Environmental and Social Impact Assessment (ESIA) of Construction of 8MW$_{(AC)}$ (10MW$_{(DC)}$) Grid Tied Solar Power Plant at Tentulia, Panchagarh

Project Number: XXXXX
October 2020

BAN: 10 MW Solar Park Project

Prepared by Sympa Solar Power Limited, Bangladesh

CURRENCY EQUIVALENTS

(As of 17 October 2020)
Currency unit –Bangladeshi Taka (Tk)
1USD=84.78 BDT
USD- United States Dollar
BDT- Bangladeshi Taka

WEIGHTS AND MEASURES

dB(A)	–	A-weighted decibel
Ft	–	Feet
ha	–	Hectare
km	–	Kilometer
km^2	–	square kilometer
KWA	–	kilowatt ampere
Leq	–	equivalent continuous noise level
µg	–	Microgram
m	–	Meter
MW (megawatt)	–	Megawatt
PM 2.5 or 10	–	Particulate Matter of 2.5 micron or 10 micron size

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PREFACE

This Environmental and Social Impact Assessment (ESIA) Report including analysis of data and conclusions and its appendices is the Sympa Solar Power Limited, Bangladesh. While IDCOL is the Executive Agency (EA) from Government of Bangladesh (GoB) for the project, the responsibility and ownership of the ESIA rest with the Sympa Solar Power Limited, Bangladesh. The key elements of the ESIA Report focus on: Assessment of Compliance Guidelines of ADB SPS 2009 and prevailing laws of GoB.

DISCLAIMER

This Environmental and Social Impact Assessment (ESIA) Report for Construction of 8MW(AC) 10MW(DC) Grid Tied Solar Power Plant at Tentulia, Panchagarh has been prepared by Sympa Solar Power Limited, Bangladesh. All the data used to prepare this ESIA Report have been collected from the project area and secondary information sources available with relevant departments, agencies and organizations through literature review, environmental sample collection and testing, questionnaire survey and direct consultations with local people.

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EXECUTIVE SUMMARY

INTRODUCTION

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. Despite its large population, Bangladesh has achieved substantial economic growth over the last 15 years. Deficient infrastructure prevents the country from achieving its full growth potential. This situation is particularly evident in the economically disadvantaged remote and rural areas. Whereas access to energy is a priority in the development framework, much work needs to be done on basic infrastructure for rural electrification. Remote and dispersed areas are currently adopting off-grid electrification as a viable alternative to the national grid service. Whereas access to energy is a priority in the development framework, much work needs to be done on basic infrastructure for rural electrification. Remote and dispersed areas are currently adopting off-grid electrification as a viable alternative to the national grid service. Current electricity cost from solar plant is almost similar to grid tariff that 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. 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.

METHODOLOGY

The study is based on both primary and secondary data and information. The primary data includes data collected from field observations 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 Project areas.

POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

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, Forests and Climate Change (MoEFCC) 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. Additionally, to meet the requirement of funding agencies, i.e., IDCOL, an Environmental and Social Impact Assessment (ESIA) needs to be conducted and approved prior to implement the project.

DESCRIPTION OF THE PROPOSED PROJECT

The location of the project is Majhipara in Tentulia Upazila of Panchagarh District. The GPS Coordinate of the project location is 26.48413°N and 88.41072°E. It takes almost 17 hours to reach Panchagarh by road from Dhaka. The project site is almost 32 km away from Panchagarh district. It takes 40 to 45 minutes to reach the project site (Majhipara) from Panchagarh Sadar by road.

Considering the local meteorological conditions and paying specific attention to extreme and average conditions, the project has opted for a configuration of strings with 34 modules in series. Eight strings are connected to a 60kw string inverter in parallel, and Per 4 String inverters are connected to an AC combiner box in parallel. Cable connection for Module to Inverter and Inverter to AC combiner box shall apply PV1-F 1×4 mm² and ZR-YJV22-0.6/1kV -3×25mm². A 5.71 Km 33 KV Transmission Line will be constructed for electricity connection. Towers will be erected along the selected route at designated intervals. Finally, after completion of construction works, checking, testing and commissioning of the transmission lines will be carried out.

DESCRIPTION OF THE BASELINE ENVIRONMENT

The project area is located in the Northern region climatic zone. The region has a tropical climate with three main seasons; pre-monsoon hot season, the rainy season and the cool dry winter season. The temperature falls below 11°C in winter that is spread over December and January and may well include November and February. The highest temperature is felt during August when the temperature may be as high as 32.30°C. The maximum monthly rainfall during May to September varies from 274 mm to 438mm in the Rangpur station. At Syedpur station, the precipitation is the lowest in December, with an average of 5.33 mm. and the maximum falls in June, averaging 455.22 mm. The statistical data of humidity from 1991 to 2013 in Rangpur and Syedpur station indicates that humidity maximized from May to September in a year for both the stations. In Rangpur station, it ranges from 80% to 86% and in Syedpur station, it ranges from 76% to 84%. On the other hand, humidity falls 69% in February, March and April during the winter season in the Rangpur station and in Syedpur station in the above months humidity falls 62%. During the month of October to January, the wind speed shows lower value. In this season, it shows 0.95 to 1.17 ms^{-1} wind speed and in the month of April to July the wind speed shows 1.72 to 2.02 ms^{-1} in Rangpur station. In Syedpur the maximum wind speed shows up to 2.74 ms^{-1} speed and the lowest speed shows 1.44 ms^{-1}. The cloud coverage of both the stations increase from June to September. Average cloud coverage data shows the value varies within 5.54 octas to 6.52octas in Rangpur station and varies within 5.11 octas to 6.06 octas in Syedpur station. The lowest value falls in November to February within the range of 1.29 octas to 1.68 octas in Rangpur and 1.23 to 1.72 in Syedpur. Average Bright Sunshine Hours data shows in Rangpur station the highest sunshine occurred on the month of March and the lowest value was on the month of June. The data for Syedpur Station show that, the sunshine hours were highest on the month of March and lowest on the month of June.

Air quality test has been conducted on 16th -17th 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. Any of the measured parameter of the local ambient air does not exceed Bangladesh standard. Noise level has been monitored at inside and outside of the project location during daytime. The results show that time weighted average value of the sound monitored at inside and outside of the project area exceeded the national standard for Kalandiganj Bazar for both day and night time, Tentulia Substation for night time, Tentulia Link Point for both day and night time, Kazigach Village for night time and Ajirnagar Bazar for night time.

The project area falls in the Himalayan Foredeep geological region. The general topography of the project area is flat. The topography of the specific project location is 10.85– 14.94m a.m.s.l. On 16th -17th March 2018, surface water and groundwater sample was collected by environmental team from the project area. The Department of Public Health Engineering

(DPHE) analyzed the sample. The concentration levels of all the parameters for surface water were within the acceptable limit set by the DoE, GoB, according to the best-practiced based classification except for the value of Nitrogen (Ammonia) and COD. The groundwater sample was analyzed and all the parameters concentration levels are within the acceptable limit of drinking water quality standard set by DoE except for the value of Iron (Fe) at Taiaganj Village. Soil sample was collected from the project location on 18th March 2018 and tested from the laboratory of University of Dhaka. The soil sample was analyzed and all the parameters concentration levels are within the acceptable limit. As per the seismic zone map project area falls in the zone II. It means the project area is prone to medium seismic intensity. No endangered/ critically endangered or threatened terrestrial or aquatic species were found in the project area. No archaeological but some culturally protected areas were found that would have anticipated impact.

The project is located at Majhipara, Salbahan Union at Tentulia Upazilla in Panchagarh district. The total area of Salbahan Union is 7632 acres. Tentulia Upazila (Panchagarh district) area 189.12 sq. km, located in between 26°24' and 26°38' north latitudes and in between 88°21' and 88°33' east longitudes. Extreme northern Upazila of Bangladesh is bounded by west Bengal state of India on the north, south and west, Panchagarh Sadar Upazilla on the east. Tentulia Thana was formed on 26 June 1917 and it was turned into an Upazila on 16 March 1993. In the Upazilla, there is 46 km of Pucca road and 422 km of mud road. Extinct or nearly extinct traditional transport includes Palanquin, horse carriage, and bullock cart. The livelihood of the people of Tentulia Upazilla mainly depends on agriculture. Average literacy rate of the Upazilla is 39% among which male is 44.1% and female is 33.5%. Renowned educational institutions.

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

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.

During pre-construction phase, the impacts associated with the land use only. The project initiator will implement the project in their own industry premises. Therefore, there are no anticipated impacts during the planning phase of the Project.

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 and social management plan (ESMP). 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 ESMP.

During the operation period, the main impact is associated with heat generation. The heat may be transferred by convection, radiation and conduction method. To minimize/mitigate the impacts the developer should follow the ESMP properly.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

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.

Environmental Monitoring Plan has incorporated key environmental components and parameters to be monitored their indicators, frequency, timing and locations of monitoring and the actors responsible for carrying out such monitoring.

Sympa Solar Power Limited 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.

Mitigation is the responsibility of Sympa Solar Power Limited. The contractor engaged by the project authority will implement the ESMP along with mitigation measures, as part of the contractual obligation, and the PMU will supervise the work. The cost for Environmental Mitigation Measures and Monitoring will be included in the DPP and allocated of fund will made accordingly.

CONCLUSION AND RECOMMENDATION

On the basis of 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.

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.

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 equipments (PPE), firefighting equipment etc. must be provided in order to reduce the potential for accidents. Solid waste will be generated during the construction period from excavation and refuse from construction camps.

The major issue is the need to minimize disturbance to the local population in the areas of construction. A positive policy of employing local people during the construction phase should be adopted.

Since, the implementation of the proposed project will bring about huge benefit through help meet countries power demand for development, certain minor environmental impacts of the associated project will have to be compromised for the better interest of the country. However, the anticipated impacts are mostly of short duration and relatively minor in nature.

In view of the above considerations and the fact that the executing agency (Sympa Solar Power Limited) will maintain standard quality of implementation of the program with due consideration to other standing rules and regulations including but not limited to updated ECA 1995 (amended 2010) and ECR 1997 the project may be recommended for implementation.

I. INTRODUCTION

A. Background

1. One important goal for any developing country is to establish and provide electric power for its citizens; an endeavor initiated by the Government of Bangladesh many years ago. Renewable energy is a key component for development and Bangladesh has already made significant strides in reaching most of the country's population; both in Urban and Rural areas. The renewable energy projects initiated by the Government are helping Private sector, Non-Government Organizations (NGOs), and Micro-Finance institutions expand the solar energy program, in terms of both Sustainability and Commercial viability. These projects are increasing awareness among consumers and suppliers of the benefits and the correct use of solar home systems.

2. Rapid urbanization, fueled by stable economic growth, has created a huge energy demand in Bangladesh. It is well known that energy plays a vital role in poverty eradication, economic growth, sustainable infrastructure development, and ensuring security of a country. In Bangladesh, electricity is the most widely used form of energy. Future economic growth significantly depends on the availability of electricity. At present, about 72% of the total population has access to electricity, and electricity supply is not adequately reliable.

3. Bangladesh is starving for energy for last few decades since its power generation is mainly depended on imported fossil fuel and natural gas. The present government has successfully increased electricity generation, yet grid electricity is not reachable in the remote areas of the country due to lack of infrastructure and longstanding distribution facilities.

4. As a vulnerable country, both private and public sectors of Bangladesh have taken multiple initiatives to move towards renewable electricity production to protect the environment and for better living conditions. The government has established SREDA to provide policy support and guidelines for sustainable growth of renewable energy.

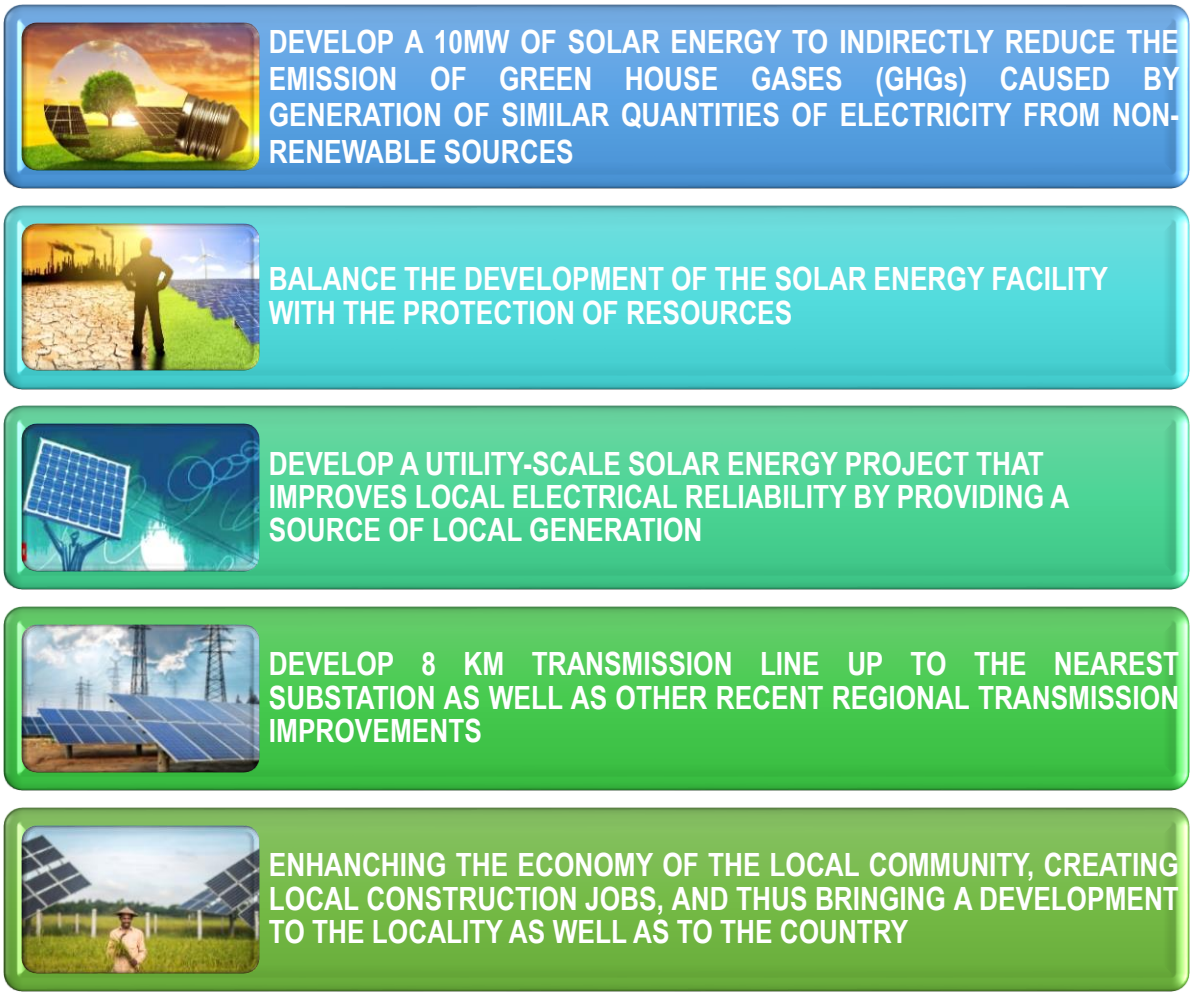
5. Bangladesh is blessed with year-round sunshine (over 300 days per year) and has an enormous potential for solar energy. We have been utilizing solar power wisely and using its experience towards diversifying renewable energy (RE) for maximum use.

6. The vision of the Government of Bangladesh is to provide quality electricity to all by 2021. To fulfill the GOB’s vision and objectives of electrification, development of renewable energy resources will play a vital role. The government has responded appropriately for generating environment-friendly electricity from renewable energy sources. The Renewable Energy Policy has already been adopted with the target to produce 10% of the total power generation by 2021 from renewable energy sources. In absolute numbers, this means that at least 2000 MW power has to be generated from renewable sources by 2021. The Infrastructure Development Company Limited (IDCOL) is working with objective to promote, develop and co-ordinate renewable energy & energy efficiency activities in the country. Government of Bangladesh has prepared a plan to generate 3100MW of electricity using RE resources from both public and private sector by 2021.

7. The environmental legislation in Bangladesh, particularly, the Environmental Conservation Act, 1995 (Amended in 2002), states that any development project shall require environmental clearance from the Department of Environment (DOE), Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh. The proposed Project falls under the "Orange-B" Category as per the Environmental Conservation Rules of 1997, which requires submission of Initial Environmental Examination (IEE) report to obtain 'Environmental Clearance' from the DOE. Additionally, to meet the requirement of funding agencies, i.e., IDCOL, an Environmental and Social Impact Assessment (ESIA) needs to be conducted and approved prior to implement the project.

B. Project Objectives

8. The main objectives of the project include:



C. Rational of the Project

9. A decade ago, less than 50 percent of Bangladeshis had access to electricity; today, 78 percent have it, underlining the impressive progress made by the Government of Bangladesh in providing power to all its citizens, which it aims to do by 2021. The performance of Bangladesh's energy sector compares favorably with that of its larger South Asian neighbors, at least when it comes to distribution and transmission losses (together around 14 percent) and collection efficiency (above 90 percent).

10. Bangladesh initiated a successful program of private power production as early as the late 1990s and has since embarked on a large public investment program in the sector as well as a systematic program of electricity imports from India.

11. However, considerable challenges remain. Demand exceeds the supply of power at current prices. Generation capacity is still only 60 percent of Pakistan's, which has a similar-sized population and per capita annual consumption of 392 kilowatts per hour is among the lowest levels in the world. Moreover, power outages are still common in Bangladesh leading to losses of about two to three percent of the country's gross domestic product, or GDP. Inefficient technology, poor operational practices, and inadequate maintenance limit the supply of energy, as does a shortage of natural gas, which fuels about 70 percent of Bangladesh's power.

12. The shortage of natural gas means many energy generators have turned to inefficient, dirty diesel and fuel oil. That has pushed up the cost of power in Bangladesh and led to government subsides of $500 million to $600 million each year to keep prices at current levels. Liquefied natural gas imports are planned but will drive up the price of gas domestically.

13. In addition, transmission capacity in Bangladesh is not growing fast enough to keep up with power generation, resulting in supply bottlenecks in important commercial corridors (such as Chittagong and Comilla) and other urban areas in Bangladesh. Moreover, periodic outages, like the November 2014 countrywide blackout, perpetuate concerns about the security and stability of the country's power grid.

14. In view of the above, the proposed Project envisages supplying reliable and grid quality electricity to the national grid with competitive price to Bangladesh Government. The project proponent; SYMPA Solar Power Limited and Aqua Breeder Limited (a concern of Paragon Group) jointly received financial support from IDCOL to establish the 8MWAC (10MWDC) Solar Power Plant within the business area of Aqua Breeders Limited where poultry production is under operations. The proponent will also establish the 5.71 Km Transmission Line with the technical assistance from Power Generation Company of Bangladesh (PGCB).

15. Generating electricity through PV power is rather pollution-free during operation and compared with the current conventional way of producing electricity, the clean energy produced from renewable energy resources is expected to reduce consumption of alternative gas/coal/liquid fuels for electricity generation in Bangladesh, and will thus help in reducing greenhouse gas emissions, as well as air pollutant emissions. The Project will produce clean energy that will contribute to lowering electricity generation costs compared to the current costs associated with other fuels and thus leads to a substantial decrease in the Government of Bangladesh's fiscal deficit. Realizing the potential of this sector, IDCOL explored the opportunity of combining their relevant expertise to promote and develop the alternative/renewable energy production through Solar Power Plant Project.

D. Approach and Methodology

1. Approach

16. The study has been conducted in accordance with Environment Conservation Rules, 1997, Government of Bangladesh (GoB) EIA Guidelines, 1997, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and

Social Considerations, April 2010), ADB safeguard policies and World Bank OP 4.01 (Environmental Assessment) guidelines. The route map of this ESIA preparation is given in Figure 1.1. The study is based on both primary and secondary data and information. The primary data includes data collected from field observations 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 the locality. The main purpose of this approach was to obtain a fair impression on the people's perceptions of the project and its environmental impacts.

2. Methodology

17. The following methodology was adopted for carrying out the ESIA of the proposed project –

(i) Orientation

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

(ii) Data Collection Planning

19. 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 ESIA 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.

(iii) Data Collection

20. 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 I.1 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
- Laboratory Analysis

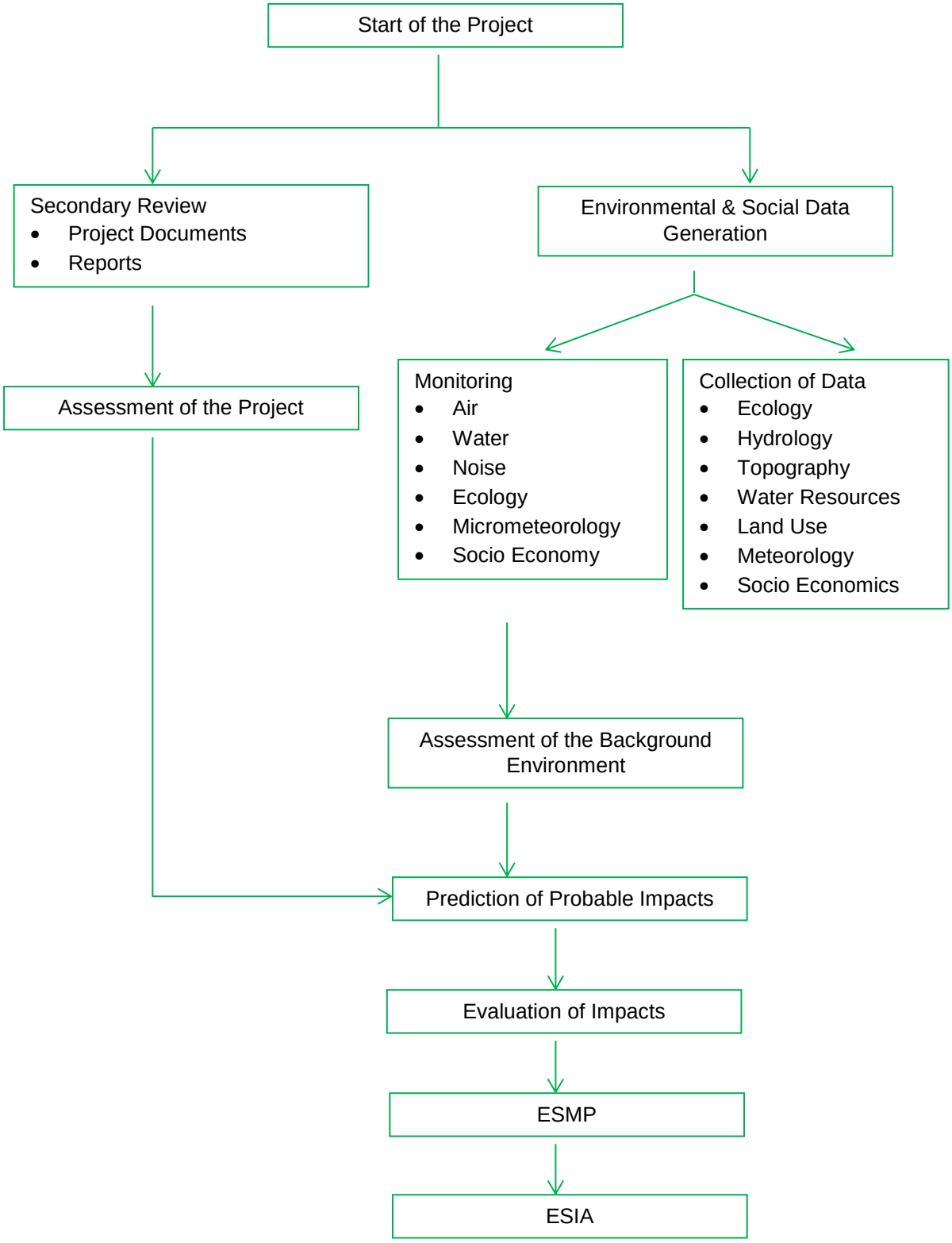


Figure I.1: Route Map of Environmental and Social Impact Assessment

Physical Environment

21. 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 I.2.

- **Geology, Topography, Soils**

22. 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. Sampling and analysis of soil quality has been carried for the following parameters: pH, Electrical Conductivity (EC), Cadmium (Cd), Lead (Pb), Copper (Cu), Zinc (Zn) and Arsenic (As).

- **Hydrology and Drainage**

23. 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**

24. 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), oxides of sulphur (SOx), oxides of nitrogen (NOx), particulate matter (PM_{10} & $PM_{2.5}$), and suspended particulate matter (SPM) have been included for ambient air quality monitoring.

- **Noise**

25. 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.

- **Ground /Drinking Water Quality**

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

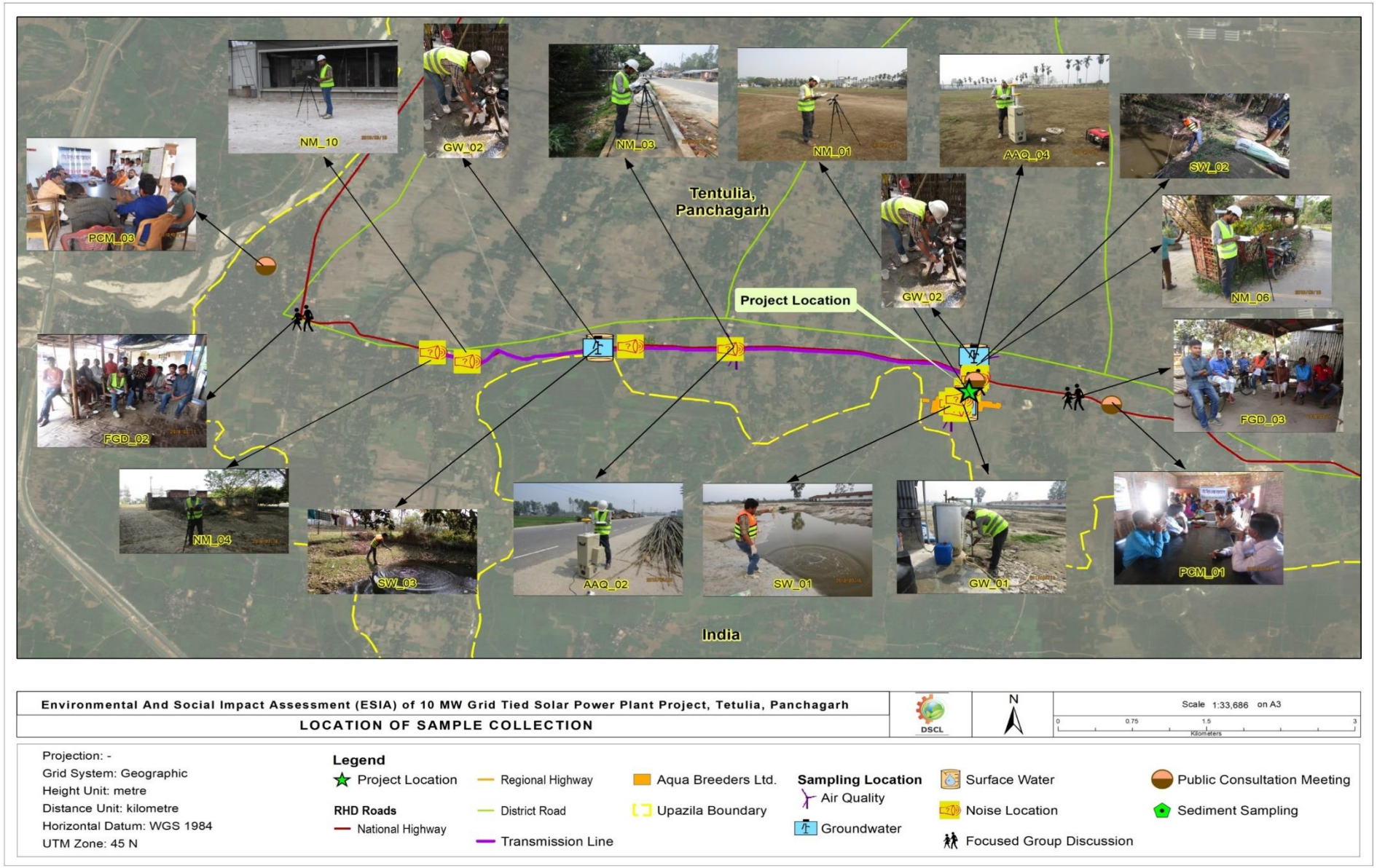


Figure I.2: Location of Sample Collection

- **Surface Water Quality**

27. Sampling and analysis of surface water quality has been carried out for the following parameters: Temperature, pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Dissolved Oxygen (DO), Chloride (Cl^-), Nitrogen (Ammonia), Chemical Oxygen Demand (COD), Biological Oxygen Demand (COD).

Biological Environment

28. 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.

- **Flora**

29. 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**

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

Socio-Cultural Environment

31. 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

(iv) Public Consultation

32. Public consultation is an important component of the ESIA preparation activities. Local knowledge about the ecosystem and problems associated with the project activities were carefully recorded and used in impact assessment and developing mitigation plan. Formal public consultation, in tandem with opportunistic informal ones involving local villagers, and people whose livelihood depends on these project areas, were executed. Detailed description of public consultation has been presented at Chapter VI.

E. ESIA Study Team

Table I.1: The ESIA Study Team

No.	Name	Position
1.	Mr. Md. Shafiqur Rahman	Team Leader (Senior Environmental Specialist)
2.	Ms. Tanzia Sharmin	Environmental Engineer
3.	Ms. Mafia Mostafa	Environmental Specialist
4	Mr. Kushal Roy	Social Specialist
5.	Mr. Tonmoy Pandit	Environmental Quality Specialist
6.	Mr. Rashaduzzaman	Junior Environmental Specialist
7.	Mr. Madhu Shudan Das	GIS Expert
8.	Mr. Md. Sirajul Islam	Environmental and Social Surveyor - 1
9.	Mr. Bappy Rahman	Environmental and Social Surveyor - 2
10.	Mr. Abdul Malek	Environmental and Social Surveyor - 3

II. LEGAL AND POLICY FRAMEWORK

A. General

33. Grid-tied Solar Project activities by their inherent nature and flexibility have negligible impacts on environmental and social attributes. The Bangladesh laws relating to environmental and social issues have strengthened in the last decade due to both local needs and international commitments. All activities under the project shall be within the purview of these laws keeping in mind appropriate international obligations and directives and guidelines with respect to environmental and social considerations of Funding Agencies.

34. The proposed project will be implemented in compliance with the applicable environmental laws and regulations, Bangladesh, JICA, WB and ADB. Bangladesh has an environmental legal framework that is conducive to both environmental protection and natural resources conservation. This environmental legal framework applies to the proposed project. In addition, there are several laws and regulations related to environmental issues in Bangladesh. Many of these are cross-sectoral and partially related to environmental issues. This section presents an overview of the major national environmental laws and regulations that are relevant and may apply to activities supported by the project, institutional arrangement and national and sub-national level, and WB safeguard policies.

35. According to the national environmental legislation of Bangladesh, all development projects are governed by some legal and institutional requirements. As such, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any project proponent or developer before execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary.

36. Before initiating any development project, it is hence required to obtain environmental clearance from Department of Environment (DoE), under the Ministry of Environment, Forests and Climate Change (MoEFCC) is the regulatory body responsible for enforcing the environmental laws and regulations like ECA'95 (amended in 2010) and ECR'97.

37. The need to comply with the requirements of the EIA Regulations ensures that decision makers are provided the opportunity to consider the potential environmental impacts of a project early in the project development process, and assess if environmental impacts can be avoided, minimized or mitigated to acceptable levels. Comprehensive, independent environmental studies are required to be undertaken in accordance with the EIA Regulations to provide the competent authority with sufficient information in order for an informed decision to be made. The following activities have been carried out under the ESIA study-

- ✓ Identification of national legal obligations in relation to the interventions which will be required to review under the ESIA study of the proposed project;
- ✓ Exploration of the national legislative provisions and policy guidelines on environmental sectors;
- ✓ Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the renewable energy project;
- ✓ Exploration of national and international legal provisions on energy sector; and
- ✓ Identification of the standard guidelines at regional and international level related to the project.

B. Applicable Policies

1. National Policies

a) Environmental Policy, 1992

38. The concept of environmental protection through national efforts was first recognized and declared with the adoption of the Environmental Policy, 1992 and the Environmental Action Plan, 1992. The importance of policies in beefing up the environmental regime is recognized in a number of international instruments including the World Conservation Strategy in 1980 and the Brundtland Commission Report, 1987. Paragraph 14 of Chapter 8 of Agenda 21 underscored the necessity of formulation of national policies as well as laws for environmental protection and sustainable development. The major objectives of Environmental Policy are to-

- Maintain ecological balance and overall development through protection and improvement of the environment;
- Protect country against natural disaster;
- Identify and regulate activities, which pollute and degrade the environment;
- Ensure environmentally sound development in all sectors; and
- Ensure sustainable, long term and environmentally sound base of natural resources; and
- Actively remain associate with all international environmental initiatives to the maximum possible extent.

39. According to this policy, the proposed project needs full environmental assessment. The proposed interventions are required to comply with all the policy directives emphasizing particularly on reducing adverse environmental impacts. The ESIA studies are required to address the potential impacts and propose mitigation measures. In compliance to the policy detail ESIA is prepared.

b) National Environment Policy (NEP), 1992

40. The National Environment Policy (NEP) is one of the key policy documents of the Government. The policy addresses 15 sectors in all, in addition to providing directives on the legal framework and institutional arrangements. The NEP sets out the basic framework for environmental action together with a set of broad sectoral guidelines for action. Major elements of the policy are as follows:

a. Maintaining of the ecological balance for ensuring sustainable development;
b. Protection of the country against natural disasters;
c. Identifying and controlling activities which are polluting and destroying the environment;
d. Ensuring environment-friendly development in all sectors;
e. Promoting sustainable and sound management of natural resources; and
f. Active collaboration with international initiatives related to the environment.

41. With regard to the project, the environmental policy aims at prevention of pollution and degradation of resources caused by electricity transmission project. The policy mentions that the ESIA should be conducted before projects are undertaken.

c) National Environmental Management Action Plan (NEMAP), 1995

42. The National Environmental Management Action Plan (NEMAP) builds on the NEP and was developed to address specific issues and management requirements during the

period 1995-2005. The plan includes a framework within which the recommendations of a National Conservation Strategy (NCS) are to be implemented. The NEMAP was developed with the following objectives:

- To identify key environmental issues affecting Bangladesh;
- To identify actions to halt or reduce the rate of environmental degradation;
- To improve management of the natural environment;
- To conserve and protect habitats and bio-diversity;
- To promote sustainable development; and
- To improve the quality of life.

43. According to this policy, the project proponent should identify the key environmental issues as well as identify the actions to reduce or halt the environmental degradation.

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

44. 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 was 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.

45. 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.

46. According to this act, the proposed project implementation works should conserve the environment as well as control and mitigate environmental pollution. The ESIA study will address the potential impacts and suggest mitigation measures to reduce them.

e) Bangladesh Environmental Conservation Rules, 1997

47. The Environment Conservation Rules, 1997 were issued by the Government of Bangladesh in exercise of the power conferred under the Environment Conservation Act (Section20), 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;

48. 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, MoEFCC has declared Sundarbans, Cox's Bazar-Teknaf 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.

49. 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

50. 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.

51. Apart from general requirement, for every Orange-B and Red category proposed industrial / plant unit or project; the application must be accompanied with feasibility report on Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) based on approved ToR by DOE, Environmental Management Plan (EMP) along with lay-out plan (showing location of ETP), time schedule of ETP, etc.

52. The project falls in "Orange-B Category" (serial no. 70. Solar Power Plant greater than 1 MW and serial no. 71. Transmission line greater than 50km) as per the Gazette of Bangladesh Government published on 24 December 2017. So, according to the above act, an IEE report has been prepared along with the EMP and submitted to the DoE for approval along with obtaining the environmental clearance.

f) National Agriculture Policy, 1999

53. This policy aims to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure a dependable and secure food system for all. One of the objectives of this Act is to preserve and develop land productivity. The policy particularly stresses on research and development of improved varieties and technologies for cultivation in waterlogged and salinity-affected areas. The policy also recognizes that adequate measures should be taken to reduce waterlogging and salinity and provide irrigation facilities for crop production.

54. Adequate measures should be taken to reduce waterlogging and hamper of irrigation system due to construction of the transmission lines and substations.

g) National Land Use Policy, 2001

55. Bangladesh government in 2001 adopted the National Land Use Policy, setting out guidelines for improved land-use and zoning regulations. The main objectives of this policy are to ensure criteria-based uses of land and to provide guidelines for usage of land for the purpose of agriculture, housing, afforestation, commercial and industrial establishments, rail and highway and for tea and rubber gardens. Overall, this policy promotes a sustainable and planned utilization of land.

The main contents of this policy are:

- Stopping the high conversion rate of agricultural land to non-agricultural purposes;
- Utilizing agro-ecological zones to determine maximum land use efficiency;
- Adopting measures to discourage the conversion of agricultural land for urban or development purposes;
- Improving the environmental sustainability of land-use practices.

56. The proposed project must adhere to this policy so that environmental sustainability of land-use practices is assured.

h) The Electricity Act, 1910

57. The primary objective of this act is to amend the laws relating to the supply and use of electrical energy in Bangladesh. This act comprises of guidelines related to licenses, works, and supply for the supply of energy. It also includes guidelines related to supply, transmission and use of energy by non-licensees. A licensee is a person authorized by the Government to supply energy in any specified area and permitted to lie down or place electric supply lines for the conveyance and transmission of energy. In Part II of this act, guidelines are provided for carrying out works for the supply of energy. This act includes guidelines related to the execution of any works involved in placing of any infrastructure in, under, over, along or across any street, part of a street, railway, tramway, canal or waterway. In addition, information on lying of electric supply lines, aerial lines, or other works near sewers, pipes or other electric supply-lines or works is provided in Part II of the act. According to this act a licensee shall, in exercise of any of the powers conferred by or under this act, cause as little damage, detriment and inconvenience as may be, and shall make full compensation of any damage, detriment and inconvenience caused by him or by any one employed by him. In Part IV of this act, Protective Clauses are provided for protection of railways and canals/waterways, docks, wharves and piers, telegraphic, telephonic and electric signaling lines. Part IV also includes guidelines for occurrences of any criminal offences such as dishonest abstraction of energy, installation of artificial means, malicious wasting of energy or injuring works, theft of line materials, tower members, equipment etc. and subsequent procedures to follow up that criminal offence.

58. The above act has a set of guidelines for electric power supply system and lying of transmission line. The guidelines should be followed while lying the transmission line.

i) Electricity (Amendment) Act, 2012 (Draft)

59. This act is an amendment to The Electricity Act, 1910. In addition to the guidelines provided in the original act (The Electricity Act, 1910), this act includes more specific instruction relating to obligation on licensee to supply energy. According to section 22A (Sub section 1) of this act: a person authorized by a license, or exempted from the requirement to obtain a license, to generate, transmit, distribute or supply electricity – (a) shall, in generating, transmitting, distributing or supplying electricity, have regard to the desirability of preserving natural beauty, of conserving flora, fauna and geological or physiographical features of special interest and of protecting sites, buildings and objects of architectural, historic or archaeological interest; and (b) shall do what the person reasonably can to mitigate any effect which such generation, transmission, distribution or supply would have on the natural beauty of the countryside or on any such flora, fauna, features, sites, buildings or objects. In section 22A (Sub- section 2) it is mentioned that, without prejudice to the provisions of Sub- section (1), a person authorized by a license, or exempted from the requirement to obtain a license, to generate, transmit, distribute or supply electricity and the Commission shall, in generating, transmitting, distributing or supplying electricity, or as the case may be, in the discharge of the

Commission's functions, avoid, so far as reasonably practicable, causing injury to fisheries or to the stock of fish in any waters. section 22A (Sub- section 3 and 4) of this act also mentions that a generation licensee shall, in circumstances specified by the Commission, be entitled to construct, subject to conditions specified by the commission in consultation with the relevant water authority, water ways and pipelines, and to use water for its licensed activities and the relevant water authority shall not unreasonably deny such right. For this purpose, the 'relevant water authority' means such authority, as the Commission shall determine.

60. This act is an amendment of the previous act including guidelines that are more specific. The project proponent should follow these specific guidelines.

j) Bangladesh National Building Code (BNBC)

61. The main purpose of the BNBC is to establish minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of all buildings within Bangladesh in order to safeguard, within achievable limits, life, limb, health, property and public welfare. The installation and use of certain equipment, services and appurtenances related, connected or attached to such buildings are also regulated herein to achieve the same purpose.

62. Chapter-3, part -7 of the BNBC has clarified the issue of safety of workers during construction and with relation to this, set out the details about the different safety tools of specified standard. In relation with the health hazards of the workers during construction, this chapter describes the nature of the different health hazards that normally occur in the site during construction and at the same time specifies the specific measures to be taken to prevent such health hazards. According to this chapter, exhaust ventilation, use of protective devices, medical checkups etc. are the measures to be taken by the particular employer to ensure a healthy workplace for the workers.

63. Chapter-1, part-7 of the BNBC, states the general duties of the employer to the public as well as workers - "All equipment and safeguards required for the construction work such as temporary stair, ladder, ramp, scaffold, hoist, run way, barricade, chute, lift etc. shall be substantially constructed and erected so as not to create any unsafe situation for the workmen using them or the workmen and general public passing under, on or near them".

64. Chapter -1, Part-7 of the BNBC clearly sets out the constructional responsibilities according to which the relevant authority of a particular construction site shall adopt some precautionary measures to ensure the safety of the workmen. According to section 1.2.1 of chapter 1 of part 7; "in a construction or demolition work, the terms of contract between the owner and the contractor and between a consultant and the owner shall be clearly defined and put in writing. These however will not absolve the owner from any of his responsibilities under the various provisions of this BNBC and other applicable regulations and byelaws. The terms of contract between the owner and the contractor will determine the responsibilities and liabilities of either party in the concerned matters, within the provisions of the relevant Acts and Codes (e.g.) the Employers' Liability Act, 1938, the Factories Act 1965, the Fatal Accident Act, 1955 and Workmen's Compensation Act 1923". (After the introduction of the Bangladesh Labor Act, 2006, these Acts have been repealed).

65. To prevent workers falling from heights, the BNBC in chapter 3 of part 7 sets out the detailed requirements on the formation and use of scaffolding. According to section 11.2 of the same chapter, "every temporary floor opening shall either have railing of at least 900 mm height or shall be constantly attended. Every floor hole shall be guarded by either a railing with toe board or a hinged cover. Alternatively, the hole may be constantly attended or protected

by a removable railing. Every stairway floor opening shall be guarded by railing at least 900 mm high on the exposed sides except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board except at entrance to opening. Every open sided floor or platform 1.2 meters or more above adjacent ground level shall be guarded by a railing on all open sides except where there is entrance to ramp, stairway or fixed ladder. The precautions shall also be taken near the open edges of the floors and the roofs".

66. The proposed project will conduct several civil works including preliminaries, additional survey, excavation and backfill, piling, foundations, all structures and buildings, as well as bridge crossing, irrigation canal, entrance road, internal roads, plant and site drainage, sewage system, and so on. While conducting the civil works, the BNBC code should be followed properly.

k) Renewable Energy Policy of Bangladesh, 2008

67. 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

68. 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.

69. The proposed project is a 10MW project that is greater than 1 MW. Therefore, according to the above policy, the project developer should make sure no adverse environmental and social impact would result from the development works.

l) Guidelines for the Implementation of Solar Power Development Program, 2013

70. 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 kW 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.

71. As the proposed project is a 10MW plant, waiver certificate/license will be required and the project proponent will have to confirm the Commission by a letter.

m) Bangladesh Labor Law, 2006

72. 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.

73. According to this law, the project proponent should provide proper PPE for the workers as well as should ensure their housing facilities, medical care etc.

n) Other Relevant National Policies, Act, Rules, Laws and Ordinances

74. Considerable number of national policy documents has been prepared during recent years and these have been accepted by the GOB. These policy initiatives, strategies and plans all emphasize consideration of the environment and natural resources in order to achieve sustainable development. A summary of the key relevant policy documents prepared is mentioned in Table II.1.

Table II.1: Relevant Key Policies

Policy	Brief Description	Responsible Agency
The National Water Policy (1999)	▪ Protection and restoration of water resources; ▪ Protection of water quality including strengthening regulations concerning agro-chemicals and industrial effluents; ▪ Sanitation and potable water;	Ministry of Water Resources (MOWR)
National Land use Policy (2001)	The policy deals with land uses for several purposes including agriculture, housing, forestry, industrialization, railways and roads. The plan identifies land use constraints in these sectors.	Ministry of Land (MOL)
National Fisheries Policy, 1998	Preservation and management of inland open water fisheries	Ministry of Fisheries and Livestock (MOFL)
National Forest Policy and Forest Sector Review (1994, 2005)	▪ Afforestation of 20% land; ▪ Bio-diversity of the existing degraded forests; ▪ Strengthening of agricultural sector; ▪ Control of global warming, desertification, control of trade in wild birds and animals; ▪ Prevention illegal occupation of the forestlands, tree felling and hunting of wild animals.	Ministry of Environment, Forest and Climate Change (MOEFCC)
National Biodiversity Strategy and Action Plan (2004)	▪ Conserve, and restore the biodiversity of the country; ▪ Maintain and improve environmental stability of ecosystems; ▪ Ensure preservation of the unique biological heritage of the nation for the benefit of the present and future generations; ▪ Guarantee safe passage and conservation of globally endangered migratory species, especially birds and mammals in the country; ▪ Stop introduction of invasive alien species, genetically modified organisms and living modified organisms.	Ministry of Environment, Forest and Climate Change (MOEFCC)
Bangladesh Climate Change Strategy and Action Plan (2008)	Establishment of six strategic pillars for action, including: (1) food security, social protection and health, (2) disaster management, (3) protective infrastructure, (4) research and knowledge management, (5) decreased carbon development, and (6) capacity building and institutional strengthening.	Ministry of Environment, Forest and Climate Change (MOEFCC)
National Land-use Policy, 2001	The Government of Bangladesh has adopted national Land use Policy, 2001. The salient features of the policy objectives relevant to the proposed are as follows: • To prevent the current tendency of gradual and consistent decrease of cultivable land for the production of food to meet the demand of expanding population; • To ensure that land use is in harmony with natural environment; • To use land resources in the best possible way and to play supplementary role in controlling the consistent increase in the	Ministry of Land (MOL)

Policy	Brief Description	Responsible Agency
	number of land less people towards the elimination of poverty and the increase of employment; • To protect natural forest areas, prevent river erosion and destruction of hills; • To prevent land pollution; and • To ensure the minimal use of land for construction of both government and nongovernment buildings.	

75. Table II.2 presents an outline of the other national legal instrument that will have relevance to the project with respect to the social and environment considerations. The ESIA is prepared in compliance with these national policies.

Table II.2: Other Relevant National Act, Rules, Laws and Ordinances

Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
Environment Court Act, 2000 and subsequent amendments in 2002	Ministry of Environment, Forest and Climate Change (MOEFCC)	The aim and objective of the Act is to materialize the Environmental Conservation Act, 1995 through judicial activities. This Act established Environmental Courts (one or more in every division), set the jurisdiction of the courts, and outlined the procedure of activities and power of the courts, right of entry for judicial inspection and for appeal as well as the constitution of Appeal Court.
Public Procurement Rule (PPR), 2008	Ministry of Public Works (MOPW)	This rule shall apply to the Procurement of Goods, Works or Services by any government, semi-government or any statutory body established under any law. The rule includes the adequate measure regarding the "Safety, Security and Protection of the Environment' in the construction works. This clause includes mainly, the contractor shall take all reasonable steps to (i) safeguard the health and safety of all workers working on the Site and (ii) protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others.
The Brick Burning (Control) Act, 1989 The Brick Burning (Control) Amendment Act, 1992 and 2001	Ministry of Environment, Forest and Climate Change (MOEFCC)	▪ Control of brick burning; ▪ Requires a license from the MOEF for operation; ▪ Restricts brick burning with fuel wood.
Water Supply and Sanitation Act, 1996	Ministry of Local Government, Rural Development and Cooperatives	Management and control of water supply and sanitation in urban areas.
Bangladesh Wildlife Preservation Order 1973 and Revision 2008 (Draft)	Ministry of Environment, Forest and Climate Change (MOEFCC)	Restricts people from damaging or destroying vegetation in wildlife sanctuaries and hunting and capturing of wild animals
National Forest Policy and Forest Sector Review (1994, 2005)	Forest Department (FD), MOEFCC	▪ Afforestation of 20% land; ▪ Bio-diversity of the existing degraded forests; ▪ Strengthening of agricultural sector; ▪ Control of global warming, desertification, control of trade in wild birds and animals; and ▪ Prevention illegal occupation of the forest lands, tree felling and hunting of wild animals.
The Forest Act 1927, Amendment 2000 (Protected, village Forests and Social Forestry)	FD, MOEFCC, Forest Department.	▪ Declare any forests land or wasteland as protected forests; ▪ May stop public or private way or watercourse in the interest of preservation of the forest; ▪ Declare a reserved forest area as village forests; and ▪ Declare an area as Social forests or launch a social forestry programme in Govt. land or private land with permission.

