that all construction plant and equipment is maintained in a good state of repair with minimal leaks; • Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal; • Oil and grease separator shall be used for wastewater generated from cleaning activities; • Adequate sanitary facilities, i.e. toilets and showers, will be	EPC Contractor	EHS person designated by EGCB	Site Inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				provided for the construction workforce; • Workers will be trained in the use of designated areas/bins for waste disposal and encouraged to use toilets; • Septic tanks will be provided to treat sanitary wastewater • Use of licensed contractors for management and disposal of waste and sludge and • All sewage and liquid effluent will be treated to meet the standards specified in Schedules 9 and 10 of the ECR, 1997					
4.3	Water Resources	Earthworks in the project area may increase the erosion, especially during rainfall events, which may increase the suspended sediment concentrations and pollute water sources;	Increase sediment content in the surface water	• The drainage pattern of the site will not be altered and the natural slope of the site will be maintained; • Water flow of present two canals in the project site should be maintained as per present scenario; • Special care needs to be taken during the road construction to maintaining the standard slop as the soil cannot wash out in the water body. As well as need proper compaction of the road structure; • Cover all slopes of the road and embankment by first growing grass; • Adequate arrangement for stormwater management during	EPC Contractor	EHS person designated by EGCB	Site Inspection (Daily monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				construction period will be made to avoid sediment runoff from the site; • During construction, it should be ensured that no run-off from construction area merges with the existing canals • Stormwater flow should be directed to the existing canals/River with silt trap to avoid sedimentation of the canals/River or the receiving water body					
4.4	Water Resources	• Improper disposal of sewage and wastewater from labor camp and construction debris • Unplanned event such as leaks and spills of oil, lubricants, fuel from heavy equipment	Groundwater contamination	• Storage of oil, lubricants, fuel at concreted laydown areas will be implemented to minimize contamination in the event of a spill. • Septic tanks will be provided to treat sanitary wastewater. • All wastewater discharges will meet the standards stipulated in Schedule 9 and 10 of ECR, 1997 prior to discharge.	EPC Contractor	EHS person designated by EGCB	Site Inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost
5.1	Drainage pattern	• Dike construction • Land development	Changes in drainage pattern	• Detail hydrology study should be carried out prior to design the dike; • Appropriate number of cross drainage channels should be provided during access road	EPC Contractor	EHS person designated by EGCB	Site Inspection upon completion of work (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				construction to maintain flow in existing natural channels • Keep both the canals functional • Design the dike and plant considering the normal functioning of the canals					
6.1	Air Quality	• Dust generation from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions • Construction of approach road • Construction of PV module and WTGs foundation, construction of building, loading and unloading equipment • Dust generated from stockpiles of waste, topsoil handling and moving excavated material and transporting	Dust generation	• Implementation of a regular watering and sprinkling dust suppression regime, during the dry season; • Stockpiles of dusty materials will be enclosed or covered by suitable shade cloth or netting to prevent the escape of dust during loading and transfer from Site. • No stockpiles will be maintained outside, and maximum Possible distance between the stockpiles and receptors will be maintained; • Covering and/or watering of all stockpiles of dusty materials such as excavated spoils to avoid fugitive dust emissions; • During construction, the approach road will be kept clean, free from mud and slurry; • Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site; • Speed of vehicles on site and approach road will be limited to	EPC Contractor	EHS person designated by EGCB	Site Inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
		wastes on vehicles.		15-20 km/hr which will help in minimizing fugitive dust emission due to vehicle movement • Idling of vehicles and equipment will be prevented					
6.2	Air Quality	• Exhaust emission from operation of machinery like pile drivers, vehicles • Point source emission from diesel generator • Vehicular emissions due to increased traffic movement on site and on the approach roads • Operation of heavy equipment's	Exhaust emission	• The movement of construction vehicles will be minimized and a 20 km/hr speed limit will be enforced in the project site as well as approach road; • Vehicles traveling on gravel roads will not exceed a speed of 30 km/hr; • All diesel-powered equipment will be regularly maintained and idling time reduced to minimise emissions; • Low sulfur diesel (S<O.5%) will be used in diesel-powered equipment in collaboration with best management practices; • Vehicle/equipment air emissions will be controlled by good practice procedures (such as turning off equipment when not in use); and • Vehicle/equipment exhausts observed emitting significant black smoke in their exhausts will be serviced/ replaced. • Solid waste burning in the project site is strictly prohibited	EPC Contractor	EHS person designated by EGCB	Site Inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
7.1	Noise	• Construction activities • Transportation of construction materials, plant materials, machinery and personnel • Operation DG sets; • Operation of batching plant • Digging of trenches to accommodate underground power cables,	Noise generation	• The contractor should ensure that all construction equipment and vehicle is fitted with silencers (where possible); • The contractor should consider the noise emission characteristics of equipment when selecting equipment for the project and select the least noisy machine available to perform the specific work (this is a requirement of OSHA 2007); • The contractor should undertake additional post development noise monitoring in accordance with National and International noise standards. • Mobile noise sources such as cranes, earth moving equipment shall be routed in such a way that there is minimum disturbance to receptors; • Developer shall instruct their Safety Officers to arrange for inherently quiet construction equipment and machines to maintain the noise level to minimum; • Only limited construction activities shall be carried out during night-time; • Restrict the night time vehicle movement through the access road;	EPC Contractor	EHS person designated by EGCB	Site Inspection (Monthly monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				• Adopt the vehicle speed limit in the access road • It is also to be ensured that no village road will be utilized for movement of equipments except the designated access road; • The number of equipment operating simultaneously should be reduced as far as practicable; • Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable; • All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50m away from the site boundary; • Rubber padding/noise isolators will be used for construction equipment • Temporary noise barriers shall be provided surrounding the high noise generating construction equipment; • The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels;					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				• Construction vehicles and machinery will be well maintained and not kept idling when not in use;					
8.1	Traffic and Transport	• Transportation of construction materials, plant materials, machinery and personnel	Local traffic and transport	• The contractor should ensure that all PV module and mounting structure components are transported in appropriate vehicles that adhere to the axle load limits. • Only trained drivers with valid license shall be recruited by the construction contractor. • Training programs shall be conducted at regular intervals for all the drivers for raising awareness about road safety and adopting best transport and traffic safety procedures once in every month. • Additionally, speed limits for all construction related vehicles shall be adhered to at all times to prevent damage to roads and other infrastructure • Mitigation measures such as emphasizing on safety amongst drivers, adopting limits for the trip duration and arranging driver roster to avoid overtiredness and avoiding dangerous routes and times of day to reduce the risk of the accident shall also be implemented.	EPC Contractor	EHS person designated by EGCB	Site Inspection (Daily monitoring)	Monthly Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				• Regular maintenance of vehicles and use of manufacturer approved parts should be adopted to minimize potentially serious accidents caused by equipment malfunction or premature failure. • The villagers will be made aware of the schedule prior to the movement of trucks and transportation of power plant equipments in the project area. • Collaboration with local communities and responsible authorities to improve signage, visibility, and awareness of traffic and pedestrian safety; • Notify the school governing body and local area responsible person prior to start the construction work and put signage before the school, mosque and madrasah on both way and instruct the driver for carefully driving in close to the sensitive area; • Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents. • The existing earthen road should keep functional as the local people can use the road;					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				• Movement of the project traffic should be limited to the planned route only and; • The traffic movement in the settlement areas should be limited for the daytime only					
9.1	Ecology	• Project site clearance; • Project site leveling; • Construction activities at site;	Impact on terrestrial flora and fauna, aquatic fauna	• The noise generating activities should be scheduled during daytime only. • Movement of construction and transport vehicles should be restricted to dedicated paths to minimise any harm to small mammals near to the proposed site. • Construction activities should be planned and undertaken in a phased manner • Project related activities should be avoided during the night time; • Damage to the natural topography and landscape should be minimized; • Strict prohibition should be implemented on trapping, hunting or injuring wildlife within the subcontractors and should bring a penalty clause under contractual agreements; • A minimum possible number of routes should be authorized for use during construction by the laborers and staff, speed limit of the vehicles plying in these	EPC Contractor	EHS person designated by EGCB supported by external ecological expert	• Site Inspection • Training records • Visual assessment by experts (One-time monitoring during start of project activity and quarterly once monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				routes should be kept 20-25 km/hr to avoid road kill; • Keep functional as present condition of the canals in project site for fish and herpetofauna species					
10.1	Occupational Health and Safety Hazard	• Accidents and injuries associated with the operation of heavy machinery and other construction activities; • Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions of air, water pollution and noise generation from construction activities as well as from storage and handling of waste, particularly hazardous waste. • Loading and unloading	Occupational health impact	• The workers (both regular and contractual) on the project will be provided with training on the Health and Safety policy in place, and their role in the same and refresher courses will be provided throughout the life of the project; • Establish a grievance redressal mechanism in place, to allow for the employees and workers to report any concern or grievance related to work activities; • Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional; • The contractor should ensure that no person is engaged in driving or operating construction machinery unless he/she is sufficiently competent and reliable, possess the knowledge of risks involved in	EPC Contractor	EHS person designated by EGCB	• Site Inspection • Training records • Visual assessment (Monthly Monitoring)	Monthly progress report from designated EHS personnel of Plant Management to designated EHS person of EGCB	EPC Contractor Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
		activities of the construction materials • Working at height, working with rotating machinery and falling objects		the operation and is medically examined periodically. • Child labor during the project construction should be prohibited; • Contractor should prepare a site Emergency Preparedness and Response Procedure, which should be followed for the subjected project; • Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures; • Job responsibility and shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries; • Safety sign should also be marked at appropriate places. • It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls. • Excessive waste debris and liquid spills will be cleaned up regularly, while electrical cords and ropes will be placed along identified corridors marked for					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost and Source
				the attention of everyone at the site. • Use of personal fall arrest system, such as full body harnesses as well as fall rescue procedures to deal with workers whose fall has been successfully arrested shall also be carried out. • Dropping/lowering of construction material or tool will be restricted and undertaken only under strict supervision if required. PPEs such as safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas					

Table 9-2: Environmental and Social Management Plan (ESMP) for Operation Phase of the Project

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
A	**Environmental Issue Associated with Operation of the Power Plant**								
1.1	Land and Soil Environment	• Monitoring of solar PV and WTG operation; • Routine maintenance activities at PV module and WTG locations; • Material handling and storage • Hazardous and Non-hazardous material and waste management	Soil contamination due to improper waste disposal	• The waste generated during operation phase will be disposed of through approved vendors; • The hazardous wastes will be stored onsite at separate designated covered area provided with impervious flooring and send for disposal to nearest designated dumping site; • During the operation phase, the quantity of municipal waste and hazardous waste generated is less and probability of the hazardous waste generation is only during maintenance and therefore occasional. The waste generated would be routed through proper collection and containment; • The water for cleaning purpose of the solar PV modules t remove dust from it is likely to get evaporate or absorbed by the vegetation and soil underneath the solar panel; • The proponent should make a MoU with the local municipality to collect the daily domestic for	Plant management	EHS team designated by EGCB	Site inspection (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				disposing of in the designated dumping site.					
				• Ensure oil/ lubricants are stored on impervious floor in the storage area having secondary containment; • Use of spill control kits to contain and clean small spills and leaks during O&M activities; and • The guidelines and procedures shall be prepared and followed for immediate clean-up actions following any spillages.	Plant management	EHS team designated by EGCB	Internal audit and records (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost
2.1	Waste Generation	• Wastes likely to be generated during routine operations are dielectric fluids, clearing agents and solvents etc; • Repair and maintenance of underground cables and associated utilities will lead to generation of hazardous wastes as used oils;	Contamination of soil, surface and groundwater	• Separate designated area should be earmarked for storage of hazardous waste like waste oil, transformer oil. These wastes shall be given to the DoE approved recyclers. • Operation waste management will be governed by an Environmental Management Plan (EMP) and will incorporate reduction, recycling, and reuse principles. • Material Safety Data Sheets for all applicable materials present	Plant management	EHS team designated by EGCB	Site inspection and record	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
		• Wastewater from PV module cleaning; • The defunct / damaged photovoltaic cells will also be generated; • Domestic liquid and solid waste		on Site will be readily available to on-site personnel. • All wastes produced from project activities on site will be transferred to designated temporary storage areas and where possible into secure containers. • Solid wastes will be segregated to facilitate reuse and recycling of specific materials. • All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal. • First of all, inspection of PV modules for defects that can appear in the form of burn marks, discoloration, or broken glass is to be undertaken. An authorized person will walk the site to confirm that there are no broken modules (shattered glass) and broken modules should not be sprayed with water. • Broken or damaged solar panels are required to be immediately shifted to a designated area in a					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				scrap yard to avoid any type of land contamination. A photograph is to be taken of the broken panel at the site to cater to Insurance settlement claims. • Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer. • Use the soak pit and septic tank in the office building and guard room for sewage.					
3.1	Water Resources	• Water use for PV module and wind turbine rotor blades cleaning; • Water Consumption for domestic use; • Possibility of groundwater level reduction due to compacted	Water availability	• The effect of groundwater water abstraction for project activities will be assessed in detail using field testing and modeling techniques, and accounting for seasonal variability and projected changes in demand in the Project area; • Periodical training need to provide to workers for best utilization of water;	Plant management	EHS team designated by EGCB	Visual Inspection and records of reading of bore well (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
		soil and covered by PV module; • Surface water pollution due to the surface runoff from the project to the drainage network passing through the project site and Choto Feni River; • Surface and groundwater pollution due to the accidental leakage and spills of oil		• Bore-wells should be established after requisite permission from the regulatory authority. Meters should be installed at the bore-wells to monitor the abstraction of water and using low flush urinals; • Wastage of water during cleaning of panels should be avoided; • Drinking water demand should be met by bottle potable water purchased • The wastewater emanating from cleaning operations shall be used for the agriculture and aquaculture pond in the project site and excess water shall be discharged after settling of the sediment; • Appropriate drainage network should be planned in the project site;					
3.2	Water Resources		Water Quality	• The drainage and sewerage system will be provided for the collection and treatment of wastewater at SCADA building/ CMS and substation areas. • No wastewater discharge on open land will be practiced;	Plant management	EHS team designated by EGCB	Visual Inspection and records of reading of bore well (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				• The plant site should be provided with adequate drainage facility to drain-off the rain water and prevent any waterlogging at site or in the surroundings; • No careless attitude in the handling of hazardous waste and oil should be tolerated during plant operation. If any oil spilled out accidentally, it should be cleaned and stored appropriately. • Fuel, oil and used oil storage areas will be contained in bunds of 110 capacity of the stored material.				EHS person of EGCB	
4.1	Air Quality	• Maintenance of vehicles • Transportation during operation and maintenance of the power plant	Air Pollution	• Vehicles traveling on gravel roads should not exceed a speed of 30 km/hr. • Regular water spray is required on unpaved road as the dust not move during heavy wind; • Use clean fuel in vehicle as the exhaust emission will be low	Plant management	EHS team designated by EGCB	Visual Inspection (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost
5.1	Ambient Noise Level	• WTG Operations • Vehicular movement • Noise from inverters and transformers	Increase noise level	• The wind turbines shall be maintained in good running conditions throughout the operational life of the project	Plant management	EHS team designated by EGCB	Visual Inspection and record (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
		• Repair and Maintenance Works of solar panels		through routine maintenance; • Periodic monitoring of noise near to the sources of generation to ensure compliance with design specification; • Maintain the speed limit when car run through the settlement area; • Aware of the unusual horn use;				EHS person of EGCB	
6.1	Ecology	• Glare/Reflection from solar module; • Fatalities of birds and bats due to possibility of collisions with wind turbines blades and electrocution from transmission line; • Hunting and Poaching of mammals and avifauna by the labors or project employees; • Increased risk of fires at the site due to failure of machinery or transmission line	Impact on avifauna	• Solar panels will absorb most of light falling on them which will be then converted to electricity. Thus there will be very less impact due to glare from the panels. The glare is reported to be similar to that of a small water body, which implies insignificant distraction for the avifauna; • Carry out detail birds and bat survey covering the full winter season to understand whether the project site is staging ground for migratory bird; • • Marking overhead cables and transmission poles using detectors and avoiding the use of	Plant management	EHS team designated by EGCB	Visual Inspection and record (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				areas of high bird concentrations, especially IBA area located close to the project site and for species vulnerable to collision. • Where possible, installing transmission cables underground in accordance with existing best practice guidelines for underground cable installation. Otherwise if possible, install overhead cables with proper insulation to avoid bat and bird electrocution through body touch. Install bird detectors on overhead transmission cables at selected points wherever possible. • Some bird reflectors can be fitted at relevant places to divert low-medium and medium-high flying bird species during daytime. • Feasibility of fixing of bird detector on the turbine to avoid perching of birds near blades can be worked out, especially raptor					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				species which prefer to perch at higher points.					
7.1	Visual Impact	Setup of PV module and WTGs	Visual impact due to glare	• The solar panels will be installed at a low height and will be kept closer to the ground so that it does not prop out of the general landscape of the area; • The panels will be arranged in a systematic manner which will give an aesthetic sense to it; • The proposed solar PV and wind hybrid power project would include a boundary wall around the perimeter of the project to further obscure the peripheral view of the project and any indirect reflection. Impacts from glare would be minor; • All cables and power lines will be located underground as far as possible; • The substations, gatehouses and maintenance and storage buildings will be grouped as far as possible to avoid the scatter of buildings in the open landscape; • The design of the buildings will be compatible in scale and form with rural buildings, such as	Plant management	EHS team designated by EGCB	Internal audit and record (Daily Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				farm barns, in the surrounding area; • All yards and storage areas to be enclosed by masonry walls or screens; • Design of wind farm according to the landmark of the site and with sensitivity to the surrounding landscape • Locate the wind farm at least a certain distance from dwellings • Selection of wind turbine design (tower, color) according to landscape characteristics; • Selection of neutral color and anti-reflective paint for towers and blades • The color of the solar array and wind structures, such as the supports and the rear of the panels, will be carefully selected, and to be in the light grey or white colors on turbine, to minimize visibility and avoid reflectivity; • Maintain uniform size and design of turbines (e.g. direction of rotation, type of turbine and tower, and height)					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				• Avoid steep slopes and flat landscapes fit well with turbine distribution in rows, • Low number of large turbines is preferable to many smaller wind turbines • External lighting will be confined to the substations and maintenance areas. Lights will be low-level and fitted with reflectors to avoid light spillage; • Signages related to the enterprise are to be discrete and confined to the entrance gates. No other corporate or advertising signage, particularly billboards or flags, to be permitted; • All lighting will be kept to a minimum within the requirements of safety and efficiency; • Where such lighting is deemed necessary, low-level lighting, which is shielded to reduce light spillage and pollution, will be used; • No naked light sources will be directly visible from a distance.					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				Only reflected light will be visible from outside the Site; • External lighting will use down-lighters shielded in such a way as to minimize light spillage and pollution beyond the extent of the area that needs to be lit; • Security and perimeter lighting will also be shielded so that no light falls outside the area needing to be lit. Unnecessarily tall light poles are to be avoided; • Retain the agricultural use of the area for grazing of livestock as much as possible.					
8.1	Occupational Health and Safety	• Leaching of materials from broken or fire damaged PV modules • Vehicle accidents, replacement of components/parts • Emergency Fire Hazard • Electrocution of workers • Electromagnetic radiation from PV modules	Health risk of the worker	• Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. • Adequate training regarding health and safety will be provided to the workers. • A health, safety, and environment (HSE) management system will be developed, rolled out and implemented. This system which will be reviewed annually or after a major accident or incident	Plant management	EHS team designated by EGCB	Internal audit, meeting with technical and other staff and record (Monthly Monitoring)	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	O&M Cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
		• Working at height for WTGs maintenance		• The switchyard building will be provided with fire extinguishers and sand buckets at all strategic locations to deal with any incident of fire. • Safety incidents will be recorded and monitored with an aim that numbers are never significant, and gradually reduce. • Workers at site handling broken solar panels shall be provided with adequate PPEs (safety gear, goggles, and gloves). • The workers at the site are also on regular basis shall be appraised about the potential health risks associated with the handling of solar panels. • WTGs supplier shall provide instructions and procedures to all the workers involved in service repair of wind turbines, which will consider wind speeds and other external conditions in such a manner that service, maintenance, and repair work on the wind turbine can be performed safely; • All work at height to be undertaken during daytime with					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				sufficient sunlight except emergency (with proper illumination arrangement); • Only workers trained in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment shall be engaged for work at height; • Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. Adequate training regarding health and safety will be provided to the workers; • Access to areas containing exposed electrical equipment (such as transformers) shall be fenced and locked. Warning signs shall be posted at hazardous locations; • Firefighting equipment's such as fire extinguishers and sand buckets shall be provided at appropriate locations; • Workers involved in electric operations shall be provided					

