

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

218.6kW Solar Mini Grid Project, Charsajai,
Kodalkathi Union, Char Rajibpur Upazila,
Kurigram District

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Prepared By

Connectia Limited

Sheltech Symphony: Apt 3A, House 09,
Road 33, Gulshan 1, Dhaka -1212

Email: info.connectia@gmail.com

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ABBREVIATIONS

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

EXECUTIVE SUMMARY

INTRODUCTION

1. The interest in Renewable energy has been reviving over last few years, especially after global awareness regarding the ill effects of fossil fuel burning, which may effects in the global climate change. Energy is the source of growth and the mover for economic and social development of a nation and its people. As we are rapidly exhausting, our non-renewable resources, degrading the potentially renewable resources and even threatening the perpetual resources, the natural resources or energy sources including fossil fuels, oil, natural gas etc. are completely used or economically depleted.
2. Bangladesh is a densely populated country with 160 million people. To meet the increasing population demand the generation of electricity is not produced as expected. The per capita generation is 348 kWh (Power Division, Government of the People's Republic of Bangladesh; Accessed on 19-08-2015). The per capita consumption of power by World Bank estimate in 2009 for India was 571 kWh, for Pakistan was 449 kWh and for China it was 2631 kWh. The Sixth Five Year Plan contains information on demand-supply gap for electricity, source of electricity supply, use of different types of energy, electricity generation program and strategy for power generation.
3. The policy of the Government of Bangladesh has been to ensure extension and stabilization of the power sector through both public and private sector undertakings toward not only meeting the existing power deficiency of the country but also ensuring continuous power in view of the projected future demand. Current undertaking by Connectia Limited constructing a Solar Mini Grid Power Plant at Charsajai, Char Rajibpur has been implemented under this policy. The proposed Project involves setting up of a 218.6 kWp solar photovoltaic (PV) based AC-DC coupled mini-grid by Connectia Limited. An 150 kVA (120 kW) diesel backup generator will be integrated into the proposed power plant in order to ensure adequate power supply during periods of low solar radiation. Once completed, the Project is expected to go into commercial operation in July 2018 and supply electricity to the adjacent 788 households, 104 shops, 11 schools, mosques, Madrashes & offices, 2 rice mills, 1 saw mill, and 20 irrigation pumps.

METHODOLOGY

4. 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 Char areas.

POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

5. Legislative bases for Environmental Impact Assessment (EIA) in Bangladesh are the Environmental Conservation Act 1995 (ECA'95, as amended in 2010) and the Environmental Conservation Rules 1997 (ECR'97). Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal

and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, the 518kWp Industrial Rooftop solar system project (50 kWp to 1MW) is considered as the **"Green category"**.

DESCRIPTION OF THE PROPOSED PROJECT

6. The proposed project is located beside Brahmaputra River at Charsajai (5 no. Ward) of Kodalkathi Union at Char Rajibpur of Kurigram district (Figure 3.1). The Global Positioning System (GPS coordinate of the project site is 25.49664° N, 089.77097° E. The proposed plant is bounded by agricultural land in two sides; in addition the north and east side of the project area is having some residential dwellings. The total land of the proposed project is about 120 decimal (equivalent to 4 bighas).
7. The proposed Project involves setting up of a 218.6kWp standalone AC mini-grid power plant by Connectia Limited at Charsajai in Char Rajibpur upazila of Kurigram district. The proposed system will include 363 batteries of 1540 Ah (at 2 V) along with a 150 kVA diesel backup generator to meet the energy demand of the area. The total budget is estimated as BDT. 81,840,633.00

DESCRIPTION OF THE BASELINE ENVIRONMENT

8. The project area is located in the Northern part of the Northern region climatic zone. 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 (Banglapedia, 2012).
9. Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon, and it has these three distinct seasons:
10. Pre-monsoon hot season (from March to May), Rainy monsoon season (from June to October), and Cool dry winter season (from November to February).
11. The pre-monsoon hot season is characterized by high temperatures and thunderstorms. April is the hottest month in the country with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud-cover reduces the temperature. Wind direction is variable during this season, especially during the early part. Rainfall, mostly caused by thunderstorms, at this time can account for 10 to 25 percent of the annual total.
12. The rainy monsoon season is characterized by southerly or south-westerly winds, very high humidity, heavy rainfall and long periods of consecutive days of rainfall. The monsoon rain is caused by a tropical depression that enters the country from the Bay of Bengal. About 80% of the annual precipitation occurs during the five-month monsoon season from May to September.
13. The cool dry season is characterized by low temperatures, cool air blowing from the west or northwest, clear skies and meager rainfall. The average temperature in January varies from 17°C in the northwest and north-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme northwest in late December and early January reach between 3°C to 4°C.
14. The proposed site is presently using for agriculture. Air quality test has been conducted on 21th February 2018 at the proposed project site. According to Bangladesh National Ambient Air Quality Standards, a methodology for analyzing the air quality sample is

described in Appendix A. 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 measures parameter of the local ambient air does not exceed Bangladesh standard; any of the measures parameter of the local ambient air does not exceed Bangladesh standard. 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 during day time. 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.

15. The project lies in the north-western part of the country and depends on the Teesta and Brahmaputra River for freshwater supply. The project area falls in the Old Brahmaputra Floodplain (4) physiographic unit. The general topography of the project area is relatively flat. The topography of the specific project location is 10.85 – 14.94 m a.m.s.l. Topographically the cluster of the project location is almost flat, with many depressions, natural water bodies, bounded by the Rivers.
16. The project area is surrounded several major surface water bodies which are Brahmaputra River, Halhali and Jinjiram etc. There are also significant numbers of natural water bodies around the project location. Most of the water bodies become waterless or contain minimum amount of water during the dry season and gets water in rainy season. People use the water from the river and ponds for washing, bathing and irrigation purposes. In the wet season, substantial amount of the land in the area is inundated due to flood. In the dry season local canals and channels provide water for irrigation for Boro cultivation and for growing winter crops. On 21th February 2018, surface water sample was collected by environmental team from a pond near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The concentration level of DO was only within the acceptable limit.
17. Furthermore, on 21th February 2018, groundwater sample was collected by environmental team from a tube well near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE except for Chloride. The concentration levels of Chloride are not within the drinking water quality standard set by DOE. However, other three measured parameters are within the standard quality.
18. The project area contains the below AEZ namely: *Active Brahmaputra-Jamuna Floodplain (7)*: This region comprises the belt of unstable alluvial land along the Brahmaputra-Jamuna rivers where land is constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. The area is occupied by sandy and silty alluvium, rich in weather able K minerals that are slightly alkaline in reaction. Six general soil types occupy the area. Organic matter status is low and fertility status is low to medium. (Banglapedia, 2014). The nature and soil characteristics of this zone influence the crops and cropping patterns within the region.
19. 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, 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, project area falls in the zone I. It means the project area is prone to high seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

20. The project area falls below the bio-ecological zone (Major Rivers (Bio-ecological zone 11)): Bangladesh consists mainly of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, Ganges and Meghna rivers. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly catkin grass for example). Dense growth of catkin grass can accelerate silt deposition on chars. Many of the species' natural distribution, migration and storage are primarily functioned via these rivers into other wetland ecosystems (GoB-IUCN, 1992). A diverse range of waterfowls are directly or ecologically dependent on these rivers and its associated ecosystems. However, it is quit alarming that, with the exception of few species of turtles, all other river biodiversity is threatened with extinction (IUCN, 2002f).
21. The proposed project is located beside Brahmaputra River at Charsajai (5 no. Ward) of Kodalkathi Union at Char Rajibpur of Kurigram district. The Global Positioning System (GPS coordinate of the project site is 25.49664° N, 089.77097° E. The proposed plant is bounded by agricultural land in two sides; in addition the north and east side of the project area is having some residential dwellings. The total land of the proposed project is about 120 decimal (equivalent to 4 bighas). There is one local market (Haat) within 1 km of the proposed project site. As per survey, there are 788 households, 104 shops, 11 schools, mosques, Madrashes & offices, 2 rice mills, 1 saw mill, and 20 irrigation pumps. There are also schools, madrasahs and mosques in the proposed location. The range of profession includes business, farmer, service etc.

ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

22. 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.
23. During pre-construction phase, the impacts associated with the land use and flood hazards. The project developer has bought the land from the owner with a good value. There is no conflict in land use. Therefore, there are no anticipated impacts of land use of the Project. Since the area is subject to potential risk of local flood hazards during the rainy season. It should be considered in the design stage.
24. 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. Soil quality may be deteriorated due to the leaching of various oily substances to the soil. The transmission line laying may occur some negative impacts on vegetation, agricultural lands and existing utility lines. All the impacts will be very much localized

in nature. The project contractor is to take responsibility of minimizing environmental impact on the surroundings during construction phases by following the project's environmental management plan (EMP). Other social impacts associated with the visual amenity, health safety of the labors, cultural resources, employment opportunity etc. such type of impacts will be localized in nature and not anticipate to the project. The contractor should follow the rules and guidelines related to the environmental and social mentioned in the EMP.

25. Photo Voltaic power plants do not release greenhouse gases or any toxic pollutants during their operation. The solar power do not exhibit any significant noise from operations, the inverters and transformers may produce noise, but this is not anticipated to the environment. In addition, there is some residential dwellings beside the project area. The residential dwellings are sensitive receptors within the project site. Every phase of the construction and operation must be followed the project's environmental management plan (EMP). Soil impacts during operation phase are limited to accidental spillage of lubricant, fuel and other chemicals that may potentially cause soil degradation. Another most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. The surface water bodies may get 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. Groundwater may get polluted due to contaminated runoff chemical materials. Additionally, the project may lead to faster development of the surrounding of the project area. This will exert stress on the availability of groundwater in the project area. Other impact issue like ecology, waste generation will not be significant for the project. Some social impact are associated with health safety, employment, visual amenity etc.
26. To minimize/mitigate the impacts the developer should follow the Environmental Management Plan (EMP) properly.

ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

27. 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.
28. Environmental Monitoring Plan has incorporated key environmental components and parameters to be monitored their indicators, frequency, timing and locations of monitoring and also the actors responsible for carrying out such monitoring.
29. Connectia 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. This will be headed by a Project Manager (PM), supported by technical staff including Design and Supervision Consultants (DSC), who will design the infrastructure, manage selection of Contractors, and supervise construction.
30. Mitigation is the responsibility of Connectia Limited. The EPC contractor engaged by the project authority will implement the EMP along with mitigation measures, as part of the contractual obligation, and the DSC 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

31. 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.
32. 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.
33. 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.
34. Solid waste will be generated during the construction period from excavation and refuse from construction camps.
35. The major issue is the need to minimize disturbance to the local population in the areas of construction.
36. A positive policy of employing local people during the construction phase should be adopted.
37. 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.
38. In view of the above considerations and the fact that the executing agency (Connectia 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.

