

Environmental and Social Assessment (ESA) of 890KWp on Ground and 211KWP on Rooftops Solar System Project at Far East Spinning Industries Ltd, Madhabpur, Habiganj



August 2018

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Executive Summary

INTRODUCTION

1. Bangladesh is a densely populated country with 160 million people. To meet the increasing population, demand the generation of electricity is not produced as expected. The per capita generation is 348 kWh (Power Division, Government of the People's Republic of Bangladesh; Accessed on 19-08-2015). The per capita consumption of power by World Bank estimate in 2009 for India was 571 kWh, for Pakistan was 449 kWh and for China, it was 2631 kWh. The Sixth Five Year Plan contains information on demand-supply gap for electricity, source of electricity supply, use of different types of energy, electricity generation program and strategy for power generation.
2. With the advent of solar based technologies and the current global trend of reduction in solar panel costs, electricity generated using solar based technologies is expected to become cheaper than electricity generated from traditional sources. Thus, different industries are being encouraged to install solar PV based power plants to save electricity expenses in future.
3. Current electricity cost from solar plant is almost similar to grid tariff which is expected to be cheaper than grid tariff in future due to the constant fall in price in solar based technologies vs. expected rise in grid tariff to minimize gap between generation cost and tariff. Thus, financing such kind of projects makes financial sense apart from achieving country's target to promote renewable energy-based technologies in the country to ensure access to electricity for all.

METHODOLOGY

4. The study is based on both primary and secondary data and information. The primary data includes data collected from field observations, on-site & laboratory test and secondary data includes review of the Bangladesh statistical and relevant information from Government Departments. Discussions were held with stakeholders including community representatives and a wide range of Char areas.

POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

5. Legislative bases for Environmental Impact Assessment (EIA) in Bangladesh are the Environmental Conservation Act 1995 (ECA'95, as amended in 2010) and the Environmental Conservation Rules 1997 (ECR'97). Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, the 890kWp on Industrial Ground

Solar project and 211kWp on Industrial Rooftop solar system project in which both components are considered as the “**Green Category**”.

DESCRIPTION OF THE PROPOSED PROJECT

6. Far East Spinning Industries Ltd. (FESIL) proposed 890 KWp on 86,749 sft ground area; and 211 KWp on Rooftop Solar System Project. Project site is located at Uttor Surma, Teliapara, Madhabpur, Habiganj. Land area of the site is around 3200 decimal. In this project 890 KWp will be installed on 86,749 square feet ground area and rest 211 KWp will be installed on rooftops. A substation rooftop with 2914 square feet area and Utility Bay roof with 17670 square feet area will house the plants with aforementioned capacity
7. In the proposed system two main equipment will be used which are solar panels and inverters. Sun shines on the solar panels to generate DC electricity. The DC electricity produced from the solar panel will be converted to 415V 3-phase AC using the inverters. Then, the energy will be fed into the busbars of industry. A Zero Export Controller will be used to ensure “net zero export” The aggregated installed capacity of the project will be 890kWp on Industrial ground area and 211kWp on Industrial Rooftop.

DESCRIPTION OF THE BASELINE ENVIRONMENT

8. The project area is located in the south-central region climatic zone. In this zone, rainfall is abundant, being above 1,900 mm. The range of temperature is, as can be expected, much less than to the west, but somewhat more than in Southeastern zone. This is a transitory zone between the Southeastern, Northwestern and Southwestern zones and most of the severe hailstorms, nor are ‘westers and tornadoes recorded in this area. The minimum monthly average temperature in the project area lies within November to February which varies generally from 9.5°C to 16.6°C while the maximum monthly average temperature is seen in April which is around 32.8°C. The maximum annual rainfall was about 3145 mm in the year of 2002 at the project area. About 90% of the total rainfall has been recorded during monsoon. The average monthly humidity in the region varied from 70% to 85% depicted data from the year 1995 to 2013. The atmosphere of this zone always enriches with humidity because of high evaporation over the wetlands water surface. Solar radiation and evaporation are maximum during the pre-monsoon periods compared to the rest of the year. During high temperature in March-May, the evaporation from the soil also became high which further increased the soil alkalinity. Sunshine hour refers to the duration of solar insolation over a specific region in a day. Cloud coverage directly influence the sunshine hour. The average sunshine remained maximum with 7.9 hours in February. The minimum sunshine was 4.22 hours in the month of June in the area of Srimangal weather station. The statistical cloud coverage data from 1995 to 2013 shows that average cloud coverage remained maximum from 5 octas to 6.4 octas during June to September. The minimum cloud coverage was 1.31 octas in the month of December recorded in the area of Srimangal weather station.

9. Air quality test has been conducted on 13th March 2018 at the proposed project site and the test was analyzed by DSCL Environmental Laboratory. According to Bangladesh National Ambient Air Quality Standards from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005; PM₁₀, PM_{2.5} and SPM of the local ambient air exceeded Bangladesh standard. The other parameters were within the Bangladesh Standard. Noise level has been monitored at inside and outside of the project location during day time. The results show that time weighted average value of the sound monitored at inside and outside of the project area exceeded the standard fixed for Auto-knitting section, Generator section and Sewing section. For the other locations, the noise level was within the national standard.
10. The project area falls in the Northern and Eastern piedmont plain. The topography of the specific project location is 10.85-14.94 m. Geological structure of project area belongs to the northeastern folded area of Bangladesh. The fold belt is characterized by folding of the sedimentary layers into a series of anticlines (upward folds) and synclines (downward fold), refer to the Tripura Chittagong Fold Belt. According to the 24 general soil types of Bangladesh the project area falls in the soil tract group 13 which are non-calcareous alluvium and brown hill soils. The project area falls in the agro-ecological region of the Northern and Eastern Piedmont Plain (AEZ-22). There is no evidence of major earthquakes in the project areas in the recent past.

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

11. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities. Potential environmental impacts associated with the proposed project activities are classified as: (i) impacts during pre-construction and construction phase and ii) impacts during operation phase (iii) impacts during decommissioning phase.
12. During pre-construction phase, the impacts associated with the land use only. The project initiator will implement the project in their own industry and the locations will be on rooftop and ground area. Therefore, there are no anticipated impacts during the planning phase of the Project.
13. During construction phases, the major impact associated with environmental quality like air, noise, water, soil quality might be degraded due to improper management of the generated waste. Dust generated from construction machineries and gaseous emissions from vehicular transport as well machineries may deteriorate the air quality of the local area. Noise quality can be deteriorated due to the operation of various machineries and equipment. Various grease and oily substances may be released from the construction machineries may deteriorate the natural water of the project site. All the impacts will be very much localized in nature. The project contractor is to take responsibility of minimizing environmental impact on the surroundings during construction phases by following the project's environmental management plan (EMP). Other social impacts associated with the visual amenity, health safety of the labors, cultural resources, employment opportunity etc. such type of impacts will be localized

in nature and not anticipate to the project. The contractor should follow the rules and guidelines related to the environmental and social mentioned in the EMP.

14. During the operation period, the main impact is associated with heat generation. The heat may be transferred by convection, radiation and conduction method.
15. To minimize/mitigate the impacts the developer should follow the Environmental Management Plan (EMP) properly.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

16. Environmental Management Plan has been developed for addressing all adverse impacts pertaining to the implementation of the project. The plan presented in tabular form includes impacts, their sources of occurrence, their mitigation measures, actors responsible for implementation of mitigation measures and their responsibilities.
17. Environmental Monitoring Plan has incorporated key environmental components and parameters to be monitored their indicators, frequency, timing and locations of monitoring and also the actors responsible for carrying out such monitoring.
18. Far East Spinning Industries Ltd is the Executing Agency, responsible for overall project implementation and will establish a Project Management Unit (PMU) to manage the project on their behalf. A Project Manager (PM), supported by technical staff, who will design the infrastructure, manage selection of Contractors, and supervise construction, will head this.
19. Mitigation is the responsibility of Far East Spinning Industries Ltd. The project authority will implement the ESMP along with mitigation measures, as part of the contractual obligation. The cost for Environmental Mitigation Measures and Monitoring will be included in the project cost and allocated of fund will made accordingly.

CONCLUSION AND RECOMMENDATION

20. Based on the analysis, it may be concluded that the project stands environmentally sound and sustainable when the recommended mitigation measure and environmental management processes are adopted properly.
21. Severe weather conditions would have an impact on the construction activities. The construction activities may even have to be stopped during these periods. So, it is recommended that commencing construction in early winter season may help to reap the benefit of full dry spell of the season.
22. In order to enhance the occupational health and worker safety during the construction period, construction equipment would have to be kept in good order. Adequate safety measures should be taken and safety related equipment including personal protective and safety equipment (PPE), firefighting equipment etc. must be provided in order to reduce the potential for accidents.

ABBREVIATIONS

ADB	Asian Development Bank
AEZs	Agro-ecological Zones
BBS	Bangladesh Bureau of Statistics
CITES	Convention on International Trade in Endangered Species
DoD	Depth of Discharge
DoE	Department of Environment
DPHE	Department of Public Health Engineering
ECA	Ecologically Critical Area
ECC	Environmental Clearance Certificate
ECR	Environmental Conservation Rule
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EQS	Environmental Quality Standards
FGD	Focus Group Discussion
GHGs	Greenhouse Gases
GIS	Geographical Information System
GPS	Global Positioning System
IEE	Initial Environmental Examination
IP	Indigenous People
IPCC	Inter-government Panel on Climate Change
IUCN	International Union for Conservation of Nature
IDCOL	Infrastructure Development Company Limited
JICA	Japan International Cooperation Agency
MFF	Multitranchise financing facility
MSDS	Material Safety Data Sheet
NAPA	National Adaptation Programme on Action
NOC	No Objection Certificate
OSHA	Occupational Safety and Health Administration
PSMP	Power Sector Master Plan
PV	Photovoltaic
SLM	Sound Level Meter
SPM	Suspended particulate matter
SRDI	Soil Resource Development Institute
SREDA	Sustainable and Renewable Energy Development Agency
TDS	Total Dissolved Solids
TMP	Traffic Management Plan
ToR	Terms of References
UNDP	United Nations Development Program

1 CHAPTER ONE: INTRODUCTION

1.1 Project Background

Electricity tariff in Bangladesh is currently subsidized which keeps electricity cost affordable to general public of the country. However, given government's aspiration to become a middle-income country by 2041, gap between electricity generation cost and tariff needs to be eliminated gradually. Thus, it can be anticipated that, electricity tariff for generated power from traditional sources will continue to soar in future to eliminate the gap. With the advent of solar based technologies and the current global trend of reduction in solar panel costs, electricity generated using solar based technologies is expected to become cheaper than electricity generated from traditional sources. Thus, different industries are being encouraged to install solar PV based power plants to save electricity expenses in future. Current electricity cost from solar plant is almost similar to grid tariff which is expected to be cheaper than grid tariff in future due to the constant fall in price in solar based technologies vs. expected rise in grid tariff to minimize gap between generation cost and tariff. Thus, financing such kind of projects makes financial sense apart from achieving country's target to promote renewable energy-based technologies in the country to ensure access to electricity for all.

The policy of the Government of Bangladesh has been to ensure extension and stabilization of the power sector through both public and private sector undertakings toward not only meeting the existing power deficiency of the country but also ensuring continuous power in view of the projected future demand. Far East Spinning Industries Ltd. (FESIL) proposed a 890 KWp ground area; and 211 KWp on Rooftop Solar System Project. Project site is located at UttorSurma, Teliapara, Madhabpur, Habiganj. Land area of the site is around 3200 decimal. In which 890 KWp will be installed on 86,749 square feet ground area and rest 211 KWp will be installed on rooftops. A substation rooftop with 2914 square feet area and Utility Bay roof with 17,670 square feet area will house the plants with aforementioned capacity.

In the proposed system two main equipment will be used which are solar panels and inverters. Sun shines on the solar panels to generate DC electricity. The DC electricity produced from the solar panel will be converted to 415V 3-phase AC using the inverters. Then, the energy will be fed into the busbars of industry. A Zero Export Controller will be used to ensure "net zero export" The aggregated installed capacity of the project will be 890kWp on Industrial ground area and 211kWp on Industrial Rooftop.

Bangladesh receives an average daily solar radiation in the range of 4-5 kWh/m². Encouraged by the availability of solar radiation, Power Division has initiated a programme to generate 500 MW of solar-based electricity. Under this programme, projects for electrification of rural health centers, educational institutions, E-centers at union levels, religious establishments and remote railway stations are required to be implemented by authorities concerned. Private sector is expected to implement commercial projects like Solar Irrigation, Solar Mini Grid, Solar Park and Solar Rooftop applications.

The government is gradually meeting part of the lighting and cooling load of public offices by installing solar panels. The national capacity of solar power development currently exceeds 150 MW. Most of the capacity addition is from Solar Home Systems (SHS) implemented by Infrastructure Development Company Limited (IDCOL), a government-owned financial

institution. Until recently, more than 3 million SHSs have been installed with aggregated capacity of about 135 MW. The international community recognizes Bangladesh's SHSs as the fastest growing solar power dissemination program in the world.

Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh, the 890kWp on Industrial Ground Solar project and 211kWp on Industrial Rooftop solar system project in which both components are considered as the **“Green Category”**.

1.2 Rationale of the Project

In the proposed system two main equipment will be used which are solar panels and inverters. Sun shines on the solar panels to generate DC electricity. The DC electricity produced from the solar panel will be converted to 415V 3-phase AC using the inverters. Then, the energy will be fed into the busbars of industry. A Zero Export Controller will be used to ensure “net zero export” The aggregated installed capacity of the project will be 890kWp on Industrial ground area and 211kWp on Industrial Rooftop.

Load shedding is a frequent phenomenon in the locality, which happens for almost 2 hours on average per day. This translates into approximately Tk.2, 030,145.00 of fuel expenditure and Tk.674,000.00 of maintenance cost in a year. For this reason, the client has now planned to install a roof top solar power system that now envisages to fully replacing the diesel generators.

Electricity tariff in Bangladesh is currently subsidized which keeps electricity cost affordable to general public of the country. However, given government's aspiration to become a middle-income country by 2041, gap between electricity generation cost and tariff needs to be eliminated gradually. Thus, it can be anticipated that, electricity tariff for generated power from traditional sources will continue to soar in future to eliminate the gap.

With the advent of solar based technologies and the current global trend of reduction in solar panel costs, electricity generated using solar based technologies is expected to become cheaper than electricity generated from traditional sources. Thus, different industries are being encouraged to install solar PV based power plants to save electricity expenses in future.

Current electricity cost from solar plant is almost similar to grid tariff which is expected to be cheaper than grid tariff in future due to the constant fall in price in solar based technologies vs. expected rise in grid tariff to minimize gap between generation cost and tariff. Thus, financing such kind of projects makes financial sense apart from achieving country's target to promote renewable energy-based technologies in the country to ensure access to electricity for all.

1.3 Project Objectives and Benefits

The main objective of the Environmental and Social Assessment (ESA) study is to assess both positive and negative environmental impacts due to the project (Roof Top and Ground

area Solar Project activities. Assess the impacts and recommend appropriate mitigation measures during preconstruction, construction, and operation phases to minimize negative impacts of the project to acceptable levels. The ESA will be used as a decision-making tool to ensure that the project design and implementation activities are environmentally sound and sustainable. During the implementation phase, the prepared Environmental and Social Management Plan (ESMP) shall serve as a framework for strengthening the mitigation, enhancement and environmental monitoring measures and system of the rooftop and ground area solar project. In the preparation phase, the ESA shall achieve the following objectives:

- To establish the environmental and social baseline in the study area, and to identify any significant environmental issue;
- To assess these impacts and provide for measures to address the adverse impacts by the provision of the requisite avoidance, mitigation and compensation measures;
- To integrate the environmental and social issues in the project planning and design;
- To develop appropriate management plans for implementing, monitoring and reporting of the environmental and social mitigation and enhancement measures suggested.

1.4 ESA Methodology

The following methodology was adopted for carrying out the ESA of the proposed project:

1.4.1 Orientation

Meetings and discussions were held among the members of the ESA Team. This activity was aimed at achieving a common ground of understanding of various issues of the study.

1.4.2 Data Collection Planning

Subsequent to the concept clarification and understanding obtained in the preceding step, a detailed data acquisition plan was developed for the internal use of the ESA Team. The plan included identification of specific data requirements and their sources; determined time schedules and responsibilities for their collection; and indicated the logistics and other supporting needs for the execution of the data acquisition plan.

1.4.3 Data Collection

In this step, primary and secondary data were collected through field observations, environmental monitoring in the field, concerned departments and published materials to establish baseline profile for physical, biological and socioeconomic environmental conditions. A map in Figure 1.2 is showing the data collection spots of several environmental features in the project area. Following activities were performed for data collection: Site Reconnaissance; Analysis of Maps and Plans; Literature Review; Desk Research; Field Observations and Studies; Public Consultations; and Laboratory Analysis.

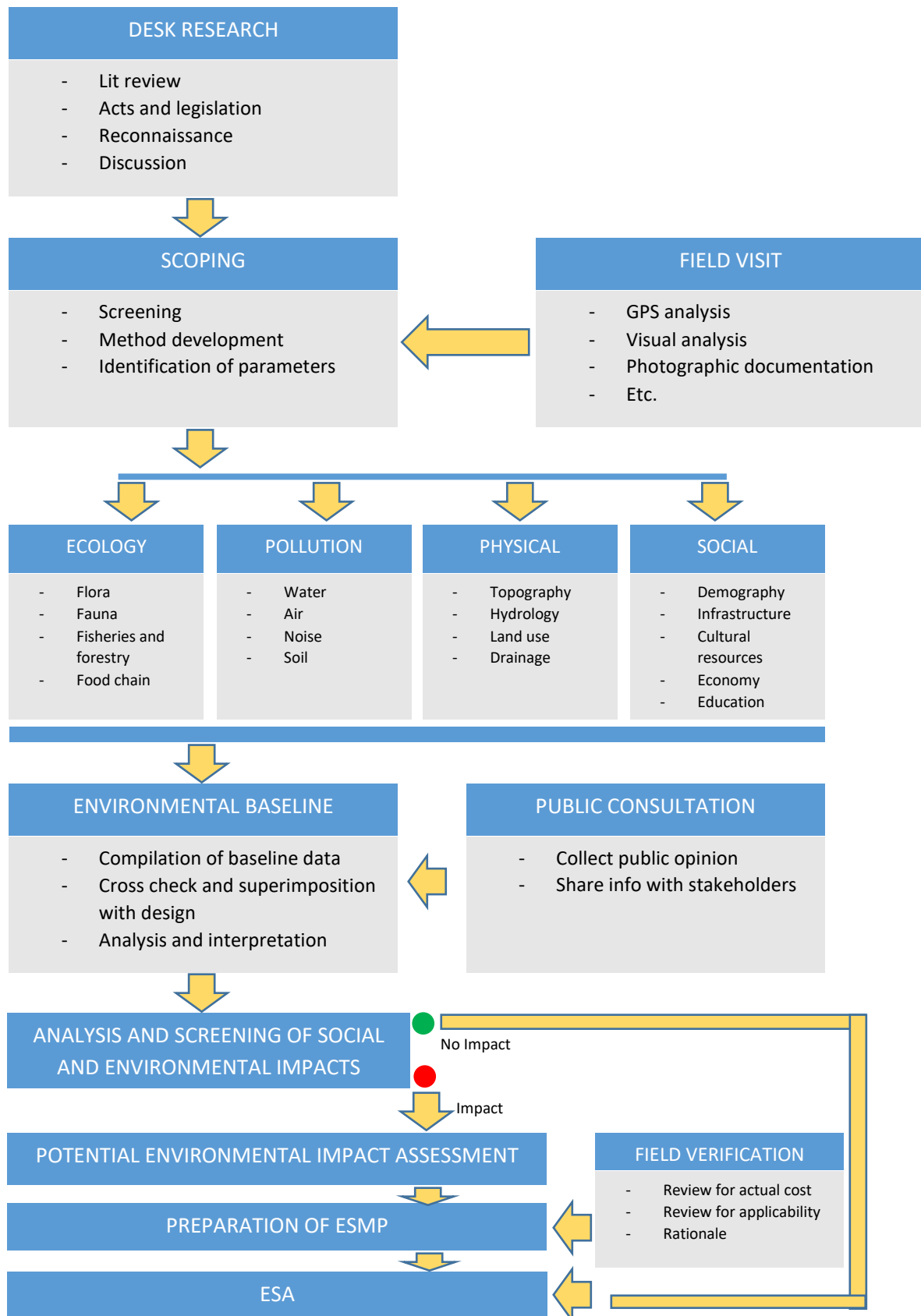


Figure 1.1 Route Map of ESA process

1.4.4 Physical Environment

Information was collected on the existing physical environment, particularly as related to geology, topography, soils, hydrology and drainage, water quality, air quality and noise. The primary sample collection map for the environmental issues has been given [Figure 1.2](#).

Geology, Topography, Soils

Data related to geology, topography and soil was collected to establish the baseline of the project area and further to find out the impacts of the Project during the construction and operational phases.

Hydrology and Drainage

Data related to hydrology and drainage was collected to identify the elements of the hydrological cycle that are likely to have impacts on the project and the possible impacts that the project could have on the hydrological regime. Field assessments included a determination and verification of all the existing inflows into the drain, assessment of drainage issues, interviews with local community members.

Air Quality

Ambient air quality measurements are essential to provide a description of the existing conditions, to provide a baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed construction on air quality conditions. To monitor ambient air quality, carbon monoxide (CO), sulphur dioxide (SO₂), particulate matter (PM₁₀), particulate matter (PM_{2.5}), Lead (Pb) and suspended particulate matter (SPM) have been included for ambient air quality monitoring.

Noise

The noise monitoring was performed by a trained specialist, using a calibrated Sound Level Meter set to A-weighting, fast response and statistical analysis settings. The Sound Level Meter (SLM) was mounted on a tripod at a height of approximately 1.5m, facing in the direction of the apparent predominant noise source. The SLM was programmed to record statistical noise levels for 15 minutes at each location and was calibrated before and after the survey; no significant drift was detected.

Surface Water Quality

Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD₅), Electric Conductivity (EC), Total Suspended Solids (TSS), NH₄-N, NO₃-N, PO₄-P.

Ground Water Quality

Sampling and analysis of ground/drinking water has been carried for the following parameters: pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chloride (Cl⁻), Electric Conductivity (EC), Temperature, Salinity, Iron (Fe), Arsenic (As), and Alkalinity.

1.4.5 Biological Environment

The status of the flora and fauna of the project area were determined by an ecological survey, review of literature relevant to the area, and an assessment of terrestrial environment.

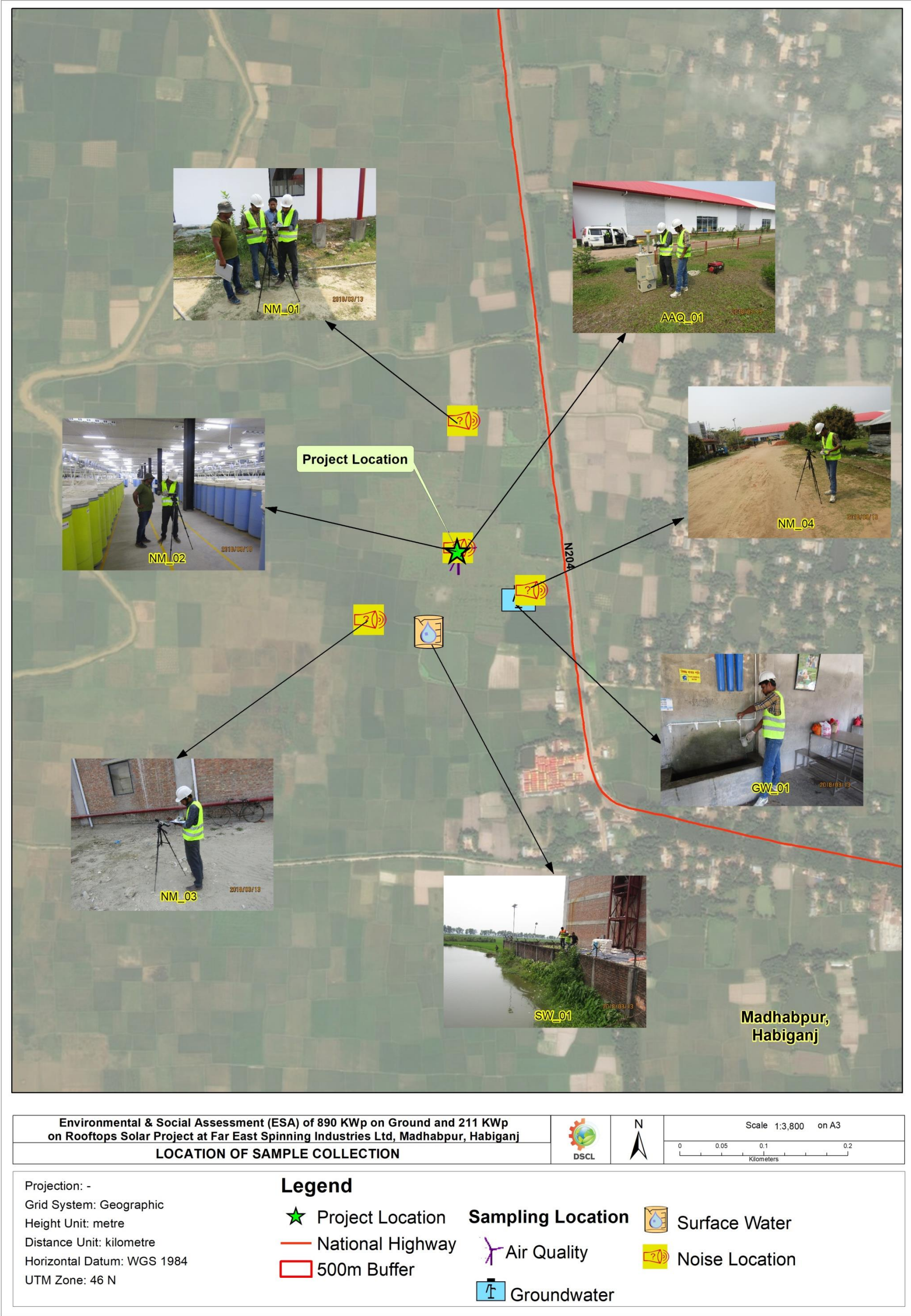


Figure 1.2 Sampling Locations

Flora

The vegetative communities were identified and classified into community types. Identification was carried out of dominant tree species, assessment of stage of growth (mature or sapling) and assessment of canopy cover.

Fauna

Information on fauna was gathered from existing literature on reported species as well as observations in the field.

1.4.6 Socio-Cultural Environment

The Consultants utilized a combination of desk research, field investigations, census data, structured interviews, maps, reports to generate the data required for description of the existing social environment and assessment of the potential impacts due to the construction of the project. Data was collected on the following aspects given below:

- Land use
- Transportation and access Roads
- Demographics
- Livelihoods
- Education
- Health
- Community facilities
- Recreational activities
- Archaeological and cultural heritage

1.5 ESA Team

The multidisciplinary team of ESA experts having experience of conducting Environmental and Social Assessment of large scale industrial and infrastructural development projects. **Table 1.1** presents the professionals' names with their positions.

Table 1-1 The ESA Study Team

No.	Name	Position
1	Mr. Md. Shafiqur Rahman	Team Leader (Senior Environmental Specialist)
2	Mr. Kushal Roy	Social Expert
2	Ms. Mafia Mostafa	Environmental Specialist
3	Mr. Tonmoy Pandit	Environmental Quality Expert
4	Mr. Md. Rasheduzzaman	Junior Environmental Specialist

2 CHAPTER TWO: PROJECT DESCRIPTION

2.1 Project Location and Design

The project site is located at Uttor Surma, Teliapara, Madhabpur, Habiganj. Land area of the site is around 3200 decimal. The 890 KWp will be installed on 86,749 square feet ground area and rest 211 KWp will be installed on rooftops. A substation rooftop with 2914 square feet area and Utility Bay roof with 17670 square feet area will house the plants with aforementioned capacity. The plant will be divided into two segments 1) 890kWp PV on the ground in front of the factory building and on the rooftop of the substation 2) 211kWp on the Utility bay. The plant will consist of total 3438 nos. of 320Wp PV modules, 40 nos. of inverters (36nos. active + 4 spare) and will feed power directly in to the factory's live BBT system. The plant is expected to inject 1756MWh energy in to the factory annually which is approx. 8% - 10% of its annual consumption.

In the proposed system two main equipment will be used which are solar panels and inverters. Sun shines on the solar panels to generate DC electricity. The DC electricity produced from the solar panel will be converted to 415V 3-phase AC using the inverters. Then, the energy will be fed into the busbars of industry. A Zero Export Controller will be used to ensure “net zero export” The aggregated installed capacity of the project will be 890kWp on Industrial ground area and 211kWp on Industrial Rooftop. Project area Photographs are presented in [Figure 2.1](#). The location of this project is shown in [Figure 2.2](#).