Act/Rule/Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features-Potential Applicability
Bangladesh Climate Change Strategy and Action Plan (2008)	Ministry of Environment, Forest and Climate Change (MOEFCC)	Establishment of six strategic pillars for action, including: 1. food security, social protection and health 2. disaster management 3. protective infrastructure 4. research and knowledge management, 5. decreased carbon development, and capacity building and institutional strengthening.
Wetland Protection Act 2000	MOWR Ministry of Water Resources	▪ Advocates protection against degradation and resuscitation of natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes; ▪ Prevents the filling of publicly-owned water bodies and depressions in urban areas for preservation of the natural aquifers and environment; and ▪ Prevents unplanned construction on riverbanks and indiscriminate clearance of vegetation on newly accreted land.
Vehicle Act 1927 and Motor vehicle ordinance 1983	Bangladesh Road Transport Authority (BRTA)	▪ Road/traffic safety; ▪ Vehicular air and noise pollutions; and ▪ Fitness of vehicles and registration.

2. International Policies

76. Bangladesh has signed most international treaties, conventions and protocols on environment, pollution control, bio-diversity conservation and climate change, including the Ramsar Convention, the Bonn Convention on migratory birds, the Rio de Janeiro Convention on biodiversity conservation and the Kyoto protocol on climate change. An overview of the relevant international treaties and conventions signed by GOB is shown in Table II.3.

Table II.3: Relevant International Treaties, Conventions and Protocols Signed by Bangladesh

Treaty or Convention	Year	Brief description	Responsible Agency
On protection of birds (Paris)	1950	Protection of birds in wild state	Department of Environment (DOE/DOF)
Occupational hazards due to air pollution, noise and vibration (Geneva)	1977	Protect workers against occupational hazards in the working environment	Ministry of Health and Family Welfare (MOHFW)
Occupational safety and health in working environment (Geneva)	1981	Prevent accidents and injury to health by minimizing hazards in the working environment	MOHFW
Occupational health services (Geneva)	1985	To promote a safe and healthy working environment	MOHFW
International convention on climate changes (Kyoto Protocol)	1997	International treaty on climate change and emission of greenhouse gases	DOE/MOEFCC

3. International Policies

a) The Japan International Cooperation Agency Requirements

77. "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.

78. The grid-tied solar project, as per the above categorization, falls under Category C for the purpose of environmental investigations.

b) World Bank's Guidelines on Environmental and Social Safeguards Policies

79. 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

80. 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, sitting, 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 bower on the Bank's EA requirements.

81. 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.

82. **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.

83. **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.

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

OP 4.04 on Natural Habitats

85. 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.

c) Environmental and Social Management System (ESMS) of IDCOL

86. IDCOL has adopted an Environmental and Social Safeguards Framework (ESSF) in 2011, which is to be complied with all infrastructure projects as are to be funded by IDCOL. According to the environmental categorization of ESSF, the project has been categorized as High-Risk project requiring significant compliance safeguards including comprehensive Environmental and Social Impact Assessment (ESIA) and regular monitoring. In consideration of social categorization, the project has been categorized as Low Risk project both for Indigenous People (IP) and for Involuntary Resettlement (IR) perspectives.

4. Funding Agency/ADB Guidelines on Environmental and Social Safeguards

87. 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 because 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.

88. 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).

C. ADB Categorization

1. The operational policy of ADB includes the Safeguard Policy Statement of 2009 (SPS, 2009) which covers environment safeguards, involuntary resettlement, and indigenous people. Safeguard policies are generally understood to be operational policies that seek to avoid, minimize, or mitigate adverse environmental and social impacts, including protecting the rights of those likely to be affected or marginalized by the development process. The policy under all 3 safeguard issues involves a structured process of impact assessment, planning, and mitigation to address the adverse effects of projects throughout the project cycle. The safeguard policies require that (i) impacts are identified and assessed early in the project cycle; (ii) plans to avoid, minimize, mitigate, or compensate for the potential adverse impacts are developed and implemented; and (iii) affected people are informed and consulted during project preparation and implementation. The policies apply to all ADB-financed projects, including private sector operations, and to all project components.

2. The classification is completed primarily by ADB staff and the Project is implemented with a classification included. Occasionally the Consultant is asked to classify projects, as was the case with this project. However, the ADB also confirmed the categorization prior to the preparation of this report.

3. Due to the nature and small scale of this project and applying safeguard standards the project has been classified as category B project. Category B refers to proposed projects if it is likely to have environmental impacts that are generally site-specific, largely reversible and readily addressed through mitigation measures.

D. Environmental Clearance

89. 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.

90. Steps to be followed for obtaining the Environmental Clearance Certificate for this project are shown in Figure II.1. As the DoE categorize the solar power plant as Orange-B so the project needs to prepare a full IEE prior to implementation for environmental clearance. Additionally, the project includes 5.7 Km Transmission Line and as per the Gazette published on 24 December 2017, this component does not fall under the Category Orange-B. However, the submitted IEE to DoE also addressed the possible impacts and its mitigation related to the Transmission Line. In line with the IEE for the DoE this ESIA study; to meet the requirement of IDCOL, also considered the possible impacts from both the solar power plant and the transmission line.

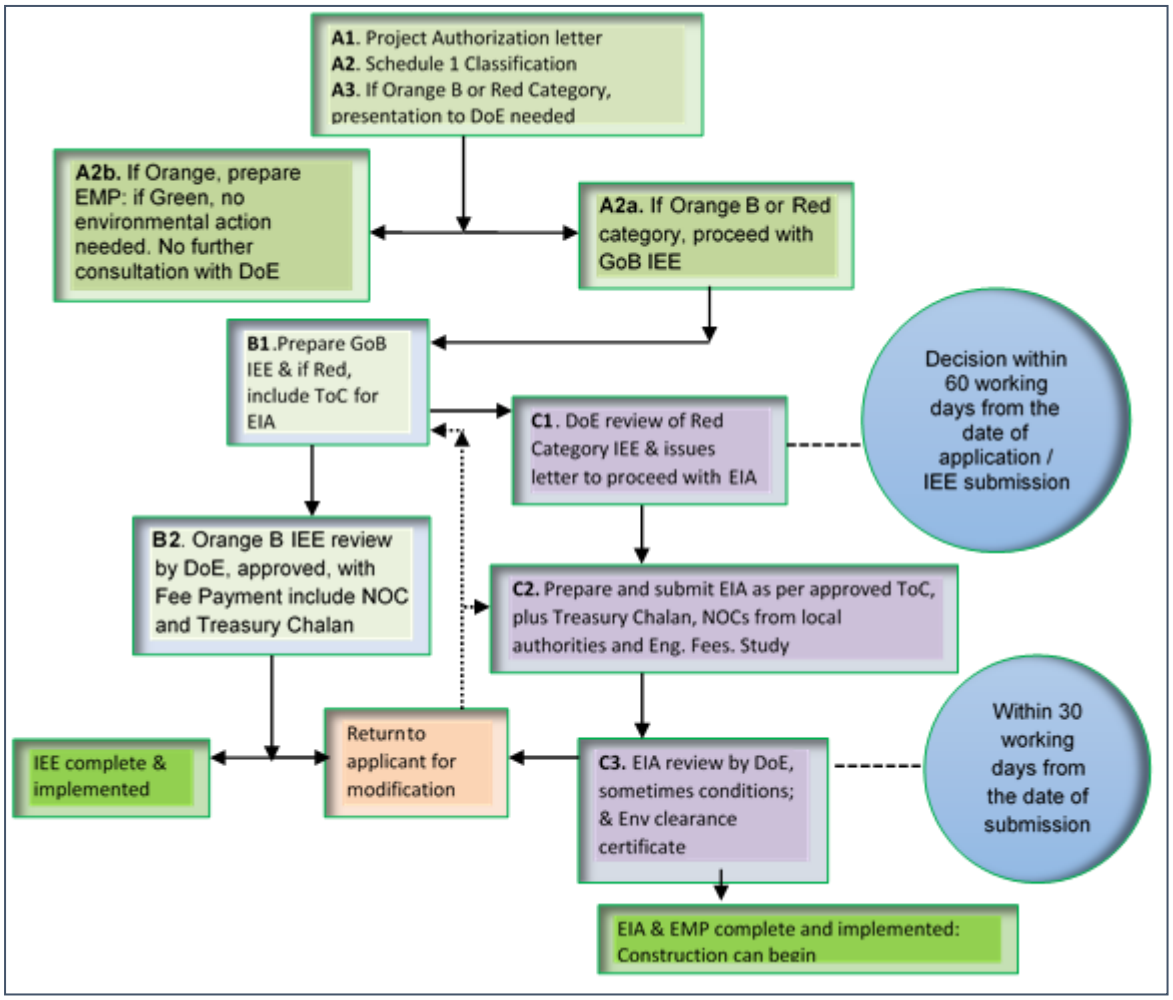


Figure II.1: Government of Bangladesh Environmental Assessment Process

91. The first to obtain environmental clearance is for the project proponent to complete & submit an application form that may be obtained from the appropriate DoE regional offices as per the category. The application is accompanied by other supporting documents (i.e. project profile, layout plan, NOC from local authority, Government fees etc.) reviewed by the divisional and district offices of DoE who has the authority to request supporting documents as applicable. The divisional office has the power to take decision on Green and Orange-A & B category projects and the Red category projects are forwarded to head office for approval. The proposed project will receive an environmental site clearance including the environmental clearance subject to the implementation of the project activities and all mitigation measures suggested in the IEE report or in the application. Additionally, this ESIA study will secure the environmental approval from IDCOL to implement the project as well as a guideline to monitor the environmental and social impacts during its construction and operation stages.

III. PROJECT DESCRIPTION

A. Project Location

92. The location of the project is Majhipara in Tentulia Upazilla of Panchagarh District. The GPS Coordinate of the project location is 26.48413°N and 88.41072°E. It takes almost 17 hours to reach Panchagarh by road from Dhaka. The project site is almost 32km away from Panchagarh district. It takes 40 to 45 minutes to reach the project site (Majhipara) from Panchagarh sadar by road.

Figure III.1: Photographs of Project Location

B. Land Requirement

93. The land requirement for the Project's Solar Power Plant depends upon the technology deployed i.e. Crystalline or Thin Film technology, conversion efficiency and solar radiation PV plant. The land required for a 1 MW power plant setup is around 4.5-5 acres for Crystalline technology and around 6.5-7.5 acres for Thin-Film technology. This is only a rough benchmark and may vary based on technology and efficiency of panels. Total land required for the installation of the PV panels and other associated facilities is already arranged within the 40 acres of existing land and the rooftop of existing six (06) poultry farm operating by this company. The layout plan of the proposed power plant is given in Figure III.3. The land is already purchased by the project proponent so no need for the acquisition of land. Additionally, the Transmission line will follow the existing network that runs through the roadside public land. Considering the local meteorological conditions and paying specific attention to extreme and average conditions, the project has opted for a configuration of strings with 34 modules in series. Eight strings are connected to a 60kw string inverter in parallel, and Per 4 String inverters are connected to an AC combiner box in parallel. Cable connection for Module to Inverter and Inverter to AC combiner box shall apply PV1-F 1×4 mm² and ZR-YJV22-0.6/1kV

-3×25mm². 5.71 Km 33 KV Transmission Line is constructed for electricity connection. Towers will be erected along the selected route at designated intervals. Finally, after completion of construction works, checking, testing and commissioning of the transmission lines will be carried out.

C. Project Components

94. The project components are:

1. Construction of $8MW_{AC}$ ($10MW_{DC}$) Solar Power Plant
2. Construction of 5.71 Km 33 KV Transmission Line

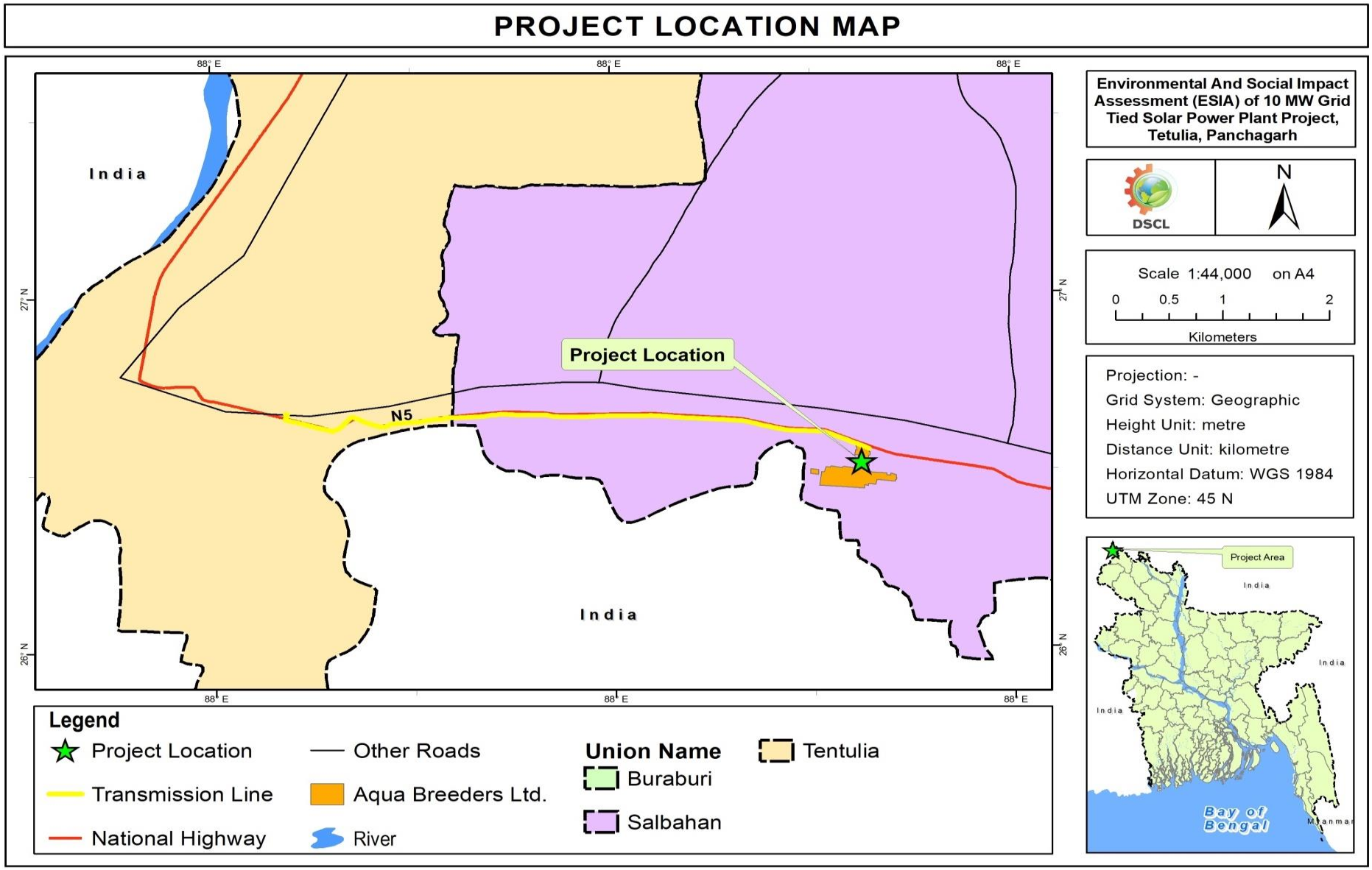


Figure III.2: Location of the Project

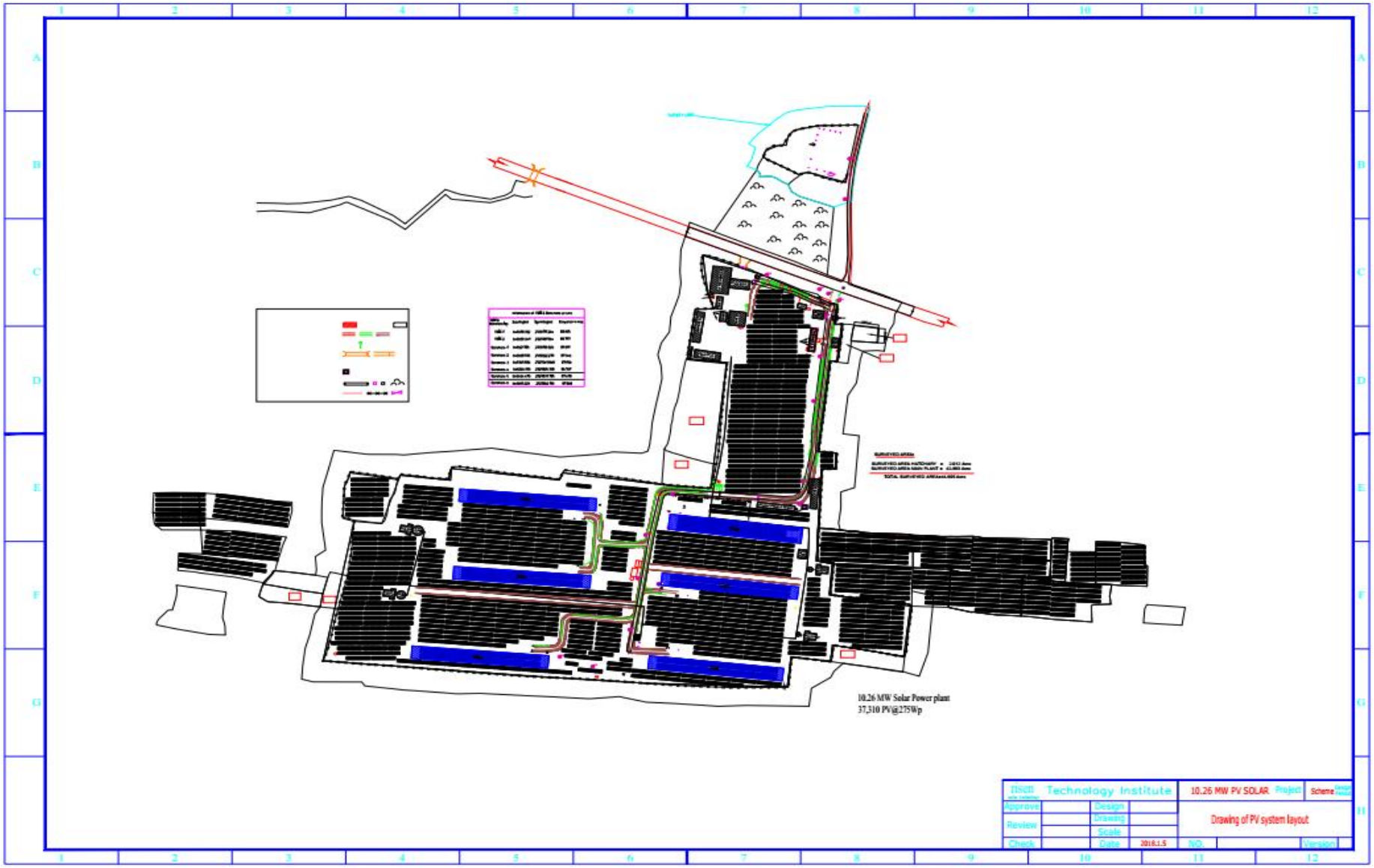


Figure III.3: Project Layout Plan

D. Construction of Solar Power Plant

1. Civil Works

95. The scope of civil works includes preliminaries, additional survey, excavation and backfill, piling, foundations, all structures and buildings, as well as bridge crossing, irrigation canal, entrance road, internal roads, plant and site drainage, sewage system, and so on. According to the soil investigation carried out by the owner, a type of bored piles is recommended.

96. All structures and their component parts is designed to be capable of withstanding the worst practicable components of dead, live loads, wind load, seismic, sideways and temperature effects, deflection and stress limits. All structures are designed to withstand a min. wind speed of 45m/s. What is more, the dimensions of all buildings can provide adequate space for the safe installation and proper operation and maintenance of all plant and equipment. The design does take account of the function of the Solar Power Plant and the local environment.

97. The project is located within Panchagarh area whereas the seismic zoning map indicates that the project site is located in seismic zone 2 where the moderate seismic intensity could be expected. The project should incorporate earthquake-resilient designs into the foundations of the PV modules and site infrastructure. The structure and foundation design has taken into account the soil conditions and the seismic value as proposed above.

98. Drainage system conveys surface runoff and roof drainage away from the equipment and buildings. Drainage system includes open flow piping, manholes, area drains, catch basin, and detention pond. On the other hand, the width of service road is 6.0m including road shoulders. The service road is designed to serve the access to transformers, inverters and general fire truck access. There is enough space for 2 cars at the control building with the specification being same as the service road.

99. As to buildings in PV power plant, there is to be constructed a one-floor control room with the height of 4.6m, which covers an area of 194.87 square meter. It includes three rooms, electrical equipment room, centralized control room and toilet, the area of which is 121.25 square meter, 38.97 square meter and 34.65 square meter, respectively. These buildings are designed to minimize solar heat gain and windows are arranged to avoid direct sunlight by blinds. In addition, all buildings with roofs have down spouts sufficient to provide adequate runoff for storm water.

100. As to PV foundation and bracket, the lower side of solar modules is designed to be installed at a min. height of 1.2m above ground level. The type of foundation is driven piles. The mounting structure is fixed mounted, not a tracking system, and can withstand all environmental loads, such as earthquake, wind, etc. All the structures are made of aluminum and steel. Moreover, all steel sections, bolts and washers are to be in accordance with the recognized authoritative standards. Steel structure will be galvanized steel with protected zinc coating of 80 microns thickness for mounting structure. What is needed to emphasize is that types of brackets on the ground and the roof are very different. The PV modules laid on the ground are inclined at an optimum tilt in order to maximize the energy production. However, those modules on the roofs have only a tilt of 8°, which are parallel to the roofs. The reason is to make full use of the area of the roofs.

2. PV Power System

101. The present chapter depicts the design basis for setting up the large Grid Connected Solar PV plant. The guidelines presented are tentative and for reference only. It may get change at the time of the execution to suit exactly the requirement of the projects.

102. The Solar Module directly converts the energy of sun light to DC electricity. After evaluating the various technologies presently available such as Crystalline, CdTe, a-SI, CIGS etc., we proposed to use crystalline modules technologies for this project. The basic reasons for considering the crystalline technologies is the reliability, proven technology, long term proven track record and highly matured & established technology. The polycrystalline silicon photovoltaic panel (275W), which is utilized widely in photovoltaic power generation project is a reasonable option.

103. We assume the site is suitable for driven pile mounting system, combination of maintenance requirements, performance and use of ground space we opted for 22 modules in portrait with a tilt of 23° south facing. The support structure is manufactured in hot galvanized steel in compliance with UNE EN ISO 1461 y UNE EN ISO 3750.

104. The support rails for the modules are made of aluminum T6005, and are assembled to withstand winds of up to 45m/s. The lowest part of the structure is at least 1.2m from the ground. Conforms to IEC 61215:2005; IEC 61730:2013, UL 1703 PV Standards ISO9001, OHSAS18001, ISO14001Certified.

105. Considering the local meteorological conditions and paying specific attention to extreme and average conditions we have opted for a configuration of strings with 34 modules in series connected to string inverter allowing up to 8 strings to be placed in parallel.

106. Based on Weather Database Consideration as per Meteonorm 7.1 and Energy Simulation for the plant using PVSYST 6.6.4, the guaranteed Performance Ration of the plant stands as follows.

Table III.1: Guaranteed Performance Ratio

Performance Parameter	Guaranteed Values
Net Performance Ratio (Net PR)	82.31%

107. The PR guarantee does not contain any loss due to Grid failure, plant shut down by any force majeure issues, losses due to transmission line, auxiliary consumption, etc.

3. Primary Electrical Components

a) Main electrical connection

108. Considering the local meteorological conditions and paying specific attention to extreme and average conditions, we have opted for a configuration of strings with 34 modules in series. Eight strings are connected to a 60kw string inverter in parallel, and Per 4 String inverters are connected to an AC combiner box in parallel. Cable connection for Module to Inverter and Inverter to AC combiner box shall apply PV1-F 1×4 mm² and ZR-YJV22-0.6/1kV -3×25mm². Per 8 sets of AC combiner box are connected to a box-type step-up transformer of 2MVA in parallel and 4 String inverters are connected to an AC combiner box in parallel. Cable connection for AC combiner box to step-up transformer shall use ZR-YJV22-0.6/1kV -3×120mm². 4 step-up transformers are connected to incoming MV cubicle of the new-built 33kV RMU in series by the use of ZR-YJV22-26/35- 3×95mm².Cable connection between step-up transformers for incoming and outgoing cables shall apply ZR - YJV22-26/35-3 x50

mm².Finally the PV power plant shall be connected to the 33kV transmission line of the grid by the application of ZR-YJV22-26/35-3×95mm².

b) Main Electrical Components

i. Inverter

109. Solar inverter, the heart of the Solar PV system, is the link between the PV array DC system and the Utility grid AC system. Its basic task is to convert the solar DC (direct current) electricity generated by the PV module into AC (alternating current) electricity by synchronizing itself to the frequency and voltage level of the Utilities Grid. The inverter receives varying DC input power from the module due to varying nature of solar radiation and motion of Sun throughout the day & year, which is converted into AC power by its highly efficient Power Electronics Circuit. In this project, the application of a 60kW string inverter is recommended, which has compact design and lightweight for easier installation. It also has plug-in design of fan and SPD, which is convenient for on-site maintenance. What is more, fast trouble shooting is available with the integrated string current monitoring function.

ii. AC Combiner Box

110. In a PV power plant applying string inverter, PV module is directly connected to the inverter. In order to reduce the number of cable connection for the inverter to step-up transformers and improve reliability of the system, AC combiner boxes shall be installed in the power plant, and it is facilitative for the construction and maintenance.

111. In this project, 4 in 1 out AC combiner box are suggested, and 34 combiner boxes are needed totally

112. The box specification and technical data are listed as below:

- Outdoor wall mounted, waterproof, anti-rust, sunscreen, apply to outdoor installation requirements
- The box can access 4 inputs, and each inverter connection shall be protected by a circuit breaker (MCCB,80A/3P, 800Vac)
- Equipped with surge protector, provided with lightning protection function
- Output of the box shall be protected by a circuit breaker (MCCB,250A/3P, 800Vac)

iii. Box-Type Step-up Transformer (33kV)

113. The step-up transformer in this project adopts the box-type step-up transformer (American model), it is equipped with high voltage and low voltage device, self-use transformer and oil immersed transformer. The incoming and outgoing lines of the box-type transformer are in cable connection.

Table III.2: Technical Data Sheet for Step-up Transformer

Rated Power	2000kVA
Rated Voltage	33kV
Rated Current (33/0.4kV)	35/1443A
Number of phases	3
Rated frequency	50Hz
Power frequency withstand voltage	HV-85 kV, LV-5 kV

Lightning impulse withstand voltage	200 kV
Connection of transformer winding	Dy11
Taps of HV winding	±2×2.5%
Type of cooling:	ONAN
Impedance voltage	6.5%

iv. 33kV RMU (Ring Main Unit)

114. The switchgears shall be designed and constructed for indoor installation and separated building each electrical feeder in the power plant.

v. Structure Data

115. The individual panels shall be of self-supporting, freestanding, and metal-clad type. They shall be assembled of steel members and steel sheets and equipped with bottom frames suitable for bolting to the concrete floor.

116. The enclosure of each panel shall be divided into several compartments.

117. Each panel shall be segregated into compartments by steel sheets for the following:

- Circuit breaker (draw-out type)
- Bus bars
- Current transformers, grounding switch, and cable termination
- Voltage transformers
- Low voltage equipment

Circuit Breakers

118. The circuit breakers shall be of vacuum and draw-out type. The circuit breakers shall have to following accessories (per Bangladesh Grid Code) as a minimum.

119. The drive system shall be supplied by the 125VDC system. Manual operation also be provided. The spring energy storage system shall ensure uniform and reliable closing. The spring shall be automatically recharged by an electric motor, and manually recharged if the power supply shall fail. The mechanism shall be trip-free.

Main and Branch Busbar

120. The main and branch busbar shall be of high conductivity drawn electrolytic copper. Busbars shall have high dynamic and dielectric strength with good heat dissipation. The busbar shall be extendable at both ends; such extension shall be easily done with the minimum possible disturbance to the existing busbars.

Instrument Transformer

121. The instrument transformers shall be of cast resin insulated, dry type. All instrument transformers of the feeder cubicles shall be mounted on the fixed part of the switch gear and correspond to the design short circuit level of the switchgear.

Protection Equipment

122. The minimum protection functions supplied shall meet the national electric code. The protection function 59 N Zero sequence over voltage shall be provided for detected internal ground fault at 33kV system (delta vector group).

123. The detailed design shall be provided until getting BPDB/REB approval of the protection logic diagrams, interlocking logic diagrams, tripping and control logic diagrams of 33kV VCB according to regulations issued by BPDB/REB.

Table III.3: Technical Data Sheet for RMU

Rated Voltage	36kV
Rated Current	1250A
Rated frequency	50Hz
Rated short circuit breaking	31.5kA
Rated short circuit making	82kA
Rated insulation level: One-minute power frequency withstand voltage, R.M.S.	170 kV (peak)
BIL	70kV rms
Rated duration of short-circuit	1s
Degree of protection of enclosure	Ip4x

Table III.4: Technical Data Sheet for Vacuum Circuit Breakers

Rated Voltage	36kV
Rated Current	1250A
Rated frequency	50Hz
Number of phases	3
Rated short circuit making	82kA

Table III.5: Technical Data Sheet for Current Transformer

Rated frequency	50Hz
Rated Voltage	36kV
accuracy class	200A/1/1/1/1/1A 31.5kA 0.2S/ /0.5/5P30/5P30/5P30 50A/1/1/1/1/1A 31.5kA 5P30/5P30/5P30/0.5/0.2S

Table III.6: Technical Data Sheet for Voltage Transformer

Rated frequency	50Hz
Rated Voltage	36kV
voltage ratio	$\frac{33}{\sqrt{3}} / \frac{0.1}{\sqrt{3}} / \frac{0.1}{\sqrt{3}} / 0.1kV$

vi. Distribution Transformer

124. A160kVA resin Insulation Dry Type Transformer shall be installed in the power plant.

Table III.7: Technical Data Sheet for Distribution Transformer

Type	SCB11-160/33
Rated Power	160kVA
Rated Voltage	33/0.415kV
Vectortortor group	Dyn11
Impedance voltage	Ud=4%
Taps of HV winding	±2×2.5%

vii. 415V Distribution Panel

125. 415V Distribution panel shall use MNS type draw-out switch cabinet.

viii. Lightning Protection & Grounding System

126. This solar photovoltaic power generation system has a complete lightning protection system for lightning damage to equipment and persons. According to the requirements of the

corresponding design specifications, proper grounding methods are adopted with inverters and main electrical equipment in the substation and control room to meet the requirements of lightning protection.

127. Module frames are connected to mounting structure as a lighting arrester for Over Voltage Protection of direct lighting. Mounting structures are connected through flat steels to main grounding network with galvanized flat steel of size 40mm*4mm. In order to prevent the intrusion of lightning waves on the electrical equipment hazards, 33V switchgear bus are installed zinc oxide arrester in the high voltage side of step-up transformer on the 33KVline.

128. Step-up transformers and other equipment in the control room will be connected to ground horizontally and be supplemented by vertical grounding of the artificial composite grounding network. The horizontal grounding is made of 50mm × 5mm galvanized flat steel, while vertical grounding body is made of DN50 5mm thick steel pipe. After the grounding network is laid, the measured value of the grounding resistance should not be greater than 4 ohms.

ix. Power Lighting

129. LED or energy-saving lamps will be used as accident lighting with UPS in the control room. Working lamps are supplied with AC screen power in the solar photovoltaic project. 33kV power distribution device room is equipped with LED lighting, and relay protection room equipped with LED lighting. Both are equipped with battery emergency lighting. 33kV power distribution unit room and the relay protection room are equipped with a power box, for maintenance energy supply and temporary maintenance lighting.

4. Secondary Electrical System

130. This section is a typical solution, and the final plan should be adjusted accordingly to the requirements of the Bengal Grid Company.

131. The photovoltaic power generation system is designed according to "less maintenance, remote control" principle, and is operated with regular or irregular periodical inspection. One set of microcomputers integrated automatic monitoring system is installed in the control room, responsible for the photovoltaic power generation system power monitoring, scheduling, fault alarm, PV square video surveillance and other functions.

132. PV array operation data and working status is sent to the automated monitoring system through the communication port. 33kV collecting power line control, measurement and metering devices are scattered on the local switchgear. 33kV integrated protective device protection action information and meter measurement, measurement information is sent to the boost station monitoring system through the Ethernet upload.

5. Computer Monitoring System

a) Computer Monitoring System

133. The integrated automation of power station is based on microcomputer protection and computer monitoring system, in addition with other intelligent equipment. The power station is equipped with a set of computer monitoring system and has a remote function and be able to monitor, control and adjust. Monitoring system can collect the status of three-phase current, voltage, power, frequency, switch, control power station switch to the retreat, and collect and send power generation data of each branch to the superior dispatching Centre.

b) PV Monitoring System

134. PV Monitoring System should collect the operation status and various parameters, irradiance, temperature and other environmental parameters, and irradiance, temperature and other environmental parameters. PV monitoring system should meet the requirements of connection to the distribution station computer monitoring system.

c) Anti-Misuse System

135. The project uses the "computer monitoring system logic lock + the device interval electrical latch" to achieve anti-misuse function, instead of setting up a separate microcomputer anti-misuse operating system. The computer monitoring system should have a perfect all-station logic latch-up function. In addition to distinguishing the blocking conditions of the electrical circuit of the interval, it is able to judge the other interlocking conditions.

d) Anti-islanding Solution

136. When the grid is blacking out, the PV power plant still maintains a state of continuing power supply to a certain part of the grid, which can be called islanding effect. The occurrence of unplanned islanding can jeopardize the safety of line maintenance personnel and users, interfere with the normal closing of the grid, and render the frequency and voltage in the island out of control. Inverter of Sun grow possess anti island safety.

e) Remote Communication Device

137. This solar photovoltaic project is a new construction project, is dispatched by Bangladesh Power Grid Company.

138. Remote communication channel is used with wireless public network, for uploading the solar photovoltaic power station remote information. One set of remote devices and two sets of GPRS data transmission terminals are equipped in the project. Remote data should be configured and uploaded according to Bangladesh grid and other related requirements.

- Telemetry: 33 kV line active and three-phase current.
- Telecommunication Circuit Breaker Signal; all the isolating switch and double position signal breaker and grounding; 33kV line protection action signal.
- Remote control: circuit breaker remote control

f) Power Quality Online Monitoring Device

139. Solar photovoltaic power generation system converts solar energy into direct current using solar photovoltaic modules, Inverters converts DC electricity current into sine wave AC current with same frequency and same phase with grid using grid-tied inverters and is interconnected into grid. A lot of harmonics and dc component will be produced in the process of converting Dc current into AC current with inverters.

140. One set of power quality monitoring devices that meets the requirements of Bangladesh grid, is installed in the power generation project side of the interconnection point to ensure effective monitoring of power quality.

g) Revenue Meter

141. This project is equipped with two revenue meters at interconnection point of 33kV line. Photovoltaic power station uploads billing system data to Bangladesh grid billing system, using wireless data transmission terminals.

142. The meter accuracy requirement of this project is 0.2 s-class and is equipped with special measuring winding; 33 kV voltage transformer measurement accuracy of the special

winding should reach 0.2 on the Richter scale; 33 kV current transformer measurement accuracy of the special winding is 0.2 S level; Secondary measurement of transformer winding should be special, should not connected into the electric energy metering devices. At the same time, single core, insulated, copper wire should be used for second measurement circuit cable and conductor cross-sectional area of voltage and current transformer secondary measurement circuit should not less than 4mm squired.

143. Final configuration of the metering device should be adjusted according to the specific requirements of Bangladesh Power Grid Company.

h) Control Power Supply System

i. DC Power Supply

144. Voltage of DC system is DC 125 V. DC system is connected with the single bus bar, equipped with one set of 120 Ah battery. High frequency switching power supply is adopted for charging devices. DC charging, feeder, batteries and other equipment are installed in a one-counter unit.

ii. UPS

145. In order to ensure reliability of the photovoltaic power station monitoring system and remote equipment power supply, the project set up a set of AC Uninterrupted Power Supply unit (UPS) with capacity of 10 kVA.

6. Protective Relays and Automation Equipment

a) Selection of Protection Devices

146. Compared with the protection of analogy integrated circuit type, microcomputer protection devices have full functions, flexible operation, high reliability, strong anti-jamming capability, and have self- checking function, moderate price, and are able to interface with power station computer monitoring system easily. As per the requirements of this power station automation level and automation level, this power station adopts the type of microcomputer relay protection device.

b) Relay Protection and Safety Automatic Device Configuration

147. The relay protection solution is only typical scheme, and the final solution shall be in accordance with the requirements of Bangladesh power grid companies.

148. Solar photovoltaic power plant relay protection configuration is as follows:

- 33 kV line protection
- 33 kV bus bar protection
- Step-up transformer protection
- Security automatic device

7. CCTV

149. CCTV is mainly used for remote monitoring the main equipment of solar photovoltaic power station control room (switchgear etc.), and for recording videos of surveillance scenes for the purpose of accident analysis. Solar photovoltaic power station image monitoring system consists of a control station, cameras, video cables, controlling cables, etc. Control station is layout in the contralateral collection station main control room, and consists of the host computer controller, keyboard, mouse, monitor and hard disk video recorders and other equipment. Cameras are installed at 33 kV transformer room, secondary equipment room and

the door of control room. The cameras and control station are connected with coaxial cables and control cables.

150. One set of image monitoring and security system, consisting of cameras, infrared correlation alarm detector and background monitoring host, hard disk video recording video server and other equipment, is designed in the scheme to monitor anti-theft, fire prevention, human accident prevention in the power plant environment.

- Monitoring Object, Control room and environment in the site
- The host is connected with fire alarm system through the communication interface. In case fire occurs, alarm screen of fire area is popped up in company with voice alarm.
- Through communication network channel, the monitored dynamic images are transferred to monitoring center with IP unicast and multicast. The monitoring system has functions of one-to-many (more than a remote terminal connection at the same time monitoring substation video processing unit), many-to-one (multiple remote terminal access at the same time a substation video processing unit). Alarm signal, station state information and control information are in real time communication with control center in TCP/IPway.
- Operation maintenance personnel is able to monitor substation equipment and the field with video processing unit or workstation and control the cameras of the control room (left and right, up and down, vision/close shot, near the focal/coke), and switch from the pictures and control digital recorders.
- Image monitoring and security guard system is connected with dispatching station system.
- The power of host of image monitoring and security guard system shall be supplied by AC uninterruptible power supply system in the control room.
- CCTV communicates with power station computer monitoring system through public interface device.

8. Quantity Required for Each System Equipment

Table III.8: List of Primary Electrical Devices and Materials

NO	Item	Specification	Unit	Quantity	Remarks
1	Electrical equipment of PV Array				
1.1	Polycrystalline Module	275Wp	Piece	37,298	
1.2	Cable	PV1-F 1×4mm²	Km	90	Module to Inverter
1.3	LV Cable	ZR-YJV22- 0.6/1kV 3×25 mm²	km	6.5	Module to AC Combiner BOX
1.4	LV Cable	ZR-YJV22- 0.6/1kV 3×120mm²	km	3.5	AC Combiner BOX to Step- up Transformer
1.5	Communication Cable	ZR-DJYVP22- 2×2×1.0 mm²	km	6	
1.6	Cable tray	100×100mm	m	1100	
1.7	Galvanized steel pipe	DN25	m	280	Cable Protection
1.8	Galvanized steel pipe	DN40	m	1150	Cable Protection
1.9	Galvanized steel pipe	DN100	m	100	Cable Protection
1.10	Metallic hose	φ40	m	400	PV Cable Protection
2	Inverter & Combiner BOX& Step-up Transformer				

NO	Item	Specification	Unit	Quantity	Remarks
2.1	Inverter	SUN2000-60KTL-HV	Set	134	
2.2	AC Combiner BOX	Incoming: 4 channel Outgoing: 1 Channel	Set	34	
2.3	Box-Type Step-up Transformer (33 kV)	ZGS11-2000kVA-33/0.8kV	Set	4	
2.4	Measuring and control device of Step-up Transformer		Set	4	
2.5	Data acquisition unit of Inverter		Set	4	
3	Materials of Lightning protection & Grounding				
3.1	flat steel for Grounding	50×5Galvanized flat steel	m	7200	
3.2	flat steel for PV support bracket Connection	40×4Galvanized flat steel	m	300	
3.3	Perpendicularity Grounding	DN50 Steel pipe, 2.5m long,≥5mm Thick	stick	180	
3.4	copper stranded wire (yellow & green)	4mm^2	m	3600	
3.5	Bolt		Set	35250	confirm Specifications on site
4	33 kV Transmission line				
4.1	33 kV Cable	ZR-YJV22-26/35-3×50mm^2	m	1020	
4.2	33 kV Cable	ZR-YJV22-26/35-3×95mm^2	m	270	
4.3	Optical Fibre	GYXTW53-8B1	m	1300	
4.4	33kV Cable Terminal	Suitable for ZR-YJV22-26/35-3×50mm^2	Set	6	
4.5	33kV Cable Terminal	Suitable for ZR-YJV22-26/35-3×95mm^2	Set	2	
5	LV overhead line renewal				
5.1	415V Cable		m	900	Change overhead line to buried cable
33kV RMU (Ring Main Unit)					
1	33kV RMU (Ring Main Unit)				
1.1	33kV MV CUBICLE	Circuit breaker (draw-out type, vacuum) 33kA, 82kA, 1250A	Set	1	Incoming
1.2	33kV MV CUBICLE	Circuit breaker (draw-out type, vacuum) 33kA, 82kA, 1250A	Set	1	Outgoing
1.3	33kV MV CUBICLE	Circuit breaker (draw-out type, vacuum) 33kA, 82kA, 1250A	Set	1	PT
1.4	33kV MV CUBICLE	Circuit breaker (draw-out type, vacuum) 33kA, 82kA, 1250A	Set	1	Distribution Transformer
1.5	Container-type RMU Room (outdoors)		Set	1	
2	Distribution Transformer				

NO	Item	Specification	Unit	Quantity	Remarks
2.1	Distribution Transformer	SCB11-160/10.5/0.415V	Set	1	
2.2	0.415kV Distribution panel	MNS	Set	3	
3	Cable applied in control room				
3.1	33kV XLPE Cable	ZR-YJV22-26/35-3×50 mm^2	M	50	
3.2	33kV Cable Terminal	Suitable for YJY23-26/35-3×50 mm^2	Set	2	
3.3	33kV XLPE Cable	YJV22-26/35-3×95 mm^2	m	100	transmission line
3.4	Power Cable	ZR-YJY-0.6/1kV-4×4 mm^2	M	300	
3.5	Power Cable	ZR-YJY-0.6/1kV-4×10 mm^2	M	500	
3.6	Power Cable	ZR-YJY-0.6/1kV-5×10 mm^2	M	200	
3.7	Power Cable	ZR-YJY-0.6/1kV-2×3×150+1×70 mm^2	m	70	
3.8	Control Cable	ZRC-KVVP-0.45/0.75-4×1.5 mm^2	m	2000	
3.9	Control Cable	ZR-KVVP-0.45/0.75-10×1.5 mm^2	m	2000	
3.10	Control Cable	ZR-KVVP-0.45/0.75-6×6 mm^2	m	500	
3.11	Control Cable	ZR-KVVP-0.45/0.75-4×2.5 mm^2	m	700	
3.12	Fireproof Cable	NH-KVVP-0.45/0.75-2×2.5 mm^2	m	600	
4	Grounding for switching station				
4.1	Horizontal Grounding	40×4 Hot Galvanized flat steel	m	470	
4.2	copper bar	-25×4mm	m	60	
4.3	Cable	50mm^2	m	120	
5	Lighting& Inspection				
5.1	LED lamp	230V 2×36W	Set	36	
5.2	socket		Set	30	
5.3	switch panel		Set	12	
5.4	high pressure sodium lamp 23	0230250W	Set	22	
5.5	lighting distribution box		Set	2	
5.6	lighting distribution box		Set	2	Outdoors
5.7	Inspection distribution box		Set	1	
5.8	Galvanized water gas pipe	DN20	m	200	
5.9	PVC wire (Cu)	ZR-YJV-1kV-3×4 mm^2	m	10	
5.10	PVC wire (Cu)	ZR-YJV-1kV-5×25 mm^2	m	25	

NO	Item	Specification	Unit	Quantity	Remarks
5.11	PVC wire (Cu)	ZR-YJV-1kV-3×25+2×16 mm^2	m	10	
5.12	PVC wire (Cu)	ZR-BV-0.75kV 2.5mm^2	m	600	
5.13	PVC wire (Cu)	ZR-BVR-0.75kV 2.5mm^2	m	300	
5.14	PVC wire (Cu)	ZR-BV-0.75kV 4 mm^2	m	300	
5.15	PVC wire (Cu)	ZR-BVR-0.75kV 4 mm^2	m	150	
6	Fire-proof sealing material				
6.1	Organic fire-proof sealing material	DFD-III	kg	500	
6.2	Inorganic fire-proof sealing material	SFD-II	kg	1345	
6.3	fireproof paint	G60-3	kg	55	
6.4	clay brick		piece	100	
6.5	fire-resistant shield	EFF	m^2	50	

Table III.9: List of Secondary Electrical Devices and Materials

NO	Item	Specification	Unit	Quantity	Remarks
Monitoring system					
1.1	Operator Workstation	5000mm×1500mm (length×width) Desk 5 chairs	Set	1	
1.2	Servers and server system	3 servers 3 server systems Remote communication device:1 set Time synchronization device:1 set	Set	1	
1.3	Communication system	Protocol converter:1 set Ethernet switch:3 sets GPS: Two sets Cabinet:1 set Server: 1set	Set	1	
1.4	Meteorological data collection system	17'LCD: 1 set Meteorological and environmental data services Cabinet:1 set	Set	1	
Relaying protection					
2.1	33kV transmission line microcomputer measuring and protection device		Set	2	Installed in the switchgear cubicle
2.2	Transformer microcomputer measuring and protection device		Set	1	Installed in the switchgear cubicle
2.3	PT microcomputer measuring and protection device		Set	1	Installed in the switchgear cubicle
2.4	Other protection devices		Set	1	The final configuration will be provided after getting the Grid Connection

NO	Item	Specification	Unit	Quantity	Remarks
					Permit
3	Revenue Metering				
3.1	Revenue Meter		Set	2	
4	Grid equipment				
4.1	Grid equipment		Set	1	The final configuration will be provided after getting the Grid Connection Permit
5	Battery and UPS				
5.1	Battery	Battery: 120Ah Battery charger	Set	1	
5.2	UPS	10kVA	Set	1	
6	Fire alarm system				
6.1	Fire alarm control panel		Set	1	
6.2	Smoke detector		Set	10	
6.3	Temperature sensing cable		M	150	
6.4	I/O module		Set	1	
6.5	Fire alarm button		Set	1	
6.6	Fire alarm apparatus		Set	1	
6.7	Alarm telephone		Set	1	
6.8	Signal wire	NH-RVVP-2x1.5 mm^2	m	100	
6.9	Power wire	NH-BV-2x2.5 mm^2	m	40	
6.10	Telephone wire	ZR-RVVP-2x2.5mm^2	m	40	
6.11	Galvanized steel pipe	DN20	m	180	
7	CCTV				
7.1	intelligence dome camera indoor	720P	Set	6	
7.2	intelligence dome camera outdoor	720P	Set	16	
7.3	CCTV system		Suit	1	

9. System Design and Layout

151. PV modules are laid on the ground of the site, and 6 roofs as well. The azimuth angle of all PV arrays is 0°. In the project, 22 PV modules are connected in series; there are two rows of which in one PV string. The site is located in Tentulia, Panchagarh in the northwest of Bangladesh near the Bangladesh -Indian border, the latitude and longitude of which are 26.485050°N and 88.410774°E, respectively. The optimum tilt angle is 23° as the result of calculation. PV modules on the ground are installed with the angle of 23°, while those on roofs are laid with the angle of 8°. According to shading calculation, when the tilt angle is 23°, the distance between edges of adjacent PV string in north-south direction is 6.0m, which is appropriate for cleaning the PV modules. The east-west distance between two PV string is 2 meters. Hence, the width of the passageway between adjacent PV string is 3.0m. According to layout plan, installed capacity on the ground is 7.9002MW, while that on the roof is 1.11672MW. It means that 9.01692 MW is the exact installed capacity for the entire project.

152. Besides the system, solar power plants are taken into consideration as well. Control room will be put between the two gates. More details are expressed in general layout plan single line diagram for the installed system and metering and relaying diagram.

10. System Performance

153. Most of Bangladesh is a subtropical monsoon climate, humid and rainy. The entire year is divided into winter (from November to February), summer (from March to June) and rainy season (from July to October). Temperature difference is obvious. The lowest temperature in winter is 4 degree centigrade, while the highest temperature in summer is up to 45 degree centigrade. Showers brought by subtropical monsoon climate can be utilized to clean and cool down photovoltaic panels, which ensure the stability of photovoltaic efficiency and reduce maintenance costs.

154. The project is located at latitude 26.485050°N, longitude 88.410774°E, solar resource data from Solar GIS is shown in the following table.