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
				with Protective Equipment rubber gloves etc; • Employees involved in electrical works shall be trained in and familiar with the safety-related work practices, safety procedures, and other safety requirements that pertain to their respective job assignments. • First aid box/ arrangement to be ensured					
9.1	Climate change	Setting up renewable energy based power plant	Positive impact	• The comparison of the GHGs emission caused by solar power plant with the GHGs emission that would have been caused by fossil fuel burned to make the same amount of electricity has been made. Thus the purpose of the project activity is to generate power from zero emissions Solar PV based power project and thereby reduce the emissions associated with the grid. According to the feasibility study, the calculation of the total GHGs emission reduction as 4601362 tCO_2e/year.	-	-	-	-	-

Table 9-3: Environmental and Social Management Plan (ESMP) for Decommissioning Phase of the Project

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
1.1	Environmental, Health and Safety	• Issue of loss of job when the workers will be asked to leave; • Improper disposal of demolition waste and obsolete machinery will lead to contamination of soil, water, and discontent of community; • Demolition activity is anticipated to generate dust and exhaust emissions which can be carried downwind to habitations; • Risks associated with health and safety issues such as trip and fall, electrical hazard etc.;	Impact on human health	• The proponent/developer shall inform the workers and local community about the duration of work; • Dismantling activities will take care of experienced professionals under the guidance of plant EMS Head. • All the dismantled infrastructures and debris shall be segregated and stored separately with cover facility to negotiate with contamination effects of such wastes; • The metal structure will be sold out to the approved recyclers, whereas, debris will be disposed-off as per their characteristics. • The workers shall be clearly informed about the expected schedule and completion of each activity; • All waste generated from decommissioning phase shall be collected and disposed of at the nearest identified disposal site; • All necessary Personal Protection Equipment (PPE)	EGCB	On-site project management team of EGCB	Vehicle maintenance record, accident record, awareness program. Visual inspection and record	Report from designated EHS personnel of Plant Management to designated EHS person of EGCB	Project management cost

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
		• The decommissioning activities of dismantling or removing the solar PV power plant and removing the ancillary facilities can lead to increased noise levels; • Generation of broken panels which is hazardous waste; • Contamination of drainage channels due to release of hazardous waste; and • During the dismantling or removing of the solar PV power plant, with the removal of ancillary facilities, visual intrusions will be likely but their consequence		shall be used by the workers during demolition work; • Solar Panels as utilized for the project even after 20 years will have the 70 – 80% power generation capacity. Due to technology improvement, after 20 years recycling or reutilisation of these panels are very much likely; • During decommissioning phase proponent should follow mitigation measures depicted in the section 5.3.6, 5.3.7. 5.3.9 and 5.3.11 for air, noise, solid & liquid waste and Occupational health and safety respectively; • Water sprinkling would be the regular practice to reduce the dust generation from the plant decommissioning activities. • Disposal panels will be disposed of off to authorized vendor through buyback agreements; • It is to be ensured that dismantling is carried out during the non-monsoon season and all the drainage channels will keep intact by creating bunds around them.				

SL	Project Stage/ Affected Aspect	Project Activity	Proposed Impacts	Proposed Mitigation Measures	Responsibility for Mitigation Implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements	Mitigation Cost Source
		will be negligible due to the fact that such impact would be temporary (over a short period).		• EGCB will be committed to ensuring that all health and safety measures are in place to prevent accidents and reduce the consequences of non-conformance events; • After decommissioning project authority will weed out the seeds of *Leucaena leucocephala* and *Prosopis Juliflora* to make the land fertile in few years.					

9.2 Environmental and Social Monitoring Plan

Environmental and social monitoring is an essential tool for environmental and social management as it provides the basic information for rational management decisions. The purpose of the monitoring program is to ensure that the envisaged purposes of the project are achieved and result in desired benefits to the target population. To ensure the effective implementation of the mitigation measures, it is essential that an effective monitoring program is designed and carried out. Compliance monitoring will be conducted in accordance with the environmental and social mitigation measures and monitoring plan provided with this report (**Table 9-4**).

The objective of environmental and social monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. The main objectives of the pre-construction, construction and operation phase monitoring plans will be to:

- Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project area for indicating the adequacy of the ESIA;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the ESIA;
- Ensure compliance with legal and community obligations including safety on construction sites;
- Ensure the safe disposal of excess construction materials.
- Appraise the adequacy of the ESIA with respect to the project's predicted long-term impacts on the physical, biological and socio-economic environment;
- Evaluate the effectiveness of the mitigation measures proposed in the ESMP and recommend improvements, if and when necessary;

Table 9-4: Environmental and Social Monitoring Plan

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
Construction Phase								
Consultation with affected PAPs	RAP Implementation	Affected PAPs	Affected Households	Monitoring	World Bank	Daily	Consultant	EGCB
External Monitoring	RAP Implementation	Affected PAPs	Affected Households	Monitoring	World Bank	Bi annual	Consultancy Agency	EGCB
Dredge materials	Soil and water pollution of the project and surrounding area	Lead (Pb), Cadmium (Cd), Chromium (Cr), Copper (Cu), Zinc (Zn), Manganese (Mn), Arsenic (As), Selenium (Se), and Mercury (Hg)	Proposed dredging sites	Monitoring	Government of Bangladesh (GoB) and international standard	Once prior to start dredging	Contractor	EGCB
Ambient Air Quality	Dust generation	Dust	Project activity areas, approach road and construction workers camp	Visual inspection of all active work areas	Monitoring	Daily	Contractor	EGCB
	Ambient Air Pollutant	SPM, PM $_{2.5}$, PM_{10}, CO, SO_2, NOx	2 samples Project site and nearest settlement	24-hour	Air quality standard by DOE, Bangladesh	Quarterly	Contractor by 3rd Party Environmental Consultant	EGCB

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq day, Leq nigh and hourly Leq	3 locations Project site at high noise generation location and adjacent sensitive receptor	24-hour	Noise Pollution Control Rules (2006)	Quarterly	Contractor by 3rd Party Environmental Consultant	EGCB
Water Quality	Contamination of surface water	Turbidity, pH, DO, Total dissolved solids, oil & grease, BOD_5, COD	Two samples form Canal	Monitoring	Surface water quality standard as per Schedule 3 of ECR 1997	Half Yearly	Contractor by 3rd Party Environmental Consultant	EGCB
	Contamination of Groundwater quality	pH, Alkalinity, Cl-, Fe, As, TSS, Pb etc	2 Locations Project site and Closest borehole of the project site	Monitoring	Drinking water quality standard as per Schedule 3 of ECR 1997	Half Yearly	Contractor by 3rd Party Environmental Consultant	EGCB
Top Soil	Soil Pollution	• Check liquid waste is carried out by experienced personnel and in proper way • Careful and proper handling of oil and other hazardous liquids	Project Site	Visual inspection of all active work areas	Monitoring	Daily	Contractor	EGCB
Waste	Liquid waste, Solid Waste	• Check storage, transportation,	Project Site	Visual inspection of	Monitoring	Daily	Contractor	EGCB

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
		disposal, handling of hazardous waste • Waste and effluents to be collected and disposed safely of camp. • Wastes and garbage from construction sites to be disposed safely		all active work areas				
Ecology	Terrestrial and aquatic flora and fauna	• Tree and Aquatic Species	Canals and vegetation clearance for approach road construction	Tree count and visual inspection	Monitoring	Once for tree prior to starting construction and yearly aquatic monitoring	Contractor	EGCB
Occupational Health and Safety	Workers Health & Safety	• Check quality of food and accommodation at construction camp; • Check safe water supply, hygienic toilet	Construction Camp & Construction area	Visual inspection of all active work areas	Monitoring	Daily	Contractor	EGCB

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
		at camp, construction of drain at campsite; • Check toilets are close to construction site; • First Aid Box with required tools and medicines; • The heavy construction material to handled and stored safely putting due care on public safety; • Heavy construction materials at construction site to be stored and handled safely; and • Check of personal protective equipment						

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
		(PPE) for worker at the sites						
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents, and complaints	Approach Road	Incidents, accidents, and community complaints	Monitoring	Based on occurrence	Contractor	EGCB
Operational Phase								
Noise	Increase in ambient noise levels	Noise levels in Leq, Leq day, Leq nigh and hourly Leq	3 locations Project site at high noise generation location and adjacent sensitive receptor	24-hour	Noise Pollution Control Rules (2006)	1/year (5 years)	O&M Unit by 3rd Party Environmental Consultant	EGCB
Water Quality	Contamination of surface water	Turbidity, pH, DO, Total dissolved solids, oil & grease, BOD_5, COD	Canals inside the project area	Monitoring	Surface water quality standard as per Schedule 3 of ECR 1997	1/year (5 years)	O&M Unit by 3rd Party Environmental Consultant	EGCB
	Contamination of Groundwater quality	pH, Alkalinity, Cl-, Fe, As, TSS, Pb etc	2 Locations Project site and Closest borehole of the project site	Monitoring	Drinking water quality standard as per Schedule 3 of ECR 1997	1/year (5 years)	O&M Unit by 3rd Party Environmental Consultant	EGCB
Soil Quality	Soil Pollution	Heavy Metal	Project site soil	Monitoring	-	1/year	O&M Unit by	EGCB

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
						(5 years)	3rd Party Environmental Consultant	
Occupational health and safety	Electromagnetic fields	Occurrence of incidence	Power plant site	Internal audit, meeting with technicians and other staff	Audit	Monthly	Operation & Maintenance Unit/EHS cell of EGCB	EGCB
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents, and complaints	Approach road	Incidents, accidents, and community complaints	Monitoring	Based on occurrence	Operation & Maintenance Unit/EHS cell of EGCB	EGCB
Disaster Management Plan (DMP) Monitoring	Earthquake	Structure Design	Project Area	As to be defined in the DMP to be prepared contractor	Not Specific	Continuous	Operation & Maintenance Unit/EHS cell of EGCB	EGCB
	Flooding	Structure Design	Project Area	As to be defined in the DMP to be prepared contractor	Not Specific	Continuous	Operation & Maintenance Unit/EHS cell of EGCB	EGCB
	Cyclone /Tornado	Project Structure Design	Project Area	As to be defined in the DMP to be prepared contractor	Not Specific	Continuous	Operation & Maintenance Unit/EHS cell of contractor	EGCB

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
CSR Activities	Community Development	Activities/ Programmes and No. of beneficiaries	Neighboring communities around the Project activity areas	No. of beneficiaries and outcome of the activities	Not Specific	Periodic and need-based	Admin/ HR Manager and Station Manager	EGCB
Decommissioning Phase								
Top Soil	Soil Pollution	• Check liquid waste is carried out by experienced personnel and in proper way • Careful and proper handling of oil and other hazardous liquids	Project Site	Visual inspection of all active work areas	Monitoring	Daily	Contractor	EGCB
Waste	Liquid waste, Solid Waste	• Check storage, transportation, disposal, handling of hazardous waste • Waste and effluents to be collected and disposed safely of project site.	Project Site	Visual inspection of all active work areas	Monitoring	Daily	Contractor	EGCB

Project Stage/ Affected Component	Environmental /social Issue	Parameters to be Monitored	Location	Measurements	Standards/ Guidelines	Frequency	Responsible Agency	
							Implemented by	Supervised by
		• Wastes and garbage from sites to be disposed safely						
Occupational Health and Safety	Workers Health & Safety	• Trip and Fall, electrical hazard	Demolition area	Vehicle maintenance record, accident record	Monitoring	Daily	Contractor	EGCB
		• Waste Generation	Demolition area	Visual inspection	Monitoring	Daily	Contractor	EGCB
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents, and complaints	Access road	Incidents, accidents, and community complaints	Monitoring	Based on occurrence	Contractor	EGCB

9.3 Environmental and Social Monitoring Budget

The estimated budget for implementation of the mitigation and monitoring measures proposed in the ESMP is presented in **Table 9-5**.

The overall costs of the ESMP will comprise:

- Environmental monitoring through sample collection and analysis;
- Any remedial measures necessary to reduce or avoid environmental damage;
- Designing and implementing all mitigating and enhancement measures;

The construction stage budget is **BDT 48, 40,000/year** and the Operation stage budget is **BDT 13, 50,000/year.** This budget does not include the decommissioning stage since the minimum operation period is 20 year and the rate will vary largely from the present cost.