[Figure 2.1](#) Photographs of Location of the project

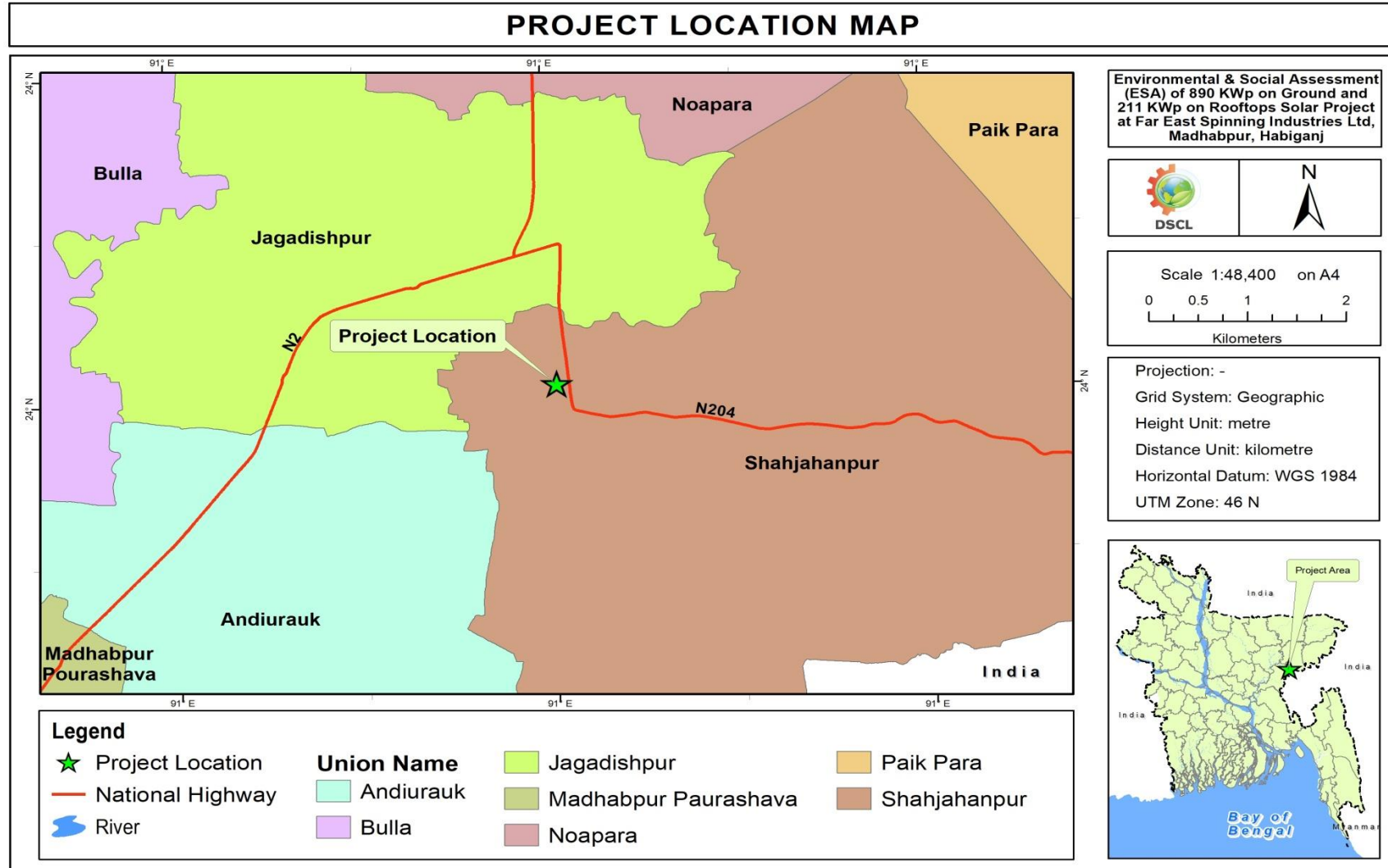




Figure 2.3 Location Map of the Project by Google Earth

2.2 Design Consideration

The design consideration of the Ground Mounted Solar PV Plant: Total Capacity 889KWp

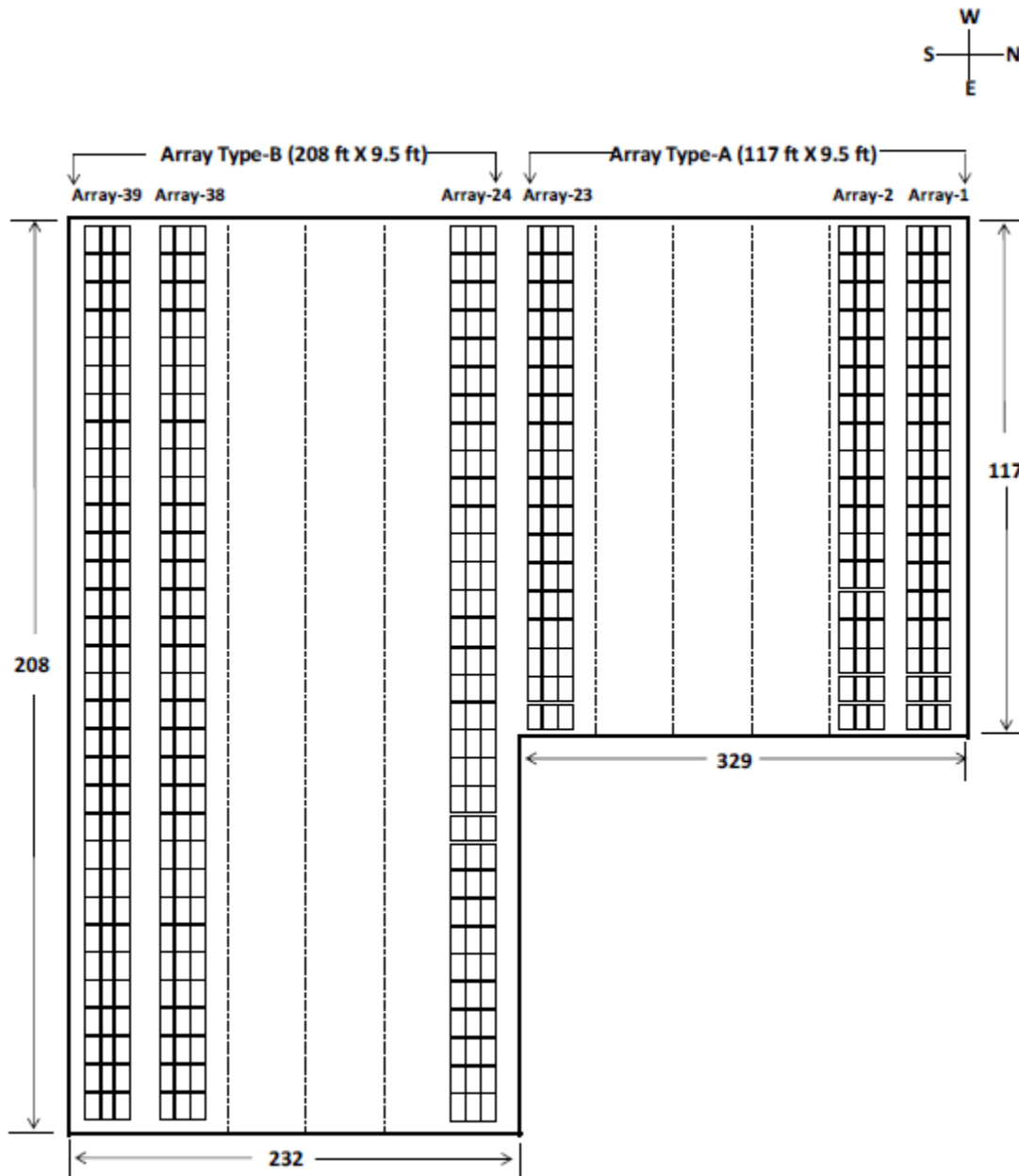


Figure: Layout of Ground Mounted Solar PV

Array Type-A

Length	117	ft
Width	9.5	ft
Nos. of PV per Array	54 (3 X 18 nos.)	Nos.
PV Power per Array	17.28	kWp
Distance between 2 Array	5	ft
Total Array	23	
Sequence of Array	Array-1 to Array-23	
Total Power	397	kWp

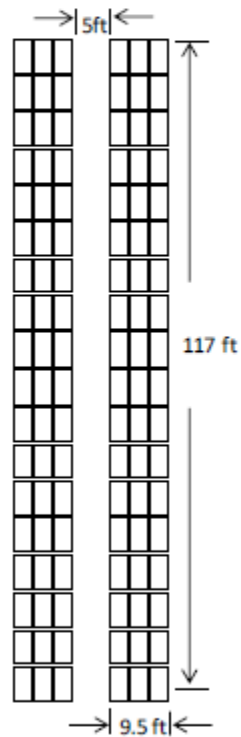


Figure: Array Type-A at Ground Mounted Solar PV

Array Type-B

Length	208	ft
Width	9.5	ft
Nos. of PV per Array	96 Nos. (3 X 32 nos.)	Nos.
PV Power	30.72	kWp
Distance between 2 Array	5	ft
Sequence of Array	Array-24 to Array-39	
Total Array	16 Nos.	
Total Power	491.52 kWp	

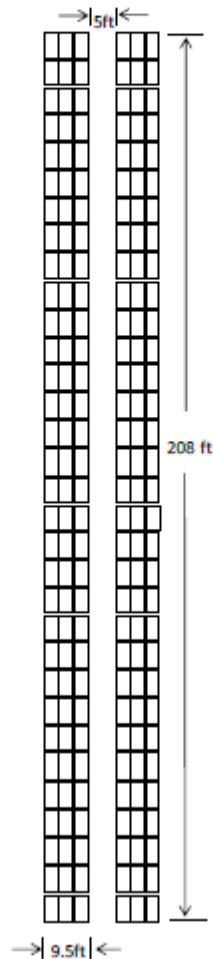


Figure: Array Type-B at Ground Mounted Solar PV

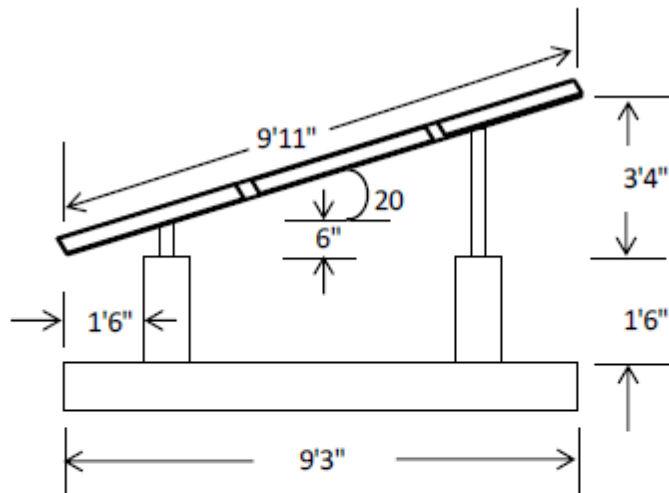
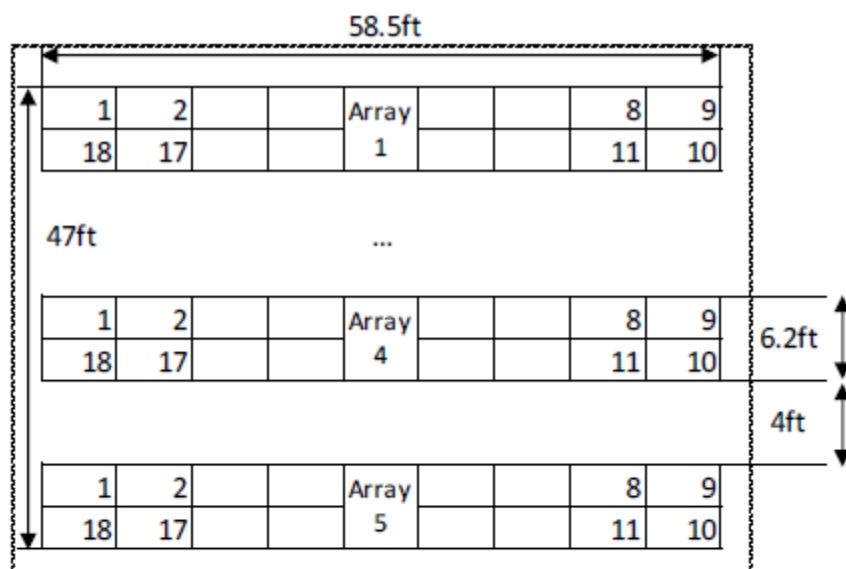


Figure: Side View of Ground Mounted Solar PV Array

ROOF-TOP OF SUBSTATION BUILDING

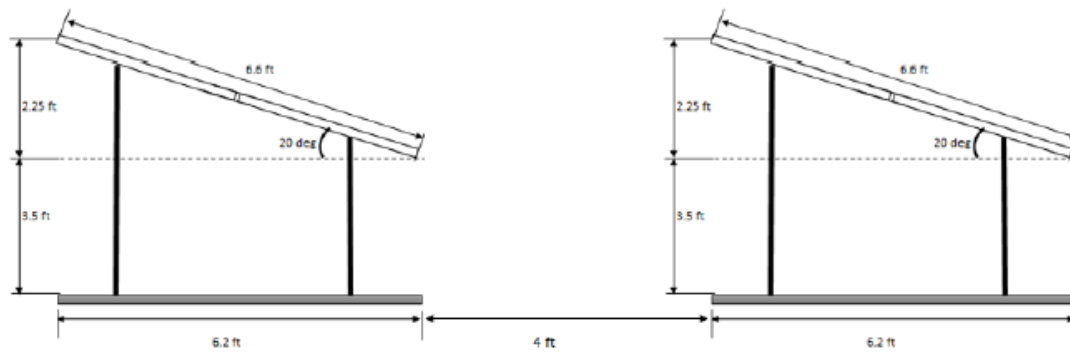


Panel spec					
L	1.96	m	=	6.50	ft
W	0.99	m	=	3.30	ft
T	0.04	m	=	0.20	ft
P	320	W			

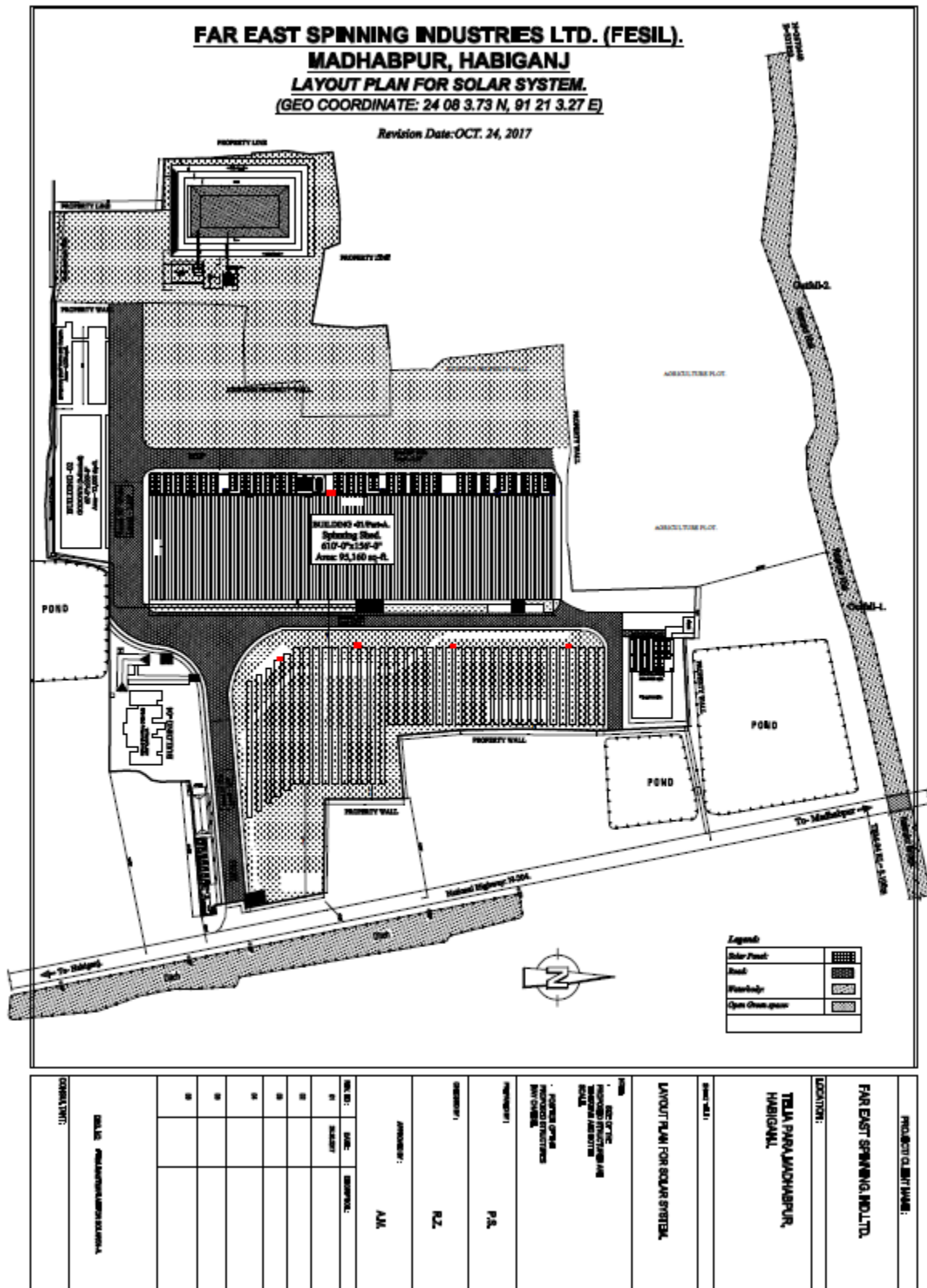
Substation dimensions					
L	18.9	m	=	62	ft
W	15.2	m	=	50	ft

Array		
Array length	58.50	ft
Array width	6.60	ft
Tilt	20.00	deg
Base height (front end)	3.50	ft
Height at column end	5.76	ft
Horizontal width of array	6.20	ft
Gap to adjacent array	4.00	ft
Array power	5.76	kW
Total nos of arrays	5	
Nos of PV modules	90	
Total array power	28.8	kW

Total nos of PV modules	9	
Total nos of inverters	1	
Total inverter power	2	kW
Total PV power on ation	2	kWp
Inverter overload	1.	
Performance ratio (1/inv ol)	0.	
PV string design		
90nos modules x 1 inverters		

PV STRUCTURE DESIGN SIDE VIEW

Layout Plant for Solar System



3 CHAPTER THREE: LEGAL AND POLICY FRAMEWORK

3.1 Applicable Policies

3.1.1 National Policies

3.1.1.1 Bangladesh Environmental Conservation Act (ECA) 1995, as amended in 2010

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

The Act was amended in 2010 on collection and recycling of used/non-functional batteries for conservation of environment, improving environmental standard and control and prevention of environmental pollution. According to this amendment, no recycling of battery will be permitted without environmental clearance of DOE. This also restricted the improper disposal of used batteries or any parts of used battery in open place, water bodies, waste bins, etc. All used batteries must be sent to the DOE approved battery recycling industry at earliest convenience. No financial transaction was allowed for used/non-functional batteries.

3.1.1.2 Bangladesh Environmental Conservation Rules, 1997

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

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

The Rule 3 defines the factors to be considered in declaring an area 'ecologically critical area' (ECA) as per Section 5 of ECA'95. It empowers the Government to declare an area 'ECA', if it is satisfied that the ecosystem of the area has reached or is threatened to reach a critical state or condition due to environmental degradation. The Government is also empowered to specify which of the operations or processes shall be carried out or shall not be initiated in the ecologically critical area. Under this mandate, MOEF has declared Sundarbans, Cox's Bazar-Tekhnaf Sea Shore, Saint Martin Island, Sonadia Island, Hakaluki Haor, Tanguar Haor, Marzat Baor and Gulshan-Baridhara Lake as ecologically critical areas and prohibited certain activities in those areas.

ECR'97 (Rule 7) classifies industrial units and projects into four categories depending on environmental impact and location for the purpose of issuance of ECC. These categories are:

- Green
- Orange A
- Orange B, and
- Red

All existing industrial units and projects and proposed industrial units and projects, that are considered to be low polluting are categorized under "Green" and shall be granted Environmental Clearance. For proposed industrial units and projects falling in the Orange- A, Orange-B and Red Categories, firstly a site clearance certificate and thereafter an environmental clearance certificate will be issued. A detailed description of those four categories of industries has been given in Schedule-1 of ECR'97.

Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh, 890 KWp on 86,749 sft ground area; and 211 KWp on Rooftop Solar System Project in which both are individually (50 KWp to 1MW) is considered as "**Green category**".

3.1.1.3 Renewable Energy Policy of Bangladesh, 2008

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 appropriate, efficient and environment 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 bio-fuels which may jeopardize the existing crops.

3.1.1.4 Guidelines for the Implementation of Solar Power Development Program, 2013

It is clearly mentioned in the section 3.8 of guidelines for the implementation of Solar Power Development Program (2013) that according to the Renewable Energy Policy, to establish a solar mini grid projects with a capacity up to 5 MW, entrepreneur will be exempted to get a waiver certificate. Mini grid projects with a capacity up to 250 MW will not be required any waiver certificate/license, but entrepreneur will have to inform the Commission by sending a letter. For implementation and operation of solar mini grid projects, license for a period of minimum 20 years may be issued with a condition to renew every year.

3.1.1.5 Bangladesh Labor Law, 2006

This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. In the chapter VI of this law safety precaution regarding explosive or inflammable dust/ gas, protection of eyes, protection against fire, works with cranes and other lifting machinery, lifting of excessive weights are described. And in the Chapter VIII provision safety measure like as appliances of first aid, maintenance of safety record book, rooms for children, housing facilities, medical care, group insurance, etc. are illustrated.

3.1.2 International Policies

3.1.2.1 The Japan International Cooperation Agency Requirements

“JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010)” provide four categories of projects as per its environmental classification system. The Projects classified under this system are screened for the anticipated environmental impacts and are set under relevant categories. JICA has classified Projects in the following four categories:

1. *Category A*: A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment. Borrowers and related parties must submit Environmental Impact Assessment (EIA) reports. For projects that will result in large-scale involuntary resettlement, basic resettlement plans must be submitted. EIA and other reports need to be submitted through the borrower before the JICA environmental reviews.
2. *Category B*: A proposed project is classified as Category B if its potential adverse environmental impact is less adverse than that of Category A projects.
3. *Category C*: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact.
4. *Category FI*: A proposed project is classified as Category FI if it satisfies all of the following:
 - JICA’s funding of the project is provided to a financial intermediary etc.;
 - the selection and assessment of the actual sub-projects is substantially undertaken by such an institution only after JICA’s approval of the funding and therefore the subprojects cannot be specified prior to JICA’s approval of funding (or assessment of the project); and
 - those sub-projects are expected to have potential impact on the environment.

The roof top solar project, as per the above categorization, falls under Category C for the purpose of environmental investigations.

3.1.2.2 World Bank’s Guidelines on Environmental and Social Safeguards Policies

There are two types of safeguards requirement of the World Bank-environmental and social. Under these two safeguards there are a number of operational policies. Among them, the following operational policies could have relevance with the proposed Project:

OP 4.01 Environmental Assessment

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

The Bank classifies the proposed project into three major categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

Category A: The proposed project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works.

Category B: The proposed project's potential adverse environmental impacts on human population or environmentally important areas-including wetlands, forests, grasslands, or other natural habitats are less adverse than those of Category A projects. These impacts are site specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than Category A projects.

Category C: The proposed project is likely to have minimal or no adverse environmental impacts.

OP 4.04 on Natural Habitats

The conservation of natural habitats, like other measures that protect and enhance the environment, is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank supports, and expects borrowers to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank promotes and supports natural habitat conservation and improved land use by financing projects designed to integrate into national and regional development the conservation of natural habitats and the maintenance of ecological functions. Furthermore, the Bank promotes the rehabilitation of degraded natural habitats.

3.1.2.3 ADB Guidelines on Environmental and Social Safeguards

Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects. New lending modalities and financing instruments, such as the multitranche financing facility (MFF), have increased the complexity of applying

safeguard policies and ensuring compliance. The new modalities and the likelihood of continued innovation, as well as changing client circumstances, suggest a need to enhance the relevance and effectiveness of ADB's safeguards, which has been reflected in an update of the Safeguard Policy by 2009, announced through the Safeguard Policy Statement 2009 (SPS 2009).

The objectives of ADB's safeguards are to:

- avoid adverse impacts of projects on the environment and affected people, where possible;
- minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
- help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks.

Since the ADB Safeguard Policy Statement had been approved it supersedes the Involuntary Resettlement Policy (1995), the Policy on Indigenous Peoples (1998), the Environment Policy (2002), and the second sentence of para 73, and paras 77–85 and 92 of the Public Communications Policy (2005).

3.2 Environmental Clearance

Formal EIA guidelines in Bangladesh are set out in “Rules and Regulations under the 1995 Environmental Protection Acts” as published in the official Gazette on August 27, 1997. Any proponent planning an industrial project is currently required under Paragraph 12 of the Environmental Protection Acts, 1995 to obtain “environmental clearance letter:” from the Department of Environment. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh, 890 KWp on 86,749 sft ground area; and 211 KWp on Rooftop Solar System Project in which both are individually (50 KWp to 1MW) is considered as **“Green Category”**.

4 CHAPTER FOUR: TECHNICAL ASPECTS

4.1 Proposed Process and Technology

The proposed Project will produce DC electricity through **Photovoltaic PV solar module** and then convert it to AC power through high-class **String Inverters**. This electricity will be directly connected to internal grid of the industries.

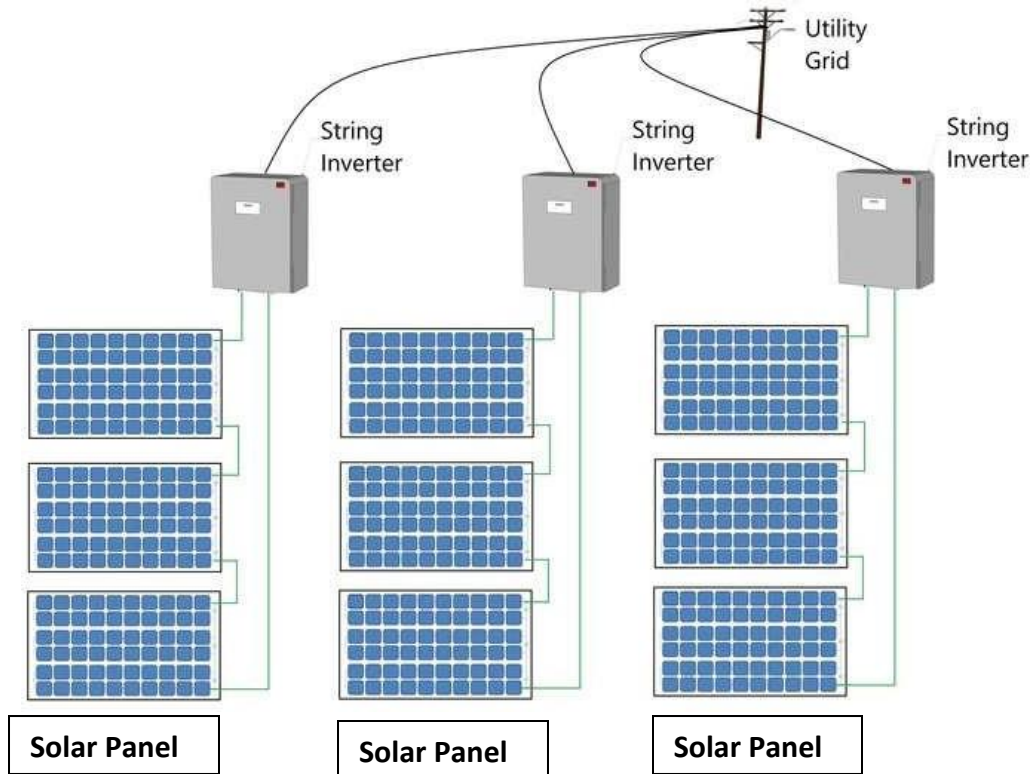


Figure 4.1: Layout of Grid Connected PV system

4.2 List of Major Equipment

Equipment	Manufacturer/Supplier	Country of Origin
Photovoltaic Module	Jinko Solar	China
Inverter	Tabuchi Electric Co., Ltd.	Japan
Master Box	Tabuchi Electric Co., Ltd.	Japan
Remote Monitoring Device	Tabuchi Electric Co., Ltd.	Japan

4.3 Description of Major Equipment

4.3.1 Photovoltaic (PV) module:

The PV Modules for this Megawatt project is polycrystalline and highly efficient. There will be 3,438 nos. of 320Wp PV Modules. The PV Module will be procured from Jinko Solar.

4.3.2 Grid-Tied String Inverter

For the proposed one-Megawatt solar plant, 40 nos. of 25 kW Grid-tied String inverters will be used. Tabuchi Electric Co., Ltd. - Japan is the manufacturer of these inverters.

4.3.3 Master Box for Three-Phase Solar

This is the Collective control device for multiple solar inverters. Basic Functions of Master Box are-

4.3.4 Remote Control

- Start/Stop, Re-Start of Stopped Inverters, and Parameter Setting.

4.3.5 Display of Operating Status

- The state of the inverter is indicated by the
- LED display on the Control Board.

4.3.6 Number of Solar Inverters

- Up to 20 solar inverters can be connected to a Master Box. Up to 10 Master Boxes may be networked together

4.4 Plant Capacity Selection

Plant capacity of a roof-top solar power project mainly depends on available space and load while other factors to be taken into consideration being shading effect, orientation of the building, tilt angle of the building, load bearing capacity and backup generator capacity. There is one 500 KVA generator, one 359 KVA Generator and one 60 KVA Generator installed. At this moment only the 500 KVA generator is operation and the other two are under maintenance. However, a new 800 KVA Generator is going to be installed in near future.