1 INTRODUCTION

1.1 Background

Bangladesh is still at a very low level of Electrification. The government of Bangladesh has declared its vision 2021 to provide electricity for all. Power Sector Master Plan 2010 (PSMP-2010) has been undertaken to accommodate the government's vision 2021, According to PSMP study the electricity demand would be 34,000MW by the year 2030. The aggregated investments for the development of the generation, transmission and related facilities are found to be at Taka 4.8 trillion (US\$ 69.5 billion). The annual average of the investment amounts to Tk. 241 billion (US\$ 3.5 billion).

The government fully recognizes the fact that public sector investment alone is not sufficient to achieve its target and has aimed at mobilizing resources from the private sector investments. The Government is strongly committed to attract private investment for installing new renewable energy capacity on a build-own-operate (BOO) basis in order to achieve overall economic development targets of the country and avoid looming power shortages. Being aware of the finite stock of fossil fuels and their negative impact on the environment, countries across the world are now leaning towards renewable energies like solar energy, wind energy, bio-energy, hydropower, geothermal and ocean energy in efforts to ensure energy security. The use of renewable energy has risen considerably in recent times, both in developed and in developing countries. According to the Global Status Report, renewable energy provided an estimated 19% of global energy consumption in 2012 compared to 16.7 % in 2010. More than hundred countries now have renewable energy policy of one kind or the other.

Keeping pace with the global trend, Bangladesh has also attached due importance to development of renewable energy. National plans - Five Year Plan, Power System Master Plan and policy documents including National Energy Policy, Industrial Policy 2010 underscored renewable energy. Development of renewable energy has been identified as one of the programmes of Bangladesh Climate Change Strategy and Action Plan. Renewable energy options are also included in the Bangladesh National Building Code. A dedicated policy, Renewable Energy Policy of Bangladesh, has been in force since 2009, which envisions having 5% power from renewable energy sources by 2015 and 10% by 2020. The government has established Sustainable and Renewable Energy Development Authority (SREDA) to promote renewable energy and energy efficiency. To strengthen international cooperation, Bangladesh became one of the initial members of the International Renewable Energy Agency (IRENA), the only inter-governmental agency working exclusively on renewable energy. Those endeavors manifest Bangladesh's commitment towards development of renewable energy.

The successful use of renewable energy technology in Bangladesh still requires extensive investigation, however, Concentrating Solar Power (CSP) and Photovoltaic (PV) technologies have been demonstrated to be economically and environmentally viable and capable of being employed on a large scale. The policy of the Government of Bangladesh has been to ensure extension and stabilization of the power sector through both public and private sector undertakings toward not only meeting the existing power deficiency of the country but also ensuring continuous power in view of the projected future demand. Current undertaking by Connectia Limited constructing 218.6kW Solar Mini Grid Power Plant at Charsajai in Char Rajibpur, Kurigram has been implemented under this policy.

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

The government is gradually meeting part of the lighting and cooling load of public offices by installing solar panels. The national capacity of solar power development currently exceeds 150 MW. Most of the capacity addition is from Solar Home Systems (SHS) implemented by Infrastructure Development Company Limited (IDCOL), a government-owned financial institution. Until recently, more than 3 million SHSs have been installed with aggregated capacity of about 135 MW. The international community recognizes Bangladesh's SHSs as the fastest growing solar power dissemination program in the world.

Connectia Limited is constructing a Solar Mini Grid Power Plant at Charsajai, Char Rajibpur. The proposed Project involves setting up of a 218.6 kWp solar photovoltaic (PV) based AC-DC coupled mini-grid by Connectia Limited. An 150 kVA (120 kW) diesel backup generator will be integrated into the proposed power plant in order to ensure adequate power supply during periods of low solar radiation. Once completed, the Project is expected to go into commercial operation in July 2018 and supply electricity to the adjacent 788 households, 104 shops, 11 schools, mosques, Madrashas & offices, 2 rice mills, 1 saw mill, and 20 irrigation pumps.

Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh, the 518kWp Industrial Rooftop solar system project (50 KWp to 1MW) is considered as the “**Green category**”.

1.2 Purpose of the Study

The purpose of the study is to provide an examination and assessment of the principal environmental impacts of the project. Environmental studies based on environmental assessment, impact prediction, mitigation and overall management has been essential for the projects funded by Infrastructure Development Company Limited (IDCOL). The aims of the environmental impact assessment (EIA) are to determine the environmental issues and impacts arising from the project and to ensure that the environmental issues have been adequately considered and will be appropriately managed.

The main purpose of this EIA are to evaluate the impact of project location from the environmental point of view along with possible measures to be included in an Environmental Management Plan (EMP) to minimize the potential impacts resulting from project activities during the implementation and operation phase of the project. This study investigates renewable energy-based rural electrification in Bangladesh, with a specific focus on the mini grid experiences. Specific references are made to solar PV technologies implemented under

publicly supported program. The study is also providing an examination and assessment of the environmental impacts of the project.

The EIA provides a road map to the environmental measures needed to prevent and/or mitigate negative environmental effects associated with the development project. The EIA also provides a detailed description of the direct and indirect environmental effects associated with the proposed project during key periods of work. In order to mitigate the potential impacts, appropriate measures have also been proposed in the Environmental Management Plan (EMP). Extensive public consultations undertaken as part of the ESIA work have been considered for identifying the mitigation measures.

This EIA is a part of the process of compliance with the guidelines and legal requirement of Government of Bangladesh, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines in relation to 218.6kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant. Connectia Limited as an implementing agency of 218.6kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant that illustrates environmental issues in connection with the planning, design and implementation of this project.

1.3 Scope of the Work

This ESIA report has been prepared keeping in view the Term of Reference (ToR) as provided by the Client. The scope of the present ESIA report describes the following most important features:

- A review of the environmental legislative, regulatory and policy guidelines and considerations relating to the implementation of the project;
- A general description of the project and existing physical, biological and socio-economic conditions;
- Consultation with the locals/stakeholder involving concerned people in order to identify and act on any undocumented or perceived environmental issues;
- Identification and assessment of the potential impacts on the natural and human environment in the project area, from the construction of the AC mini-grid power plant;
- Identification of mitigation measures and monitoring actions in the form of an Environmental Management Plan (EMP); and
- Recommendations and conclusions in order to operate the project works in an environmentally safe and sound manner.

1.4 Extent of the Study

This ESIA is carried out based on proposed development. The influence of impact has been defined as 1 Km radius of the project location. Geographical Information System (GIS) techniques have also been used based on recent satellite imageries of the project area for above purposes. Assessment is carried out on the following environment components: terrestrial and aquatic ecology, soil, water, air, noise, and socio-economic aspects. The impacts on ecologically sensitive areas (e.g. wildlife sanctuaries, biosphere reserve, and protected places) within 1 Km of the project areas have also been assessed.

1.5 ESIA Content

The report fulfills the requirements of ESIA under ECR, 1997 and has been prepared in accordance with the TOR. This ESIA report is also consistent with the Government of Bangladesh guidelines, JICA Guidelines for Loan Aid (Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, April 2010) and World Bank OP 4.01 (Environmental Assessment) guidelines. The report contains twelve chapters and the chapter details are discussed below:

- **Chapter 1** describes the introduction containing background, purpose of the ESIA study, scope of the study, and approach methodology of ESIA study.
- **Chapter 2** is on policy, legal and administrative framework describing the relevant policy and legal frameworks for the ESIA process.
- **Chapter 3** contains detailed project description including the all the aspects of the proposed project.
- **Chapter 4** describes the technological aspects
- **Chapter 5** describes environmental baseline condition with details on physical environment, land resources, agricultural resources, fisheries, ecosystem condition and social characteristics of the area.
- **Chapter 6** describes social baseline condition including socio-economic condition and social characteristics of the area.
- **Chapter 7** describes analysis of the project alternatives
- **Chapter 8** describes public consultation discussion with local stakeholders with their ideas, views about the project through knowledge sharing
- **Chapter 9** presents the impacts of project during pre-construction; construction and post-construction phase and describes mitigations measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts.
- **Chapter 10** describes the environmental management plan (EMP) and monitoring plan along with the costing of the mitigation measures and monitoring plan.
- **Chapter 11** includes the environmental and social benefits.
- **Chapter 12** concluding the ESIA report along with the recommendations.

1.6 Approach and Methodology

1.6.1 Approach

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 Char areas. The main purpose of this approach was to obtain a fair impression on the people's perceptions of the project and its environmental impacts. 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) and World Bank OP 4.01 (Environmental Assessment) guidelines. The route map of this ESIA preparation is given in Figure 1.1.

1.6.2 Methodology

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

(i) Orientation

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

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

In this step, primary and secondary data were collected through field observations, environmental monitoring in the field, concerned departments and published materials to establish baseline profile for physical, biological and socioeconomic environmental conditions. A map in **Figure 1.2** presents the sampling locations 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