Table III.10: Global Horizontal Irradiation in project site area (kWh/m^2)

Lat 26.485050 Lon 88.410774	Jan	Feb	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov	Dec.	Year
Solar GIS	93.0	110.0	155.0	153	157	135	134.0	135.0	130	137	113	99.0	1551

155. From the data, Annual level solar irradiation is about 1551 kWh/m2. According to calculation result of PV system, we can get the monthly average solar irradiation data at inclined surfaces at some angle. It is supposed to set angel 23° to be the optimal angel, at which the panel can receive maximum irradiation, 7290 MJ/m2 for a year.

156. Efficiency analysis of solar photovoltaic power generation system is as below:

i. PV temperature factor

157. The efficiency of PV cells will change as the temperature variety. When it is hotter and hotter, efficiency of a wide range of PV cells will show a downward trend. Hence, reduction factor is 95%.

ii. Dust loss

158. Due to the pollution of dust or water on the surface of PV panels, generating efficiency will definitely be impacted. There is a rainy weather in the project site. Besides, sand storm rarely happens in a year. Relevant reduction factor is 96%.

iii. Invert average efficiency

159. Considering possible failure rate, the reduction factor is 97.5%.

iv. Energy loss

160. Preliminarily estimated loss of DC distribution and 10kV set-up transformer will affect the generating efficiency. Relevant reduction factor is 96%.

v. Utilization rate of PV system

161. Although there is an extremely low failure rate, loss of periodic inspection and grid fault cannot be ignored. Relevant reduction factor is 98%.

vi. Loss of differential performance of PV modules

162. Coefficient of utilization is 98%.

vii. Loss from unavailable irradiation in the morning and evening

163. Coefficient of utilization is 98%.

164. Hence, the conclusion is that overall efficiency of polysilicon system with stationary bracket is 81%.

Table III.11: Annual Power Generation

Year	attenuation coefficient	Annual power generation (10,000 GW·h)	Equivalent utilization hours
1	0.975	1384.83	1349.74
2	0.967	1350.21	1315.99
3	0.959	1305.65	1272.57
4	0.951	1252.12	1220.39
5	0.943	1190.77	1160.59
6	0.935	1122.89	1094.44
7	0.927	1049.90	1023.30
8	0.919	973.26	948.60
9	0.911	894.43	871.76
10	0.903	814.82	794.18
11	0.895	735.79	717.14
12	0.887	658.53	641.84
13	0.879	584.11	569.31
14	0.871	513.44	500.43
15	0.863	447.20	435.87
16	0.855	385.94	376.16
17	0.847	329.98	321.61
18	0.839	279.49	272.41
19	0.831	234.49	228.55
20	0.823	194.86	189.92
Sum		**15702.71**	**15304.79**
average		**785.14**	**765.24**

165. As previously listed, the total power generation of twenty years is about 15702.71 million GW·h and average equivalent utilization time is 765.24h.

11. Operation and Maintenance

166. The Operation & Maintenance (O&M) option is an additional service to customers. This option can be considered if the customer wishes to have an extended maintenance on the operational Solar Photovoltaic System after the expiration of the Defects Liability Period to keep the system running in optimal condition.

167. Local contractor offers this option to customers with a value-added basis of understanding and rectifications, warranty issues and product replacements can be processed effectively with already established foundation of logistics, financial and resource links to the customer.

168. The O&M option shall be a separate contract and based on an agreed period. The separate contract will be provided upon request confirmation from the customer for an official agreement procedure.

169. The scope of O&M includes:

- Routine maintenance Reactive maintenance
- Fees for monitoring portal and 3G interconnection
- Cleaning as required
- Parts replacement as required

12. Scope of supply

a) General

170. Solar energy provides an autonomous and self-sufficient electrical generator over years with no other input than sunlight. Even though, to keep the performance of a solar installation at its maximum level, some periodical revisions and maintenances are mandatory.

171. Maintenance is generally realized through two different approaches. On one hand the Preventive Approach, in order to avoid deterioration of the facilities due to the normal use and, on the other hand the Corrective Actions which will deal with the unforeseen events, solving them as efficiently as possible.

172. The Work to be performed by Contractor under this proposal comprises the performance of all activities and provision of all resources necessary to complete the Operation and Maintenance of a Grid Connected Photovoltaic System in commercial operation.

173. These activities include:

- Maintenance Activities
- Rectification
- Response Time
- Spare Part Inventory
- Exclusion

b) Relevant Standards

174. Contractor shall be responsible for the completeness and consistency of all Operation and Maintenance supplies and services shall be as according to relevant standards.

175. Compliance shall be made to the latest applicable standards as listed, but not limited to, the table in below. All other applicable international and local standards shall also be taken into account.

STANDARD	DESCRIPTION OF STANDARD
SS CP5	Code of Practice for Electrical Installations
SS CP14	Code of Practice for Scaffolds
SS CP20	Code of Practice for Suspended Scaffolds
SS CP88	Code of Practice for Temporary Electrical Installations
SS 506	Occupational Safety and Health (OSH) Management Systems
SS 569	Code of Practice for Manual Handling
SS 571	Code of Practice for Energy Lockout and Tag-out
SS 601	Code of Practice for Maintenance of Grid-tied Solar Photovoltaic (PV) Power Supply System

c) Site Preliminaries

176. Pertaining to all preventive maintenance activities, the Contractor shall officially notify the client one week in advance from the scheduled date. Contractor shall coordinate directly with the end client on key access areas, duration of work and purpose of work, all subjected to the end client's facility management approval.

177. The work shall be performed no later than the scheduled date and no earlier than one (1) week of the scheduled date. Any changes due to but not limited to, site conditions, unfavorable weather, end-client's request.

178. The Contractor shall adhere to all Health, Safety and Environment protocol implemented by the owner of the site premise, which are applicable during the activities carried out. This shall also include, but not limited to:

- Safety Induction Course to be completed with the end client's HSE team, if requiredPermit-to-work system implemented by the end client
- Other aspects of compliance specific to the end client's HSE protocol
- Site Amenities
- Working hours

179. The Contractor shall undertake all responsibilities pertaining to site activities. Application for a Factory License shall be done by the Contractor subjected to the requirements of the owner of the premise.

180. All other insurance necessary for the risk in the work performed by the contractor, such as Work Injury Compensation policy.

d) Deviation from the Scope of Work

181. In the event of an anomaly in the scope of work involved which the Contractor is unable to provide, or there are deviations in the Contractor's proposal from the specifications in this document, the Contractor shall list down the deviations and exclusions clearly, including the respective valid reasons.

e) Scope of Services

i. Maintenance Activities

182. The Contractor shall perform regular maintenance on an operational Solar Photovoltaic System over the specified contracted period of time. Wherein the activities to be performed by the Contractor as according to the table below.

Table III.12: Preventive Maintenance Activities

Inspection Criteria	Remedy Action
▪ Inspection for dry spots or stain on surface of modules ▪ Visible accumulation of dust or debris of surface of Module ▪ Physical defects ▪ Record the equipotential resistance of lightning protection tapes	▪ Cleaning as required ▪ Activate replacements where required ▪ Record measurements and document in O&M checklist
▪ Check for rust or corrosion on mounting fixtures and fastening points ▪ Check for any sign of deflected, loose parts	▪ Apply coating ▪ Replace and rectify where necessary
▪ Status of operation on Inverters and for any sign of alarm ▪ Observe and record any abnormal voltage and current measurements ▪ Possible clogging on ventilation (for forced cooling concepts) at the fans ▪ Physical defects on Inverters	▪ Analyze root cause and restore operational status ▪ Activate replacements or servicing where required Cleaning of vents where applicable
▪ Status of DC Surge Protection indicators ▪ Status of DC Fuse, Circuit Breakers and Isolators (if applicable)	▪ Activate replacement where required ▪ Analyze root cause and ▪ restore operational status
▪ Status of AC Circuit Breakers Functional status of Earth Fault Protection Devices and Metering Devices	▪ Activate replacement where required ▪ Analyze root cause and restore operational status
▪ Outdoor field sensors are not displaced from their respective locations ▪ Functional status of Data Loggers, Routers and associated Wiring	▪ Activate replacement where required ▪ Analyze root cause and restore

Inspection Criteria	Remedy Action
	▪ operational status
▪ Internet connectivity	

183. A list of completed Solar Photovoltaic Systems in the form of an excel spreadsheet shall be maintained. The content of the spreadsheet is listed below.

184. The content of information shared between owner and the Contractor in the excel spreadsheet shall be as follows:

- Name of client and respective contact person and contact number or email
- Name of Solar Photovoltaic System and respective site address
- Scheduled date of preventive maintenance
- Archive of reactive and preventive maintenance services performed
- Template of preventive maintenance checklist
- Inventory of spare parts available on end client's site, REC or Contractor
- Payment schedule from REC to the Contractor

185. It shall be the Contractor's responsibility to update items 4 and 6 in proactively.

186. The Contractor shall have obligations to provide the service on all days, including weekends and public holidays, wherein each day the working hours shall be from 0800 hours to 1800 hours.

f) Scope of Rectification

187. The Contractor and the owner of the premise shall report all fault observations prior to rectifications. Depending on the nature of the fault, the proposed solution to rectify the system may be either from the Contractor. Regardless of the source, the actual task of rectification shall fall under the Contractor's responsibility.

188. When replacement of equipment is necessary, the Contractor shall replace defective equipment with new equipment of equal specifications. The specifications of the new equipment shall also be verified with owner and the task may only proceed after acceptance.

189. All cost involved in the work force required to perform rectifications shall be covered by the Contractor. Exceptions to the cost coverage shall be only allowed on a mutually agreed basis if upon investigation or an RCA is done, the fault is found to be caused by the actions of other parties due to unauthorized modifications to the system, negligence, or criminal intention.

190. Any rectification work that upon completing the task requires a re-commissioning test, the Contractor shall cover all fees payable to third party services, for example, the Licensed Electrical Worker fees if necessary.

191. Subject to the warranty period of Inverters, the Contractor may request owner to activate the warranty terms of a faulty Inverter if applicable. Owner shall process the exchange request under warranty, while the Contractor shall bear all other expenses to expedite the replacement.

192. In the event that the warranty of the Inverter has expired, the Contractor shall procure the necessary replacement Inverter from the vendor.

g) Response Time

193. The following table is the expected period allowed for response from the Contractor categorized by the nature of the fault that occurs.

Nature of Fault	Response Time
Activation upon detection of fault and conducting on-site Analysis	Within 2 hours
After On-Site Analysis	Target Time to Resolve
Minor fault where system can be restored without requiring any replacement of parts	Within 24 Hours
Minor fault where system can be restored when any replacement of parts is required	Within 48 Hours
Major fault where system cannot be restored within 48 Hours	Within 96 Hours

194. Faults are considered major when one of the following conditions is present:

- The fault has caused a period of downtime on part or whole of the system for more than 48 hours
- The fault has caused a possibility or risk to human life or property
- The fault has caused a disruption to the operational loads of the premise, such as a power failure

13. Annual O&M Cost

195. According to the situation of this project, the power plant with the power capacity of 8MWAC (10MWDC) is suggested to arrange a local staff to carry out routine maintenance, including equipment and system operation. We also suggest that during the rainy season cleaning is not necessary, while in non- rainy seasons solar panels should be washed every 3 months. In addition, it is considered that spare parts of equipment, mainly photovoltaic panels, take the proportion of 0.2%. Daily maintenance is enough.

196. Based on past experience, the daily maintenance cost is mainly composed of human and equipment spare parts, and regular equipment maintenance costs, the labour costs are about 672000 BDT per year, the equipment maintenance cost is about $10000 840000 BDT one year, as to other daily expenses, about 1680000 BDT operation and maintenance costs annual.

14. Recommended Cleaning Process

197. There are mainly four methods to clean the PV modules, which are manual cleaning, high-pressure water jet cleaning, spray system cleaning and professional equipment cleaning.

198. The manual-cleaning method is widely utilized in the maintain process of PV power plant. Its advantages are low water consumption and cost, while the disadvantages are large number of employees, management difficulty, poor consistency of the cleaning results, low efficiency and possible damage of the PV modules. It is expected that one employee is able to clean PV modules of 100 m2 of modules per day. According to the general layout plan, there are 33396 PV modules in the project, the total cleaning-area of which is about 54663 m2. It means that 80 people are needed to finish the cleaning work in a week. It is estimated that the labour cost is approximately 840 BDT per day. Hence, the total labour cost of cleaning PV modules is approximately 3234000 BDT for the project.

199. The effect of high-pressure water jet cleaning is better; however, there is a large water consumption, which means that much more water is needed than the manual-cleaning method. 10 tons of water should be provided to wash PV panels of 1MW. On the other hand, high water press may cause cracks of PV panels. The cost of water transporting vehicles, drivers and water piles will definitely increase the upfront investment.

200. For spray system cleaning, labour is not necessary. What is more, cleaning speed will be dramatically improved. However, the effect is not manual cleaning or high-pressure water jet cleaning. Large water consumption cannot be neglected, either. 6 tons of water is needed

for PV modules of 1 MW. Investment of $0.03-$0.04 for 1W will be added due to the spray system.

201. There is no doubt that professional equipment cleaning has an amazing speed and effect of cleaning. Water consumption is not as large as high-pressure water jet cleaning or spray system cleaning. However, this kind of measure is suitable to plain site, and requires operation under the direction of the professional. The relevant fee is undoubtedly high. But cost difference still exists due to various kinds of equipment.

202. Cost, local condition and effect to the project are all taken into comprehensive consideration. Then the final decision is that recommended cleaning process is manual cleaning due to the low cost.

203. Since Bangladesh has a humid and rainy weather, it is suggested that PV panels don't have to be cleaned in rainy season, while in the other period of a year cleaning process should be conducted at least once. Employees wash the PV modules with mop and bucket from a PV string to another. Water can be obtained from the nearest source.

E. Construction of Transmission Line

204. The first step in constructing the transmission lines is conducting a survey of the probable route. A topographical survey is often carried out along the selected route to assess the need for ground modification and/or preparation. Towers are erected along the selected route at designated intervals. Finally, after completion of construction works, checking, testing and commissioning of the transmission lines are carried out. The following specific activities need to be considered for assessing environmental impacts during construction phase of 33 kV transmission lines.

- Route survey for finalizing alignment of transmission line;
- Mobilization of material and equipment, including procurement of towers components, conductor and line materials;
- Construction of transmissions lines including erection of the towers;
- Clearing of right of way by cutting/trimming trees where necessary (following figure III.4);
- Stringing of conductor and earth wire after fixing clamps, insulators; and
- Checking, testing and commissioning of transmission lines.

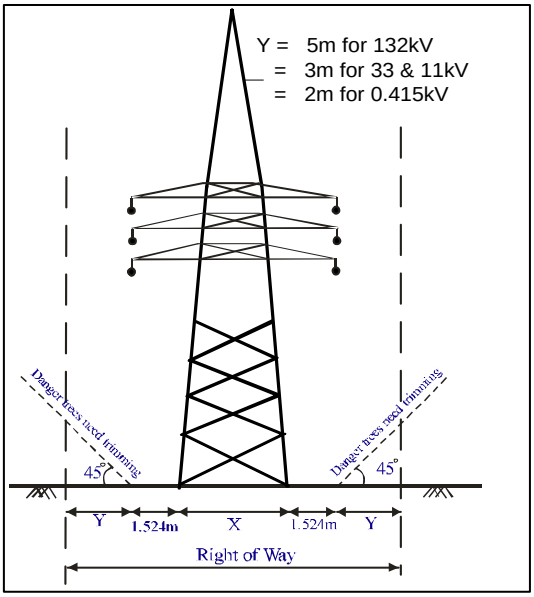


Figure III.4: Pictorial Guidelines for Trimming Trees

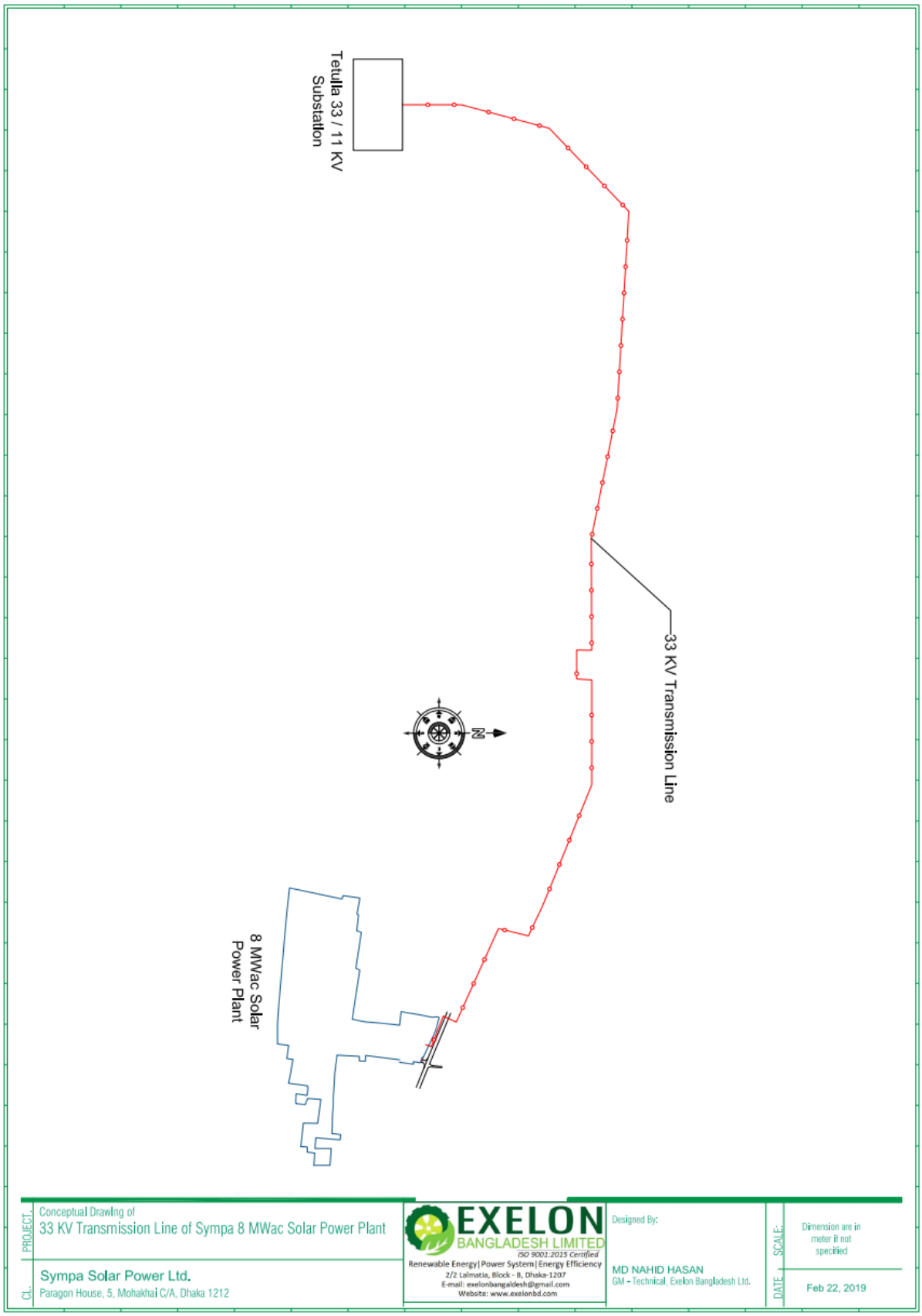


Figure III.5: Route Map of the Proposed Transmission Line

205. Transmission lines are sets of wires, called conductors, that carry high voltage electric power from station to station in our system. They run over long distances across the villages.

Conductors are connected to large metal towers that are placed on public and private properties along a transmission line route.

206. The use a transmission line routing process that's based on an internationally recognized methodology. The process has been used on over all transmission lines in Bangladesh. The process:

- ✓ incorporates routing preferences from human, environmental and engineering perspectives;
- ✓ uses these perspectives to help minimize overall impact of the project.

207. There are some steps to selecting a transmission line route

- ❖ **Determine a route planning area:** Determine the start and end points and develop a broad route-planning area based on opportunities and constraints on the landscape.
- ❖ **Plan alternative routes:** Draw segments connecting the start and end points within the route-planning area. These segments form alternative route options which we present to the public, stakeholder groups, Indigenous communities and organizations, and to a team of specialists (biologists, agricultural, engineers, heritage, etc.) for feedback.
- ❖ **Collect and incorporate public and Indigenous feedback throughout the transmission line route selection process:**
    - During the decision-making process, document site-specific issues and feedback from those potentially affected by a possible route. Pass this compiled information to relevant specialists to help them enhance their assessments of a preferred route.
    - Local feedback and knowledge of the environment help us design the route and plan tower placement.
    - Feedback received may require the development of mitigative segments which will be considered by the project team.
    - Information we collect helps us determine ways to mitigate potential impact on people, wildlife and the environment.
- ❖ **Develop mitigative segments**: A mitigative segment is a part of the route which added to the transmission line routing process based on feedback from the public or from our project specialists. These segments are added to mitigate concerns or a potential effect on the landscape.
    - o Evaluate these segments for technical feasibility and cost. Also consider whether the segment results in a "net-minimization of effect", which means evaluate whether or not the segment will shift effect from one landowner to another. If evaluations deem the new segments are reasonable, they are then incorporated in the comparative evaluation of routes to determine a preferred route.
- ❖ **Determine a preferred route**: A comparative evaluation of alternative routes determines the preferred route that will be presented to the public and Indigenous communities and organizations. All specialists focus their evaluations on this area to better understand potential effects of the preferred route on people and the environment. Once determined a subset of routes to select a preferred route, compare the options for:
    - costs;
    - community considerations;
    - reliability;
    - risk to schedule;
    - built environment and the natural environment.

- **Finalize the preferred route and submit an environmental assessment report**: Following finalization of the preferred route, consider potential changes based on feedback from the public, Indigenous communities and organizations, and project specialists. After incorporating feedback, determine a final preferred route and present it to regulators for review.
    - During the regulatory review process with DoE, provide details regarding transmission line routing and the environmental impact statement is available for review and comment.

208. Throughout each step of the transmission line route selection process are regularly planning, gathering feedback, analyzing information, and evaluating. Feedback from stakeholders assists in the development of criteria used to evaluate strengths and weaknesses of route options. Criteria are developed to represent the natural, the human and engineering perspectives, i.e.:

- Natural environment: acres of natural forest, acres of wetland area, stream and river crossings;
- Engineering: project cost, existing transmission line crossings, length;
- Human environment: proximity to residences, land use and capability, historic resources, public use areas.

209. The team work with a range of environmental, socio-economic and technical specialists. The team strive to balance concerns and feedback from the public, project specialists, stakeholder groups, and indigenous communities and organizations. The project goal is to achieve consensus amongst a project team (with a range of specialties) on the final preferred route of a transmission line.

IV. ANALYSIS OF ALTERNATIVES

A. General

210. An ESIA 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 ESIA 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.

211. 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 ESIA 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.

212. 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 ESIA 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.

B. Do Nothing

213. 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 both to 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 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.

C. Alternative Energy Generation Technology

214. 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. Wind energy provides several benefits, including, but not limited to the following:

- Wind is a renewable and infinite resource.
- The generation of wind energy does not produce any air emissions, including carbon dioxide (GHG).
- Although wind energy requires a significant upfront capital investment, it is a free resource after the capital cost of installation (excluding maintenance).
- In addition, energy production from wind power would not require the significant water usage associated with coal, nuclear, and combined-cycle sources.

215. Commercial wind farms typically use three-bladed turbines that range in size from 300 feet up to 500 feet in height, with blades of 150 feet in length that are pointed into the wind by computer-controlled motors. The wind farm would consist of a group of wind turbines placed where sufficient, consistent wind resources exist, and electrical power transmission infrastructure is located. The individual turbines would be interconnected with a medium-voltage power collection system and a communications network. Similar to solar energy production facilities, wind energy production facilities also require substations, which would increase the medium-voltage electrical current through a transformer before connection to the high-voltage transmission system. Compared with traditional energy sources, the environmental effects of wind power are relatively minor.

216. Unlike the proposed project, wind turbines would have the potential to affect avian species in the local area. The development of wind farms would also typically result in greater adverse aesthetics impacts due to the height of the turbines. Agriculture resources would also still be impacted by the presence of wind turbines and associated facilities. Additionally, wind energy production facilities do not reduce short-term construction-related air quality emissions.

217. 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 to relatively low wind speeds and directionality sufficient to drive wind turbines. No significant facilities have been developed in the project vicinity due to the lack of adequate wind resources.

218. As noted above, alternatives may be eliminated from detailed consideration in an ESIA if they fail to meet most of the project objectives, are infeasible, or do not avoid or substantially reduce any significant environmental effects. Therefore, this alternative was eliminated from further consideration because:

- It would result in additional/greater impacts than the proposed project (aesthetics and biological resources);
- It would not substantially reduce the significant environmental impacts associated with aesthetics, agriculture resources, air quality and biological resources;
- It would fail to meet the objectives for the proposed project; and
- The project site is not suited for wind energy production; therefore, a wind energy production facility would not generate as much electricity as solar equipment.
- Wind energy is uncommon in Bangladesh and the production material is not available.

D. Alternative Land Use

219. The land which is being used for the project is owned by the Project Authority. The land is inside the project boundary. As well as it is just beside the roadside, this makes it suitable for the transmission line establishment. The land is currently an open space that is sometimes used as playing ground. If we consider any other alternative land use like water

body or agricultural land outside the factory boundary, the Project authority had to purchase the land from the owner. As well as, the agricultural land would have been ruined. Therefore, the current used land is the best possible land for the project.

E. Alternative Site

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

221. Looking for the land 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 is also worth noting that the said project is already underway in terms of seeking development approvals in various government departments.

222. 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.

V. DESCRIPTION OF ENVIRONMENT & SOCIAL BASELINE

A. Physical Environment

1. Climate

223. Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass (Rashid, 1991).

224. Brammer (Brammer, 1996) has identified four distinct seasons resulting from this weather pattern, namely:

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

225. Despite the general predictability of the seasons in Bangladesh, local conditions may still vary widely across the country. As such, Bangladesh can be divided into seven climactic sub-zones based on differences in a range of factors including rainfall, temperature, evapotranspiration and local seasonality (Rashid, 1991). Figure V.1 shows that the Project Area is located within the Northern part of the Northern region.

226. **Northern part of the northern region:** This is an area of extremes. In summer, the mean maximum temperature is well above 32°C whereas in winter the mean minimum is below 10°C. The summer is dry, with a scorching westerly wind, but the rainy season is very wet, with 2,000 to 3,000 mm of rainfall.

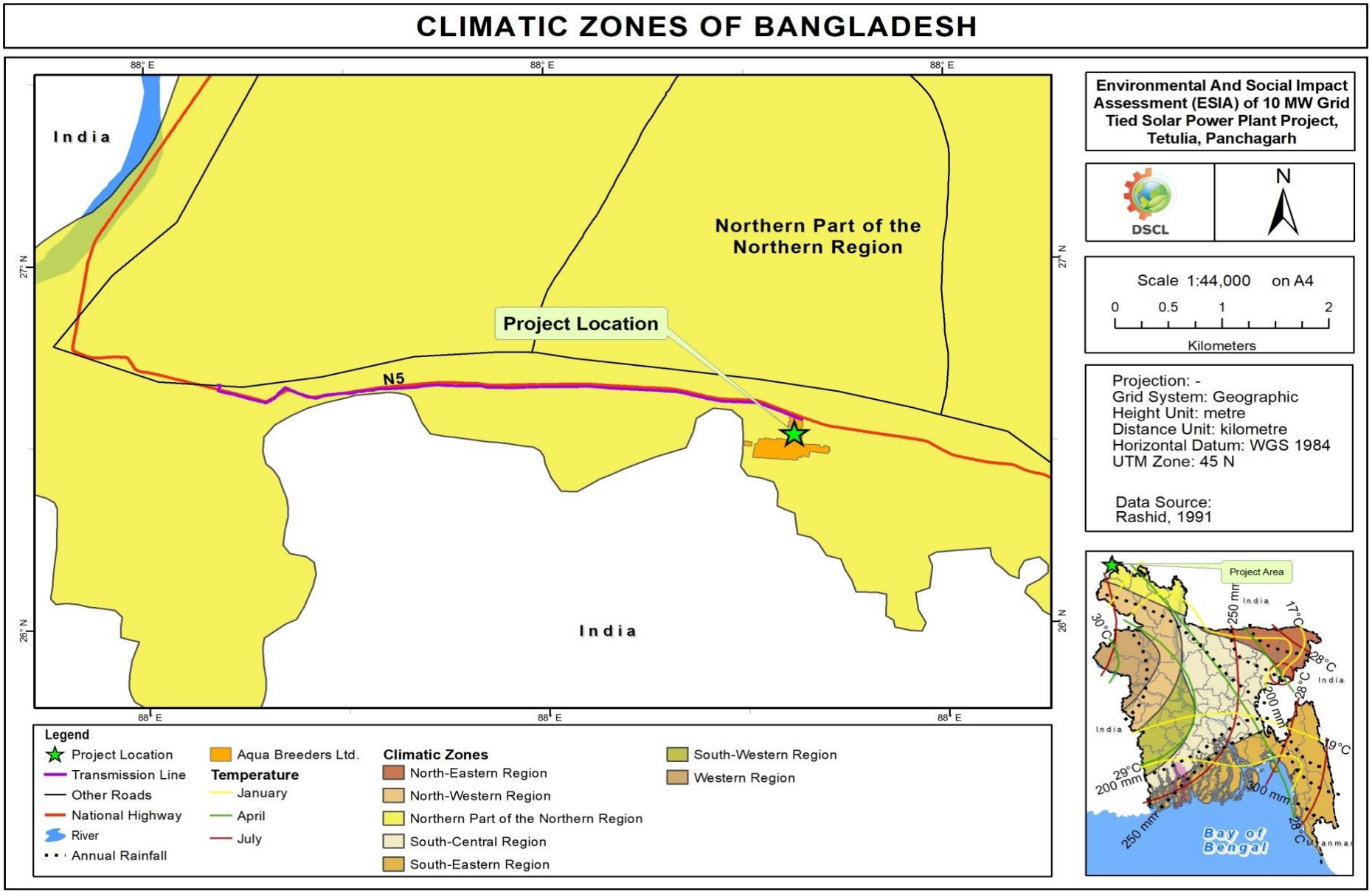
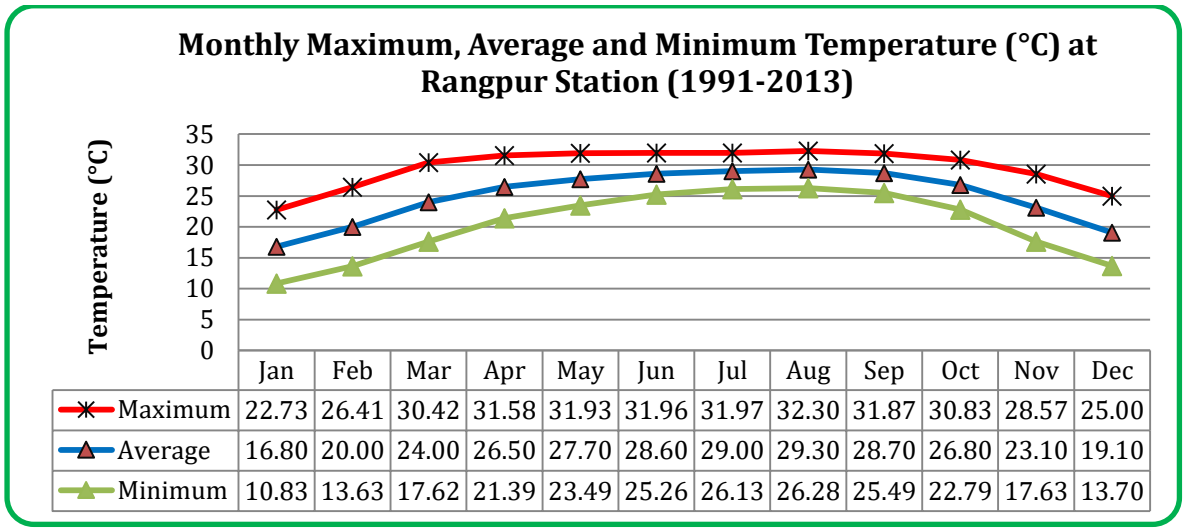


Figure V.1: Climatic Zones of Bangladesh

a) Temperature

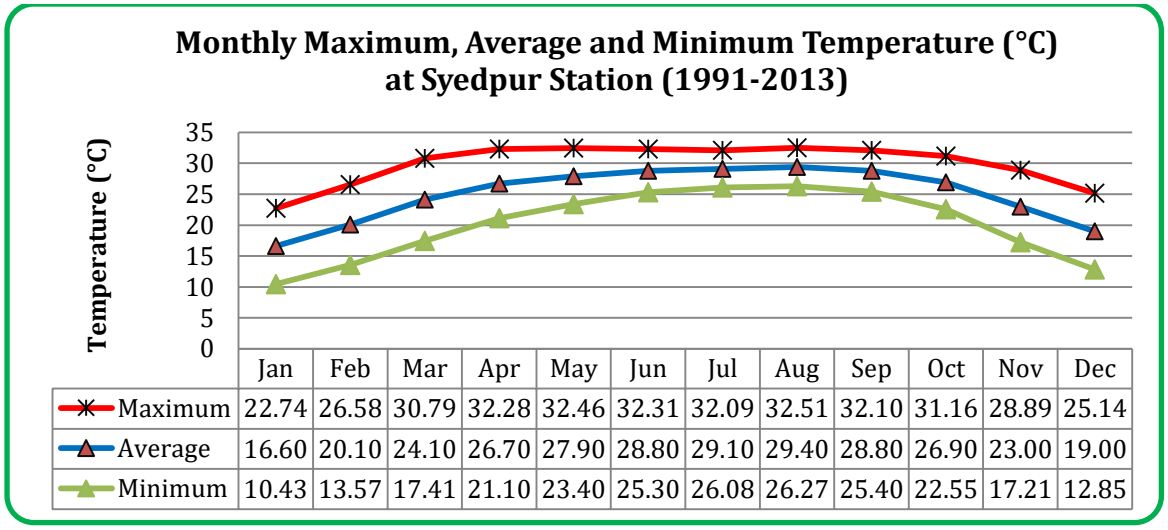
227. The study area is in Panchagarh and this area is near to Rangpur and Syedpur meteorological stations. The monsoon starts in April or May and continues until September to October. During the monsoon, the temperature varies between 30.83°C and 32.30°C. The temperature falls below 11°C in winter that is spread over December and January and may well include November and February. The highest temperature is felt during August when the temperature may be as high as 32.30°C. These values of temperature are derived from the temperature data from 1991 to 2013 of Bangladesh Agricultural Research Council. Figure V.2 shows the variation of maximum, average and minimum temperature of Rangpur station that can represent the temperature of the study area.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	22.73	26.41	30.42	31.58	31.93	31.96	31.97	32.30	31.87	30.83	28.57	25.00
Average	16.80	20.00	24.00	26.50	27.70	28.60	29.00	29.30	28.70	26.80	23.10	19.10
Minimum	10.83	13.63	17.62	21.39	23.49	25.26	26.13	26.28	25.49	22.79	17.63	13.70

Figure V.2: Variation of Monthly Surface Air Temperature of Rangpur Station

228. In Syedpur, the maximum temperature occurs in August, which is 32.5°C; January is the coldest month, with temperatures averaging 10.4°C (Figure V.3).



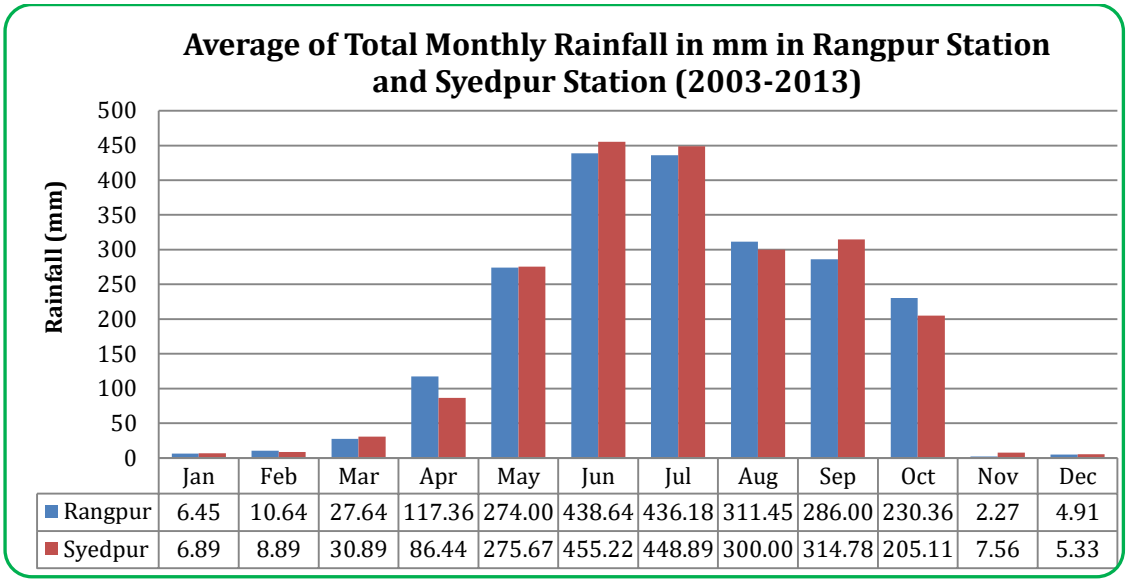
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum	22.74	26.58	30.79	32.28	32.46	32.31	32.09	32.51	32.10	31.16	28.89	25.14
Average	16.60	20.10	24.10	26.70	27.90	28.80	29.10	29.40	28.80	26.90	23.00	19.00
Minimum	10.43	13.57	17.41	21.10	23.40	25.30	26.08	26.27	25.40	22.55	17.21	12.85

Figure V.3: Variation of Monthly Surface Air Temperature of Syedpur Station

b) Precipitation

229. Figure V.4 represents the Monthly accumulated rainfall at Rangpur and Syedpur station. The monsoon starts in May or June and continues until August to September in both of the stations. The maximum monthly rainfall during May to September varies from 274 mm to 438mm in the Rangpur station. At Syedpur station, the precipitation is the lowest in

December, with an average of 5.33 mm. and the maximum falls in June, averaging 455.22 mm.

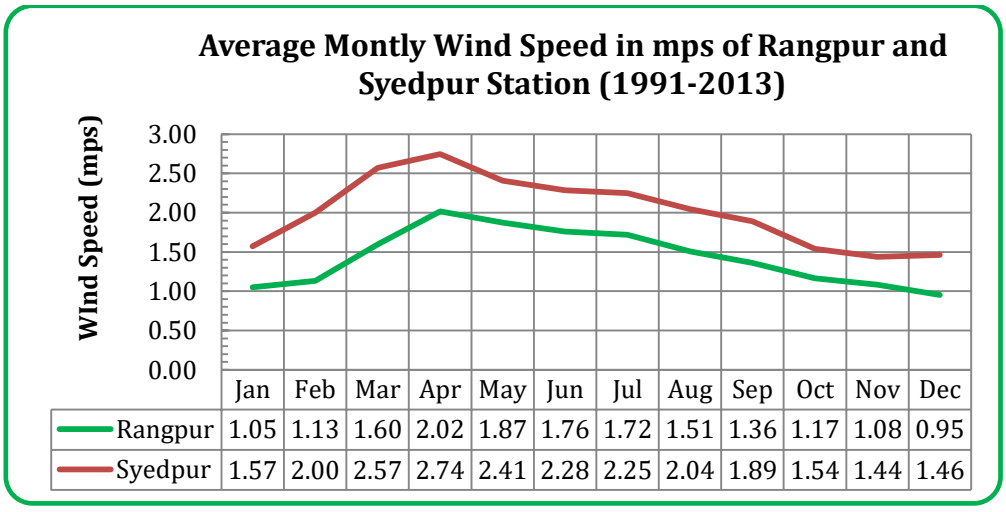


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rangpur	6.45	10.64	27.64	117.36	274.00	438.64	436.18	311.45	286.00	230.36	2.27	4.91
Syedpur	6.89	8.89	30.89	86.44	275.67	455.22	448.89	300.00	314.78	205.11	7.56	5.33

Figure V.4: Average Monthly Accumulated Rainfall at Rangpur and Syedpur Station

c) Wind Speed

230. Figure V.5 shows the average wind speed from 1991 to 2013 at Rangpur and Syedpur station. Wind speed in the study area represents seasonal variation between the dry season (October to January) and the monsoon season (April to August) in both of the stations. During the month of October to January, the wind speed shows lower value. In this season, it shows 0.95 to 1.17 ms-1 wind speed and in the month of April to July the wind speed shows 1.72 to 2.02 ms-1 in Rangpur station. In Syedpur the maximum wind speed shows up to 2.74 ms-1 speed and the lowest speed shows 1.44 ms-1.



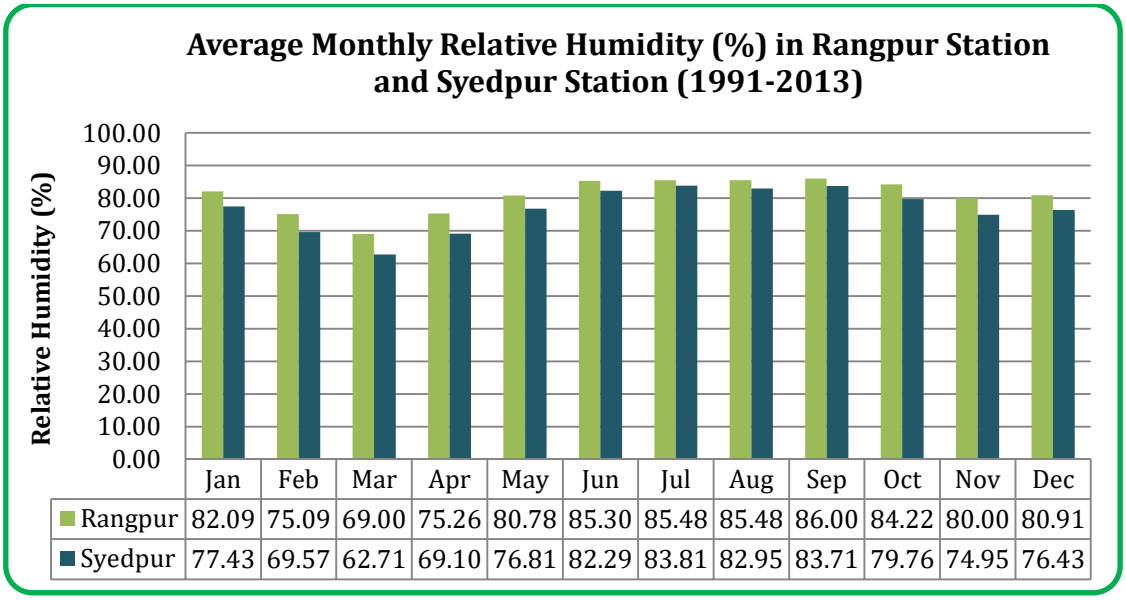
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rangpur	1.05	1.13	1.60	2.02	1.87	1.76	1.72	1.51	1.36	1.17	1.08	0.95
Syedpur	1.57	2.00	2.57	2.74	2.41	2.28	2.25	2.04	1.89	1.54	1.44	1.46

Figure V.5: Average Monthly Wind Speed at Rangpur and Syedpur Station

d) Humidity

231. Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1991 to 2013 in Rangpur and Syedpur station indicates that humidity maximized from May to September in a year for both the stations. In Rangpur station, it ranges from 80% to 86% and in Syedpur station, it ranges from 76% to 84%. On the other

hand, humidity falls 69% in February, March and April during the winter season in the Rangpur station and in Syedpur station in the above months' humidity falls 62%. (Figure V.6).

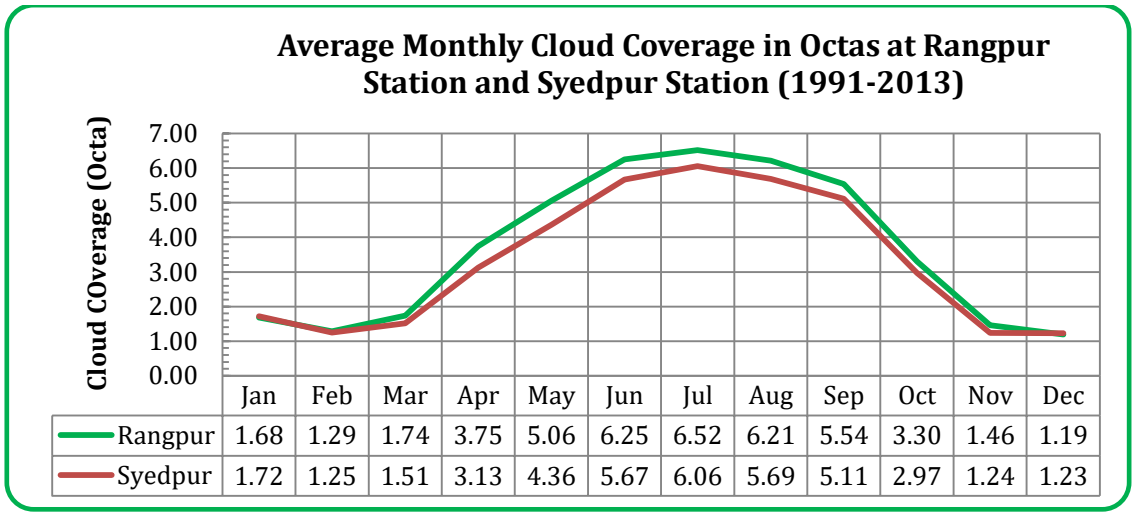


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rangpur	82.09	75.09	69.00	75.26	80.78	85.30	85.48	85.48	86.00	84.22	80.00	80.91
Syedpur	77.43	69.57	62.71	69.10	76.81	82.29	83.81	82.95	83.71	79.76	74.95	76.43

Figure V.6: Average Monthly Relative Humidity in Rangpur and Syedpur Station

e) Cloud Coverage

232. Figure V.7 shows the average monthly cloud coverage of Rangpur and Syedpur Station. From the figure, it is seen that, the cloud coverage of both the stations increase from June to September. The value varies within 5.54 octas to 6.52octas in Rangpur station and varies within 5.11 octas to 6.06 octas in Syedpur station. The lowest value falls in November to February within the range of 1.29 octas to 1.68octas in Rangpur and 1.23 to 1.72 in Syedpur.

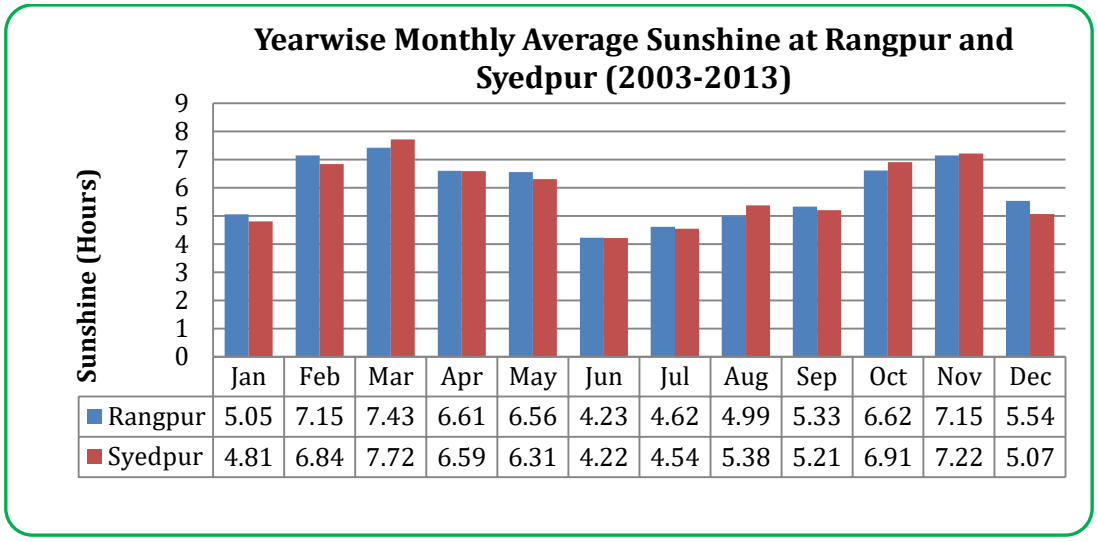


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rangpur	1.68	1.29	1.74	3.75	5.06	6.25	6.52	6.21	5.54	3.30	1.46	1.19
Syedpur	1.72	1.25	1.51	3.13	4.36	5.67	6.06	5.69	5.11	2.97	1.24	1.23

Figure V.7: Average Monthly Cloud Coverage in Rangpur and Syedpur Station

f) Bright Sunshine

233. The Year-Wise Monthly Average Sunshine Hours data (2003-2013) for Rangpur and Syedpur stations are showed below. From the graphs, it is seen, in Rangpur station the highest sunshine occurred on the month of March and the lowest value was got on the month of June. The data for Syedpur Station show that, the sunshine hours were highest on the month of March and lowest on the month of June.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rangpur	5.05	7.15	7.43	6.61	6.56	4.23	4.62	4.99	5.33	6.62	7.15	5.54
Syedpur	4.81	6.84	7.72	6.59	6.31	4.22	4.54	5.38	5.21	6.91	7.22	5.07

Figure V.8: Average Monthly Sunshine in Rangpur and Syedpur Station

g) Solar Radiation

234. The monthly solar radiation is estimated using GIS for the project area. The Figure V.9 shows the average monthly solar radiation in a year at the proposed project location.