Present minimum load is 100 KW and the maximum load is 350-400KW. The factory is expecting an increase a load of 700KW very shortly. The total installed load will be 1.4 MW with a base load of 400 KW.

There is an 11KV/415V 500 KVA transformer installed in the factory. But the factory is going to install a 1.6 MVA transformer shortly. To ensure net zero export and considering the available roof space, the plant capacity was calculated to be 502 KWp.

The 890 KWp on Ground area; and 211 KWp on Rooftop Solar plant, to be installed at the Far East Spinning Industries Ltd, Madhabpur, Habiganj, is a grid tied peak load support system. The plant will be divided into two segments 1) 919.8kWp PV on the ground in front of the

factory building and on the rooftop of the substation 2) 180.6kWp on the Utility bay. The plant will consist of total 3438 nos. of 320Wp PV modules, 40 nos. of inverters (36nos. active + 4 spare) and will feed power directly in to the factory's live BBT system. The plant is expected to inject 1756MWh energy in to the factory annually which is approx. 8% - 10% of its annual consumption.



5 CHAPTER FIVE: ANALYSIS OF ALTERNATIVE

5.1 General

An ESA should describe a range of reasonable alternatives to the proposed project or to the location of the proposed project site that could feasibly avoid or lessen any significant environmental impacts of the proposed project while attaining most of the project's basic objectives. An ESA also must compare and evaluate the environmental effects and comparative merits of the alternatives. This chapter describes alternatives considered but eliminated from further consideration (including the reasons for elimination) and compares the environmental impacts of several alternatives retained with those of the proposed project.

The range of feasible alternatives is selected and discussed in a manner to foster meaningful public participation and informed decision making. Among the factors that may be taken into account when addressing the feasibility of alternatives are environmental impacts, site suitability, economic viability, social and political acceptability, technological capacity, availability of infrastructure, general plan consistency, regulatory limitations, jurisdictional boundaries, and whether the proponent could reasonably acquire, control, or otherwise have access to an alternative site. An ESA need not consider an alternative whose effects could not be reasonably identified, whose implementation is remote or speculative, and that would not achieve the basic project objectives.

The proposed project has the potential to have significant adverse effects on visual amenity; air quality; noise; biological resources; cultural resources; geology/soils; GHG emission; hazards and hazardous materials; hydrology and water quality; land use and planning; noise; public services; transportation and traffic; and utilities and service systems within the County. Even with the mitigation measures described in Chapter 7 of this ESA impacts in some of these issue areas would be significant and unavoidable. Therefore, this section discusses alternatives that are capable of avoiding or substantially lessening effects on these resources.

5.2 Do Nothing

The Do Nothing Alternative in respect to the proposed project implies that the status quo is maintained. This option is most suitable alternative from an extreme environmental perspective as it ensures non-interference with the existing conditions. However, the project activities have already been started. This option will however, involve several losses to both the project proponent and the donor organization. The property will remain under-utilized. The No Project Option is the least preferred from the socio-economic and partly environmental since if the project is not done.

- The economic benefits especially during construction i.e. provision of jobs for skilled and non-skilled workers will not be realized.
- There will be no generation of income by the developer to the Government.
- The local skills would remain under-utilized.
- No employment opportunities will be created who will work in the project area.
- Discouragement for donors to allot this level of standard and affordable developments.

5.3 Alternatives Energy Generation Technology

This alternative would involve the use of wind energy as an alternative to development of a solar site. Similar to solar power, power from the wind is an alternative to energy production from nonrenewable resources like coal and oil, or nuclear sources.

While the project area has been identified as suitable for solar projects based on the solar insolation levels (the amount of solar radiation energy) in the area, wind energy production is not well suited to the project site due in sufficient area to drive wind turbines on the ground area and rooftop.

5.4 Alternative Land Use

As the proposed project is for ground area and rooftop solar system, no alternative land use selection is possible.

5.5 Alternative Site

Relocation option to a different site is an option available for the project implementation. At the moment, there are no alternative sites for the proposed development (i.e. the project proponent doesn't have an alternative site). This means that the proponent has to look for another rooftop if relocation is proposed and rooftop is not available and if available, it will be too expensive for the proponent to realize his dream.

Looking for another rooftop to accommodate the scale and size of the project and completing official transaction on it may take a long period. In addition, it is not a guarantee that such land would be available. It's also worth noting that the said project is already underway in terms of seeking development approvals in various government departments.

The project proponent would spend another long period of time on design and approvals of the plans by the relevant government departments. The project design and planning before the stage of implantation would call for cost; already encountered in the proposed development i.e. whatever has been done and paid to date would be counted as a loss to the proponent. Assuming the project will be given a positive response (after relocation) by the relevant authorities including DoE, it (project) would have been delayed for a long period before implementation. This would also lead to a situation like No Action Alternative. In consideration of the above concerns and assessment of the current proposed site, relocation is not a viable option.

6 CHAPTER SIX: DESCRIPTION OF ENVIRONMENTAL AND SOCIAL BASELINE

6.1 General

The baseline environmental quality is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, land and socio-economic, etc. The primary objective of identifying and describing existing environmental conditions is to provide an understanding of the baseline conditions prior to undertaking any development activities.

Data was collected from secondary sources for the macro-environmental setting like climate (temperature, rainfall, humidity, and wind speed), physiography, geology etc. Firsthand information has been collected to record the micro-environmental features within and adjacent to the project area. Collection of primary information includes extrapolating environmental features on proposed project design, tree inventories, location and measurement of socio-cultural features adjoining proposed project area. Ambient air, noise, and water quality samples were collected in terms of environment quality to prepare a baseline database. Consultation was another source of information to explain local environmental conditions, impacts, and suggestions, etc.

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

- **Physical Environment-** factors such geology, climate and hydrology;
- **Ecological Environment-** factors related to life such as flora, fauna and ecosystem; and
- **Social Environment-** anthropological factors like demography, income, land use and infrastructure.

6.2 Physical Environment

Physical environment denotes the physical features that occur naturally (air, water, soil, atmosphere, etc.). In order to depict the existing physical environment in the project area, a few of the major parameters are considered like geology & soil, ambient air, noise, surface & ground water, etc.

6.2.1 Climate

The project area is heavily influenced by the Asiatic monsoon and it has three distinct seasons:

- Pre-monsoon hot season (from March to May),
- Rainy monsoon season (from June to October), and
- Cool dry winter season (from November to February).

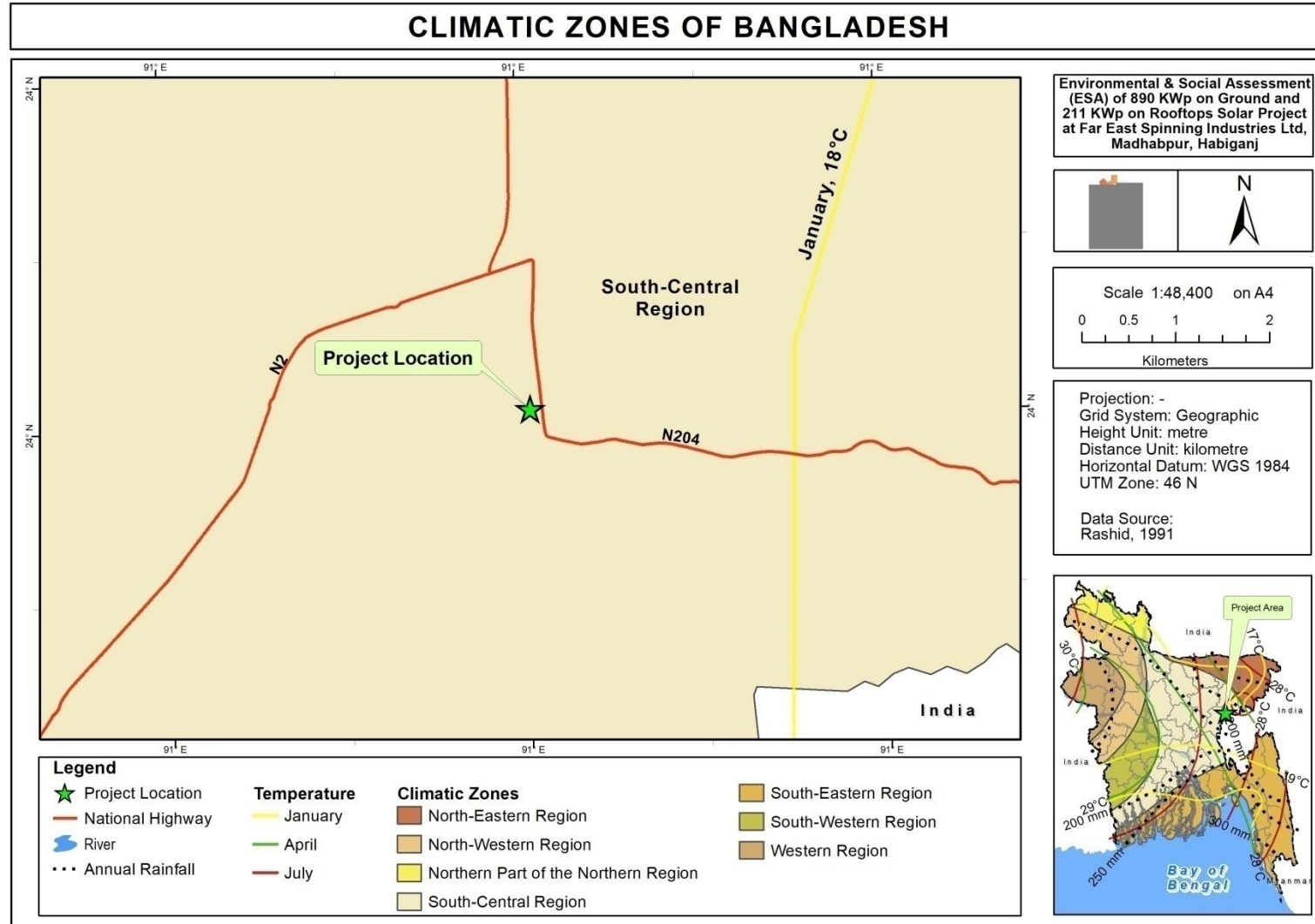
High temperatures and thunderstorms characterize the pre-monsoon hot season. April is the hottest month in the country with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud-cover reduces the temperature. Wind direction is variable during this season, especially during the early part. Rainfall, mostly caused by thunderstorms, at this time can account for 10 to 25 percent of the annual total.

The rainy monsoon season is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall and long periods of consecutive days of rainfall. The monsoon rain is caused by a tropical depression that enters the country from the Bay of Bengal. About 80% of the annual precipitation occurs during the five-month monsoon season from May to September.

The cool dry season is characterized by low temperatures, cool air blowing from the west or northwest, clear skies and meager rainfall. The average temperature in January varies from 17°C in the northwest and north-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme northwest in late December and early January reach between 3°C to 4°C.

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the Figure 6.1, the project site falls in the South-Central Region Climate Zone.

South-central zone: In this zone, rainfall is abundant, being above 1,900 mm. The range of temperature is, as can be expected, much less than to the west, but somewhat more than in Southeastern zone. This is a transitory zone between the Southeastern, Northwestern and Southwestern zones and most of the severe hailstorms, nor are 'westers and tornadoes recorded in this area.



6.2.1.1 Temperature

The minimum monthly average temperature in the project area lies within November to February which varies generally from 9.5°C to 16.6°C while the maximum monthly average temperature is seen in April which is around 32.8°C. Figure 6.2 shows the monthly maximum and minimum average temperature at Srimangal station from 1995 to 2013.

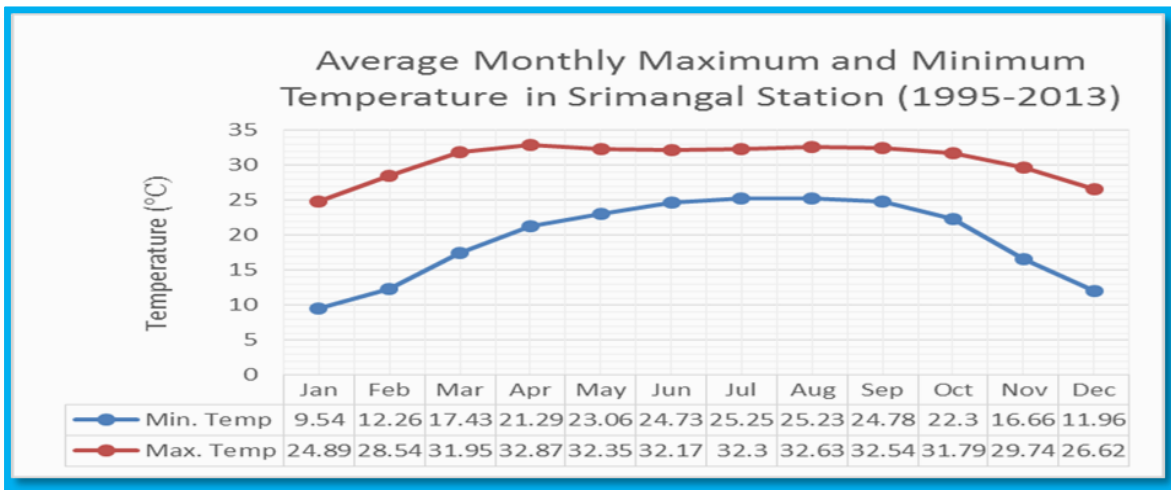
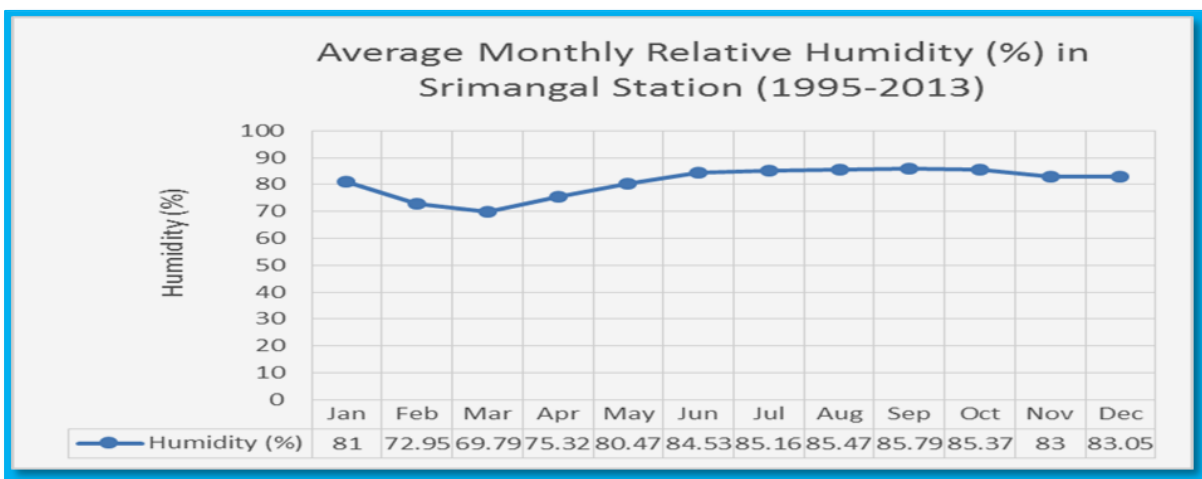


Figure 6.2 Variation of Monthly Surface Air Temperature of Srimangal Station

6.2.1.2 Humidity

Figure 6.2 shows the average monthly humidity in the region varied from 70% to 85% depicted data from the year 1995 to 2013. In general, the relative humidity of the study area is the lowest in January to May and from June there is a steady increase until November and then December decrease is observed down to January again.

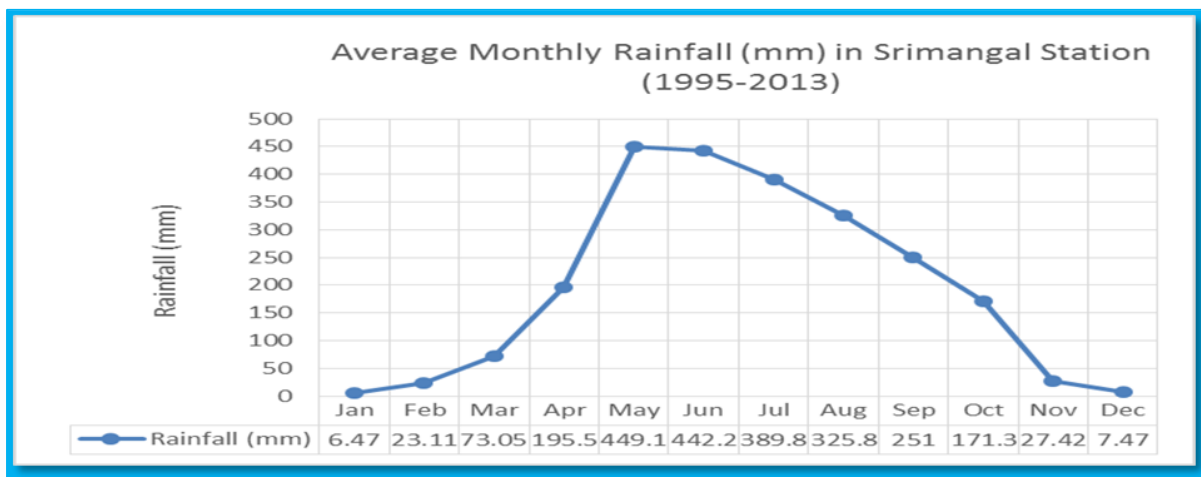


(Source: Bangladesh Agricultural Research Council)

Figure 6.3: Monthly Average Humidity of Srimangal Station (1995-2013)

6.2.1.3 Rainfall

The maximum annual rainfall was about 3145 mm in the year of 2002 at the project area. About 90% of the total rainfall has been recorded during monsoon. The rainfall data collected from the above stated station represents that maximum rainfall occurs during May to September and the lowest rainfall occurs in November to February during winter season. Statistical data of 1995 to 2013 shows that Srimangal stations experience almost 450 mm rainfall during monsoon. In the month of December and January of winter season around 8 mm rainfall occurred in the region of Srimangal weather station.



(Source: Bangladesh Agricultural Research Council)

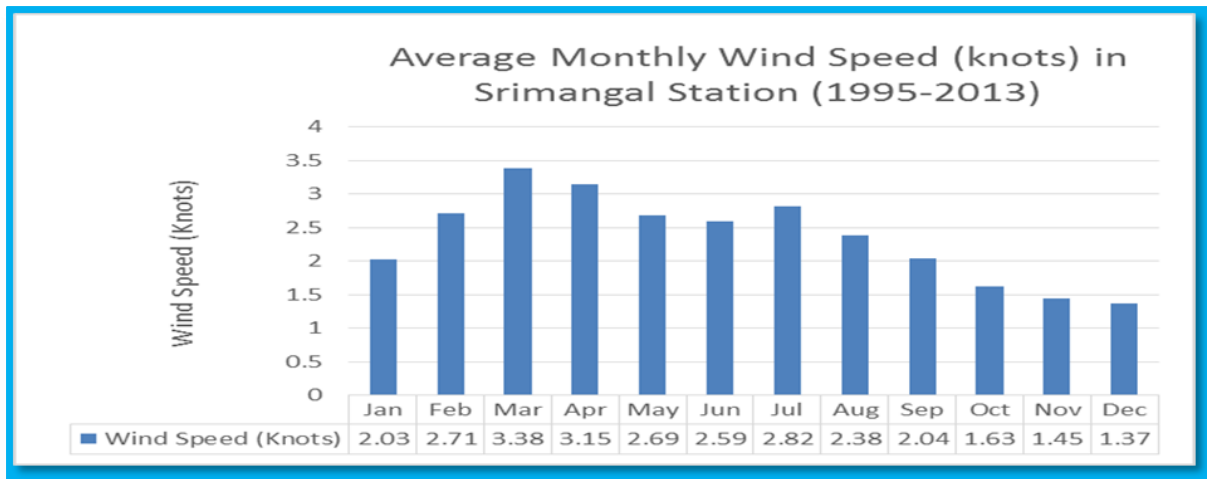
Figure 6.4: Monthly Average Rainfall of Srimangal Station

6.2.1.4 Evaporation

Evaporation is the process by which water changes from a liquid to a gas or vapor and back into the water cycle as atmospheric water vapor. The atmosphere of this zone always enrich with humidity because of high evaporation over the wetlands water surface. Solar radiation and evaporation are maximum during the pre-monsoon periods compared to the rest of the year. During high temperature in March-May, the evaporation from the soil also became high which further increased the soil alkalinity. A significant rainfall during this period could help mitigate the alkalinity problem.

6.2.1.5 Wind Speed

The statistical wind speed data from 1995 to 2013 (Figure 4.6) shows that average wind speed remained maximum with 3.38 knots in March. The minimum wind speed was 1.37 knots in the month of December in the area of Srimangal weather station.

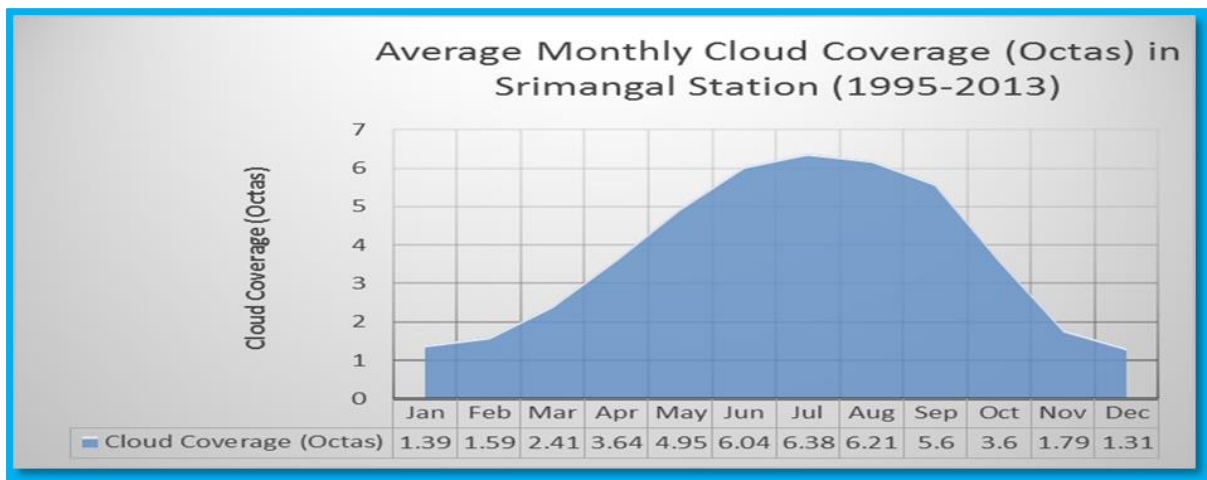


(Source: Bangladesh Agricultural Research Council)

Figure 6.5: Graphical representation of Wind speed at Srimangal Station

6.2.1.6 Cloud Coverage

The statistical cloud coverage data from 1995 to 2013 shows that average cloud coverage remained maximum from 5 octas to 6.4 octas during June to September. The minimum cloud coverage was 1.31 octas in the month of December recorded in the area of Srimangal weather station.

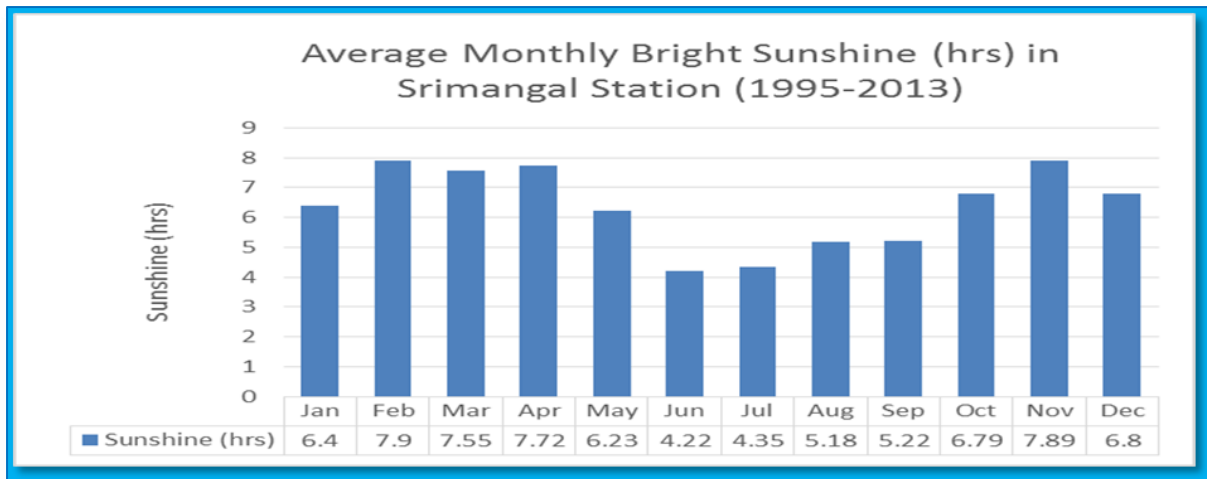


(Source: Bangladesh Agricultural Research Council)

Figure 6.6: Average Monthly Cloud Coverage at Srimangal Station

6.2.1.7 Sunshine

Sunshine hour refers to the duration of solar insolation over a specific region in a day. Cloud coverage directly influence the sunshine hour. The average sunshine remained maximum with 7.9 hours in February. The minimum sunshine was 4.22 hours in the month of June in the area of Srimangal weather station



(Source: Bangladesh Agricultural Research Council)

Figure 6.7: Average Monthly Maximum Sunshine at Srimangal Station

6.2.1.8 Ambient Air Quality

Ambient air quality refers to the background air quality levels in a region, characterized by concentrations of various pollutants in the atmosphere. The presence of air pollutants and their concentrations depends on the type of polluting sources, and other factors that influence their flow and dispersion. In most cases vehicular emissions are the predominant source of air pollution.



Figure 6.8 Air Quality Monitoring at Project Site

Ambient air quality measurements are essential to provide a description of the existing conditions or the baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed ground area and rooftop solar project air quality. Air quality test has been conducted on 13th March 2018 at the proposed project site and the test was analyzed by DSCL Environmental Laboratory. The test results (Appendix A) is given in the below **Table 6.1**. According to Bangladesh National Ambient Air Quality Standards from the Environmental Conservation Rules, 1997 which was amended on 19th July 2005 vide S.R.O. No. 220-Law/2005; PM₁₀, PM_{2.5} and SPM of the local ambient air exceeded Bangladesh standard. The other parameters were within the Bangladesh Standard.

Table 6-1: Test Results of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site	Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
PM ₁₀	µg/m ³	98	150	24	Sunny	Gravimetric
PM _{2.5}	µg/m ³	35	65	24		Gravimetric
SPM	µg/m ³	123	200	24		Gravimetric
SO ₂	µg/m ³	5.74	365	24		West- Geake
CO*	ppm	1	9	8		CO-Meter
Pb	µg/m ³	0.1	0.5	24		AAS Method

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DSCL Environmental Laboratory

Note:

* CO concentrations and standards are 8-hourly only.

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

***WHO AQGs have been taken from WHO Air Quality Guideline Standards (AQGs), Global Update, 2006.

Project Site GPS Coordination: Latitude - 24.13454°N, Longitude - 91.35057°E

Abbreviation: PM_{2.5} - Fine Particulate Matter, PM₁₀ - Respirable Dust Content, SPM - Suspended Particulate Matter, SO₂ - Sulphur Di-oxide, NO_x - Oxides of Nitrogen, CO - Carbon Monoxide, µg/m³ - microgram/cubic meter, ppm - parts per million.

6.2.2 Physiography

In the context of physiography, Bangladesh can be divided into three broad categories based on topography, physical features, and geological history (Brammer, 1996):

1. Floodplains
2. Terraces
3. Hills

Within these 3 broad categories, a number of authors have further divided the land surface into a series of Physiographic Units based on a combination of topographical/landscape features, underlying geology and surface soils (Brammer, 1996, Rashid, 1991, Morgan and McIntyre, 1959). The most recent study was undertaken by the Soil Resource Development Institute (SRDI) who further refined the previous classifications into 26 Physiographic Units (20 primary units and 6 sub-units) based on an assessment of more recent and detailed data (SRDI, 1997).

Physiography is the description of the physical nature (form, substance, arrangement, changes) of objects, especially of natural features. Physiographic region/unit refers to a region of which all parts are similar in terms of physical characteristics and which have consequently had a uniform geomorphic history, and whose pattern of topographical features or landforms differs significantly from that of adjacent regions. The project location comprises the Northern and Eastern piedmont plain (Figure 6.8)

Northern and eastern piedmont plains generally sloping piedmont plains border the northern and eastern hills; (similar piedmont plains adjoining the hills in Chittagong region have been included in the Chittagong coastal plain). These plains, which comprise coalesced alluvial fans, mainly have silty or sandy deposits near to the hills, grading into clays in the basin adjoining the neighbouring floodplains. The whole area is subject to flash floods during the rainy season. On the higher parts, flooding is mainly intermittent and shallow; but it is

moderately deep or deep in the basin. The sub-region covers most or parts of the upazilas of Nalitabari (Sherpur), Tahirpur, Bishwamvarpur, Dowarabazar, Companiganj (Sylhet), Gowainghat, Madhabpur, Habiganj Sadar, Chunarughat, Sreemangal, Kamalganj and Kulaura.

6.2.3 Regional and Site Topography

Topography is the configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers.

The general topography of the project area is relatively flat. The general topography of the project area is moderately flat. The topography of the specific project location is 10.85 – 14.94 a.m.s.l (Figure 6.9). Topographically the cluster of the project location is almost flat, with many depressions, natural water bodies, bounded by the Rivers.