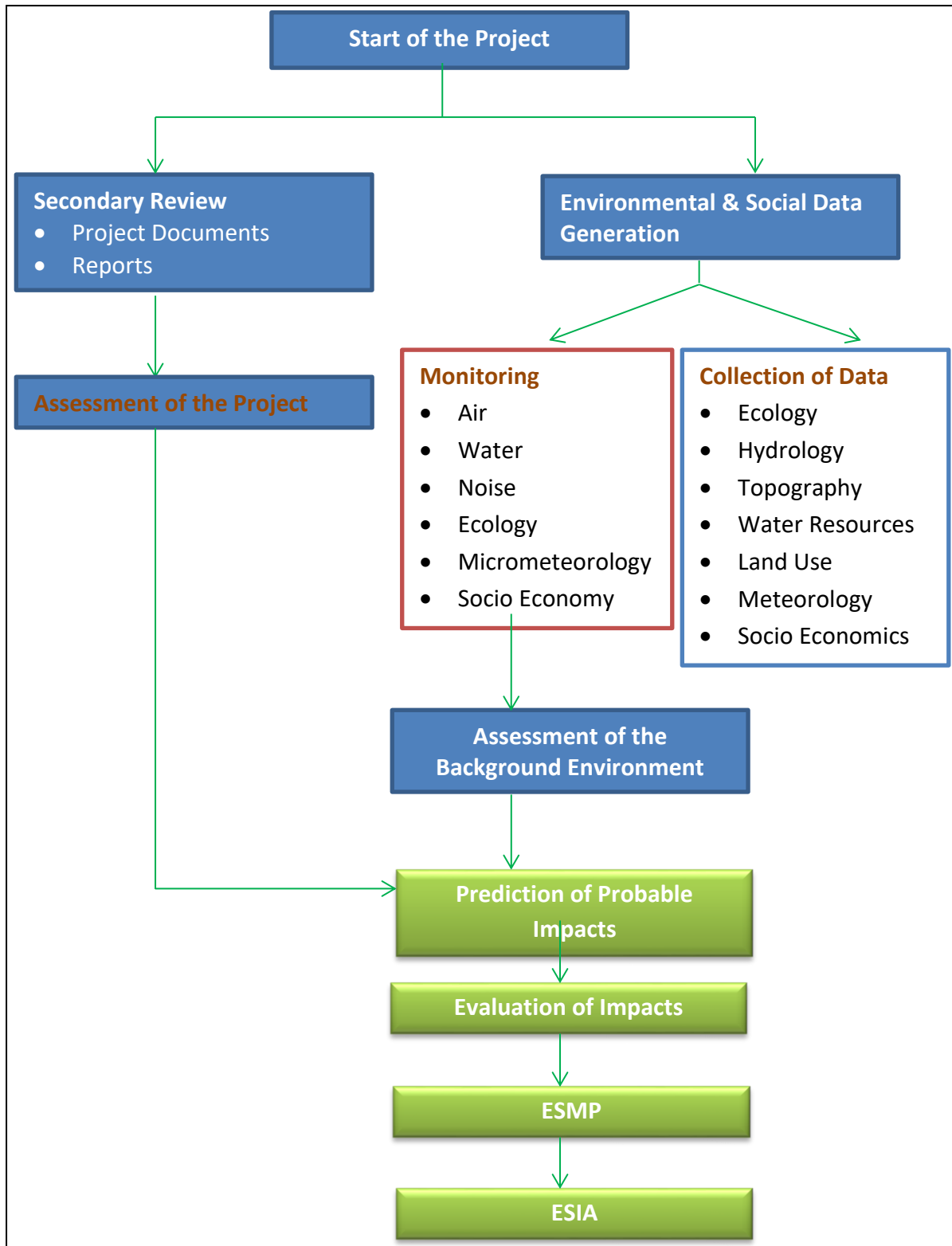


Figure 1.1: Route Map of Environmental and Social Impact Assessment

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

Geology, Topography, Soils

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

Hydrology and Drainage

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

Air Quality

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

Noise

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

Ground /Drinking Water Quality

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

Surface Water Quality

Sampling and analysis of surface water quality has been carried out for the following parameters: pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD₅).

Biological Environment

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

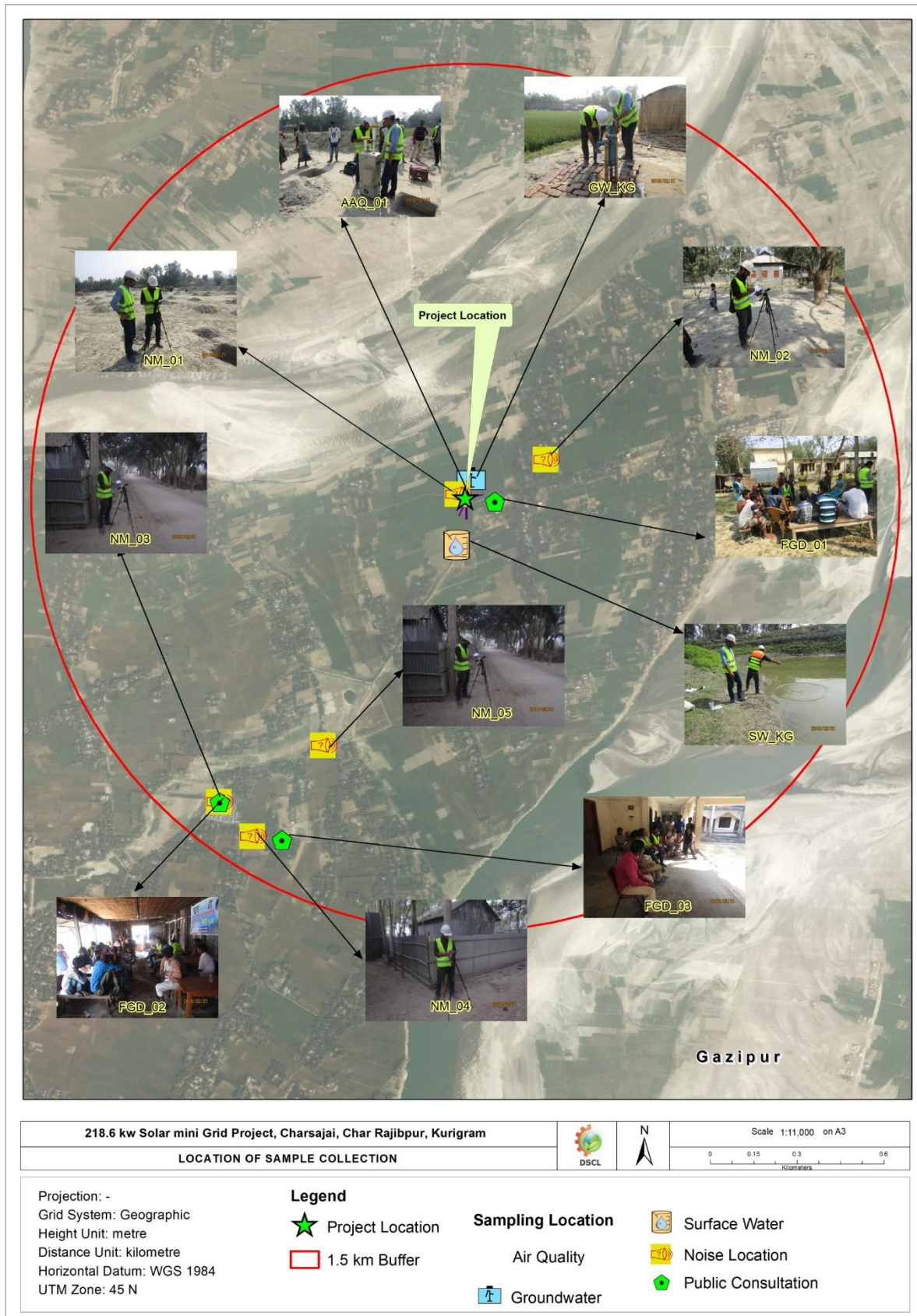


Figure 1.2: Location of Sample Collections

Flora

Flora is the plant life occurring in a particular region or time, generally the naturally occurring or indigenous—native plant life

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

Fauna is all of the animal life of any particular region or time.

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

Socio-Cultural Environment

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

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

(iv) Public Consultation

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 7.

(v) Impact assessment and mitigation

Impact Assessment and Mitigations were undertaken in accordance with the ESIA objectives presented earlier. The general process includes:

- **Impact assessment:** Identification and assessment of potential environmental and social impacts with reference to applicable country and international regulations, standards and guidelines. Impact assessment also includes identifying opportunities

to enhance beneficial impacts of the Project and to improve social development opportunities.

- **Mitigation measures:** Mitigation measures have been developed with consideration of baseline conditions; identified constraints; concerns and suggestions raised by the community; GoM, WB, IFC and other relevant requirements, and the level of design information available at the time of preparation of this ESIA. Mitigation may include:
 - Environmental controls (eg. measures for minimizing harmful noise, air, water and waste emissions);
 - Design optimization (eg. relocation of dam wall to avoid graveyard);
 - Procedural measures (eg. setting up catchment management committee);
 - Avoidance/reduction (eg. waste minimization process management to conserve water);
 - Compensatory measures (eg. biodiversity offsets); and
 - Timing measures (eg. no construction at night).
- **Risk assessment:** Risk assessment has been undertaken to gauge the level of 'Residual' impact after mitigation and acceptability against international criteria and sustainability principles. Further opportunities for reducing identified 'high' risk residual impacts are then canvassed.

2 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

2.1 General

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

An ESIA is an effective planning and decision-making tool for the project proponent. It allows for the identification and management of environmental impacts/issues that may occur through the establishment and operation of such a facility. Furthermore, an ESIA allows for resolution of the issue(s) reported on in the Scoping and ESIA Reports as well as dialogue with affected parties.

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.

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

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

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

2.3 Bangladesh Environmental Conservation Rules, 1997

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

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

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

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

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

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

Department of Environment (DoE), under the Ministry of Environment and Forests (MoEF) is the regulatory body responsible for enforcing the ECA'95 and ECR'97. It is the responsibility of the proponent to conduct an Environmental Assessment (EA) of development proposal and the responsibility to review EIAs for the purpose of issuing Environmental Clearance Certificate (ECC) from the DOE. According to the Gazette on 24th December 2017 under Environment Division-3 of Ministry of Environment and Forest, Government of the Peoples Republic of Bangladesh, the 518kWp Industrial Rooftop solar system project (50 KWp to 1MW) is considered as the **"Green category"**.

2.4 Renewable Energy Policy of Bangladesh, 2008

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

- institutional arrangements
- resource, technology and program development
- investment and fiscal incentives
- regulatory policy

The policy promotes appropriate, efficient and environment friendly use of renewable energy. It also suggest 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.

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

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

2.6 Remote Area Power Supply Systems (RAPSS) Guideline of 2007

The Remote Area Power Supply Systems (RAPSS) guideline of 2007 allows for private sector participation in development, operation, and maintenance of electricity generation system and distribution networks in remote rural areas including isolated islands to supplement GoB efforts at achieving universal access by 2020. However, there has not been much progress in implementing the RAPSS schemes. GoB is in the process to establish the Sustainable and Renewable Energy Development Agency (SREDA) as an autonomous body to lead its efforts in promoting renewable energy and energy efficiency in the country.

2.7 Bangladesh Labor Law, 2006

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

2.8 The Japan International Cooperation Agency Requirements

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

1. *Category A:* A proposed project is classified as Category A if it is likely to have significant adverse impact on the environment. Borrowers and related parties must submit Environmental Impact Assessment (EIA) reports. For projects that will result in

large-scale involuntary resettlement, basic resettlement plans must be submitted. EIA and other reports need to be submitted through the borrower before the JICA environmental reviews.

2. *Category B*: A proposed project is classified as Category B if its potential adverse environmental impact is less adverse than that of Category A projects.
3. *Category C*: A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impact.
4. *Category FI*: A proposed project is classified as Category FI if it satisfies all of the following:
 - JICA's funding of the project is provided to a financial intermediary etc.;
 - the selection and assessment of the actual sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding and therefore the subprojects cannot be specified prior to JICA's approval of funding (or assessment of the project); and
 - those sub-projects are expected to have potential impact on the environment.

The solar mini grid project, as per the above categorization, falls under Category B for the purpose of environmental investigations. Final EIA report approved by DoE needs to be submitted to JICA and JICA discloses the results of environmental reviews on its website after concluding agreement documents for category B projects.

2.9 World Bank's Guidelines on Environmental and Social Safeguards Policies

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

OP 4.01 Environmental Assessment

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

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

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

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

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

OP 4.04 on Natural Habitats

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

2.10 ADB Guidelines on Environmental and Social Safeguards

Asian Development Bank (ADB) has three safeguard policies that seek to avoid, minimize or mitigate adverse environmental impacts and social costs to third parties, or vulnerable groups as a result of development projects. New lending modalities and financing instruments, such as the multitranche financing facility (MFF), have increased the complexity of applying safeguard policies and ensuring compliance. The new modalities and the likelihood of continued innovation, as well as changing client circumstances, suggest a need to enhance the relevance and effectiveness of ADB's safeguards, which has been reflected in an update of the Safeguard Policy by 2009, announced through the Safeguard Policy Statement 2009 (SPS 2009).