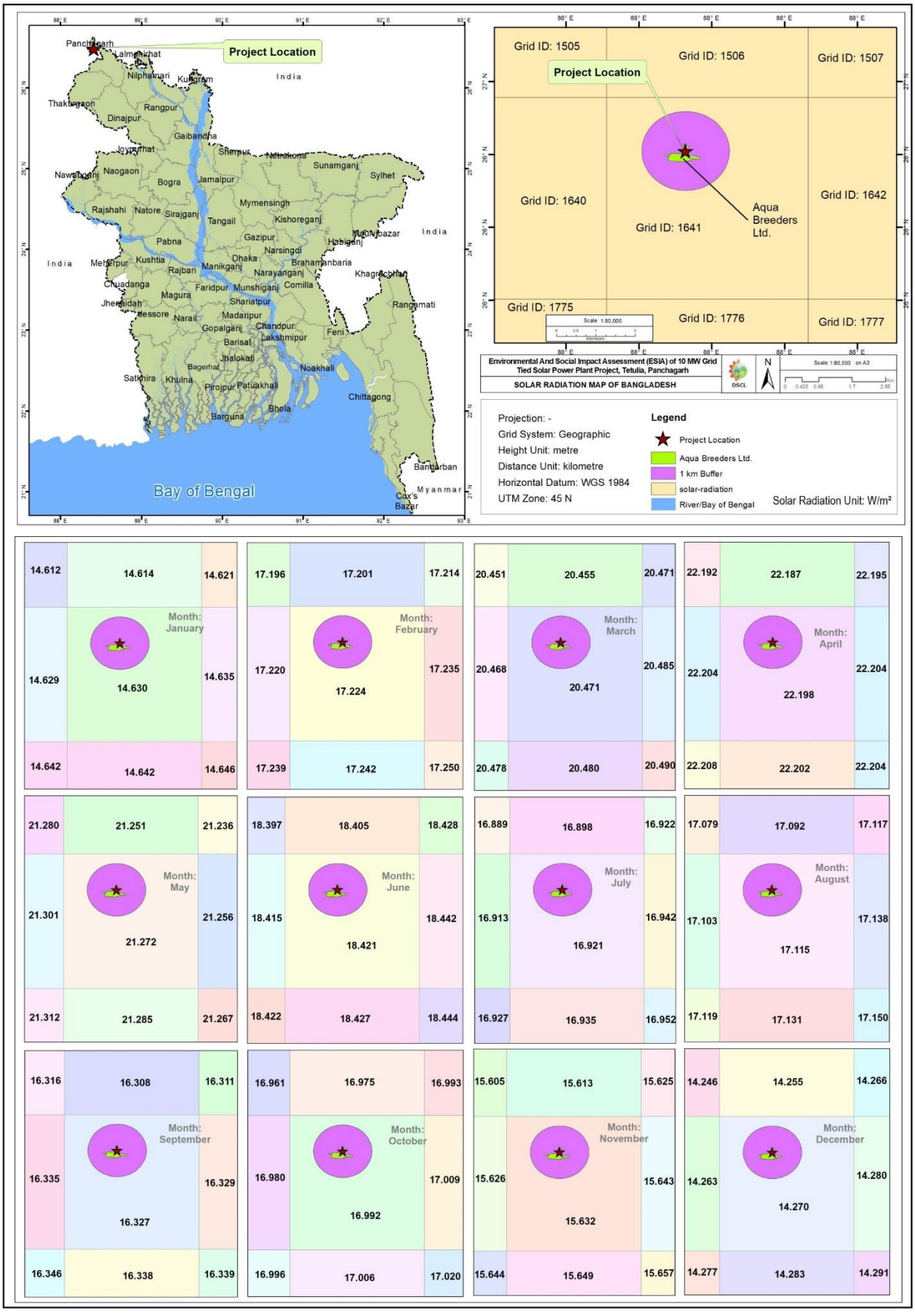


Figure V.9: Average Monthly Solar Radiation at Project Area

2. Ambient Air Quality

235. 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. The project area is predominantly a rural settlement where main air pollution source is the household biomass combustion. Additionally, the national highway runs beside the project location where heavy vehicles move every day. Since, one of the major land ports, Banglabandha Land Port is situated few kilometers far from the project site thus significant number of passengers and heavy goods vehicles move daily. This is a major source of air pollution in the project area.

Figure V.10: Air Quality Monitoring at Project Site

236. 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 Solar Power Plant air quality. Air quality test has been conducted on 16th-17th March 2018 at the proposed project site and the test was analyzed by DSCL Environmental Laboratory. The test results (see Appendix D) are given in the below Table V.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; any of the measured parameter of the local ambient air does not exceed Bangladesh standard.

Table V.1: Test Results of Ambient Air Quality Analysis

Parameter	Unit	AAQ_01 26.48413°N 88.41072°E	AAQ_02 26.48859°N 88.38705°E	AAQ_03 26.48205°N 88.40876°E	AAQ_04 26.48731°N 88.41187°E	Bangladesh Standard**	WHO AQGs***	Duration (hours)	Weather Condition	Method of Analysis
$PM_{2.5}$	µg/m³	31.49	33.56	30.64	29.78	65	25	24	Sunny	Gravimetric
PM_{10}	µg/m³	86.20	88.13	83.35	89.43	150	50	24		Gravimetric
SPM	µg/m³	108.55	111.86	102.97	106.69	200	NF	24		Gravimetric
SO_2	µg/m³	8.25	10.22	09.45	12.26	365	20	24		West- Geake
NOx	µg/m³	11.60	9.16	12.24	10.51	100	40	Annual		Jacob and Hochheiser
CO*	ppm	<1	<1	<1	<1	10	10	8		CO Meter

* 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 19thJuly 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 - 25.11302°N, Longitude - 89.65751°E

Abbreviation: *$PM_{2.5}$ - Fine Particulate Matter, PM_{10} - Respirable Dust Content, SPM - Suspended Particulate Matter, SO_2 - Sulphur Di-oxide, NO_X - Oxides of Nitrogen, CO - Carbon Monoxide, µg/m3 - microgram/cubic meter, ppm - parts per million.*

237. **SPM:** Atmospheric particulate matter, also known as particulate matter (PM) or particulates, or suspended particulate matter (SPM) are microscopic solid or liquid matter suspended in Earth's atmosphere. The term aerosol commonly refers to the particulate/air mixture, as opposed to the particulate matter alone. Sources of particulate matter can be natural or anthropogenic. They have impacts on climate and precipitation that adversely affect human health. The above table shows that, for all the locations, SPM values did not exceed the national standard because this is under rural area and it consists low pollution of air and low traffic volume.

238. **$PM_{2.5}$:** $PM_{2.5}$ are 2.5 micrometers in diameter or smaller, and can only be seen with an electron microscope. Fine particles are produced from all types of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and some industrial processes. The test results show that for all the locations the values did not exceeded the national standard because of rural area.

239. **PM_{10}:** Particle pollution, also called particulate matter or PM, is a mixture of solids and liquid droplets floating in the air. Some particles are released directly from a specific source, while others form in complicated chemical reactions in the atmosphere.PM_{10} are 2.5 to 10 micrometers in diameter. Sources include crushing or grinding operations and dust stirred up by vehicles on roads. From the above table of test results, it is seen that, the PM10 value did not exceeded the national Standard. The Highway Road adjacent the project site possesses the highest concentration of PM_{10} values than other location because of the amount of dust and high traffic volume.

240. **SO_X:** Sulfur oxides (SO_X) are compounds of sulfur and oxygen molecules. Sulfur dioxide (SO_2) is the pre-dominant form found in the lower atmosphere. It is a colorless gas that can be detected by taste and smell in the range of 1,000 to 3,000 micrograms per cubic meter ($\mu g/m^3$). From the test results it can be said that, for all the locations, the value was within the national standard. But the Kagigach village possess highest concentration of SO_X value because this is rural village.

241. **NOx:** In atmospheric chemistry, NOx is a generic term for the nitrogen oxides that are most relevant for air pollution, namely nitric oxide (NO) and nitrogen dioxide (NO_2). These gases contribute to the formation of smog and acid rain, as well as tropospheric ozone. The test results above show that, for all the locations, the value was within the national standard because this project site is situated in rural area where traffic volume is low and lower amount of dust particles are present.

242. **CO:** Carbon monoxide is a gas and is found in air. High levels of carbon monoxide are poisonous to humans and, unfortunately, it cannot be detected by humans as it has no taste or smell and cannot be seen. The main sources of additional carbon monoxide are motor vehicle exhaust and some industrial activities, such as making steel. Tobacco smoke is one of the main indoor sources of carbon monoxide. The above table shows that, for all the locations, CO was within the national standard and all of the values are less than 1 because of their Meteorological condition and lower amount of traffic volume.

3. Physiography

243. 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

244. 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 Soil Resource Development Institute (SRDI) who further refined undertook the most recent study 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).

245. The project area falls in the Old Himalayan Piedmont Plain physiographic unit (Figure V.11)

246. ***Old Himalayan Piedmont Plain*** comprises gently sloping land at the foothills with colluvial and alluvial sediments derived from the hills deposited by rivers or streams. A portion of the Old Himalayan Piedmont Plain stretches into Bangladesh at the northwestern corner of the country, which occupies the whole of Thakurgaon, and major parts of Panchagarh and Dinajpur districts. This region is covered by Piedmont sands and gravels which were deposited as alluvial fans of the Mahananda and Karatoya rivers and their distributaries issuing from the Terai area at the foot of the Himalayas. The piedmont deposits may possibly be as old as late Pleistocene or early Holocene, but they are younger than the Madhupur clay. The drainage pattern is that of a braided river, with broad, smooth, but irregular ridges crossed by numerous broad, shallow channels which frequently branch out and are again reconnected. The Teesta abandoned this landscape a long time ago, since when the area appears to have been uplifted so that small rivers crossing the plain are now entrenched up to about 6m deep (in the north; less in the south) below the main level of the plain. This plain gently slopes south from about 96m down to 33m above MSL (mean sea level).

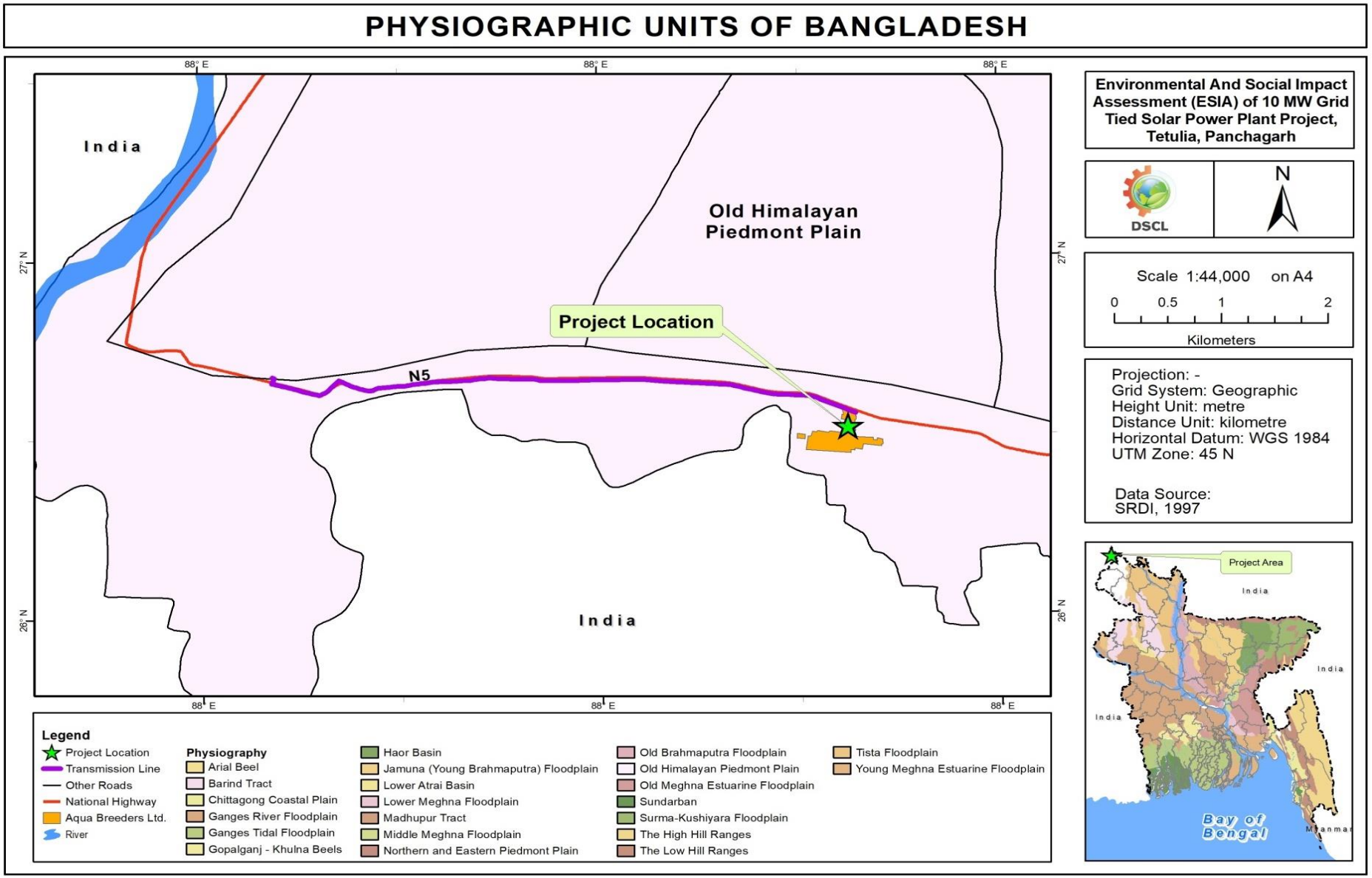


Figure V.11: Physiographic Units of Bangladesh

4. Regional and Site Topography

247. Topography configuration of a land surface including its relief and contours, the distribution of mountains and valleys, the patterns of rivers, and all other features, natural and artificial, that produce the landscape. Although Bangladesh is a small country, it has considerable topographic diversity. It has three distinctive features: (i) a broad alluvial plain subject to frequent flooding, (ii) a slightly elevated relatively older plain, and (iii) a small hill region drained by flashy rivers. On the south, a highly irregular deltaic coastline of about 600 km featured by many estuarine rivers and channels flowing into the Bay of Bengal. The alluvial plain is part of the larger plain of Bengal, which is sometimes called the Lower Gangetic Plain. Elevations of the plains are less than 10m above the sea level; elevation furthers decline to a near sea level in the coastal south.

248. The general topography of the project area is flat (Figure V.12). The topography of the specific project location is 10.85– 14.94m a.m.s.l. (Figure V.13).

Figure V.12: General Topography of the Project Area

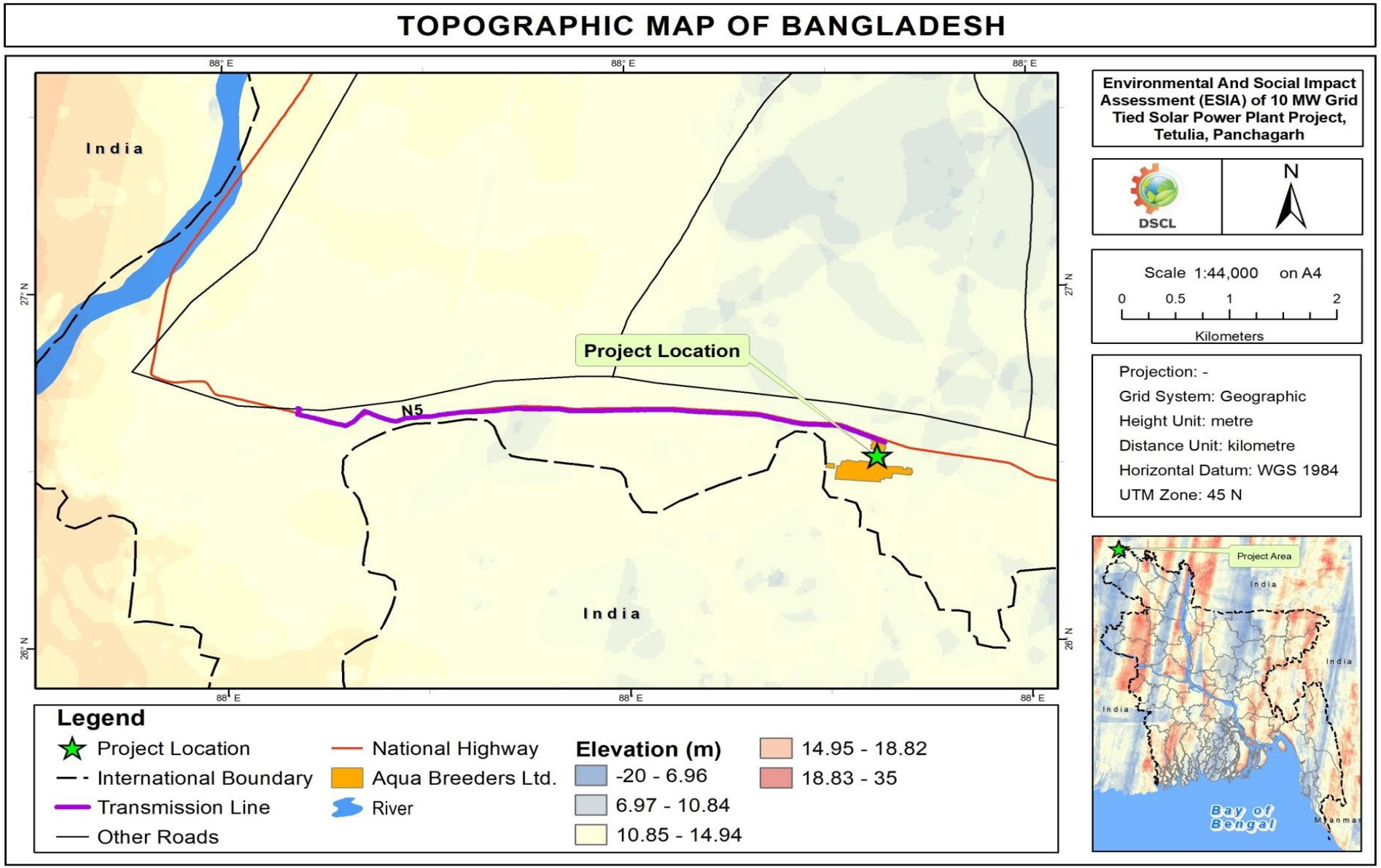


Figure V.13: Topographic Map of Bangladesh

5. Geology

249. Bangladesh is situated to the east of the Indian sub-continental plate. Nearly deltaic and alluvial deposits of the Ganges, Brahmaputra, and Meghna river systems underlie 85% of Bangladesh.

250. The project area falls in the Himalayan Foredeep (Figure V.14).

251. ***Himalayan Foredeep*** is a different tectonic domain that separates the Himalayas to the north and the peninsular India to the south. The Himalayan Foredeep, the Indo Gangetic Alluvium Plain (IGAP), is an E-W tectonic basin located along southern margin of the Himalayan fold belt. In terms of crustal nature and overlying sediments, the Himalayan foredeep widely varies from west to east. The crustal-model studies indicate that to the west of Aravalli ranges the crust is of oceanic affinity and the crust to the east of Malda-Kishenganj fault is also of oceanic nature. In the cental part, the Gangetic foredeep is underlain by continental cratonic crust over which the Vindhyyan platform sediments were deposited.

6. Soil Quality

252. The type of soil present in the project area is, Black Terai Soil. (Figure V.15)

253. ***Black Terai soils***: They Occupy the Old Himalayan Piedmont Plain. These soils have very dark grey or black topsoil at a thickness of 25 cm or more. When the dark colored topsoil is less than 90 cm thick, it is underlain by a well-oxidised cambic B-horizon. This topsoil is either mollic or umbric horizon. The texture of these soils ranges from loamy sands on the highest ridge sites to sandy loams and sandy clay loams over most of the landscape. They are either Umbric or Mollic Gleysols.

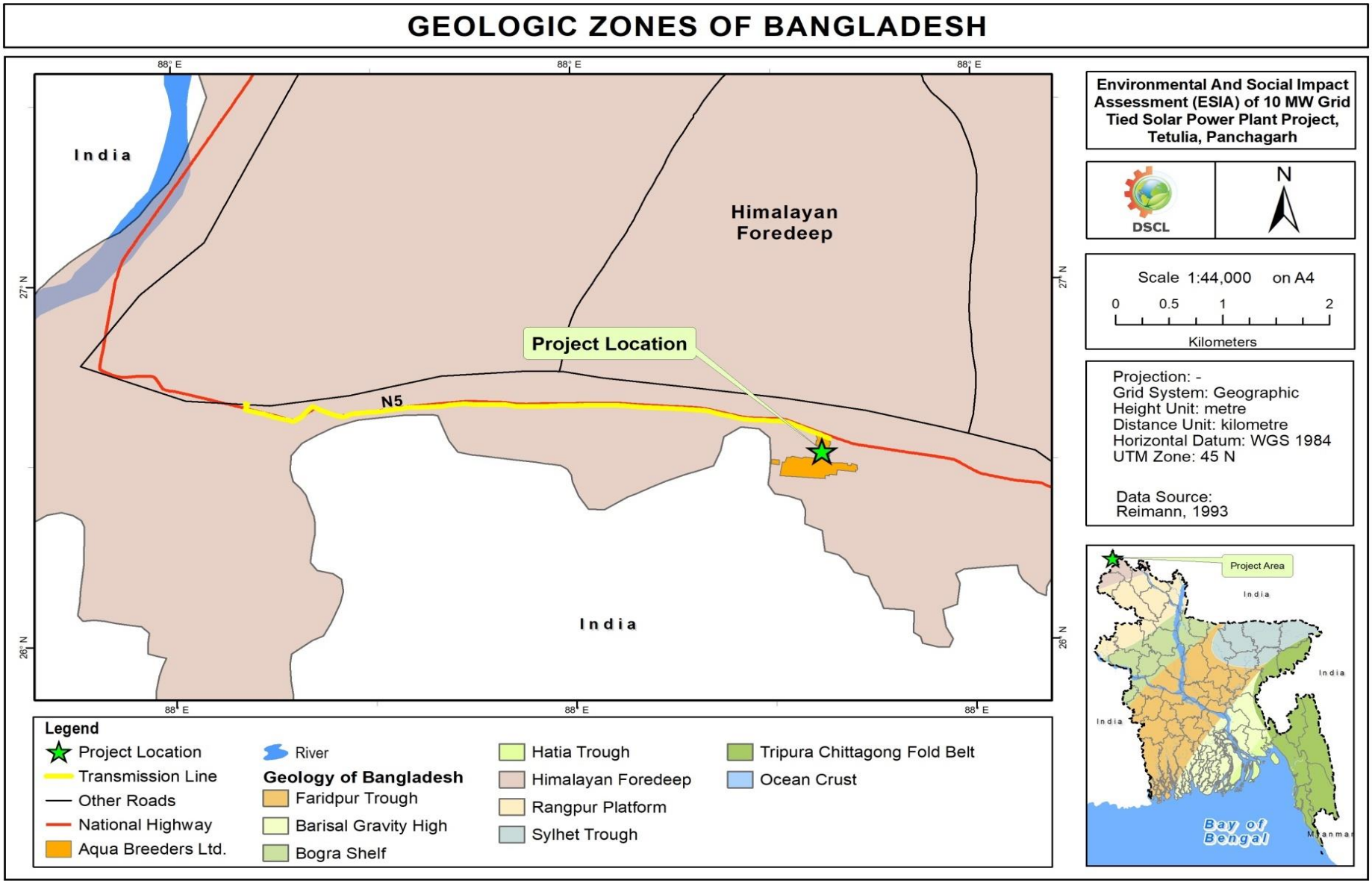


Figure V.14: Geology of Bangladesh

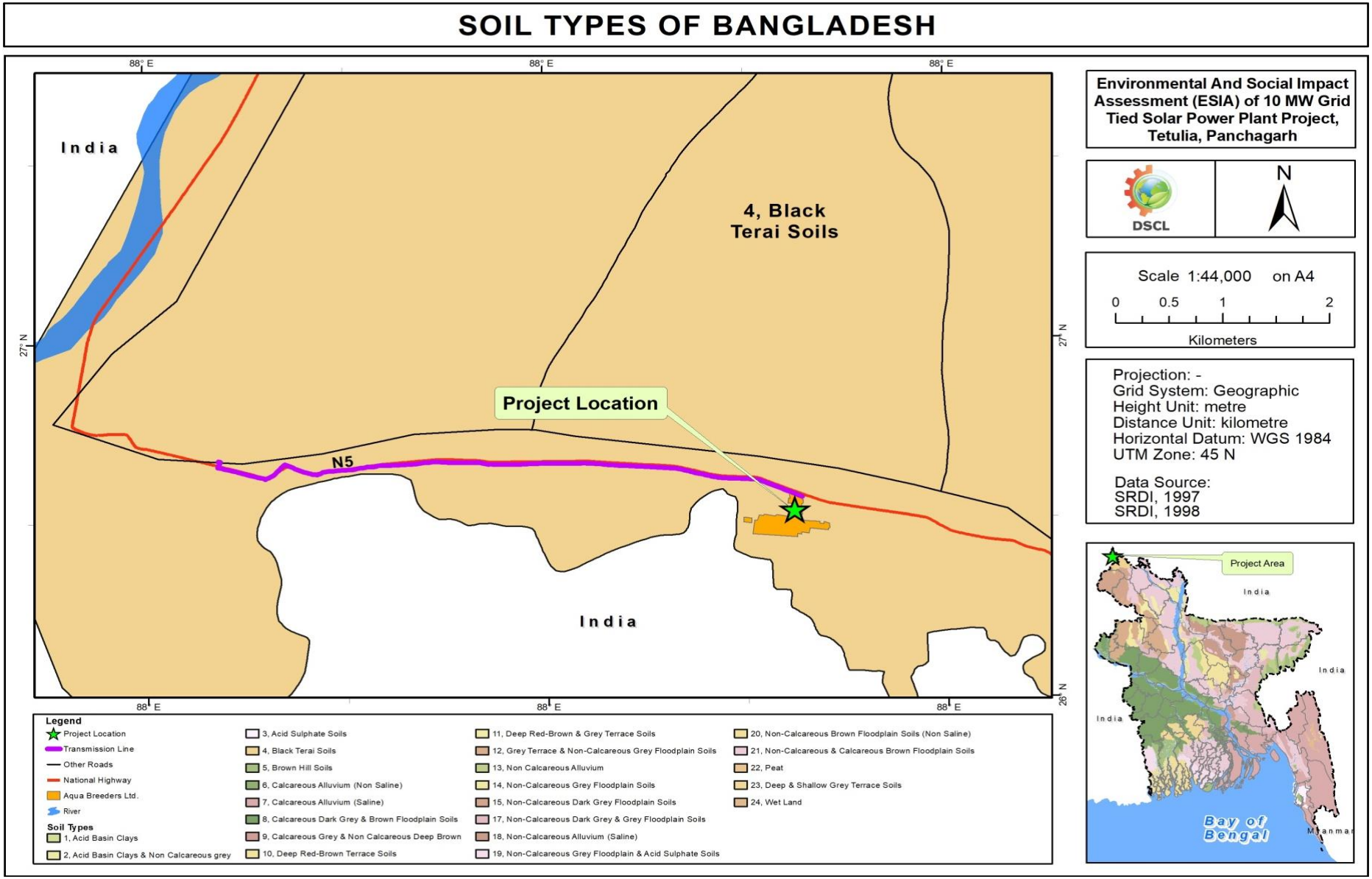


Figure V.15: Soil Type of Bangladesh

254. On 17th March, 2018 soil sample was collected from the project site. The soil sample was submitted to the laboratory of University of Dhaka for analyzing the parameters. The test results are shown in the below Table. Since there is no national standard for soil quality that's why the result is not compared also.

Figure V.16: Soil Sample Collection

Table V.2: Test Result of Soil Quality Analysis of Project Influenced Area

Parameters	Unit	Project Site	Method of Analysis
		SL_01	
		26.48413° N 88.41072° E	
pH	-	6.94	pH Meter
Electrical Conductivity (EC)	µS/cm	38.6	EC Meter
Cadmium (Cd)	mg/kg	0.328	AAS
Lead (Pb)	mg/kg	3.025	AAS
Copper (Cu)	mg/kg	22.655	AAS
Zinc (Zn)	mg/kg	52.385	AAS
Arsenic (As)	mg/kg	1.956	AAS

Source: DU Laboratory Test, April 2018

7. Agro-Ecological Zones

255. A 1988 study carried out by the United Nations Development Program (UNDP) classified Bangladesh into a series of Agro-ecological Zones (AEZs) based on an assessment of commonalities in characteristics such as physiography, soil types, climate and drainage. In total, 34 regions were identified and characterized, however this information has been updated and further refined on numerous occasions since the original study was undertaken.

256. The purpose of assessing the AEZs within the project area is to establish a broad overview of expected soil conditions that can be compared against more detailed, Upazila-level data sources.

257. The Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs completed the most recent assessment. The project area contains the below AEZ (refer Figure V.18), namely:

258. ***Old Himalayan Piedmont Plain*** (4,008 sq km) this distinctive region is developed in an old Tista alluvial fan extending from the foot of the Himalayas. It has a complex relief pattern. Deep, rapidly permeable sandy loams and sandy clay loams are predominant in this region. They are strongly acidic in topsoil and moderately acidic in subsoils; low in weatherable K minerals. Seven general soil types occur in the region, of which non-calcareous brown floodplain soils, black terai soils, and non-calcareous dark grey floodplain soils predominate. Organic matter contents are generally higher than in most floodplain soils of Bangladesh. The natural fertility of the soil is moderate but well sustained. Soil fertility problems include rapid leaching of N, K, S, Ca, Mg and B. Most of Panchagarh and Thakurgaon districts and the northwestern part of Dinajpur district are included in this zone.

Figure V.17: Agricultural Practice in the Project Area

259. A significant land of the project area is being used for tea garden. However, people cultivate sugarcane, wheat and vegetables. The sugarcane is usually planted for three years period. Wheat and vegetables are cultivated during the winter period. The main crops of the Upazilla are paddy, jute, wheat, sugarcane, potato, garlic, vegetables. The extinct or nearly extinct crops are Kaun, barley, mustard, sweet potato, arahar, linseed. Main fruits of the Upazilla are Mango, blackberry, jackfruit, litchi, watermelon, papaya, pineapple, and orange. The main exports of the Upazilla are watermelon, pineapple, jackfruit, papaya, garlic, gravel. The percentage of agricultural landowners and land less are given below:

Table V.3: Ownership of Agricultural Land

Agricultural Land Owner/Landless	Percentage (%)		
	Total	Rural	Urban
Agricultural Land Owner	54.75	55.51	39.45
Landless	45.25	-	-

Source: Banglapedia 2014

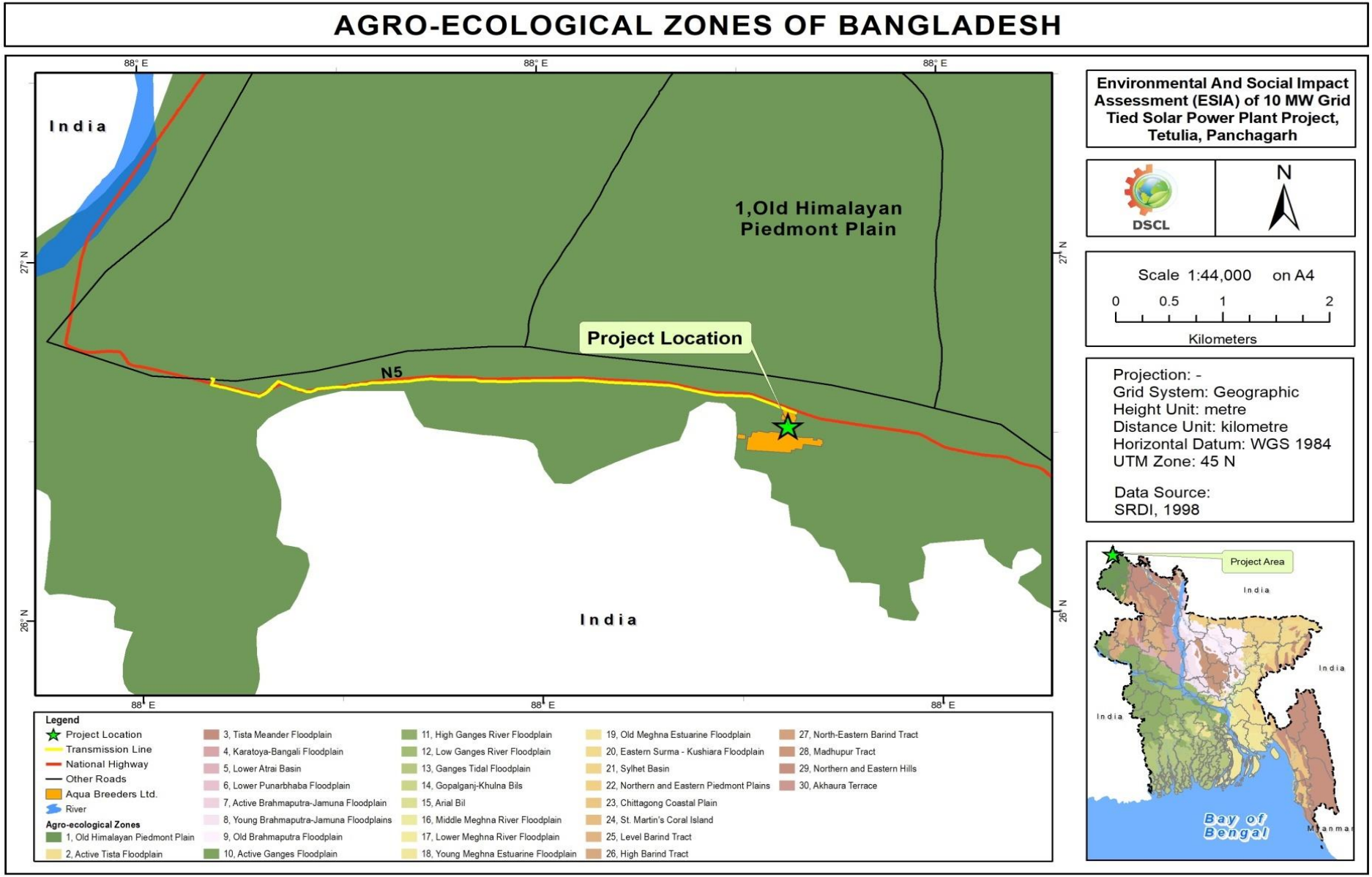


Figure V.18: Agro-ecological Zones of Bangladesh

8. Hydrology

260. Bangladesh is located over a subsiding basin of tectonic origin overlain with a great thickness of sedimentary strata. This sedimentary stratum is an unconsolidated alluvial deposit of recent age overlaying marine sediments. The recent delta and alluvial plains of the Ganges, Brahmaputra and the Meghna Rivers constitute the upper formation. The near surface Quaternary alluvium contains good aquifer characteristics (transmission and storage coefficients). The groundwater (GW) storage reservoir has three divisions: upper clay and silt layer, a middle composite aquifer (fine to very fine sand) and a main aquifer consisting of medium to coarse sand. Drinking water is generally taken from deep tube wells with strainers set between depths of 200 meters to around 400 meters (DPHE, 2011). The Ground water level is at or very close to the surface during the monsoon; whereas, it is at maximum depth during the months of April and May (Banglapedia, 2014).

Figure V.19: Water Bodies in the Project Area

a) Surface Water

261. The nearest river from the project site is Korotoya. There are also some natural water bodies near the project location. There are total 36 ponds, and 6 canals along the ROW of the proposed transmission line. Most of the water bodies become waterless during dry period or contain minimum amount of water and full of water in rainy season. People use the water from the river and ponds for washing, bathing and irrigation purposes.

262. The overall quality of surface water around the project site and its surroundings varies throughout the year. Typically, water quality improves during the monsoon due to the influx of fresh rainwater, and worsens during the dry season as water evaporates and the concentration of contaminants increases.

263. On 16th and 17th March, 2018, surface water samples were collected by environmental team from three ponds near the project area. The Department of Public Health Engineering (DPHE) analyzed the samples. The result (Appendix F) of the surface water samples and the GoB standards for fishing water (ECR, 1997) are shown in Table V.3. All the Parameters are within the acceptable limit except Chemical Oxygen Demand (COD) and Nitrogen (Ammonia) for all the locations.

Figure V.20: Surface Water Sampling from the Project Location

Table V.4: Results for Surface Water Sample Analysis

Water Quality Parameters	Unit	Inside Project Area (26.48242°N 88.41021°E)	Kazigach Village (26.48745°N 88.41121°E)	Taiaganj Village (26.48885°N 88.37334°E)	Bangladesh Standard for Inland Surface Water*	Method of Analysis
		SW_01	SW_02	SW_03		
Temperature	°C	25.3	25.8	23.4	NYS	Multimeter
pH*	---	7.39	7	8.4	6.5-8.5	pH Meter
Total Dissolved Solids (TDS)*	mg/l	392	143	179.5	-	TDS Meter
Dissolved Oxygen (DO)*	mg/l	4.3	4.16	3.8	6	DO Meter
Chemical Oxygen Demand (COD)	mg/l	16	8	8	4.0	CRM
Biochemical Oxygen Demand (BOD)	mg/l	5	3	2	6 or less	5 Days Incubation
Electric Conductivity (EC)*	µS/m	597	125.2	298	NYS	Multimeter
Chloride	mg/l	30	26	23	150-600	Titrimetric
Nitrogen (Ammonia)	mg/l	1.2	0.9	0.7	0.50	UVS

* Onsite Test Using Field Test Kit

Source: DPHE, April 2018

Table V.5: Description of the Surrounding Environment

Sample Location and ID	Sample Site Description
SW_01 (Inside Project Area)	➢ The pond is inside the project area. ➢ Fish is not cultured in the pond. ➢ Water are not remaining in the pond all-round the year. ➢ Rain water drains in the pond.
SW_02 (Kazigach Village)	➢ The pond is beside the residential dwellings. ➢ Fish is cultured in the pond. ➢ Water are constant in the pond all-round the year. ➢ Household water drains in the pond. ➢ Rain water and domestic sewage water drains in the pond.
SW_03 (Taiaganj Village)	➢ The pond is 100m way beside the road. ➢ Fish is cultured in the pond. ➢ Water are constant in the pond all-round the year. ➢ Household water drains in the pond. ➢ Rain water and domestic sewage water drains in the pond. ➢ The depth at which the sample was collected at approximately 6 inches.

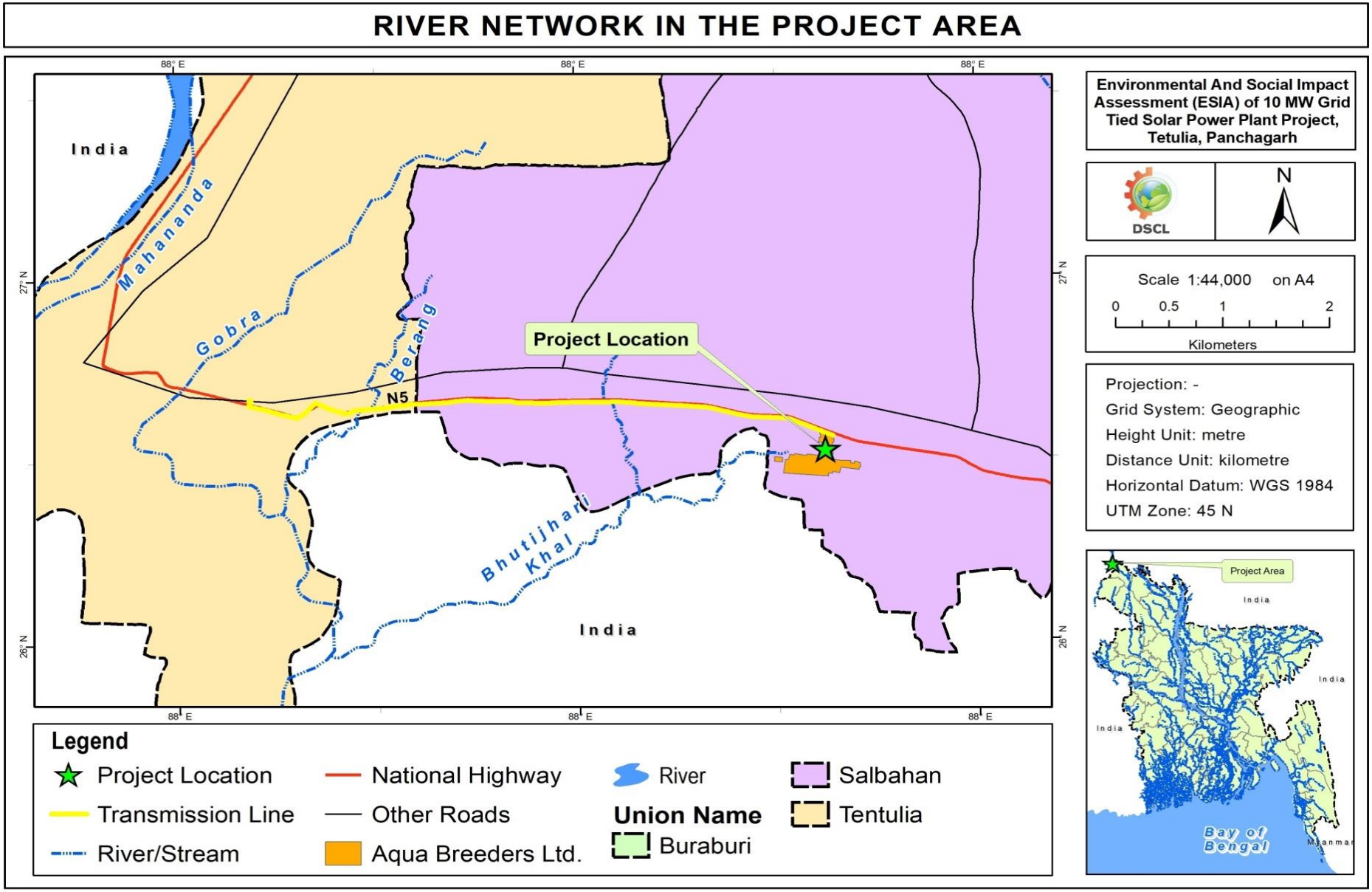


Figure V.21: Water Bodies and River Network Map

b) Groundwater

264. Arsenic is a problem in large part of Bangladesh ground water. However, the project area has acceptable limit or free from Arsenic 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. According to the Figure V.23 the project area is free from arsenic contamination.

265. 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 groundwater reservoir usually recharges from rainfall, and river water. In summer season, the water table slightly goes down and goes up in rainy season.

266. On 17th March 2018, groundwater samples were collected by environmental team from a tube well near the project area. The Department of Public Health Engineering (DPHE) analyzed the samples. The result (see Appendix G) of the groundwater samples and the GoB standards for drinking water (ECR, 1997) are shown in Table V.4. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE except for Iron at GW-03 (Taiaganj Village).

Figure V.22: Groundwater Sampling from the Project Location

Table V.6: Results for Groundwater Sample Analysis

Parameters	Unit	Inside Project Area	Kazigach Village	Taiaganj Village	Drinking Water Quality Standard, DOE	Method of Analysis
		26.48242°N 88.41021°E	26.48745°N 88.41121°E	26.48885°N 88.37334°E		
		GW_01	GW_02	GW_03		
Temperature	°C	25.7	24.5	25.9	20-30	Multimeter
pH*	---	7.40	6.88	6.51	6.5-8.5	Multimeter
Total Dissolved Solids (TDS)*	mg/l	119.6	62.3	91.2	1000	Multimeter
Dissolved Oxygen (DO) *	mg/l	2.3	1.7	1.9	6	DO meter
Alkalinity	mg/l	45	40	50	-	Titrimetric
Arsenic (As)	mg/l	0.002	0.004	0.002	0.05	AAS
Electric Conductivity (EC) *	µS/cm	155.9	105.2	114	-	Multimeter
Iron (Fe)	mg/l	0.14	0.44	2.14	0.3-1.0	AAS
Chloride	mg/l	10	10	12	150-600	Titrimetric

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE, April 2018

Table V.7: Description of the Surrounding Environment

Sample Location and ID	Sample Site Description
Inside Project Area (GW_01)	➢ Boring was 450 ft. ➢ The source was established in 2014. ➢ Distance of the source from septic tank is 50ft. ➢ Owner of this source is factory authority.
Kazigach Village (GW_02)	➢ Boring was 380ft. ➢ The source was established on 2011. ➢ Distance of the source from septic tank is 100ft. ➢ Owner of the source is Md. Fazlul Karim
Taiaganj Village (GW_03)	➢ Boring was 350ft. ➢ Drinking water source ➢ Owner of the source is MD. Bazar Mia ➢ Distance of the source from septic tank is 50 ft.

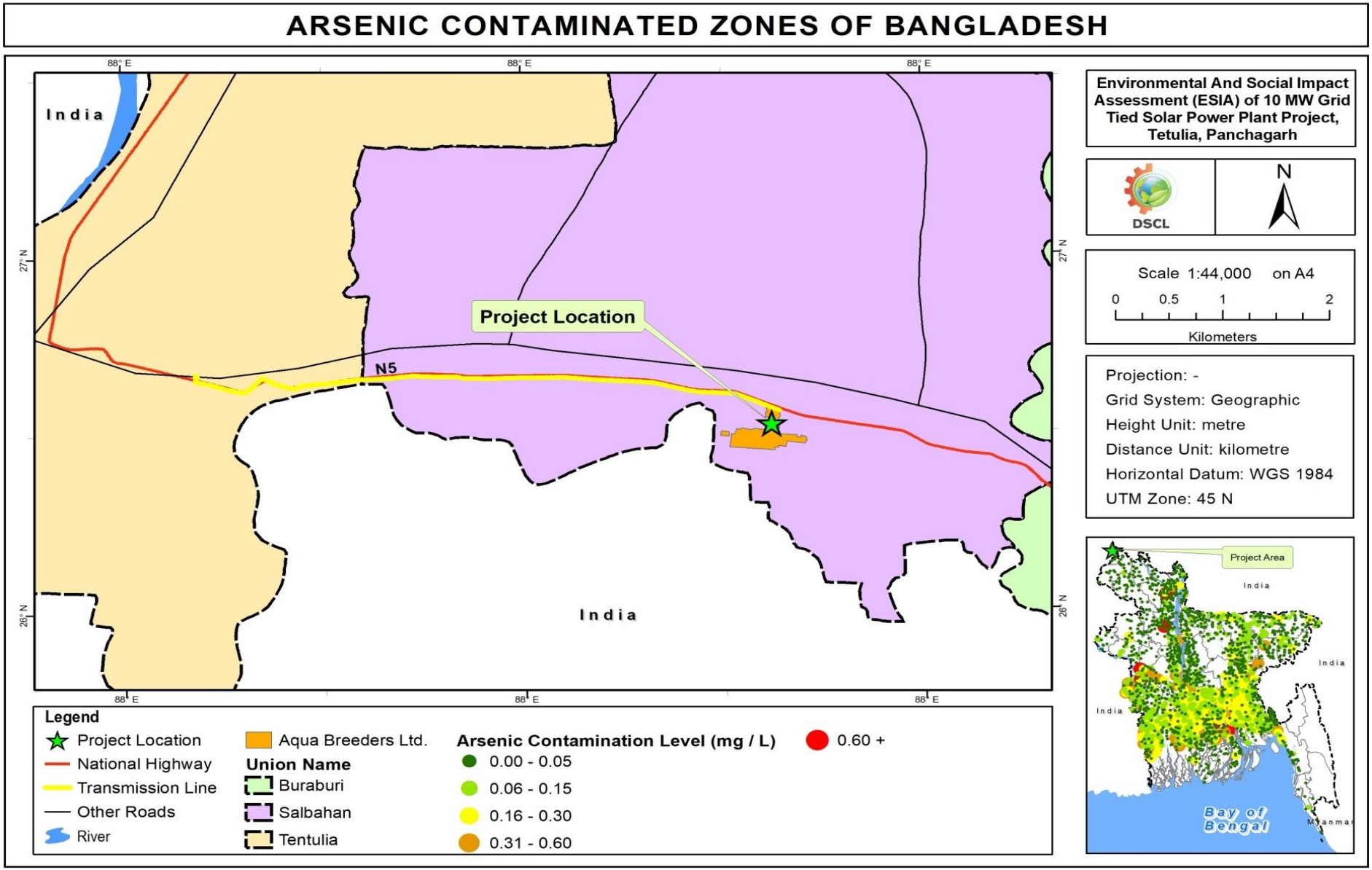


Figure V.23: Arsenic Contaminated Zones of Bangladesh

9. Noise Assessment

267. Excessive noise is a potential issue for both human and biological receivers, 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.

268. 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 E) during daytime (Figure V.24). Results of the noise level monitored along with details of the sampling locations have been showed in Table V.5. The results show that time weighted average value of the sound monitored at inside and outside of the project area did not exceed the standard fixed for the respective areas except for some places. The locations that exceeded the national standard are Kalandiganj Bazar for both day and night time, Tentulia Substation for nighttime, Tentulia Link Point for both day and night time, Kazigach Village for nighttime and Ajirnagar Bazar for nighttime.