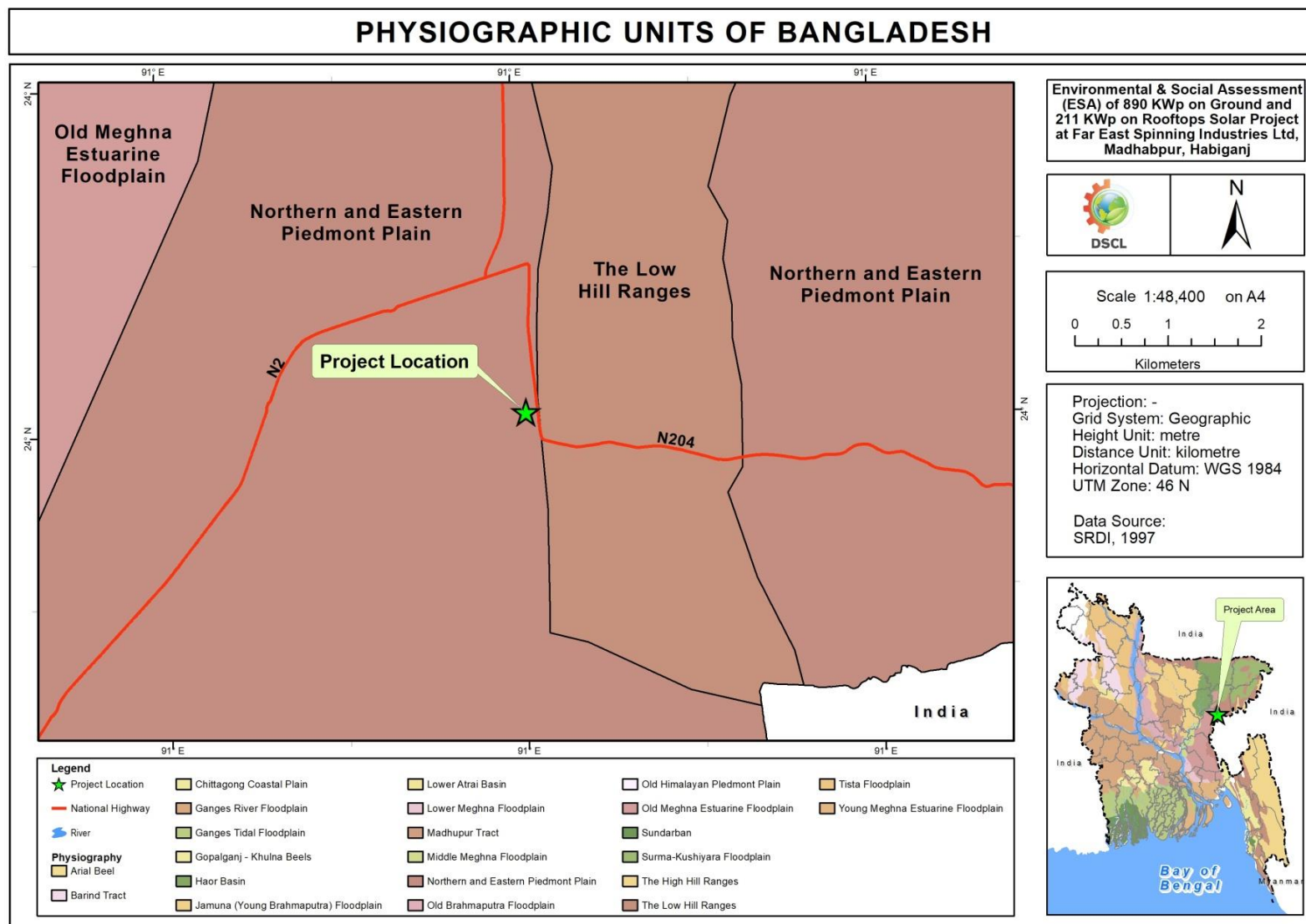


Figure 6.9: Physiography of the Project Area

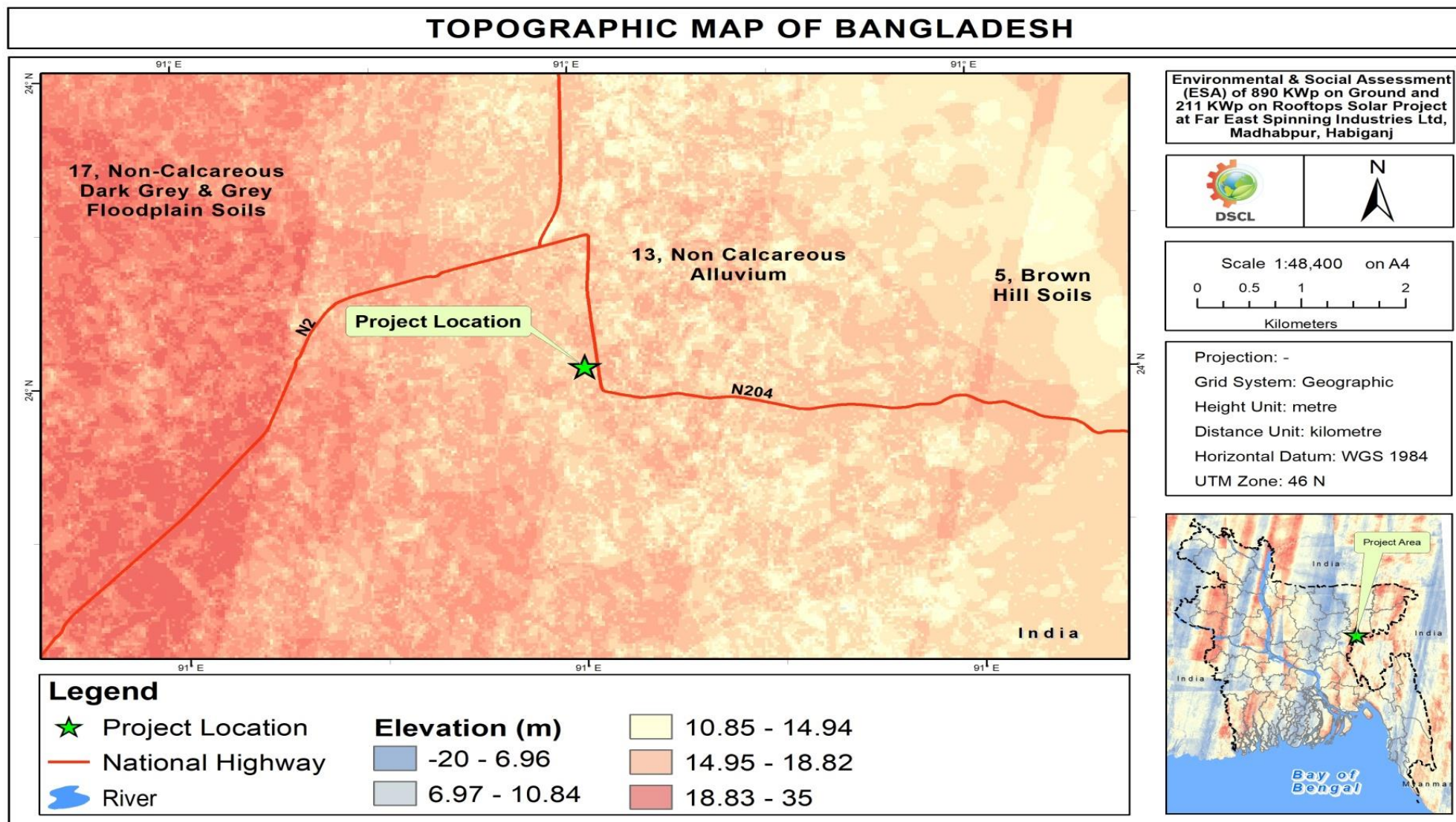


Figure 6.10: Topography of the Project Area

6.2.4 Geology

Geological structure of project area belongs to the northeastern folded area of Bangladesh. The fold belt is characterized by folding of the sedimentary layers into a series of anticlines (upward folds) and synclines (downward fold), refer to the Tripura Chittagong Fold Belt as show in Figure 4.11. The age of the sediments outcropping in the folded belt ranges from Lower Miocene (about 24 million years before the present) to recent age. The Miocene sediments were deposited under marine and predominantly deltaic conditions in a rapidly subsiding, unstable basin, while the depositional environments were governed by subaqueous to subaerial, fluvial to lacustrine conditions in Plio-Pleistocene times (5 million years to 0.1 million years before the present).

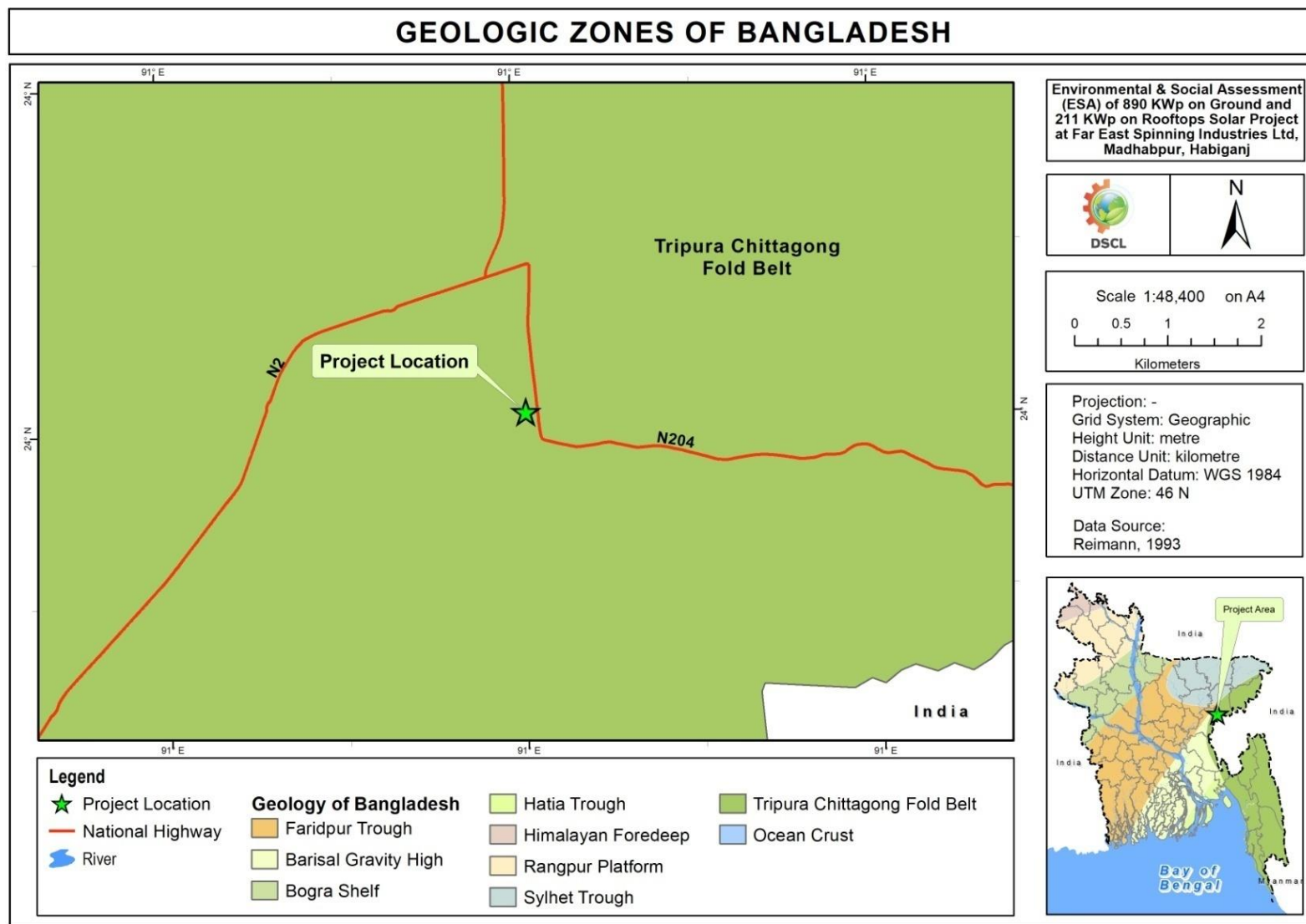


Figure 6.11: Geology of the Project Area

6.2.5 Soil Quality

Soils of the project area are mainly formed from recent alluvial sediments. The area has a wide variation in geology and landforms due to variation of sediment deposits or deposited in different times. Soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. The soils have a moderate content of organic matter and soil reaction is mainly acidic. Fertility level is medium to high. According to the 24 general soil types of Bangladesh (Figure 6.11) the project area falls in the soil tract group 13 which are non-calcareous alluvium and brown hill soils.

6.2.6 Agro-Ecological Zones within the Project Area

Thirty agro-ecological zones and 88 sub-zones have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. These layers are: 1) Physiography (land forms and parent materials), 2) Soils, 3) Depth and duration of seasonal flooding and 4) Agro-climatology, comprising four elements: length of Kharif and Rabi growing seasons, length of pre-Kharif transition period, number of days below certain winter critical temperatures ($<15^{\circ}\text{C}$) and number of days with extremely high summer temperature ($>40^{\circ}\text{C}$).

The project area falls in the agro-ecological region of the Northern and Eastern Piedmont Plain (AEZ-22). The locations of agro-ecological zones are shown in Figure 6.12.

This is a discontinuous region occurring as a narrow strip of land at the foot of the northern and eastern hills. The region comprises merging alluvial fans which slope gently outward from the foot of the northern and eastern hills into smooth, low-lying basins. Grey piedmont soils and non-calcareous grey floodplain soils are the major general soil types of the area. Soils of the area are loams to clays, slightly acidic to strongly acidic in reaction. General fertility level is low to medium.

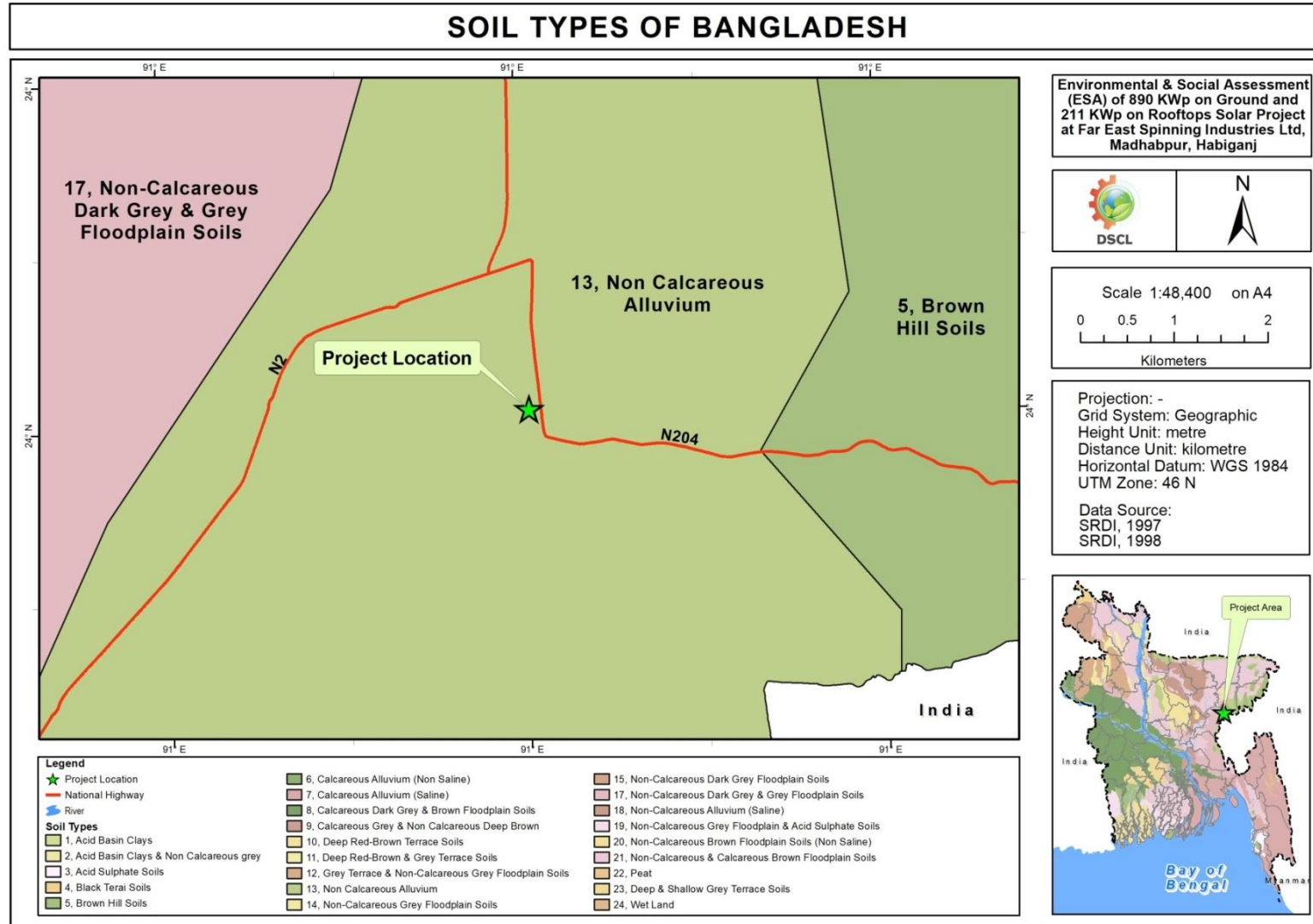


Figure 6.12: General Soil Type Map of Bangladesh

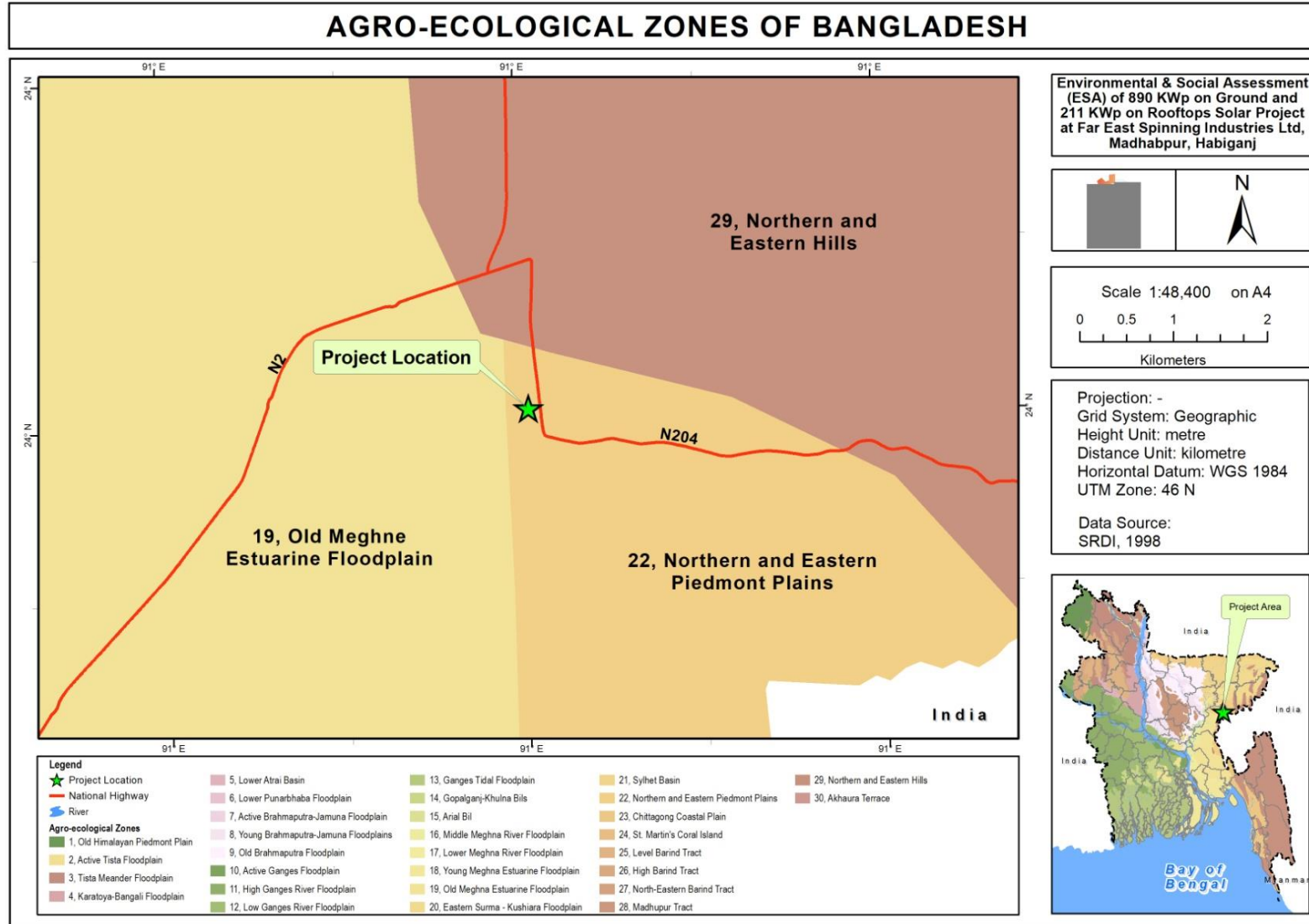


Figure 6.13: Agro-ecological Regions of Bangladesh

6.2.7 Hydrology

The rivers of Bangladesh mark both the physiography of the nation and the life of the people. About 700 in number, these rivers generally flow south. The larger rivers serve as the main source of water for cultivation and as the principal arteries of commercial transportation. Rivers also provide fish, an important source of protein. Flooding of the rivers during the monsoon season causes enormous hardship and hinders development, but fresh deposits of rich silt replenish the fertile but overworked soil. The rivers also drain excess monsoon rainfall into the Bay of Bengal. Thus, the great river system is at the same time the country's principal resource and its greatest hazard. The profusion of rivers can be divided into five major networks.

- The Jamuna-Brahmaputra
- The second system is the Padma-Ganges
- The third network is the Surma-Meghna system.
- The fourth river system--the Padma-Meghna
- A fifth river system, unconnected to the other four, is the Karnaphuli.

The project area falls in the third river system of Bangladesh. The project area covers Khowai, Kushiara and Upper Meghna River. Khowai River is a trans-boundary river that originates in the eastern part of the Atharamura Hills of Tripura in India. Flowing north-north-west, it leaves India at Khowai, and enters Bangladesh at Balla in Habiganj District. The river passes east of Habiganj town, where it is under pressure from encroachment and pollution. North of town it turns west, and joins the Kushiara River.

The third network is the Surma-Meghna system, which courses from the northeastern border with India to Chandpur, where it joins the Padma. The Surma-Meghna, at 669 kilometers by itself the longest river in Bangladesh, is formed by the union of six lesser rivers. Below the city of Kalipur it is known as the Meghna. When the Padma and Meghna join together, they form the fourth river system--the Padma-Meghna--which flows 145 kilometers to the Bay of Bengal. The following Figures 6.13 shows the river network map of the project area respectively.

6.2.7.1 Surface Water

On 14th March 2018, surface water sample was collected by environmental team from a pond near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The result (Appendix B) of the surface water sample and the GoB standards for fishing water (ECR, 1997) are shown in [Table 6.2](#).

Table 6-2: Results for Surface Water Quality

Water Quality Parameters	Unit	Concentration Present	Bangladesh Standard	Method of Analysis
pH*	---	7.98	6.5-8.5	pH Meter
Temperature*	-	29.9°C	-	
Electrical Conductivity (EC)*	mg/l	367	-	
Total Dissolved Solids (TDS)*	mg/l	786	-	TDS Meter
Dissolved Oxygen (DO)*	mg/l	4.4	6	Multimeter
Salinity*	mg/l	179	-	
Chemical Oxygen Demand (COD)	mg/l	80	4	CRM
Biochemical Oxygen Demand (BOD)	mg/l	18	0.2	5 Days Incubation
Total Suspended Solids (TSS)	mg/l	26	10	Gravity Multimeter
Phosphate	mg/l	1.52	6	UV-VIS
Nitrogen (Amonia)	mg/l	0.83	0.50	UV-VIS
Nitrogen (Nitrate)	mg/l	19	10	UV-VIS

* Onsite Test Using Field Test Kit, Source: Lab Analysis by DPHE

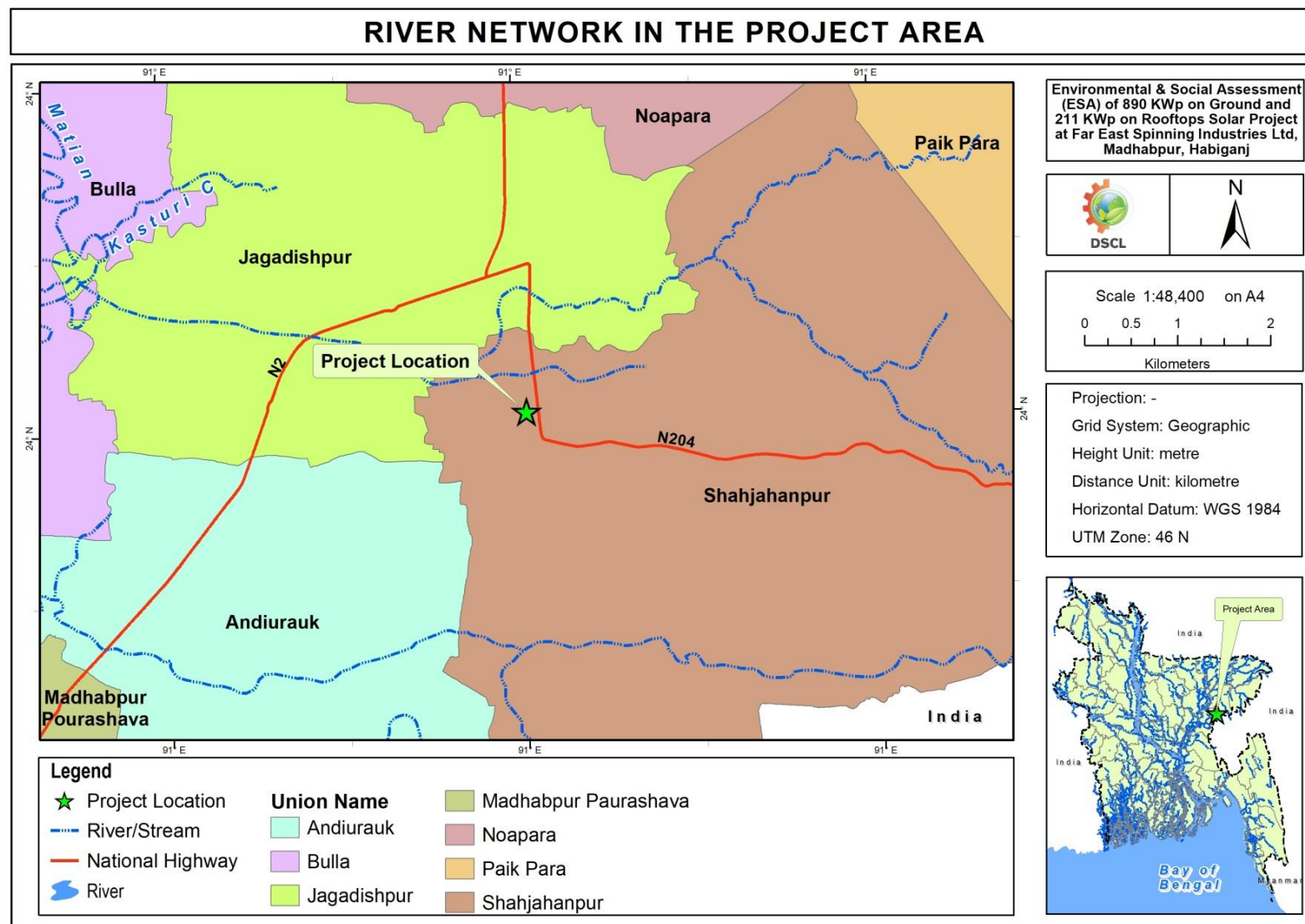




Fig: 6.15 Surface water sampling in the project area

6.2.7.2 Ground Water

Arsenic is a problem in large part of Bangladesh ground water. The project area also has acceptable limit of Arsenic levels in ground water. The acceptable quantity of arsenic in potable water is 0.05 mg per liter under the Department of Environment standard and 0.01 mg per liter under the WHO standards (Figure 6.15).

Based on field observations and interviews with local residents it was found that groundwater in the area is used as a drinking water source in many instances, as well as for irrigation purposes. Water is generally extracted via hand pump (tube wells) from the shallow regions of the composite aquifer, and via machine-driven pumps (deep tube wells) which draw from the deeper main aquifers. The ground water reservoir usually recharges from rainfall, floods and river. In summer season, the water table slightly goes down and goes up in rainy season.

On 14th March 2018, groundwater sample was collected by environmental team from a tube well near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The result (see Appendix C) of the groundwater sample and the GoB standards for drinking water (ECR, 1997) are shown in Table 6.3. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE except for Chloride. The concentration levels of Chloride are not within the drinking water quality standard set by DOE. However, other three measured parameters are within the standard quality.