The objectives of ADB's safeguards are to:

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

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

2.11 Environmental Clearance

Formal EIA guidelines in Bangladesh are set out in "Rules and Regulations under the 1995 Environmental Protection Acts" as published in the official Gazette on August 27, 1997. Any

proponent planning an industrial project is currently required under Paragraph 12 of the Environmental Protection Acts, 1995 to obtain “environmental clearance letter:” from the Department of Environment.

Steps to be followed for obtaining the Environmental Clearance Certificate for this rail link are shown in Figure 2.1 as the solar power plant is yet not categorized by the DoE so they have circulated an amendment to prepare a full EIA prior to implementation of such project for approval.

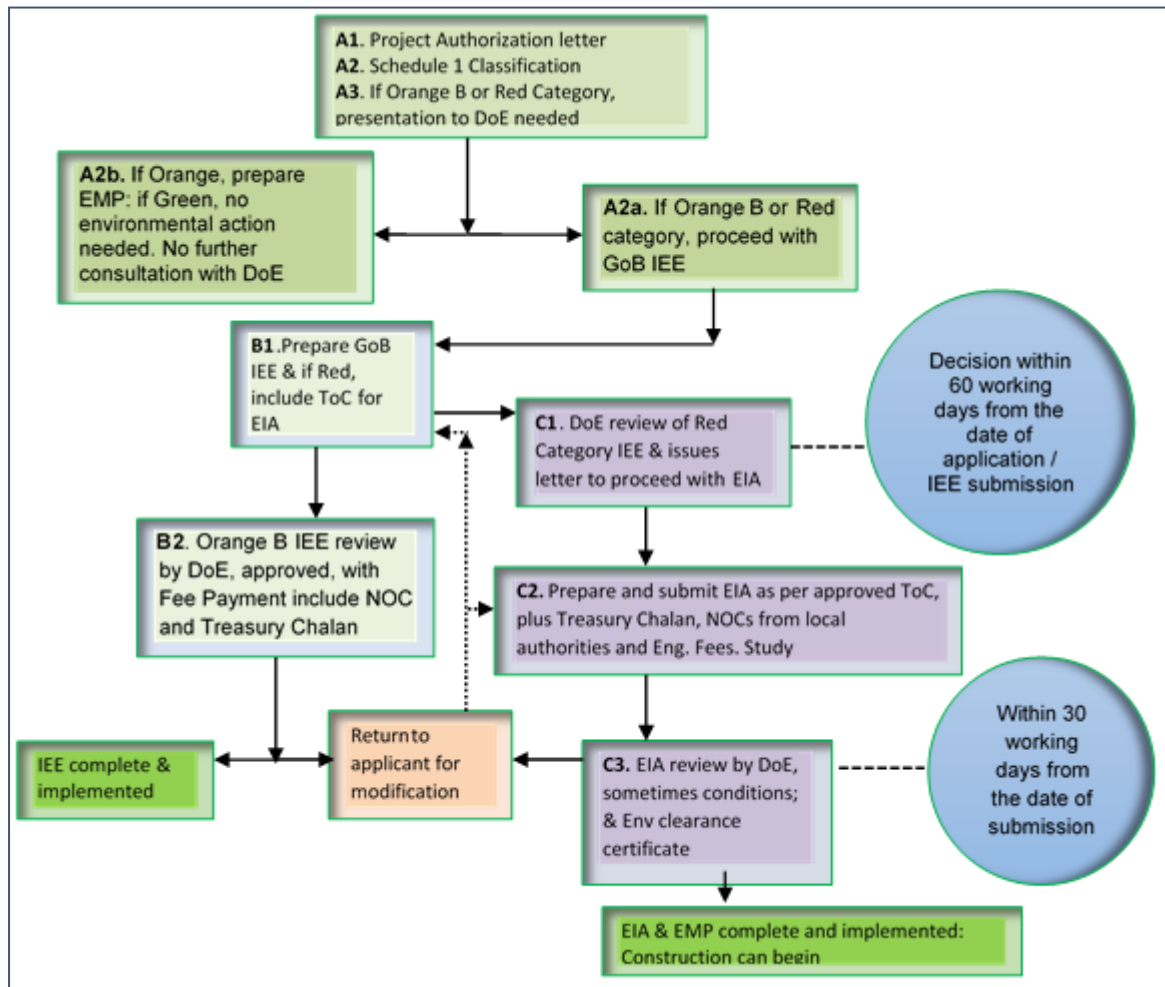


Figure 2.1: Government of Bangladesh Environmental Assessment Process

The first to obtain environmental clearance is for the project proponent to complete & submit an application form which 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, lay-out 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 Amber-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 at the beginning and the environmental clearance subject to the implementation of the project activities and all mitigation measures suggested in the EIA report or in the application.

3 DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Location

3.1.1 Extent

The proposed project is located beside Brahmaputra River at Charsajai (5 no. Ward) of Kodalkathi Union at Char Rajibpur of Kurigram district (Figure 3.1). The Global Positioning System (GPS coordinate of the project site is 25.49664° N, 89.77097° E. The proposed plant is bounded by agricultural land in two sides; in addition, the north and east side of the project area is having some residential dwellings. The total land of the proposed project is about 120 decimal (equivalent to 4 bighas).

3.1.2 Rationale for location setting

Because of its geographical position, ensuring grid electricity services on the island in the near future seems to be challenging and expensive. Currently, the electricity demand of the area is met by solar home systems, diesel generators, and kerosene lamps.

3.1.3 Accessibility

Charsajai can be accessed by boat from Kartimari Bazar which is in Char Rajibpur Upazila of Kurigram District. It takes almost forty minutes to reach at Charsajai from Kartimari Bazar Ghat by boat. In order to reach Kartimari Bazar, one has to start from Dhaka by private or public transportation. In a private microbus, our team reached Kartimari Bazar in around 10 hours. After reaching at Kartimari Bazar, horse-cart is used to reach project location, which is another forty to fifty minutes journey.

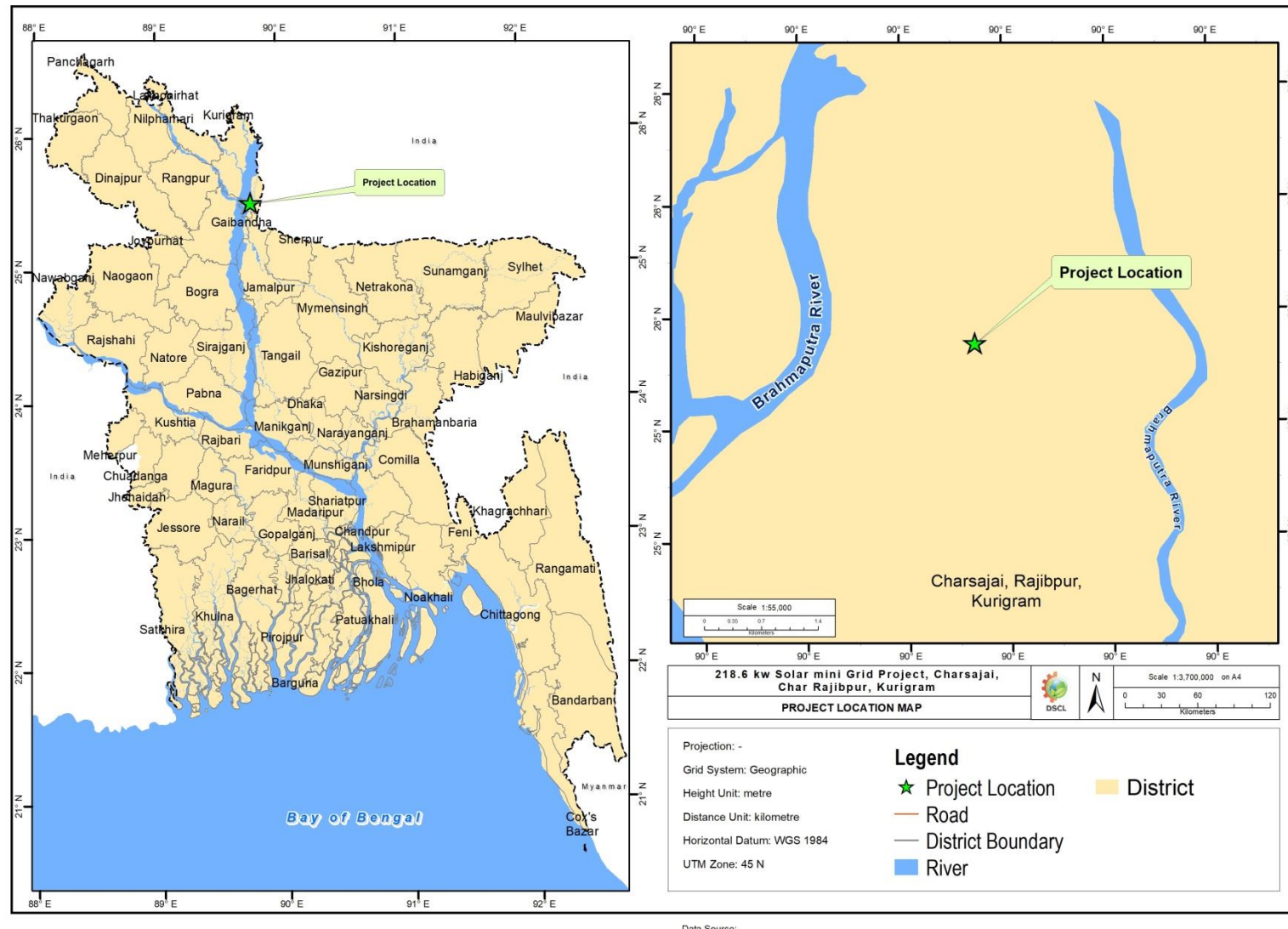


Figure 3.1: Project Location

3.2 Project Description

The proposed Project involves setting up of a 218.6kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant by Connectia Limited. at Charsajai under Char Rajibpur Upazilla of Kurigram district. The proposed system will include 345,833 kWh/year on-grid solar PV panels, 9,431 kWh/year from diesel generator, 366 batteries of 1540 Ah (at 2 V) along with a 150 kVA diesel backup generator to meet the energy demand of the area.

Once completed, the Project is expected to go into commercial operation in July 2018 and supply electricity to the adjacent 788 households, 104 shops, 11 schools, mosques, Madrasahs & offices, 2 rice mills, 1 sawmill, and 20 irrigation pumps.

Expansion of rural electrification is the key to the development of rural areas of the country. The Government of Bangladesh has a vision of ensuring access to affordable and reliable electricity for all by 2021. However, supply of electricity at subsidized prices with depleting fossil fuel is becoming an ongoing challenge for the government. Only 62% of the population (including renewable energy) has access to electricity most of which are living in urban areas. Given the dispersed nature of rural settlements, grid expansion into those areas is difficult and expensive. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

The proposed area, Charsajai, is an island located in the river Brahmaputra. Expansion of grid in this location will be challenging as well as expensive, making it unlikely for the grid electricity to be expanded in the project location in the near future. The Power Division also notified in writing that there is no immediate plan for grid extension in the project area in the near future.