Figure V.24: Noise Level Monitoring in the Project Area

Table V.8: Noise Level at Different Locations of Project Area

Location	GPS Location	Land Use Category	Time		Noise Level (dBA)	
			Day	Night	Day	Night
Proposed Project Site (Under PV Panel)	26.48422°N 88.41069°E	Commercial	10:40	20:47	50.02	51.35
Aqua Breeders Ltd. (Set-5)	25.48270°N 88.40977°E	Commercial	10:11	22:30	50.40	51.53
Kalandiganj Bazar	26.48858°N 88.38669°E	Commercial	11:03	20:08	69.60	64.78
Tentulia Substation	26.48856°N 88.35652°E	Residential	15:28	21:30	60.12	64.74
Tentulia Link Point	26.48897°N 88.37659°E	Commercial	15:58	21:52	69.17	68.35
Kazigach Village	26.48551°N 88.41154°E	Residential	16:30	20:22	53.52	51.22
Aqua Breeders Ltd. (Set-2)	26.48280°N 88.40912°E	Commercial	16:59	20:47	58.35	50.54
Aqua Breeders Ltd. (Set-4)	26.48215°N 88.40956°E	Commercial	17:19	21:35	44.95	49.31
Aqua Breeders Ltd. (Set-1)	26.48321°N 88.40975°E	Commercial	13:14	22:56	63.48	49.54
Ajirnagar Bazar	26.48760° N 88.36003° E	Commercial	12:57	19:33	64.36	61.23
Proposed Substation	26.48522°N 88.41135°E	Commercial	11:36	20:26	57.14	54.43

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

10. Seismicity

269. Bangladesh is situated in one of the most tectonically active regions in the world. Here are 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 V.6), 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 V.25), project area falls in the zone II. It means the project area is prone to medium seismic intensity.

Table V.9: Seismic Zoning of Bangladesh

Zoning	Area Mercalli Scale	Bask 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

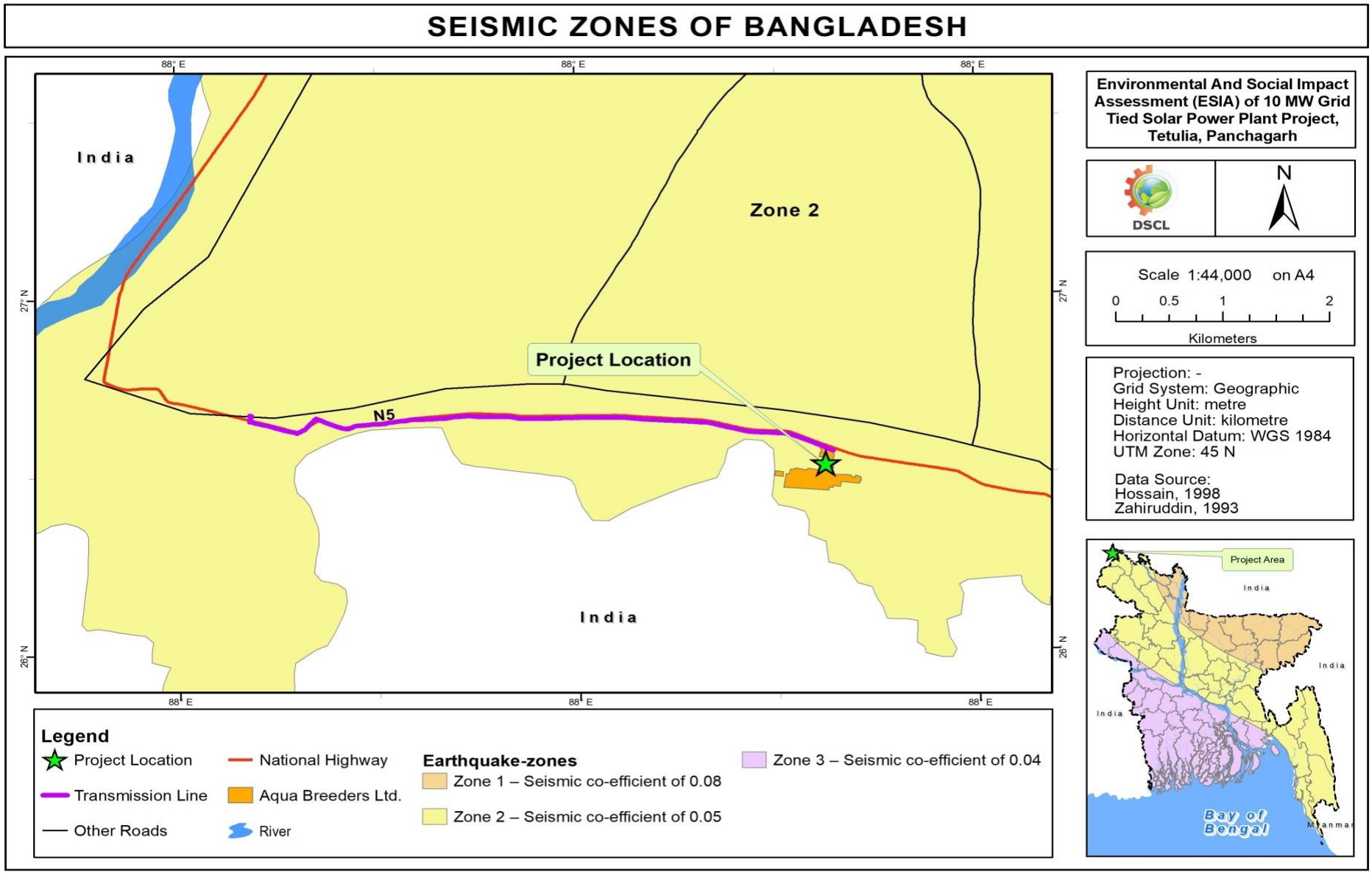


Figure V.25: Seismic Zones of Bangladesh

B. Ecological Environment

1. Overview

270. The report contains the results of biological survey of flora from the proposed project area. Overall results section of the project report contains inventory list of plant species with scientific names, local Bangla names, English names (if available) and families. It also contains the amount of terrestrial and aquatic flora of the project area. The fauna list was presented according to the class. Amphibians, Aves and Mammals are the main concerns. The list includes the scientific names, local names and English names of the terrestrial and aquatic fauna. Both of the lists were made by mostly using visual observation in the site, consulting with local people and using secondary reports.

2. Bio-Ecological Zones

271. 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.

272. 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 V.26). The project area falls into the bio-ecological zones described below.

273. ***The Himalayan Piedmont Plain***: occupies most of Dinajpur and parts of Jamalpur, Netrokona, Sherpur, Sunamganj and Sylhet district. The area is composed of numerous smooth but irregular-shaped ridges with broad and braided rivers. Being the ecotone between hill forests and low land swamps, ecologically this zone is very rich and diverse. Reeds and grasslands are the characteristic vegetation of this zone. Wildlife species of this zone is also diverse. Although the bird population, like that of mammals, has been affected by the disappearance of its natural habitats, there still exist a large number of birds in this zone.

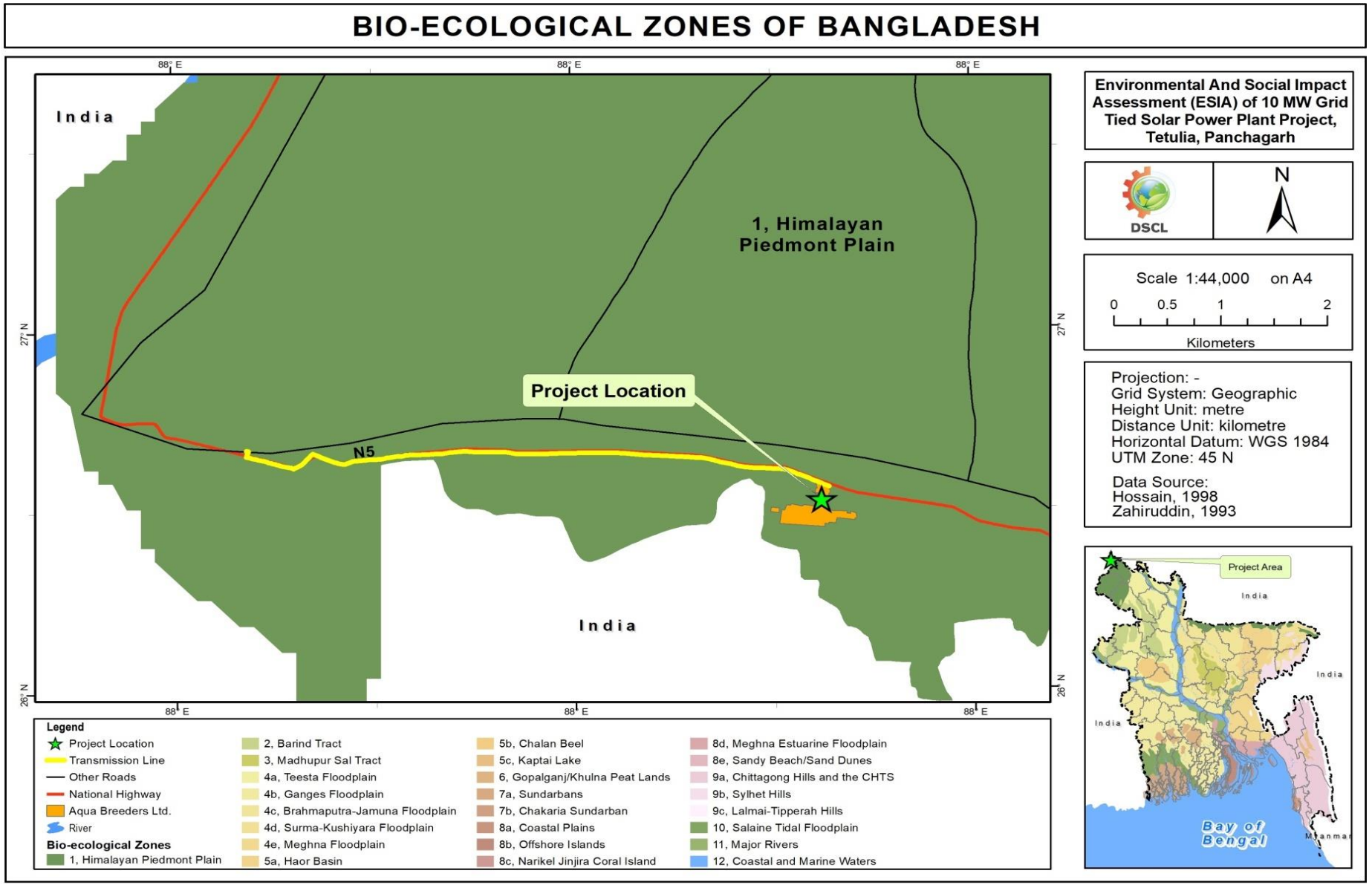


Figure V.26: Bio-Ecological Zones of Bangladesh

a) Terrestrial Ecosystem

274. 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., homesteads, and roadside vegetation (Figure V.27). The roadside vegetation dominates the area providing widespread habitat types for various species of flora and fauna under flooded and non-flooded conditions. The homestead ecosystem provides the main tree covered areas within rural Bangladesh including the project site. The homesteads are covered by fruit, timber, fuel wood, medicinal plants and various multipurpose tree species. 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.

Figure V.27: Homestead and Roadside Ecology in the Project Area

i. Flora

275. The project influence area (PIA) has mixed vegetation. The area is mostly dominated by roadside and homestead vegetation. The data was 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 V.10.

Table V.10: List of Flora in the Project Influenced Area

Species Name	Local Name	Family
Areca catechu	Supari	Palmae
Mangiferaindica	Aam	Anacardiaceae
Carica papaya	Pepe	Caricaceae
Musa	Kola	Musaceae
Camellia sinensis	Cha	Theaceae
Vetiveria zizanioides	Benna Ghash	Poaceae
Saccharum spontaneum	Kansh	Poaceae
Acacia moniliformes	Akashmoni	Leguminosae
Azadirachtaindica	Neem	Meliaceae
Annonasquamosa	Ata	Annonaceae
Borassusflabellifer	Taal	Arecaceae
Cocosnucifera	Narikel	Palmae
Artocarpusheterophyllus	Kanthal	Moraceae
Bambusa vulgaris	Bansh	Poaceae
Ficusindica	Bot	Moraceae
Colocasiaesculenta	Kochu	Araceae

Species Name	Local Name	Family
Dilleniaindica	Chalta	Dilleniaceae
Citrus maxima	Jambura	Rutaceae
Acacia arabica	Babul	Fabaceae
Salmaliamalabarica	Shimul	Malvaceae
Citrus limon	Lebu	Rutaceae
Phoenix sylvestris	Khejur	Palmae
Swieteniamacrophylla	Mahogony	Meliaceae
Tamarindusindica	Tentul	Leguminosae
Tectoniagrandis	Shegun	Lamiaceae
Terminaliachebula	Horitoki	Combretaceae
Eucalyptus globulus	Eucalyptus	Myrtaceae
Psidiumguajava	Peyara	Myrtaceae
Neolamarckiacadamba	Kodom	Rubiaceae
Punicagranatum	Dalim	Lythraceae
Moringaoleifera	Shajna	Moringaceae
Albizialebbeck	Koroi	Fabaceae
Lagerstroemia speciosa	Jarul	Lythraceae
Litchi sinensis	Lichu	Sapindaceae
Phyllanthusemblica	Amloki	Phyllanthaceae
Erythrinaindica	Mandar	Fabaceae
Zingiberofficinale	Ada	Zingiberaceae

ii. Fauna

276. The diversified habitat and ecosystem in the project area support various types of animals as given in table V.11. 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.

Table V.11: List of Fauna in the Project Influenced Area

Scientific Name	English Name	Local Name
Class: Amphibia		
Bufo melanostictus	Common toad	Kuno bang
Rhacophorusleucomystax	Tree frog	Gecho bang
Ranatigrina	Indian bull frog	Kula bang
Class: Reptilia		
Calotesversicolor	Common garden lizard	Rokto-chosha
Gecko gecko	Wall lizard	Tokkhok
NajaNaja	Indian cobra	Gokhra
Varanusbengalensis	Bengal monitor	Guishap
Class: Aves		
Copsychussaularis	Magpie robin	Doyel
Corvussplendens	Crow	Kaak
Acridotherestristis	Common myna	Shalik
Passer domesticus	House sparrow	Charui
Anatidaeanatidae	Duck	Hash
Eudynamysscolopacea	Asian cuckoo	Kokil
Egrettagarzetta	Little egret	Bok
Gallus gallus	Wild cock	Murgi
Melopsittacusundulatus	Budgerigar	Tia pakhi
Class: Mammalia		
Bostauras	Cow	Goru
Capra aegagrushircus	Goat	Chagol
Canis lupus familiaris	Dog	Kukur
Ovisaries	Sheep	Bhera
Bubalusbubalis	Buffalo	Mohish
Equuscaballus	Horse	Ghora

Scientific Name	English Name	Local Name
Herpestesedwardsii	Mongoose	Beji
Viverrazibetha	Large Indian civet	Bon biral
Sciuruscarolinensis	Grey Squirrel	Kathbirali
Mus musculus	Mouse	Nengtiindur
Rattusrattus	Rat	Indur

b) Aquatic Flora and Fauna

277. However, some aquatic species like Hijal (Barringtonia acutangula) are not seasonal and can survive during the dry season as well. The common aquatic plants in the project area include Kachuripana (Eichhornia crassipes), Shada Shapla (Nymphaea nouchali), Panchuli (Nymphoides indicum), Singara (Trapa bispinosa) (Nishat et al.1993, Nishat et al.2002). Species like 'Kachuripana' grow well in the stable aquatic environment where water flow is less or absent. In the project area, this species is very abundant in pond and lake.

278. As there is no pond or river present near the project site, no specific aquatic fauna was found in the project site.

3. Protected Areas and Red Book Species

279. 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.

280. In and around the project area some wildlife species were identified as locally vulnerable. Some species were also identified as locally endangered. Any construction must consider impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns. Figure V.28 shows that no environmental sensitive area is present around the project region.

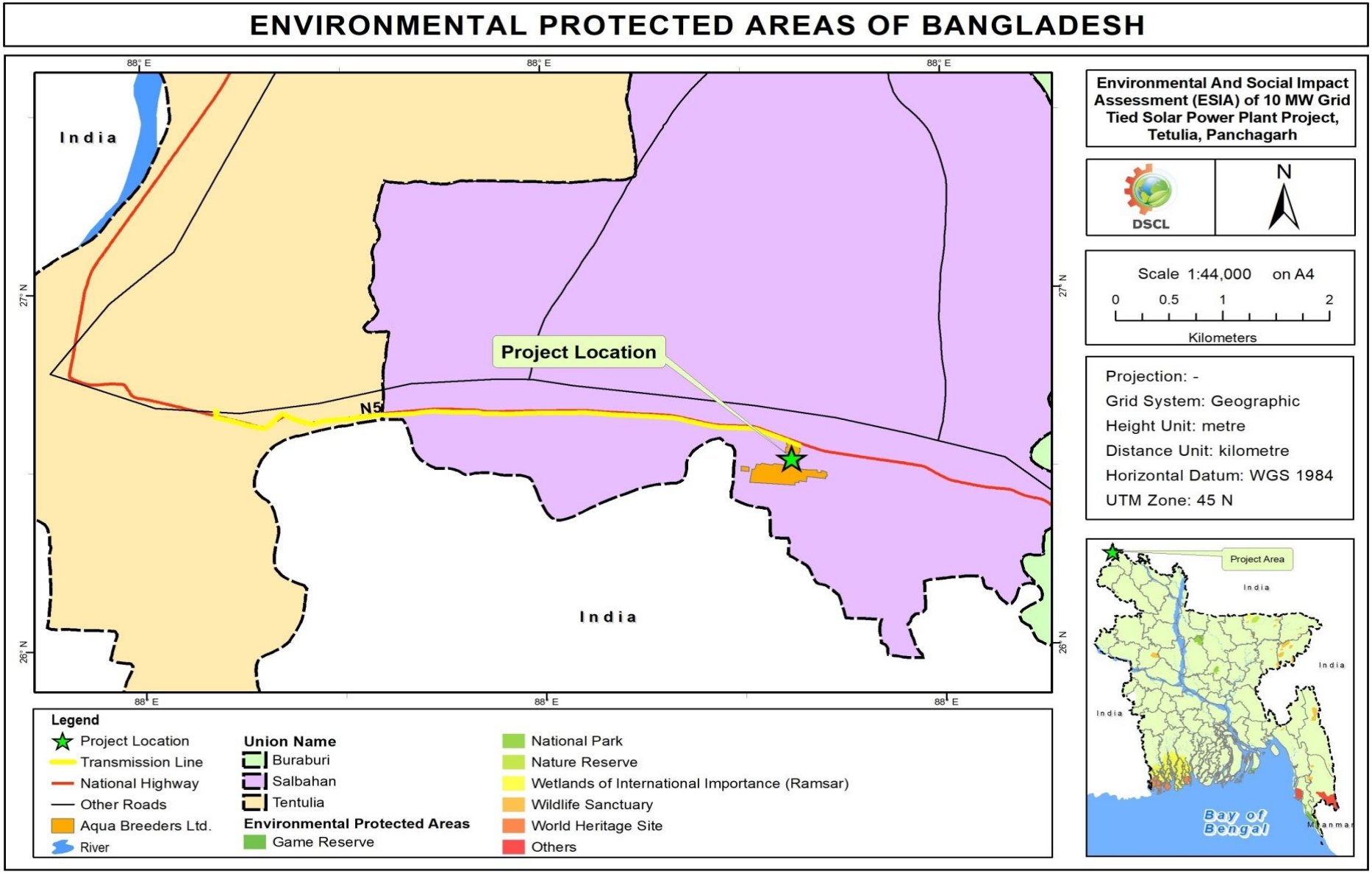


Figure V.28: Environmental Protected Areas of Bangladesh

C. Social Environment

281. 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. The project land is occupied or purchased by project authority which is in private land. There is no govt, land is occupied for this project activities whether the land is completely purchased by the project authorities so that three is no resettlement issues or resettlement cost are needed for this project. There are some tribal or indigenous people living in Panchagarh district but in the project area there is no tribal community. There are only two community people living here one is Muslim and others is Hindu community.

282. The following tools and techniques were used to collect the relevant data/information on the social and economic aspects of affected people:

- Literature review and
- Focus Group Discussion (FGD);

283. 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).

1. Administrative Information

284. It is important to highlight the administrative setup as framed by District and Municipal boundaries of the Project area, as those will be referred to many times throughout the ESIA document.

285. The project is located at Majhipara, Salbahan Union at Tentulia Upazilla in Panchagarh district. The total area of Salbahan Union is 7632 acres. Tentulia Upazila (Panchagarh district) area 189.12 sq. km, located in between 26°24' and 26°38' north latitudes and in between 88°21' and 88°33' east longitudes. Extreme northern upazila of Bangladesh is bounded by west Bengal state of India on the north, south and west, Panchagarh Sadar upazila on the east. Tentulia Thana was formed on 26 June 1917 and it was turned into an upazila on 16 March 1993.

2. Demographic Information

286. With an estimated 164.4 million inhabitants and an annual population growth rate of 1.4%, Bangladesh is considered one of the most densely populated countries in the world (UNFPA, 2010). The detail of demographic profile of the project area is presented below (Table V.12). The demographic information is collated from Population Census, 2001 by Bangladesh Bureau of Statistics (BBS).

Table V.12: Demographic Profile of the Project Area

Union/Upazilla	District	Population		
		Total	Male	Female
Salbahan Union	Panchagarh	17795	9182	8613
Tentulia Upazilla	Panchagarh	105368	54078	51290

Source: BBS, 2001

287. The religious distribution of population of Tentulia Upazilla is given below:

Table V.13: Religious Distribution of Population in Tentulia Upazilla

Area	Religious Distribution of Population					Percentage (%) Distribution of Population			
	Total	Muslim	Hindu	Buddhist	Others	Muslim	Hindu	Buddhist	Others
Tentulia Upazilla	105368	103277	1963	119	9	97.98	1.86	0.11	0.0085

Source: BBS, 2001

288. Indigenous communities such as Sawntal, Orao and Barmon belong to this upazila.

3. Utility Services

289. The term utilities can also refer to the set of services provided by different organizations consumed by the public: electricity, natural gas, water, sewage, telephone, and transportation.

290. ***Access to electricity***: All the unions of the upazila are under rural electrification net-work. However, 4.36% of the dwelling households have access to electricity.

291. ***Sources of drinking water:*** There are various sources of drinking water in the Upazila. A summary of the user percentage of the sources is listed below,

Table V.14: Sources of Drinking Water

Source	Percentage (%)
Tube-well	81.24
Tap	0.49
Pond	0.81
Others	17.46

Source: Banglapedia 2014

292. ***Sanitation***: The percentages of different sanitation facilities are shown in below table.

Table V.15: Sanitation Facilities

Sanitary System	Percentage (%)		
	Total	Rural	Urban
Sanitary Latrine	11.51	9.98	42.21
Non-Sanitary Latrine	44.71	44.46	49.81
No Latrine Facilities	43.78	-	-

Source: Banglapedia 2014

293. ***Natural resources:*** The natural resources of the Upazilla includes, Glass Sand, Bolder Stone, stone chips.

4. Land Use

294. Lands at the project area are used for agriculture, fisheries, agro-forestry, homestead, homestead forestry, vegetation, animal husbandry, and most importantly tea gardening. The areas through which the transmission line passes are characterized by an agricultural ecosystem with very little of the natural ecosystem remaining. The most heavily vegetated areas along the alignment are the homestead areas where several species of trees of economic value are present.

295. The land use pattern in the project area like other areas has traditionally been devised based on soil condition, relief, climate, hydrology and flood conditions, availability of resources, etc. The project would not affect the local land uses since the power plant will be established within a boundary and it is a grid tied power plant. Additionally, the transmission line will go through the existing roadside transmission line where the land use pattern is already established.

296. Land use analysis is carried out within 1km buffer zone of the proposed power plant (Figure V.29) and along 200m buffer zone from centerline of the transmission line (Figure V.31) using optical satellite imageries.

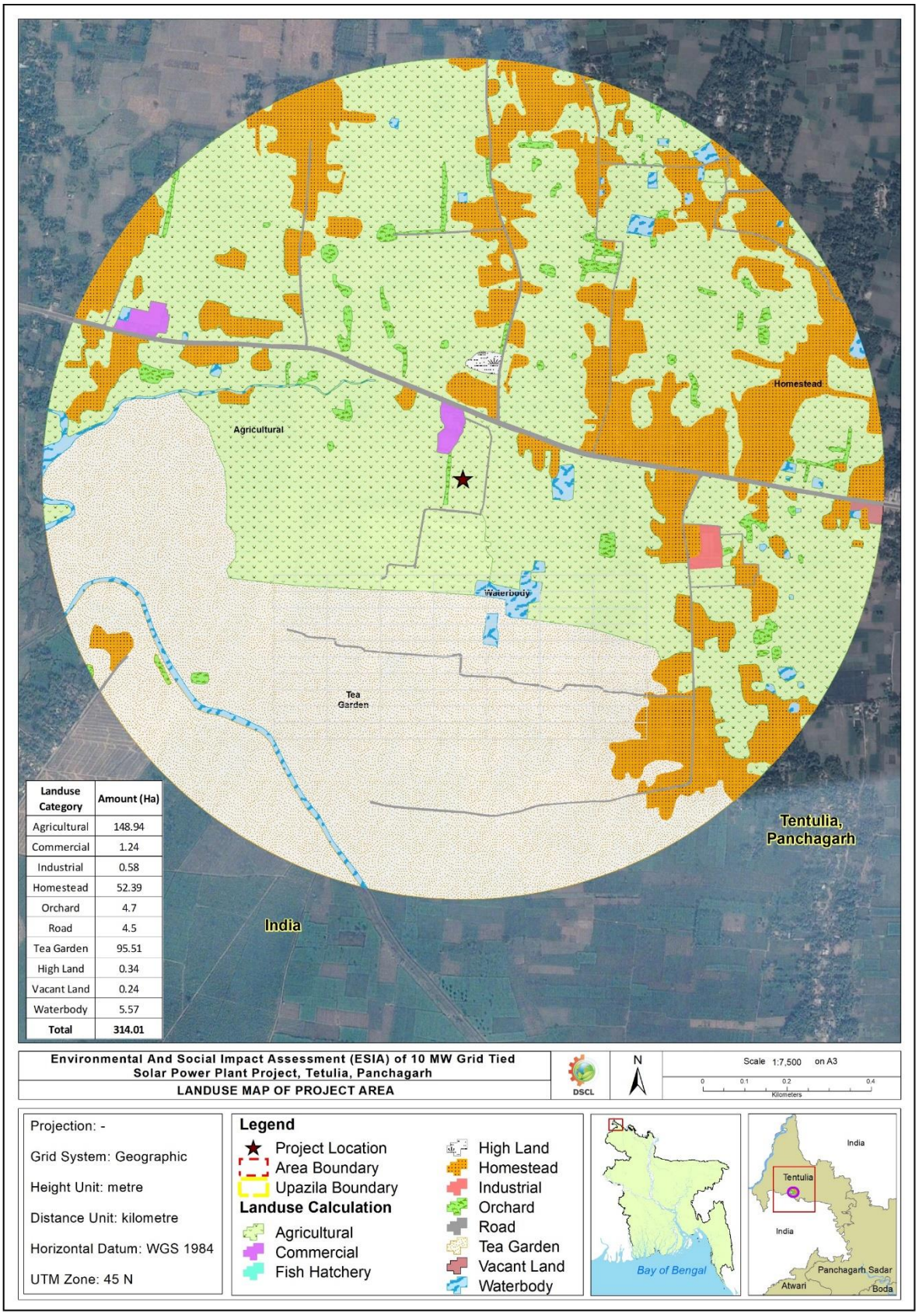
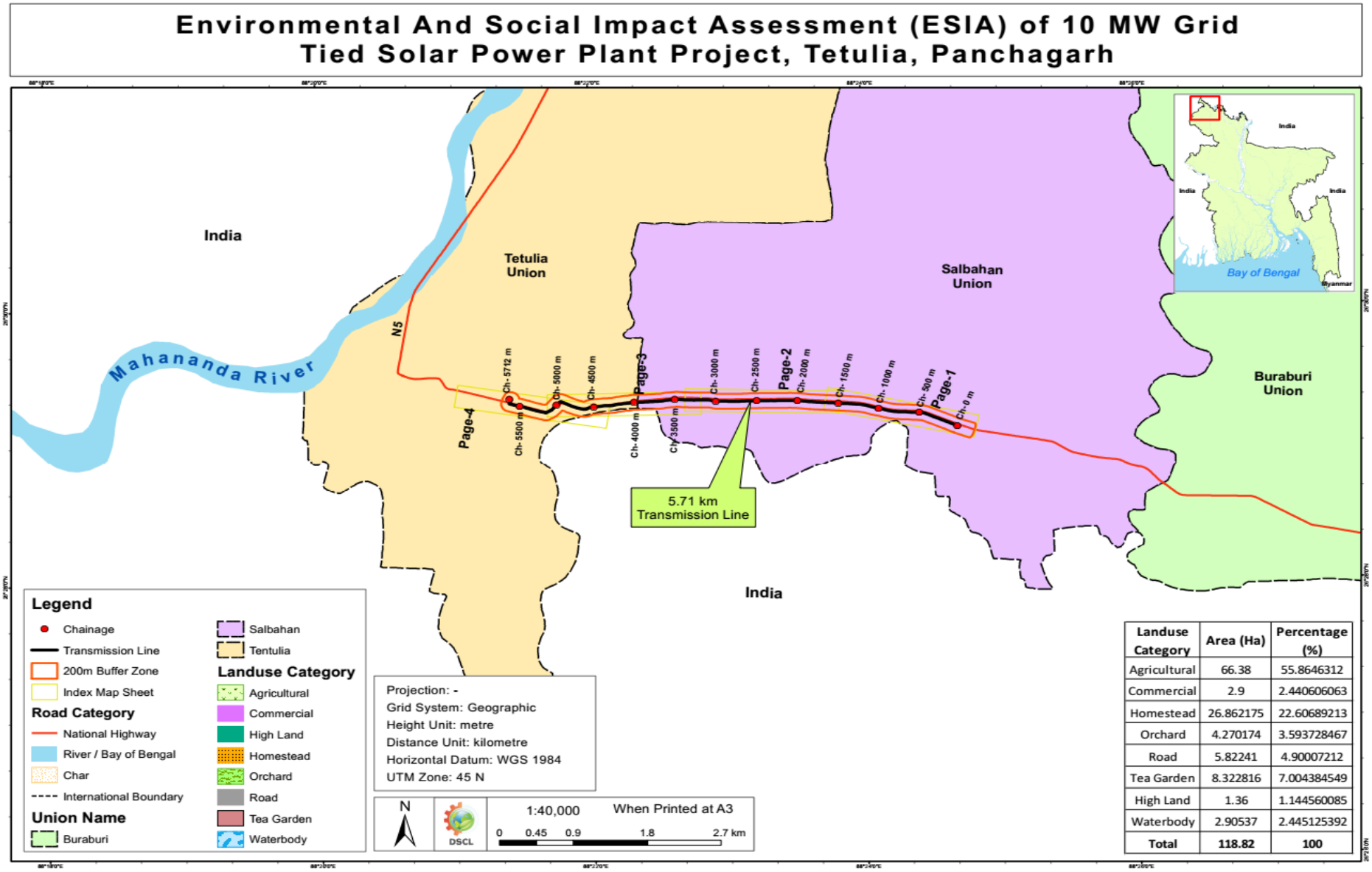


Figure V.29: Land Use within 1Km Buffer Area of the Proposed Power Plant



Landuse Category	Area (Ha)	Percentage (%)
Agricultural	66.38	55.8646312
Commercial	2.9	2.440606063
Homestead	26.862175	22.60689213
Orchard	4.270174	3.593728467
Road	5.82241	4.90007212
Tea Garden	8.322816	7.004384549
High Land	1.36	1.144560085
Waterbody	2.90537	2.445125392
Total	**118.82**	**100**

Figure V.30: Land Use Category Map of the Project Area

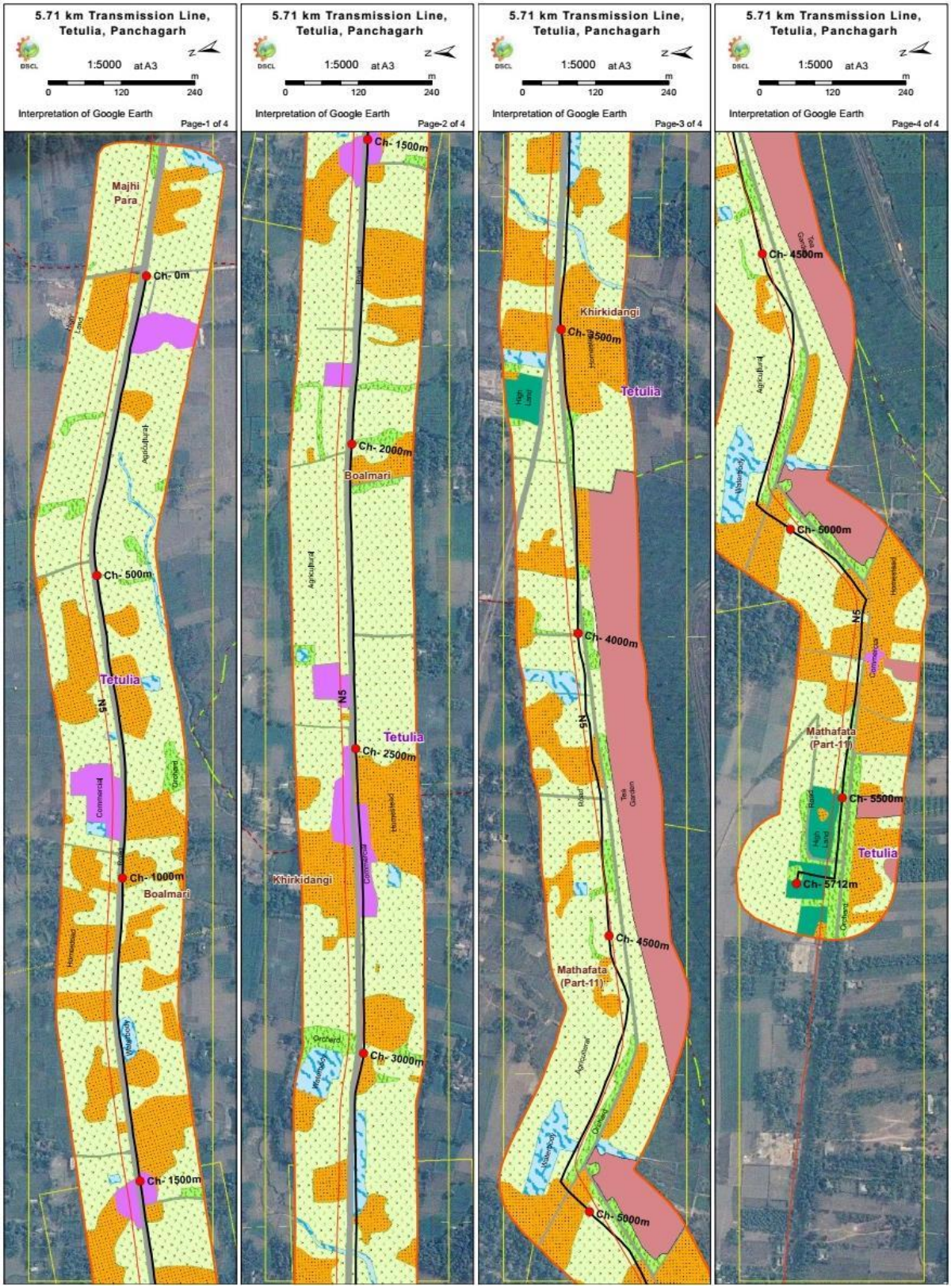


Figure V.31: Land Use within 200m Buffer of the Proposed Transmission Line

5. Transports and Communications

297. In the upazila, there is 46 km of Pucca road and 422 km of mud road. Extinct or nearly extinct traditional transport includes Palanquin, horse carriage, and bullock cart.

6. Livelihoods

298. The livelihood of the people of Tentulia Upazila mainly depends on agriculture. A list of the percentage of the livelihood of the people of Tentulia Upazila is given below:

Table V.16: Sources of Drinking Water

Livelihood Source	Percentage (%)
Agriculture	62.72
Non-Agricultural Laborer	16.01
Commerce	8.84
Transport and Communication	2.33
Service	4.38
Construction	0.46
Religious Service	0.09
Rent and Remittance	0.09
Others	6.08

Source: Banglapedia, 2014

7. Education

299. Average literacy rate of the Upazilla is 39% among which male is 44.1% and female is 33.5%.Renowned educational institutions includes, Kazi Shahabuddin Girls' School and College (1965), Tentulia College (1986), Bhojanpur' Degree College (1987), Tentulia Technical College (2004), Boda Mainaguri Bilateral High School (1917), Bhojanpur Bilateral High School (1956), Salbahan Bilateral High School (1962), Tentulia Pilot High School (1959), Majhipara Bilateral High School (1973), Haradighi Bilateral High School (1969), Kalandiganj Senior Madrasa (1976), Begum Fakhrunnisa Fazil Madrasa (1978).

300. The number of the educational institutions of the Upazila is listed below.

Table V.17: Educational Institutions of Tentulia Upazila

Educational Institution	Number
College	4
Secondary School	27
Primary School	67
Kindergarten	3
Madrasha	11

Source: Banglapedia 2014

8. Health

301. There are three different types of health centers in the Upazila including, Upazila health complex 1, family planning centre 6 and satellite clinic 3. The number of these health centers is listed below,

Table V.18: Health Centers of Tentulia Upazila

Health Centers	Number
Upazila Health Complex	1
Family Planning Center	6
Satellite Clinic	3

Source: Banglapedia 2014

9. Recreational Activities

302. The amusement centers of Tentulia Upazila includes, Tentulia Picnic Corner, Dahuk Picnic Centre, Anandadhara and Tea Garden at Raushanpur, Zero Point and Landport at Banglabandha.

10. Archaeological, Cultural Heritage and Community Organizations

303. The Archaeological heritage and relics include, Bhadreswar Temple, Shiva Temple, Mausoleum built as per design of the Greek architecture, Tentulia Dakbungalow. There are two types of religious institutions including mosques and temples. The number of mosques is 120 and 2 number of temples. The list of the number of the cultural organizations is given below:

Table V.19: Cultural Organizations of Tentulia Upazila

Cultural Organizations	Number
Library	1
Club	16
Music School	1
Cinema Hall	1
Theatre Group	1

Source: Banglapedia 2014

304. The common community organizations are NGO activities. Among the NGOs, the operationally important NGOs are Building Resources Across Communities (BRAC) and Rangpur-Dinajpur Rural Service (RDRS).

305. The environmental and social survey team conducted a detailed survey around the power plant project and along the proposed transmission line to identify the environmental, social and community features. The findings of the survey have been plotted in the GIS and the outcome map is given in Figure V. 32.

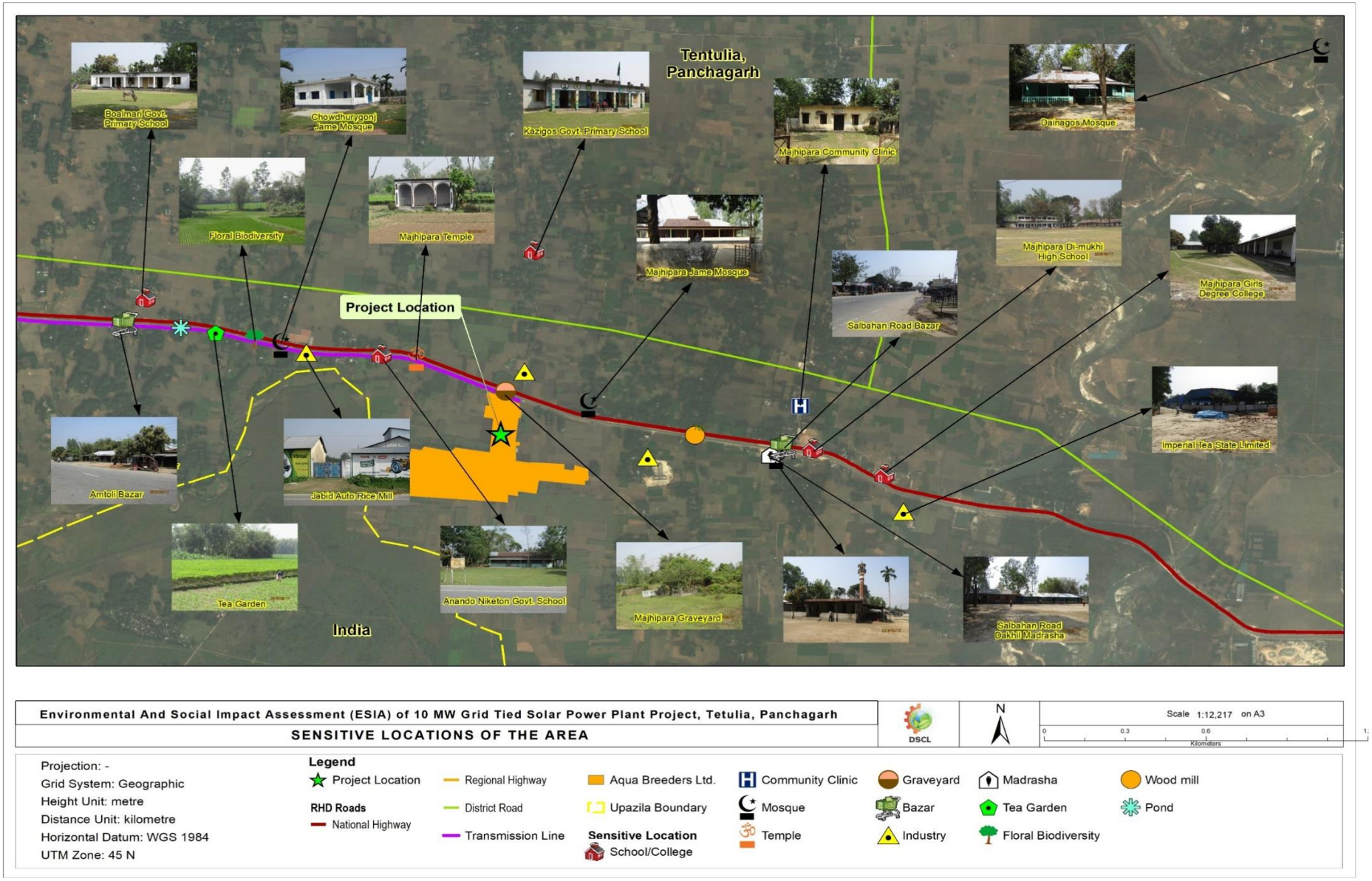


Figure V.32: Important Environmental and Social Features in the Project Influence Area

VI. PUBLIC CONSULTATION

A. General

306. Public Consultation is a tool for managing two-way communication between the project sponsor and the public. Its goal is to improve decision-making and build understanding by actively involving individuals, groups and organizations with a stake in the project. This involvement will increase a project's long-term viability and enhance its benefits to locally affected people and other stakeholders. Stakeholder engagement is an integral part of ESIA good practice and is a statutory requirement of the national ESIA legal framework in Bangladesh and within the World Bank (WB) Policy on Environmental and Social Safeguards. The consultation program for the Project is based on informed consultation and participation in line with ESIA requirements with affected people and is designed to be both fair and inclusive. Consultation activities have been conducted during the environmental survey of the ESIA in March 2018.

B. Objectives

307. The objective of public consultation is to ensure that a participatory approach takes place, which in turn documents concerns of all stakeholder groups and makes sure that such concerns are considered, responded to, and incorporated into the decision-making process of the development. Stakeholder consultation needs to be a two-way communication process that imparts information to stakeholders, but also obtains additional and on-the-ground information from them. Stakeholder consultation and engagement must take place at the inception phase of the ESIA process and implemented all through the study period.

308. The specific objectives of this chapter are to:

- Summarize Developer, national and international legal & policy requirements for stakeholder engagement;
- Describe and identify the stakeholders affected and/or with an interest in the Project;
- Summarize stakeholder engagement and consultation conducted to date;
- Describe how the views and issues raised have informed and influenced the development of the Project; and
- Outline the future plans and approach to stakeholder engagement.

C. Consultation with Various Stakeholders

309. A stakeholder is defined as any individual or group who is potentially affected by the proposed Project or can they affect the proposed Project directly or indirectly. Stakeholder consultation is an inclusive process for sharing information that enables stakeholders to understand the risks, impacts, and opportunities of a development or project, allowing them to express their views and articulate their perceptions towards it. The consultation of the project authority has discussed with Department of Environment (DoE), Rangpur for project related activities, possible impacts and mitigation measures. The photograph of consultation meeting is given in Figure VI.1.

Figure VI.1: Photos of Discussion with Department of Environment (DoE), Rangpur

1. Focus Group Discussion

310. Through the project preparation stage extensive consultations/FGDs have been arranged during the conduct of the ESIA surveys. The participants of FGDs are given in the following Table VI.1. The findings of these FGDs are summarized in Table VI.2 and the list of attendance of these FGDs is given in Appendix I.

Table VI.1: Participants of FGDs

FGD No.	Type of Participants	No. of Participants
01	Farmer, service holder, businessmen, Driver, Student	15
02	Farmer, service holder, businessmen, Labor, Student	15
03	Farmer, service holder, businessmen, Student, Driver	15
Total		**45**

FGD-01

FGD-02

FGD-03

Figure VI.2: Photos of Focus Group Discussions (FGD)

2. Public Consultations

311. The detailed participants and the summary of the Public Consultation Meeting held in the area is given in the below tables.

Table VI.2: Participants of the PCM

PCM No.	Type of Participants	No. of Participants
01	Teacher, Student, Service Holder, Businessman	31
02	Businessmen, Political Person, Job Holder, Labour, Driver, worker	20
03	Teacher, Student, Service Holder	30
Total		**81**

PCM-01

PCM-02

PCM-03

Figure VI.3: Photos of Public Consultation Meeting (PCM)

3. Summary of Consultations

312. The outcome of both the FGDs and PCMs are given in Table VI.3.

Table VI.3: Summary of the FGDs and PCMs

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of the 10.6 MW Grid Tied Solar Park project? If yes, what are they?	Yes, the project proponent has shared this information with us. The owner will establish the solar plant, which will be connected to the main grid, and then government will distribute electricity among us. It is a good initiative for the local people.
How the project will impact on surrounding environment? Please mention both positive and negative sites.	The project will have less environmental impact because the project area is surrounded by boundary wall and the project area is far away from the residential area.
Any air pollution in the area due to the project activities? If yes, how to mitigate?	The air quality will not be affected significantly because of construction activities. More traffic will run to carry construction materials which will increase dust around the roadside. Roads need to be constructed plain for carrying construction materials. Construction of building for workers shed and other facilities will decrease the local air quality temporarily. As the project site is far away from the residential dwellings so there is minor possibility of anticipated impact but proper care about panels, sensitive equipment etc. should minimize the anticipated impact. The proponent needs to take some attention to reduce this impact.
Any noise- impact of the project during construction and operation at the locality? If yes how to mitigate?	The noise level will increase a bit because of running construction machineries and movement of workers. The effect will be temporary. After the construction is finished, the noise level will return to the previous limit. Still, there should be proper noise barrier or boundary wall at the noise source to minimize the minor possibility of the anticipated impact. The proponent needs to take some attention to reduce this impact
Any impact on local soil due to the project activities? If yes, how to mitigate?	Agricultural land will decrease because of the implementation of this project. The implementation of this project will hamper the nearest agricultural practices of the proposed plant area. Any spillage of chemicals and toxic materials will degrade the soil quality of the project site. The project proponent should take proper attention regarding this accident. The waste materials should be maintained properly and it should not be kept at dumping place.

Questions to the Groups	Participants opinion, comments and suggestions
Any impact on ground/ drinking water quality due to the project? If yes, how to mitigate?	There is no problem with the groundwater quality because of the Grid tied Solar Power Plant construction. However, the project proponent should confirm that no accidental spillage or washout of hazardous/waste material to surrounding water bodies during construction; particularly in the monsoon.
Any impact on the surface water body (river, pond, khal, beel, canal etc.)? If yes, how to mitigate?	There is no problem with the surface water quality because of the Solar Power Plant construction. However, the project proponent should confirm that no accidental spillage or washout of hazardous/waste material to surrounding water bodies during construction; particularly in the monsoon.
Is the proposed area inundated during flood? If yes, how much?	The project area is high land. So, there is no risk of flooding of the project site.
Is wildlife (birds, snakes, crabs, fox etc.) available in the area? If yes, mention their name. Among them which are endangered?	The availability of the wildlife (birds, snakes, crabs, fox etc.) is low in this area. No endangered species are found.
Are any Environmental Protected Area (EPA) / Environmental Sensitive Area located nearby the project? If yes, where & how far from the project?	No.
Is there any particular sensitive area nearby the project that you think should be protected? If yes, where & how far from the project location?	No particular sensitive area nearby the project area. But there are schools, mosques, graveyards and bazar within 0.5 to 1 km radius.
Will the project impact on your social and economic sector? If yes, how?	Yes, due to the implementation of this project unskilled and poor women can develop their skills. They will help their family by earning money which in the long run will contribute to the national economy. The local economy will develop after having the access of electricity. The educational status of this area will develop.
Are you in favor of this project? Why?	Yes, we all support the project. We appreciate the initiative. This project in the long run will help to develop the economic and social condition in this area as well as the country also.