Table 6-3: Results for Ground Water Quality

Parameters	Unit	Concentration Present	Drinking Water Quality Standard, DOE	Method of Analysis
pH*	---	6.9	6.5-8.5	pH Meter
Electric Conductivity*	mg/l	204	-	EC Meter
Dissolved Oxygen(DO)	mg/l	3.0		
Temperature*		29.4°C		
Total Dissolved Solids (TDS)*	mg/l	553	-	TDS Meter

Parameters	Unit	Concentration Present	Drinking Water Quality Standard, DOE	Method of Analysis
Salinity*	mg/l	99		
Alkalinity	mg/l	80	-	Trimetric
Arsenic (As)	mg/l	0.001	0.05	AAS
Chloride (Cl ⁻)	mg/l	12	150-600	Trimetric
Iron (Fe)	mg/l	0.11	0.3-1.0	AAS



Fig: 6.16 Ground water sampling in the project area

6.2.8 Noise Assessment

Excessive noise is a potential issue for both human and biological receivers and can potentially cause a range of negative issues, from mild annoyance and moderately elevated levels of aggression to significant disturbance of behavioral patterns and in severe cases temporary or permanent hearing loss. According to World Health Organization's Guidelines for Community Noise (1999), daily sound pressure levels of 50 decibels (dB) or above can create discomfort amongst humans, while ongoing exposure to sound pressure levels over 85 dB is usually considered the critical level for temporary hearing damage.

The noise level of the surroundings of the project area is insignificant. The proposed site is presently using for agriculture and the anthropogenic disturbance is less. However, there is negligible sound pollution from the traffic movement on the nearby road. Noise level has been monitored at inside and outside of the project location (Appendix C) during day time (**Figure 6.16**). Results of the noise level monitored along with details of the sampling locations have been showed in **Table 6.3**. **The results show that time weighted average value of the sound monitored at inside and outside of the project area exceeded the standard fixed for Auto-knitting section, Generator section and Sewing section.** For the other locations, the noise level was within the national standard.



Fig: 6.17 Noise Level Measurements in the Project Area

Table 6-4: Noise Level at Different Locations of Project Area

ID	Location	Zone	GPS Location	Starting Time	Noise Level dB(A) at Day Time	Bangladesh Standard at Day Time dB (A)	Remarks
NM-01	Substation area of Industry	Commercial	24.13593°N, 91.35070°E	10:39 am	47.17	65	Low
NM-02	Spinning Section of the Industry	Commercial	24.13452°N, 91.35057°E	11:01 am	83.36	65	High
NM-03	Back Side of the Industry	Commercial	24.13383°N, 91.34953°E	11:25 am	53.16	65	Low
NM-04	Entrance of the Industry	Commercial	24.13409°N, 91.35143°E	12:57 pm	55.81	65	Low

Notes:

- Land use category is based on the classification provided in the Noise Pollution Control Rules (2006)
- Shaded cells indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area
- The sound level standards for residential area are 45 dBA, for silent area 50 dBA and for commercial area 70 dBA at day time
- The sound level standards for silent area are 35 dBA, for residential area 40 dBA and for commercial area 60 dBA at night time

Noise Level is the average noise recorded over the duration of the monitoring period

Abbreviation:

NM- Noise Measurement, dB- decibel

6.2.9 Seismicity

Bangladesh is situated in one of the most tectonically active regions in the world. Here is where three major plates meet (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate). The project area is located over the Indian Plate, which is moving north. However due to the location of relevant plates, fault lines and hinge zones, Bangladesh itself is divided into three seismic zones (Table 6.4), based on the ranges of the seismic coefficient (*note: the seismic coefficient is a measure of how strong an earthquake has the potential to be based on a combination of the mass of the plate and the seismic forces acting on it, as well as how frequently these quakes are likely to occur*). As per the seismic zone map (Figure 6.17), project area falls in the zone I. The northeastern folded regions of Bangladesh are the most active zones and belong to the zone-I. The zone I consists of the regions and the Bask

coefficient for this zone is 0.08. The project area within the vicinity of Habiganj district falls in seismic zone I of the seismic zoning map of Bangladesh.

Table 6-5: Seismic Zonation of Bangladesh

Zoning	Area Mercalli Scale	Base Seismic Coefficient
I	North and eastern regions of Bangladesh (Seismically most active)	0.08
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt.	0.05
III	Khulna division S-E Bangladesh (Seismically relatively quiet)	0.04

6.2.10 Climate Change and Natural Hazards

Building large solar power plants requires significant long-term investment so understanding impacts from climate change will aid financial planning, technology selection, and energy output projections. Climate change and its associated impacts will be experienced through changing temperatures and precipitation, rising sea levels, changes in the frequency and severity of climate extremes and in the dynamics of hazardous conditions (IPCC, 2007). Developing countries are considered to be particularly susceptible to climate change because of their exposures and sensitivities to climate-related extremes, and especially because of their limited adaptive capabilities to deal with the effects of hazardous events. Given this limited capacity to adapt, they are considered to be particularly vulnerable to damages associated with climate, just as they are particularly vulnerable to other stresses.

Climate change is a global issue. The world's climate is changing and will continue to change in the coming century. Climate Change is basically the change in climate over a time period that ranges from decades to centuries. It is a normal part of the Earth's natural variability, which is related to interactions among the atmosphere, ocean, and land, as well as changes in the amount of solar radiation reaching the earth. However, the United Nations Framework Convention on Climate Change (UNFCCC) as "A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (IPCC, 2007) defines the term "climate change". The risks associated with these changes are real but highly uncertain. Societal vulnerability to the risks associated with climate change may exacerbate ongoing social and economic challenges, particularly for those parts of societies in developing countries dependent on resources that are sensitive to changes in climate.

Bangladesh is recognized worldwide as one of the most vulnerable countries to the impacts of climate change. This is due to dominance of floodplains, low elevation from the sea, high population density, high levels of poverty, and overwhelming dependence on nature, its resources and services. The country has a history of extreme climatic events claiming millions of lives and destroying past development gains. The people and social system have knowledge and experience of coping with the effects of such events—to some degree and extent. Historically, Bangladesh is trying to adapt with the changing environment. The Intergovernmental Panel on Climate Change (IPCC) has identified the country as one of the most vulnerable countries to climate change, which may severely affect lives and livelihoods of millions of Bangladeshi people in coming decades. In this regard, Bangladesh has already prepared the National Adaptation Programme on Action (NAPA) and Climate Change Strategy and Action Plan (MoEF, 2005 and MoEF, 2009).

According to the fourth assessment, report of IPCC, continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century, which would very likely be more severe than those observed during the 20th century would.

Photovoltaic (PV) electricity generation depends on solar irradiance, named surface-down welling shortwave (that is, wavelength interval 0.2–4.0 μm) radiation (RSDS) by climate models, and other atmospheric variables affecting panel efficiency, namely surface air temperature (TAS) and surface wind velocity (VWS). Climate change may therefore affect PV power generation and its temporal stability for a given panel fleet.

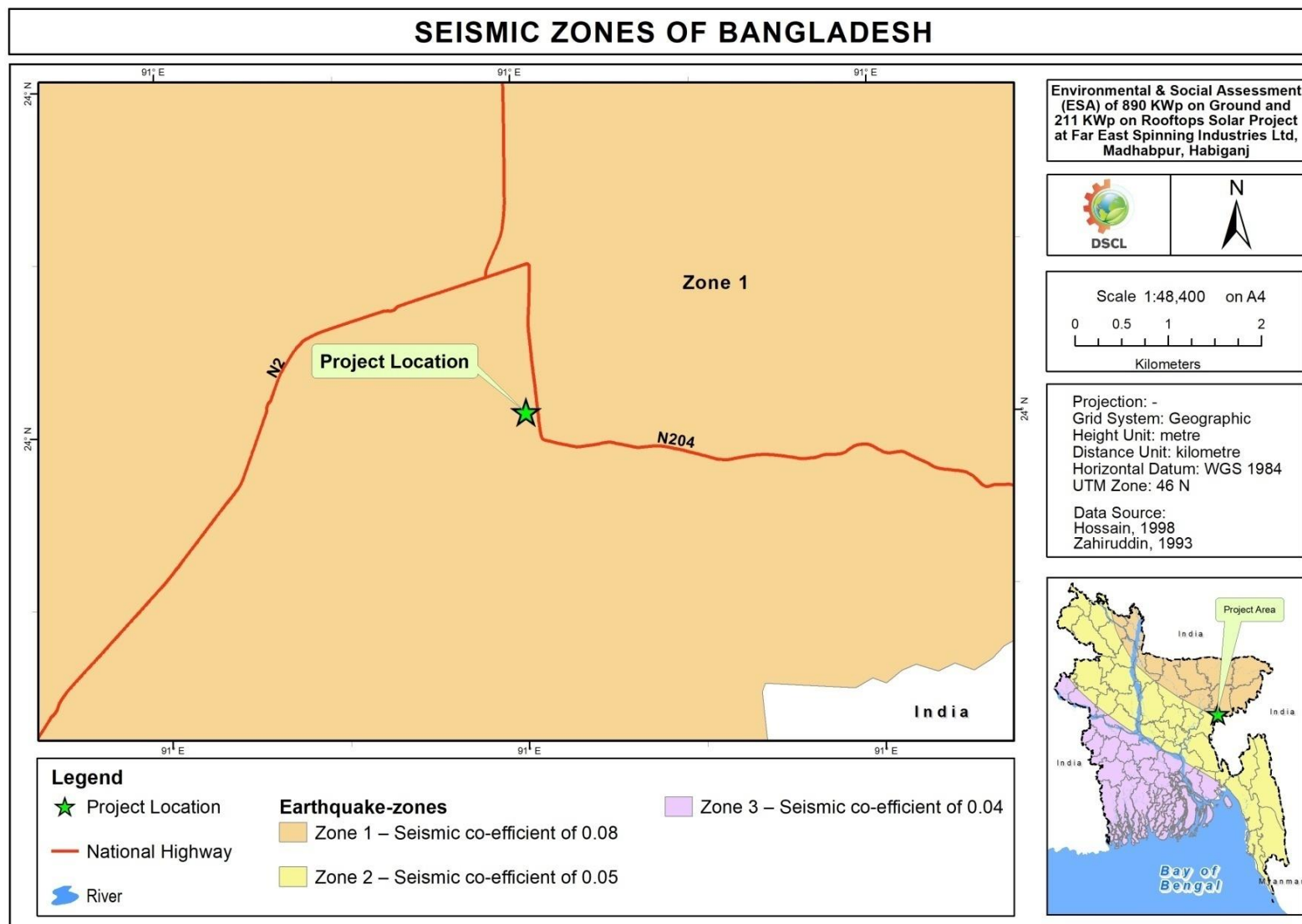


Fig 6.18: Seismic Zones of Bangladesh

6.2.11 Biological Environment

The countries of South and Southeast Asia are recognized by International Union for Conservation of Nature (IUCN) to be regions of high species diversity. A large number of native plants, including 3,000-4,000 species of woody flora, have been recorded from Bangladesh. The country lies at the meeting point (ecotonal region) of several floristic provinces, including the Manipur-Khasia, Bengal and North Burman provinces within the Indo-Malayan realm (IUCN, 2002).

Bangladesh was once well forested, but most of the native forests have disappeared in recent decades due to mounting pressure from human populations. Only scattered patches of native trees, wetlands and associated fauna habitat remain in isolated locations within the terrestrial environment (IUCN, 2002). In many parts of the country, the abundance of plantations and groves of trees around villages creates an aspect of discontinuous forest (Wahab, 2008).

The floodplains of Bangladesh have long been subject to cultivation, the most dominant land use within the project area, with only scattered patches of native trees, wetlands and associated fauna habitat remaining in isolated locations within the terrestrial environment (IUCN, 2002).

6.2.12 Bio-ecological Zones

Within a relatively small geographic boundary, Bangladesh enjoys a diverse array of ecosystems. Being a low-lying deltaic country, seasonal variation in water availability is the major factor, which generates different ecological scenarios of Bangladesh. Temperature, rainfall, physiographic variations in soil and different hydrological conditions play vital roles in the country's diverse ecosystems. The ecosystems of Bangladesh could be categorized into two major groups, i.e. (i) land based and (ii) aquatic. The land-based ecosystems include forest and hill ecosystems, agro-ecosystems and homestead ecosystems; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine ecosystems fall into the aquatic category.

Each of the ecosystems has many sub-units with distinct characteristics as well. IUCN Bangladesh in 2002 classified the country into twenty-five bio-ecological zones (Figure 6.18). The project area falls below the bio-ecological zone.

Sylhet Hills (4,573 sq km) the region occupies the lower, western side of the Surma-Kushiyara floodplain. Relief is locally irregular near rivers. Soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basins. The soils have a moderate content of organic matter and soil reaction is mainly acidic. Fertility level is medium to high.

6.2.13 Terrestrial Flora and Fauna

The status of terrestrial floras and faunas at the project site were assessed from visual observations, review of literature, and information documented by other agencies. The project area consists of several ecological subsystems e.g. open agricultural land, homesteads, and roadside vegetation. The open agriculture land ecosystem dominates the area providing widespread habitat types for various species of flora and fauna under flooded and non-flooded conditions. The vegetation covers of agricultural lands are different crop species, weeds and other herbaceous plants species. The faunal species in the agriculture land and

roadside bush ecosystems include birds, amphibians, fishes, snakes rodents and few mammals. The homestead ecosystem provides the main tree covered areas within rural Bangladesh including the project site. Fruit, timber, fuel wood, medicinal plants and various multipurpose tree species cover the homesteads. The wildlife species in homestead ecosystem include the birds, amphibians, reptiles, rodents and mammals like mongoose, jackal, cats, monkey, etc. Many of the species including mammals are vulnerable or/and endangered in Bangladesh due to habitat loss, over exploitation, natural calamities and lacking of management. The project command area is not the specific habitat for any particular species of flora and fauna hence none such species will be specifically affected due to project implementation.

6.2.14 Flora

The project influence area (PIA) has mixed vegetation. The area is mostly dominated by roadside vegetation. Besides some fruit trees were also observed. The data collected from the field survey and suggests that the predominant species are those of cultivated vegetables and trees. A detailed list of terrestrial floral species found in the project area is shown in **Table 6.5**.

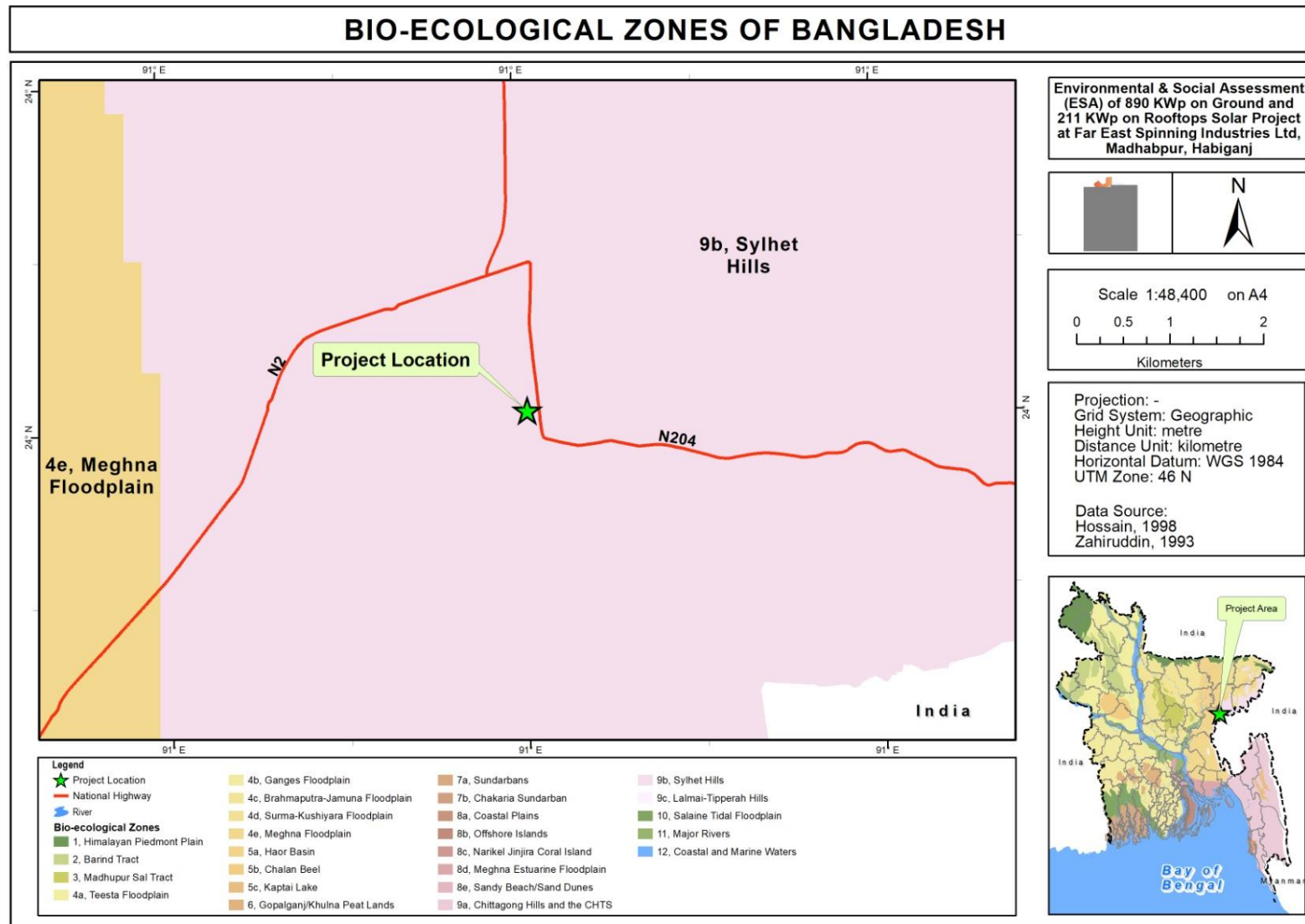


Fig 6.19: Bio-ecological Zones of Bangladesh

Table 6-6: List of Flora in the Project Influenced Area

Scientific Name	Local Name	Family	Habit	Habitat	Status
<i>Acacia auriculiformis</i>	Akasia	Leguminosae	Tree	Riverside	C
<i>Albizia procera</i>	Shilkoroi	Leguminosae	Tree	Homestead	C
<i>Areca catechu</i>	Shupari	Arecaceae	Tree	Homestead	C
<i>Axonopus compressus</i>	Ghash	Poaceae	Herb	Riverside	C
<i>Azadirachta indica</i>	Neem	Meliaceae	Tree	Homestead	LC
<i>Benincasa hispida</i>	Chalkumra	Cucurbitaceae	Herb	Cultivated	CU
<i>Capsicum annum</i>	Kachamorich	Solanaceae	Herb	Cultivated	CU
<i>Carica papaya</i>	Papey	Caricaceae	Tree	Cultivated	C
<i>Citrus aurantifolia</i>	Lebu	Rutaceae	Shrub	Homestead	C
<i>Cocos nucifera</i>	Narikal	Arecaceae	Tree	Homestead	C
<i>Cucurbita maxima</i>	Mishti kumra	Cucurbitaceae	Herb	Cultivated	CU
<i>Delonix regia</i>	Krishnachura	Leguminosae	Tree	Homestead	C
<i>Eucalyptus Citriodora</i>	Eucalyptus		Tree	Homestead	LC
<i>Lablab purpureus</i>	Seem	Leguminosae	Herb	Cultivated	CU
<i>Lagenaria vulgaris</i>	Lao	Cucurbitaceae	Herb	Cultivated	C
<i>Lawsonia inermis</i>	Mendi	Lythraceae	Shrub	Homestead	LC
<i>Mangifera indica</i>	Aam	Anacardiaceae	Tree	Homestead	C
<i>Artocarpus heterophyllus</i>	Kathal	Moraceae	Tree	Homestead	C
<i>Musa sapientum</i>	Kola	Musaceae	Herb	Cultivated	C
<i>Oryza stiva</i>	Dhan	Poaceae	Herb	Cultivated	CU
<i>Psidium guajava</i>	Peyara	Myrtaceae	Tree	Homestead	LC
<i>Samanea saman</i>	Rain tree	Leguminosae	Tree	Homestead	LC
<i>Solanum melongena</i>	Begun	Solanaceae	Herb	Homestead	CU
<i>Syzygium cumini</i>	Jam	Myrtaceae	Tree	Homestead	C
<i>Tagetes patula</i>	Ganda	Asteraceae	Herb	Homestead	CU
<i>Tectona grandis</i>	Shegun	Verbenaceae	Tree	Homestead	LC
<i>Zizyphus mauritiana</i>	Boroi	Rhamnaceae	Tree	Homestead	LC
<i>Swietenia Mahagoni</i>	Meheguni	Meliaceae	Tree	Homestead	LC
<i>Dalbergia Shishu</i>	Shishu	Leguminosae	Tree	Homestead	LC
<i>Bamboo Spp.</i>	Bash	Gramine	Shrub	Homestead	LC
<i>Eichhornia crassipes</i>	Kochuripana	Pontederiaceae	Herb	Wetland	LC
<i>Aphanamixis ploystachya</i>	Pitraj	Meliaceae	Tree	Homestead	UC
<i>Litchi chinenses</i>	Lichu	Sapindceae	Tree	Homestead	UC
<i>Bombax ceiba</i>	Shimul	Bombacaceae	Tree	Homestead	LC
<i>Phoenix sylvestris</i>	Khejur	Palmae	Tree	Homestead	C
<i>Ficus bengalensis</i>	Bot	Moraceae	Tree	Homestead	LC

C= Common, CU= Critically Uncommon, LC= Least Common, UC= Uncommon

6.2.14.1 Fauna

The diversified habitat and ecosystem in the project area support various types of animals as given in **Table 6.6**. Primary and secondary mode was adopted for identification of fauna. Most of the birds are identified through direct observation rather than from people. Most of the amphibians, reptiles and mammals were identified by using books and description of the local people during the field survey.

Fishes

Fish is still reasonably available in the area, given the overall and increasing scarcity of fish in the country. Small fishes, which are very popular also in overall Bangladesh, are available and caught and used widely, particularly during early monsoon and pre- winter season.

Among reptiles, narrow headed soft-shell turtle deserves special mention. Among birds, Bok, Salik, Finge etc. deserve special mention.

The fishes include catfishes (Magur and Shing), major carps (Katla, Rui and Mrigal), minor carps (Puti), other (Tengra, Boal, Mola, Taki, Shol). Also prawn, particularly the popular small prawns, locally known as Ichha, Wildlife, and Reptile. The common types of reptiles are found in the area, water snake, house lizard, soft-shell, etc.

Amphibians

Mostly Toads and frogs- two species are prominent.

Mammals

These include bengal fox, small indian mongoose, flying fox etc. No major mammal species of national significance are present in this area.

Birds

A number of those are including common kingfishers, House crow, House sparrow, etc.

Table 6-7: List of Fauna in the Project Influenced Area

Scientific Name	English Name	Local Name	Local Status
Class: Amphibia			
<i>Bufo melanostictus</i>	Common Toad	Kuno bang	NO
<i>Rana temporalis</i>	Bull Frog	Kola bang	NO
<i>R. pipens</i>	Grass Frog	Sona bang	NO
Class: Reptilia			
<i>Hemidactylus flaviviridis</i>	Common House Lizard	Tiktiki	NO
<i>Calotes versicolor</i>	Common Garden Lizard	Rokto-chosha	NO
<i>Varanus bengalensis</i>	Bengal monitor	Gui shap	VU
<i>Xenochrophis piscator</i>	Checkered keelback	Dhora shap	NO
<i>Amphiesma stolata</i>	Stripped keelback	Dora shap	NO
<i>Enhydryis enhydryis</i>	Common smooth water snake	Paina shap	NO
<i>Coluber mucosus</i>	Rat snake	Daraj shap	VU
<i>Atretium schistosum</i>	Olive keelback	Maitta shap	NO
Class: Aves			
<i>Phalacrocorax niger</i>	Little cormorant	Paan-kowri	NO
<i>Ardeola grayii</i>	Indian pond heron	Kani bok	NO
<i>Casmerodius albus</i>	Great egret	Sada bok	NO
<i>Haliastur indus</i>	Brahminy kite	Shankho chil	NO
<i>Milvus migrans</i>	Black kite	Bhubon chil	NO
<i>Streptopelia chinensis</i>	Spotted dove	Tila Ghughu	NO
<i>Psittacula krameri</i>	Rose-ringed parakeet	Tia	NO
<i>Eudynamys scolopacea</i>	Asian cuckoo	Kokil	NO
<i>Tyto alba</i>	Barn owl	Laxmi Pencha	NO
<i>Alcedo atthis</i>	Common kingfisher	Choto Maachranga	NO
<i>Dinopium benghalense</i>	Black-rumped flameback	Kaththokra	NO
<i>Corvus splendens</i>	House crow	Pati Kak	NO
<i>Dicrurus macrocercus</i>	Black drongo	Fingey	NO
<i>Copsychus saularis</i>	Oriental magpie robin	Doel	NO
<i>A. tristis</i>	Common myna	Bath Shalik	NO
<i>Orthotomus sutorius</i>	Common tailorbird	Tuntuni	NO
<i>Passer domesticus</i>	House sparrow	Charui	NO

Scientific Name	English Name	Local Name	Local Status
<i>Ploceus philippinus</i>	Baya weaver	Babui	NO
Class: Mammalia			
<i>Pteropus giganteus</i>	Flying Fox	Badur	NO
<i>H. auro-punctatus</i>	Small Indian Mongoose	Benji	NO
<i>Felis chaus</i>	Jungle Cat	Ban biral	EN
<i>Vulpes bengalensis</i>	Bengal Fox	Khek shial	VU
<i>Viverricula indica</i>	Small Indian Civet	Khatash	VU
<i>Rattus rattus</i>	Common House Rat	Indur	NO
<i>Mus musculus</i>	House Mouse	Nengri indur	NO
<i>Suncus murinus</i>	House Shrew	Chicka	NO
NO= Not Observed, VU= Vulnerable, EN= Endangered			

6.2.15 Aquatic Flora and Fauna

Some aquatic plant species exist in the canal nearby the industry. The species commonly found are Kochuripana, DholKalmi, Sheola, Malanchi, Kalmi, Helencha etc.

The species of fish found in the area are Mrigel, Rui, Katla, Grass Carp, Silver Carp, Mirror Carp, Big Head, Koi, Tengra, Taki, Singh, Chingri, Loitta, etc.

It is observed from the consultations that no endangered/ rare fish species were identified. No anticipated impact on aquatic species as well as fish species due to the project activities.

6.2.16 Protected Areas and Red Book Species

Many wildlife species are in stress in Bangladesh, many more are endangered/ threatened and a large number already faced extinction. The status of faunal species in Bangladesh has been published by IUCN (2000). According to the IUCN findings this country has lost 10% of its mammalian fauna, 3% avifauna and 4% reptiles over the last 100 years. More than 50 species are presently critically endangered in Bangladesh of which 23 species are already declared as endangered in the Red Data Book of IUCN. In addition, 83 species are commercially threatened and are included in the appendices of Convention on International Trade in Endangered Species (CITES). Among the most endangered species are: elephant, tiger, wild Cat, Leopard or wild goat, serao, dolphin; birds: white-winged duck, comb duck, stork, carne, pheasant, partridge, and crocodile, python, monitor, lizard, tiger terrapin, roofed turtle, soft turtle, and marine turtles.

In and around the project no environmentally protected areas were found. Construction impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns are not anticipated. Figure 6.19 shows that no environmental sensitive area is present around the project region.

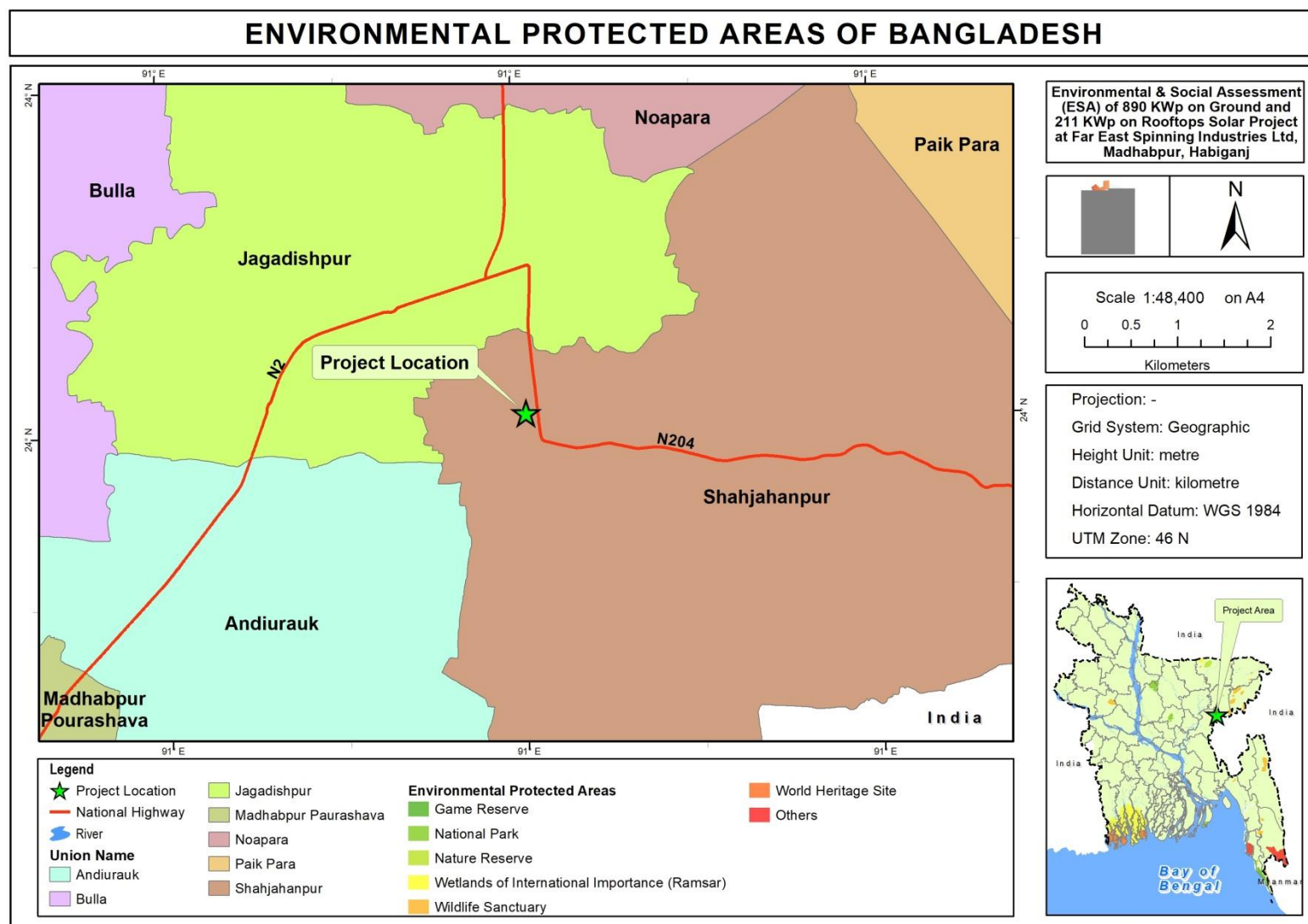


Fig 6.20: Environmental Protected Areas in Project Area

6.3 Social Environment

This section provides a profile and analysis of the socio-economic characteristics and practices that currently exist within the Project Area. Socio-economic baseline data has been collected in order to achieve a number of outcomes, namely to:

- Assess potential impacts that may arise as a result of the Project;
- Provide a basis for the effective monitoring of the Project during construction and operation; and to
- Allow for the evaluation of any social, economic and demographic changes in the Project Area that could be attributable to the Project.