The **Table 3.1** presents key Project information while **Figure 3.2** represents project plant layout:

Table 3-1 Project Key Information

Particulars	Description
Project Company	Connectia Limited
Plant Type and Capacity	218.6 kW solar PV based AC-DC coupled mini-grid
Location	Charsajai, Char Rajibpur, Kurigram
Project Land Area	4 bigha
Major Equipment and Accessories	Solar modules, batteries, grid-tie and bi-directional inverters, backup diesel generator.
Installation and Supervision	Respective supplier except for solar panel
Estimated no. of Customers	788 households, 104 shops, 11 schools, mosques, Madrasahs & offices, 2 rice mills, 1 saw mill, and 20 irrigation pumps.
Tentative Commercial Operation Date (COD)	July 2018

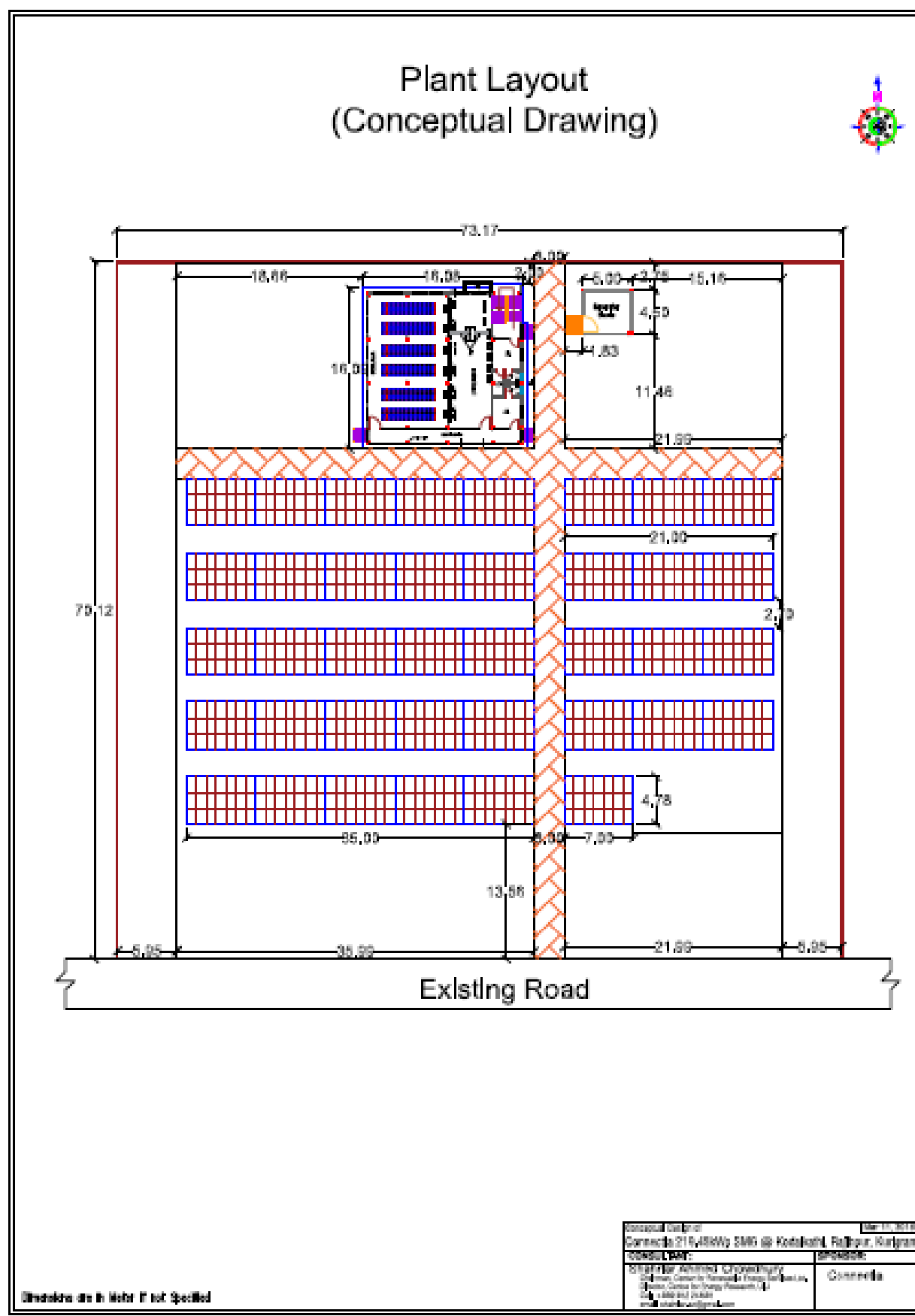


Figure 3.2: Project Plant Layout

3.3 Rationale of the Project

In Bangladesh, 32% of total population is connected to grid electricity. But still, most households meet their daily needs with biomass fuel. The country's electricity distribution board is failing to cope with the exponential growth in demand for power in the capital and all over the country. The possibilities of using solar power are already being tested and will mostly increase. Therefore, ensuring electricity through stand-alone renewable energy based options is being explored.

Despite efforts by the governments in Bangladesh to improve electricity access and services during the last five decades, household electrification levels and electricity availability continues to lag behind the global average. While the global average electrification rate in 2011 was 81.9 percent, the average electrification rate for Bangladesh stood at 62 percent. About 40 percent populations in Bangladesh were living without electricity in 2015.

Bangladesh is predominantly a rural country with approximately 80 percent of the total population living in villages. Bangladesh's economic and social development is inherently linked to growth in the rural sector. In order to contribute to Bangladesh's overall development, the rural sector must have access to modern forms of energy such as electricity.

According to the survey findings of Connectia Ltd. and IDCOL, the project location has a dynamic population comprising of various income generating people who have capabilities and willingness to pay premium price for electricity connection. The range of profession includes business, farmer, service etc.

In view of the above, the proposed Project envisages supplying reliable and grid quality electricity to the households and local shops in villages. Electricity would be supplied at an affordable, reasonable and competitive price to encourage income generating activities more than before and enhance standard of living of the local people. Electricity will be mainly used for lighting, operating TV, DC ceiling and table fans, refrigerator, use of mobile phone chargers, etc. and for running motors of some commercial entities such as rice mills and saw mills.

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 which 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.

3.4 Sand Filling Activities

Environmental team visited the project site in February 2018 to physically verify the suitability of project location for implementation. According to local people, the highest flood level

experienced was around 4.5-5 feet in 1998. The flood occurred recent year had a flood level of 3.5-4 feet. During consultation meeting with the local people, it was found that the island (Charsajai) was formed more than 60-65 years ago. The char is not susceptible to any momentous river-erosion. However, the proposed project site is situated on the lower ground and it needs about 7 feet of sand filling. The land filling was ongoing during field visit time (Figure 3.3).

The soil filling material will be collected from the nearby private land, which will be given for digging a pond. A mutual understanding with the private landowner and developer will be developed for using this land for extraction of soil. The developer will use dredging machine for extracted soil for land filling of the project site. The extracted soil materials will be deposited in the project site through a long pipe.

For land filling of the project site, anticipated impact will be found on vegetation and agricultural practices. According to the local people no significant vegetation were observed in the land. The land mainly used for agricultural practices. But no significant anticipated impact was found for this activity.



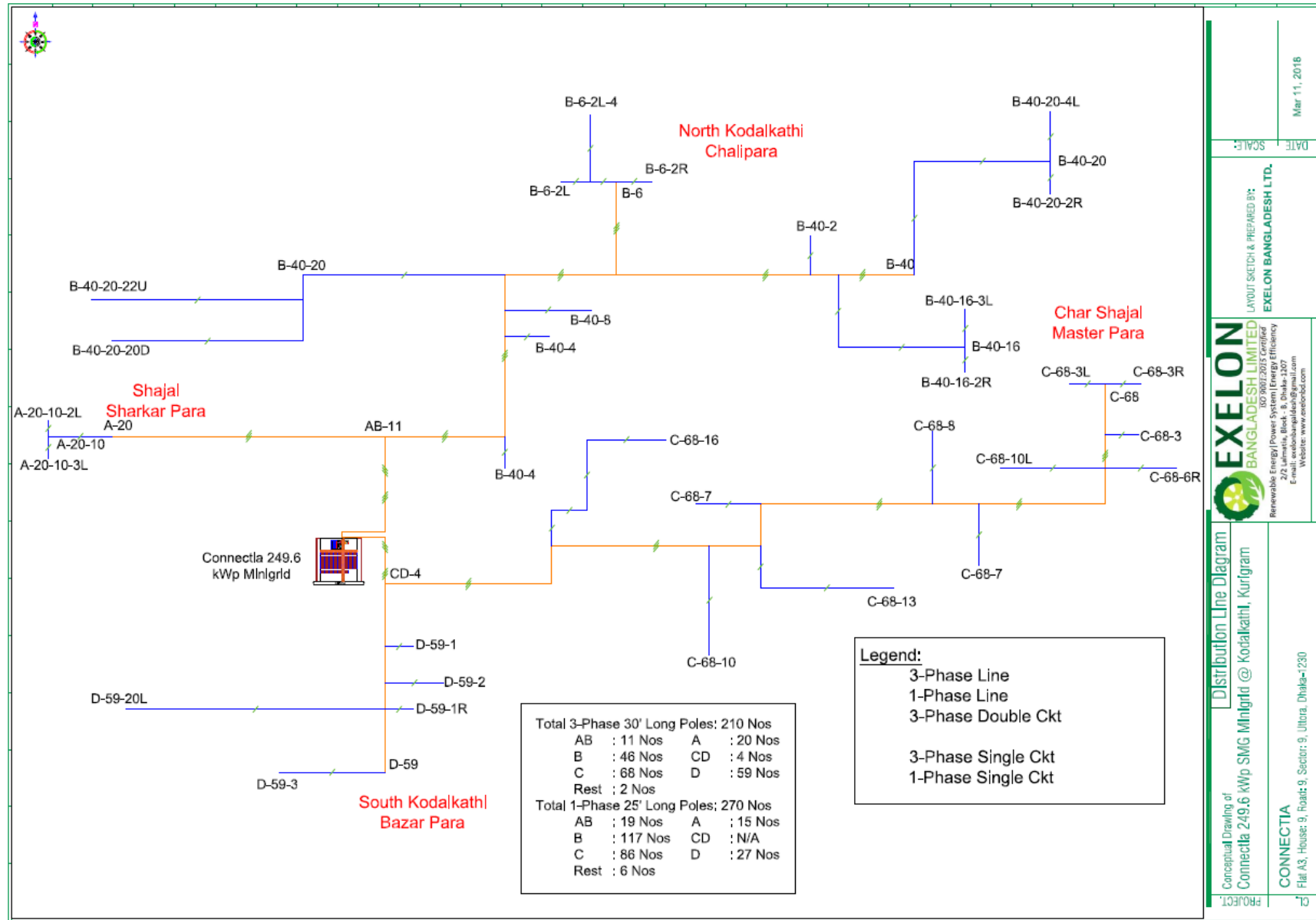
Figure 3.3: Sand Filling Activities in the Project Area

3.5 Details of Transmission and Distribution Line

Detailed description of the transmission line and distribution line is given in **Table 3.2** and **Figure 3.4**. The distribution line will cover South Kodalkathi Bazar Para, Char Sajal Master para, Shajal Sarkar Para and North Kodalkathi Challi Para.