4. Individual Consultations

313. A number of informal individual public consultations were held in the project influenced area. In all the places, respondents mostly welcomed the project. However, they did point out few issues of concern noise pollution, air pollution, and accident hazard. In the time of field survey, 28 local people were interviewed.

Md. Ashraf Hossain
Mobile: 01712469687

Azhar Uddin
Mobile: 01688525412

	
Saddam Hossain Mobile: 01788640471	Abdul Jalil Mobile: 01790538349
	
Md. Mahfuz Mobile: 01935715005	Yeasmin Begum Mobile: 01774595309

Figure VI.4: Photographs of Individual Consultations

VII. ANTICIPATED IMPACTS & MITIGATION MEASURES

A. Environmental and Social Considerations

314. This chapter identifies and evaluates the potential environmental and social impacts of the proposed solar power project on the physical, social and human environment within the area of influence of the proposed project. The likely impacts were assessed for all activities in the construction; installation, operation and maintenance, and decommissioning /abandonment phases of the project development.

315. All potential impacts from the proposed project have been evaluated as part of the ESIA process – effluent, ambient air quality, noise, surface water, and groundwater, geology, terrestrial and aquatic ecology and socio-economics.

316. Based on the characterization of the environment (Description of the Environment) conducted by the consultancy team, describing the physical, biological, socioeconomic and archeological conditions of the zone of location of the Project, the potential impacts, as well as the environmental factors to be affected and the impacting activities to be performed in the stages of construction and operation of the Project have been determined.

317. During the construction phase, the impacts may be regarded as temporary or short-term; while long-term impacts may be observed during the operation stage. Spatially the impacts have been assessed over the study area of 1 km radius of the project site.

318. The project has overall positive impacts by providing a competitive, cost-effective, pollution free reliable mode of Solar PV power. It will certainly meet the ever-increasing Demand of Power and to bridge the Gap between Demand and Supply of Power.

B. Impact Magnitude

319. 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 VII.1.

Table VII.1: Parameters for Determining Magnitude

Parameter	Major	Medium	Minor	Nominal
Duration of Potential Impact	Long term (more than 35years)	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 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

Parameter	Major	Medium	Minor	Nominal
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

C. Sensitivity of Receptor

320. 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 VII.2.

Table VII.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

321. **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 VII.3

D. Summary of Assessed Impacts

322. The project's potential impacts on the key environmental parameters have been assessed and their significance determined using the methodology described in Section VII.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 VII.4, and VII.5 for different phases of this project; the potential impacts are discussed in the subsequent sections.

Table VII.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

323. 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

324. 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.

E. Corridor of Impact (CoI)

325. 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 proposed power plant site. In this project the farm area has been considered as core impact zone and 1km as buffer zone for better understanding. On the other hand, 200m buffer for the transmission line has been considered as core impact zone and 1km in both sides from the transmission line as buffer zone.

F. Impacts of Solar Power Plant

1. Pre-Construction Phase

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

a) Land Use / Land-filling

Impact

327. The Project site location does not conflict with any of the relevant governmental entities formal planning context. The project site is owned by the project proponent and it is within the project boundary. In addition, the Project site does not provide any major value to local communities. Therefore, there are no anticipated impacts during the planning phase of the Project. However, the project land is right now a vacant land that is sometimes used as playing ground. There will be some minor impacts due to land-filling: Pollution from overflow of filled earth (dredged materials); Erosion from the filled materials and side slope of filled lands.

Mitigation

328. The project developer is to take responsibility of minimizing environmental impact on the surroundings by following the project's environmental and social management plan (ESMP). For example, the developer should advise contractor to must fenced the proposed area so that the surrounding agricultural land will not be disturbed. Since these activities are to be performed temporarily the minimum impact is expected to be acceptable. 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.

b) Flood Hazards

Impact

329. The project site is a high land, so there is no risk of flood hazards.

Mitigation

330. The project developer should undertake a flood risk study which will generally aim to determine flood quantities within the Solar Power Plant area and to estimate peak flood to determine the peak flow for the return period of 50years. The study will identify the required

hydraulic design structure which would be able to convey the flows safely and prevent flood risks for the infrastructure elements within the Solar Power Plant under the responsibility of project developer.

2. Construction Phase

331. Environmental effects of the construction phase are expected to be temporary. Construction impacts are considered 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 ESMP section. Following is the brief description of impacts envisaged during the construction phase.

a) Visual Amenity

Impact

332. The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, excavation, backfilling, and spoil.

333. The project site consists of areas that are sparsely vegetated or have no vegetative covers, and hence no trees or bushes will need to be removed as part of construction. In addition, 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 largely limited to effect only employees living in the company's temporary camp facilities during construction (if any).

Mitigation

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

b) Angel of the solar panel

Impact

335. The angle is important as inappropriate siting of the solar panel will be resulted in loss of solar irradiance and also damage batteries.

Mitigation

336. The effect of solar radiation falling on a solar cell is greater when the radiation is exactly orthogonal on the cell face and this depends on the tilt angle. The variation of the tilt angle from the optimal value decreases the cell performance due to visual and engineering impact. The productivity of the cell depends heavily on the intensity and angle of the solar radiation.

c) Water Resources

Impact

337. Surface water quality in the adjacent ponds and ditches 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 solar power plant.

Mitigation

338. 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.

d) Noise

Impact

339. Construction activities for solar power plant will contribute to noise impacts. There are several noise generating activities such as opening access roads to construction personnel camp and facilities (if needed), earthworks, haulage activities, excavation, backfilling, and installation of PV panels, and other equipment within the facility in addition to noise sources generated from machinery and equipment on site.

340. The project site is far from any cultural, religious site but there are some residences. These are the closest sensitive location to the project area. Hence, it can be said that the project site could not be a potential source of noise. However, some reptiles and mammals, within the project area can potentially be driven away from the site due to the sound levels.

Mitigation

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

- If noise levels were found to be excessive, construction activities should be stopped until adequate control measures are implemented;
- 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.; 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).

e) Air Quality

Impact

342. The main impacts associated with construction activities will be:

1) **Dust generation:** resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions.
2) **Exhaust emissions:** Exhaust emissions of SO_2, NO_x, CO, CO_2, and $PM_{10,}$ $PM_{2.5}$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

343. 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:

- 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;
- 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:
- Regular watering of all active construction areas.
- Proper planning of dust causing activities to take place simultaneously in order to reduce the dust incidents over the construction period.
- Proper management of stockpiles and excavated material (e.g. watering, containment, covering, bunding).
- Proper covering of vehicles transporting aggregates and fine materials
- Develop a regular inspection and scheduled maintenance program for vehicles, machinery, and equipment to be used throughout the construction phase for early detection of issue to avoid unnecessary pollutant emissions.

f) Soil

Impact

344. 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.

345. 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 topsoil which may degrade lower layers of soil depending on the amount of spills.

Mitigation

346. 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.

347. 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.

g) Terrestrial Ecology

Impact

348. The activities anticipated during the construction phase will include earthworks, excavations, grading, site leveling, 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.

349. 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.

350. 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

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

- 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. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30cm);
- 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:
    - Prohibit hunting at any time and under any condition by construction workers onsite
    - Ensure proper storage, collection, and disposal of waste streams generated
    - 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
    - Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.

h) Waste Generation

Impact

352. 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.

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

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

Mitigation

355. 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.

i) Employment Opportunities

Impact

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

Recommendation

357. Contractor as far as practicable will recruit construction workers from amongst the locals where possible, and shall maintain gender equity while employing the locals. Priority shall always be given to people from amongst the PAPs and from those unemployed and belong to the lower income group. 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 affected local community.

j) Health and Safety

Impact

358. 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, emergency provisions and a rescue/evacuation plans in case of major accidents.

Mitigation

359. 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 contactor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

360. 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.

k) Traffic

Impact

361. 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 project site is located near the national highway and high volume of traffic move through the road daily.

362. 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

363. Proper Traffic Management Plan (TMP) should be prepared by the contractor during starting of construction and follow it strictly. Minimum numbers of vehicles should be used for carrying construction materials.

l) Archaeology and Cultural Resources

Impact

364. The field visits conducted at the project site and it is found that there are some schools, colleges and madrasahs located within 1km of the project area. Hence, it can be said that there will be some minor impacts from construction on these receptors; therefore, the impact assessment process for this receptor has yielded the low significance.

Mitigation

365. 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 labor camp must maintain proper distance from the cultural sites.

3. Operational Phase

366. 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 that are beyond the purview of this project.

a) Visual Amenity

Impact

367. The presence of a large area of PV panels is not expected to constitute a risk for glare since it is situated 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 flyway over the project area.

Mitigation

368. 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.

369. 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 will therefore vary based on, among others, geographic location, time of year, cloud cover, and PV module orientation.

b) Battery Disposal

Impact

370. Risks associated with disposal of lead-acid batteries and lithium batteries used in mini-grids will present a challenge for the project's long-term sustainability

Mitigation

371. Long-term implications of the increased number of the energy storage units (mostly containing lithium ion batteries). Contractor should prepare battery disposal training program.

c) Disposal of Solar Panel

Impact

372. Solar panels are manufactured using hazardous materials, such as sulfuric acid and phosphine gas, which make them difficult to recycle. They cannot be stored in landfills without protections against contamination. They contain toxic metals like lead, which can damage the nervous system, as well as chromium and cadmium, known carcinogens that can leak out of existing e-waste dumps into drinking water supplies. Moreover, solar panels create about 300 times more toxic waste per unit of electricity generated than nuclear power plants.

Mitigation

373. Solar panels need to be replaced accordingly and also need to maintain regular maintenance.

d) Water Resources

Impact

374. The surface water bodies may be flooded and polluted due to uncontrolled release of contaminated storm-water/runoff from plant area. The pollutants associated with the plant activities include, hydrocarbons, heavy, corrosive products and suspended solids including insoluble heavy metals as colloidal materials from plant chemicals such as batteries etc.

375. Groundwater may be polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster infrastructure development near the project area. This will exert stress on the availability of groundwater in the project area.

Mitigation

376. The following mitigation measures are proposed to attenuate water quality related impacts:

- Prior to operation, an emergency response plan for spills of hazardous materials and oil will be prepared.
- The surface water quality monitoring will also be carried out at defined intervals and for environmental quality monitoring parameters suggested in the Environmental Monitoring Plan. If these parameters are above the prescribed limits, suitable control measures will be taken;
- Groundwater quality monitoring will be carried out as per schedule suggested in the Environmental Monitoring Plan.

e) Noise

Impact

377. 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.

378. 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 nighttime. Photovoltaic (PV) systems make no noise and cause no pollution in operation. Solar energy is clean, silent, and freely available.

Mitigation

379. 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.

f) Air Quality

Impact

380. No emissions are expected to be released during the operation phase, because solar PV power plants 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.

381. 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

382. 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 and social management plan (ESMP) included in this report.

383. 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 and battery.

g) Soil

Impact

384. 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.

Mitigation

385. 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.

h) Terrestrial Ecology

Impact

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

Mitigation

387. 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.

i) Waste Generation

Impact

388. ***PV modules:*** PV modules wastes are the other waste besides the lead-acid battery 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.

389. ***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.

390. 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 10000 to 15000 liters for cleaning the panels during different weather conditions.

391. ***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

392. 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 and battery.

393. 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.

j) Employment Opportunities

Impact

394. During the operation phase job opportunities will be created for executing the project activities. Local people can be involved in the project activities as per their skill.

Mitigation

395. During the recruitment of workers and other professionals, local poor and distressed people followed by project affected and poor women should be given priority as per their competence and skill. While recruiting and giving wage gender equity must be maintained.

k) Health and Safety

Impact

396. 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

397. *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.

398. *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.

399. *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.

400. *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.

401. *Transmission Line:* Workers specially engaged with the operation of transformers and other electrical equipment will be affected. Short circuit may be occurred if large trees come in contact with the substation during storm and as a result, accident may be happened.

Mitigation

402. 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.

403. 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 contactor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

l) Traffic

Impact

404. Impacts from traffic are not expected to occur during the operation phase due to minimal number of personnel present within the project site. Therefore, increased traffic load is not considered a significant impact.

Mitigation

405. This impact is temporary and minor negative in nature and can be mitigated by providing proper alternative traffic management plan during operation of the power plant.

4. Decommissioning Phase

406. 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.

a) Visual Amenity

Impact

407. During the dismantling of the solar power plant, removal of ancillary facilities, and the rehabilitation of the project area (if needed), visual intrusions will be likely.

Mitigation

408. 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.

b) Disposal of the Solar Panel

Impact

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.

Mitigation

If the solar panel is not handled and disposed of properly, these hazardous materials could pose serious environmental or public health threats. Manufacturers/project proponent have a strong financial incentive to ensure that these highly valuable and often rare materials are recycled rather than thrown away

c) Noise

Impact

409. 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

410. 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.

d) Air Quality

Impact

411. 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

412. 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 and social management plan (ESMP) included in this report.

e) Soil

Impact

413. During the decommissioning phase, the 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

414. 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.

f) Terrestrial Ecology

Impact

415. The activities associated with decommissioning will involve dismantling of the solar power plant and removal its facilities. This temporary phase 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

416. 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.

g) Waste Generation

Impact

417. 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.

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

419. 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.

420. PV modules and others: PV modules wastes are the other waste besides 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.

421. 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.

422. *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.

423. 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

424. 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.

h) Employment Opportunities

Impact

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

426. 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

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

i) Health and Safety

Impact

428. 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

429. 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.

j) Traffic

Impact

430. 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

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

G. Impacts of Transmission Line (TL)

1. Pre-Construction/Construction Phase

a) Clearing of Vegetation

Impacts

432. From the survey, we found no major trees in the surrounding area. However, for construction of TL trees need to be trimmed instead of cutting and thus the impact will be medium significant. The proposed TL stretch approximately 5.71 Km and no tree will be required to trim or cut for clearance of ROW. However, some general vegetation destruction shall result in reduction of biodiversity as valuable trees such as those of medicinal importance, wild fruits, and endangered species may be adversely impacted upon. Fauna providing habitat for most birds, snakes and other predators may also be affected, as vegetation cover of the understory is reduced. Disturbance to flora will lead to reduction in biodiversity.

Mitigation

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

- Before construction commences, undertake a flora survey (through an ecological expert) to identify the presence of any key floral species of importance. Should viable populations of such key species exist within the Project site then it should be relocated outside of construction active areas;

- 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.

b) Disturbance of Fauna

Impacts

434. Due to project activities such as earthworks, movement of project heavy equipment & transports with noise especially during nighttime, wildlife especially birds will be disturbed.

435. The way leave for the proposed distribution line could open or truncate some migratory routes for wild animals. However, open areas under the way leave could provide new browsing grounds for various animals. The presence of the construction workers in the project area may induce poaching. Leftover Aluminum conductors from construction works may give rise to snare wire that poachers eventually use to trap animals. Tower foundation works could disturb habitats for smaller mammals such as rodents and rats.

436. Adverse impacts may arise, from erected transmission lines, through accidental ramming of large birds into the power lines during their normal or regional and seasonal migratory flights. All vegetation layers, emergent, canopy and under-storey, allows for birds' habitat and nesting and therefore, the removal of vegetation may impact negatively on these activities.

Mitigations

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

- 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;
- Implement proper management measures to prevent damage to the natural fauna 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:
    - Prohibit hunting at any time and under any condition by construction workers onsite
    - 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
    - Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.

c) Loss of Top Soil

Impacts

438. For the construction of tower base and transmission line approximately 5.71kmlength will be temporarily used. Construction of the line might open up areas that could be exposed to soil erosion. The variability in soil texture in the study area entails that certain sections of the route could be exposed without any serious threat to water induced erosion. For instance, clayey top soils are highly prone to water induced erosion once exposed.

Mitigations

439. The impact will however be minimal as the area to be disturbed is small. The exposed soils will be paved with impervious material or grass turfing to minimize soil erosion.

d) Noise Pollution

Impacts

440. The proposed areas are relatively tranquil. Noise shall be created during construction especially since heavy-duty equipment shall be used in excavating, stringing and tower erection. Noise pollution shall, however, be limited to the construction and routing maintenance period. As a result, local community, project workers, wildlife and other lives will be affected specially during nighttime.

Mitigation

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

- If noise levels were found to be excessive, construction activities should be stopped until adequate control measures are implemented;
- 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.; 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).

e) Air and Dust Pollution

Impacts

442. Exhaust emissions are likely to be generated by the construction equipment during the construction phase of proposed transmission line. Motor vehicles that will be used to ferry construction materials would cause air quality impact by emitting pollutants through exhaust emissions. The impacts will not be significant.

443. Particulate matter pollution is likely to occur during the site clearance, excavation and spreading of the topsoil during construction of proposed substations. There is a very small possibility of PM_{10} suspended and settleable particles affecting the site workers and even neighbors' health, it is minimal given the construction method of minimum excavation and nil cart away of soil.

Mitigations

444. 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:

- 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;
- 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:
- Regular watering of all active construction areas.
- Proper planning of dust causing activities to take place simultaneously in order to reduce the dust incidents over the construction period.
- Proper management of stockpiles and excavated material (e.g. watering, containment, covering, bunding).
- Proper covering of vehicles transporting aggregates and fine materials
- Develop a regular inspection and scheduled maintenance program for vehicles, machinery, and equipment to be used throughout the construction phase for early detection of issue to avoid unnecessary pollutant emissions.

f) Pollution due to Wastes

Impacts

445. Generation of construction wastes (such as solid wastes: electric wire, pipes, stones, woods, rods etc., and liquid waste: paint, oil, bitumen etc.,) from the construction camp and general wastes (solid wastes: papers, containers, residues of food, fruits etc., and liquid waste: waste water from bathroom and kitchen etc.) from workers' camp will impact on H&S of the local community and workers as well as on aesthetic beauty of the area, air and soil if inadequate arrangements exist for the disposal of wastes.

Mitigations

446. 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.

g) Hydrology and Water Quality

Impacts

447. The surface water along the transmission line may be polluted due to wastes from the construction of transmission line. There are total 36 ponds and ditches and 6 canals along the ROW of the proposed transmission line. Solid wastes and erection of the tower base activities may pollute the surface water quality.

Mitigations

448. 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.

h) Traffic Congestion/Road Accident

Impacts

449. The heavy construction vehicles will be required for carrying of construction materials and equipment. Vehicles such as trucks, buses, jeeps, microbuses, cars, rickshaw vans, votvoti, motor bikes, bicycles as well as students and local people walk on the roads and as a

result, traffic jams occur specially during morning and evening times as observed during field survey. The construction vehicles will add more traffic and as a result, traffic congestion and road accident will be increased. Traffic congestion also will be occurred, if the stock piling of construction materials will be at the roadsides.

Mitigations

450. 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 and most of them will be non-motorized vehicle. Hence, the accidental loss is expected at the lowest. Moreover, the project authority will try to carry the construction materials during post monsoon when the water level remains the maximum so that the boat can reach at the closest point of the project location.

i) Siting of Construction Camps

Impacts

451. The project proponent in consultation with the project contractors will decide the precise locations for construction camps for the proposed project. However, the siting of the camps may cause a number of issues such as loss of plantation and vegetation, permanent physical and visual impact on the area. The construction process will take several years, with the result that the camps will take on a semi-permanent appearance. The people and the changes they bring can have significant impacts on the local communities and social structures. Substantial numbers of workers will inhabit the area in temporary camps loading local infrastructure and causing ambient social influence. Most important aspects are pollution risk of soil and surface water due to sanitation of the labour camps and wastes from the camps.

Mitigations

452. The construction camp will be sited in such a way, that there will be minimum impact on the nearby locality and environment. The wastes should not be thrown in open places. The contractor should train the labors to properly dispose their wastes. As well as, proper regulations should be implemented to prevent illegal hunting of animals and birds.

j) Occupational Health and Safety

Impacts

453. Health concerns over exposure to EMF are often raised when a new TL is proposed. To date the research has not been able to establish a cause and effect relationship between exposure to magnetic fields and human disease, nor a plausible biological mechanism by which exposure to EMF could cause disease. Rehabilitation of existing power lines is unlikely to increase EMF but new lines may induce EMF. Although any TL lines do not pass over the housing areas/populated areas however health may be affected however inspection of existing EMF along the selected routes of the existing and new Transmission and Distribution lines and around the Substation sites would be necessary, as a part of carrying out ESIA (by the consultant engaged for this purpose).

454. Construction workers are more likely to face occupational health hazards such as minor or major injuries due to lack of general safety requirements and precautions applicable while working at construction sites, and handling with machines and equipment, use of equipment and driving vehicles and so on. Poorly designed temporary labour camp and sanitation facilities may pose a health threat and nuisance to the workers. Uncontrolled vending of food and drinking water at the work site may also pose a risk with respect to the transmission of contagious diseases like Typhoid, Diarrhea, Malaria, and Dengue in particular.

Although presently, total ratio of the affected people in Bangladesh by HIV/AIDS is far less than 0.1%, however this percentage slowly increased due to injection drug users and overseas migrant workers returned to Bangladesh.

Mitigations

455. 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 contactor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

456. 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.

k) Community Health and Safety

Impacts

457. Improper health and safety policy maintained at the site may lead to outbreak of different diseases to the surrounding communities/public through the sick construction workers.

Mitigations

458. 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 contactor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

459. 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.

l) Employment Generation/Income

Impacts

460. During construction a considerable quantity of workers (both male & female) will be required for the construction activities. Conflict between male & female may be arisen if women workers are deprived. Some local people may also involve themselves in small businesses (e.g. tea stall, grocery shop etc.). Local people can be involved in the project construction work as per their skill.

Mitigation

461. During the recruitment of workers and other professionals, local poor and distressed people followed by project affected people and poor women should be given priority as per their competence and skill. While recruiting and giving wage gender equity must be maintained.

2. Operation Stage

a) Landscape

Impacts

462. Due to construction of transmission line in the rural areas, the natural landscape will be changed but not significantly.

Mitigations

463. As there will be no significant impacts, no specific mitigation measure is needed. But the project proponent should be careful while laying the transmission lines, so that the natural landscape does not change in a significant way.

b) Collision of Birds with Overhead Earth Wire

Impacts

464. Collision of birds with overhead earth wire has been identified as one of the most significant impacts on avifauna for the project. The open patches of grassland however would attract species such as storks, which could be at risk of collisions.

Mitigations

465. Mitigation in the form of route selection and earth wire marking will reduce the impact to Medium. The preferred route passes through habitat areas should be avoided in order to reduce the chances of collisions.

c) Community Health and Safety

Impacts

466. A total of 41 people is killed per year in Bangladesh due to short circuit. Short circuit may be occurred if large trees are exposed to the substation during storm and as a result, accident may be happened.

467. The effects of the corona are as follows:

i. The glow appears across the conductor which shows the power loss occur on it;
ii. The audio noise occurs because of the corona effect which causes the power loss on the conductor;
iii. The vibration of conductor occurs because of corona effect;

iv. The corona effect generates the ozone because of which the conductor becomes corrosive;
v. The corona effect produces the non-sinusoidal signal thus the non-sinusoidal voltage drops occur in the line;
vi. The corona power loss reduces the efficiency of the line; and
vii. The radio and TV interference occurs on the line because of corona effect.

Mitigations

468. 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.

469. 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 contactor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

d) Occupational Health and Safety

Impacts

470. Workers specially engaged with the operation of transformers and other electrical equipment will be affected. Short circuit may be occurred if large trees are exposed to the substation during storm and as a result, accident may be happened.

Mitigations

471. 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.

472. 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 contactor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

e) Improvement of Social & Economic Life

Impacts

473. Due to increase of power generation and the reliability of power supply, social life and economic condition of the people will be improved.

Recommendations

474. The government will distribute the power. Therefore, it is expected that, no illegal or no discrimination will happen in the payment method.

H. Summary of Significant Impacts

475. Table VII.4 and Table VII.5 present a summary of the anticipated impacts during the planning and construction, operation, and decommissioning phase of the Solar Power Plant and Transmission Line Project.

Table VII.4: Summary of Anticipated Impacts for Solar Power Plant

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Planning and Construction Phase									
Land-filling/ Earthworks	Soil erosion from the fill material, changes in existing landscape.	Short term	Local	Reversible	Certain	Medium	Severe	Moderate Negative	Low Negative
Flood Hazards	Project area is highland, no risk of flood	No anticipated impact							
Visual Amenity	The construction activities that are likely to create a visual intrusion and a disruption to aesthetics include: materials lay down, excavation, backfilling, and spoil.	Short term	Local	Reversible	Certain	Medium	Severe	Moderate Negative	Low Negative
Water Resources	Surface water quality in the adjacent rivers, channels, 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.	Could be long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	High Positive
Angle of the Solar Panel	Default in solar panel angle will be resulted in higher consumption providing lower output	Could be long term	Local	Reversible	Likely	Medium	Mild	Low Negative	High Positive
Battery Disposal	Resulted in severe health hazard as well as negative impact over environment	Could be long term	Local	Reversible	Likely	High	Severe	Moderate Negative	Low Negative
Solar Panel Disposal	Resulted in severe health hazard as well as negative impact over environment	Could be long term	Local	Reversible	Likely	High	Severe	Moderate Negative	Low Negative
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
Air Quality	Exhaust emissions are likely to be generated by the construction equipment during the construction phase of proposed transmission line. Motor vehicles that will be used to ferry construction materials would cause air quality impact by emitting pollutants through exhaust emissions.	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	High Positive

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Soil	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.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive
Terrestrial Ecology	Construction activities could disturb existing habitats (flora, fauna, and avifauna) and any threatened or endangered species that 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
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
Employment Opportunities	Positive benefits of the project may arise either from short-term job opportunities during construction, or from long-term job opportunities during operation. It is important that construction and operation job to be targeted to the local people within *Majhipara* where feasible.	Short term	Local	Reversible	Likely	High	Severe	Low Negative	High Positive
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
Traffic	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.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Archaeology and Cultural Resources	The field visits conducted at the project site and it is found that there are some schools, colleges, and madrasah located within 1km of the project area. Hence, it can be said that there will be some minor impacts from construction on these receptors	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Operation Phase									
Visual Amenity	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	Long term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	visual impacts related to interaction with surrounding landscape.								
Water Resources	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, most significant sources of soil and water pollution are the chemicals from PV panel's damage and from the expired batteries.	Long term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low negative
Noise	The only significant noise source from the operation activities that will likely include the use of backup generators to ensure continuous power supply.	Long term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Angle of the Solar Panel	Default in solar panel angle will be resulted in higher consumption providing lower output	Could be long term	Local	Reversible	Likely	Medium	Mild	Low Negative	High Positive
Battery Disposal	Resulted in severe health hazard as well as negative impact over environment	Could be long term	Local	Reversible	Likely	High	Severe	Moderate Negative	Low Negative
Solar Panel Disposal	Resulted in severe health hazard as well as negative impact over environment	Could be long term	Local	Reversible	Likely	High	Severe	Moderate Negative	Low Negative
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
Soil	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.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive
Terrestrial Ecology	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
Waste Generation	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	Long term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	and health effects on people due to battery maintenance.								
Employment Opportunities	During the operation phase, job opportunities will be created for executing the project activities. Local people can be involved in the project activities as per their skill.	Short term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative
Occupational and Community Health and Safety	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
Traffic	Impacts from traffic are not expected to occur during the operation phase due to minimal number of personnel present within the project site. Therefore, increased traffic load is not considered a significant impact.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Decommissioning Phase									
Visual Amenity	During the dismantling of the solar power plant, removal of ancillary facilities, and the rehabilitation of the project area (if needed), visual intrusions will be likely.	Long term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative
Noise	Possible noise emissions to the environment from the decommissioning activities that 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
Air Quality	Decommissioning activities will likely result in an increased level of dust and particulate matter emissions that in turn will directly affect ambient air quality.	Short term	Local	Reversible	Certain	Medium	Low	Moderate Negative	Low Negative
Soil	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.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive
Terrestrial Ecology	The activities associated with decommissioning will involve dismantling of the solar power plant and	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	Moderate Positive

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	removal its facilities. This temporary phase could result in some additional noise and dust disturbances.								
Waste Generation	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 health effects on people due to battery maintenance.	Long term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative
Employment Opportunities	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.	Short term	Local	Reversible	Certain	Medium	Mild	Moderate 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
Traffic	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.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

Table VII.5: Summary of Anticipated Impacts for Transmission Line

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Planning and Construction Phase									
Clearing of Vegetation	From the survey, we found no major trees in the surrounding area. However, most of the trees need to be trimmed instead of cutting and thus the impact will be medium significant.	Short term	Local	Reversible	Certain	Medium	Severe	Moderate Negative	Low Negative

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Disturbance of Fauna	Adverse impacts may arise, from erected transmission lines, through accidental ramming of large birds into the power lines during their normal or regional and seasonal migratory flights. All vegetation layers, emergent, canopy and under-storey, allows for birds' habitat and nesting and therefore, the removal of vegetation may impact negatively on these activities.	Short term	Local	Reversible	Certain	Medium	Severe	Moderate Negative	Low Negative
Loss of Top Soil	For the construction of tower base and transmission line, approximately 5.2km length will be temporarily used. Construction of the line might open up areas that could be exposed to soil erosion.	Short term	Local	Reversible	Certain	Medium	Severe	Moderate Negative	Low Negative
Water Resources	The movement of surface water in wetlands contributes to the character of the existing ecosystem. Cut and fill activities may inhibit, enhance, or redirect the flow of water and, in so doing, change the nature of both the established water regime and the biological community of a site.	Could be long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	High Positive
Noise	The proposed areas are relatively tranquil. Noise shall be created during construction especially since heavy-duty equipment shall be used in excavating, stringing and tower erection. Noise pollution shall, however, be limited to the construction and routing maintenance period.	Long term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative
Air Quality	Exhaust emissions are likely to be generated by the construction	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	High Positive

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	equipment during the construction phase of proposed transmission line. Motor vehicles that will be used to ferry construction materials would cause air quality impact by emitting pollutants through exhaust emissions.								
Soil	Due to accidental spillage and leakage of oil and toxic chemical (if falls on the soil surface) will pollute the local soil.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive
Waste Generation	Generation of construction wastes (such as solid wastes: electric wire, pipes, stones, woods, rods etc., and liquid waste: paint, oil, bitumen etc.,) from the construction camp and general wastes (solid wastes: papers, containers, residues of food, fruits etc., and liquid waste: waste water from bathroom and kitchen etc.) from workers' camp will impact on H&S of the local community and workers as well as on aesthetic beauty of the area, air and soil if inadequate arrangements exist for the disposal of wastes.	Short term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative
Traffic	The heavy construction vehicles will be required for carrying of construction materials and equipment. Vehicles such as trucks, buses, jeeps, microbuses, cars, rickshaw vans, votvoti, motor bikes, bicycles as well as students and local people walk on the roads and as a result, traffic jams occur specially during morning and evening times as observed during field survey.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Siting of Construction Camp	The project proponent in consultation with the project contractors will decide the precise locations for construction camps for the proposed project. However, the siting of the camps may cause a number of issues such as loss of plantation and vegetation, permanent physical and visual impact on the area.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Occupational Health and Safety	Construction workers are more likely to face occupational health hazards such as minor or major injuries due to lack of general safety requirements and precautions applicable while working at construction sites, and handling with machines and equipment, use of equipment and driving vehicles and so on.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Community Health and Safety	Improper health and safety policy maintained at the site may lead to outbreak of different diseases to the surrounding communities/public through the sick construction workers.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Terrestrial Ecology	Construction activities could disturb existing habitats (flora, fauna, and avifauna) and any threatened or endangered species that 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
Employment Opportunities	During construction a considerable quantity of workers (both male & female) will be required for the construction of the substation. Conflict between male & female may	Short term	Local	Reversible	Likely	High	Severe	Low Negative	High Positive

Environmental Attribute	Likely Impacts	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	be arisen if women workers are deprived. Some local people may also involve themselves in small businesses (e.g. tea stall, grocery shop etc.)								
Operation Phase									
Landscape	Due to construction of transmission line in the rural areas, the natural landscape will be changed but not significantly.	Short term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative
Collision of Birds with Overhead Earth Wire	Collision of birds with overhead earth wire has been identified as one of the most significant impacts on avifauna for the project. The open patches of grassland however would attract species such as storks, which could be at risk of collisions.	Short term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative
Occupational and Community Health and Safety	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
Improvement of Social and Economic Life	Due to increase of power generation and the reliability of power supply, social life and economic condition of the people will be improved.	No Anticipated Impacts							

VIII. CLIMATE CHANGE ASSESSMENT

A. Overview

476. Climate change is one of the significant factors considered in the Environmental/Ecological Assessment. Climate change assessment is done for the current assessment process with the objective to provide assurance that climate change implications are being appropriately considered in the design of the proposed project. The specific objectives are to:

- Support the project authority manage or reduce the potential risk posed by the impacts of climate change to the project and contribute to climate change action;
- Provide project managers of the co-financiers with information that will assist their broader climate change action; and
- Help decision makers to address climate change implications in a risk management context.

477. The current assessment is conducted climate change related investigation based on globally and nationally published climate change prediction reports focusing particularly on the variability of rainfall intensity, temperature changes, sea level rise. These variables are directly related to the functionality and durability of the proposed project.

478. To conduct the assessment literature review has been conducted available from different national climate change relevant agencies, such as Department of Disaster Management, Department of Environment and Bangladesh Meteorological Department. International and National Climate Change Communication reports, especially the 5th Intergovernmental Panel on Climate Change IPCC Assessment report has been reviewed for relevant major sources of information for impact and vulnerability projection on global and regional temperature, sea level rise, rainfall fluctuation and their impacts on proposed infrastructures. This climate change projection information will help in making the proposed project climate resilient.

B. Climate Change Impact Considerations

479. The impacts consideration assessed the hydro-meteorological parameters that are directly and indirectly exposed to climate change phenomenon for facilitating the detail design and environmental impact assessment process. Projecting the impact of global climate change on any infrastructure/related natural resources requires representation of climate processes on a variety of spatial scales, from global down to local level. In this regard, under the current scope of works, neither any climatic models nor any hydro-dynamic simulation was newly conducted; rather raw data available from different existing climate and hydro-metric observations and regional projections from different sources were used. The assessment provides some recommendation/potential solutions/mitigation for climate resilient structures based on the findings of the literature review.

1. Climate Projections: Temperature

480. The IPCC 5th assessment report (AR5) indicates that the global mean temperatures will continue to rise over the 21st century if greenhouse gas (GHG) emissions continue unabated. Global surface temperature change for the end of the 21stcentury is likely to exceed 2.5°C relative to 1986 to 2005 for all RCP (Representative Concentration Pathway) scenarios except RCP2.6, and warming will continue beyond 2100 under all RCP scenarios except RCP2.6. Table VIII.1shows the projected change in global mean surface air temperature.

Table VIII.1: Projected Change in Global Mean Surface Temperature (Likely Range)

Time Period (Base Year 1986 to 2005)	Temperature (°C)			
	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
2046-2065	0.4 to 1.6	0.9 to 2.0	0.8 to 1.8	1.4 to 2.6
2081-2100	0.3 to 1.7	1.1 to 2.6	1.4 to 3.1	2.6 to 4.8

481. On the other hand, for South Asia the report projections indicate that, compared to the average in the 20th century, average annual temperatures could rise by more than 2°C over land in most of South Asia by the mid-21st century and exceed 3°C, up to more than 6°C over high latitudes, by the late 21st century under a high-emissions scenario (RCP8.5); while under a low-emissions scenario (RCP 2.6) average temperatures could rise by less than 2°C in the 21st century, except at higher latitudes, which could be up to 3°C warmer.

482. Even though, IPCC assessment report does not provide any country level projections, under the Comprehensive Disaster Management Programme (CDMP II) of Department of Disaster Management (Ministry of Disaster Management & Relief) acclimate model PRECIS (Providing Regional Climates for Impacts Studies) is used to get climate change scenario for Bangladesh. Table VIII.2 shows the projected temperature change for Bangladesh under CC scenario.

Table VIII.2: Projected Temperature Change for Bangladesh under CC Scenario

Time Period	Temperature (°C)		
	Annual	Monsoon (Jun-Sep)	Winter (Dec-Feb)
(Base Year 1961-1990, Mean)	24.6	31.83	16.2
2071-2100	4.34	3.43	5.37
2011-2041	1.49	1.50	1.80

2. Climate Projections: Precipitation

483. AR5 reports that, in the long term, global precipitation will increase with increased global mean surface temperature. Global mean precipitation will increase at a rate per degree Celsius smaller than that of atmospheric water vapour. It will likely increase by 1 to 3% / ˚C for scenarios other than RCP2.6, for RCP2.6 the range increase will be 0.5 to 4% / ˚C at the end of the 21st century.

484. In the South Asian region AR5 projections indicate that under a high-emissions scenario more rainfall will be very likely at higher latitudes by the mid-21stcentury and over southern areas of the late 21st century. Under a low-emissions scenario, more rainfall at higher latitudes is likely by mid-century but no likely substantial changes in rainfall patterns at low latitudes. More frequent and heavy rainfall days are projected over parts of South Asia. (IPCC, 2007)

485. Analysis of past trend of rainfall by (CDMP II, 2013) study reveals that all-Bangladesh annual normal rainfall has not changed much in Bangladesh. For a period of 30 years (1980-2009), the annual normal rainfall is found to be 2,306 mm, such rainfalls were 2,298 and 2,314 mm during 1960-1989 and 1970-1999, respectively. On the other hand, Bangladesh normal rainfalls in different seasons show some mixed trend. Pre-monsoon (March-May) and post-monsoonal (October-November) normal rainfalls have increased and the monsoonal (June-September) normal rainfall has decreased over the three time periods (1960-89, 1970-99 & 1980-2009). The winter (December-February) normal rainfall has increased in the last two periods compared to the first period. The change in projected precipitation for Bangladesh, as found by PRECIS run (CDMP II report) is presented in the following Table VIII.3.

Table VIII.3: Projected Precipitation Change for Bangladesh under CC Scenario

Time Period	Precipitation (mm/day)		
	Annual	Monsoon (Jun-Sep)	Winter (Dec-Feb)
(Base Year 1961-1990, Mean)	3.5	7.24	0.59
2071-2100	0.90	1.43	0.03
2011-2041	0.64	1.40	-0.05

3. Climate Projections: Sea Level Rise

486. AR5 predicted, it is very likely that the rate of global mean sea level rise during the 21st century will exceed the rate observed during 1971–2010 for all Representative Concentration Pathway (RCP) scenarios due to increases in ocean warming and loss of mass from glaciers and ice sheets Table VIII.4.

Table VIII.4: Global Mean Sea Level Rise (Values Shown as Median and Likely Range)

Time Period (Base Year 1986-2005)	Sea Level Rise (m)			
	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
2020	0.08 [0.06 to 0.10]	0.08 [0.06 to 0.10]	0.08 [0.06 to 0.10]	0.08 [0.06 to 0.11]
2050	0.22 [0.16 to 0.28]	0.23 [0.17 to 0.29]	0.22 [0.16 to 0.28]	0.25 [0.19 to 0.32]
2080	0.35 [0.24 to 0.48]	0.41 [0.28 to 0.54]	0.40 [0.28 to 0.53]	0.50 [0.37 to 0.67]
2100	0.44 [0.28 to 0.61]	0.53 [0.36 to 0.71]	0.55 [0.38 to 0.73]	0.74 [0.53 to 0.98]

487. It is very likely that in the 21stcentury and beyond, sea level change will have a strong regional pattern, with some places experiencing significant deviations of local and regional sea level change from the global mean change. However, no local level SLR data could be found for Bangladesh based on the AR5 by the current assessment. The potential impact of SLR on the infrastructures of the proposed project described in the following section based on available literatures.

4. Salinity Intrusion

488. Saline water intrusion is highly seasonal in Bangladesh and during dry season deep landwards intrusion occurs through the various tidal rivers in the western part of the delta, and through the Lower Meghna estuary. Studies show that more saline water intrusion is likely to occur during dry season with the increased sea level rise. A study by WARPO (2005) shows that sea level rise would increase the extent of saline intrusion by pushing the saline waterfront landwards as projected based on IPCC 3rd Assessment Report (TAR 2001, which predicted global sea level rise of 32 cm by 2050 and 88 cm by 2100).

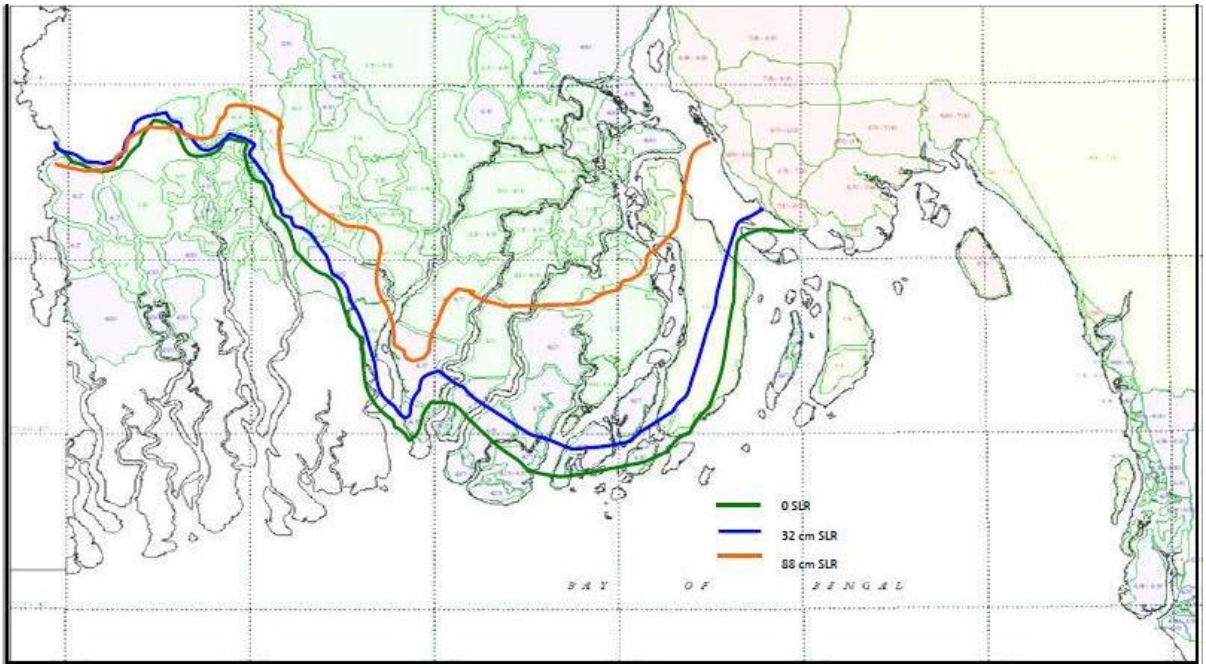


Figure VIII.1: Salinity Intrusion for Different Sea Level Rise during Dry Season (WARPO 2005)

489. Another study by DEFRA (2007) with a modified SLR projection (under high emission scenario A2) of TAR presented salinity intrusion map as follows.

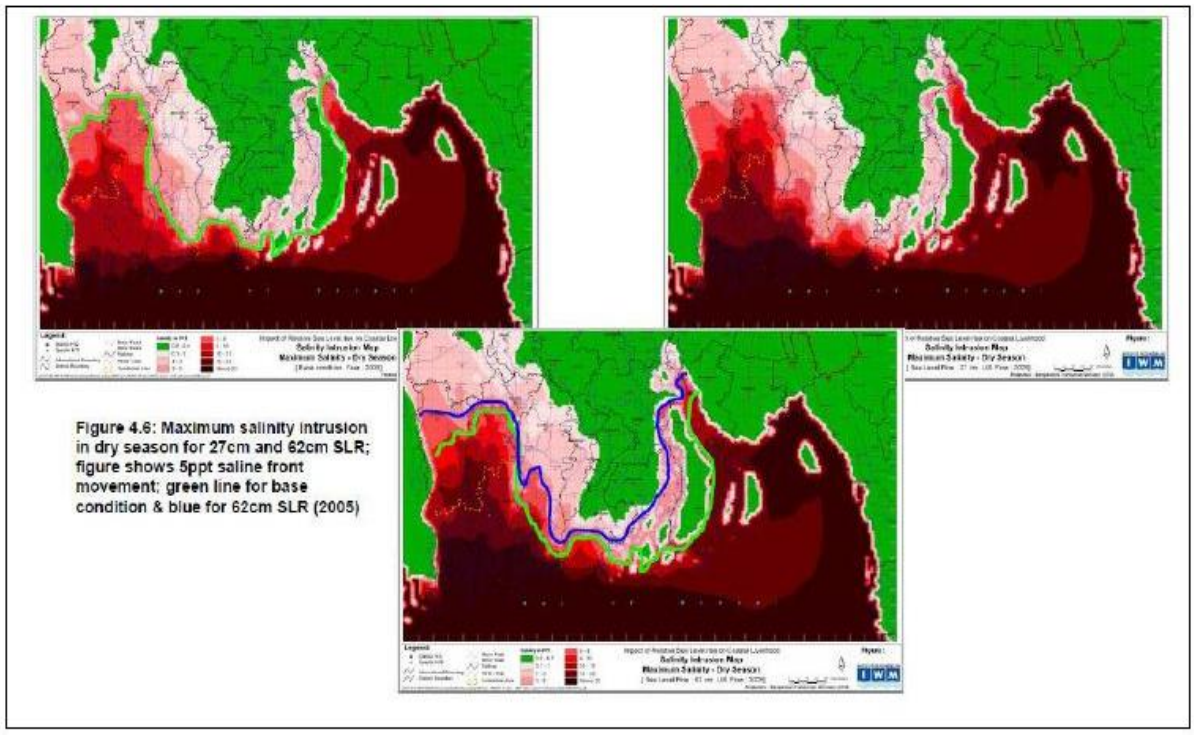


Figure VIII.2: Salinity Intrusion for Different Sea Level Rise during Dry Season (DEFRA 2007)

C. Mitigation

- Since the project is located far from the coastal region thus it is free from the impact of cyclones and storm surges. So, the project proponent does not need any further mitigation measures related to these impacts;
- The prediction of sea level rise and salinity intrusion also shows that the area is free from the impacts also;

- The climate change assessment also revealed that the amount of precipitation will increase due to climate change. Since during the longer monsoon will hamper the power production so the project owner should take consideration the future impact in plant design;
- Emission of GHG is mostly negligible for the current assessment as the project is a solar power project. On the other-hand it would contribute in reduction of GHG by establishing a renewable energy-based power generation system. However, following are some recommendations to contribute in country's effort in GHG reduction:
  - ✓ Plantation along the both side of the highway near the project area and Swietenia mahagoni (Mehogoni), *Lophopetalum fimbriatum* (Rokton), *Anthocephalous chinensis* (Kadam), *Samanea saman* (Raintree), *Trewia polycarpa* (Pitali), *Salix tetrasperma* (Indian willow), *Terminalia bellirica* (Bohera) and *Syzygium grandis* (Dhakijam) are suitable for plantation in this region.
  - ✓ Adopt an energy-efficient construction mechanism.

IX. DISASTER IMPACT ASSESSMENT

A. Overview

490. Disaster is another significant factor considered in the Environmental/Ecological Assessment in a disaster-prone country like Bangladesh. Disaster impact assessment is done to provide assurance that possible disaster and natural hazards are being appropriately considered in the design of the proposed project. The specific objectives are to:

- Identification of significant disasters that should be assessed for the project.
- Assessment of the significant impacts of considered disasters and suggesting general management and mitigation measures for the disasters.

491. The current assessment is conducted disaster related investigation based on globally and nationally published disaster related reports focusing particularly on flooding, waves, cyclones, tsunami and earthquakes.

492. Literature review has been conducted available from different national climate change relevant agencies, such as Department of Disaster Management, Department of Environment, and Bangladesh Meteorological Department. This disaster impact projection information will help in making the proposed project climate resilient.

a) Flood Hazards

493. Bangladesh is located at the confluence of three major river basins: the Ganges, Brahmaputra and Meghna (GBM) basins. In order to understand the future impacts on water resources in Bangladesh, it is necessary to investigate these trans-boundary rivers (only 5% of the Ganges catchment and 7% of the Brahmaputra catchment lie in Bangladesh) (Faifung, Franchis, & Jahir, 2006).

494. The previous phenomena related with flooding illustrates that, the magnitudes of water level of peak flows at Bahdurabad in the Brahmaputra in 2007, 2004, 1998, 1988 were found 0.88m, 0.68m, 0.87m and 1.12 mPWD above danger level respectively. At Hardinge Bridge of the Ganges River, the magnitudes of water level during floods in 2007, and 2004 were always below the danger level. During 1998 and 1988, magnitudes of the peak flow were found 0.94m and 0.62 mPWD above danger level respectively. In terms of the magnitudes of peak flows in the Meghna River at Bhairab Bazar point in 2007, 2004, 1998, 1988 were found 0.69m, 1.53m, 1.08m and 1.41 mPWD above danger level respectively (Islam, Haque, & Bala, May 2008).

495. Bangladesh is one of the first line victims of ongoing and upcoming threats of climate change due to its geographical location, poverty and higher dependence on climate sensitive sectors like agriculture. The Merciless face of climate change and sea level rise reflects in the form of intense and frequent cyclone with tidal surge, subsequent flooding, salinity regression, extreme temperature and precipitation along with local problems like river erosion, water logging and weak institutional framework poses the highest vulnerability in Bangladesh. Flooding is caused downstream from dams when reservoirs, which normally help to prevent downstream areas of rivers from flooding, are opened due to unusually high levels of precipitation to prevent the reservoir from overflowing the dam.