Table 9-5: Environmental Budget for 50 MW Solar photovoltaic (PV) Power Plant Project

Component	Item	Location	Unit	Quantity	Rate (in BDT)	Amount (BDT)
A. CONSTRUCTION STAGE (PER YEARS)						
Consulation with PAPs	Affected PAPs	-	No.	6	300,000	1800,000
External Monitoring	Affected PAPs	-	-	-	Ls	1500,000
Dredge Materials for Dike construction	Dredge materials quality measurement	1	No.	1	100,000	100,000
Air Quality	Measuring air quality	2	No.	8	40,000	320,000
Noise	Measuring ambient noise level	3	No.	12	10,000	120,000
Water Quality	Surface water quality measurement	2	No.	4	50,000	200,000
	Groundwater quality measurement	2	No.	4	50,000	200,000
Waste disposal and management	Disposal and management of construction waste	Project Site	Lump sum	-	100,000	100,000
Aquatic ecology	Aquatic survey	Canal within the project site	Lump sum		3,00,000	300,000
Contingency	-	-	Lump sum			200,000
SUB TOTAL (A)						**48,40,000**
B. OPERATION STAGE – (PER YEAR)						
Noise	Monitoring ambient noise level	3	No.	3	10,000	30,000
Water	Monitoring surface water quality	2	No.	2	50,000	100,000
	Monitoring ground water quality and levels	2	No.	2	50,000	100,000
Soil Quality	Heavy Metal	1	No.	1	100,000	100,000

Component	Item	Location	Unit	Quantity	Rate (in BDT)	Amount (BDT)
Health and safety	Internal audit and training	1	No.	12	50,000	600,000
Training	Environmental training and awareness	-	Lump sum	As per training details	-	200,000
Contingency	-	-	Lump sum	-	-	200,000
SUB TOTAL (B)						**13,50,000**
GRAND TOTAL (A+B)						**61,90,000**

9.4 Institutional Setting and Implementation Arrangement

The ESMP (mitigation plan) will be included in the construction contract and the contractor will be responsible for implementation of the measures associated with design and construction. The EGCB's staff, specifically the EHS Officer and Site Engineer, will monitor the implementation of these mitigation measures by the contractors at the site. These two officers will be responsible for the field level monitoring of the Project.

The roles and responsibilities of the EGCB and EPC Contractor for implementation and monitoring have been outlined in **Table 9-6**. The flow diagram depicting the institutional arrangement for implementation of the ESMP is presented in **Figure 9-1**.

Table 9-6: Roles and Responsibilities of EGCB and EPC Contractor

EGCB	EPC Contractor
Obtaining statutory clearances required during pre-construction stage of the Project	Obtaining permits required during the construction stage
Overall project coordination and management through EPC and supported by the third party environmental consultant/s	Joint verification with EGCB and Third Party Environmental Consultant for review of ESMP implementation
Interaction and reporting to the respective department of GOB	Interaction with EGCB and appointed supervision consultant, if any
Interaction and reporting to lenders	Filling of reporting formats as per the reporting schedule and submission to EGCB
Effective implementation of ESMP and monitoring of ESMP implementation	Environmental monitoring through Third Party Environmental Laboratory
Carry out verification/ supervision exercises during the construction phase of the Project for implementation of ESMP	Preparation of various plans for effective implementation of ESMP as detailed out in the "Specification Manual" by the EGCB
Keeping records of all permits obtained by EPC Contractor	Identification of site for labor camp, batch mix plant, laydown areas
Overall supervision of ESMP implementation	Management of labor camp and to provide drinking water, sanitation facility
Approval of plans prepared by EPC Contractor	
Addressing grievances of local community and information dissemination	
Environmental monitoring through laboratory	

While the contractor or a particular party is responsible for physical implementation of the mitigating measures, the whole implementation process requires supervision, checking, documentation, and verification so that problems are identified and properly addressed before they get out of hand. In order to ensure proper execution of the EMP, implementation

reviews will be conducted by the project engineer such as the weekly construction meetings, construction log book, monthly and other construction reports etc.

Records of these minutes of the weekly meeting, monthly reports and special reports on the implementation of the mitigating measures will also be maintained and available for review by the Project management. It is suggested to identify documents and records that require templates and accordingly suitable templates shall be developed, which shall include but not limited to policies, procedures and work instructions, meeting minutes, monitoring results, training attendance records, emergency contact lists, action plans etc. Further, all these templates shall be communicated to all potential users. All these records will be archived at the Project office and will be maintained by the EHS officer. All documents and records shall be archived with a unique identifier so that they can be distinguished from any other material and can be easily retrieved. EGCB will document the process for creating, allocating and approving unique identifiers and will communicate this to relevant staff.

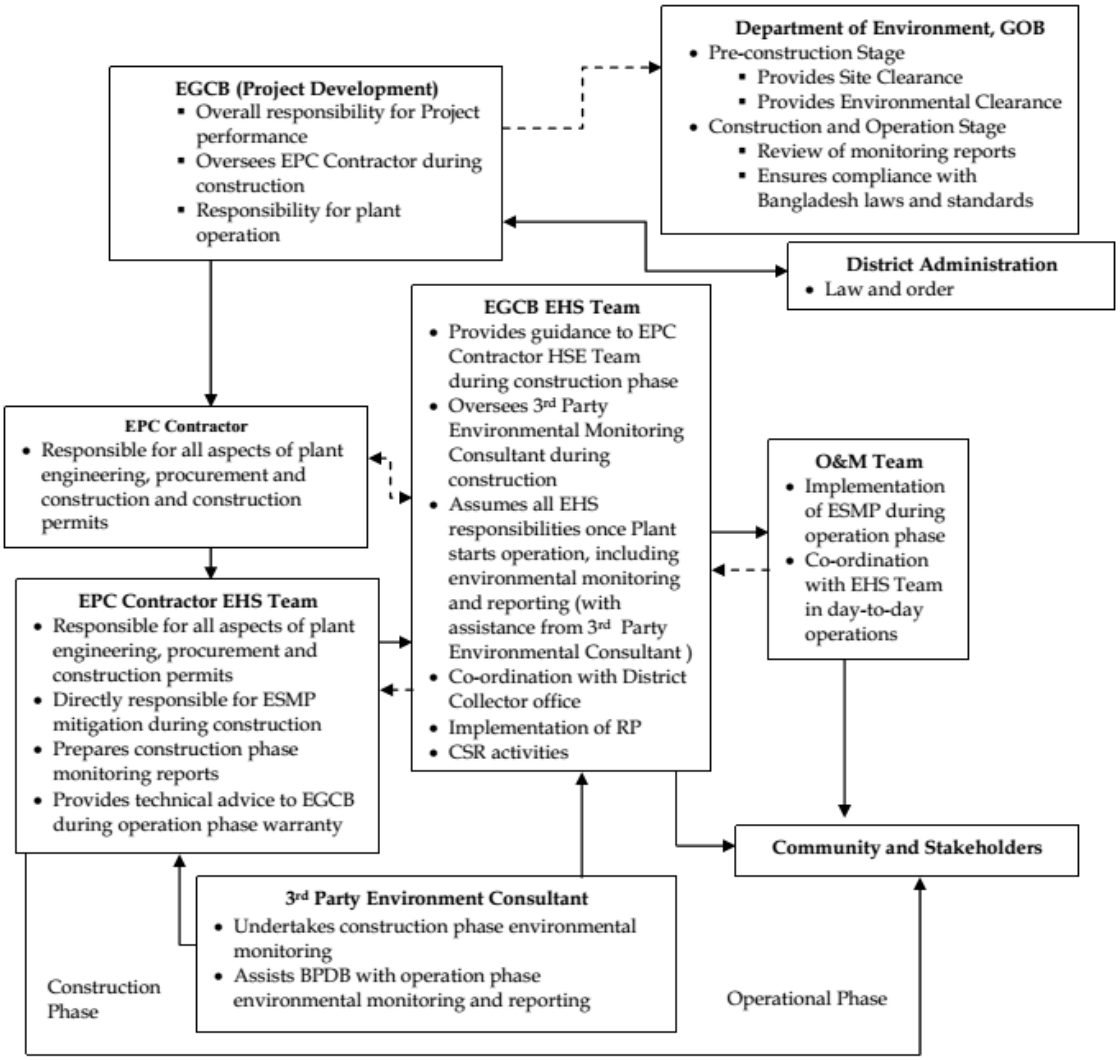


Figure 9-1: Organization Chart for Environmental and Social Management and Reporting Responsibilities during Construction and operation phase of the project

9.5 Waste Management Plan

All project generated wastes will need to be managed and disposed of in a manner to prevent potential impacts on the environment and risks to human health. A Waste Management Plan (WMP) for the proposed project has been developed.

9.5.1 Objectives

The construction and operation of the proposed project will generate various type of waste which will need appropriate collection, transportation, primary treatment, and disposal. Hence, to serve the purpose, a Waste Management Plan has been formulated to demonstrate:

- Inventorisation of waste in different type of categories like garbage, rubbish, hazardous, waste etc.;
- Maintain the site in a clean and tidy state to reduce the attraction of pest species, impacts on the local environment and negative impacts on visual amenity; and
- The suggestion of options for waste handling and disposal during construction and operation phase of the project

9.5.2 Scope

This plan shall be applicable to the EPC contractor engaged by EGCB for the construction phase of the proposed project. The elements of the plan will be directly implemented by the contractors hired by the EGCB. The Plan also identifies the individuals currently assigned to the various roles designated in this Plan.

9.5.3 Roles and Responsibilities

Site Supervisor of EPC Contractor

Site Supervisor will be responsible for the following activities:

- Management of onsite waste generation associated with construction works to help avoid excessive generation where practicable;
- Maintaining of all records of waste type which are construction waste and debris, hazardous waste;
- Laisioning with government approved vendors for disposal of hazardous waste generated;
- Renewal and Management of Buy Back Agreements for defunct solar panels with the Manufacturers; and
- To have authorization for hazardous waste generation and storage granted by the government in place.

EHS Manager of EPC Contractor

The following responsibilities are entrusted to the EHS Manager:

- Demarcation of area within the module area for keeping of segregated wastes;
- Labelling of the drums containing hazardous wastes like used oil;
- Maintaining of receipts for hazardous waste management records;
- Notifying the Site Supervisor of any activity that may generate a large amount of waste to allow appropriate controls to be put in place to manage waste generated; and

- Ensure safe transportation of defunct solar panels as per specified procedures.

9.5.4 Waste Types and Quantities Generated

All wastes generated from the project will be categorized as either non-hazardous or hazardous following an assessment of the hazard potentials of the material, in line with local and national requirements.

9.5.4.1 Construction Phase

The waste will generate from construction activities like site clearing, leveling etc. Other categories of waste will be produced daily and comprise of the following:

- Scrap metal;
- Soil waste;
- Food waste from kitchen premises of labor camps;
- Construction debris; and
- Sewage from temporary toilets;

The construction and decommissioning phases will require the use of hazardous materials such as diesel or petrol to cater the fuel equipment and vehicles and maintain equipment. The following hazardous wastes will also be produced from construction activities.

- Oily rags;
- Used oil and oil filters - from generators or vehicle maintenance; and
- Scrap and packaging material

9.5.4.2 Operation Phase

Operations and maintenance of the PV power facility are not expected to generate any significant amount of waste. PV panels, array enclosures, and inverter/transformer enclosures will not produce waste during operation except the following:

- Defunct solar panels;
- Broken solar panels generated during cleaning and other maintenance activities;
- Fuel requirements like greasing, transformer oil etc.
- Used oil; and
- Oily rags

9.5.5 Waste Handling, Management, and Disposal

Construction Phase

All wastes produced from the project activities on site will be temporarily stored in designated waste storage areas. All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal. Following steps will be taken to manage the waste generated during construction phase:

- Fuel will be stored on-site in temporary aboveground storage tanks and will be stored in a locked container within a fenced and secure temporary staging area;
- Trucks and construction vehicles will be serviced off-site;

- All concrete mixing be undertaken on impermeable plastic lining to prevent contamination of the soils and surrounding areas;
- Food waste and other refuse are to be adequately deposited in sealable containers and removed from the kitchen frequently to avoid accumulation;
- The use, storage, transport and disposal of hazardous materials used for the project will be carried out in accordance with all applicable regulations;
- All hazardous waste to be disposed of off to government approved vendors;
- Material Safety Data Sheets for all applicable materials present on site will be readily available to onsite personnel;
- All construction debris will be placed in appropriate on-site storage containers and periodically disposed of by a licensed waste contractor;
- The construction contractor will remove refuse collected from the designated waste storage areas at the site at least once a week and
- Empty fuel containers will also be stored at a secured area designated for scrap and sold to authorized vendors. All packaging material will also be collected at the storage area and sold to scrap dealers.

Operation Phase

Damaged cells would need to be characterized and managed as hazardous waste. Following measures to be taken for management of waste:

- EPC Contractor need to have buyback agreements for defunct solar panels;
- A designated area needs to be demarcated within the module premises for storage of defunct and broken solar panels with restricted access and on impervious surface;
- All fuel storage should be equipped with secondary containment and spillage trays;
- It is to be ensured that authorization for hazardous waste storage and generation has been taken from government;
- All used oil is required to send off to government approved vendors and recyclers; and
- Transportation of defunct solar panels is required to be undertaken as per the procedures specified by the Manufacture of Solar Panels.

Table 9-7: Handling of Broken Solar Modules generated due to cleaning and other maintenance activities

Impact	Mitigation Action	Monitoring Frequency	Responsibility
Land Contamination (Soil Quality)	• Broken or damaged solar panels are required to be shifted to a designated area in a scrap yard to avoid any type of land contamination. • The designated area should be isolated and to be	Continuous A separate storage yard to store broken solar panels are required to be established	EHS Team of contractor (EHS Manager and Safety Officer (s))

	established on an impervious surface. • A photograph is to be taken of the broken panel at the site to cater to Insurance settlement claims		
Risk on health of workers	• Proper PPE is provided to the workers handling the broken solar panels. • The workers at site are also on regular basis appraised about the potential health risks associated with handling of solar panels.	Continuous	EHS Team of contractor (EHS Manager and Safety Officer (s))

9.6 Occupational Health and Safety Plan

The section below presents an overview of the potential occupational health and safety risks including the potential disasters on the proposed project. It defines the various risks involved during the construction and operation phase of the project. The occupational health and safety plan (OHSP) will address the following:

- Evaluation and Identification of hazards;
- Elimination and removal of hazards;
- Control of Hazards which cannot be eliminated; and
- Recovery from accidents.

9.6.1 Purpose and Scope

This OHSP is provided as a guidance document for identifying the potential risks involved during construction and operation phase of the proposed project. This plan provides guidance with respect to occupational risks and disasters which aims to achieve the following:

- Identification of hazards, associated risks and control measures for each activity;
- Defining responsibilities to ensure effective implementation of health and safety (H&S) risk control measures;
- Avoid and/or minimize the impacts on workers and local communities' health due to various project activities;
- Provide and maintain safe working procedures and operations for workers; and
- Reduce human injury and damage to property and environment in case of an emergency.

9.6.2 Definitions

Competent Person: any person having the knowledge, training, and experience specific to the work or task being performed.

Confined Space: "Confined space" means a compartment of small size and limited access which by its small size and confined nature can readily create or aggravate a hazardous exposure.

Emergency: An unforeseen occurrence, a sudden and urgent occasion for action

First aider: A person who has received training and who holds a current first aid certificate from an organization or employer whose training and qualification for first aiders are approved by the authority.

Hazard: A source, situation or act with a potential for harm in terms of:

- Ill Health
- Damage to property, plant, ships etc
- Production losses or increased liabilities

Hazardous Substance: The term "hazardous substance" means a substance which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritant, or otherwise harmful is likely to cause injury.

Health and Safety Plan: A documented plan which addresses hazards identified and includes safe work procedures to mitigate, reduce or control the hazards identified.

Hot Work: The term "hot work" means riveting, welding, burning or other fire or spark producing operations.

Incident: An event or occurrence occurring at work or arising out of or in connection with the activities of persons at work, or in connection with the use of plant or machinery.

Risk: the probability that injury or damage will occur

Safe: free from any hazard

9.6.3 Roles and Responsibilities

Site Supervisor of EPC Contractor

The Site Supervisor is responsible for overall management of the project and EMP implementation. The following tasks will fall within his/her responsibilities:

- Monitor site activities on weekly basis for compliance;
- Supervise the performance of the work being carried out within the project boundary;
- Conduct internal audits of the construction site against the EMP;
- Confine the construction site to the demarcated area; and
- Keeping a check on operation and maintenance services of solar project components required during the operation phase.