Table 3-2 Description of transmission and distribution line

Total 3-Phase 30' Long Poles: 210 Nos			
AB	: 11 Nos	A	: 20 Nos
B	: 46 Nos	CD	: 4 Nos
C	: 68 Nos	D	: 59 Nos
Rest	: 2 Nos		
Total 1-Phase 25' Long Poles: 270 Nos			
AB	: 19 Nos	A	: 15 Nos
B	: 117 Nos	CD	: N/A
C	: 86 Nos	D	: 27 Nos
Rest	: 6 Nos		



4 TECHNOLOGICAL ASPECTS

4.1 Proposed Process and Technology

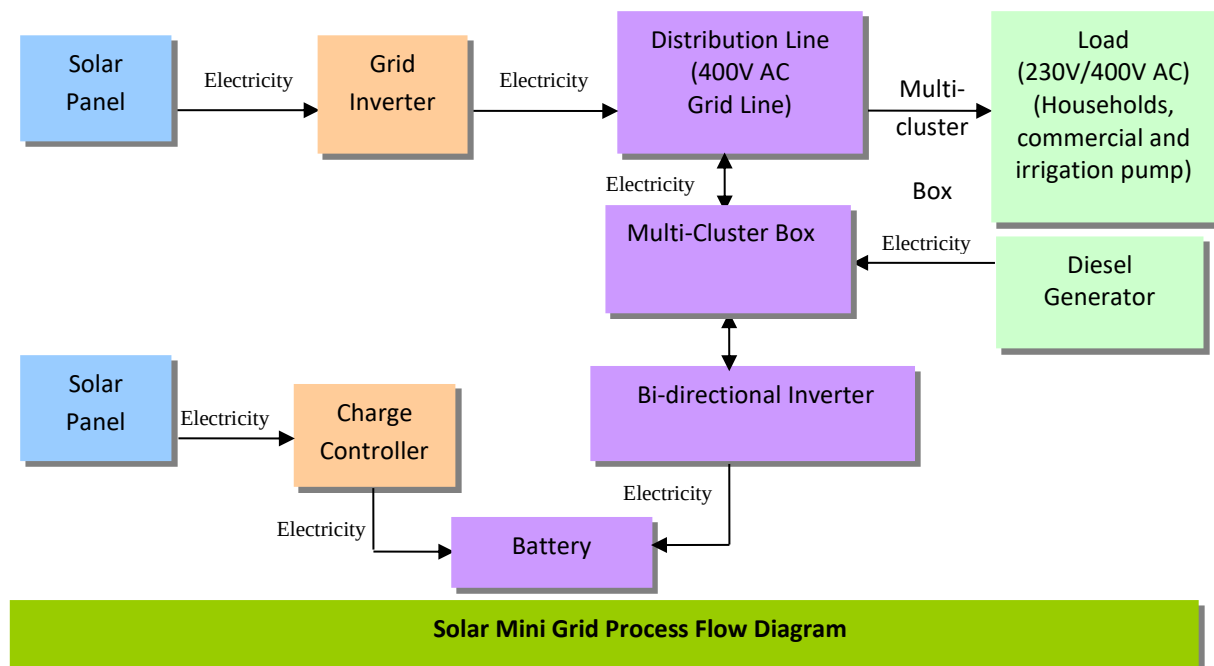


Figure 4.1: Overview of Project Technology

The plant is composed of the following parts:

(i) Solar PV modules and grid connected inverters:

Grid connected inverters convert the DC output from solar panels to grid quality AC electricity. During daytime, the solar PV modules are the main sources of power generation. PV modules of 201.25 kWp capacity will be connected to seven grid inverters (“Sunny Tri-power”), which will supply AC power at 400V through 3-phase distribution line. However, electricity will be supplied to the customers at 230V using single-phase distribution line. Remaining 38.75 kWp PV modules (off-grid) will be used to charge the batteries.

(ii) Battery bank and bi-directional inverters:

Off-grid solar PV modules will charge the batteries through charge controllers. Power generated from off-grid PV module will be stored in the battery banks. Battery banks will be comprised of 366 units of 2V low maintenance lead acid type batteries, each of 1540 Ah capacity. Energy stored in the battery banks will be converted to AC electricity using bi-directional inverters (Sunny Island inverters) to be supplied to the grid. Excess power from on grid PV modules will also be stored in the battery bank using bi-directional inverters. Sunny Island inverters will be automatically synchronized with the generator through a multi-cluster box.

(iii) Multi-cluster box and the charge controllers

There is a multi-cluster box, which is the interface for all the connectors and control. Excess electricity from AC bus will be passed to the battery side to charge them

through multi-cluster box and bi-directional inverters. It is completely wired and fitted at the factory to make all the connections easier.

Charging of the batteries with the electricity from off-grid PV modules will be monitored using charge controllers. Off-grid PV modules will be connected to the charge controllers. Charge controllers to be installed in the proposed Project will be equipped with a MPPT (Maximum Power Point Tracking) system to maximize the energy yield by 15% to 30% than that of conventional charge controllers. Energy will be stored in the battery banks through these charge controllers.

(iv) Diesel generator

Diesel generator is connected to the mini-grid system to provide back-up during periods of low solar radiation. A backup diesel generator will be connected to the mini-grid system to supply electricity in case of electricity shortage from PV modules and the batteries. This scenario might happen during the peak time or during rainy and foggy days. Using the multi-cluster box, the generator can also be used to charge the batteries in case of consecutive foggy and rainy days to avoid any damage to the batteries due to insufficient charge for a longer period of time. The generator will be there to supply power to the AC bus in case of shortage of production from solar PV array. Without any back-up generator, the battery bank can be damaged because of prolonged deep discharge and insufficient charge during rainy and foggy days. The generator is turned off when the batteries are fully charged. The consumption of the diesel generator is optimized automatically by programmable Sunny Remote Control (SRC) supplying electricity to the loads and charging the batteries with the surplus. The diesel generator will also run in parallel with the battery bank to supply electricity to high load demand if necessary.

A typical single line diagram of plant along with the process mentioned above is provided below **Figure 4.2**.

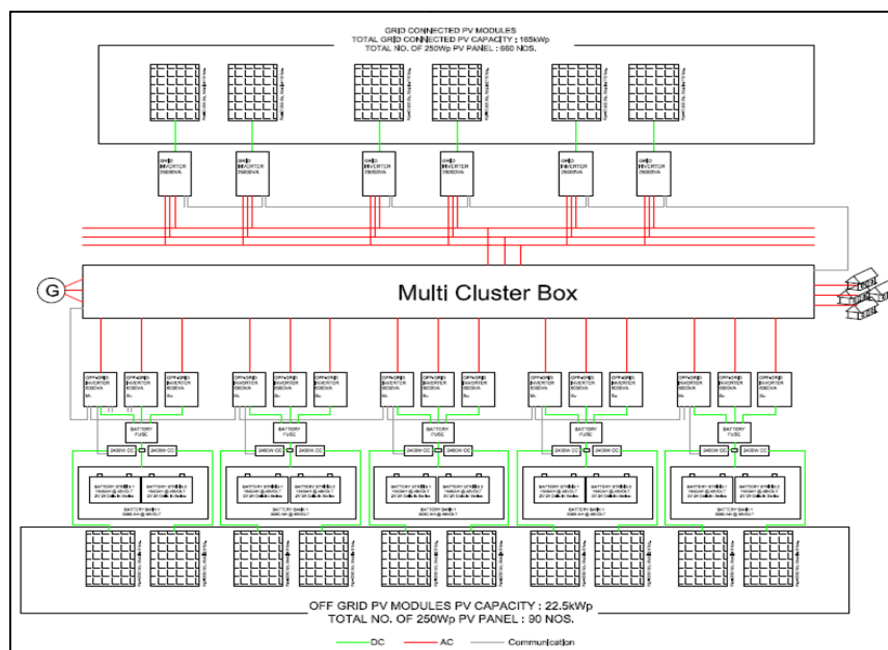


Figure 4.2: Single Line Diagram of the Plant

4.2 Adequacy of Solar Irradiation

The proposed location of the Project is at Charsajai (5 no. Ward) of Kodalkathi Union at Char Rajibpur of Kurigram district. The latitude of the proposed location is 25.49664° N and longitude is 089.77097° E. The solar irradiance profile¹ of the project location is as follows in Table 4.1.

Table 4-1: Monthly Average Solar Insolation Incident at 24 Degree Tilted Angle

Month	Average irradiation (kWh/m ² /day)
January	5.29
February	5.77
March	5.98
April	5.74
May	5.14
June	4.26
July	3.95
August	4.02
September	4.04
October	4.81
November	5.10
December	5.35

The optimum tilt angle for solar panels in Bangladesh is considered to be 23.7±1 degrees at any place in Bangladesh². Average solar insolation in Bangladesh is considered to be 4.5kWh/m²/day. In the project site, the average insolation is greater than the average of the country by 10%. Insolation data of the project site suggests that the project location is suitable for solar mini grid project as the solar irradiance profile is steady all through the year and the plant is expected to yield high energy output.

4.3 Plant Capacity Selection

Plant capacity selection is based on the conducted load survey and optimization parameters. Optimization parameters for selecting plant capacity are chosen carefully to ensure satisfactory plant performance. The optimization parameters used by the sponsor are (a) energy supplied by DG, (b) unused solar energy as percentage of total solar generation and (c) ratio between capacities of grid-tied inverters and bi-directional inverters. The trade-off analysis of these three parameters is discussed below:

(a) Energy supplied by DG

Diesel generator will be used as backup to meet the supply and demand gap throughout the year. The diesel generator will run in cases e.g. lack in stored energy in battery backup, rainy and foggy days. However, under sizing the plant capacity will result in excessive usage of the diesel generator. Purposes of installing a Solar PV based mini grid project will be hampered if diesel generator is used most of the time. Hence, minimization of usage

¹ Source: Surface meteorology and Solar Energy website of NASA. Website: <https://eosweb.larc.nasa.gov/cgi-bin/sse/grid.cgi?email=ekarim@idcol.org>.