496. A summary of year-wise percentage of areas inundated by flood is given in below Table IX.1.

Table IX.1: Year wise Percentage of Area Inundated by Flood in Bangladesh

Year	Flood Affected Area		Year	Flood Affected Area		Year	Flood Affected Area	
	KM²	% of area inundated		KM²	% of area inundated		KM²	% of area Inundated
1954	36,800	25	1975	16,600	11	1995	32,000	22
1955	50,500	34	1976	28,300	19	1996	35,800	24
1956	35,400	24	1977	12,500	8	1998	1,00,250	68
1960	28,400	19	1978	10,800	7	1999	32,000	22
1961	28,800	20	1980	33,000	22	2000	35,700	24
1962	37,200	25	1982	3,140	2	2001	4,000	2.8
1963	43,100	29	1983	11,100	7.5	2002	15,000	10
1964	31,000	21	1984	28,200	19	2003	21,500	14
1965	28,400	19	1985	11,400	8	2004	55,000	38
1966	33,400	23	1986	6,600	4	2005	17,850	12
1967	25,700	17	1987	57,300	39	2006	16,175	11
1968	37,200	25	1988	89,970	61	2007	62,300	42.21
1969	41,400	28	1989	6,100	4	2008	33,655	22.80
1970	42,400	29	1990	3,500	2.4	2009	28,593	19
1971	36,300	25	1991	28,600	19	2010	26,530	18
1972	20,800	14	1992	2,000	1.4	2011	29,800	20
1973	29,800	20	1993	28,742	20	2012	17,700	12
1974	52.600	36	1994	419	0.2	2013	15,650	10.6

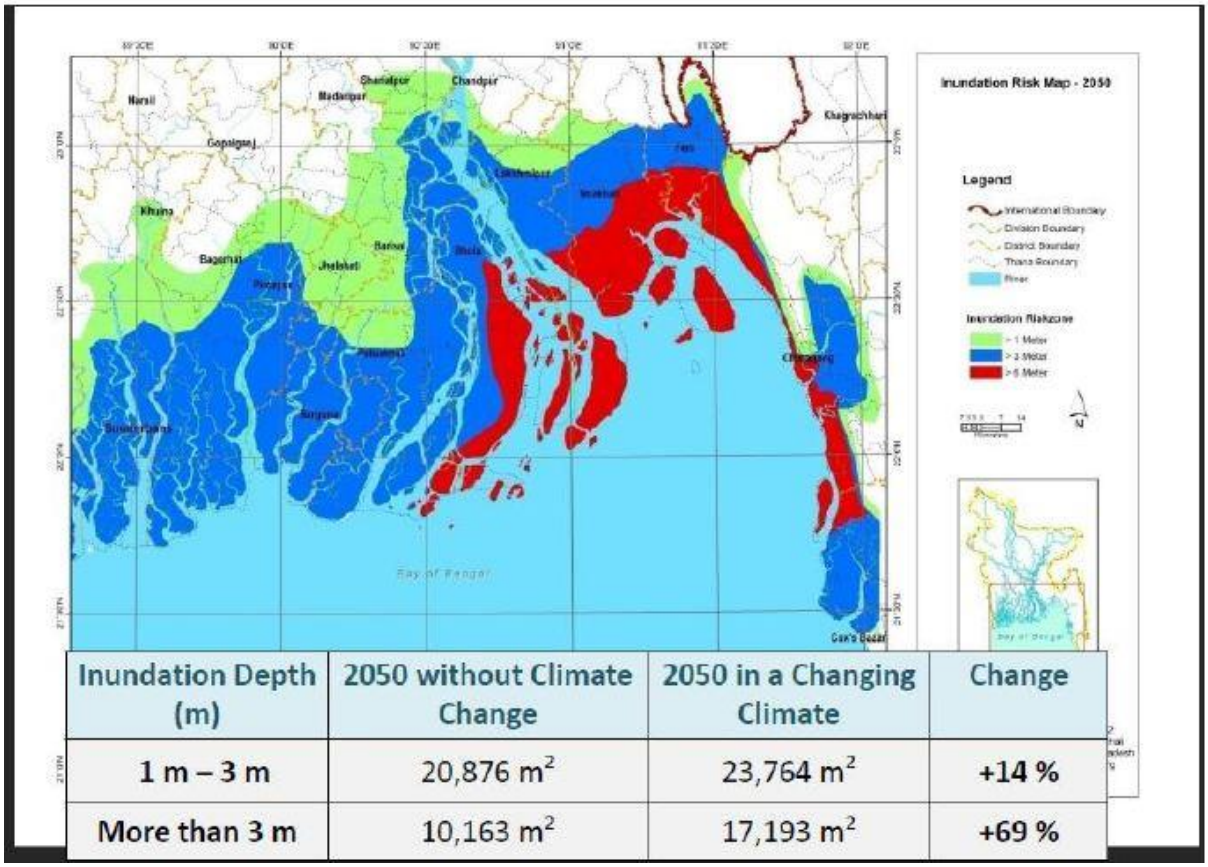
Source: FFWC, 2012

497. Due to the location of Northwest Bangladesh, the situation in this area is deeply inter-related with Himalayan riverine systems and its tributaries and therefore many communities along the major rivers (Brahmaputra and Teesta) are at risk. It is expected that climate change induced alterations in temperature would affect the timing and rate of snow melt in the upper Himalayan reaches. Recent study shows that glaciers in the Himalaya are receding faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate (IPCC, 2007c).Four major floods occurred over a span of 17 years from 1987 to 2004.Riverbank erosion is in second place, not in terms of deaths, but in terms of the process of impoverishment and landlessness of the many people affected. The number of deaths during monsoon floods, even during extraordinary events, is comparatively small. Flood occurs in the month of Ashar to Aswin. However, the severe damages toke place in the month of Srabon and Vadro. The second places hazard, riverbank erosion happened in the same time. The agricultural drought occurs in the months of Katrik to Agrahayan during Aman cultivation and severely occurs in the month of katrik. Pest infestation occurs in the month of Aswin, katrik and Agrahayan, during aman cultivation, when rainfall is rare. Cold wave is another problem that affects in the months of poush and Magh; it has an effect on human health and rabi crops like potato and mustered. Active floodplains lie within and along the main river channels. These are marginal environments for human occupancy and are highly vulnerable to floods and riverbank erosion. Stable floodplain land provides good crops in normal years, but kharif crops are vulnerable to untimely or unusually high floods.

498. The project area of Panchagarh has very steep slope. Hence, floodwater quickly passes this region. However, the rivers around the area sometimes experiences flash flood due to heavy rainfall at upstream. This cause sometimes overbank flooding for a very small duration and limited areas. As the project area is 2 km away from Dahuk River, there is almost no chance of flooding of this area.

b) Storm-Surge Inundation

499. World Bank conducted a GIS-based research in Bangladesh to delineate vulnerable zone in coastal areas to larger storm-surges and sea-level rise in a changing climate by 2050 during 2010 (Figure IX.2). The project developed inundation risk map due to SLR under climate change condition following IPCC AR4 (IPCC, 2007). The project area does not have the risk from storm-surge inundation due to its location.



Inundation Depth (m)	2050 without Climate Change	2050 in a Changing Climate	Change
1 m – 3 m	20,876 m^2	23,764 m^2	+14 %
More than 3 m	10,163 m^2	17,193 m^2	+69 %

Figure IX.1: Storm-Surge Inundation Area (2050 in a Changing Climate)

c) Wave and Marine Currents

500. Bangladesh lies on mostly flat, alluvial land at the mouth of the Ganges-Brahmaputra-Meghna (GBM) Basins facing the Bay of Bengal to the south, with approximately 710 km of coastline. Bangladesh is well known to be one of the most vulnerable countries to the future sea level rise (SLR) due to global warming. While it is not currently experiencing adverse impact, it is projected to be the most vulnerable country to the SLR in the future climate. Therefore, a number of studies have been conducted assessing the impacts of climate change on Bangladesh [*Ali*, 1996, 1999; *Karim and Mimura*, 2008; *Rahman et al*., 2009; *Ruane et al*., 2013; *Sarwar*, 2005]. Among these studies, *Rahman et al*. [2009] give a comprehensive overview of climate change projections for rainfall, temperature, river floods, and sea level rise for subregions of Bangladesh and identify adaptation strategies according to particular impact factors and vulnerabilities from interviews and stakeholder workshops. *Ruane et al*. [2013] present a good list of studies of the impact of climate change on agricultural production in Bangladesh considering various factors, such as coastal flooding, temperature and carbon dioxide effects, and river flooding, and also present studies testing adaptation strategies. *Karim and Mimura* [2008] study the impacts of climate change and SLR on present and future conditions on storm surge floods in the western coastal region and suggest a countermeasure based on shelters.

501. Coast of Bangladesh is 734 km long along the Bay of Bengal. 50 Million People 19 districts and 147 sub-districts are affected by coastal problems directly or indirectly. 48 sub-districts of 12 districts are directly exposed to the sea or lower estuary and considered as 'exposed' coastal areas. Traditionally the coast of Bangladesh is divided into three parts; the Ganges Deltaic Coast, Estuarine Coast and the Cliff Coast.

502. Cyclones in Bangladesh and Bay of Bengal occurred from 1981 to 1985 are: 174 severe cyclones (with wind speeds of more than 54 km/ hr) formed in the Bay of Bengal. Cyclones occur mostly during pre-monsoon (April-May) and post-monsoon (September-December) period.

Table IX.2: Major cyclones that hit the Bangladesh Coast

Date	Maximum Wind Speed (Km/hr)	Storm Surge Height (m)	Death Toll
11 May, 1965	161	3.7-7.6	19,279
15 December, 1965	217	2.4-3.6	873
01 October,1966	139	6.0-6.7	850
12 November, 1970	224	6.0-10.0	300,000
25 May, 1985	154	3.0-4.6	11,069
29 April,1991	225	6.0-7.6	138,882
19 May, 1997	232	3.1-4.6	155
15 November (SIDR) 2007	223-3363		3363
25 May (AILA), 2009	92-190		

Source: Bangladesh Meteorological Department

d) Cyclone and Storm Surges

503. Bangladesh, with its repeated cycle of floods, cyclones, and storm surges, has proved to be one of the most disaster-prone areas of the world. During the years from 1797 to 1991, Bangladesh has been hit by 60 severe cyclones (mostly accompanied by storm surges). This paper gives a brief account of these disasters with particular reference to the wind speed, surge height, loss of life, and damage to crops and properties, etc.

504. In order to protect the coastal areas of Bangladesh from cyclonic storm surges and floods, a major system of embankments was constructed during the 1960s and 1970s, but this is now in need of rehabilitation. The Cyclone Protection Project, which was approved by the World Bank in 1989, would rehabilitate some of the existing embankments, build new embankments, and construct roads. Locally available materials, indigenous technology, and cheap surplus work force should be used in this project. A variety of fruit trees should be planted along the dikes and roads.

505. To the southwestern part of Bangladesh bordering the Bay of Bengal, lies the world's largest single mangrove tract, known as the Sundarbans, which covers a total area of 571,500 ha. This mangrove forest is of extreme importance since it provides efficient protection to life and property against cyclones and storm surges. However, due to deforestation, the width of the mangrove belt is being rapidly diminished. The author therefore lays emphasis on coastal afforestation.

506. Absolute security against cyclone hazard is probably out of the question, but an effective cyclone warning response can definitely reduce loss of life and damage to property. The author discusses the current conditions for cyclone forecasting and warning in Bangladesh, and then puts forward some proposals for improving the Cyclone Preparedness Programme.

e) Earthquakes and Tsunamis

507. Mega thrust faults occur at subduction zones, where Earth's tectonic plates are colliding with each other and one plate is moving (or "subducting") under another. These faults produce the largest earthquakes, reaching and even exceeding 9.0 magnitude, with recent examples being the 2011 Japan earthquake and tsunami, as well as the 2004 Banda Aceh earthquake and resulting Indian Ocean tsunami.

508. A vast majority of these mega thrust faults and their resulting earthquakes occur under the ocean, which is why they can unleash tsunamis. It is rare to find these types of faults under land, and even more rare -- and potentially catastrophic -- to have one directly underneath such a major population center. The study indicates that more than 140 million people live within 100 kilometers (60 miles) of this fault in Bangladesh, India and Myanmar.

509. A recent historical earthquake statistic is shown in Table IX.3.

Table IX.3: Historical major Earthquakes around Bangladesh

Sl. No.	Date (D/M/Y)	Lat (°N)	Long (°E)	Magnitude (Richter Scale)	Location of Epicenter
1	10-01-1869	24.79	93.17	7.5	Kachar, Assam, India
2	14-07-1885	24.70	89.55	7.0	Eastern Province, Nepal
3	12-06-1897	25.84	90.38	8.8	Shilang, Meghalaya, India
4	08-07-1918	24.16	91.75	7.6	Dauki, Meghalaya, India
5	02-07-1930	25.95	90.04	7.1	Dhubri, Assam, India
6	15-01-1934	26.60	86.8	8.3	Bihar-Nepal Border
7	23-10-1943	26.80	94.00	7.2	Assam, India
8	15-08-1950	28.79	95.62	8.6	Tibet, China
9	21-03-1954	25.86	94.00	7.2	Assam, India
10	08-07-1975	25.58	92.60	6.5	Assam, Sillon
11	06-08-1988	25.13	95.15	6.6	Manipur-Myanmar Border
12	21-11-1997	22.07	92.75	8.5	Arakan, Myanmar
13	11-08-2009	15.01	92.30	7.8	Andaman Islands

(Source: National Encyclopedia of Bangladesh, Banglapedia, CD Edition February 2006)

510. Tsunami is a series of very long waves generated by any rapid, large-scale disturbance of the sea or by sea floor displacements from large undersea earthquakes. Thus, tsunami is defined as a large destructive ocean wave caused by an underwater earthquake or some other movement of the earth's surface or some geologic processes like undersea landslide or volcanic eruption.

511. Tsunamis can cause great destruction and loss of life within a minute on shores near their source. They are capable of obliterating coastal settlements, and may cause severe coastal flooding and ecological disruption of coastal areas. It is very hard to escape violent disasters caused by tsunami.

512. However, it is very important to create public awareness, improved tsunami detection, mitigation and warning system for avoiding huge loss of life and property. Experts have suggested the following steps: i. Preservation of coral reef and natural mangrove forests; ii. Afforestation in coastal areas; iii. To keep a pollution free sea; iv. Stop excessive fishing and introduce modern sustainable fish catching methods; v. Public dwellings should be kept at least 500 meters away from a seashore, coastal embankment etc.

B. Mitigations

513. The mitigation measures that should be taken for the mitigation or preparedness of disaster impacts are:

- Analyze the annual disaster trends of the project area and identify the most disastrous months.
- Avoid construction works during that period.
- Use earthquake resistant construction materials.
- Design and implement the project keeping in mind about the possible disaster and their impacts.

X. CUMULATIVE AND INDUCED IMPACTS

A. General

514. According to the ADB Environment Safeguards Sourcebook Cumulative Impacts is described as: "The combination of multiple impacts from existing projects, the proposed project, and anticipated future projects that may result in significant adverse and/or beneficial impacts that cannot be expected in the case of a stand-alone project."

515. The objective of the current cumulative impact assessment is to evaluate the combined effects of proposed developments along the proposed project route. The project adverse impacts have been broadly classified as impacts on land, structures (residential, commercial, residential cum commercial and others) impacts on other immovable assets, impacts on other property assets, impact on community property resources (religious structures, madrasah, school, passenger shelter, etc.), impacts on livelihood, etc.

B. Cumulative Negative Impacts

1. Deterioration of Water Quality

516. The project activities will generate several types of wastes during their construction and O/M stages. Typical wastes are likely of solid and liquid that may further be classified as hazardous/toxic and non-hazardous/non-toxic. Disposal of these wastes without treatment will contaminate surface water surrounding the dumping sites. Contamination of surface water quality will have potential significant negative impact on biological functions of surface water as well as fish/aquatic life resources therein. Deterioration in groundwater quality is likely to occur due to the dumping of untreated wastes. Leachate of wastes that contains hazardous elements will percolate soils reaching groundwater contaminating the natural resources.

2. Residual Impacts

517. After analysis the air quality, the concentrations of CO, SO2, NOx, PM10 and PM2.5 have been recorded. This project will contribute insignificant of pollutants to the ambient environment.

518. From the cumulative impact assessment, it can be concluded that the proposed project will not contribute significantly during the initial stages.

519. Only the particulate matters may cross the standard limits of ECR, 2006 due to raise background concentration. Therefore, policy level environmental management plan should be introduced to reduce the particulate matters as due diligence.

3. Noise Level

520. The proposed project location is near the Bangladesh-India border area. There are no other development works are going on nearby the location except some building construction works of tea factories. The proposed project will create some construction noise during the construction period. However, during the operation stage there is no such possibility.

C. Mitigation Measures

521. Construction related cumulative impacts would be effectively minimized by adopting proper mitigation measures, including:

- coordination between all project components and other projects (if any) in the area of influence in terms of construction schedule, possible access road and disposal sites sharing;
- contractors will develop material transport plan with consultation of local community;
- enforcement of good construction management to minimize dust, noise and waste generation;
- education of construction workers to minimize social disturbance and cultural conflict;
- provision of temporary access to local traffic;
- Proper maintenance of the access roads and timely restoration/strengthening upon completion. With effective implementation of good construction management measures, these common construction-related cumulative impacts can be adequately mitigated to acceptable levels.

D. Cumulative Beneficial Impacts

522. The cumulative beneficial impact of the project will result in

- increased employment
- better economic integration of major economic and trade centers within Bangladesh.

E. Induced Impacts

523. The sourcebook also describes Induced Impacts as "Adverse and/or beneficial impacts on areas and communities from unintended but predictable developments caused by a project, which may occur at later or at a different location".

524. After the construction of the project, many developments are expected to take place due to the electricity supply from national grid. With the completion of the project, a lot of trade and commerce improvement and industrialization are expected.

1. Deterioration of Roadside Air Quality

525. Construction activities of the project will generate air emission including dust that will affect population and communities along the route. However, during the operational stage, no extra air pollution is expected.

2. Employment

Employment generation will occur due to the project implementation and in the increased commercial and business activities induced with electricity supply.

3. Deterioration of Surface Water Quality

526. The proposed project will generate several types of wastes during their construction and O/M stages. Typical wastes are likely of solid and liquid that may further be classified as hazardous/toxic and non-hazardous/non-toxic. Disposal of these wastes without treatment will contaminate surface water surrounding the dumping sites. Contamination of surface water quality will have potential significant negative impact on biological functions of surface water as well as fish/aquatic life resources therein.

4. Deterioration of Groundwater Quality

527. Deterioration in groundwater quality is likely to occur due to the dumping of untreated wastes. Leachate of wastes that contains hazardous elements will percolate soils reaching groundwater contaminating the natural resources.

5. Wastes

528. Wastes will be generated during construction and O/M of the proposed project, and unless they are properly managed, they will cause severe impact on environment. Particularly hazardous wastes would affect the health quality of the workers as well as will contaminate soil and water at their dumping locations.

F. Mitigation Measures

529. The proposed project will not have any significant impacts. Only some impacts could be generated due to improper management of the project. So, the proper management and monitoring and following the ESMP during the project implementation may reduce the possibility of the induced impacts.

XI. ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN

A. Objectives

530. 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.

531. 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 and Social Management programs to allow for iterative improvement;
- Ensure that all stakeholder concerns are addressed.

532. 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.

B. Environmental and Social Management Plan (ESMP)

533. On the basis of identification of the environmental and social impacts and recommended mitigation measures linked with the Solar Power Plant 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 ADB Environmental and Social 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 XI.1: Environmental and Social Management Plan (ESMP) of Solar Power Plant

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Pre-construction Phase						
Land Use / Land-filling	Land-filling/ Earthworks	Soil erosion from the fill material, changes in existing landscape.	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
Flood Hazards	Flood may damage the Project and its various components.	Should undertake a flood risk study to determine flood quantities within the plant area and to estimate peak flood to determine the peak flow for the return period of 50 years.	no. of flood	Consideration of flood hazard in project design	Project developer	
Construction Phase						
Visual Amenity	Visual impacts from construction activities such as materials lay down, excavation, backfilling	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. ▪ The fill material is maintained in a clean and tidy manner.	Contractor	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995
Water Resources	Surface water quality in the adjacent rivers, channels and ponds might insignificantly degrade during construction stage due to disposal of solid wastes, sewage effluent, and dredged materials,	▪ 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.	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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	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.	▪ 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	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
		emissions. Not running engines for longer than is necessary.				
Soil	Soil disturbance due to removal of top soil, potential 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. ▪ To control soil erosion surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows	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)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	▪ 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. ▪ 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.	Daily	▪ Compliance with Waste management procedures. ▪ Current and Complete records of regular waste pickup and disposal.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ The Environment (Pollution Control) Act, 1995 ▪ Environmental Conservation Rules (ECR), 1997
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	
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	▪ 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	Continuously	▪ Total Recordable Incidence Rate (TRIR) ▪ Lost Time Incidence Frequency ▪ Fatal Accident Rate ▪ Number of safety Training performed		▪ Bangladesh Labour Law, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	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.	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, 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		▪ Number of nonconformance events Reports. ▪ Medical Treatment Case (MTC) ▪ HSE Training Hours		

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		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 signage 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. ▪ 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,				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		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 cramps, heat exhaustion, heat stroke, dehydration. ▪ Ensure adequate quantities of drinking water are available at different locations within the site, ▪ Provision of sunshades 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				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		how to protect themselves and there should be effective supervision to ensure that the correct methods are being used.				
Operation Phase						
Visual Amenity	Potential glare from PV panels	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
Water Resources	Surface water quality in the adjacent rivers, channels 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.	▪ 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.	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
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. ▪ 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.	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.	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ Noise Pollution Control Rules, 2006

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
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)
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. ▪ Waste shall be stored on site within closed container, especially food remnants to avoid attracting birds on site.	Weekly	No reported harm to birds.	Project Developer	▪ 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	▪ Solid wastes from PV modules which contains toxic metals. ▪ Besides the wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical	▪ Collected the lead-acid battery for recycling after the warranty period. ▪ 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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	wastes, metallic wastes and stationary wastes of office works etc.					
Health and Safety	▪ Entering of lead into human body from lead-acid battery ▪ Acid hazard during battery handling ▪ Leaching of materials from broken or fire damaged PV modules ▪ Emergency Fire Hazard ▪ Electrocution of workers ▪ Electromagnetic radiation from PV modules ▪ 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. ▪ The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. ▪ As a power plant, the plant has always some risks of fire hazards. Electrical equipment is	▪ 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. ▪ 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. ▪ Adequate first aiders shall be on site in accordance with Bangladesh Labour Law requirements.	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
	the main source of a potential fire hazard. ▪ Risk of electrocution of workers during performing duties in a power plant is always present.	▪ 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.				
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	

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, ESIA Study has considered potential decommissioning impacts in case there was a need for the facility to be dismantled and end operations.

- As can be noted from the impact assessment chapter 6, 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.
- Therefore, to avoid repetition, please refer to Table 7.1 for detailed mitigation measures that are overlap with decommissioning as well.
- 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.

Table XI.2: Environmental and Social Management Plan (ESMP) of Transmission Line

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Pre-construction/Construction Phase						
Clearing of Vegetation	From the survey, we found no major trees in the surrounding area. However, most of the trees need to be trimmed instead of cutting and thus the impact will be medium significant. In general vegetation destruction shall result in reduction of biodiversity as valuable trees such as those of medicinal importance, wild fruits, and endangered species may be adversely impacted upon.	▪ Before construction commences, undertake a flora survey (through an ecological expert) to identify the presence of any key floral species of importance. 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 floral species within the area. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30cm); ▪ 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.	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)
Disturbance to Fauna	Due to project activities such as earthworks, movement of project heavy equipment & transports with noise especially during night time, wildlife specially birds will be disturbed. The way leave for the proposed distribution line could open or truncate some migratory routes for wild animals. However, open areas under the way leave could provide new browsing grounds for various animals. The presence of the construction workers in the project area may induce poaching. Leftover Aluminum conductors from construction works may give	The following identifies the mitigation measures to be applied by the Contractor during the construction phase and which include: • 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. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30cm); • Implement proper management measures to prevent damage to the natural fauna 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:	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)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	rise to snare wire that poachers eventually use to trap animals. Tower foundation works could disturb habitats for smaller mammals such as rodents and rats.	– Prohibit hunting at any time and under any condition by construction workers onsite – Ensure proper storage, collection, and disposal of waste streams generated – 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 – Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.				
Loss of Top Soil	For the construction of tower base and transmission line approximately 5.2km length will be temporarily used. Construction of the line might open up areas that could be exposed to soil erosion. The variability in soil texture in the study area entails that certain sections of the route could be exposed without any serious threat to water induced erosion. For instance, clayey top soils are highly prone to water induced erosion once exposed.	▪ The impact will however be minimal as the area to be disturbed is small. The exposed soils will be paved with impervious material or grass turfing to minimize soil erosion.	Weekly	The fill material is collected from the approved sources.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental Conservation Rules (ECR), 1997
Hydrology, Surface and Groundwater Quality	The movement of surface water in wetlands contributes to the character of the existing ecosystem. Cut and fill activities may inhibit, enhance, or redirect the flow of water and, in so doing, change the nature of both the established water regime and the biological community of a site. Engineering structures in wetlands can often affect both	▪ 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	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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	the timing and duration of water regime fluctuations. When the changes are pronounced, they may have significant effects (e.g., alteration of vegetation assemblages) on the wetlands involved. A shift in wetland habitat composition (such as distribution and abundance of wetland habitat types within the wetland) is a community level effect that may result from altered water levels and may occur to a lesser extent from changes in periodicity or sedimentation. Any changes in composition of wetland can result in wildlife disturbance.	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.	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
		▪ Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. Not running engines for longer than is necessary.				
Soil	Soil disturbance due to removal of top soil, potential 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. ▪ To control soil erosion surface run-off should be collected from all paved working areas into retention ditches to restrict concentration of flows	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
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	▪ 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. ▪ 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.	Daily	▪ Compliance with Waste management procedures. ▪ Current and Complete records of regular waste pickup and disposal.	Contractor	▪ Environmental Pollution Control Ordinance, 1977 ▪ The Environment (Pollution Control) Act, 1995 ▪ Environmental Conservation Rules (ECR), 1997

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		▪ The sanitary and organic wastes shall be collected in a septic tank to be installed on site and disposed off regularly.				
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	
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, 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.	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
		▪ 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. ▪ 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.				

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
		▪ 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 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.				
Operation Phase						
Landscape	Due to construction of transmission line in the rural areas, the natural landscape	The project proponent should be careful about the natural landscape.	N/A	N/A	Project Developer	▪ National Land use Policy, 2001

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	will be changed but not significantly					▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995
Collision of Birds with Overhead Earth Wire	Collision of birds with overhead earth wire has been identified as one of the most significant impacts on avifauna for the project. The open patches of grassland however would attract species such as storks, which could be at risk of collisions.	Mitigation in the form of route selection and earth wire marking will reduce the impact to Medium. The preferred route passes through habitat areas should be avoided in order to reduce the chances of collisions.	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)
Health and Safety	▪ Entering of lead into human body from lead-acid battery ▪ Acid hazard during battery handling ▪ Leaching of materials from broken or fire damaged PV modules ▪ Emergency Fire Hazard ▪ Electrocution of workers ▪ Electromagnetic radiation from PV modules ▪ 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 penetrates into	▪ 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. ▪ 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	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
	the lungs result in absorption in the bloodstream. ▪ The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. ▪ 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.	specific foreseeable emergency situations, organizational roles and authorities, responsibilities and expertise, emergency response and evacuation procedure, in addition to training for personnel. ▪ 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.				

C. Environmental and Social Monitoring Plan (ESMoP)

1. General

534. An Environmental and Social Monitoring Plan (ESMoP) will be prepared to provide guidelines for environmental management plan during the construction and operation phases of the solar mini grid Power Plant. 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 XI.3.

2. Objectives

535. 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 ESIA;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the ESIA;
- Ensure compliance with legal and community obligations including safety on construction sites;
- Ensure the safe disposal of excess construction materials.
- Appraise the adequacy of the ESIA with respect to the project's predicted long-term impacts on the physical, biological and socio-economic environment;
- Evaluate the effectiveness of the mitigation measures proposed in the ESMP and recommend improvements, if and when necessary;

Table XI.3: 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	Twice	Contractor	ABL/Sympa Solar
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Twice	Contractor	ABL/Sympa Solar
Water Quality	Surface water: pH, TDS, DO, COD, BOD_5	Surface water quality standard by DoE, Bangladesh	Twice	Contractor	ABL/Sympa Solar
	Groundwater: pH, Alkalinity, Fe, Cl^-, TDS, As	Groundwater quality standard by DoE, Bangladesh	Twice	Contractor	ABL/Sympa Solar
Construction Stage					
Air Quality	SO_2, NO_x, CO, SPM, $PM_{2.5}$, PM_{10}	Air quality standard by DoE, Bangladesh	Twice	Contractor	ABL/Sympa Solar
Dust	Dust control	Air quality standard by DoE, Bangladesh	Twice	Contractor	ABL/Sympa Solar
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Twice	Contractor	ABL/Sympa Solar
Water Quality	Surface water: pH, TDS, DO, COD, BOD_5	Water quality standard by MoEF, Bangladesh	Twice	Contractor	ABL/Sympa Solar
	Groundwater: pH, Alkalinity, Fe, Cl^-, TDS, As	Water quality standard by MoEF, Bangladesh	Twice	Contractor	ABL/Sympa Solar
Soil Pollution	▪ Check liquid waste is carried out by experienced personnel and in proper way ▪ Careful and proper handling of oil and other hazardous liquids	Monitoring	Regularly	Contractor	ABL/Sympa Solar
Waste	▪ Check storage, transportation, disposal, handling of hazarders 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	ABL/Sympa Solar
Health and Safety	▪ Check quality of food and accommodation at construction camp; ▪ Check safe water supply, hygienic toilet at camp, construction 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	Monitoring	Regularly	Contractor	ABL/Sympa Solar

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
	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	2/year (5 year)	ABL/Sympa Solar	DOE/IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	2/year (5 year)	ABL/Sympa Solar	DOE/IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD_5	Water quality standard by DOE, Bangladesh	2/year (5 year)	ABL/Sympa Solar	DOE/IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl^-, TDS, As	Water quality standard by DOE, Bangladesh	2/year (5 year)	ABL/Sympa Solar	DOE/IDCOL
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	----------	ABL/Sympa Solar	DOE/IDCOL
PV panels, and Battery	Chemicals		2/year (5 year)	ABL/Sympa Solar	DOE/IDCOL
Soil Quality	Heavy metals		2/year (5 year)	ABL/Sympa Solar	DOE/IDCOL
Decommissioning Stage					
Air Quality	SO_2, NO_x, CO, SPM, $PM_{2.5}$, PM_{10}	Air quality standard by DOE, Bangladesh	Twice	Contractor	ABL/Sympa Solar/IDCOL
Dust	Dust control	Air quality standard by DOE, Bangladesh	Twice	Contractor	ABL/Sympa Solar/IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Twice	Contractor	ABL/Sympa Solar/IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD_5	Water quality standard by MoEF, Bangladesh	Twice	Contractor	ABL/Sympa Solar/IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl^-, TDS, As	Water quality standard by MoEF, Bangladesh	Twice	Contractor	ABL/Sympa Solar/IDCOL
Soil Pollution	▪ Check liquid waste is carried out by experienced personnel and in proper way ▪ Careful and proper handling of oil and other hazardous liquids ▪ Careful and proper handling of PV panels and batteries	Monitoring	Regularly	Contractor	ABL/Sympa Solar/IDCOL
Waste	▪ Check storage, transportation, disposal, handling of hazarders 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	ABL/Sympa Solar/IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Monitoring Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
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; ▪ The heavy construction material to be handled and stored safely putting due care on public safety; and ▪ Check of personal protective equipment (PPE) for worker at the sites	Monitoring	Regularly	Contractor	ABL/Sympa Solar/IDCOL

D. Environmental and Social Budget

536. The estimated budget for implementation of the mitigation and monitoring measures proposed in the ESMP is presented in Table IX.3. The overall costs of the ESMP will comprise:

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

537. The total budget is estimated as BDT.14,69,600. This budget does not include the decommissioning stage since the minimum operation period is 20 year and the rate will vary largely from the present cost.

Table XI.4: Environmental Budget for Solar Power Plant Project

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
PRE-CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	2	40,000	80,000
Noise	Measuring ambient noise level	No.	10	5,000	50,000
Water Quality	Surface water quality measurement	No.	2	8,000	16,000
	Groundwater quality measurement	No.	2	8,000	16,000
	SUB TOTAL (PRE-CONSTRUCTION STAGE)				**162,000**
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	4	40,000	1,60,000
Noise	Measuring ambient noise level	No.	12	5,000	60,000
Water Quality	Surface water quality measurement	No.	4	8,000	32,000
	Groundwater quality measurement	No.	4	8,000	32,000
Soil	Maintenance cost in soil conservation	Lump sum			80,000
Dust Management	Water sprayer / watering	Covered in Engineering Cost			
Waste disposal and management	Disposal and management of construction waste and solar panels, and transmission line wire, etc.	Lump sum			1,00,000
Construction Safety	General Safety (provision of PPE like ear muffs, gloves, hard hut, etc.)	Lump sum			20,000
Health	Health check-up camps for construction workers	Camp	-	20,000	20,000
	SUB TOTAL (CONSTRUCTION STAGE)				**5,04,000**
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	10 (2/year)	40,000	4,00,000
Noise	Monitoring ambient noise level	No.	10 (2/year)	5,000	50,000
Water	Monitoring surface water quality	No.	10 (2/year)	8,000	80,000
	Monitoring ground water quality and levels	No.	10 (2/year)	8,000	80,000
	SUB TOTAL (OPERATION STAGE)				**6,10,000**
ESTABLISHMENT and TRAINING					
Training	Environmental training and awareness	Lump sum	As per training details	40,000	40,000
Management Information System		Lump sum	-	20,000	20,000

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
SUB TOTAL (ESTABLISHMENT and TRAINING)					60,000
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					13,36,000
CONTINGENCIES @ 10 % on total Environmental Costs					1,33,600
GRAND TOTAL (in BDT)					14,69,600

XII. INSTITUTIONAL ARRANGEMENTS

A. Proposed Institutional Arrangement

538. Institutional arrangement is essential to implement the suggested mitigation measures and to execute monitoring plan at different project phases illustrated in chapter 6 under ESMP. The implementation of the ESMP also requires capacity building of the ESMP implementation agency through training needs and plan. The structured institutional settings facilitate proper implementation of the environment safeguard requirements for the project. The SYMPA Solar Power Limited, Risen Solar Technology and Aqua Breeders Limited (ABL) and PGCB (Transmission Line) are the key authority to follow up all the relevant environmental safeguard requirements following institutional arrangement.

539. The project will require the implementation of multi-year mitigative and monitoring actions, as defined in the Environmental and Social Impact Assessment. SYMPA Solar, Risen Solar, Aqua Breeders as well as PGCB (Transmission Line) will be responsible for ensuring the construction and operation period mitigative and monitoring tasks defined the ESIA's ESMP are completed on time and in a technically sound manner. During construction and operation periods, a Consultant will assist. Monitoring of ESMP will require field surveys, analyses and technical reporting to DoE as well as to IDCOL. Further, throughout the Project, the project authority will be receiving environmental reports from the contractor as well as the Supervision Consultant, and will need to evaluate and comment on the technical content, etc. The project proponent is agreed to set up an environmental and social development cell within Project Implementation Unit (PIU) of Project.

540. **PIU staffing:** The PIU within the project proponent will include environmental and social expertise, who will oversee and ensure all agreed environmental and social management measures are fully implemented through all project civil works activities, as well as guide and oversee the various studies, planning efforts, and technical assistance components of the project with potential social and environmental implications. Given the complexity of the project from an environmental and social perspective, the various management tasks which will fall to SYMPA, Risen, Aqua Breeders and PGCB rather than works contractors to implement (including, notably, land acquisition and resettlement as well as management of dredge spoils deposited on-land), and the lack of any existing in-house capacity or systems related to environmental and social management to draw from, the PIU will require a robust team of experts who can oversee these aspects. This team will also have the task of raising awareness more broadly through the organization on environmental, health and safety, and social implications and aspects of the agency's work, and the necessary systems and processes to effectively manage such aspects, to suggest specific permanent capacity building measures that can be further built upon in subsequent projects. The PIU will therefore include a senior environmental officer, a senior social officer, as well as supporting specialist staff for each, as outlined in Figure XII.1 below. The senior (officer) individuals will preferably be permanent staff deputed by the agency for the life of the project. Supporting specialists would be hired as consultants to provide necessary expertise and additional capacity.

541. **Independent monitoring/supervision consultants:** In addition, the independent monitoring consultant for the grid tied solar plant contractor, as well as the Construction Supervision Consultant for the contractors developing the transmission line, will also include requisite environmental and social expertise to monitor implementation of agreed ESMPs for each activity. These independent consultants will report to PIU and provide "eyes and ears

on the ground" on implementation of safeguards measures. The consultants' role in safeguards management of the project is also shown in Figure XII.1 below.

542. **Contractors:** Contractors for all civil works activities, including the construction contractor, will be required to maintain adequate in-house environmental, health and safety, and social expertise to ensure effective implementation of agreed ESMP requirements, as specified in their contracts.

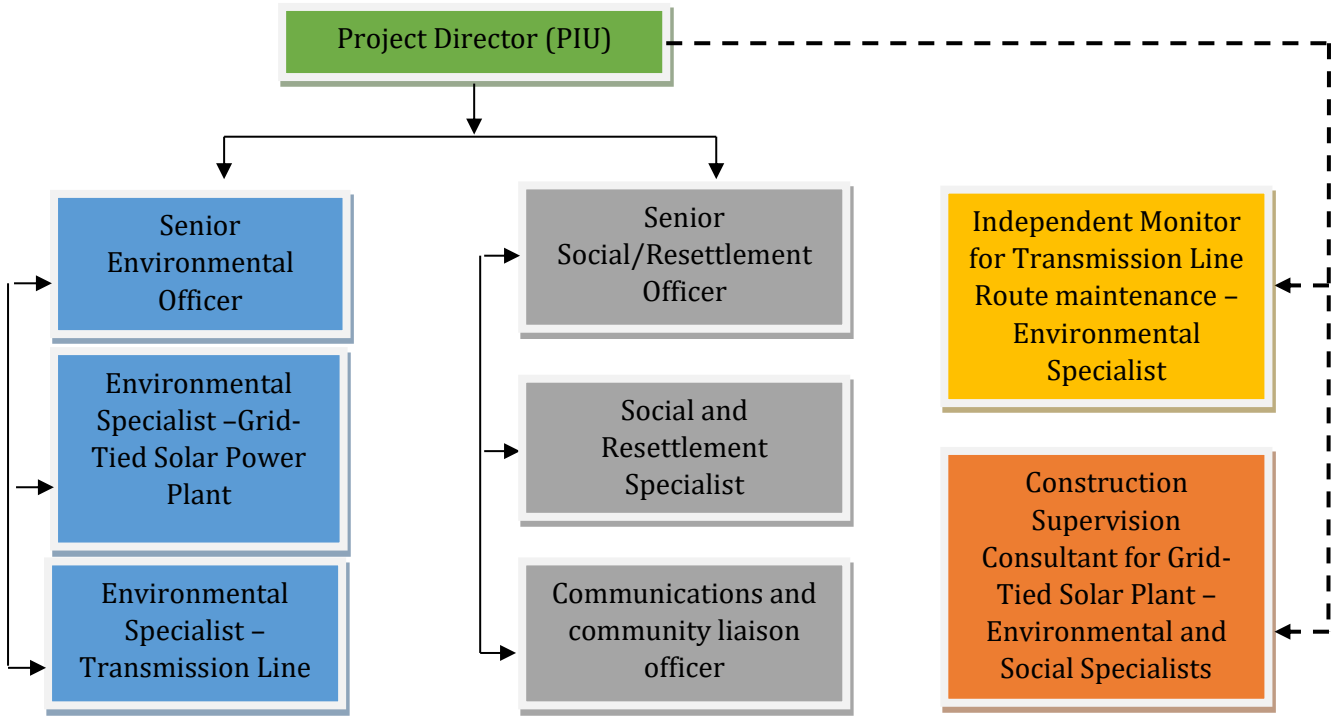


Figure XII.1: Proposed Institutional Arrangement for the Project

B. Project Management Organization

543. In order to make full use of the human resources, achieve standard, professional, modernized project construction management, and improve the overall management level and economic benefits, the construction project management is supposed to be conducted by the EPC contractor and the construction units.

544. During the construction period, the management content includes design, construction, installation, equipment transport, debugging, connection to the grid and completion. According to the composition of work objects, linear function of the organizational structure of management organization is recommended.

545. One project manager will be in charge of the entire project and daily management. The other four persons are in finance department, purchasing department, project administration department and Integrated Management department, who are responsible for expense payment and settlement, equipment transportation and field storage, construction design and quality, internal management and coordination task, respectively.

546. Main management facilities are to be setup on site with site offices and welfare facilities, providing constant communication with our back office in the headquarters in Dhaka, Bangladesh. Technical support and backup is available from the technical offices in Dhaka, Bangladesh.

Figure XII.2: Organization Chart

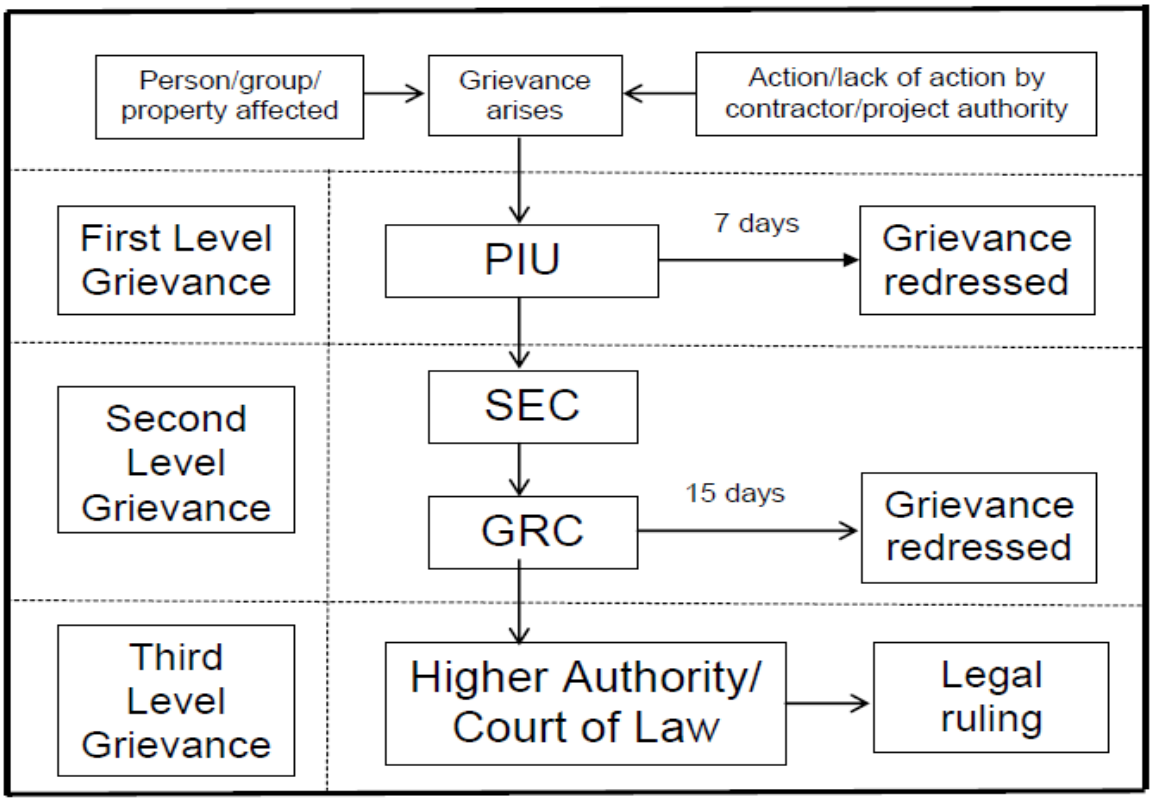
C. Training Schedule

547. In order to ensure the correct operation of the photovoltaic power station, the necessary training for plant management and technical personnel is required. Theory and practical training are adopted. Theory subject training is planned for 10 days, and the actual site operation training is planned for eight days.

D. Grievance Redress Mechanism

548. The concern/grievances from local/affected people may come up related to inappropriate implementation of various components of ESMP or the overall components/activities of the subproject itself. These issues will be addressed through acknowledgement, evaluation and corrective action and response approach. A Grievance Redress Mechanism (GRM) will be established to receive, evaluate, and facilitate the resolution of affected people's concerns, complaints, and grievances about the social and environmental performance of the project. The GRM aims to provide a trusted way to voice and resolve concerns linked to the project, and to be an effective way to address affected people's concerns.

549. The project proponent will make the public aware of the GRM through public awareness campaigns. The project information brochure will include information on the GRM and shall be widely disseminated through the project area by the Environmental Specialist/Engineer, with support from the NGOs and communication firm. Grievances can be filed in writing or by phone with any member of the responsible team. Figure XII.3 represents how GRM will be implemented for the project.



GRC=Grievance Redress Mechanism, PIU= Project Implementation Unit, SEC= Soci Environmental Circle

Figure XII.3: Proposed GRM for the Project

550. ***First Tier of GRM:*** The Project Manager (PM), shall be the designated person as the key specialist for grievance redress (1st tier). Resolution of complaints will be done within 7 working days. Investigation of grievances will involve site visits and consultations with relevant parties (e.g., affected persons, contractors, etc.) Grievances will be documented and personal details (name, address, date of complaint, etc.) will be included, unless anonymity is requested. A tracking number shall be assigned for each grievance, including the following elements:

- Initial grievance sheet (including the description of the grievance), with an acknowledgement of receipt handed back to the complainant when the complaint is registered;
- Grievance monitoring sheet, mentioning actions taken (investigation, corrective measures); and
- Closure sheet, one copy of which will be handed to the complainant after he/she has agreed to the resolution and signed off.

551. The updated register of grievances and complaints will be available to the public at the SEC office, construction site, and other key public offices along the project area. Should the grievance remain unresolved, it will be elevated to the second tier.

552. ***Second Tier of GRM:*** ABL/Sympa Solar will activate the second tier of GRM by referring the unresolved issue (with written documentation). The GRC shall be established by the responsible team of the project proponent before commencement of site works. The GRC will consist of the following persons: (i) project director; (ii) representative of city ward; (iii) representative of the affected persons; (iv) representative of the local upazila parishad's office; and (v) representative of the Department of Environment (DOE) for environmental related

grievances. A hearing will be called with the GRC, if necessary, where the affected person can present his or her concerns and issues. The process will facilitate resolution through mediation. The local GRC will meet as necessary when there are grievances to be addressed. The local GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision within 15 working days. The contractor will have observer status on the committee. If unsatisfied with the decision, the existence of the GRC shall not impede the complainant's access to the government's judicial or administrative remedies.

553. The functions of the local GRC are as follows: (i) resolve problems and provide support to affected persons arising from various environmental issues, including dust, noise, utilities, power and water supply, waste disposal, traffic interference, and public safety, as well as social issues such as land acquisition, asset acquisition, and eligibility for entitlements, compensation, and assistance; (ii) reconfirm grievances of displaced persons, categorize and prioritize them, and aim to provide solutions within a month; and (iii) report to the aggrieved parties about developments regarding their grievances and decisions of the GRC. The PM, SEC will be responsible for processing and placing all papers before the GRC, maintaining database of complaints, recording decisions, issuing minutes of the meetings, and monitoring to see that formal orders are issued and the decisions carried out.

554. ***Third Tier of GRM:*** In the event that a grievance cannot be resolved directly by the PIU (first tier) or GRC (second tier), the affected person can seek alternative redress through the city ward committees or in appropriate courts. The PIU or GRC will be kept informed by the city corporation authority. The grievance redress mechanism and procedure is depicted in Figure 12.3. The monitoring reports of the ESMP shall include the following aspects pertaining to progress on grievances: (i) number of cases registered with the GRC, level of jurisdiction (first, second, and third tiers), number of hearings held, decisions made, and the status of pending cases; and (ii) lists of cases in process and already decided upon, which may be prepared with details such as name, identification (I.D.) with unique serial number, date of notice, date of application, date of hearing, decisions, remarks, actions taken to resolve issues, and status of grievance (i.e., open, closed, or pending).

1. Construction Workers Grievance

555. At construction sites, work camps and on-the-job, labourers and other unskilled hired employees of the contractor have little recourse when either their living conditions are badly degraded, they are not paid according to agreement, or basics, such as potable water, are not supplied. Under this contract, as part of the written agreement with each hire, the contract or letter of assignment with the work will include the name and contact information for the worker to contact. The letter/agreement will contain a second statement indicating that the contractor will not penalize the worker for reporting a complaint and if that occurs, the contract will be levied a fine equal to the employee's contract duration from the time of the incident to the end of the contract period. That amount will be paid to the complainant. The contractor will provide a compliant box, sealed by the CSC and collected by the CSC, thus allowing the construction worker to file complaints by going directly to the CSC.