EHS Manager of Contractor

The duties of an EHS Manager shall include the following:

- Ensure that the operations at the facility are in compliance with EHS requirements at all times;

- Conducting HS&E Audits on regular basis & advice management for necessary action;
- Maintaining first aid facilities and personal protective equipment as demanded by the nature of the work/Material Safety Data Sheets;
- Review of investigation of all type of accidents & Reporting to Site Supervisor;
- Training of workers and ensuring that they are issued with adequate instructions and creating awareness of safe work practice among them;
- Carrying out Job Safety Analysis to determine" Hazards of the operations/activity" and facilitating suitable solutions;
- Liasoning with members of EHS on a regular basis to ensure that all Local/National Health & Safety requirements are met; and
- Participate in the preparation of, all Safety instructions, procedures and activities.

Safety Officer(s)

The EPC shall ensure the appointment of safety officer(s) for employees and workers working at the site, to:

- review the effectiveness of health and safety measures;
- identify potential hazards and potential major incidents;
- in collaboration with his employer, examine the causes of incidents;
- investigate complaints by any employee /workers relating to that their health or safety on the site;
- inspect the site with a view to, the health and safety of employees, at regular intervals;
- participate in consultations with inspectors at the workplace and accompany inspectors on inspections of the workplace; and
- Participate in any internal health or safety audit.

The client shall ensure the provision of necessary assistance, facilities and training to carry out the functions of a health and safety representatives established above.

First Aider

- Initial emergency response resuscitation and stabilization of critically ill or injured personnel;
- First Aid of non-emergency medical conditions;
- Management and administration of medical services, supplies, nurse activities and patient records;
- Implementation of site health plans and preventive medicine activities including first aid training of employees and workers; and
- Undertake a regular health and hygiene inspections.

Employees/Workers

- Use the correct tools and equipment for the job; use Safety equipment and protective equipment/clothing supplied, e.g. Safety helmets, shoes, harness, goggles, etc.; and
- Report all defects in plant or equipment to health and safety representatives.

9.6.4 Creating and Maintaining a Safe and Healthy Work Environment

The EPC shall with respect to the site and the construction works that are contemplated:

- cause a preliminary hazard identification to be performed by a competent person before commencing any physical construction activity;
- evaluate the risks associated with such work constituting a hazard to the health and safety of such employees and the steps that need to be taken; and
- As far as is practicable, prevent the exposure of such employees to the hazards concerned or, where prevention is not reasonably practicable, and minimize such exposure.

The client shall ensure that:

- all practicable steps are taken to prevent the uncontrolled collapse of any new or existing structure or any part thereof, which may become unstable or is in a temporary state of weakness or instability due to the carrying out of construction work; and
- no structure or part of a structure is loaded in a manner which would render it unsafe.

The client shall carry out regular inspections and audits to ensure that the works are being performed in accordance with the requirements of this specification.

9.6.5 Risk Assessment

EPC shall before the commencement of any work on site and during construction work, cause a risk assessment to be performed by a competent person appointed in writing. Such an assessment shall as a minimum:

- identify the risks and hazards to which persons may be exposed to;
- analyze and evaluate the identified risks and hazards;
- document a plan of safe work procedures, including the use of any personal protective equipment or clothing and the undertaking of periodic "toolbox talks" or inductions before undertaking hazardous work, to mitigate, reduce or control the risks and hazards that have been identified;
- provide a monitoring plan; and
- Provide a review plan.

Risk assessment is an important step in protecting workers. It helps to focus on the potential risks in a particular workplace. Workers and others have a right to be protected from harm caused by a failure to take reasonable control measures. The following four steps are recommended:

1. Identify the hazards by expected harm, discuss with workers and employees actually working at site, check manufacturer's instructions or data sheets for chemicals and equipment, review accident and ill- health records, long-term Hazards to health (e.g. high levels of noise or exposure to harmful substances) as well as safety hazards etc.;
2. Identify who may be harmed and how by identifying how employees/workers

might be harmed i.e. what type of injury or ill health might occur;
3. Evaluate the risks and decide on precautions to protect people from harm Consider if the hazard can eliminated, and controlled so that harm is unlikely, organize work to reduce exposure to the hazard; provide personal protective equipment (e.g. clothing, footwear, goggles etc.);
4. Provide welfare facilities (e.g. First aid and washing facilities for removal of contamination); and
5. Record the findings by writing down the findings of the risk assessment.

9.6.6 Training

Site Supervisor of the contractor shall ensure that every employee/worker (direct or contractual) is aware of the EHS risks associated with the work being carried out at the site and is trained and competent in the relevant work practices and maintenance procedures.

EPC Contractor should establish procedures to identify training needs and provide adequate safety training for all levels of employees. The safety training should provide staff with the knowledge and skills necessary for organizing and managing occupational safety and health programmes; team leaders with leadership skills and knowledge to lead, implement and apply occupational safety and health activities; and workers with the knowledge, skills and right attitudes to enable them to work safely.

Table 9-8: Proposed Training Modules

Sl.	Training	Frequency	Description	Responsibility
1.	Induction Training on Health and Safety covering the following: • HSE policy; • Hazards and risks associated with operation and workplace; • Control measure to eliminate or minimise HSE risks, including safe working systems and procedures; use of personal protective equipment; action to be carried out during emergency; • Emergency response procedures, such as firefighting and evacuation procedure	-	All staff and contractor workers at the time of joining/engagement	EHS Manager of the EPC Contractor
2.	Tool Box Training or pre-task briefings, highlighting hazards and the method of dealing with them	Daily	Held at each work location by head of the contractor to discuss day's	Contractor Supervisor

Sl.	Training	Frequency	Description	Responsibility
			activities and specific hazards	
3.	Worker Safety Training	Fortnightly	Review safety performance for week Discuss safety for upcoming operations	Contractor Supervisor
4.	Group Training	Monthly	Presentation of significant safety issues	EHS Manager
5.	Special Job Hazard Training including entry into confined space and other hazardous environment	Half Yearly	Training about safety measures to be incorporated related to specific jobs	EHS Manager
6.	Safety Bulletins	Weekly	Specific issues Visible through job site for constant awareness	EHS Manager
7.	Fire Safety	Half Yearly	Presentation of fire safety measures	EHS Manager
8.	Emergency Response	Half Yearly	For emergency preparedness	EHS Manager
9.	First Aid	Half Yearly	For emergency preparedness	EHS Manager
10.	Use of Personal Protective Equipment	Half Yearly	For workplace safety	EHS Manager and Contractor Supervisor

9.6.7 Documentation and Record Keeping

Site Supervisor of the EPC should maintain data and records concerning the identification of hazards, assessment, and control of risks of the ongoing activities. The document should establish and maintain procedures for controlling all relevant EHS documents and data. Such documents can include but not limited to:

- EHS Policy;
- Hazard Identification Records;
- Risk Register;
- Legal Register;
- Licenses, Certificates, Permits;
- Control Methods including process control and machine design, safe work procedures, in-house work rules;
- Design Drawings;

- Organisation Structure;
- HSE group meeting records;
- Training Records;
- Drill Reports;
- Inspection and Audit Records; and
- Medical and Health Surveillance Records

9.6.8 Communication and Information Dissemination

EPC Contractor should communicate and inform any persons affected by the risks of:

- The nature of the risks involved; and
- The control measures or safe work procedures to be taken to address the risks involved.

Review

The risk assessment should be reviewed and revised upon the occurrence of any injuries to any person as a result of exposure to a hazard in the workplace; or where there is a significant change in work practices or procedures.

9.6.9 Safe Work Practices

Construction and operation of a solar power project involve many on job hazards which need to be identified and eliminated or minimized to an expectable level in order to achieve a safe and healthy work environment. For a solar power plant involved in the generation of clean and green electricity, safe working practices should be established for works including but not limited to the following:

- Falls
- Lockout/Tagout (LOTO)
- Crane and Hoist Safety
- Electrical
- Heat/Cold Stress
- Personal Protective Equipment

Falls

Workers, who install and/or maintain solar panels often work on roofs, use ladders and scaffolding, are in proximity to ledges, and are exposed to fall hazards. Construction workers involved in the installation of solar panels exposed to fall distances of 6 feet or more must be protected from falls by using one of the following methods:

- Guardrail Systems
- Safety net Systems
- Personal fall arrest systems

Workers should never be allowed to climb ladders while carrying solar panels. Lifting equipment, such as ladder hoists, swing hoists, or truck-mounted cranes/conveyors, should be used wherever possible.

Maintenance workers working on solar panels when exposed to fall hazards of 4 feet or more must be protected by a standard railing. If such a railing is not possible then the workers must be protected by a fall protection device such as a personal fall arrest system or a safety net.

Lockout/Tagout (LOTO)

LOTO refers to specific practices and procedures to safeguard employees from the start-up of machinery and equipment, or the release of hazardous energy during service or maintenance activities.

Many workers face the greatest risk of injury if lockout/tagout is not properly implemented. Compliance with the lockout/tagout standard prevents an estimated 120 fatalities and 50,000 injuries each year. In a study conducted by the United Auto Workers (UAW), 20% of the fatalities (83 of 414) that occurred among their members between 1973 and 1995 were attributed to inadequate hazardous energy control procedures specifically, lockout/tagout procedures.

Solar energy equipment can generate electrical energy and may be connected to electrical circuits. Workers may be exposed to electrical hazards from solar panels and from electrical circuits. While installing or servicing solar panels, employers should assure that workers cover the solar panels, in addition to protecting workers from electrical circuits. Workers performing servicing or maintenance of solar panels may be exposed to injuries from the unexpected energization or release of stored energy in the equipment.

The following are some of the significant requirements of a Lockout/Tagout procedure required under a Lockout/Tagout program.

- Only authorized employees may lockout or tagout machines or equipment in order to perform servicing or maintenance;
- Lockout devices (locks) and tagout devices (tags) shall not be used for any other purposes and must be used only for controlling energy;
- Lockout and Tagout devices (locks and tags) must identify the name of the worker applying the device;
- All energy sources to equipment must be identified and isolated;
- After the energy is isolated from the machine or equipment, the isolating device(s) must be locked out or tagged out in safe or off position only by the authorized employees;
- Following the application of the lockout or tagout devices to the energy isolating devices, the stored or residual energy must be safely discharged or relieved;
- Prior to starting work on the equipment, the authorized employee shall verify that the equipment is isolated from the energy source, for example, by operating the on/off switch on the machine or equipment;
- Lock and tag should not be removed from the machine until the work is completed; and
- Only the authorized employee who placed the lock and tag must remove his/her lock or tag.

Electrical

Solar energy workers are exposed to potential electrical hazards present in their work environment, which makes them more vulnerable to the danger of electrocution and arc flash hazards. Workers may be exposed to electric shocks and burns when hooking up the solar panels to an electric circuit.

Workers must pay attention to overhead power lines and stay at least 10 feet away because they carry extremely high voltage. Fatal electrocution is the main hazard, but burns and falls from elevations can occur while installing solar panels. Another hazard is from using tools and equipment that can contact power lines.

Heat/Cold Stress

Solar energy workers often work in very hot weather where hazards include dehydration, heat exhaustion, heat stroke, and death. Employers should monitor employees and workers should be trained to identify and report early symptoms of any heat-related illness. Workers may also be exposed to extremely cold weather conditions and should be protected from such conditions.

Heat Stroke occurs when the body's system of temperature regulation fails and body temperature becomes abnormally high. Some of the signs and symptoms of heat stroke are:

- Confusion;
- Loss of consciousness;
- Convulsions;
- Lack of sweating (usually) hot, dry skin; and
- Very high body temperature

If a worker shows signs of possible heat stroke, medical treatment should be obtained immediately. While waiting for medical help, the worker should be:

- Placed in a shady area and the outer clothing should be removed;
- The worker's skin should be wetted and air movement around the worker should be increased; and
- Fluids should be replaced as soon as possible.

The signs and symptoms of heat exhaustion are:

- Headache;
- Nausea;
- Vertigo;
- Weakness;
- Thirst; and
- Giddiness.

Workers suffering from heat exhaustion should be removed from the hot environment and given a fluid replacement. They should also be encouraged to get adequate rest.

Protective Equipment (PPE)

Using personal protective equipment is often essential, but it is generally the last line of defense after engineering controls, work practices, and administrative controls. Solar energy employers must assess their workplace to determine if hazards are present that require the use of protective equipment. Solar energy workers can be exposed to many hazards that may require the use of safety glasses, hard hats, gloves, respirators, or other personal protective equipment used to protect against injuries and illnesses. Workers exposed to potential electrical hazards must be provided with appropriate electrical protective equipment, and workers must use them. Electrical protective equipment must be maintained in a safe and reliable condition. They must be periodically inspected or tested for their workability.

9.6.10 General Working Conditions

Housekeeping

- Work areas should be maintained in a neat and orderly condition;
- Scrap material, such as rags, bolts, and wedges should not be allowed to accumulate in the site area;
- Spills of oil, grease, paint and other slippery substances should be cleaned up immediately;
- Walkways should be kept clear of tripping hazards at all times;
- All personal protective equipment required for a procedure or production area must be properly fitted and worn;
- Maintain a free access to all safety equipment including firefighting equipment, electrical panels, and boxes, etc.;
- Scaffolding and ladders; etc. must be secured;
- Proper barricades, safety rings, and safety wires should be used for openings, manholes, etc. Barricades must be properly lighted for visibility;
- Operating equipment, tools or machinery without proper guards and/or signaling devices is prohibited;
- Observe all warning signs in the yard; and
- Before leaving the job, always check the area for any sparks or smoldering materials.

Ventilation

- Adequate Local Ventilation (with filtration/mitigation arrangements where required) is to be arranged in connection with all types of works involving injurious or irritating gases/smoke/ fumes, which may occur or may form while the work is going on; and
- Ventilation is to start up before work commences; a check is to be made by the EHS Manager;

First Aid

- All work areas must be provided with adequate first aid facilities with a trained first aider during working hours; and
- The developer must provide or ensure that there is the provision of adequate and appropriate facilities for enabling first aid to be rendered to their employees if they

are injured or become ill at work.

9.7 Construction Labour Management Plan

The proposed 50 MW solar power project is in its preliminary phase of execution. It is envisaged that during the construction phase of the project, laborers for various jobs such as civil, mechanical and electrical works will be hired through authorized manpower agencies. The labor requirement will range from 100-150 workers during normal operations which can reach up to 150 workers during peak construction activities. Therefore, it is also envisaged that many of the laborers will be employed from outside the region and will, therefore, be migrant laborers and hence, accommodation will be provided. These migrant laborers will be accommodated in a temporary campsite within the project area. The construction of power plant can lead to increase in migrant labor at a given point of time. This could result in stress on local resources, disruption in community relations, and movement of labors.

A Construction Labour Management Plan has been developed in conformity with the requirements of the International industry practice provided in the IFC/EBRD Good Practice Note on Worker Accommodation. Construction Labour Management Plan can be changed based on project needs but it must meet the requirements of IFC/EBRD Good Practice Note.

9.7.1 Objectives

The influx of migrant labor will have both negative and positive impacts on the nearby community and local environment. The labor will be accommodated in temporary campsite within the project boundary which can have significant interface with the nearby community. However, the influx of migrant workers would lead to a transient increase of population in the immediate vicinity of the project area for a limited time. This would put pressure on the local resources such as roads, fuelwood, water etc.

Hence, a plan has been designed to demonstrate the:

- Potential impacts associated with influx on the host population and receiving environment are minimized;
- Provision of safe and healthy working conditions, and a comfortable environment for migrant labor; and
- To ensure compliance with the national labor laws;

9.7.2 General Requirement

All migrant workers are envisaged to be accommodated in temporary campsite within the project area. If migrant workers are accompanied by their families, provisions should be made accordingly. Guidance on Workers Accommodation developed by IFC/national labor law is also referred for the inclusion of requirements for labor camp to be established by the developer during the construction phase of the project. EPC shall ensure implementation of the following measures to minimise the potential negative impacts of worker accommodation and workers on local communities:

Cleanliness: Pest extermination, vector control, and disinfection are to be carried out throughout the living facilities in compliance with local requirements and/or good practice.

Complaints and incident reporting: A formal Complaints Procedure will be implemented to ensure timely and transparent response to complaints as received from labor.

Labour education: The workforce will be sensitized to local social and cultural practices through provision of an induction course for all employees that stipulates expected behavior;

Labour behavior in campsite provided: A Code of Behaviour governing appropriate behavior in the accommodation facilities to be kept in place and to be strictly enforced. The contractor shall ensure implementation of the "rules of engagement" between labors living in campsite and community and shall be implemented by construction contractors for all engaged labors.

Labour Compensation and Accommodation: Client shall ensure that labors are provided with benefits such as annual leave, weekly rest day, etc. Accommodation to be provided for the construction labor which covers facilities (including catering facilities, dining areas, washing and laundry facilities etc.) and supporting utilities.