It is essential for every development project, whether small or large, to understand the social, human and economic aspects of the primary stakeholders, i.e., people living in and around the project site. Extensive literature review and field survey were used to collect the relevant data/information on the social and economic aspects of affected people.

In addition, data obtained from secondary sources were compared with the primary data/information gathered during the study. Data on population, age/sex composition, household patterns, and sources of drinking water, sanitation facility, and ownership of agricultural land were enumerated from the latest community series census published by the Bangladesh Bureau of Statistics (BBS).

There is one local market (Haat) within 500 m of the proposed project site. There are also schools and mosques near the proposed location with in 1km. The range of profession includes business, farmer, service etc.

Habiganj subdivision was established in 1874 under Sylhet District and was turned into a district in 1984. The district consists of 8 upadistricts, 77 unions, 1255 mauzas, 2143 villages, 6 paurashavas, 54 wards and 188 mahallas. The upadistricts are Ajmiriganj, Baniachang, Bahubal, Chunarughat, Habiganj Sadar, Lakhai, Madhabpur and Nabiganj.

6.3.1 Demography

Demography is the scientific study of the number of population, especially with reference of their size, structure, sex distribution, population density, literacy rate etc. The core point is the Habiganj was one of the sub-divisions of former Sylhet District was created in 1888. It was up-graded to a district on the 1 February, 1984. There are different views about the origin of the district name. There is a popular view that in the past there lived a prominent man named Habibullah, who set up a Ganj meaning trading centre in the present district headquarters. It is belived that the district name might have been originated from the word Habibullah and Ganj. Area and Location: Habiganj district is bounded on the north by Sunamganj district, on the east by Maulvibazar district and Sylhet district, on the south by Tripura state of India and on the west by Kishoreganj district and Brahmanbaria district. The total area of the district is 2636.59 sq.km. (1017.00 sq.miles) of which 149.48 sq.km (57.72 sq.miles) are under forest. The district lies between 23°58' and 24°42' north latitudes and between 91°09' and 91°40' east longitudes.

Habiganj Town Committee was established in 1881 and it was turned into a municipality in 1913. During the British period an embankment was constructed along the Khowai River to protect the town. The main business centre of the town is Chowdhury Bazar.

The maximum and minimum temperature in Habiganj district varies from 33.2°C to 13.6°C. The annual average rainfall of the district is 3334 mm.

Khowai, Sutang, Korangi, Kalni, Kushiara, Gopala, Ratna and Barak are the important rivers of Habiganj district.

Number of household, population and density: In Habiganj district, the total population is 1757665. Male population is 893020 and female population is 864645.

Table 6-8 Population of the Habigonj District

Total Population	Number of Males	Number of Females
1757665	893020	864645

Source: Banglapedia (2014)

Population by Religion: Census2011, BBS data shows that in Habigonj Muslims form 81.47 percent of the population (1431886). Other major religions in the city are Hinduism, at 18.26 percent (321077); Buddhism, at 0.11 percent (1973); Christianity, at 0.014 percent (258); and others, at 0.14 percent (2471). Indigenous communities such as KHASIA and MANIPURI belong to this upazila.

Table 6-9 Population Distribution by Religion

Total Population	Muslim (%)	Hindu (%)	Buddhist (%)	Christian (%)	Other (%)
1757665	81.47	18.26	0.11	0.014	0.14

Source: Banglapedia (2014)

6.3.2 Livelihood

Livelihood means a supporting of one's existence, especially in terms of financial support. It encompasses people's capability, assets, income, etc. Main sources of income are commerce, employment, service, rent and remittance, transport and communication, industry, religious service, agricultural and non-agricultural labor, construction, and others. The percentage of the different livelihood sources of Habiganj City Corporation are presented in below **Table 6.10**:

Table 6-10 Livelihood Sources of Habigonj

Income Source	Rate (%)
Agriculture	61.13
Non-agricultural Laborer	7.20
industry	2.25%
Commerce	10.95
Transport & Communication	1.98
Service	4.58
Construction	1.13
religious service	0.39
rent and remittance	1.80
Others	10.74

Source: Banglapedia, 2014

6.3.3 Land Use

Leasing out of land on annual rent basis is a common practice in the area. The average agricultural land owner of Madhabpur upazila is about 48.04%, whereas landless is about 51.96%. All the wards and unions of the upazila are under rural electrification net-work. However, 25.49% of the dwelling households have access to electricity.

6.3.4 Economic Status

The economy of Habiganj is predominantly agricultural. Out of total 342,178 holdings of the district, 57.61% holdings are farms that produce varieties of crops namely local and HYV rice, wheat, vegetables, jute, spices, cash crops, pulses, oilseeds and others. Various fruits like pine apple, banana, mango, guava, jackfruit, black berries, coconut, papaya, palm, lichi, dates etc. are grown. Fish of different varieties are caught from rivers, tributary channels and creeks and even from paddy fields during rainy season. Besides crops, livestock and fishery are the main sources of household income.

Habiganj is famous for growing a considerable quantity of tea which is one of the most important cash crops of Bangladesh earning a good amount of foreign exchange. More than 20% of tea gardens of Bangladesh are located in this district. The required conditions prevail in this district for growth of tea.

Non-farm activities also play a significant role in economic development of Habiganj district. The following table1 shows total establishments in the urban and rural areas and persons engaged by sex and activity in Habiganj.

6.3.5 Public Health and Sanitation

In Madhabpur Upazila *Sources of drinking water* Tube-well 90.44%, tap 1.37%, pond 2.54% and others 5.65%.

Upazila health complex 1, union health and family welfare centre 6, family planning centre 6, community clinic 2, private clinic 1, mother and child welfare centre 2, maternity 6, charitable dispensary 2, satellite clinic 1, diagnostic centre 1, veterinary hospital 1.

Sanitation 28.13% (rural 26.59% and urban 50.47%) of dwelling households of the upazila use sanitary latrines and 58.32% (rural 59.14% and urban 43.86%) of dwelling households use non-sanitary latrines; 13.55% of households do not have latrine facilities.

6.3.6 Education

The literacy rate of Habiganj is 37.72% Male literacy rate is 41.76% and female literacy rate is 33.62%. Some noted educational institutions of Habiganj are, Habiganj Government Bindaban College, Paniumda Ragib-Rabeya School and College, Alif Sobhan College, Gobindapur Government High School (1832), Habiganj Government High School (1843), Rajar Bazar Government High School (1867), Jalsukh Krishna Govinda Public High School (1876), Mirashi High School (1887), Fakirabad Government High School (1890), LR Government High School (1896), Adaoir Lokenath High School (1911), Habiganj High School (1913), Nabiganj JK High School (1916), Shayestaganj High School (1918), Chhatian Bishwanath High School (1921), Dinarpur High School (1921), BKGC Government Girls' High School (1923), GK and HK High School (1924), Jagadishpur JC High School (1924),

Dakshina Charan Pilot High School (1928), Laskarpur Primary School (1843), Habiganj Government Primary School (1883), Ubahata Kudratia Dakhil Madrasa (1870), Mirpur Dakhil Madrasa (1920), Shankhola Dakhil Madrasa (1928), Shayestaganj Kamil Madrasa, Habiganj Daruchchhunnat Senior Madrasa. The number of various educational institutions is shown in the next **Table 6.10**:

Table 6-11 Educational Institutions of Habigonj

Educational Institution	Number
College	19
primary training institute	1
Technical College	1
Secondary School	155
Primary School	885
Community School	2
kindergarten	17
Madrasa	140

6.3.7 Transport Infrastructure in Habigonj City

Palanquin, horse carriage and bullock cart, boat are the traditional transports found in the rural area of Habiganj district. These means of transport are either extinct or nearly extinct. Now a day, all the upazilas are connected with the district headquarters with metalled roads. Bus, minibus, three wheelers ply over the district.

6.3.8 Environmental and Social Hotspot

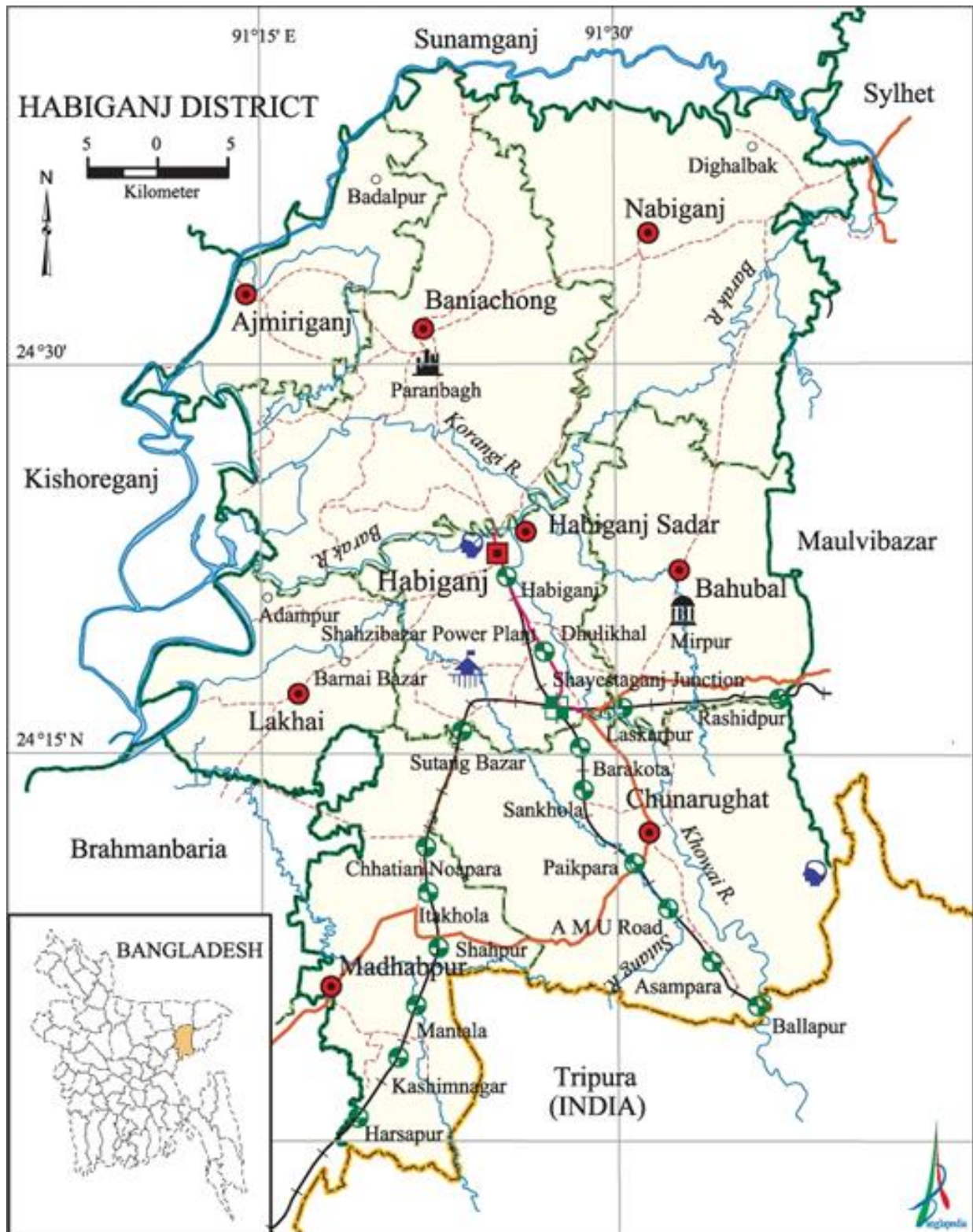
The socio-cultural aspects include the educational institutions, hospitals/health centres, religious structures, cultural structures, burial grounds, market places, water bodies, etc., few of which would be affected directly and indirectly through implementation of the project. Such sites could be termed as Environmental Hotspots in relation to project activities and, hence, need to be dealt carefully during the construction phase. Locations of major environmental hotspots in the project area are shown in the Figure 6.21. A detail list of the cultural and sensitive areas located within 1km buffer of the project area is presented in Appendix F.

6.3.9 Archaeological and Cultural Resources

There is no archeological structure within this project. However, some religious structures are found within the project influence area. A list of such cultural physical properties has been given in Appendix E of this ESA report.

6.3.10 Important Environmental and Social Features (IESFs)

The socio-cultural aspects include the educational institutions, religious structures, burial grounds, market places, etc., few of which would be affected directly and indirectly through implementation of the project. Such sites could be termed as Important Environmental and Social Features (IESFs) in relation to project activities and, hence, need to be dealt carefully during the construction phase. Locations of major IESFs in the project area are shown in the Figure 6.21. A detail list of the cultural and sensitive areas located within 600m radius of the project area is presented in Appendix D.



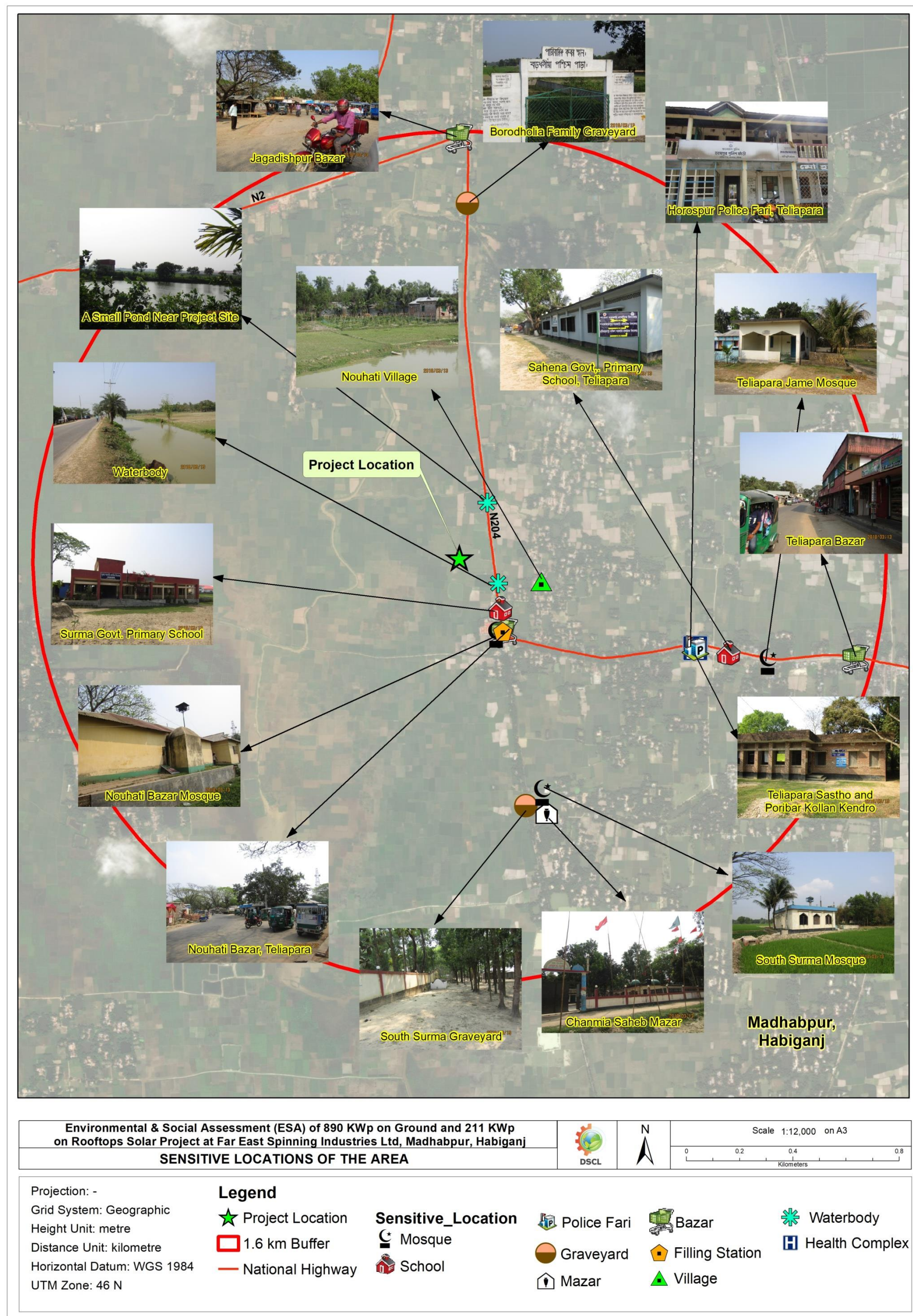


Fig: 6.21 Cultural and Sensitive Structures within 1km Radius of the Project Location

7 CHAPTER SEVEN: ANTICIPATED IMPACTS AND MITIGATION MEASURES

7.1 General

This section identifies the overall impacts on the physical, biological and socio-economic environment of the project area. An environmental impact is defined as any change to an existing condition of the environment. Identification of potential impacts has been done on the basis of baseline data collected from secondary and primary sources. Environmental impacts assessment was carried out considering present environmental setting of the project area, and nature and extent of the proposed activities.

7.2 Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. These magnitude categories are defined in [Table 7.1](#).

Table 7-1: Parameters for Determining Magnitude

Parameter	Major	Medium	Minor	Nominal
Duration of Potential Impact	Long term (more than 35 years)	Medium term lifespan of the project (5 to 15 years)	Limited to construction period	Temporary with no detectable potential impact
Spatial extent of the potential impact	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project Boundary	Specific location within project component or site boundaries with no detectable
Reversibility of potential Impacts	Potential impact is Effectively permanent, requiring considerable intervention to return to baseline	Baseline requires a year or so with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains Constant
Legal standards and established professional criteria	Breaches national standards and or international guidelines/obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction Conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (occasional)	Unlikely to occur

7.3 Sensitivity of Receptor

The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic.

Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in [Table 7.2](#).

Table 7-2: Criteria for Determining Sensitivity

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

Assigning Significance: Following the determination of impact magnitude and sensitivity of the receiving environment or potential receptors, the significance of each potential impact has been established using the impact significance matrix shown below in [Table 7.3](#).

7.4 Summary of Assessed Impacts

The project's potential impacts on the key environmental parameters have been assessed and their significance determined using the methodology described in Section 7.2 above. A summary of the potential impacts of the project on the key environmental parameters and significance of these impacts are presented in Table 7.4, 7.5 and 7.6 for different phases of this project; the potential impacts are discussed in the subsequent sections.

Table 7-3: Significance of Impact Criteria

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

Potential environmental impacts associated with the proposed project activities of both the projects are classified as:

- (i) Impacts during pre-construction/design phase
- (ii) Impacts during construction phase and
- (iii) Impacts during operation phase.
- (iv) Impacts during decommissioning phase

Qualitative and quantitative techniques have been applied for direct and indirect impact identification. Impacts are classified as being insignificant, minor, moderate and major. Impacts are described in the sections below.

7.5 Corridor of Impact (CoI)

The corridor of the proposed Impact (CoI) was delineated as the extent, which has direct or indirect impact of project. All direct impacts are constrained within the project boundary.

Indirect impacts could be beyond the project boundary. According to the Department of Environment (DoE) guideline the project impact area is divided into two sections. One, those related to the project. Another section is those related to the background environmental features of the project site. This should cover not only the project site in proper, but generally an area of 1km radius around the site. In this project the farm area have been considered as core impact zone and 1km as buffer zone for better understanding.

7.6 Pre-construction Phase

Following is the brief description of impacts envisaged during the Pre-construction/Design Phase:

7.6.1 Land Use

Impact

The Project site location does not conflict with any of the relevant governmental entities formal planning context. The project initiator will implement the project in their own industry rooftop and ground area. Therefore, there are no anticipated impacts during the planning phase of the Project.

Mitigation

The project developer is to take responsibility of minimizing environmental impact on the surroundings by following the project's environmental management plan (EMP). Since these activities are to be performed temporarily the minimum impact is expected to be acceptable. As per the circulation of BGMEA the RMG building's rooftop should not be occupied by the other facilities or any tin shade structures¹. Additionally, the Bangladesh National Building Code (BNBC) instruct to keep at least 40% open space on the rooftop. The project building also follows the guideline of BNBC.

7.7 Construction Phase

Environmental effects of the construction phase are expected to be temporary. Construction impacts are considered to be minimal as all the construction works will be carried out within the site boundary of the procured land and will be controlled via the mitigation measures defined in the EMP section. Following is the brief description of impacts envisaged during the construction phase.

7.7.1 Visual Amenity

Impact

- The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, backfilling, and spoil.
- The project site is the rooftop and ground area of the industry. There are some close communities such as some residences that would be within the visual radius of the project. Therefore, visual intrusions are anticipated to be limited to employees. Hence, the visual effects of the construction will be of low significance within the project area and

¹ BGMEA Letter#BGA/Safety/18000/2011/28180, Dated: 28th December, 2011

largely limited to effect only employees living in the company's temporary camp facilities during construction (if any).

Mitigation

The contractor must be careful while doing construction works as though the adjacent agricultural practices and close communities do not hamper.

7.7.2 Water Resources

Impact

- Rooftop PV electricity generation involves little to no water. That stands in contrast to almost all power plants that make electricity using steam. These include coal and nuclear plants, many natural gas plants, and some other renewable energy facilities, which depend on water for cooling. This dependence can cause problem when, cooling water becomes too scarce or too hot. PV systems, in contrast, require no water to make electricity. However, photovoltaic generators require water to wash dust and dirt off of the front of modules, as cell efficiency is reduced when the modules are dirty. This depends on the type of system, large-scale solar can use considerable amounts of water. These requirements can be similar or even higher than conventional fossil fuel plants. As the amount of water requirement is too little, the impact on water resources is not that significant.
- For Ground area solar project surface water quality in the adjacent rivers, canals and ponds might insignificantly degrade during construction stage due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, and noxious chemicals. The problem will be more dangerous if the construction work will continue even in the monsoon when the flood occurrence is very high. There will have no major impacts on ground water quality due to the construction of the proposed project.

Mitigation

In order to minimize the adverse impact on water quality, the following mitigation measures are proposed:

- The contractor will dispose of the debris material to a designated disposal site.
- All reasonable measures will be taken to prevent the wastewater produced in construction from entering into creek and stream.
- Contractor's camp will be provided with sanitary latrines that do not pollute surface waters.
- The ground water in the project area has been used for different purposes like drinking and irrigation, hence proper mitigation measures must be ensured at construction site to avoid any spillage and leakage of oil. All the staffs at construction areas must be refrained of discharge any liquid wastes on the ground.

7.7.3 Noise

Impact

During construction of rooftop and ground area solar power project noise might be generated from construction work. Movement of construction materials, handling of equipment can cause significant noise which has impact on environment.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase and which include:

- Apply adequate general noise suppressing measures. This could include the use of well-maintained mufflers and noise suppressants for high noise generating equipment and machinery, developing a regular maintenance schedule of all vehicles, machinery, and equipment for early detection of issues to avoid unnecessary elevated noise level, etc.
- If noise levels were found to be excessive, construction activities should be stopped until adequate control measures are implemented etc.; and

Comply with the Occupational Safety and Health Administration (OSHA) requirements and the Bangladesh Codes to ensure that for activities associated with high noise levels, workers are equipped with proper Personal Protective Equipment (e.g. Earmuffs).

7.7.4 Air Quality

Impact

As with the development of any large-scale industrial facility, the construction of rooftop solar energy power plants can pose hazards to air quality. Such threats include the release of soil-carried pathogens and results in an increase in air particulate matter which has the effect of contaminating water reservoirs.

As the proposed project is also for ground area solar system 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 but impacts are low.

Exhaust emissions: Exhaust emissions of SO₂, NO_x, CO, CO₂, and PM₁₀, PM_{2.5} will be attributed predominantly to the operation of the construction plant and road vehicles such as movement of vehicles during construction works. These emissions will be limited to the project area and are anticipated to be generated in small concentrations and dispersed rapidly within the area leading to an impact of low significance. This means that these effects are localized and temporary which implies that any deterioration in air quality at project location is unlikely to be significant and is expected to be transient.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase (to prevent impacts caused by their construction activities and which are within their control) and which include:

- Comply with the Occupational Safety and Health Administration (OSHA) requirements and the Bangladesh Codes to ensure that for activities associated with high dust levels, workers are equipped with proper Personal Protective Equipment (e.g. masks, eye goggles, breathing equipment, etc.);
- Apply basic dust control and suppression measures which could include:
- If dust or pollutant emissions were found to be excessive, construction activities should be stopped until the source of such emissions have been identified and adequate control measures are implemented;
- Proper planning of dust causing activities to take place simultaneously in order to reduce the dust incidents over the construction period.
- Regular watering of all active construction areas.

7.7.5 Soil

Impact

There will be no significant impact on the soil except for accidental spillage of the chemicals to the ground and disposal of solid wastes and wastewater for rooftop solar system.

For ground area solar system construction activities are expected to result in significant soil loss. The excavation, leveling and other earthworks are the possible source to disturb the soil due to the removal of top soil, which could trigger soil erosion process. Additionally, the proposed project area is flood prone and needs huge amount of land filling. The total area is 4 bigha or 132 decimal.

The other source of impact to soil is waste generation from construction material, accidental leakage of fuel, oil, or chemicals stored within a bounded area causing direct contamination to soil which may degrade lower layers of soil depending on the amount of spills.

Mitigation

Assuming that spill response plans shall be in place by the contractor, it is anticipated that impacts to soil resulting from these activities will be likely, with a marginal consequence, yielding medium impact significance.

The filling material should be collected from the approved source dredging location with proper care so that no spillage will be happen. Retention wall or water proof boundary with plastic material should be constructed before the dredged material placement to prevent the spillage from site to adjacent agricultural land.

7.7.6 Terrestrial Ecology

Impact

Installing a rooftop solar photovoltaic (PV) system requires lopping/pruning of tree branches to ensure shadow-free area. Additionally, it also needs to removing of existing rooftop vegetation/gardening if there any.

The activities anticipated during the construction phase for ground area solar system will include earthworks, excavations, grading, site leveling, asphaltting, paving and the operation of construction machinery and equipment. However, according to the baseline description,

the project area does not encompass natural systems, which means that no significant flora and fauna are present.

As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site.

However, it may cause temporary disturbance to resident birds with ground nests due to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, reptiles present within the project site may temporarily move to adjacent locations during construction activities, however are expected to return back as construction is completed.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor during the construction phase and which include:

- Implement proper management measures to prevent damage to the natural vegetation of the site. This could include establishing a proper code of conduct and awareness raising / training of personnel and good housekeeping which include the following:
 - Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off roading to minimize disturbances
 - Prohibit hunting at any time and under any condition by construction workers onsite
 - Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures Ensure proper storage, collection, and disposal of waste streams generated
- Before construction commences, undertake a fauna survey (through an ecological expert) to identify the presence of any key faunal species of importance (reptiles and mammals). Should viable populations of such key species exist within the Project site then it should be relocated outside of construction active areas;
- Ensure that the fencing constructed for the Project site allows for the natural movement of small faunal species within the area.

7.7.7 Waste Generation

Impact

Improper management of non-hazardous and hazardous waste generated during construction may lead to impacts on soil, water, visual environment, in addition to health and safety of workers.

Non-hazardous waste includes paper, wood, plastic, scrap metals, glass and mud.

Hazardous waste includes absorbent material, batteries, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

Mitigation

All waste generated at construction site will be managed as per Contractor's Waste Management procedures. Domestic wastewater generated at site will be collected in septic tanks.

7.7.8 Employment Opportunities

Impact

Positive benefits of the project may arise either from short-term job opportunities during construction, or long-term job opportunities during operation. It is important that construction and operation jobs to be targeted to the local people within *Madhabpur upazila* where feasible.