² Source: Optimum Tilt Angle for the south facing solar devices installing in Bangladesh, M M Rahman, Indian Journal of Radio and Space Physics, Volume: 30, December 2001, pp 292-293.

of diesel generator is an important optimization parameter. The parameter will be defined as follows:

Percentage of energy supplied by DG=

$$\frac{\text{Annual consumption of energy from diesel generator} \times 100\%}{\text{Total annual consumption of energy from the plant}}$$

(b) Unused solar energy

Increasing the plant capacity will certainly decrease the percentage of diesel consumption annually. However, it can lead to the wastage of excessive solar energy during peak solar irradiation. Minimizing the excessive unusable energy will restrain the sponsor from overdesigning the system. There is a trade-off between minimization of unused solar energy and diesel consumption. The parameter of unused solar energy is defined as follows:

$$\text{Percentage of unused solar energy} = \frac{\text{Annual unused solar energy from the plant} \times 100\%}{\text{Total generation from solar PV modules}}$$

(c) Ratio between capacities of grid-tied inverters and bi-directional inverters

The proposed design of the mini grid is AC-DC coupled system. To ensure safety of the plant, an extreme situation needs to be analyzed and kept into design consideration. Bi-directional inverters to be used in the plant are of 6kW capacity and take maximum of 11.5 kWp AC input power. If the loads are disconnected in any case, the bi-directional inverters should be capable of handling the AC input power from the grid-tied inverters before necessary measures are taken. Hence, the ratio of grid-tied inverters and bi-directional inverters is an important parameter. Since the bi-directional inverters can take up to twice its power, the ratio of grid tied inverter and bi-directional inverter capacity should not cross the value of 2. The parameter can be defined as:

$$\text{Ratio} = \frac{\text{Capacity of a grid tied inverters} \times \text{No of grid tied inverters}}{\text{Rated Capacity of bi-directional inverter} \times \text{No of bidirectional inverters}}$$

4.4 Adequacy of Generator Size

Diesel Generator will play a pivotal role in operating solar mini-grid when the generation of electricity from solar plant is insufficient to meet the demand. In that case, the diesel generator should be able to supply necessary electricity as per the electricity demand. While undersized generator will be overloaded if the demand is higher than the rated capacity of the generator, using oversized generators will be inefficient, as it will result in higher diesel consumption. In view of the above, Connectia Limited selected a generator of 150 kVA prime capacity.

5 ANALYSIS OF PROJECT ALTERNATIVES

5.1 General

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. Three general rules are followed in an EIA or ESIA:

1. An EIA 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.
2. An EIA 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.
3. An EIA also must compare and evaluate the environmental effects and comparative merits of the alternatives. This chapter describes alternatives considered but eliminated from further consideration (including the reasons for elimination), and compares the environmental impacts of several alternatives retained with those of the proposed project.

The 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 8 of this EIA 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. Section 5.2, below, restates the project objectives. Section 5.3 summarizes the project. Section 5.4 presents alternatives to the proposed project that were considered but eliminated for further analysis. Section 5.5 presents alternatives fully analyzed in this EIA and provide a comparison of alternatives. Section 5.6 makes a determination about the environmentally superior alternative.

5.2 Project Objectives

The following objectives have been established for the proposed project and will aid decision makers in the review of the project and associated environmental impacts:

The objectives for the proposed project are to:

- Electrify of remote rural area.
- Make positive impact on the livelihood of the local people.
- Improve the socio-economic status of the area.

5.3 Proposed Project Summary

The proposed project is located beside Brahmaputra River at Charsajai (5 no. Ward) of Kodalkathi Union at Char Rajibpur of Kurigram district (Figure 3.2). The Global Positioning System (GPS coordinate of the project site is 25.49664° N, 089.77097° E. The proposed plant

is bounded by agricultural land in two sides; in addition the north and east side of the project area is having some residential dwellings. The total land of the proposed project is about 120 decimal (equivalent to 4 bighas).

The proposed Project involves setting up of a 218.6kWp stand-alone AC-DC coupled solar photovoltaic based mini-grid power plant by Connectia Limited at Charsajai under Char Rajibpur Upazilla of Kurigram district. The proposed system will include 345,833 kWh/year on-grid solar PV panels, 9,431 kWh/year from diesel generator, 366 batteries of 1540 Ah (at 2 V) along with a 150 kVA diesel backup generator to meet the energy demand of the area.

Once completed, the Project is expected to go into commercial operation in July 2018 and supply electricity to the adjacent 788 households, 104 shops, 11 schools, mosques, Madrashes & offices, 2 rice mills, 1 saw mill, and 20 irrigation pumps.

5.4 Alternatives Eliminated from Further Consideration

Alternatives may be eliminated from detailed consideration in an EIA if they fail to meet most of the project objectives, are infeasible, or do not avoid or substantially reduce any significant environmental effects. Alternatives that are remote or speculative, or the effects of which cannot be reasonably predicted, also do not need to be considered. Connectia Limited considered several alternatives to reduce project impacts on aesthetics and agriculture resources, and cumulative impacts on aesthetics, agriculture resources, air quality, and biological resources. The following alternatives were initially considered but were eliminated from further consideration in this EIA because the alternatives do not meet project objectives or were infeasible.

5.4.1 Other Energy (e.g., Wind) Alternative

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.

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 and 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.

Unlike the proposed project, wind turbines would have the potential to impact 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.

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.

As noted above, alternatives may be eliminated from detailed consideration in an EIA 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.

5.4.2 Alternative Site

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 doesn't 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.

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.

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.

5.5 Alternatives Selected for Analysis

The following four alternatives have been determined to represent a reasonable range of alternatives that have the potential to feasibly attain most of the basic objectives of the proposed project but which may avoid or substantially lessen any of the significant impacts of the proposed project. The “Environmentally Superior” Alternative, as required by is described in Section 5.5, Environmentally Superior Alternative. The following alternatives are analyzed in detail below:

- Alternative A: No Project
- Alternative B: Reduced Project
- Alternative C: Build-Out of Existing Land Use
- Alternative D: No Utility-Solar Development—Distributed Commercial and Industrial Rooftop Solar Only

Table 5.1 provides a summary of the relative impacts and feasibility of each alternative. A complete discussion of each alternative is provided below.

Table 5-1 Summary of Development Alternatives

Alternative	Description	Basis for Selection and Summary for Analysis
Proposed Project	218.6 kW standalone AC-DC coupled solar photovoltaic mini grid power plant on 4 bighas	-
Alternative A: No Project Alternative	• Existing land use designations and zoning designations would remain. • No Development would occur on site. • Site would remain as agricultural land.	Avoids significant impacts.
Alternative B: Reduced Project Alternative	45 kWp on 1 acre	Avoids significant impacts to agricultural lands.
Alternative C: Build-Out of Existing Land Use Alternative	Existing land use designation will be build out.	Several environmental impacts reduced whereas others increase.
Alternative D: No Utility Solar Development – Distributed Household, Commercial and Industrial Rooftop Solar Only	218.6 kW of photovoltaic solar distributed on rooftops throughout the region.	Avoids significant impacts to visual amenity, air quality and ecological resources.

5.5.1 Alternative A: No Project Alternative

The No Project 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. This option will however, involve several losses to both the project proponent and the donor organization. The property will remain under-utilized. The No Project Option is the least preferred from the socio-economic and environmental perspective. However, the No Project Option will create the scenario where:

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

5.5.2 Alternative B: Reduced Project Alternative

Under the Reduced Project Alternative, development would involve an 82 percent reduction in project size. The project under this alternative would consist of an approximate 45 kWp solar PV generating facility on 1 bigha. Under this alternative, the following specific project components could be reduced in number or size in comparison to the proposed project:

- A solar field of PV panels and associated improvements (e.g., access roads, fencing, secondary access drives, combiners, etc.),
- An electrical collection system (transformer and inverter) that aggregates the output from the PV panels and converts the electricity from DC to AC,
- The transmission to the transmission line, and Project substations.

5.5.3 Alternative C: Build-Out of Existing Land Use Alternative

Under Alternative C: Build-Out of Existing Land Use Alternative, the project site could be developed to the maximum intensity allowed under the land use designations of the plan of Connectia Limited. This alternative would yield a number of residential units with agricultural and grazing uses, including breeding and/or grazing of animals. Under this alternative, no utility scale solar PV panels would be developed, as those entitlements do not currently exist on-site.

5.5.4 Alternative D: No Utility Scale Solar Development Distributed Commercial and Household Rooftop Solar Only Alternative

This alternative would involve the development of a number of geographically distributed small to medium solar PV systems within existing developed areas, typically on the rooftops of commercial and industrial facilities situated throughout the project area.

Under this alternative, no new land would be developed or altered. However, depending on the type of solar modules installed and the type of tracking equipment used (if any), a similar or greater amount of acreage (i.e., greater than 4 bighas of total rooftop area) may be required to attain proposed project's capacity of 218.6 kW of solar PV generating capacity. Because of space or capital cost constraints, many rooftop solar PV systems would be fixed-axis systems or would not include the same type of sun-tracking equipment that would be installed in a freestanding utility-scale solar PV project and, therefore, would not attain the same level of

efficiency with respect to solar PV generation. This objective would enable the generation of 218.6 kWp of electricity, but it would be for on-site use only. This alternative assumes that rooftop development would occur primarily on commercial and industrial structures due to the greater availability of large, relatively flat roof areas necessary for efficient solar installations.

This alternative would involve a number of installation locations across the area, many of which would require discretionary action, such as design review, or zone variances, depending on local jurisdictional requirements. Similar to the proposed project, this alternative would be designed to operate year-round using PV panels to convert solar energy directly to electrical power. Power generated by such distributed solar PV systems would typically be consumed on site by the commercial or industrial facility without requiring the construction of new electrical substation or transmission facilities.

Like utility-scale PV systems, the area of rooftops or other infrastructure required per kWp of electricity produced is wide ranging, which is largely due to site-specific conditions (e.g., solar insolation levels, intervening landscape or topography, PV panel technology, etc.).

6 DESCRIPTION OF THE BASELINE ENVIRONMENT

6.1 General

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

Information of baseline environmental status of the project area is useful for impact assessment process of assessing and predicting the environmental consequences of the significant actions. Based on the existing environmental scenario potential impacts of road improvement will be identified and accordingly management plan will be proposed in forthcoming sections. The baseline environmental conditions will help in comparing and to monitor the predicted negative and positive impacts resulting from the project during pre-construction, construction and operation phases. Significant action depicts direct adverse changes caused by the action and its effect on the health of the biota including flora, fauna and human being, socio-economic conditions, current use of land and resources, climate change aspects, physical and cultural heritage properties and biophysical surroundings. Baseline data generation of the following environmental attributes is essential in EIA studies.

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

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

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

6.2 Physical Environment

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

6.2.1 Climate

Although less than half of Bangladesh lies within the tropics, the presence of the Himalaya mountain range has created a tropical macroclimate across most of the east Bengal land mass. Bangladesh can be divided into seven climatic zones (Rashid 1991). According to the

classification, the project area is located in the Northern part of the Northern region climatic zone (**Figure 5.1**).

- **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 (Banglapedia, 2012).