9.7.3 Hiring and Recruitment Procedure

The manpower contractor shall, wherever possible, locally recruit the available workforce and shall provide appropriate and requisite on job and EHS training as necessary. The following general measures shall be considered for the workforce during their employment tenure:

- EGCB should include a code of conduct relating to the accommodation to be signed with the contract document of EPCs.
- The contractor shall not employ any person below the age of 18 years nor will have any forced labor;
- The construction laborers will be provided with documented information regarding their rights under national labor law;
- First priority for employment of labor should be given those impacted by the project such as landowners who have lost land;
- No discrimination shall be done by the construction contractor with respect to recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, job assignment, termination of employment or retirement, and disciplinary practices;
- The contractor to ensure that work hours are set at eight hours a day, 48 hours a week, with a weekly rest day for all engaged labors;
- Every labor is entitled to maximum of only two hours a day as Overtime (OT) work. OT pay is twice the hourly remuneration;
- Client shall ensure equal wages for male and female workers for work of equal nature or value is maintained;
- A grievance redress mechanism for workers shall be put in place by the contractor to raise workplace concerns. The workers will be informed about the grievance mechanism at the time of recruitment; and
- The EPC shall ensure that their contractors develop and implement a procedure to review the performance of their sub-contractors.
- The procedure developed should include regular inspection of the campsites,

maintaining information pertaining to labors sourced by sub-contractors;

9.7.4 Worker's Accommodation

The EPC will supervise and monitor the activities performed by their contractor and accommodation facilities provided in the campsite. The following measures shall be provided:

- The labor will be provided with accommodation on twin sharing basis made of insulated material and locally available building material, etc.;
- The migrant workers with families shall be provided with individual accommodation comprising bedroom, sanitary and cooking facilities;
- The units will be supported by common latrines and bathing facilities duly segregated for male and female labor;
- Adequate number of toilets shall be provided in the accommodation facilities. A minimum of 1 unit to 15 males and 1 unit for 10 females shall be provided;
- The contractor shall provide a canteen facility for the construction workers and the food will be of appropriate nutritional value and will take into account religious/cultural backgrounds;
- All doors and windows shall be lockable and mobile partitions/curtains shall be provided for privacy;
- Facilities for the storage of personal belongings for workers shall be provided within the campsite only;
- Dustbins shall be provided for collection of garbage and will be removed on a daily basis;
- It is also required to provide first aid box in adequate numbers; and
- Ventilation should be appropriate for the climatic conditions and provide workers with a comfortable and healthy environment to rest and spend their spare time.

9.7.5 Security

The contractors shall put in place the following security measures to ensure the safety of the workers. The following measures shall be incorporated:

- Access to the campsite shall be limited to the residing workforce;
- The contractor shall be responsible for deploying adequate number of guards;
- Adequate, day-time night-time lighting shall be provided;
- The security personnel shall be provided with training to respect the community traditions and in dealing with, use of force etc.; and
- The rental accommodation shall be provided with firefighting equipment and portable fire extinguishers.

9.7.6 Provisions for Drinking Water

Access to an adequate and convenient supply of free potable water is necessity for workers. The domestic water supply shall be made available by the contractor.

- Safe drinking water shall be provided;
- Private tanks can be utilized for provision of drinking water for the migrant labors;
- The direct usage of water from bore well should not be allowed and water shall be

adequately treated;

- The EPC should regularly monitor the quality of drinking water available. In case of noncompliance with the Drinking Water Specifications, additional treatment shall be provided or alternative sources of water supply shall be arranged; and
- All tanks used for the storage of drinking water are constructed and covered as to prevent water stored therein from becoming polluted or contaminated.

9.7.7 Cooking Arrangements

The construction phase will involve engagement of a large number of migrant people in the project area for a limited time. Hence, there shall be a requirement of provision of cooking facilities (kitchen) as listed below:

- Places for food preparation are designed to permit good food hygiene practices, including protection against contamination between and during food preparation;
- Adequate personal hygiene including a sufficient number of washbasins designated for cleaning hands with clean, running water; and
- All kitchen floors, ceiling and wall surfaces adjacent to or above food preparation and cooking areas are built using durable, non-absorbent, easily cleanable, non-toxic materials;
- Food preparation tables are equipped with a smooth, durable, easily cleanable, non-corrosive surface made of non-toxic materials.

To ensure that the fuel need of laborers in the project area does not interfere with the local requirements, necessary arrangements for the supply of fuelwood to the laborers shall be done by the contractor. Fuel requirement for cooking purposes is only to be met by fuelwood that to be purchased only from authorized vendors only.

9.7.8 Wastewater Generation

There will a generation of wastewater from the campsite. About 80% of water used shall be generated as sewage/wastewater. EPC shall ensure that the campsite is equipped with a septic tank and soak pit for disposal of sewage. It is also recommended that the stormwater and sewage system should be separate. The surface water drainage shall include all necessary gutters, downpipes, gullies, traps, catch pits, manholes etc. Sanitary and toilet facilities are constructed of materials that are easily cleanable. Sanitary and toilet facilities are required to be cleaned frequently and kept in working condition.

9.7.9 Solid Waste Management

The municipal solid waste generated from campsite will mostly comprise of compostable wastes like vegetable matters (kitchen waste) and combustible waste like paper, cans, plastic and some non-degradable waste like glass/glass bottles. Improper disposal of solid waste will lead to environmental degradation and health hazards to labor as well as the nearby community.

The following measures shall be adopted by contractors for ensuring effective management of solid waste:

- The solid wastes of domestic nature generated shall be collected and stored

separately in appropriate containers with proper sealing on them;
- Separate bins with proper markings in terms of recyclable or non-recyclable waste shall be provided in the houses and kitchen premises in sufficient numbers for collection of garbage;
- Food waste and other refuse are to be adequately deposited in sealable containers and removed from the kitchen frequently to avoid accumulation; and
- The contractor shall identify the nearest municipal solid waste storage facility and tie up with the concerned urban local body for disposal of waste at frequent intervals

9.7.10 Medical Facilities

Effective health management is necessary for preventing the spread of communicable diseases among labor and within the adjoining community. The following medical facilities shall be provided by contractors for the construction workers:

- A first aid center shall be provided for the labor within the construction site equipped with medicines and other basic facilities;
- Adequate first aid kits shall be provided in the campsite inaccessible place. The kit shall contain all type of medicines and dressing material;
- Contractor shall identify and train an adequate number of workers to provide first aid during medical emergencies;
- Regular health check-ups shall be carried out for the construction laborers every six month and health records shall be maintained;
- Labours should have easy access to medical facilities and first aider; where possible, nurses should be available for female workers;
- First aid kits are adequately stocked. Where possible a 24/7 first aid service/facility is available.
- An adequate number of staff/workers is trained to provide first aid; and
- Information and awareness of communicable diseases, AIDS etc. shall be provided to workers.

9.7.11 Recreation Facilities

- Basic collective social/rest spaces are provided to workers;
- Facilities like a common television can be provided in labor camps

9.7.12 Inspection of Accommodation Facilities

Campsite shall be inspected at frequent intervals to ensure that the facilities are well organized and maintained to acceptable and appropriate standards by the EPC. The key areas are:

- Daily sweeping of rooms and houses shall be undertaken;
- Regular cleaning of sanitary facilities shall be undertaken;
- The kitchen and canteen premises shall be established under good hygiene conditions;
- Daily meal times shall be fixed for the labor;
- Smoking and alcohol consumption shall be prohibited in the workplace;
- Waterlogging shall be prevented in areas near the accommodation facilities and

adequate drainage is to be provided; and
- Checklists pertaining to the daily housekeeping schedule shall be maintained and displayed at houses, toilets, and kitchen.

To limit the impact due to cumulative labor onsite during the construction phase, the developer shall provide adequate labor camp which should be appropriate for its location and be clean, safe and, at a minimum, meet the basic needs of workers.

- Developer should assess the location of labor camp, that it should not be constructed in immediate vicinity of any drainage channel;
- It should be ensured that the labor camp(onsite) should have basic amenities such as electricity, drinking water, health& sanitation facility, kitchen and restroom;
- All tanks used for the storage of drinking water are constructed and covered as to prevent water stored therein from becoming polluted or contaminated and all the migrant workers will be instructed accordingly;
- Employers should ensure that accommodation which is provided is not overcrowded and does not pose a risk to the health and safety of workers;
- The labor camp will be equipped with septic tanks and soak pits and avoid presence of stagnant water is a factor of proliferation of potential disease vectors such as mosquitoes;
- EPC should ensure that the disruption of local communities is minimum, in particular, local communities' transport infrastructures and if required limit the worker's movements in nearby areas;
- Security staff have a clear mandate and have received clear instruction about their duties and responsibilities, in particular, their duties not to harass, intimidate, discipline or discriminate against workers;
- EPC should ensure that workers and members of the surrounding communities have specific means to raise concerns about security arrangement and staff;
- Where possible, an adequate transport system to surrounding communities will be provided. It is good practice to provide workers with free transportation to and from local communities.

9.7.13 Grievance Redress Mechanism

A Grievance Redress Mechanism (GRM) shall be formulated for the construction laborers (local and migrant) comprising of a review committee including representatives elected by labor and management representatives. EGCB can extend the grievance mechanism proposed in Chapter 8 of the report for the project to the EPC also. A documented GRM shall have the following elements:

- Proper system for lodging grievances;
- Provision for raising anonymous complaints;
- Appropriate level of management for addressing concerns;
- Workers and members of the surrounding communities have specific means to raise concerns about security arrangement and staff;
- Provision for timely action and feedback;
- Monitoring and review of grievances raised and action taken; and

- Scope for continual improvement of the system.

9.8 Framework for Emergency Preparedness and Response Plan

The primary objective of formulating a framework of Emergency Preparedness and Response Plan (EPRP) is to undertake immediate rescue and relief operations and stabilize the mitigation process as quickly as possible. The main parameters of a response plan based on such mechanism include:

- Identification and declaration of potential emergencies;
- Signal/warning mechanism;
- Activities and their Levels;
- Command and control structure;
- Individual roles and responsibilities of each specified authority to achieve the activation as per response time;
- Emergency procedures;
- Alternate plans & contingency measures; and
- Coordination with External parties

9.8.1 Identification of Emergencies

Identification of all the hazards and risks associated with each activity which may lead to an emergency and anticipate the actions to be taken before or after the emergency arises. This section identifies the hazardous areas and activities in both construction and operation phases. Probable emergencies that might arise due to these hazards for the duration of the project have been listed below.

Hazardous areas

Following potentially hazardous areas and activities have been identified at the construction site:

- Fuel storage areas
- Kitchen premises in labor camps
- Electrical installations - improper laying of cables
- Scaffolds
- Confined Spaces

The potentially hazardous areas and activities during project operations will be a storage area of broken panels, hazardous waste such as used oil, oily rags etc.

Emergency Situations

The possible emergency situations identified for the construction and operation phases of the Project areas listed below:

Fire and Explosion

- Leakage of fuel from storage areas;
- Short-circuit at campsite/project site; and

Mechanical and Electrical Hazards

- Structural Collapse;
- Accidentally dropped object;
- Loss of stability; and
- Electrocution.

Occupational Hazards

- Outbreak of Disease / Illness;
- Handling of chemicals;
- Accidents due to vehicle movement; and
- Vandalism.

9.8.2 Declaration of Emergencies

Level 1 (Minor Emergency)

All events with no escalation potential and which can be controlled and contained by the action of Safety Officer at the site will be considered as Level 1. In such cases of local alert, EHS Manager of EPC will be notified only. Some typical incidents are:

- Vehicle collision (involving no loss of life);
- Equipment damage;
- Medical Evacuation (not very serious cases);
- Minor fires.

Level 2 (Serious Emergency)

All events with escalation potential, depending on the effectiveness of the local response will be considered as Level 2. These incidents may impact the entire construction activity/ project operations or have cascading effect. For such type of incidents, Site Supervisor of EPC will take the lead. Some typical incidents are:

- Substantial security incident / Vandalism;
- Structural collapse;
- Minor Flooding;
- Serious damage to structures;
- Substantial fire; and
- Cultural conflict.

Level 3 (Major Emergency)

The crisis that requires assistance from external resources in order to save lives, minimize damage and to bring the abnormal situation back under control is Level 3 emergencies. These incidents have the potential to impact beyond the project footprints and affect the community. In such cases appropriate Government / regulatory authorities. Some typical Level 3 incidents are:

- Major fire/explosion;
- Fatality ;
- Severe flooding;

Personnel on site will know that a Major Emergency has been declared if the site fire alarm siren and /or the local fire alarm systems are activated. The Emergency Siren Modes will be demonstrated and shared with all workers to identify with them.

Level 2 and level 3 will be declared using emergency siren and evacuation shall be done

9.8.3 Emergency Equipment's

The following points should be implemented to tackle emergency situations:

- Onsite emergency equipment's such as first aid boxes, firefighting equipment, PPEs etc. shall be maintained at project site;
- The adequacy and availability of emergency equipments shall be assessed at periodic intervals by the EHS Manager of EPC.
- Inventory and locations of respective emergency equipment's shall be displayed at project office building, construction areas and other work areas;

It is to be ensured that the staff of developer is trained on the usage of each type of emergency equipment.

First Aid Boxes

First aid boxes shall be provided at identified locations throughout the plant premises. A first aid box shall contain, but not limited to the following articles:

- Cotton wool
- Sterile gauze
- Antiseptic lotion
- Box of adhesive dressing (Plasters) for small wounds
- Blunt-ended scissors
- Tweezers for removing splinters
- Triangular bandages (for making a sling or emergency bandage)
- Safety pins
- Sterile eye dressings
- Crepe bandages
- Aspirin/ Paracetamol tablets
- Skin creams for treating burns
- Anti-histamine cream for insect bites and stings

Fire Fighting Equipment's

During the construction phase, fire extinguishers and sand buckets will be provided at critical areas such as fuel storage area, waste storage area, labor camps, kitchens, first aid center, areas with electrical installations and project office.

Other firefighting systems to be installed should include:

- Heavy-duty ABC powder type fire extinguishers kept at important electrical equipment areas;
- Portable CO_2 extinguishers provided throughout the plant;

Provision of Personal Protective Equipment's

Onsite workers and the team deployed by respective EPC should be provided with an adequate number of personal protective equipment's (PPEs) to deal with emergency situations. The PPEs shall be stored at the designated Emergency Control Centre in the plant premises and will be easily accessible during times of emergency. Training of proper use of PPEs shall be provided to all working personnel on a periodic basis.

Assembly Areas

- Considering the area of the plant, three Sub-Assembly Zones and one Main Assembly Zone should be identified and finalized. The assembly zones shall be marked accordingly and employees will be mandated to gather at the zones during emergencies;
- In cases of minor emergencies when evacuation is not required, the employees/ workers and contractors shall gather at the Sub Assembly Zones nearest to their working area;

In case the facility is to be evacuated, assembly from sub-assembly zones is undertaken at Main Assembly Area where the final headcount is undertaken and finally workers can be routed to evacuate the premises.

The following codes of sirens will be followed during emergencies:

Sl.	Sirens	Indicates	Authority
1.	120 seconds Continuous Whelming Sound	ON-SITE EMERGENCY (ALERT) for evacuation	EHS Manager
2.	30 + 30 + 30 seconds Sound with an interval of 5 seconds	EMERGENCY CONTROLLED	EHS Manager

Below points shall be noted during the prevalence of emergency situation:

- Emergency siren to be sounded only if required.
- All staff shall be prior informed of the use of emergency sirens during mock drills.
- All employees in areas other than affected to continue work unless disaster siren is blown.
- No worker will leave the emergency spot unless 'all clear' siren blown.

9.8.4 Coordination with External Agencies

During emergency situations, Safety Officer and EHS Manager of EPC shall form the Emergency Control Centre (ECC). Safety Officer shall coordinate with the following departments:

- Fire brigade;
- Police department;
- Hospitals/Ambulance Services;
- Utility departments (electricity and water);
- Local Authorities and District Administration

- District Disaster Control Room, Feni

9.8.5 Emergency Response Team

The Emergency Response Team (ERT) will be set up immediately for the construction phase and the same will be revised for the commencement of plant operations.

Each personnel identified as part of the ERT shall be designated specific roles and responsibilities for handling emergency situations.

The ERT at the operating site under its control will have the following role:

- Control the emergency and render the facility premises safe by the application of local resources; and
- Support the local response effort by coordinating additional equipment, personnel, and other external resources for the direct response effort.