Recommendation

Contractor as far as practicable will recruit construction workers from amongst the locals where possible and shall maintain gender equity while employing the locals. Additional benefits will be derived by setting aside areas within contractor camps/labor shed for local people to sell their products or to provide additional services to the workers. Replacement on a suitable location in a better form will be done with the help and consent of the local community.

7.7.9 Health and Safety

Impact

The construction activities include site preparation, infrastructure utilities installation, building structures. Therefore, there will be potential impacts on workers' health and safety due to exposure to risks through construction activities that lead to accidents causing injuries and death. Construction works and activities bear frequent accident and health risks for both the laborers and the public general, with varying direct and indirect consequences. Therefore, the project authority needs to make provision for specific medical services, workers insurance policies and indemnities, emergency provisions and a rescue/evacuation plans in case of major accidents.

Mitigation

- The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.
- The project authority will be requested to prepare an approved Construction Environmental Action Plan (CEAP), which will, among others, delineate all work safety aspects he intends to apply. Focal points of the CEAP will relate to means, type and number of protective clothing, safety precautions at specific work sites, first aid, rescue plans, work hours, and all intended measures for avoiding or proper clearance of hazardous substances, including fueling operations, transport and handling of hazardous materials and explosives, securing measures etc. The CEAP will further explain methods

and volumes for using any local resource, and how to address common risks associated with public safety. The project authority will disclose the CEAP with the local stakeholders for further developments on the health and safety issue.

7.7.10 Traffic

Impact

During the construction phase traffic is expected to increase to a certain degree due to the nature of activities that will take place such as the transport of equipment and materials to and from the site through the surrounding road network. Additional traffic load will be evident at certain times during the day, especially if there are slow moving heavy vehicles transporting material to and from the site.

The above potential traffic impacts can possibly occur during the construction, especially during working hours. However, this is considered a short-term impact. This impact is likely to happen but is not anticipated to cause any permanent effect on the receiving environment.

Mitigation

Proper Traffic Management Plan (TMP) should be prepared by the contractor during starting of construction and follow it strictly. However, minimum numbers of vehicles will be used for carrying construction materials. Hence, the accidental loss is expected at the lowest. Moreover, the project authority will try to carry the construction materials during off peak hours when the traffic volume is the minimum.

7.7.11 Archaeology and Cultural Resources

Impact

The field visits conducted at the project site and it is found that there are some schools, located near the project area. Hence, it can be said that there is no anticipated impact from construction on these receptors; therefore, the impact assessment process for this receptor has yielded the low significance.

Mitigation

This impact is temporary and minor negative in nature. Mitigation measures will include:

- Timely completion of the construction work and provision of alternative routes during the construction;
- Establishment of construction site camp and labour camp must maintain proper distance from the cultural sites.

7.8 Operational 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 are beyond the purview of this project.

7.8.1 Visual Amenity

Impact

The presence of a large area of PV panels is not expected to constitute a risk for glare since it is situated in the industrial rooftop and far from any significant areas, nor residential dwellings, moreover, no potential visual disturbance to birds are expected given the fact, and as a result, there is no migratory birds fly way over the project area.

Mitigation

It is not anticipated that visual impacts will be generated due to the PV system design, which is specifically designed to include dark, light-absorbing materials and covered with an anti-reflective coating (ARC) for glass surfaces, which reduces the reflectance from PV panels to 2.5%-2.6% while at the same time improving their efficiency.

It is essential to point out that the intensity of light reflected from a PV module surface depends on factors such as the amount of sunlight reaching the surface and rooftop and will therefore vary based on, among others, geographic location, time of year, cloud cover, and PV module orientation.

7.8.2 Heat Generation

Impact

The presence of the PV panels will reflect heat and increase the surrounding temperature. The heat may be transferred by convection, radiation and conduction method. Theoretically, the solar thermal placement in the shell of the buildings could increase fire risk and water intrusion into the roof.

Mitigation

In order to reduce the impact, air gap between the PV panels may be simulated. These air gaps will be freely connected to the outdoor air to keep the PV panels cool.

7.8.3 Noise

Impact

The solar power as a facility is not considered to exhibit any significant noisy operations, although the facility's inverters and transformers may produce noise, but this is not considered a serious issue, since they will not generate any significant noise. In addition, there are some close by sensitive receptors such as a school and some residential dwellings within the project site.

In addition, noise generated from inverters is only heard when distance is close (i.e. within 1-2 m, however, as distance increases, noise will be greatly reduced, not to mention that they do not generate noise during night time.

Mitigation

These noise impacts are not considered to significantly harm animals nor cause impacts on a population level. The increased noise levels are considered occupational noises that require occupational health and safety measures. The worker inside the project area should use earmuffs during the operation of diesel generator.

7.8.4 Air Quality

Impact

No emissions are expected to be released during the operation phase, because solar PV power plants systems do not release greenhouse gases or any toxic pollutants during their operation, as a result, no impacts on ambient air quality are anticipated during the operation phase. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people.

It is worth mentioning that solar power plants have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide during operations compared to fossil fuel power generation facilities, since solar power plants do not involve combustion processes.

Mitigation

- The project developer shall be committed to control emitted dust and gaseous pollutant from such operations through the proposed emission control procedures described in the environmental management plan (EMP) included in this report.
- Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels.

7.8.5 Soil

Impact

Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. However, since the project area is designated for solar projects near roadside and settlements area, they do not have any agricultural significance. Another most significant source of soil pollution is the damage of PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality.

Mitigation

Through implanting spill response procedures, and proper storage and handling of any chemicals on site, the impact probability will be reduced. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.

7.8.6 Terrestrial Ecology

Impact

The project area does not encompass any natural systems. The anticipated impacts on terrestrial ecology is considered low, however, activities such as vehicular movement, may cause disturbance to resident birds and their ground nests.

Mitigation

The anticipated impacts on terrestrial ecology are considered low and hence no particular mitigation measure should be followed. However, the vehicular movement should be very limited and proper attention should be given to minimize the disturbance on surrounding ecological environment.

7.8.7 Waste Generation

Impact

PV modules: PV modules wastes and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.

Ground-mounted PV solar arrays are typically made up of panels of silicon solar cells covered by a thin layer of protective glass attached to an inert solid underlying substance (or “substrate”). While the vast majority of PV panels currently in use are made of silicon, certain types of solar cells may contain cadmium telluride (CdTe), copper indium diselenide (CIS), and gallium arsenide (GaAs). All solar panel materials, including the chemicals noted, are contained in a solid matrix, insoluble and non-volatile at ambient conditions, and enclosed. Therefore, releases to the ground from leaching, to the air from volatilization during use, or from panel breakage, are not a concern.

Waste water: Water consumption in PV panel cleaning operations can be a major operating cost over the lifetime of a solar panel installation. Control of water use is a key element to the economic viability and environmental stewardship of many PV installations.

Water requirement for cleaning panels (and its frequency) mainly depends on the cost and the environmental conditions of project area. In the dry and dusty season the water requirement will be higher but during the monsoon the water consumption will be very minimum or no consumption. Usually the cleaning frequency may be two times a month. The water requirement may vary from 5000 to 10000 liters for cleaning the panels during different weather conditions.

Others: Waste generation during the operation phase is considered part of daily operations, therefore, it is not considered to have any significant impacts to the environment or health of personnel present on site.

Mitigation

Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels.

Cleaning of solar panels will be conducted on an overcast day, early in the morning or in the evening. If the sun is beating down on the panels, any water used can quickly evaporate and dirt will become smeared. Early morning can be a particularly good time for cleaning as dew that has settled on the panels overnight will likely have softened grime; meaning that will need to use less water and less energy to clean the solar panels. Groundwater will be used for the cleaning purpose but reuse of water will be emphasized.

7.8.8 Health and Safety

Impact

- a. There are many hazards associated with a solar PV 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
 - Emergency Fire Hazard
 - Electrocution of workers
 - Electromagnetic radiation from PV modules
- b. **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 diphenylethers (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.
- c. **Emergency Fire Hazard:** Since this is a 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 taken during site preparation including the removal of fuels and the lack of burnable materials mostly glass and aluminum contained in a solar panel.
- d. **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. The most possibilities of electrocution during the regular PV wash. Since the worker needs to handle with water which has very high electric conductivity and may be in high risk of electrocution.
- e. **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.

Mitigation

- The project developer shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks during operation phase including all safety prevention and mitigation measures to avoid non-conformance events.
- Check modules for excessive soiling from dirt buildup or animal droppings. During the wash of the PV panels try to use deionized water to avoid electrocution. Wear rubber sole shoes with good traction to prevent slips and falls. Never walk on the modules. Use non-conductive extended reach broom and hose handles to reach modules. A lift may be needed to access the array. Follow aerial lift safety procedures, including wearing a harness if required.
- The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

7.9 Decommissioning Phase

The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. However, some of the major impacts are described below.

7.9.1 Visual Amenity

Impact

During the dismantling of the solar rooftop ground area solar system, removal of ancillary facilities visual intrusions will be likely.

Mitigation

Their consequence will be negligible due to fact that such impact would be temporary (over a short period). Moreover, the actual dismantling of the solar power plant will reduce or remove the visual impacts witnessed during the operation phase.

7.9.2 Noise

Impact

The decommissioning activities of dismantling the solar power plant and removing the ancillary facilities are associated with potential increased noise levels. The receptors of the increased noise level will be only the workers of decommissioning activities.

Mitigation

As the only receptors will be the workers at the site and within the proposed facilities within the vicinity of the solar power plant, these increased noise levels are considered occupational noises that require occupational health and safety measures.

7.9.3 Air Quality

Impact

Similar to construction, the decommissioning phase is anticipated to generate dust and exhaust emissions. Decommissioning activities will involve site preparation, dismantling and disassembling of the components of the solar power plant facility, clearance of the site, and rehabilitation if needed.

Mitigation

The project developer shall be committed to control emitted dust and gaseous pollutant from such operations through the proposed emission control procedures described in the environmental management plan (EMP) included in this report.

7.9.4 Soil

Impact

During the decommissioning phase, the decommissioning activities are anticipated to have an impact of medium significance to soil. This is due to possible accidental leakage of fuel, oil, or chemicals during demolition activities.

Mitigation

Proper environmental protection measures should be followed to prevent or control the occurrence of such incidences. Take proper attention in removing the PV panels to prevent any damage as it contains chemicals and might be harmful for soil quality.

7.9.5 Terrestrial Ecology

Impact

The activities associated with decommissioning will involve dismantling of the solar power plant and removal its facilities. This is a temporary phase that could result in some additional noise and dust disturbances. These activities are not anticipated to harm any flora elements due to absence or scarcity of vegetative cover within and around project area, provided dust suppression measures and other procedures are followed. On the other hand, decommissioning activities may cause disturbance to bird species.

Mitigation

The mitigation measures should be the same as it was considered during the construction phase since the decommissioning activities will be same as construction phase.

7.9.6 Waste Generation

Impact

Waste generated during decommissioning limited to non-hazardous and inert wastes such as scrap metals, paper, wood, plastic, given that the contractor will adhere his waste management procedures.

Similar to the construction phase, potential generation of hazardous waste includes absorbent material, batteries, tires, metal drums, empty chemical containers, waste oil from machinery lubricants, etc.

It is not expected that hazardous wastes will be generated from dismantling the solar power plant since the project developer will opt for recycling PV panels of the facility.

PV modules and others: PV modules wastes and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.

Ground-mounted PV solar arrays are typically made up of panels of silicon solar cells covered by a thin layer of protective glass attached to an inert solid underlying substance (or “substrate”). While the vast majority of PV panels currently in use are made of silicon, certain types of solar cells may contain cadmium telluride (CdTe), copper indium diselenide (CIS), and gallium arsenide (GaAs). All solar panel materials, including the chemicals noted, are contained in a solid matrix, insoluble and non-volatile at ambient conditions, and enclosed. Therefore, releases to the ground from leaching, to the air from volatilization during use, or from panel breakage, are not a concern.

End-of-Life Solar Panels: The solar PV panels that will be used in the project will have a life span of 25 years. Disposal of wasted solar PV modules is very important because if not properly decommissioned, the greatest health risk from end-of-life crystalline solar modules arises from lead containing solders. Under the right conditions it is possible for the lead to leach into landfill soils and eventually into water bodies.

While the solar cell is the heart of a photovoltaic system, on a mass basis it accounts for only a small fraction of the total materials required to produce a solar panel. The outer glass cover constitutes the largest share of the total mass of a finished crystalline photovoltaic module (approximately 65%), followed by the aluminum frame (~20%), the ethylene vinyl acetate encapsulant (~7.5%), the polyvinyl fluoride substrate (~2.5%), and the junction box (1%). The solar cells themselves only represent about four percent (4%) of the mass of a finished module.

Mitigation

The following identifies the mitigation measures to be applied by all involved entities:

- Ensure that hazardous materials are stored in proper areas and in a location where they cannot reach the land in case of accidental spillage. This includes storage facilities that are of hard impermeable surface, flame-proof, accessible to authorized personnel only, locked when not in use, and prevents incompatible materials from coming in contact with one another.
- Maintain a register of all hazardous materials used and accompanying Material Safety Data Sheet (MSDS) must present at all times. Spilled material should be tracked and accounted for;

- If spillage on soil occurs, spill must be immediately contained, cleaned-up, and contaminated soil disposed as hazardous waste;
- Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.

7.9.7 Employment Opportunities

Impact

Short-term job opportunities may be arise during decommissioning, however, this can negatively impact permanent personnel at the solar power plant since the facility will cease its operations, therefore permanent staff may lose their jobs.

Although this impact is very unlikely given that fact that an upgrade is expected for the facility during its post–design life, however, the consequence is considered critical to permanent personnel if the facility underwent decommissioning, yielding a low impact significance.

Recommendation

Preference should be given to employing the local communities in various positions.

7.9.8 Health and Safety

Impact

The decommissioning activities will include equipment dismantling and demolishing facilities at project site. As all project components will be recycled after decommissioning, the prospect risks from decommissioning phase will be limited to dismantling and demolishing activities including moving all recyclable components to their final destination. There will be potential impacts on workers' health and safety due to exposure to risks through decommissioning activities.

Mitigation

The project developer will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The developer shall ensure all prospect risks during decommissioning phase are assessed and all prevention and mitigations measures are in place accordingly.

7.9.9 Traffic

Impact

The anticipated impacts during decommissioning are similar to those for the construction phase, where the heavy machinery that transports disassembled parts of the project solar power plant facility might be of more significance than normal vehicles and pickups.

Mitigation

Proper management actions with adequate mitigations can reduce significantly such anticipated impacts.

7.9.10 Summary of Anticipated Impacts

Table 7.4, **Table 7.5**, and **Table 7.6** below present a summary of the anticipated impacts during the planning and construction, operation, and decommissioning phase of the Project.

Table 7-4: Summary of Anticipated Impacts during the Planning and Construction Phase

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Landscape and Visual	Visual and landscape impacts due to presence of elements typical of a construction site such as equipment and machinery.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Geology and Hydrology	The Project site is <i>rooftop and ground area</i> and there is no significant surface water sources around. Only some possible impacts are dumping of solid waste to the nearby source during construction.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
	Risk of soil contamination during the various construction activities from spillage of hazardous material, random discharge of waste and wastewater. No risk of groundwater contamination.	Could be long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	High Positive
Biodiversity	Construction activities could disturb existing habitats (flora, fauna, and avifauna) and any threatened or endangered species which might be present within the Project site. In addition, other impacts could be from improper management of the site (e.g. improper conduct and housekeeping practices).	Long term	Local	Irreversible	Certain	Minor	Mild	Low Negative	High Positive
Air Quality	Construction activities will likely result in an increased level of dust and particulate matter emissions which in turn will directly impact ambient air quality.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Noise	Possible noise emissions to the environment from the construction activities which will likely include the use of machinery and equipment such as generators, hammers, and compressors and other activities	Long term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	Short term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative
Socioeconomic	The Project is expected at a minimum to provide job opportunities for local communities. This, to some extent, could contribute to enhancing the living environment for its inhabitants, elevate their standards of living, and bring social and economic prosperity to local communities.	Not applicable.							
Health and Safety	There will be some generic risks to workers health and safety from working on construction sites, as it increases the risk of injury or death due to accidents.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

Table 7.5: Summary of Anticipated Impacts during the Operation Phase

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Landscape and Visual	The Project is expected to be visible within the immediate vicinity and up to some long distance around the Project site only and thus is likely to create visual impacts related to interaction with surrounding landscape.	Long term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative
	Potential for glare caused by minimal sunlight reflected off the PV panel modules which in turn could affect nearby receptors.	Long term	Local	Reversible	Likely	Medium	Mild	Low Negative	Low Negative
PV panels	The most significant source of soil pollution is the damage of PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people.	Long term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative
Heat Generation	Increased heat by radiation, convection and conduction	Long term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low negative
Geology and Hydrology	Risk of soil and groundwater contamination during the various operational activities from improper housekeeping activities, spillage of hazardous material, random discharge of waste and wastewater. However,	Long term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low negative

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	most significant sources of soil and water pollution are the chemicals from PV panel's damage and from the expired batteries.								
Biodiversity	Impacts limited to improper management of the site (e.g. improper conduct and housekeeping practices).	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	Moderate Positive
Air Quality	Solar power plants have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide during operations.	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	High Positive
Noise	The only significant noise source from the operation activities which will likely include the use of backup generators to ensure continuous power supply.	Long term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Socio-economic	The Project is expected at a minimum to provide job opportunities for local communities. This, to some extent, could contribute to enhancing the living environment for its inhabitants, elevate their standards of living, and bring social and economic prosperity to local communities.	Not applicable.							
Occupational and Community Health and	There will be some risks to workers health and safety during the operation and maintenance activities of the Project.	Long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	Moderate Positive

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Safety	Trespassing of unauthorized personnel into the Project site could result in potential risks from several hazards of the various Project components (e.g. electric shock, thermal burn hazards, exposure to chemicals and hazardous materials, etc.). Leaching of materials from broken or fire damaged PV modules. Emergency Fire Hazard. Electrocution of workers. Electromagnetic radiation from PV modules.	Long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	Moderate Positive

Table 7.6: Summary of Anticipated Impacts during the Decommissioning Phase

Environmental Attribute	Likely Impact– Decommissioning Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Geology and Hydrology	Risk of soil and groundwater contamination during the various decommissioning activities from improper housekeeping activities, spillage of hazardous material, random discharge of waste and wastewater.	Short term	Local	Could be irreversible	Likely	Medium	Low	Moderate Negative	Low Positive
Air Quality	Decommissioning activities will likely result in an increased level of dust and particulate matter emissions which in turn will directly impact ambient air quality.	Short term	Local	Reversible	Certain	Medium	Low	Moderate Negative	Low Negative

Environmental Attribute	Likely Impact– Decommissioning Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Noise	Possible noise emissions to the environment from the decommissioning activities which will likely include the use of machinery and equipment such as generators, hammers, and compressors and other activities.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Infrastructure and utilities	Of particular importance related to infrastructure and utilities is the final disposal of the panels at the end of their lifetime. Final disposal of panels, which may contain hazardous material, needs to ensure that existing waste facilities would be able accept such solar modules. In addition, it is also important to investigate other disposal options such as buy back and recycling programs.	Long term	Local	Reversible	Likely	High	Severe	High Negative	Low Negative
Health and Safety	There will be some generic risks to workers health and safety from working on decommissioning sites, as it increases the risk of injury or death due to accidents.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

8 CHAPTER EIGHT: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1 General

The Environmental and Social Management Plan (ESMP) aims to ensure the compliance of all activities undertaken during the implementation and the operation of the proposed project with the environmental and social safeguard requirements of the Donor and Government of Bangladesh. Furthermore, it aims at integrating the environmental and social components of the project with existing initiatives and programs in these fields. The plan consists of mitigation, monitoring and institutional measures to be taken during implementation and operation to eliminate adverse environmental impacts, offset them, or reduce them to acceptable levels. The plan also includes the actions needed to implement these measures.

8.2 Objectives

This Environmental and Social Management Plan (ESMP) aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

The key objectives of the ESMP are summarized below:

- Minimizing any adverse environmental, social and health impacts resulting from the project activities;
- Conducting all project activities in accordance with relevant Bangladesh Legislation and applicable World Bank guidelines.
- Implementation of on-going environmental monitoring programs;
- Periodic review of the Environmental Management programs to allow for iterative improvement;
- Ensure that all stakeholder concerns are addressed.

Overall, this ESMP aims at ensuring the application of the mitigation and monitoring measures needed to reduce and control the various environmental and social impacts associated with the implementation of the proposed project.

8.3 Environmental and Social Management Plan (ESMP)

On the basis of identification of the environmental impacts and recommended mitigation measures linked with the project activities, an ESMP has been prepared which will be followed at the pre-construction, construction, operation and decommissioning stages. While preparing the ESMP, medium and significant impacts are taken into consideration to recommend possible mitigation measures. A mitigation measure will be considered as successful when it complies with the Environmental Quality Standards (EQS), policies, legal requirements set by JICA Guidelines for Environmental and Social Considerations / World Bank Safeguard Policies, and DoE environmental guidelines & other relevant GoB legal requirements. In absence of DoE's own EQS, other relevant international or other recognized organization's quality standard will be applied.

Table 8.1: Environmental and Social Management Plan (ESMP)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Pre-construction Phase						
Land Use / Land-filling	The proposed plant will degrade surrounding agricultural land.	Fence the proposed area so that the surrounding agricultural land will not be disturbed. Land-filling for side slope of filled lands should be done only within the boundary line of the project to avoid damage to adjacent agricultural land, crops, trees or any other properties. In case of damage by any construction activity, adequate compensation should be paid to the owner in time	Quantity of land use	Consideration of minimum use of agricultural land.	Project developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995 ▪ Industrial Policy, 1986 ▪ Private Sector Power Generation Policy of Bangladesh, 1996 - Policy Guideline for small Power Plants in Private Sector, 1997
Construction Phase						
Visual Amenity	Visual impacts from construction activities such as materials lay down, infrastructure development, etc.	The contractor shall ensure general cleanliness and good housekeeping practice at the project site at all times.	Daily	▪ Good housekeeping and tidiness of work areas within the project site.	Contractor	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995
Water Resources	As the amount of water requirement is too little, the impact on water resources is not that significant. Again, there is no surface water body around the project area.	▪ The contractor will dispose of the debris material to a designated disposal site. ▪ All reasonable measures will be taken to prevent the wastewater produced in construction from entering into creek and stream.	Daily	Compliance with DoE and National guideline limits for Environmental noise at sensitive receptors.	Contractor	▪ Environmental Pollution Control Ordinance, 1977

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		- Contractor's camp will be provided with sanitary latrines that do not pollute surface waters. - The ground water in the project area has been used for different purposes like drinking and irrigation, hence proper mitigation measures must be ensured at construction site to avoid any spillage and leakage of oil. All the staffs at construction areas must be refrained of discharge any liquid wastes on the ground.				
Noise	Increased noise levels during to construction & machinery	- The contractor shall use heavy equipment, machinery, and fuels in compliance with national regulations. The contractor shall perform regular maintenance on all equipment, vehicle and machinery to prevent noise emissions. - The contractor shall limit idling of engines when not in use to reduce its contribution to noise emissions.	Every week and after receiving any complaints from worker or third parties.	Compliance with DoE and National guideline limits for Environmental noise at sensitive receptors.	Contractor	- Environmental Pollution Control Ordinance, 1977 - Noise Pollution Control Rules (2006)
Air Quality	- Dust generation due to construction activities. - Exhaust Emissions due to operation of construction plant and machinery.	- Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. - During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an "as needs" basis. - Unnecessary handling of dusty materials will be avoided such as minimizing drop heights when loaders dump soils into trucks. - Train workers to handle construction materials and debris during construction to reduce fugitive emissions. - Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. Not running engines for longer than is necessary.	Daily	- No visible dust plumes originating From construction sites. - Regular machineries maintenance records.	Contractor	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000 - Bangladesh Climate Change Strategy and Action Plan (2008)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Soil	Soil disturbance due to accidental spillage	- A spill prevention and response plan shall be prepared by the contractor in order to control any inadvertent leakage or spillage. Spill response measures shall be implemented (as necessary) to contain and clean up any contaminated soil. - Construction of bunds around relevant work and storage areas. Bunds in areas of hazardous chemical storage (including temporary storage) should be lined to contain accidental spillage and minimize the potential for migration to the underlying soil. - Any spilled chemical shall be immediately collected and disposed of in accordance with Spill Prevention and Response Plan and MSDS. - Contractor shall ensure that a spill kit and adequate PPE is available at the site for emergency cleanup activities in case of chemical/oil spillage.	Weekly	- Number of spills or incidents to be recorded during onsite audits. - Training records of Personnel trained in spill response procedures must be filed	Contractor	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995
Terrestrial Ecology	Potential disturbance to birds	- Minimize human and vehicular contact with fauna, including their burrows / nests and feeding grounds. - Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Daily	N/A	Contractor	- Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft) - National Forest Policy and Forest Sector Review (1994, 2005) - The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry) - National Biodiversity Strategy and Action Plan (2004)
Waste Generation	Improper management and handling of hazardous and non-hazardous	The contractor shall segregate storage for different types of wastes, such as hazardous, non-hazardous recyclable construction material, plastic, paper, etc. to facilitate proper disposal.	Daily	- Compliance with Waste management procedures. - Current and	Contractor	Environmental Pollution Control Ordinance, 1977

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	waste during construction.	- The contractor shall provide a separate storage area for hazardous materials. The hazardous materials/products must be labeled with proper identification of its hazardous properties. - Chemical waste shall be stored in accordance with the provisions of Material Safety Data Sheets (MSDS). The contractor shall keep MSDS onsite. - The contractor shall establish regular intervals for waste collection and disposal as per contractor's waste management procedures. - The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly.		Complete records of regular waste pickup and disposal.		- The Environment (Pollution Control) Act, 1995 - Environmental Conservation Rules (ECR), 1997
Health and Safety risks	- Potential of exposure to safety events such as tripping, working at height activities, fire from hot works, smoking, failure in electrical installation, mobile plant and vehicles, and electrical shocks. - Exposure to health events during construction activities such as manual handling and musculoskeletal disorders, hand-arm vibration, temporary or permanent hearing loss, heat stress, and dermatitis.	- All construction equipment used for the execution of the project works shall be fit for purpose and carry valid inspection certificates and insurance requirements. - Risk assessment shall be prepared and communicated prior to commencement of work for all types of work activities on site. - Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. - Signpost any slippery areas, ensure proper footwear with a good grip is worn for personnel working within slippery areas. - Avoid work at height where it reasonably practicable to do so, e.g. by assembly at ground level. - Prevent any person falling a distance liable to cause personal injury e.g. by using a scaffold platform with double guard-rail and toe boards; - Arrest a fall with equipment to minimize the distance and consequences of a fall,	Continuously	- Total Recordable Incidence Rate (TRIR) - Lost Time Incidence Frequency - Fatal Accident Rate - Number of safety Training performed - Number of nonconformance events Reports. - Medical Treatment Case (MTC) - HSE Training Hours		Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		e.g. safety nets, where work at height cannot be avoided or the fall prevented. ▪ Carry out fire risk assessment for the construction areas, identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. ▪ Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. ▪ Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. ▪ Establish and communicate emergency response plan (ERP) with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel and drills to test the plan ▪ Ensure all plant machines and vehicles are regularly inspected, serviced and maintained; ensure all staff assigned is trained and competent to operate plant machines and vehicles. ▪ Ensure clear signages are in place, such as Warning of speed limits, obstructions, allowable widths/heights...etc. ▪ Electrical equipment must be safe and properly maintained; works shall not be carried out on live systems. ▪ Only competent authorized persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks.				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		▪ Lock-Out / Tag-Out (LOTO) system shall be implemented during any electrical works. ▪ Adequate number of staff and first aiders shall be on site in accordance with Bangladesh Labor Law requirements. ▪ First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. ▪ Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills. ▪ Ensure all equipment is suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc.), provide the lowest vibration tools that are suitable and can do the works. ▪ Ensure all tools and other work equipment are serviced and maintained in accordance with maintenance schedules and manufacturer's instructions. ▪ Regular noise exposure assessments and noise level surveys of noisy areas, processes and equipment shall be carried out in order to form basis for remedial actions when necessary. ▪ As far as reasonably practical, all steps to reduce noise exposure levels of employees by means other than that of personal protective equipment shall be taken, such as reducing exposure times, enclosures, silencers, machine covers, etc. ▪ Awareness training sessions should be established and provided to all personnel involved during the construction phase in order to highlight the heat related illnesses of working in hot conditions such as heat				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		cramps, heat exhaustion, heat stroke, dehydration. ▪ Ensure adequate quantities of drinking water are available at different locations within the site, ▪ Provision of sun shades at different locations within the site. ▪ Eliminate the risk of exposure whenever possible, provide proper PPE wherever necessary and to ensure that there are satisfactory washing and changing facilities. ▪ Ensure that all workers exposed to a risk are aware of the possible dangers. They should be given thorough training in how to protect themselves and there should be effective supervision to ensure that the correct methods are being used.				
Traffic	Additional traffic load due to transport of equipment and materials to and from the site through the surrounding road network	▪ The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators. ▪ Pedestrians Safety: All project vehicles and trucks shall comply with the proposed speed limits ▪ Ensure adequate maintenance and inspection of vehicles ▪ Presence of flagman at the entrance and exit of the project site in order to control vehicles and truck movement.	Continuously	▪ No complains or concerns from traditional users of the area's roads routes are received during the construction activities. ▪ No incidents or accidents (collisions) are recorded	Contractor	
Operation Phase						
Visual Amenity	Reflection from the solar panel will create visual intrusion.	The used technology has Anti- Reflective coating (ARC) that significantly reduces the reflectance of the Panels (from 2.5% to 2.6% only).	N/A	N/A	Project Developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995
Noise	Significant sound pollution from backup generator	▪ Establish the generator inside an insulated room and use noise reduction canopy to keep the environment free from sound pollution.	Every week and after receiving any complaints	Compliance with DoE and National guideline limits for	Project Developer	▪ Environmental Pollution Control Ordinance, 1977