XIII. ENVIRONMENTAL & SOCIAL BENEFIT

A. Introduction

556. 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.

B. Emission Reduction

557. 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.

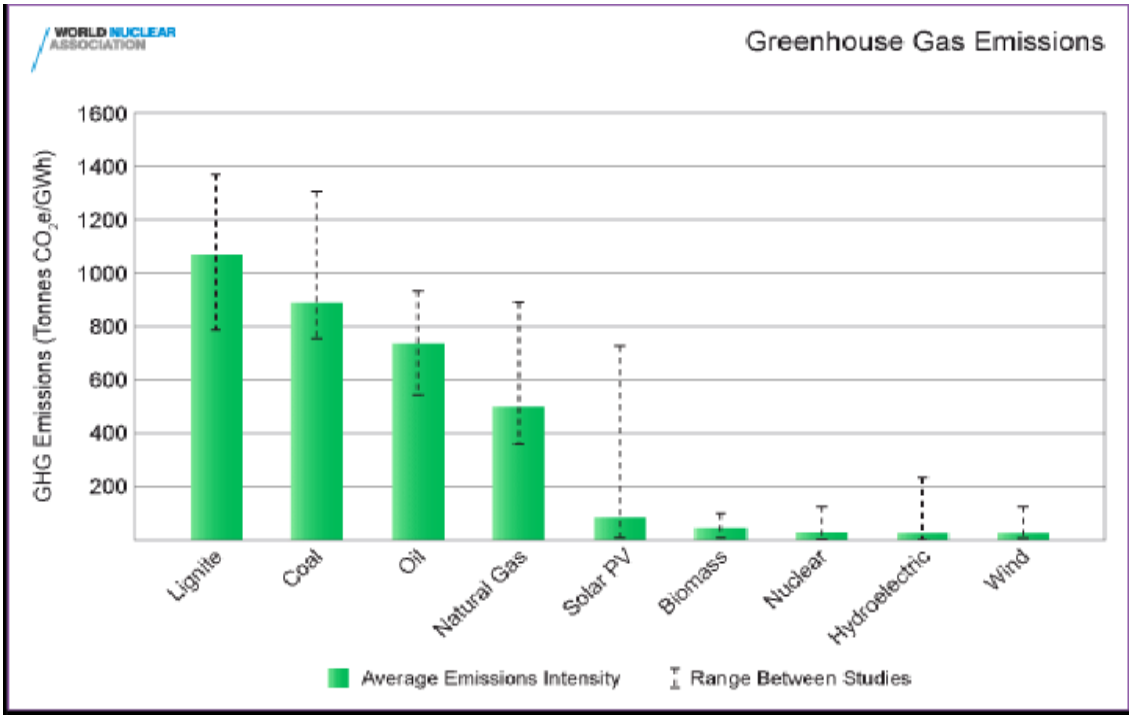


Figure XIII.1: Comparison of GHGs Emissions from different Energy Sources

558. Solar power projects generate electricity with no associated air pollution emissions. While solar energy systems emit some air pollutants, total air emissions are generally much lower than those of coal and natural gas-fired power plants (Figure XIII.1). 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.

C. Energy and Climate Concern

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

560. In addition, the burning of fossil fuels results in carbon dioxide emissions; a primary greenhouse gas emitted through human activities that 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.

561. 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.

D. Energy and Livelihood Concern

562. The belief that the provision of electricity in rural areas can bring about desired socio-economic changes (increased economic opportunities, improved health and education facilities). First, it is argued that electrification only brings changes to resource-rich households, and second, that it drains the resource-scarce rural economy. However, changes in electrified areas might demonstrate some positive outcomes. In response to the availability of electricity, village people could find various productive uses for it.

563. The development of micro-enterprises in rural areas is linked with the increase in access and use of grid electricity services, leading to changes in micro-enterprises, and changes in livelihood characteristics of entrepreneurs, employees and community members in areas where these enterprises located. Micro-enterprises are important in their role as contributors to the economy of the rural poor especially women, technological development of rural people and in their potential for employment creation.

E. Energy and Economy Concern

564. 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.

565. 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.

566. 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.

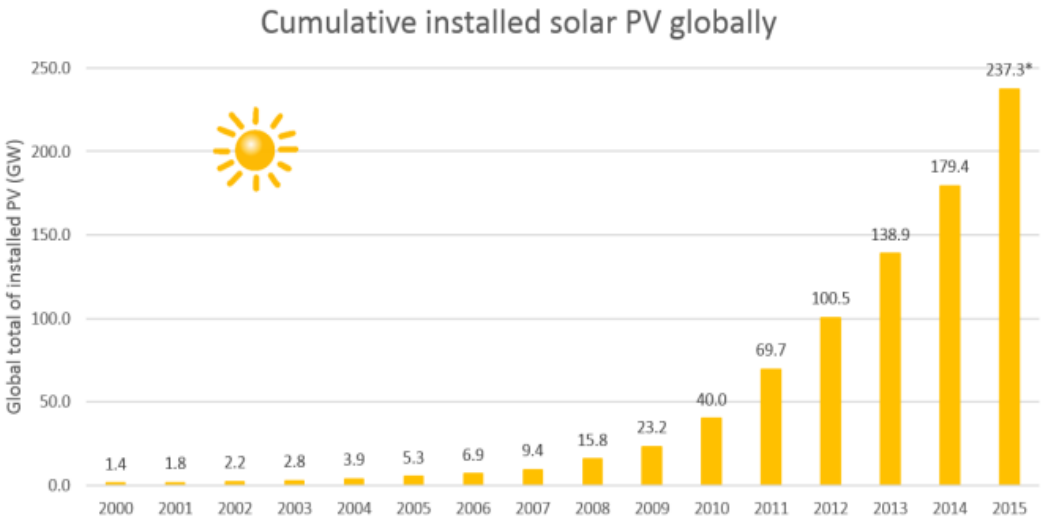


Figure XIII.2: Trends of World Solar Energy Growth

567. 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.

F. Improvement of Local Communities

568. The project will benefit the residents and economies of local communities near the project site. In addition to providing employment opportunities and improving the local economy, the project authority is committed to preserving the heritage and cultures of nearby villages.

569. The Project authority is committed to providing additional sustainable benefits, primarily for the local region affected by the project.

G. National Economic Benefits

570. The project will provide a significant boost to the national economy by eliminating the country's previous power deficit and significantly reducing the use of expensive and air-polluting oil-fired thermal power generation. The project will support economic growth and job creation as well as will enhance the competitiveness of the local goods both regionally and internationally.

571. The project's principal macro benefits for Bangladesh include:

- New supply of clean, reliable energy
- Lower electricity costs
- Eliminate government subsidies for power production
- Reduced electricity rationing
- Increase in economic investment and national income
- Reduced trade deficit and need to import oil products
- Support for rural electrification programs

XIV. CONCLUSIONS & RECOMMENDATIONS

A. Conclusions

572. 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.

573. Primarily the national economy will be benefitted by the project. Benefits in the project area will be insignificant except for some short term's employment and business opportunities during the construction phase. However, the needs of the solar photovoltaic power plant are obvious for the achievement of energy target of Bangladesh as per the Power System Master Plan, 2016.

574. 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.

575. 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.

B. Recommendations

576. 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.

577. 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 and Social Management Plan that 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.

578. 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.

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APPENDICES

Appendix A: Rapid Environmental Assessment Checklist for the Proposed Project

Instructions:

(i) The PIU completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to ADB.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and tribes, minor races, ethnic sects and communities;[1] (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title:	Bangladesh/Construction of 10MW Grid-Tied Solar Power Plant
Sector Division:	Renewable Energy

Screening Questions	Yes	No	Remarks
A. Project Siting Is the project area adjacent to or within any of the following areas?			
▪ Underground utilities			
▪ Cultural heritage site			
▪ Protected Area			
▪ Wetland			
▪ Mangrove			
▪ Estuarine			
▪ Buffer zone of protected area			
▪ Special area for protecting biodiversity			
▪ Bay			
B. Potential Environmental Impacts Will the Project cause…			
▪ Encroachment on historical/cultural areas?			
▪ Encroachment on precious ecology (e.g. sensitive or protected areas)?			
▪ Impacts on the sustainability of associated sanitation and solid waste disposal systems?			
▪ Dislocation or involuntary resettlement of people?			
▪ Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?			
▪ Accident risks associated with increased vehicular traffic, leading to loss of life?			
▪ Increased noise and air pollution resulting from increased traffic volume?			
▪ Occupational and community health and safety risks?			
▪ Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?			
▪ Generation of dust in sensitive areas during construction?			
▪ Requirements for disposal of fill, excavation, and/or spoil materials?			

[1]Groups or population identified as Indigenous Peoples within the context of ADB's Safeguard Policy Statement will be referred to in this document as tribes, minor races, ethnic sects and communities (following the request of the Government of Bangladesh).

Screening Questions	Yes	No	Remarks
▪ Noise and vibration due to blasting and other civil works?			
▪ Long-term impacts on groundwater flows as result of needing to drain the project site prior to construction?			
▪ Long-term impacts on local hydrology as a result of building hard surfaces in or near the building?			
▪ Large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?			
▪ Social conflicts if workers from other regions or countries are hired?			
▪ Risks to community safety caused by fire, electric shock, or failure of the building's safety features during operation?			
▪ Risks to community health and safety caused by management and disposal of waste?			
▪ Community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?			

Climate Change and Disaster Risk Questions The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.	Yes	No	Remarks
▪ Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes (see Appendix I)?			
▪ Could changes in precipitation, temperature, salinity, or extreme events over the Project lifespan affect its sustainability or cost?			
▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g. high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?			
▪ Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., increasing traffic or housing in areas that will be more prone to flooding, by encouraging settlement in earthquake zones)?			

Appendix B: No Objection Certificate (NOC) from Local Authority

চেয়ারম্যানের কার্যালয়

৪নং শালবাহান ইউনিয়ন পরিষদ

উপজেলা : তেঁতুলিয়া, জেলা : পঞ্চগড়।

স্মারক নং- ২০১৮/৪(২০)

তারিখ: ২৮/০৪/১৮

অবস্থানগত/পরিবেশগত ছাড়পত্রের জন্য স্থানীয় কর্তৃপক্ষ কর্তৃক প্রদেয় অনাপত্তিপত্রের ছক

১। আবেদনকারীর নাম ঃ মোঃ মশিউর রহমান

২। পিতা/স্বামীর নাম ঃ মৃত. মিজানুর রহমান

৩। আবেদনকারীর ঠিকানা ঃ ৫, মহাখালী, বা/এ, ঢাকা-১২১২।

৪। কারখানা/প্রকল্পের অবস্থানগত ঠিকানা ঃ মাঝিপাড়া, তেতুলিয়া, পঞ্চগড়।

৫। কারখানা/প্রকল্পের তফসিল ঃ

জেলার নাম	থানার নাম	মৌজার নাম	খতিয়ান নং	দাগ নং	জমির ধরণ	মোট জমির পরিমান
পঞ্চগড়	তেতুলিয়া	বোয়ালমারী ও মাঝিপাড়া	সংযুক্তি-ক	সংযুক্তি-ক	শিল্প	৪১.৩২ একর

৬। কারখানা/প্রকল্পের উৎপাদিত/উৎপাদিতব্য পণ্যের নাম ঃ বিদ্যুৎ উৎপাদন ও পরিচালন।

উপরোক্ত তথ্যাদির আলোকে সিমপা সোলার পাওয়ার লিঃ কারখানা/প্রকল্পকে নিম্ন বর্ণিত শর্ত সাপেক্ষে অনাপত্তিপত্র প্রদান করা হলো।

শর্তবলী ঃ

১। প্রকল্প/ কারখানা স্থাপন ও পরিচালনার ক্ষেত্রে পরিবেশ সংরক্ষণ আইন ও বিধি যথাযথভাবে অনুসরণ করতে হবে।

২। পরিবেশ অধিদপ্তর হতে বিধি দ্বারা নির্ধারিত পদ্ধতিতে ছাড়পত্র গ্রহণ করতে হবে।

৩। কর্মরত শ্রমিকদের পেশাগত স্বাস্থ্য ও নিরাপত্তা নিশ্চিত করতে হবে।

৪। উপযুক্ত অগ্নি নির্বাপক ব্যবস্থা রাখতে হবে এবং অগ্নিকান্ড কিংবা অন্য কোন দুর্ঘটনার সময় জরুরী নির্গমন ব্যবস্থা থাকতে হবে।

৫। বায়ু ও শব্দ দূষণ করা যাবে না।

৬। কারখানা/প্রকল্প সৃষ্ট তরল বর্জ্য অপরিশোধিত অবস্থায় বাইরে নির্গমন করা যাবে না।

উল্লিখিত যে কোন শর্ত লঙ্ঘন করলে যথোপযুক্ত কর্তৃপক্ষ কর্তৃক কারখানা/প্রকল্পের বিরুদ্ধে আইনানুগ ব্যবস্থা নেওয়া যাবে।

২৮/৪/২০১৮

তারিখঃ

স্থানীয় কর্তৃপক্ষের স্বাক্ষর ও সীল ঃ

মোঃ ফজলুর রহমান (লিটন)
চেয়ারম্যান
৪নং শালবাহান ইউনিয়ন পরিষদ
তেঁতুলিয়া, পঞ্চগড়।

Appendix C: Important Sensitive Locations in the PIA

Name	Location		Description	Photo
	N	E		
Majhipara Graveyard	26.48567°	88.41093°	Graveyard consists of 7 Grave	
Majhipara Temple	26.48691°	88.40762°	One Temple	
AnandoNiketon Govt. School	26.48707°	88.40632°	One storied tin shed building is used for academic activities of Anando Niketon Govt. School.	

Name	Location		Description	Photo
	N	E		
Jabid Auto Rice Mill	26.48716°	88.40353°	1 Auto Rice Mill	
ChowdhurygonjJame Mosque	26.48743°	88.40260°	1 storied building mosque.	
Tea Garden	26.48791°	88.40016°	1 Tea Garden	

Name	Location		Description	Photo
	N	E		
A Small Pond	26.48810°	88.39887°	Small Pond in the Project Influenced Area.	
Amtoli Bazar	26.48821°	88.39679°	A small Bazar with some grocery shop.	
Boalmari Govt. Primary School	26.48922°	88.39756°	One storied Building is used for the educational activities of this school.	

Name	Location		Description	Photo
	N	E		
Floral Biodiversity	26.48767°	88.40160°	Most of the project influenced ares is consists of floral biodiversity.	
Kazigos Govt. Primary School	26.49082°	88.41204°	A one storied building is used for educational activities of this school.	
Dainagos Mosque	26.49783°	88.44144°	One-tin shed building Mosque.	

Name	Location		Description	Photo
	N	E		
Jamrigori Govt. Primary School	26.50203°	88.41038°	One storied two building is used for educational activities of this school.	
Paragon Poultry Limited	26.48639°	88.41163°	Production Center of Paragon Poultry Limited.	
MajhiparaJame Mosque	26.48514°	88.41401°	One storied tin shed building Mosque	

Appendix D: Ambient Air Quality Test Result

DSCL

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DSCL Environmental Laboratory

Name of the Project	10MW of Grid-tied Solar Power Plant Project, Tetulia, Panchagarh
Sampling Location	Project Site, Aqua Breeders Limited, Salbahan Road, Majhipara, Tetulia, Panchagarh
GPS Coordination	26.48413°N; 88.41072°E
Description of sample	Ambient Air Quality
Sample Collector	Collected by DSCL Personnel
Sample ID	AAQ_01
Sampling Date	16th March 2018

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site (AAQ_01)	Bangladesh Standard**	WHO AQGs***	Duration (hours)	Weather Condition	Method of Analysis
PM_{10}	µg/m³	31.49	150	25	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	86.20	65	50	24		Gravimetric
SPM	µg/m³	108.55	200	NF	24		Gravimetric
SO_2	µg/m³	8.25	365	20	24		West- Geake
NOx	µg/m³	11.60	100	40	Annual		Jacob and Hochheiser
CO*	ppm	<1	9	10	8		CO-Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO AQGs have been taken from WHO Air Quality Guideline Standards (AQGs), Global Update, 2006.*

Test Performed By:
Tonmoy Pandit
Jr. Environmental Specialist

Development Solutions Consultant Limited * DSCL *

Checked By:
Tanzia Sharmin
Deputy Manager
(Water & Environment)

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	10MW of Grid-tied Solar Power Plant Project, Tetulia, Panchagarh
Sampling Location	Kalandiganj Bazar, Salbahan Road, Majhipara, Tetulia, Panchagarh.
GPS Coordination	26.48859°N; 88.38705°E
Description of sample	Ambient Air Quality
Sample Collector	Collected by DSCL Personnel
Sample ID	AAQ_02
Sampling Date	16th March 2018

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site (AAQ_03)	Bangladesh Standard**	WHO AQGs***	Duration (hours)	Weather Condition	Method of Analysis
PM_{10}	µg/m³	30.64	150	25	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	83.35	65	50	24		Gravimetric
SPM	µg/m³	102.97	200	NF	24		Gravimetric
SO_2	µg/m³	09.45	365	20	24		West- Geake
NOx	µg/m³	12.24	100	40	Annual		Jacob and Hochheiser
CO*	ppm	<1	9	10	8		CO-Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO AQGs have been taken from WHO Air Quality Guideline Standards (AQGs), Global Update, 2006.*

Test Performed By:
Tonmoy Pandit
Jr. Environmental Specialist

Development Solutions Consultant Limited DSCL

Checked By:
Tanzia Sharmin
Deputy Manager
(Water & Environment)

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

DSCL

Multidisciplinary Development Consultants

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Name of the Project	10MW of Grid-tied Solar Power Plant Project, Tetulia, Panchagarh
Sampling Location	Back side of the Aqua Breeders Limited, Salbahan Road, Majhipara Tetulia, Panchagarh.
GPS Coordination	26.48205°N; 88.40876°E
Description of sample	Ambient Air Quality
Sample Collector	Collected by DSCL Personnel
Sample ID	AAQ_03
Sampling Date	17th March 2018

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site (AAQ_03)	Bangladesh Standard**	WHO AQGs***	Duration (hours)	Weather Condition	Method of Analysis
PM_{10}	µg/m³	33.56	150	25	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	88.13	65	50	24		Gravimetric
SPM	µg/m³	111.86	200	NF	24		Gravimetric
SO_2	µg/m³	10.22	365	20	24		West- Geake
NOx	µg/m³	9.16	100	40	Annual		Jacob and Hochheiser
CO*	ppm	<1	9	10	8		CO-Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
****WHO AQGs have been taken from WHO Air Quality Guideline Standards (AQGs), Global Update, 2006.*

Test Performed By:
Tonmoy Pandit
Jr. Environmental Specialist

Development Solutions Consultant Limited * DSCL *

Checked By:
Tanzia Sharmin
Deputy Manager
(Water & Environment)

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	10MW of Grid-tied Solar Power Plant Project, Tetulia, Panchagarh
Sampling Location	Kazigach Village, Salbahan Road, Majhipara, Tetulia, Panchagarh.
GPS Coordination	26.48731°N; 88.41187°E
Description of sample	Ambient Air Quality
Sample Collector	Collected by DSCL Personnel
Sample ID	AAQ_04
Sampling Date	17th March 2018

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site (AAQ_04)	Bangladesh Standard**	IFC/World Bank Standard	Duration (hours)	Weather Condition	Method of Analysis
PM_{10}	µg/m³	29.78	150	25	24	Sunny	Gravimetric
$PM_{2.5}$	µg/m³	89.43	65	50	24		Gravimetric
SPM	µg/m³	106.69	200	NF	24		Gravimetric
SO_2	µg/m³	12.26	365	20	24		West- Geake
NOx	µg/m³	10.51	100	40	Annual		Jacob and Hochheiser
CO*	ppm	<1	9	10	8		CO-Meter

Note:
** CO concentrations and standards are 8-hourly only.*
*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*
***WHO AQGs have been taken from WHO Air Quality Guideline Standards (AQGs), Global Update, 2006.

Test Performed By:
Tonmoy Pandit
Jr. Environmental Specialist

Development Solutions Consultant Limited * DSCL *

Checked By:
Tanzia Sharmin
Deputy Manager
(Water & Environment)

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

Appendix E: Noise Level Test Result

DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	10MW of Grid-tied Solar Power Plant Project, Tetulia, Panchagarh
Sub-project Location	Proposed Project Site (Under PV Panel), Aqua Breeders Ltd. (Set-5), Kalandiganj Bazar, Tetulia Substation, Tetulia Link Point, Kazigach Village, Aqua Breeders Ltd. (Set-2), Aqua Breeders Ltd. (Set-4), Aqua Breeders Ltd. (Set-1), Ajirnagar Bazar, Proposed Project Substation.
Description of sample	Noise Level
Sample Collector	Collected by DSCL Personnel
Sampling Date	16-17 March, 2018

Noise Level Analysis

Location	GPS Location	Land Use Category	Time		Noise Level (dBA)	
			Day	Night	Day	Night
Proposed Project Site (Under PV Panel)	26.48422°N 88.41069°E	Commercial	10:40	20:47	50.02	51.35
Aqua Breeders Ltd. (Set-5)	26.48270°N 88.40977°E	Commercial	10:11	22:30	50.40	51.53
Kalandiganj Bazar	26.48858°N 88.38669°E	Commercial	11:03	20:08	69.60	64.78
Tetulia Substation	26.48856°N 88.35652°E	Residential	15:28	21:30	60.12	64.74
Tetulia Link Point	26.48897°N 88.37659°E	Commercial	15:58	21:52	69.17	68.35
Kazigach Village	26.48551°N 88.41154°E	Residential	16:30	20:22	53.52	51.22
Aqua Breeders Ltd. (Set-2)	26.48280°N 88.40912°E	Commercial	16:59	20:47	58.35	50.54
Aqua Breeders Ltd. (Set-4)	26.48215°N 88.40956°E	Commercial	17:19	21:35	44.95	49.31
Aqua Breeders Ltd. (Set-1)	26.48321°N 88.40975°E	Commercial	13:14	22:56	63.48	49.54
Ajirnagar Bazar	26.48760° N 88.36003° E	Commercial	12:57	19:33	64.36	61.23
Proposed Substation	26.48522°N 88.41135°E	Commercial	11:36	20:26	57.14	54.43

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

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 standards for commercial area are 65 dBA at day time and 55 dBA at night time , for silent area 55 dBA at day time and 45 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

Development Solutions Consultant Limited DSCL

Tanzia Sharmin

Checked By:
Tanzia Sharmin
Deputy Manager (Water & Environment)

Development Solutions Consultant Ltd.
House# 734 (5-B), Road# 10, Avenue# 04
DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444
Email: dscl@dsclbd.com Web: www.dsclbd.com

Appendix F: 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

Lab Memo: 689/ CC, DPHE, CL, Dhaka. Date: 25-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018040052	Sample Receiving date: 22-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 20-03-2018	Sample Source: Suface Water
Sent by:Tonmoy Pandit ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Panchagarh, Upa:Tentulia
Care Taker: DSCL (SW-01)	Union:, Vill.:
Sample Collection date: 20-03-2018	Date of Testing: 22/03/2018-24/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	5	mg/L	5 days Incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	16	mg/L	CRM	-
3	Chloride	150-600	30	mg/L	Titrimetic	-
4	Nitrogen (Ammonia)	0.50	1.2	mg/L	UVS	0.01

Comments: Sample was collected & Supplied by client.
N.B: UVS- UV-Visible Spectrophotometer, CRM-Closed Reflex Methods , LOQ - Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	25.04.18	1.) Name: Md. Biplab Hossain Designation: Chief Chemist	25/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
2.) Name: Taslima Akhter Designation: Sample Analyzer	25.04.18	2.) Name: Designation:	

নমুনা বিশ্লেষক
জনস্বাস্থ্য প্রকৌশল অধিদপ্তর
কেন্দ্রীয় পরীক্ষাগার
মহাখালী, ঢাকা

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

Lab Memo: 689/ CC, DPHE, CL, Dhaka. Date: 25-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018040053	Sample Receiving date: 22-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 20-03-2018	Sample Source: Suface Water
Sent by:Tonmoy Pandit ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Panchagarh, Upa:Tentulia
Care Taker: DSCL (SW-02)	Union:, Vill.:
Sample Collection date: 20-03-2018	Date of Testing: 22/03/2018-24/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	3	mg/L	5 days Incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	8	mg/L	CRM	-
3	Chloride	150-600	26	mg/L	Titrimetic	-
4	Nitrogen (Ammonia)	0.50	0.9	mg/L	UVS	0.01

Comments: Sample was collected & Supplied by client.
N.B: UVS- UV-Visible Spectrophotometer, CRM-Closed Reflex Methods , LOQ - Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	25.04.18	1.) Name: Md. Biplab Hossain Designation: Chief Chemist	25/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
2.) Name: Taslima Akhter Designation: Sample Analyzer	25.04.18 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	2.) Name: Designation:	

Page 1 of 1

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

Lab Memo: 689/ CC, DPHE, CL, Dhaka.

Date: 25-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018040054	Sample Receiving date: 22-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 20-03-2018	Sample Source: Suface Water
Sent by:Tonmoy Pandit ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Panchagarh, Upa:Tentulia
Care Taker: DSCL (SW-03)	Union:, Vill.:
Sample Collection date: 20-03-2018	Date of Testing: 22/03/2018-24/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	2	mg/L	5 days Incubation	0.1
2	Chemical Oxygen Demand (COD)	4.0	8	mg/L	CRM	-
3	Chloride	150-600	23	mg/L	Titrimetic	-
4	Nitrogen (Ammonia)	0.50	0.7	mg/L	UVS	0.01

Comments: Sample was collected & Supplied by client.
N.B: UVS- UV-Visible Spectrophotometer, CRM-Closed Reflex Methods , LOQ - Limit of Quantitation.

Test Performed by:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	25.04.18	1.) Name: Md. Biplab Hossain Designation: Chief Chemist	25/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
2.) Name: Taslima Akhter Designation: Sample Analyzer	25.04.18 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	2.) Name: Designation:	

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Appendix G: 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

Lab Memo: 689/ CC, DPHE, CL, Dhaka.

Date: 25-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018040055	Sample Receiving date: 22-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 20-03-2018	Sample Source: Ground Water
Sent by:Tonmoy Pandit ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Panchagarh, Upa:Tentulia
Care Taker: DSCL (GW-01)	Union:, Vill.:
Sample Collection date: 20-03-2018	Date of Testing: 22/03/2018-24/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	45	mg/L	Titrimetic	-
2	Arsenic (As)	0.05	0.002	mg/L	AAS	0.001
3	Chloride	150-600	10	mg/L	Titrimetic	-
4	Iron (Fe)	0.3-1	0.14	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:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	25.04.18	1.) Name: Md. Biplab Hossain Designation: Chief Chemist	25/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
2.) Name: Taslima Akhter Designation: Sample Analyzer	25.04.18	2.) Name: Designation:	

নমুনা বিশ্লেষক
জনস্বাস্থ্য প্রকৌশল অধিদপ্তর
কেন্দ্রীয় পরীক্ষাগার
মহাখালী, ঢাকা

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

Lab Memo: 689/ CC, DPHE, CL, Dhaka.

Date: 25-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018040056	Sample Receiving date: 22-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 20-03-2018	Sample Source: Ground Water
Sent by:Tonmoy Pandit ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Panchagarh, Upa:Tentulia
Care Taker: DSCL (GW-02)	Union:, Vill.:
Sample Collection date: 20-03-2018	Date of Testing: 22/03/2018-24/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	40	mg/L	Titrimetic	-
2	Arsenic (As)	0.05	0.004	mg/L	AAS	0.001
3	Chloride	150-600	10	mg/L	Titrimetic	-
4	Iron (Fe)	0.3-1	0.44	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:	Countersigned/Approved by:
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature 25.04.18	1.) Name: Md. Biplab Hossain Designation: Chief Chemist Signature 25/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
2.) Name: Taslima Akhter Designation: Sample Analyzer 25.04.18 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	2.) Name: Designation:

Page 1 of 1

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

Lab Memo: 689/ CC, DPHE, CL, Dhaka. Date: 25-04-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018040057	Sample Receiving date: 22-03-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 20-03-2018	Sample Source: Ground Water
Sent by:Tonmoy Pandit ,Jr. Environmental Specialist , DSCL, Mirpur DOHS, Dhaka-1216.	Dist:Panchagarh, Upa:Tentulia
Care Taker: DSCL (GW-03)	Union:, Vill.:
Sample Collection date: 20-03-2018	Date of Testing: 22/03/2018-24/04/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	50	mg/L	Titrimetic	-
2	Arsenic (As)	0.05	0.002	mg/L	AAS	0.001
3	Chloride	150-600	12	mg/L	Titrimetic	-
4	Iron (Fe)	0.3-1	2.14	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:	Signature	Countersigned/Approved by:	Signature
1.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer	25.04.18	1.) Name: Md. Biplab Hossain Designation: Chief Chemist	25/04/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা।
2.) Name: Taslima Akhter Designation: Sample Analyzer	25.04.18 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	2.) Name: Designation:	

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Appendix H: Soil Quality Test Result

মৃত্তিকা, পানি ও পরিবেশ বিভাগ
ঢাকা বিশ্ববিদ্যালয়
ঢাকা-১০০০
বাংলাদেশ

Department of Soil, Water and Environment
University of Dhaka
Dhaka 1000
Bangladesh

Date: 10. 04. 2018

Report of Analysis

Sample supplied by
Mr. Tonmoy Pandit
Junior Environmental Specialist
Development Solutions Consultant Ltd.
House-734 (5-B), Road-10, Avenue-04
DOHS Mirpur, Dhaka-1216, Bangladesh

Re.: 10.6 Mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

Sample Title: Soil Quality Test

Analytical Results:

Serial No.	Soil Sample ID	Test Parameters						
		pH (1:2.5)	Electrical Conductivity (EC) (1:5) (µS/cm)	Cadmium (Cd) (mg/kg)	Lead (Pb) (mg/kg)	Copper (Cu) (mg/kg)	Zinc (Zn) (mg/kg)	Arsenic (As) (mg/kg)
1.	SL_01	6.94	38.6	0.328	3.025	22.655	52.385	1.956

Methods Used:

1. pH : pH meter
2. EC : EC meter
3. Cd, Pb, Cr, Cu and Zn : AAS method

(Professor Dr. Sirajul Hoque)
Chairman

Dr. Sirajul Hoque
Professor & Chairman
Department of Soil, Water & Environment
University of Dhaka, Dhaka-1000

Telephone: 9661920-73/7470, Fax: (880-2) 8615583, e-mail: swed@du.ac.bd

Appendix I: Attendance List of the FGDs

FGD No. – 1: Project Site, Aqua Breeders Limited, Majhipara, Salbahan Road, Upazilla: Tentulia, District: Panchagarh
GPS Coordination: 26.48495°N, 88.41126°E
Date: 17 March 2018
Time: 12:30 PM To 01:00 PM

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for FGD (01)

FGD No. 01

Address Project Site (Panagaon Poultry Limited)

Date 17.03.2018 **Time** 12.30-1.00 Pm

GPS Location 26.48495°N 088.41126°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
01	Sazzad Hossain	30	Priveat Job	01757267494	
02	Golum Sorower	29	Preivet job	01816603843	
03	Uttam kumarroy	29	Poriretjob	01733776052	
04	Hahfiz Rahman	30	privetjob	01743-39225	
05	Ahad khandkar	30	private job	01737-272687	
06	MD. SOIBAHM	47	Pmrtt	01726467023	
07	MD. Morowan	28	job	01717204533	
08	MD: Asraful	27	Job	01767469154	
09	MD: JS Rafel	22	job	01963486420	
10	MD: Abdul Hakim	30	Job	01746738544	
11	MD: Kabir	32	Job	01739455179	
12	Tonmoy Pandit	24	Jobholder	01704679289	
13	Sheikh Munir	33	Driver	01739734381	
14	Shahidul Islam	26	Job holder	01719419413	
15	Bappy Rahman	21	Student	01755406941	

Facilitated By Tonmoy Pandit

Signature

FGD No. – 2: Tentulia Bazar Upazilla: Tentulia, District: Panchagarh
GPS Coordination: 26.49215°N, 88.34325°E
Date: 17 March 2018
Time: 03:00 PM To 03:30 PM

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for FGD

FGD No. 02

Address Tetolia Bazar

Date 17.03.18 **Time** 3.00 PM – 3.30 PM

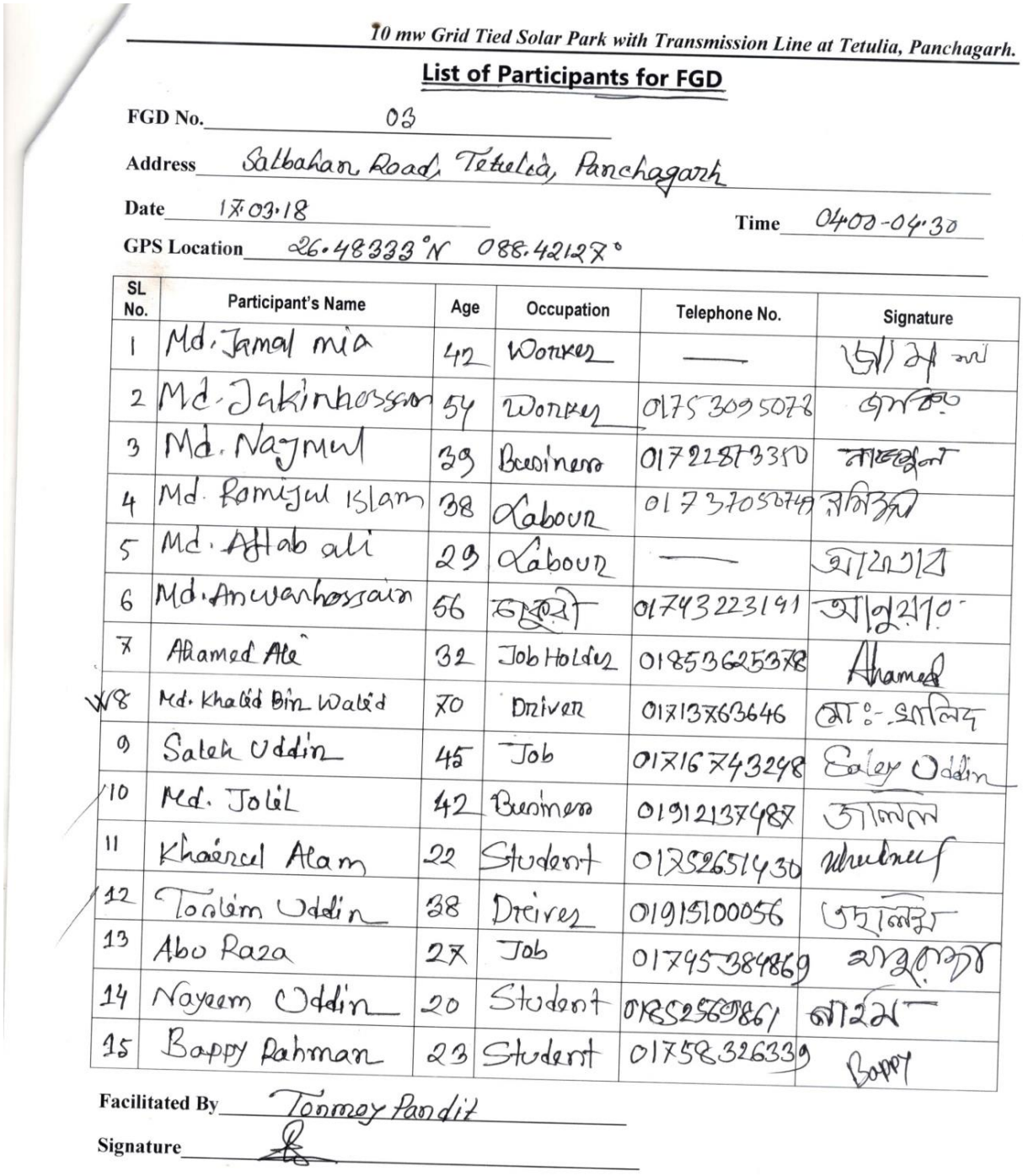
GPS Location 26.49215°N 088.34325°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	Md. Sher Ali	38	Worker	01750762136	
2	Md. Sirajul Islam	32	Worker	01737232916	
3	Ajimul	28	Worker	01750870336	
4	Md. Lablu	35	Labour	01761004862	
5	Md. Abutaleb	36	Famer	0175-103604	
6	Md. Ismail	48	Labour	—	
7	Md. Sharif	34	Farmer	01781 977948	
8	Md. Rony	28	Student	01755427804	
9	Md. Aminhossain	44	Farmer	01751263842	
10	Md. Ariful hossain	52	Businessman	01787080	ARIF
11	Rafiqul Islam	45	Job	01943653243	
12	Kismat Ali	42	Labour	-	
13	Moninul Hasan	35	Busines	01843354369	
14	Sahidul Islam	26	Student	01245693273	
15	Monir Mahmud	33	Driver	01948353265	

Facilitated By Tormoy Pondit

Signature

FGD No. – 3: Salbahan Road Bazar Upazila: Tentulia, Dist: Panchagarh.
GPS Coordination: 26.48333°N, 88.42127°E
Date: 17 March 2018
Time: 04:00 PM To 04:30 PM



10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for FGD

FGD No. 03

Address Salbahan Road, Tetulia, Panchagarh

Date 17.03.18 **Time** 0400-04.30

GPS Location 26.48333°N 088.42127°

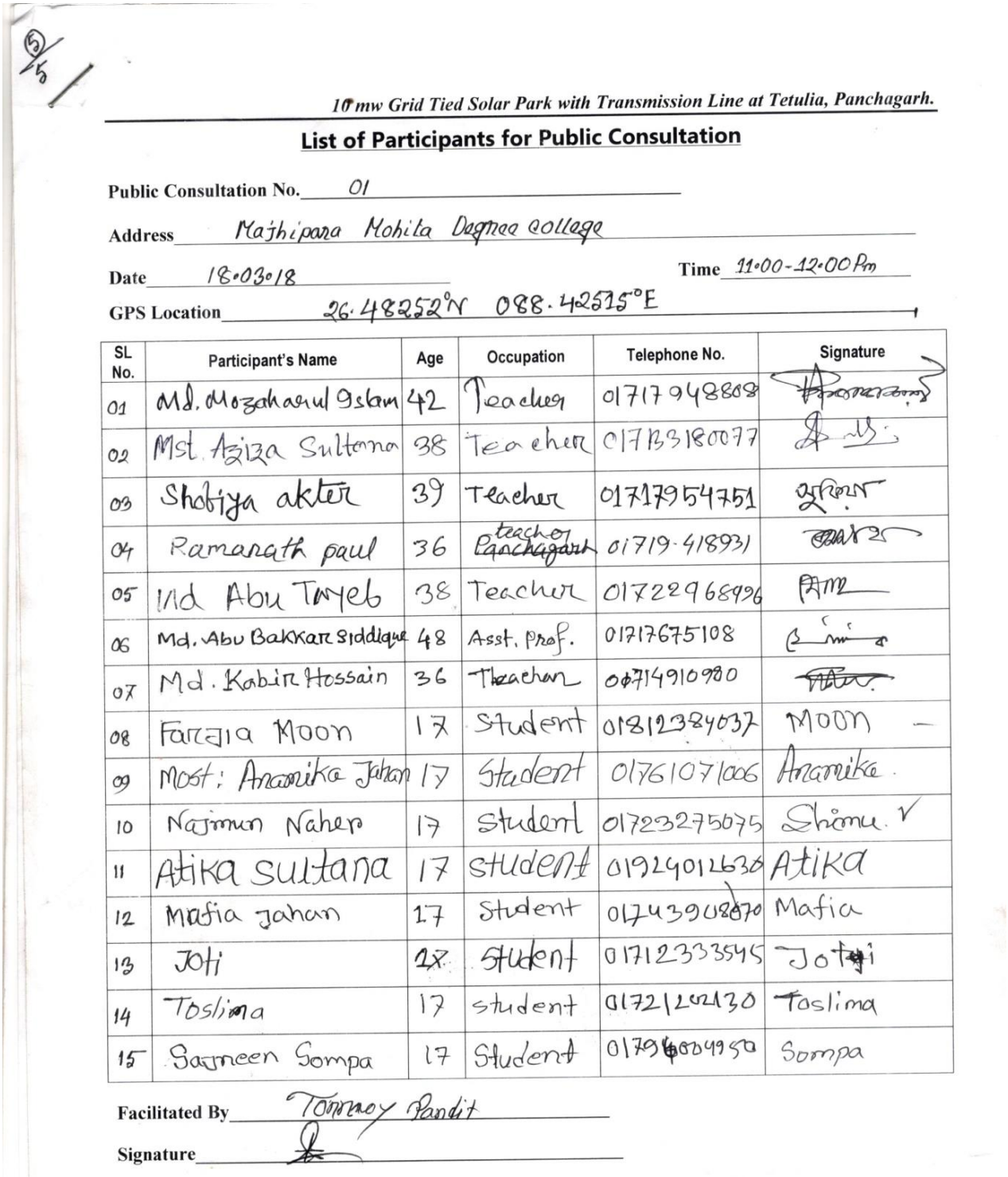
SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	Md. Jamal mia	42	Worker	—	
2	Md. Jakirhossain	54	Worker	0175 309 5078	
3	Md. Najmul	39	Business	01722873350	
4	Md. Romijul Islam	38	Labour	01737050749	
5	Md. Aftab ali	23	Labour	—	
6	Md. Anwarhossain	56		01743223141	
7	Ahamed Ali	32	Job Holder	01853625378	Ahamed
8	Md. Khalid Bin Walid	70	Driver	01713763646	
9	Saleh Uddin	45	Job	01716743248	Saleh Uddin
10	Md. Jolil	42	Business	01912137487	
11	Khairul Alam	22	Student	01752651430	
12	Toslim Uddin	38	Dreiver	01915100056	
13	Abo Raza	27	Job	01745384869	
14	Nayeem Uddin	20	Student	01852569861	
15	Bappy Rahman	23	Student	01758326339	Bappy

Facilitated By Tonmoy Pandit

Signature

Appendix J: Attendance List of PCMs

PCM No. – 1: Majhipara Girls Degree College, Salbahan Road Upazilla: Tentulia District: Panchagarh
GPS Coordination: 26.48252°N, 88.42515°E
Date: 18 March 2018
Time: 11:00 AM To 12:00 PM



10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for Public Consultation

Public Consultation No. 01

Address Majhipara Mohila Degree college

Date 18.03.18 **Time** 11.00-12.00 Pm

GPS Location 26.48252°N 088.42515°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
01	Md. Mozaharul Islam	42	Teacher	01717948808	
02	Mst. Aziza Sultana	38	Teacher	01733180077	
03	Shofiya akter	39	Teacher	01717954751	
04	Ramanath paul	36	teacher Panchagarh	01719-418931	
05	Md Abu Tayeb	38	Teacher	01722968496	
06	Md. Abu Bakkar Siddique	48	Asst. Prof.	01717675108	
07	Md. Kabir Hossain	36	Teacher	01714910980	
08	Farzia Moon	17	Student	01812384037	Moon
09	Most: Anamika Jahan	17	Student	01761071006	Anamika
10	Najmun Naher	17	student	01723275075	Shimu.
11	Atika sultana	17	student	01924012636	Atika
12	Mafia Jahan	17	Student	01743908870	Mafia
13	Joti	17	student	01712333545	Joti
14	Toslima	17	student	01721202130	Toslima
15	Sajneen Sompa	17	Student	01796084950	Sompa

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Signature

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for Public Consultation

Public Consultation No. 01

Address Majhipara Mohila Degree college

Date 18.03.18 **Time** 11.00-12.00

GPS Location 26.48252°N 088.42515°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
16	Md. Mostafizur	41	Teacher	01716275249	
18	Md. ZahangenAlam	31	Teacher	01717976891	Falam
19	Mossa. shamima Nasrin	32	Teacher	01717330435	
20	Matilal Sarkar	38	Teacher	01723018594	
21	MD. SAZZAD Hossen	35	Teacher	01717184874	
22.	MD JOYNAL ABEDIN	38	Teacher	01711781988	
23.	Md. Noor Alom Siddique	35	Teacher	01922030405	
24	Md. Saiful Islam	96	Teacher	01725740854	
25	Sweety	19	Student	01785358247	Sweety
26	Suley	18	Student	01721159756	
27.	Rowsonara	18	student	01757686221	
28	Rumi	18	Student	01750115358	Rumi
29.	Tonmoy Pandit	23	Job holder	01794679289	
30.	Bappy Rahman	20	Student	01755406941	Bappy
31.	Sahidul Islam	26	Envt Expert	01719419413	

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Signature

PCM No. – 2: Project Site, Aqua Breeders Limited, Majhipara, Salbahan Road, Upazilla: Tentulia Dist: Panchagarh
GPS Coordination: 26.48511°N, 88.41129°E
Date: 17 March 2018
Time: 12:30 PM To 01:30 PM

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for Public Consultation

Public Consultation No. 02

Address Aqua Breeders Limited (Paragaon Group)

Date 18.03.18 **Time** 12.30-1.30Pm

GPS Location 26.48511°N 088.41129° E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
01	MD. Ashraful Islam	30	Bussines	01712469687	
02	MD. Abu taher	45	Bussines	01788070193	
03	MD Abdel Karim	60	VP. Member	01723429032	
04	Utam roy	29	Job	01733776052	
05	Sujon Kabir.	28	Job.	01234262572	
06	Soleman	35	Job.	01832320882	
07	mahabin ali	42	Job	01863007539	
08	Tonmoy Pandit	22	Envt Expert	01794679289	
09	Jamirul Uddin	30	Labour	01953337251	
10	Ashequl Islam	40	Job	01717722232	18.03.18
11	Alif	28	Driver	01935501421	
12				01744836454	
13	Md. Aminul Islam	46	Bm	01767224848	
14	Md. Golam Rabbani	18	Run-	01712594857	18/3/18
15	Golam Sorower	30	private job	01816603893	

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Signature

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for Public Consultation

Public Consultation No. 02

Address Aqua Breddera Limited (Paragaon Group)

Date 18.03.18 **Time** 12.30 - 1.30

GPS Location 26.48511°N 088.41129°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
16	Rashaduzzaman	26	Job Holder	01742568223	Rara
17	Bappy	20	Student	01755406941	Bappy
18	Sahidul	26	Job Holder	01719419413	
19	Moninul Islam	33	Driver	01739729381	Monir
20	Md. Sajjad Hossen	37	Private Job	01713361916	Shazad

Facilitated By Tonmoy Pandit

Signature

PCM No. – 3: Tentulia Pilot Model High Scholl, Upazilla: Tentulia Dist: Panchagarh
GPS Coordination: 26.49755°N, 88.33958°E
Date: 17 March 2018
Time: 03:00 PM To 04:00 PM

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for Public Consultation

Public Consultation No. 03

Address Tetulia Pilot Model High School

Date 18.03.18 **Time** 3.00-4.00

GPS Location 26.49755°N 088.33958°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1.	Md. Rafiqul Islam	52	Job	01734996840	
2.	MD SAIFUL ISLAM	40	Trade Instruct	01724443245	
3.	Most. Hosneara Begum	30	Assistant teacher	01784940248	
4.	Md. Abu Taler Alam	30	Ass. Teacher	01750513465	Taler
5.	Md. Asaduzzaman	30	Trade Instruct	01717956653	
6	MD. IRSHADUL ALAM	48	service	01719858372	
7	MOST. JANNATUN FERDOSS	30	Assistant teacher	01717-849289	
8	MD. SHAHJAHAN	58	Assit teach	01728216084	Shah
9	MOST. SULTANA YEASMIN	39	" "	~~01757207~~ 01757073327	
10.	MD. GIASH UDDIN	40	ASST. TEA	01734871362	
11	MD. BASHIR UDDIN	45	Trade instru	01726677	Bash.
12	MD. MAMUN	58	JOB	01723367322	
13	Md. Sadique Hasan Raj	13	Student	01535086071	Raj
14	MD. Abrar Jawad Rahin	13	student	01720992570	Rahin
15	Nokib Mahmud Zisun	13	student	01774660565	Zisun.

Facilitated By_____

Signature_____

10 mw Grid Tied Solar Park with Transmission Line at Tetulia, Panchagarh.

List of Participants for Public Consultation

Public Consultation No. 03

Address Fori Pilot Model High School

Date 18.03.18 **Time** 3.00 - 4.00

GPS Location 26.49755°N 088.33958°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
16	MD: Radowan	14	Student	01751401404	Radowan
17	MD:- RAKIBUL	13	Student	01737359451	RAKIB
18	Riya	13	student	01837359811	Riya
19	Usha	12	student	01537783111	Usha
20	Ayat	11	Student	01752854265	Ayat
21	Masud	15	student	01714941375	Masud
22	Bappy rahman	20	student	01712941375	BAPPY
23	RABBYE	15	Student	01812416381	RABBYE
24	Rocky	15	Student	01737796393	Rocky
25	Shimanto	15	Student	01712375063	Shimanto
26	Digonto	15	student	01727345118	Digonto
27	Adnan	15	Student	01739210356	Adnan
28	Tamim	15	student	01635362691	Tamim
29	TARAK	16	Student	01747754003	Tarak
30	Fazlul Kasem	56	Teacher	01737526809	F.Z

Facilitated By _____

Signature _____