The ERT will comprise of the following personnel:

o Site Supervisor; o EHS Manager; o Safety Officer(s); o Evacuation Officer; o Employee/Workers

9.8.6 Response Procedures

Effective command and control start with a clear definition of the overall command and control structure, and description of the duties of key personnel with specific responsibilities for emergency response. The control of emergencies will consider the minimum number of persons required to provide an adequate response to emergencies.

All emergencies occurring as a result of project activities shall be managed according to the following order of priorities:

- Preservation of Life (self, team, community);
- Protection of the Environment;
- Protection or Property/assets; and,
- Preservation of Evidence.

9.8.7 Reporting and Documentation

The following aspects need to be communicated for the emergency reporting:

- While witnessing or receiving notification of an emergency, as much information as possible should be taken and/or conveyed to the relevant emergency activation authority;
- Where possible, all information should be logged in written form with time and date included and provided to EHS Manager of EPC Contractor;
- Personnel working on the site may, at any time, be exposed to an emergency which could take many forms, for example (but not limited to):
    - ✓ Injuries and/or fatalities
    - ✓ Fires and/or explosions
    - ✓ Extreme weather
- When an emergency occurs, an appropriate and prompt response is required,

providing precise action to control, correct and return the site to a safe condition.

- Timely action will also be required to protect people, the environment, and property from damage;
- All near misses and unsafe acts will be written in logbooks / reported in the 'Near miss, unsafe acts, hazards and sub-standard conditions report' and verbally communicated to the concerned Site Supervisor within a reasonable time. All accidents and incidents will be immediately reported to the EHS Manager, and requisite forms completed.

9.9 Disaster Management Plan

A separate Disaster Impact Assessment (DIA) study report including appropriate mitigation measures has been prepared for the proposed project. EGCB and O&M team should follow the mitigation measures proposed in the DIA study report. The following Disaster Management Plan (DMP) is developed on the framework of EPRP (as detailed in section 9.8) and outlines procedures essential for effectively responding to any natural and man-made accidental and emergency situations for operations and activities during construction, operation and decommissioning phases of the project. The procedures will include plans for addressing training, resources, responsibilities, communication and all other aspects required to effectively respond to emergencies associated with their respective hazards.

9.9.1 Objectives

This DMP has the following objectives:

- Protect the employees, contractors, assets, communities and the environment through the development of disaster response strategies and capabilities;
- Set out the framework for hazard identification in order to define procedures for response to the situations including the development of contingency measures;
- Structure a process for rapid and efficient response to and manage emergency situations during the construction, operational and decommissioning phases of the project; and
- Assign responsibilities for responding to emergency situations.

9.9.2 Definitions

- Accident - an unintended incident which results in injury to persons and/or damage to property, the environment, third party or which leads to production loss.
- Contractors - persons working for external companies (or employed by an employment agency) that are under contract to carry out work for the project.
- Emergency - a serious, unexpected and often dangerous situation which poses an immediate threat to, personals, processes, assets, environment, and communities and requiring an immediate action.
- Incident - a sudden accident or near miss.
- Medical Treatment Case - injury at work (other than a lost-time injury and restricted work case) requiring treatment by a doctor, or nurse in consultation with a doctor, before the injured person's resumes normal work.
- Natural Disasters - are types of disasters that cause material and physical damages

and human losses. These include drought, water rise, earthquake, flood, storms, epidemics, and others.

- Unnatural Disasters - disasters causing a material and physical damage and destruction and human losses. These include explosions, plane crash, fire accidents due to human negligence and other human-generated disasters.

9.9.3 Roles and Responsibilities

Site Supervisor of EPC

The Site Supervisor is responsible for overall management of the project and ESMP implementation. The following tasks will fall within his/her responsibilities:

- Review monthly and annual incident reporting;
- Review disaster response drill outcomes and work with EHS Manager and safety officers to identify necessary improvements;
- Appoint a Disaster Response Coordinator tasked with responding to emergencies.

EHS Manager of EPC

The duties of an EHS Manager shall include the following:

- Distribution of the DMP to all parties with responsibilities in implementing the plan (including contractors);
- Review monthly incident report;
- Review quarterly report of accidents/incidents and reviews of contractor practices;
- Plan disaster response drills;
- Develop response Training;
- Receive all notifications of incidents/accidents and ensure the proper response is being followed including reporting and review.

Safety Officer(s)

The EPC shall ensure the appointment of safety officer(s) for employees and workers working at the site, to:

- Support the EHS Manager as required in disaster response planning and in development of training and management plans to ensure environmental concerns are addressed;
- Provide regular incident reporting;
- Schedule monthly inspections and audits and resolve issues identified;
- Schedule emergency response training sessions for relevant staff;
- Prepare monthly incident reports.

Evacuation Officers

- Ensure they are easily recognizable to their colleagues/visitors and the emergency services during any evacuation;
- Responsible for all occupants' safety during evacuation and to ensure the safety of personnel to reenter the site;
- Keep an updated list of employees and visitors on site and carry the name list with

them during evacuation;
- Ensure all occupants have evacuated the area where the incident has taken place (including people in restrooms, site office rooms etc.);
- To be fully trained in the provision of first aid

Employees/Workers

- All persons employed or under a service contract (e.g. contractor, transporter etc.), who witnesses or cause an incident are responsible for immediate reporting of the incident to his/her supervisor.

9.9.4 Emergency Procedure

The event of the following disasters, the emergency procedures to be followed are:

Flooding	• The Disaster Response Coordinator must be notified; • All personnel on site, including the designated Evacuation personnel must be immediately notified; • All equipment must be safely shut down and all electrical equipment must be isolated.
Fire	• The Disaster Response Coordinator must be notified; • Personnel in the immediate vicinity of the fire, including the designated Evacuation personnel must be immediately notified; • All persons located in the area in which the fire is located must be evacuated. Evacuation must be carried out as per the Evacuation Procedure; • The fire must be contained with the correct extinguisher only by those trained to do so; • Those requiring assistance must be assisted and first aid must be rendered only by those trained to do so; • Those confined to an area where there is smoke, must move under the level of the smoke and cover their nose/mouth.
Site Office building collapse	• The Disaster Response Coordinator must be notified; • Personnel in the immediate vicinity of the collapsed building move away from the building to a safe location - there could be a secondary collapse; • Enter and rescue others only by those trained to do so; • If you know the identity or location of someone who is trapped, notify emergency personnel; • All persons located in the area must be evacuated. Evacuation must be carried out as per the Evacuation Procedure.

9.9.5 Evacuation Procedure

All staff must be aware of the possible escape routes prior to the emergency situation. Always assure the safety of the assembly point prior to evacuation. The procedure associated with an evacuation event is detailed below:

- The Disaster Response Coordinator will give instruction or the alarm sound to evacuate specific assembly areas;
- All staff appointed as Evacuation Officers must assist with the evacuation;
- All personnel on site must follow the instructions of the Evacuation Officer;
- Personnel must follow the directional pointers to the nearest assembly points;
- Evacuation must be undertaken in accordance with the emergency layout plan;
- Mobile employees must be the first to be evacuated followed by the frail and the injured;
- Evacuation personnel must work in pairs where possible to assist one another lifting injured employee (if any);
- Mobile employees who are struggling or appear unsure must be assisted;
- Personnel must evacuate by walking briskly and must not run;
- Evacuating personnel must stay calm and must not panic. Panic can spread and cause unnecessary chaos;
- Evacuating personnel must always keep left along the evacuation routes;
- In the case where the emergency situation results in fire or smoke, evacuating personnel must consider crawling, as this may be better than walking;
- Visitors that are not familiar with the evacuation procedure must be assisted;
- A daily record of staff and visitors must be kept;
- The task of the professional Emergency Services must not be obstructed;
- If necessary, a search/check for all unaccounted personnel must be undertaken before leaving the area;
- The evacuation officer must be the last one to leave the area;
- All personnel on site must report directly to the allocated assembly point;
- Personnel must not leave the assembly point until it has been deemed safe to do so.

9.9.6 Verification and Monitoring

The EHS Manager has been tasked with the responsibility for auditing the project and implementation of emergency response procedures associated with all phases of the project. The execution of disaster response drills will include the following:

- Fire Drills;
- Flooding Drills;
- Medical Drills; and
- Emergency Evacuation Drills.

Reporting and monitoring requirements for the DMP will include:

- Monthly inspections and audits;
- Quarterly report of accidents/incidents;
- Reporting at the time of any incidents;
- Bi-annual disaster response drills; and
- Annual reporting on training.

Disaster response drills and reporting maintained by the EHS Managers will provide information regarding required revisions to training or the disaster response actions. Each

incident reported will be reviewed and investigated upon occurring. Actions will be identified where possible to improve the site's overall response to disasters.

9.9.7 Training

All employees and contractors will be trained in disaster response procedures within one month of their start- date. The EHS Manager shall distribute the DMP (together with the associated Evacuation Plan) to all parties in charge of ensuring the implementation of the plan. All relevant information in the DMP shall be communicated to employees and contractors. This information shall include information on potential emergency risks/threats, appropriate first-person response/contact to incidents/emergencies and notification procedures.

All site personnel, including contractors, are to be trained in the appropriate responses to possible disasters. The training is mandatory and is to be conducted on a regular basis. The frequency and timing of training are to take place at least quarterly.

Awareness programs for the community should also be arranged to apprise them about the potential emergencies that can arise in construction and operation phase.

Training is to include, but not limited to the following:

- Firefighting;
- First Aid;
- Emergency Evacuation; and
- Medical Emergencies.

CHAPTER 10: CONCLUSION AND RECOMMENDATIONS

10. CONCLUSION AND RECOMMENDATIONS

The environmental and social impact assessment of the proposed Solar and wind plant at Soanagazi has been conducted in accordance with the administrative framework, identified herein, including national legislative requirement, the World Bank Policies, IFC's Performance Standards and World Bank's Environmental Health and Safety (EHS) Guidelines.

The ESIA study has been carried out based on the site visit, baseline environmental and social condition survey, stakeholder consultation, analysis of the possible project intervention and finally experts identified and evaluated potential environmental impact associated with all aspects of the proposed project.

The proposed project will be developed on medium high land where only aman rice is cultivated during post monsoon season. The total 999.65 acres land occupied by government khas land, government land leased to vulnerable people and some private land. The key environmental impact due to the project construction observed as an outcome of the ESIA study impacts on land use, loss of cultivable land, drainage pattern change, water quality solid waste generation and disposal, increase traffic and transport and occupational health and safety. The economic opportunities in terms of local employment during construction and operation phase are assessed as positive. During the operation of the proposed project, the key issues related to the environment has been identified from the ESIA study are hazardous waste generation and management, ecological, visual impact and occupational health and safety.

The Environmental and Social Management Plan (ESMP) describes mitigation measures for impacts specific to the project activities and also discuss implementation mechanism for recommended mitigation measures along with monitoring plan. The ESMP also suggest to follow the waste management plan, occupational health and safety plan, construction labor management plan, emergency preparedness, and response plan and disaster management plan. Implementation of ESMP will help EGCB to comply with the national regulatory framework as well as to meet IFC Performance Standard requirements.

The project should take structurally protective measures towards flood, cyclone and tidal surge as the site is located in the coastal region. Moreover, as per the loss of land and livelihood assessment this study also suggests preparing Resettlement Action Plan & Livelihood Restoration Plan and successful implementation, if required, in compliance with the relevant policy appropriate for the funding agency.

CHAPTER 11: REFERENCES

11. REFERENCES

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Annex A: Rapid Environmental Assessment (REA) Checklist

Screening Questions	Yes	No	Not Known	Remarks
A. Project Siting ▪ Is the Project area adjacent to or within any of the following environmentally sensitive areas?				
▪ Physical cultural heritage site		√		As per the information available from Department of Archaeology, Bangladesh (www.archaeology.gov.bd) and District Office website (www.dcfeni.gov.bd), there are reportedly no cultural heritage sites and archeological monuments in the Sonagazi upazila. However, there are religious structures such as local mosques and temples in the unions. The nearest religious structure (7 no union jame masque , Musapur) is about 790 m from the Project boundary.
▪ Located in or near to legally protected area		√		There is reportedly no protected area, such as National Park, Wildlife Sanctuary, Game Reserve, Safari Parks, Eco-Parks, Protected Forests within the 5km study area. Planted Musapur reserve is located 1.40 km southwest of the project boundary.
▪ Located in or near to special habitats for biodiversity (modified or natural habitats)		√		According to the Bird Life International, the Muhuri dam and its surrounding 500 ha area is a migratory staging ground which is located approximately 5.5 km north-east of proposed project boundary.
▪ Wetland		√		In Bangladesh wetlands area classified into river, streams, Baors, Haors and Beels. All of these are considered as wetlands and regarded as valuable fish and wildlife habitat. The project site is situated next the Choto Feni River. However none of the important wetlands are located in the 5 km study radius. The nearest major wetland is Sunderban wetland about 176 km away from the project site.
▪ Mangrove		√		Manmade mangrove plantation cluster is located 1.50 km of the project boundary.

Screening Questions	Yes	No	Not Known	Remarks
▪ Estuarine	√			Feni River mixed with the Sandwip channel at 3.50 km southeast of the project boundary
B. Potential Environmental Impacts Will the Project cause…				
▪ large scale land disturbance and land use impacts specially due to diversion of productive lands?		√		The project site is medium high land and seasonally flooded during the monsoon period. Low yield variety aman rice is cultivated on the land during the post monsoon season. The land is not productive for agricultural production due to the saline nature of soil
▪ involuntary resettlement of people? (physical displacement and/or economic displacement)		√		No physical structure is present in the project site
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?			√	There is no reported social survey available for the project and surrounding areas. There is a possibility of vulnerable groups around the site – poor families, potential land less or marginal farmers, any community that is given protection by the government etc., which can be established only after a socioeconomic survey.
▪ noise, vibration and dust from construction activities?	√			Noise and dust will be generating due to site preparation, movement of heavy machinery, transportation of man & material, excavation of earth, and other construction activities.
▪ an increase in local traffic during construction?	√			Traffic will be increased during the construction period for carrying construction materials, plant equipment and people movement.
▪ environmental disturbances such as soil erosion, land contamination, water quality deterioration, air pollution, noise and vibrations during construction phase?	√			Construction activities may impact on soil, water quality, noise and vibration due to the accidental spill as well as improper management of liquid and solid waste.

Screening Questions	Yes	No	Not Known	Remarks
• aesthetic degradation and property value loss due to establishment of plant and ancillary facilities?	√			The Project will have aesthetic degradation as it is coming up in plain land, which has no precedence of any industrial activity in and around the project site. However, loss of property value is not assessed at this stage.
▪ changes in flow regimes of the water intake from surface water or underground wells due to abstraction for cooling purposes?		√		Water is available both surface and ground water source. Ground water is shallow in the project area therefore changes in flow regimes of water intake from surface and underground wells due to abstraction will be minimum.
▪ pollution of water bodies and aquatic ecosystem from wastewater treatment plant, from cooling towers, and wash-water during operation?		√		Its solar power plant and water will be used only for panel washing which will not be contaminated
▪ a threat to bird or bat life from colliding with the project facilities and/or being burned by concentrated solar rays?	√			Now a day the modern PV panel is not creating such type of glare that may affect bird. On the other hand there is a possibility of bird or bat collision with the wind turbine.
▪ industrial liquid (dielectric fluids, cleaning agents, and solvents) and solid wastes (lubricating oils, compressor oils, and hydraulic fluids) generated during construction and operations likely to pollute land and water resources?	√			There is a possibility of such risk during the construction and operation period due to improper management of liquid waste
▪ Soil/water contamination due to use of hazardous materials or disposal of broken or damaged solar cells (photovoltaic technologies contain small amounts of cadmium, selenium and arsenic) during installation, operation and decommissioning?	√			Improper management of broken solar cells during installation, operation and decommissioning period may contaminate soil and water contamination.
▪ noise disturbance during operation due to the proximity of settlements or other features?		√		The closest settlement is approximately 1 km away from the project site therefore impact due to the noise generation on closest settlement will be negligible
▪ visual impacts due to reflection from solar collector arrays resulting in glint or glare?	√			Now a day the modern PV panel is absorbing most of the sunlight. However as the PV panel will cover large area so it may crate visual impact on road user.

Screening Questions	Yes	No	Not Known	Remarks
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?	√			The economic activity in the area is low and major occupations are agriculture and fishery. The proposed Power Plant is a unique project in the area and therefore there will be population influx both during construction and operation phases of the Project. There will be potential burden on local resources.
▪ social conflicts between local laborers and those from outside the area?			√	
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during construction, installation, operation, and decommission?	√			There is a possibility of accidental injury during installation, operation, and decommission phase.
▪ risks to community health and safety due to the transport, storage, and use and/or disposal of materials and wastes such as explosives, fuel and other chemicals during construction, and operation?	√			The settlement is located in safe distance from the project site. Only community may impact due to the accident during transportation of the materials
▪ community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		√		The settlement is located in safe distance from the project site therefore impact on community is negligible.