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		- Noise barrier should also be given around the generator room. - The worker inside the project area should use earmuffs during the operation of diesel generator.	from worker or third parties.	Environmental noise at sensitive receptors.		Noise Pollution Control Rules, 2006
Air Quality	Very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the greenhouse gas carbon dioxide.	- Check regularly to identify potential source of air pollutants. - Replace the damaged and expired tools, equipment, PV panels and batteries as soon as it is notices.	Daily	- No visible dust plumes originating from project site. - Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000 - Bangladesh Climate Change Strategy and Action Plan (2008)
Heat Generation	- Potential glare from PV panels and Reflected Heat. - Theoretically the solar thermal placement in the shell of the buildings could increase fire risk and water intrusion into the roof.	- This can be easily avoided, since only four holes per panel on the roof will be integral part of the roof. - Air gaps will be provided to keep the system cool.	N/A	No heat generation and complains from the worker.	Project Developer	Environmental Pollution Control Ordinance, 1977
Soil	Potential spillage of stored oil and chemicals	- Specific procedures shall be developed for the removal of waste or spilled fuel, oil and contaminated soil at approved disposal facilities. - Proper storage for chemicals and fuel within confined areas on site and adopting proper safety measures when handling those chemicals to prevent their leakage and infiltration into the soil.	- Post rainfall Event - Weekly	Maintain readily available records of all workers training on spill response procedures.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995
Terrestrial Ecology	Potential disturbance and harm to birds	- Minimize human and vehicular contact with resident birds including their burrows / nests and feeding grounds. - Ground nests found on site shall be translocated outside the project boundary.	Weekly	No reported harm to birds.	Project Developer	Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.				- National Forest Policy and Forest Sector Review (1994, 2005) - The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry) - National Biodiversity Strategy and Action Plan, 2004
Waste Generation	- Solid wastes from PV modules which contains toxic metals. - Wasted PV modules and few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.	- A proper temporary storage facility is needed for the wasted batteries to avoid potential lead contamination. - Collect the domestic waste in septic tanks to treat according to the approved procedure.	Continuously	- Compliance with Waste management procedures. - Current and Complete records of regular waste pickup and disposal.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995
Waste water	Waste water generation due to wash of PV panels	- Cleaning of solar panels will be conducted on an overcast day, early in the morning or in the evening. - If the sun is beating down on the panels, any water used can quickly evaporate and dirt will become smeared. - Early morning can be a particularly good time for cleaning as dew that has settled on the panels overnight will likely have softened grime; meaning that will need to use less water and less energy to clean the solar panels. - Groundwater will be used for the cleaning purpose but reuse of water will be emphasized.	Once in a month	Compliance with Waste management procedures.	Project Developer	- Environmental Conservation Rules, 1997 - Environmental Pollution Control Ordinance, 1977 - The Environment (Pollution Control) Act, 1995

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
PV panels	The most significant source of soil pollution is the damage of PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people. Wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.	Photovoltaic (PV) is now a proven technology which is inherently safe as opposed to some dangerous electricity generating technologies. Photovoltaic systems make no air pollution and cause no pollution in operation. PV panel should be clean and maintenance regularly for dust free. The supplier will collect wastage PV panels for maintenance and destroy and they will be responsible for management of PV panels. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000
Health and Safety	- Leaching of materials from broken or fire damaged PV modules - Emergency Fire Hazard - Electrocution of workers - Electromagnetic radiation from PV modules	- Provide walkways that are clearly designated as a walkway; all walkways shall be provided with good conditions underfoot; signposted and with adequate lighting. - Ensure all works and storage areas are tidy, all material deliveries shall be planned to minimize accumulated materials at project site. - Signpost any slippery areas, provide proper footwear during working within slippery areas.	Continuously	- Total Recordable Incidence Rate (TRIR) - Lost Time Incidence Frequency - Number of safety Training performed - Number of nonconformance events.	Project Developer	Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	- Slipping and tripping, working at height activities - Lead can enter body in two ways: by breathing or by swallowing it. Lead Sulfide dust enters the body through breathing. Very fine lead particles may penetrate into the lungs result in absorption in the bloodstream. - As a power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. - Risk of electrocution of workers during performing duties in a power plant is always present.	- Carry out fire risk assessment during operation to identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire. - Set up a system to alert workers on site. This may be temporary or permanent mains operated fire alarm. - Fire extinguishers should be located at identified fire points around the site. The extinguishers shall be appropriate to the nature of the potential fire. - Establish and communicate emergency response plan with all parties, the ERP to consider such things as specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel's. - Adequate first aiders shall be on site in accordance with Bangladesh Labour Law requirements. - First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. - Only competent authorized persons shall carry out maintenance on electrical equipment, adequate Personal Protective Equipment (PPE) for electrical works must be provided to all personnel involved in the tasks.				
Decommissioning Phase						
- The solar power plant facility is considered a large scale long-term investment that will contribute to economic benefits to the country through provision of power supply, designed in accordance with best practice, taking into account all relevant national and internal codes and legislation. - The design life of the facility will be approximately 20 years. Therefore, the post-design life is expected to involve rehabilitation, upgrading and modernization of the facility, with a possible expansion (retrofitting and addition of new technology). As a result, impacts from decommissioning are not expected to arise in the near future unless retrofitting and upgrade of the facility was not feasible. However, this, ESA Study has considered potential decommissioning impacts in case there was a need for the facility to be dismantled and end operations.						

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
- As can be noted from the impact assessment chapter 8, no impacts with high significance are anticipated to take place during decommissioning of the project since all facilities will be removed, solar power plant decommissioned, and PV panels will be dismantled and sent for recycling or disposal. - The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. - The solar PV panels that will be used in the project will have a life span of 25 years. Disposal of wasted solar PV modules is very important because if not properly decommissioned, the greatest health risk from end-of-life crystalline solar modules arises from lead containing solders. Under the right conditions it is possible for the lead to leach into landfill soils and eventually into water bodies. - While the solar cell is the heart of a photovoltaic system, on a mass basis it accounts for only a small fraction of the total materials required to produce a solar panel. The outer glass cover constitutes the largest share of the total mass of a finished crystalline photovoltaic module (approximately 65%), followed by the aluminum frame (~20%), the ethylene vinyl acetate encapsulant (~7.5%), the polyvinyl fluoride substrate (~2.5%), and the junction box (1%). The solar cells themselves only represent about four percent (4%) of the mass of a finished module. - Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.						

8.4 Environmental and Social Monitoring Plan

8.4.1 General

An Environmental and Social Monitoring Plan will be prepared to provide guidelines for environmental and social management plan during the construction and operation phases of the project. The environmental components that will be monitored are those that will be positively or negatively affected, or expected to be affected, by construction activity. Environmental management is a sustainable way of planning, arranging, supervising, organizing, and developing the environment for the maintenance of the preservation of natural resources and the prevention or reduction of damage to the environment. The major environmental impact, monitoring method, responsible organization, and expense for each environmental item in the construction and operation phases for the proposed development are listed in [Table 8.2](#).

8.4.2 Objectives

The objective of environmental 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 ESA;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the ESA;
- 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 ESA 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 8.2: Environmental and Social Monitoring Plan

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Pre-Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	FEIL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	FEIL
Water Quality	Surface water: pH, EC, TDS, DO, COD, BOD, TSS, Temperature, Salinity, Nitrate, Ammonia, phosphate	Surface water quality standard by DoE, Bangladesh	Once	Contractor	FEIL
	Ground Water: pH, Alkalinity, Fe, Cl ⁻ , TDS, DO, EC,As, Temperature, Salinity	Surface water quality standard by DoE, Bangladesh	Once	Contractor	FEIL
Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE, Bangladesh	Once	Contractor	FEIL
Dust	Dust control	Air quality standard by DoE, Bangladesh	Once	Contractor	FEIL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	FEIL
Water Quality	Surface water: pH, EC, TDS, DO, COD, BOD, TSS, Temperature, Salinity, Nitrate, Ammonia, phosphate	Water quality standard by MoEF, Bangladesh	Once	Contractor	FEIL
	Ground Water: pH, Alkalinity, Fe, Cl ⁻ , TDS, DO, EC,As, Temperature, Salinity	Water quality standard by MoEF, Bangladesh	Once	Contractor	FEIL
Waste	▪ Check storage, transportation, disposal, handling of hazardous waste ▪ Waste and effluents to be collected and disposed safely from camp. ▪ Wastes and garbage from construction sites to be disposed safely	Monitoring	Weekly	Contractor	FEIL
Health and Safety	▪ Check quality of food and accommodation at construction camp; ▪ Check safe water supply, hygienic toilet at camp, construction	Monitoring	Regularly	Contractor	FEIL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	of drain at camp site; ▪ 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 (PPE) for worker at the sites				
Operation Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DOE, Bangladesh	1/year (5 year)	FEIL	DOE/IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	1/year (5 year)	FEIL	DOE/IDCOL
Water Quality	Surface water: pH, EC, TDS, DO, COD, BOD, TSS, Temperature, Salinity, Nitrate, Ammonia, phosphate	Water quality standard by DOE, Bangladesh	1/year (5 year)	FEIL	DOE/IDCOL
	Ground Water: pH, Alkalinity, Fe, Cl ⁻ , TDS, DO, EC, As, Temperature, Salinity	Water quality standard by DOE, Bangladesh	1/year (5 year)	FEIL	DOE/IDCOL
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	-----	FEIL	DOE/IDCOL
PV panels	Chemicals		1/year (5 year)	FEIL	DOE/IDCOL
Decommissioning Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DOE, Bangladesh	Once	Contractor	FEIL /IDCOL
Dust	Dust control	Air quality standard by DOE, Bangladesh	Once	Contractor	FEIL /IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	FEIL /IDCOL
Water Quality	Surface water: pH, EC, TDS, DO, COD, BOD, TSS, Temperature, Salinity, Nitrate, Ammonia, phosphate	Water quality standard by MoEF, Bangladesh	Once	Contractor	FEIL /IDCOL
	Ground Water: pH, Alkalinity, Fe, Cl ⁻ , TDS, DO, EC, As, Temperature, Salinity	Water quality standard by MoEF, Bangladesh	Once	Contractor	FEIL /IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Waste	▪ Check storage, transportation, disposal, handling of hazardous waste ▪ Careful and proper handling of PV panels and batteries ▪ Waste and effluents to be collected and disposed safely from camp. ▪ Wastes and garbage from worker sites to be disposed safely	Monitoring	Weekly	Contractor	FEIL /IDCOL
Health and Safety	▪ Check quality of food and accommodation at worker camp; ▪ Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; ▪ Check toilets are close to construction site; ▪ First Aid Box with required tools and medicines; ▪ Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	FEIL /IDCOL

8.5 Environmental and Social Budget

The estimated budget for implementation of the mitigation and monitoring measures proposed in the ESMP is presented in **Table 8.3**. The overall costs of the ESMP will comprise:

- Environmental and social monitoring through sample collection and analysis;
- Any remedial measures necessary to reduce or avoid environmental and social damage;
- Designing and implementing all mitigating and enhancement measures;

The total budget is estimated as BDT. 4,59,800. This budget does not include the decommissioning stage since the minimum operation period is 20 years and the rate will vary largely from the present cost.

Table 8.3: Environmental Budget

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
PRE-CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	30,000	30,000
Noise	Measuring ambient noise level	No.	5	4,000	20,000
Water Quality	Surface water quality measurement	No.	1	9,000	9,000
SUB TOTAL (PRE-CONSTRUCTION STAGE)					59,000
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	30,000	30,000
Noise	Measuring ambient noise level	No.	5	4,000	20,000
Water Quality	Surface water quality measurement	No.	1	9,000	9,000
Waste disposal and management	Disposal and management of construction waste and solar panels of individual households	Lump sum			30,000
Construction Safety	General Safety (provision of PPE like ear muffs, gloves etc.)	Lump sum			15,000
Health	Health check-up camps for construction workers	Camp	-	10,000	10,000
SUB TOTAL (CONSTRUCTION STAGE)					114,000
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	5 (1/2year)	30,000	1,50,000
Noise	Monitoring ambient noise level	No.	5 (1/2year)	4,000	20,000
Water	Monitoring surface water quality	No.	5 (1/2year)	9,000	45,000
SUB TOTAL (OPERATION STAGE)					2,15,000
ESTABLISHMENT and TRAINING					
Training	Environmental training and awareness	Lump sum	As per training details	20,000	20,000
Management Information System		Lump sum	-	10,000	10,000
SUB TOTAL (ESTABLISHMENT and TRAINING)					30,000
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					4,18,000
CONTINGENCIES @ 10 % on total Environmental Costs					41,800
GRAND TOTAL (in BDT)					4,59,800

9 CHAPTER NINE: ENVIRONMENTAL AND SOCIAL BENEFIT

9.1 Introduction

Renewable energy is recognized internationally as a major contributor in protecting our climate, nature, and the environment as well as providing a wide range of environmental, economic, and social benefits that will contribute towards long-term global sustainability.

Increasing the supply of renewable energy would allow replacing carbon-intensive energy sources and significantly reducing global warming emissions. Generating electricity from renewable energy offers significant public health benefits. The air and water pollution emitted by coal and natural gas plants is linked to breathing problems, neurological damage, heart attacks, and cancer.

Solar power plant systems generate electricity with no associated air pollution emissions. While solar plant energy systems emit some air pollutants, total air emissions are generally much lower than those of coal and natural gas-fired power plants. In addition, solar energy requires essentially no water to operate and thus do not pollute water resources or strain supply by competing with agriculture, drinking water systems, or other important water needs.

9.2 Energy and Climate Concern

The negative environmental impacts from generating electricity through conventional fossil fuel burning at thermal power plants are very well known. This most importantly includes air pollutant emissions such as ozone, sulfur dioxide (SO₂), Nitrogen Dioxide (NO₂), particulate matter, and other gases, which are the cause of some serious environmental concerns such as smog, acid rain, health effects, and many others.

In addition, the burning of fossil fuels results in carbon dioxide emissions; a primary greenhouse gas emitted through human activities, which contributes to global warming. The main human activity that emits CO₂ is the combustion of fossil fuels for electricity production and transportation. Concurrently, global climate change has become an issue of concern and so reducing greenhouse gas emissions have also emerged as primary issues to be addressed as the world searches for a sustainable energy future.

Electricity produced using solar energy emits no greenhouse gases (GHGs) or other pollutants. As with any electricity-generating resource, the production of the PV systems themselves requires energy that may come from sources that emit GHGs and other pollutants. Since solar PV systems have no emissions once in operation, an average traditional PV system will need to operate for an average of four years to recover the energy and emissions associated with its manufacturing. A thin-film system currently requires three years. Technological improvements are anticipated to bring these timeframes down to one or two years. Thus, a residential PV system that can meet half of average household electricity needs is estimated to avoid 100 tons of carbon dioxide (CO₂) over a 30-year lifetime.

9.3 Energy and Economy Concern

Energy is a foundation stone of the modern industrial economy. Energy provides an essential ingredient for almost all human activities: it provides services for cooking and space/water heating, lighting, health, food production and storage, education, mineral extraction, industrial production and transportation. Modern energy services are a powerful engine of economic and social development, and no country has managed to develop much beyond a subsistence economy without ensuring at least minimum access to energy services for a broad section of its population. Throughout the world, the energy resources available to them and their ability to pay largely determine the way in which people live their lives. Nevertheless, it is critical to recognize that what people want are the services that energy provides, not fuel or electricity per se. Many factors play a role in influencing energy supply, not least of which is its availability, price and accessibility. The regional endowment of energy sources and the pace at which they are developed and distributed are not uniform around the world.

The last two centuries have seen massive growth in the exploitation and development of energy sources, and the world has gained many benefits from these activities. The magnitude of energy consumed per capita has become one of the indicators of development progress of a country, and as a result, energy issues and policies have been mainly concerned with increasing the supply of energy. This approach is now seen as a vision that needs challenging.

In the last two years, countries around the world have added almost as much new solar photovoltaic (PV) capacity as had been added since the invention of the solar cell. Nearly 38,000 megawatts of PV came online in 2013, a new annual record. In all, the world's installed PV generating capacity is now close to 140,000 megawatts. Falling costs and effective policies continue to drive tremendous growth in solar power.

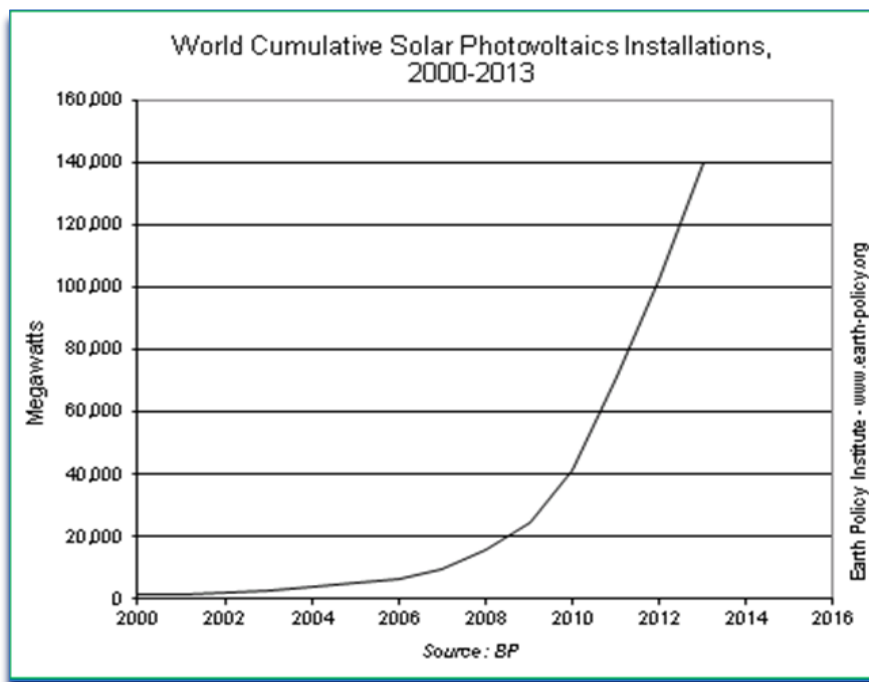


Figure 9.1: Trends of World Solar Energy Growth

PV remains the most rapidly growing energy technology by a wide margin. Indeed, global PV installations for 2014 should reach at least 40,000 megawatts, expanding world PV capacity by another 30 percent. As concerns about climate change grow, solar PV has firmly established itself as an integral player in the transition from fossil fuels.

10 CHAPTER TEN: CONCLUSION

10.1 Conclusion

According to the above analysis, we can conclude that, if the recommended mitigation measures and environmental management processes are adopted properly, the project will be environmentally sound and sustainable.

During the construction stage, there will be some negative impacts of the project. There are no significant cumulative adverse impacts during operation that are identifiable at this stage. The construction impacts should be very predictable and manageable, and with appropriate mitigation, few residual impacts are likely. Additional human and financial resources will be required to improve environmental capability, and to progress and achieve necessary statutory compliance and environmental clearance certification for the project or associated activities that also require environmental assessment and environmental permits under the environmental laws of Bangladesh.

The project is expected to have a small "environmental footprint". No endangered or protected species of flora or fauna are reported at the project site. The proposed project activities have no significant adverse environmental impact so far as a time bound execution program with application of advanced construction technology is ensured. The mitigation measures are well within such codes and practices of construction and operation of the proposed project.

10.2 Recommendations

Adequate provisions have been made for the environmental mitigation and monitoring of predicted impacts, along with their associated costs. Adverse impacts if noticed during implementation will be mitigated using appropriate design and management measures. The potential cumulative and residual impacts of the project classify as not a highly sensitive or complex.

The ESMP, its mitigation and monitoring programs, contained herewith shall be included within the Bidding documents for project works. The Bid documents state that the contractor shall be responsible for the implementation of the requirements of the ESMP through his own Site Specific Environmental Management Plan, which will adopt all of the conditions of the ESMP. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

The ESMP and all its requirements shall then be added to the contractor's contract, thereby making implementation of the ESMP a legal requirement according to the contract. To ensure compliance with the ESMP the contractor should employ an environmental specialist to monitor and report project activities throughout the project construction phase.

11 REFERENCES

- Banglapedia, 2015. National Encyclopedia of Bangladesh Online [Online]. Available at <http://www.banglapedia.org>
- Brammer, H., 1996. The Geography of the Soils of Bangladesh. Dhaka: University Press Limited.
- International Union for Conservation of Nature (IUCN), 2002. Bio-ecological zones of Bangladesh. Dhaka: IUCN Bangladesh.
- International Union for Conservation of Nature (IUCN), 2002. Bio-ecological zones of Bangladesh. Dhaka: IUCN Bangladesh.
- IPCC (Intergovernmental Panel on Climate Change), 2007. Climate change 2007: Synthesis Report. Contribution of Working Groups I, II, III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland.
- IUCN Bangladesh. ed. 2002f. Bio-ecological Zones of Bangladesh. Dhaka: IUCN-The World Conservation Union.
- IUCN Bangladesh. ed. 2002f. Bio-ecological Zones of Bangladesh. Dhaka: IUCN-The World Conservation Union.
- MoEF, 2009. Bangladesh Climate Change Strategy and Action Plan 2009, Ministry of Environment and Forest, Bangladesh.
- MoEF/UNDP, 2005. National Adaptation Programme on Action (NAPA). Final Report. Ministry of Environment and Forests, GOB, Bangladesh.
- Rashid, H. E. (1991). "Geography of Bangladesh". University Press Limited, Dhaka.
- Soil Resource Development Institute (SRDI), 1998. Agro-ecological regions of Bangladesh. Dhaka: SRDI, Ministry of Agriculture.
- United Nations Population Fund (UNFPA), 2010. State of World Population 2010- From Conflict and Crisis to Renewal: generations of change [Online]. Available at: http://www.unfpa.org/webdav/site/global/shared/swp/2010/swop_2010_eng.pdf
- Wahab, A., (2008), Bangladesh Introduction (Ramsar Wetland Information). [Online] Available at: <http://ramsar.wetlands.org/Portals/15/Bangladesh.pdf>

12 Appendices

Appendix A: Air Quality Test Result

Appendix B: Noise Level Measurement Result

Appendix C: Surface Water Test Result

Appendix D: Important Sensitive Locations in the PIA

Appendix A: Air Quality Test Result


DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	Environmental and Social Assessment of 1.1MWp Industrial Rooftop Solar Project at Far East Spinning Industries Limited, Madhabpur, Habiganj.
GPS Coordination	24.13454°N; 91.35057° E
Description of Sample	Ambient Air Quality
Sampling Location	Project Site (Uttor Surma, Teliapara, Madhabpur, Habiganj)
Sample Collector	DSCL Personnel
Sample ID	AAQ_01
Sampling Date	13 March, 2018

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site	Bangladesh Standard**	Duration (hours)	Weather Condition	Method of Analysis
PM ₁₀	µg/m ³	98	150	24	Sunny	Gravimetric
PM _{2.5}	µg/m ³	35	65	24		Gravimetric
SPM	µg/m ³	123	200	24		Gravimetric
SO ₂	µg/m ³	5.74	365	24		West- Geake
CO*	ppm	1	9	8		CO-Meter
Pb	µg/m ³	0.1	0.5	24		AAS Method

Note:

* CO concentrations and standards are 8-hourly only.

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

Test Performed By:

 Tonmoy Pandit
Jr. Environmental Specialist

Checked By:

 Tanzia Sharmin
Deputy Manager
(Water & Environment)

Development Solutions Consultant Ltd.

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DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

Appendix B: Surface Water Test Result

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
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Lab Memo: 648/ CC, DPHE, CL, Dhaka.

Date: 05-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

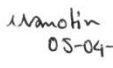
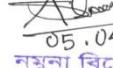
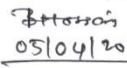
Sample ID: CEN2018040050	Sample Receiving date: 14-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 14-03-2018	Sample Source: Surface Water
Sent by: Rashaduzzaman, Jr. Environmental Specialist, DSCL, Mirpur DOHS, Dhaka-1216.	Dist: Habiganj, Upa:
Care Taker: DSCL (SW-01)	Union:, Vill.: Uttar Surma, Teliapara, Madhupur
Sample Collection date: 14-03-2018	Date of Testing: 14/03/2018-05/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	18	mg/L	5 days Incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	80	mg/L	CRM	-
3	Nitrogen (Nitrate)	10.0	19	mg/L	UVS	0.10
4	Nitrogen (Ammonia)	0.50	0.83	mg/L	UVS	0.01
5	Phosphate	6.0	1.52	mg/L	UVS	-
6	Total Suspended Solid (TSS)	10	26	mg/L	Gravity Multimeter	-

Comments: Sample was collected & Supplied by client.

N.B: UVS- UV-Visible Spectrophotometer, CRM-Closed Reflex Methods, LOQ - Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  05-04-18 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  05.04.18 নমুনা বিশ্লেষণ জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Chief Chemist Signature:  05/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা 2.) Name: Designation:
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Appendix C: Groundwater Test Result

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
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Lab Memo: 648/ CC, DPHE, CL, Dhaka.

Date: 05-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

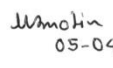
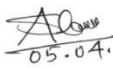
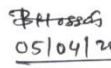
Sample ID: CEN2018040051	Sample Receiving date: 14-03-2018
Ref. Memo No: DSCL/2018/Nil & Dated: 14-03-2018	Sample Source: Surface Water
Sent by: Rashaduzzaman, Jr. Environmental Specialist, DSCL, Mirpur DOHS, Dhaka-1216.	Dist: Habiganj, Upa:
Care Taker: DSCL (GW-01)	Union:, Vill.: Uttar Surma, Teliapara, Madhupur
Sample Collection date: 14-03-2018	Date of Testing: 14/03/2018-05/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	80	mg/L	Titrimetic	-
2	Arsenic (As)	0.05	0.001	mg/L	AAS	0.001
3	Chloride	150-600	12	mg/L	Titrimetic	-
4	Iron (Fe)	0.3-1	0.11	mg/L	AAS	0.05

Comments: Sample was collected & Supplied by client.

N.B: AAS- Atomic Absorption Spectrophotometer, LOQ - Limit of Quantitation.

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  05-04-18 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  05.04.18 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Chief Chemist Signature:  05/04/2018 2.) Name: Designation: মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা
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Appendix D: Noise Level Test Result



Multidisciplinary Development Consultants

DSCCL Environmental Laboratory

Name of the Project	Environmental and Social Assessment of 1.1MWp Industrial Rooftop Solar Project at Far East Spinning Industries Limited, Madhabpur, Habiganj.
Description of sample	Noise Level Analysis
Sampling Location	Project Site (Uttor Surma, Teliapara, Madhabpur, Habiganj)
Sample Collector	DSCCL Personnel
Sampling Date	13 March, 2018

Noise Level Analysis

ID	Location	Zone	GPS Location	Starting Time	Noise Level dB(A) at Day Time (LAeq)	Bangladesh Standard dB (A) at Day Time	Remarks
NM-01	Substation area of Industry	Commercial	24.13593°N, 91.35070°E	10:39 am	47.17	65	Low
NM-02	Spinning Section of the Industry	Commercial	24.13452°N, 91.35057°E	11:01 am	83.36	65	High
NM-03	Back Side of the Industry	Commercial	24.13383°N, 91.34953°E	11:25 am	53.16	65	Low
NM-04	Entrance of the Industry	Commercial	24.13409°N, 91.35143°E	12:57 pm	55.81	65	Low

Notes:

- Land use category is based on the classification provided in the Noise Pollution Control Rules (2006)
- Shaded cell indicate noise levels in excess of Noise Pollution Control Rules ambient noise limits for a given land use area
- The sound level standard for commercial area is 65 dBA at day time and 55 dBA at night time.
- Noise Level is the average noise recorded over the duration of the monitoring period

Abbreviation:

NM- Noise Measurement, dB- decibel

Test Performed By:
Tonmoy Pandit
 Jr. Environmental Specialist



Checked By:
Tanzia Sharmin
 Deputy Manager
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Appendix D: Important Sensitive Locations in the PIA

Name	Location		Description	Photo
	N	E		
Madhukhola English Education School	24.17637°	90.43641°	There are two one storied tinshed building in this school.	
NasaHitech Style Limited	24.17606°	90.43784°	This is an industrial building	
Madhukhola Graveyard	24.17860°	90.43730°	There are five graves in the graveyard.	

Name	Location		Description	Photo
	N	E		
Madhukhola National Central Mosque	24.17680°	90.43890°	One storied mosque.	
Madhukhola Govt. Primary School	24.17775°	90.43928°	Two one-storied buildings, used for academic activities of Madhukhola Govt. Primary School.	
Madhukhola English Academy	24.17820°	90.43740°	Two one storied tinshed buildings used for academic activities of Madhukhola English Academy.	

Name	Location		Description	Photo
	N	E		
Madhukhola Paschimpara Rahmania Jame Mosque	24.17866°	90.43567°	Three storied mosque.	
Lamiha Poultry Farm	24.18041°	90.43958°	One storied tinshed primary school.	
Madhukhola Bazar	24.17956°	90.43955°	A small bazar for the local people	

Name	Location		Description	Photo
	N	E		
Community/ Homestead Forest	24.17680°	90.43890°	A small homestead forest	