Climate Change and Disaster Risk Questions The following questions are not for environmental categorization purposes. However, the questions are included in this checklist to help the project team identify the potential climate and disaster risks of the project.	Yes	No	Not Known	Remarks
▪ Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes (see Appendix I)?	√			The project site is susceptible to seasonal floods and tropical cyclone winds.
▪ Could changes in precipitation, temperature, salinity, or extreme events over the Project lifespan affect its sustainability or cost?	√			The source of water for the proposed power plant is Choto Feni /Feni River and changes in precipitation can affect the flow during lean period. Also changes in salinity of the water can affect the operational parameters in the long run.

▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g. high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?		√		From the reconnaissance survey, no such aspects emerged but a socio-economic study needs to be undertaken during the public consultation phase to understand and rule out such aspects in totality.
▪ Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., increasing traffic or housing in areas that will be more prone to flooding, by encouraging settlement in earthquake zones)?	√			Yes, the proposed project would result in increase of traffic to the area and may result in increased accidents. Also, the Project Site and surrounding areas are susceptible to flood hazard.

Appendix I: Environments, Hazards and Climate Change

Environment	Natural Hazards and Climate Change
Arid/Semi-arid and desert environments	Low erratic rainfall of up to 500 mm rainfall per annum with periodic droughts and high rainfall variability. Low vegetative cover. Resilient ecosystems & complex pastoral and systems, but medium certainty that 10–20% of drylands degraded; 10-30% projected decrease in water availability in next 40 years; projected increase in drought duration and severity under climate change. Increased mobilization of sand dunes and other soils as vegetation cover declines; likely overall decrease in agricultural productivity, with rain-fed agriculture yield reduced by 30% or more by 2020. Earthquakes and other geophysical hazards may also occur in these environments.
Humid and sub-humid plains, foothills and hill country	More than 500 mm precipitation/yr. Resilient ecosystems & complex human pastoral and cropping systems. 10-30% projected decrease in water availability in next 40 years; projected increase in droughts, heatwaves and floods; increased erosion of loess-mantled landscapes by wind and water; increased gully erosion; landslides likely on steeper slopes. Likely overall decrease in agricultural productivity & compromised food production from variability, with rain-fed agriculture yield reduced by 30% or more by 2020. Increased incidence of forest and agriculture-based insect infestations. Earthquakes and other geophysical hazards may also occur in these environments.
River valleys/ deltas and estuaries and other low-lying coastal areas	River basins, deltas and estuaries in low-lying areas are vulnerable to riverine floods, storm surges associated with tropical cyclones/typhoons and sea level rise; natural (and human-induced) subsidence resulting from sediment compaction and ground water extraction; liquefaction of soft sediments as result of earthquake ground shaking. Tsunami possible/likely on some coasts. Lowland agri-business and subsistence farming in these regions at significant risk.
Small islands	Small islands generally have land areas of less than 10,000km² in area, though Papua New Guinea and Timor with much larger land areas are commonly included in lists of small island developing states. Low-lying islands are especially vulnerable to storm surge, tsunami and sea-level rise and, frequently, coastal erosion, with coral reefs threatened by ocean warming in some areas. Sea level rise is likely to threaten the limited ground water resources. High islands often experience high rainfall intensities, frequent landslides and tectonic environments in which landslides and earthquakes are not uncommon with (occasional) volcanic eruptions. Small islands may have low adaptive capacity and high adaptation costs relative to GDP.
Mountain ecosystems	Accelerated glacial melting, rockfalls/landslides and glacial lake outburst floods, leading to increased debris flows, river bank erosion and floods and more extensive outwash plains and, possibly, more frequent wind erosion in intermontane valleys. Enhanced snow melt and fluctuating stream flows may produce seasonal floods and droughts. Melting of

	permafrost in some environments. Faunal and floral species migration. Earthquakes, landslides and other geophysical hazards may also occur in these environments.
Volcanic environments	Recently active volcanoes (erupted in last 10,000 years – see www.volcano.si.edu). Often fertile soils with intensive agriculture and landslides on steep slopes. Subject to earthquakes and volcanic eruptions including pyroclastic flows and mudflows/lahars and/or gas emissions and occasionally widespread ashfall.

Annex B: Scoping Report

Annex C: OP 4.03- Performance Standards for Private Sector Activities

Performance Standard 1: Assessment and Management of Environment and Social Risks and Impact

PS1 emphasizes on the importance of managing environmental and social performance throughout the project span. This can be done by initiating an effective Environmental and Social Management System (ESMS) which involves engagement between the client, its workers, the local communities directly affected by the project and other stakeholders involved. The good ESMS, appropriate to the nature and scale of the project promotes sound and sustainable environmental and social performance. It can also lead to improved financial, social and environmental outcomes. The objective of this performance standard 1 is to identify and evaluate environmental and social risks and impacts of the project.

Applicability

PS 1 is applicable to the proposed project. The PS1 is applicable to the project with the environment and social risk and impacts. The proposed project is a combination of solar and wind power plant project and will have an environmental and social impact such as stress on existing water resources, generation of noise, construction activities etc.

Performance Standard 2: Labour and Working Conditions

PS2 recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. For any business, the workforce is a valuable asset, and a sound worker-management relationship is a key ingredient in the sustainability of an establishment. Failure to establish this can undermine worker commitment and retention, which can jeopardize a project.

The requirements set out in this Performance Standard have been in part guided by a number of international conventions and instruments, including those of the International Labour Organization (ILO) and the United Nations (UN).

The objectives of this Performance Standard include:

- To promote the fair treatment, non-discrimination, and equal opportunity of worker
- To establish, maintain, and improve the worker-management relationship
- To promote compliance with national employment and labour laws
- To protect workers, including vulnerable categories of workers such as children, migrants workers, workers engaged by third parties, and workers in the client's supply chain
- To promote safe and healthy working conditions and the health of workers
- To avoid the use of forced labour

Applicability

PS 2 is applicable to this project. The proposed project will involve the employment of direct and contractual workers during construction and operation phases. The client will engage direct workers, workers engaged through third parties (contracted workers) as well as workers engaged by the developer's primary suppliers.

Performance Standard 3: Resources Efficiency and Pollution Prevention

PS3 recognizes that increased economic activities and urbanization often generate increased levels of pollution to air, water, and land, and consumes finite resources in a manner that may threaten people and the environment at local, regional and global levels. There is a growing global consensus that the current and projected atmospheric concentration of greenhouse gases (GHG) threatens the public health and welfare of current and future generations. At the same time, more efficient resource use and pollution prevention and GHG emission avoidance and mitigation technologies and practices have become more accessible and achievable in virtually all parts of the world. These are often implemented through continuous improvement methodologies similar to those used to enhance quality or productivity, which are generally well known to most industrial, agricultural, and service sector companies. The objectives of the Performance Standard 3 are:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities
- To promote more sustainable use of resources, including energy and water
- To reduce project-related greenhouse gases (GHG) emissions

Applicability

PS 3 is applicable to the proposed project. The proposed project is a clean energy project and will not have major pollution sources associated with it. The construction works for the development of the project will involve generation of wastes like wastewater, waste oil and construction debris. The operation phase will result in the generation of waste such as transformer oil and wastewater from cleaning of solar panels, broken solar panels during cleaning activities.

Performance Standard 4: Community Health, Safety, and Security

PS4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts due to project activities. This Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related-activities, with particular attention to vulnerable group. In conflict and post-conflict areas, the level of risks and impacts described in this Performance Standard may be greater. The objectives of this include:

- To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances
- To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.

Applicability

PS 4 is applicable to the project. The proposed project will involve transportation of construction material and movement of construction machinery which may pose safety risks to the affected communities.

Performance Standard 5: Land Acquisition and Involuntary Resettlement

Performance Standard 5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) as a result of project-related land acquisition and/or restrictions on land use. Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement. This occurs in cases of (i) lawful expropriation or temporary or permanent restrictions on land use and (ii) negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail.

Applicability

The proposed project land belongs to both public and private ownership. PS 5 is application for the project as the land acquisition will be taken place. Though there is no displacement due to the proposed project intervention but the seasonal cultivated land will be acquired from the private landowner.

Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources

PS 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources are fundamental to sustainable development. The Performance Standard addresses how clients can sustainably manage and mitigate impacts on biodiversity and ecosystem services throughout the project's lifecycle.

Applicability

PS 6 is applicable to the proposed project. The wind turbine may impact on avifauna. There are two natural canals pass through the proposed project area that would be impacted during the construction phase.

Performance Standard 7: Indigenous Peoples

Performance Standard 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. Indigenous Peoples are particularly vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also come under threat. As a

consequence, Indigenous Peoples may be more vulnerable to the adverse impacts associated with project development than non-indigenous communities. This vulnerability may include loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and diseases.

Applicability

PS7 is not applicable to the proposed project. There is no settlement within the project boundary as well as indigenous people.

Performance Standard 8: Cultural Heritage

Performance Standard 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities. In addition, the requirements of this Performance Standard on a project's use of cultural heritage are based in part on standards set by the Convention on Biological Diversity. The objectives of this include:

- To protect cultural heritage from the adverse impacts of project activities and support its preservation;
- To promote the equitable sharing of benefits from the use of cultural heritage

Applicability

PS 8 is not applicable for the proposed project as no such tangible forms of cultural heritage or objects were observed in and around the project area, hence, this PS is not applicable to the proposed project.

Annex D: Applicable Standards

Table 1: Bangladesh Standard for Inland Surface Water

Best practice based classification	Parameter			
	pH	BOD mg/l	DO mg/l	Total Coliform Number/100
Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
Water usable for recreational activity	6.5-8.5	3 or less	5 or more	200 or less
Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or more	5000or less
Water usable by fisheries	6.5-8.5	6 or less	5 or more	-
Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or more	5000 or less
Water usable for irrigation	6.5-8.5	10 or less	5or more	1000 or less

Source: Rule 12, Schedule-3, ECR. 1997, Bangladesh

Figure 2: Bangladesh Standards for Drinking Water

Parameters	Units	Bangladesh Standards
Aluminum	mg/l	0.2
Ammonia (NH3)	mg/l	0.5
Arsenic	mg/l	0.05
Balium	mg/l	0.01
Benzene	mg/l	0.01
BOD5 20°C	mg/l	0.2
Boron	mg/l	1.0
Cadmium	mg/l	0.005
Calcium	mg/l	75
Chloride	mg/l	150- 600
Chlorinated alkanes	mg/l	0.01
1,1 dichloroethylene	mg/l	0.01
1,2 dichloroethylene	mg/l	0.03
Tetrachloroethylene	mg/l	0.03
Trichloroethylene	mg/l	0.09
Chlorinatedphenols pentachlorophenol	mg/l	0.03
2.4.6 trichlorophenol	mg/l	0.03
Chlorine (residual)	mg/l	0.2

Parameters	Units	Bangladesh Standards
Chloroform	mg/l	0.09
Chromium (hexavalent)	mg/l	0.05
Chromium (total)	mg/l	0.05
COD	mg/l	4
Coliform (fecal)	n/100 ml	0
Coliform (total)	n/100 ml	0
Color	Hazen unit	15
Copper mg/l	mg/l	1
Cyanide	mg/l	0.1
Detergents	mg/l	0.2
DO	mg/l	6
Fluoride	mg/l	1
Hardness (as CaCO3)	mg/l	200-500
Iron	mg/l	0.3-1.0
Kjeldahl Nitrogen (total)	mg/l	1
Lead	mg/l	0.05
Magnesium	mg/l	30-35
Manganese	mg/l	0.1
Mercury	mg/l	0.001
Nickel	mg/l	0.1
Nitrate	mg/l	10
Nitrite	mg/l	<1
Odor	mg/l	Odorless
Oil and grease	mg/l	0.01
pH	mg/l	6.5-8.5
Phenolic compounds	mg/l	0.002
Phosphate	mg/l	6
Phosphorus	mg/l	0
Potassium	mg/l	12
Radioactive materials (gross alpha activity)	Bq/l	0.01
Radioactive materials (gross beta activity)	Bq/l	0.1
Selenium	mg/l	0.01

Parameters	Units	Bangladesh Standards
Silver	mg/l	0.02
Sodium	mg/l	200
Suspended particulate matters	mg/l	10
Sulfide	mg/l	0
Sulfate	mg/l	400
Total dissolved solids	mg/l	1000
Temperature	°C	20-30
Tin	mg/l	2
Turbidity	JTU	10
Zinc	mg/l	5

Source: Rule 12, Schedule-3, ECR.1997, Bangladesh

Figure 3: Bangladesh Standards for Waste from Industrial Units or Project Waste

Parameters	Units	Inland Surface Water
Ammonical Nitrogen (as elementary N)	mg/l	50
Ammonia (as free ammonia)	mg/l	5
Arsenic	mg/l	0.2
BOD5 20°C	mg/l	50
Boron	mg/l	2
Cadmium	mg/l	0.50
Chloride	mg/l	600
Chromium (as total Cr)	mg/l	0.5
COD	mg/l	200
Chromium (as hexavalent Cr)	mg/l	0.5
Copper	mg/l	0.5
Dissolved Oxygen (DO)	mg/l	4.5-8
Electrical Conductivity (EC)	micro mho/cm	1200
Total Dissolved Solids	mg/l	2100
Fluoride (as F)	mg/l	2
Sulfide (as S)	mg/l	1
Iron (as Fe)	mg/l	2
Total Kjeldahl Nitrogen (as N)	mg/l	100
Lead (as Pb)	mg/l	0.1
Manganese (as Mn)	mg/l	5
Mercury (as Hg)	mg/l	0.1

Parameters	Units	Inland Surface Water
Nickel (as Ni)	mg/l	1.0
Nitrate (as elementary N)	mg/l	10
Oil and Grease	mg/l	10
Phenolic Compounds (as C6H5OH)	mg/l	1.0
Dissolved Phosphorus (as P)	mg/l	8
pH	mg/l	6-9
Selenium (as Se)	mg/l	0.05
Zinc (as Zn)	mg/l	5
Temperature	°C	Summer-40, Winter-45
Suspended Solids (SS)	mg/l	150
Cyanide (as Cn)	mg/l	0.1

Source: Rule- 13, Schedule-10, ECR.1997, Bangladesh

Figure 4: IFC Indicative Values for Treated Sanitary Sewage Discharges

Pollutants	Units	Guideline values
pH	-	6-9
BOD	mg/l	30
COD	mg/l	125
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/ 100ml	400

Source: IFC EHS General Guidelines 30 April, 2007

Figure 5: Bangladesh Standards for Sewage Discharge

Pollutants	Units	Standard limit for discharge into surface and inland water bodies
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
Suspended Solids (SS)	mg/l	100
Temperature	°C	30
Coliform number	Per 100 ml	1000

Source: Rule- 12, Schedule-9, E.C.R.1997, Bangladesh

Figure 6: WHO* Ambient Air Quality Guidelines

Parameters	Guideline value	Averaging period
PM 10 (µg/m^3)	20	Annual
	50	24 hour
PM 2.5 (µg/m^3)	10	Annual
	25	24 hour
NOx	40	Annual
	200	1 hour
SOx	20	24 hour

Source: WHO guideline available at www.who.int/en

*World Health Organization (WHO) Ambient Air Quality Guideline Values (2005 and 2000), which are also being referred in the World Bank and IFC's General EHS Guidelines (2007)

Figure 7: Ambient Air Quality Standards of Bangladesh

Parameter	Standard	Average time
Carbon Monoxide (mg/m^3)	10	8 hour
	40	1 hour
SPM (µg/m^3)	200	8 hour
PM 10 (µg/m^3)	50	Annual
	150	24 hour
PM2.5 (µg/m^3)	15	Annual
	65	24 hour
NOx (µg/m^3)	100	Annual
Ozone (µg/m^3)	235	1 hour
	157	8 hour
SOx (µg/m^3)	80	Annual
	365	24 hour

Source: Bangladesh Gazette 19th July, 2005 under ECR 1997

Figure 8: Bangladesh Standards for Ambient Sound Level

Category area	Day (dB)	Night (dB)
Silent Zone*	50	40
Residential Area	55	45
Mixed Area**	60	50
Commercial Area	70	60
Industrial Area	75	70

Source: Bangladesh Gazette 7th September, 2006 under ECR, 1997

* Area up to radius of 100 m around hospitals or educational institutions or special institutions/establishments identified/to be identified by the government designated as silent zone where use of horns of vehicles or other audio signals, and loudspeakers are prohibited)

** Mainly residential area, and also simultaneously used for commercial and industrial purposes.

Figure 9: The WB/IFC Noise Level Guidelines*

Receptor	One hour LAeq (dB)	
	Daytime (07:00 –22:00)	Night time (22:00 –07:00)
Residential, institutional, educational**	55	45
Industrial, commercial	70	70

Source: IFC EHS General Guidelines 30 April, 2007

** Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.*

*** For acceptable indoor noise levels for residential, institutional, and educational settings refer to WHO (1999).*

Noise Standard for Occupational Exposure

Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA). No exposure in express of 115 dB (A) is to be permitted. For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.

Figure 10: Standards for Occupational Noise Exposure

Total Time of Exposure per Day in Hours (Continuous or Short-term Exposure)	Sound Pressure Level in dB (A)
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
3/4	107
1/2	110
1/4	115
Never	>115

Annex E: Checklist of Homestead Plantation According to Block Survey

Block#HP1

Sl.#	Local Name	Common name	Scientific name	Family	Number	Types
1.	Supari	Areca palm	*Areca catechu*	Arecaceae	3	T
2.	Narikel	Coconut	*Cocos nucifera*	Arecaceae	2	T
3.	Rain Tree	Rain tree	*Samanea saman*	Fabaceae	3	T
4.	Kola	Banana	*Musa sapientum*	Musaceae	10	H
5.	Khezur	Date palm	*Phoenix dactylifera*	Arecaceae	2	T
6.	Peyara	Guava	*Psidium guajava*	Myrtaceae	2	T
7.	Amm	Mango	*Mangifera indica*	Anacardiaceae	2	T
8.	Mehegony	Mehegoni	*Swietenia mahagoni*	Meliaceae	3	T

Block#HP2

Sl.#	Local Name	Common name	Scientific name	Family	Number	Types
1.	Rain Tree	Rain tree	*Samanea saman*	Fabaceae	3	T
2.	Narikel	Coconut	*Cocos nucifera*	Arecaceae	5	T
3.	Tetul	Tamarind tree	*Tamarindus indica*	Fabaceae	1	T
4.	Amm	Mango	*Mangifera indica*	Anacardiaceae	2	T
5.	Khezur	Date palm	*Phoenix dactylifera*	Arecaceae	5	T
6.	Kola	Banana	*Musa sapientum*	Musaceae	13	H
7.	Peyara	Guava	*Psidium guajava*	Myrtaceae	2	T
8.	Supari	Areca palm	*Areca catechu*	Arecaceae	3	T

Block#HP3

Sl.#	Local Name	Common name	Scientific name	Family	Number	Types
1.	Narikel	Coconut	*Cocos nucifera*	Arecaceae	5	T
2.	Amm	Mango	*Mangifera indica*	Anacardiaceae	4	T
3.	Supari	Areca palm	*Areca catechu*	Arecaceae	6	T
4.	Chalta	Chalta	*Dillenia indica*	Dilleniaceae	1	T
5.	Bash	Bamboo	*Bamboo spp.*	Poaceae	10	T
6.	Jam	Java Plum	*Syzygium cumini*	Myrtaceae	3	T

Annex F: Checklist of Forest Land Vegetation According to Block Survey

Block#FP1

Sl.#	Local Name	Common name	Scientific name	Family	Number	Types
1.	Gewa	Milkey Mangrove	*Excoecaria agallocha*	Euphorbiaceae	21	T
2.	Babla	Indian Gum-arabic tree	*Acacia nilotica*	Mimosaceae	2	T
3.	Hargoza	Holy mangrove	*Acanthus ilicifolius*	Acanthaceae	7	S

Block#FP2

SL#	Local Name	Common name	Scientific name	Family	Number	Types
1.	Gewa	Milkey Mangrove	*Excoecaria agallocha*	Euphorbiaceae	18	T
2.	Babla	Indian Gum-arabic tree	*Acacia nilotica*	Mimosaceae	3	T
3.	Hargoza	Holy mangrove	*Acanthus ilicifolius*	Acanthaceae	5	S

Block#FP3

Sl.#	Local Name	Common name	Scientific name	Family	Number	Types
1.	Gewa	Milkey Mangrove	*Excoecaria agallocha*	Euphorbiaceae	23	T
2.	Babla	Indian Gum-arabic tree	*Acacia nilotica*	Mimosaceae	1	T
3.	Hargoza	Holy mangrove	*Acanthus ilicifolius*	Acanthaceae	8	S

Annex G: Checklist of Grass Land Species

Sl.#	Local Name	Scientific Name	Family	Local status	Red data Book of Bangladesh (National Herbarium 2001)
1.	Durba	*Cynodon dactylon*	Gramineae	VC	Not Evaluated
2.	Hachuti	*Dentella repens*	Rubiaceae	R	Not Evaluated
3.	Kancha ghash	*Cotula hemispherica*	Compositae	C	Not Evaluated
4.	Niratraba	*Cyperus cephalotes*	Cyperaceae	VC	Not Evaluated
5.	Sachishak	*Alternanthera sessilis*	Amaranthaceae	R	Not Evaluated
6.	Mutha	Cyperus rotundus	Cyperaceae	C	Not Evaluated
7.	Vhadale	*Kyllinga nemoralis*	Cyperaceae	VC	Not Evaluated
8.	lesser spear grass	*Chrysopogon aciculatus*	Poaceae	VC	Not Evaluated
9.	Indian goosegrass	*Eleusine indica*	Poaceae	C	Not Evaluated

Note: Local status: C-Common, VC-Very Common, R-Rare, VR-Very Rare

Annex H: Checklist of Aquatic Vegetation

Sl.#	Common Name	Family Name	Scientific Name	local Status	Red data Book of Bangladesh (National Herbarium 2001)
1.	Alligator weed	Amaranthaceae	*Alternanthera philoxeroides*	*C*	Not Evaluated
2.	Flatsedge	Cyperaceae	*Cyperus sp.*	*VC*	Not Evaluated
3.	Common water hyacinth	Pontaderiaceae	*Eichhornia crassipes*	*VC*	Not Evaluated
4.	Swamp morning-glory	Convolvulaceae	*Ipomoea aquatica*	*VC*	Not Evaluated
5.	Minute duckweed	Lemnaceae	*Lemna perpusilla*	C	Not Evaluated
6.	Four Leaf Clover	Mersileaceae	*Marsilea quadrifolia*	C	Not Evaluated
7.	Arrow Leaf Pondweed	Pontaderiaceae	*Monochoria hatata*	C	Not Evaluated
8.	Bishkatali	Polygonaceae	*Polygonum lanatum*	C	Not Evaluated
9.	Common duckweed	Lemnaceae	*Spirodela polyrhiza*	C	Not Evaluated
10.	Watermeal	Lemnaceae	*Wolffia microscopica*	C	Not Evaluated

Note: C-Common, VC- Very Common

Annex I: Checklist of Bird (Avifauna)

Sl. #	Local Name	Common Name	Scientific name	Family	IUCN status Bangladesh 2015
1.	Bon Shalik	Jungle Myna	*Acridotheres fuscus*	Sturnidae	LC
2.	Pakra Shalik	Asian Pied Starling	*Gracupica contra*	Sturnidae	LC
3.	Dhan salik	Common Myna	*Acridotheres tristis*	Sturnidae	LC
4.	Kala Fingey	Black Drongo	*Dicrurus macrocercus*	Dicruridae	LC
5.	Dhar Kak	Jungle Crow	*Corvus macrorhynchos*	Corvidae	LC
6.	Pati Chorui	House Sparrow	*Passer domesticus*	Passeridae	LC
7.	Kana kukhra	Greater Coucal	*Centropus sinensis*	Cuculidae	LC
8.	Go Bok	Cattle Egret	*Bubulcus ibis*	Ardeidae	LC
9.	Boro Sada bok	Great Egret	*Ardea alba*	Ardeidae	LC
10.	Deshi Kanibok	Indian Pond Heron	*Ardeola grayii*	Ardeidae	LC
11.	Doyel	Oriental Magpie Robin	*Copsychus saularis*	Muscicapidae	LC
12.	Lenja Latora	Long tailed shrike	*Lanius schach*	Lanidae	LC
13.	Dar Kak	Jungle Crow	*Corvus levaillantii*	Corvidae	LC
14.	Telia Ghughu	Spotted Dove	*Spilopelia chinensis*	Columbidae	LC
15.	Lal Chil	Brahminy Kite	*Haliastur indus*	Accipitridae	LC
16.	Chhoto pankouri	Little Cormorant	*Microcarbo niger*	Phalacrocoracidae	LC
17.	Pati Kak	House Crow	*Corvus splendens*	Corvidae	LC
18.	Pati Maachranga	Common Kingfiher	*Alcedo atthis*	Alcedinidae	LC
19.	Lapwing	Red- Wattled Lapwing	*Vanellus indicus*	Charadriidae	LC
20.	Pati Batan	Common sandpiper	*Actitis hypoleucos*	Scolopacidae	LC
21.	Choto Pankoiri	Little Cormorant	*Microcarbo niger*	Phalacrocoracidae	LC
22.	Choto Gulinda	Whimbrel	*Numenius phaeopus*	Scolopacidae	LC
23.	Sitrin Khonjon	Citrine Wagtail	*Motacilla citreola*	Motacillidae	LC

Note: LC- Least Concern

Annex J: Checklist of Fish Species

Sl.#	Local Name	English Name	Scientific Name	Family	IUCN Red List Status Bangladesh 2015
1.	Guchi Baim	Striped spiny eel	*Macrognathus pancalus*	Mastacembelidae	LC
2.	Khailsha	Giant gourami	*Colisa fasciatus*	Osphronemidae	LC
3.	Lal Khalisha	Red gourami	*Colisa lalia*	Osphronemidae	LC
4.	Koi	Climbing perch	*Anabas testudineus*	Anabantidae	LC
5.	Bele	Tank goby	*Glossogobius giuris*	Gobiidae	LC
6.	Chanda	Glass-Perchlet	*Pseudambasis lala*	Ambassidae	LC
7.	Lomba Chanda	Elongate glass perchlet	*Chanda nama*	Ambassidae	LC
8.	Shol	Striped snakehead	*Channa striatus*	Channidae	LC
9.	Taki	Spotted Snakehead	*Channa punctatus*	Channidae	LC
10.	Telo taki	Asiatic Snakehead	*Channa orientalis*	Channidae	LC
11.	Chang Taki	Dwarf Snakehead	*Channa gachua*	Channidae	LC
12.	Kaikka	Needle fish	*Xenentodon cancila*	Belonidae	LC
13.	Shing	Stinging catfish	*Heteropneustes fossilis*	Heteropneustidae	LC
14.	Magur	Air breathing Catfish	*Clarias batrachus*	Clariidae	LC
15.	Tengra	Striped dwarf Catfish	*Mystus vittatus*	Bagridae	LC
16.	Golsha tengra	Gangetic Mystus	*Mystus bleekeri*	Bagridae	LC
17.	Bujuri-tengra	Tengra	*Mystus tengara*	Bagridae	LC
18.	Gutum	Cross fish	*Lepidocephalichthys guntea*	Cobitidae	LC
19.	Puiya	Annandalle loach	*Lepidocephalichthys annandalei*	Cobitidae	LC
20.	Rui	Rohu	*Labeo rohita*	Cprinidae	LC
21.	Catla	Catla	*Catla catla*	Cyprinidae	LC
22.	Kalibaus	Orange fin labeo	*Labeo calbasu*	Cyprinidae	LC

Sl.#	Local Name	English Name	Scientific Name	Family	IUCN Red List Status Bangladesh 2015
23.	Bhangna, Bata	Reba	*Cirrhinus reba*	Cyprinidae	NT
24.	Chola Punti	Swamp barb	*Puntius chola*	Cyprinidae	LC
25.	Jat punti	Pool barb	*Puntius stigma*	Cyprinidae	LC
26.	Mola Punti	Glass barb	*Puntius guganio*	Cyprinidae	LC
27.	Mola	Indian carplet	*Amblypharyngodon microlepis*	Cyprinidae	LC
28.	Khoira	Indian grass Barb	*Chela laubuca*	Cyprinidae	LC
29.	Choukka	Indian pellona	*Pellona ditchela*	Pristigasteridae	LC
30.	Kachki	Ganges river spart	*Corica soborna*	Clupeidae	LC
31.	Bata	Corsula mullet	*Rhinomugil corsula*	Mugilidae	LC
32.	Mur Bailla	Bartail Flathead	*Platycephalus indicus*	Platycephalidae	LC

Annex K: Photograph of Stakeholder Consultation Meeting


Consultation with Department of Agriculture


Consultation with Department of Fisheries


Consultation with Department of Forest


Consultation with Department of Public Health and Engineering

Annex L: Attendance Sheet of Public Consultation Meeting

ATTENDANCE SHEET

Location: Char Chandia union P. Date: 22th January Time: 11:00 am

Sl.	Name of Participant	Gender	Age	Occupation	Phone Number	Signature
1	Md. Mosharef hossain milon		39	Chairman	01817384526	
2	Sayed Ahmed Kuddus	M	50	Farmer	0181-7732066	
3	Nijam uddin	M	65		01827436260	
4	Liton Boswas	M	47	Farmer	01815455402	
5	Nurnobi	M	35	Teacher	01823592601	
6	Mujibul Haque	M	41	Businessman		
7	Shirajul Islam	M	43	Farmer	01814978109	
8	Nur Nabi	M	39	Businessman	01831585926	
9		M				
10	Md. Mostafa	M	55	Fisherman	01823[illegible]26	
11	Mir Ahmed	M	57	Farmer	01812506090	
12	Md. Anayet ullah	M	60	U.P member	01814837378	
13	Md. Mostafa	M	61	Farmer	01830559251	
14	Mojibur Molla	M	45	Mawlana		
15	Mahadi Hasan	M	38	Rickshaw-Driver	0167241041	
16	Abdul Mutaleb	M	58	Elder person	01556-328518	
17	Nazimul Alam	M	45	Farmer	01915-328291	
18	Amzad Ali	M	65	Elder person	01673-125217	
19	Moshiur Mia	M	37	Driver	01782-325191	
20	Ataur Alam	M	53	Farmer	01831-423349	
21	Shamim Khanda kar	M	57	Elder Person	01841-556583	
22	Muktar Hossain	M	60	"	01914-321762	
23	Hazzyum Mia	M	41	Businessman	01791-428311	

Annex M: Draft Terms of Reference for ESIA Study of River Dredging

TORs for The Environmental and Social Impact Assessment (ESIA) and Environmental and Social Management Plan (ESMP) for River Dredging

The ESIA/ ESMP should be based on World Bank and Bangladesh guidelines and should take into consideration the latest relevant best international practices. The EIA should provide:

1) Description of the river area proposed for dredging activities and its surrounding local communities and natural ecosystems that could be impacted by the anticipated potential environment risks. It should also provide information on the dredging processes including methods, equipment, labor and permit requirements among other logistics.

2) Baseline data and description of the major environmental and social aspects including:

a. Physical environment: geology and hydrology of the river, flooding potential, drainage patterns among other issues.
b. Biological environment: fauna of the area, with special emphasis on rare, endemic, protected or endangered species; spawning and breeding areas, and migratory species, etc.
c. Water quality and the specific quality indicators.
d. Climatic conditions and air quality in the area of influence.
e. Affected local communities.

3) Pertinent national and local legislations, regulations and standards including environmental quality, safety and health, protection of sensitive areas, and protection of endangered species

4) Prediction of the likely direct, indirect and cumulative impacts of the dredging activities on the river ecosystem and vicinity as related, but not restricted, to the following:

a. Change in drainage pattern
b. Flooding potential/ alteration
c. Landscape impacts of excavation and construction
d. Loss of natural features, habitats and species by modification
e. Impact on coastal stability
f. Pollution of coastal waters
g. Impact on River ecosystem including dolphin (if present)
h. Impact on Sediment Quality
i. Impact of dredging and excavation and spoil disposal
j. Impact of spoil plumes generated by dredging
k. Air pollution
l. Noise
m. Transportation of dredge material to the construction site of the dike
n. Occupational health and safety
o. Community health and safety
p. Socio-economic impacts (if any).

5) Public Consultation and Disclosure

a. Introduction
b. Objectives of public Consultation and Disclosure Meeting
c. Approach and Methodology of Public Consultation and Disclosure Meeting
d. Outcome of Public Consultation Meetings
e. Outcome of Public Disclosure Meetings

6) Mitigation measures, associated costs and guidelines to avoid and/ or minimize the environmental and social impacts of the propose river dredging

7) Conclusion and Recommendations