Like other parts of the country, the project area is heavily influenced by the Asiatic monsoon, and it has these three distinct seasons:

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

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

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

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

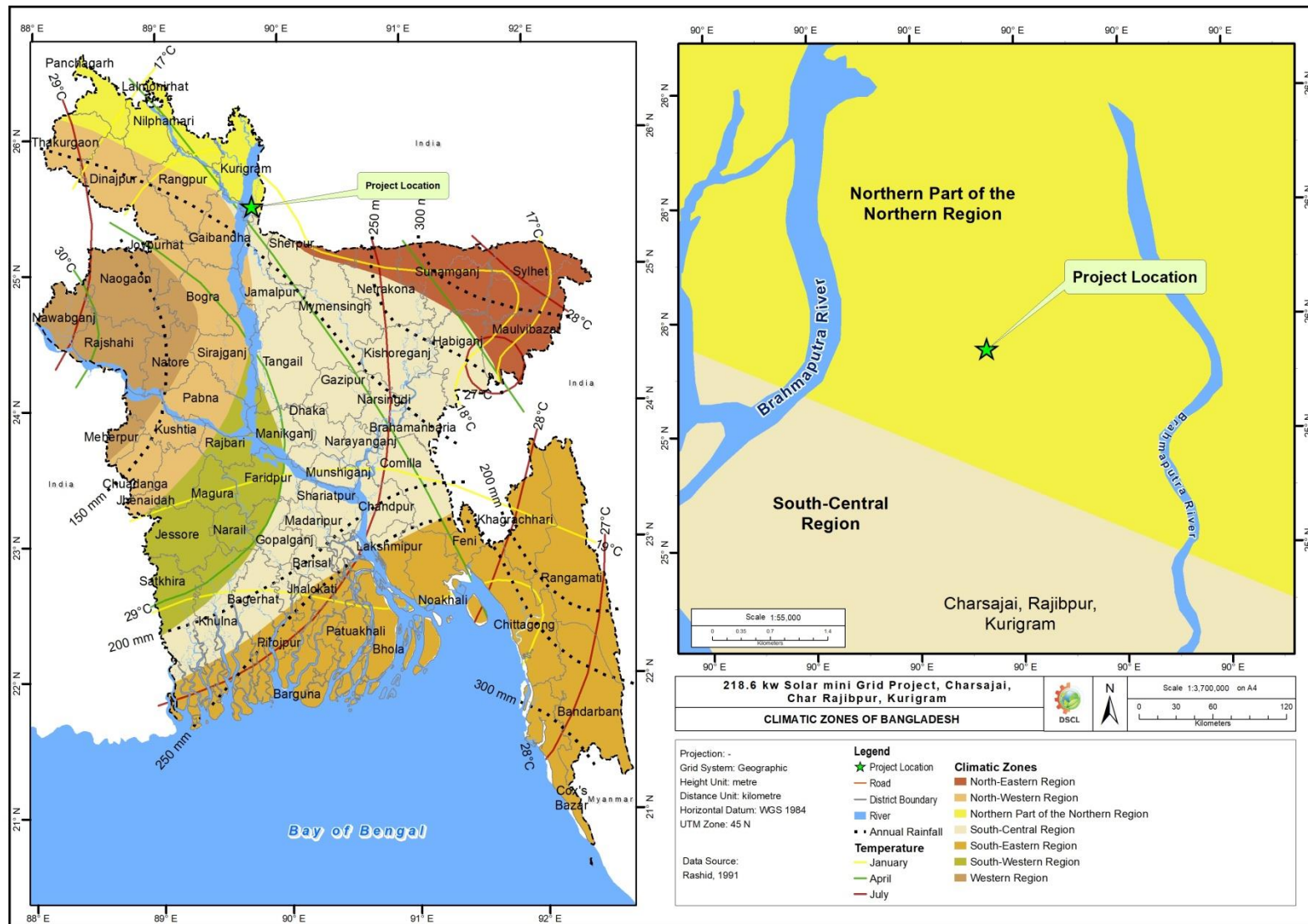


Figure 6.1: Climatic Zones of Bangladesh

Temperature

Long-term average monthly temperature data (1991-2014) collected at Rangpur and Sayeedpur weather station of Bangladesh Meteorological Department. The highest average temperature recorded in the two weather stations Rangpur and Sayeedpur have been 37.8 °C and 37.6 °C in May accordingly. The lowest average temperature recorded at the two weather stations Rangpur and Sayeedpur were found in the same month January which were 7.2°C and 7.1 °C respectively. Both of the average monthly temperature graphs show that these two areas face high temperature from March to May and lowest temperature during winter remains from December to February in the year (**Figure 6.2**).

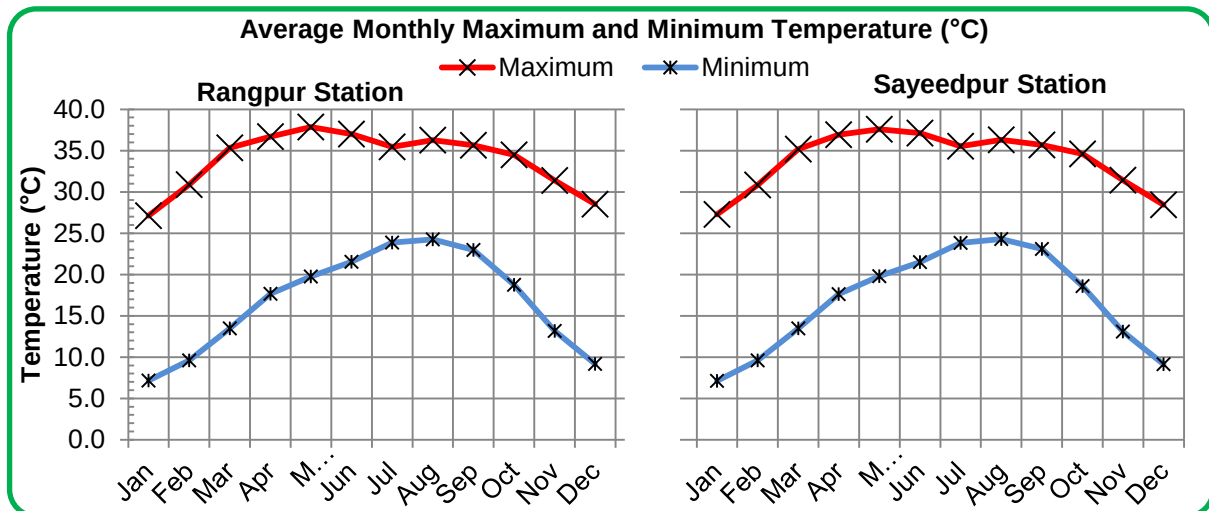


Figure 6.2: Average Monthly Maximum and Minimum Temperature

Rainfall

The rainfall data collected from the two above stated stations represents that maximum rainfall occurs during June to September and the lowest rainfall occurs in November to February during winter season (**Figure 6.3**). Statistical data of 1991 to 2012 shows that both stations experience more than 300 mm rainfall during monsoon. In the month of December and January of winter season around 10 mm rainfall occurred in the region of Rangpur and Sayeedpur stations.

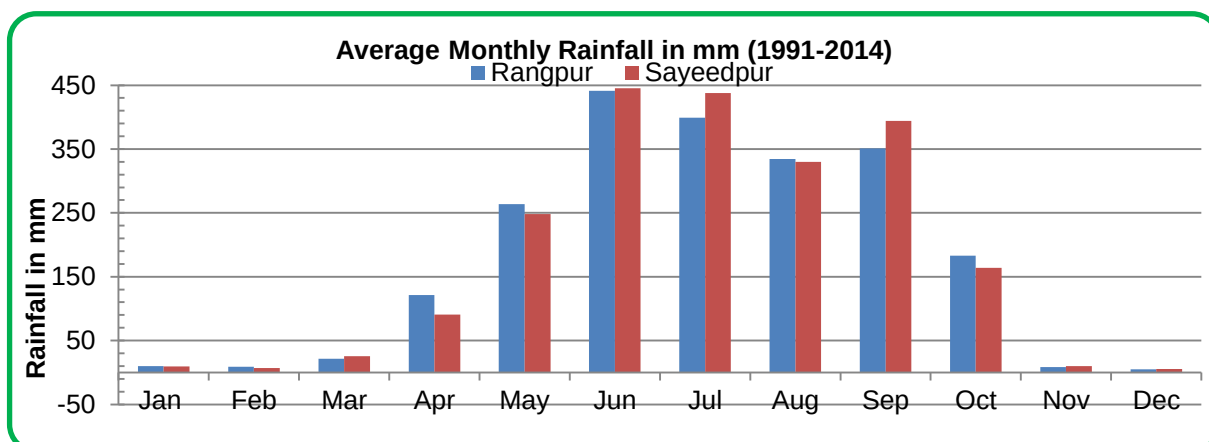


Figure 6.3: Average Monthly Total Rainfall

Humidity

Humidity remains high in summer and comparatively low in winter season. The statistical data of humidity from 1991 to 2014 indicates that humidity in the above two stated areas maximized in June to October in the year which is ranges from 80% to 85%. On the other hand, humidity falls 60% to 75% in February, March and April during the winter season in the considered stations area (**Figure 6.4**).

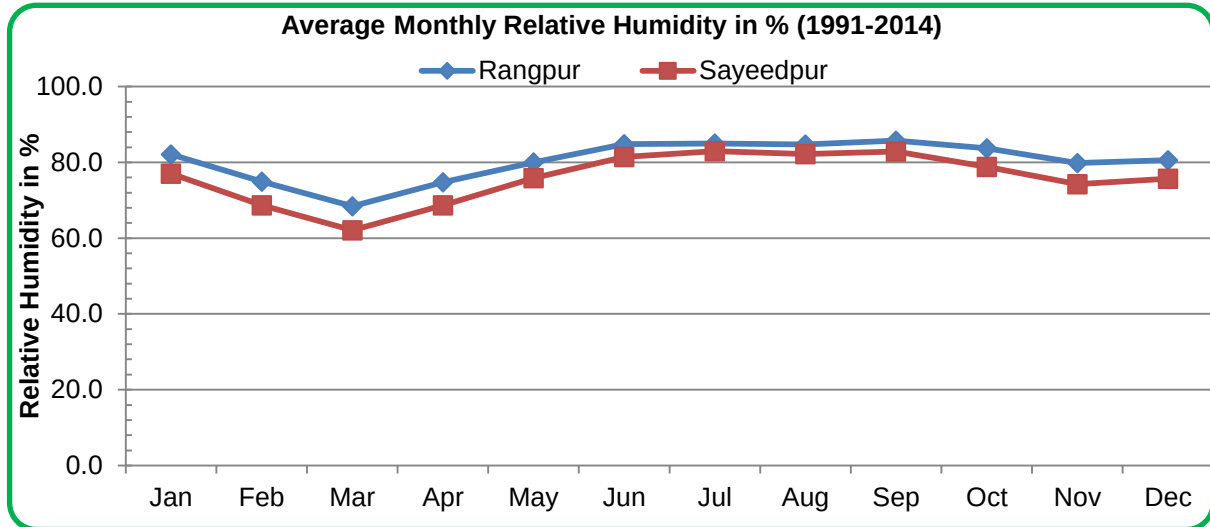


Figure 6.4: Average Monthly Relative Humidity

Wind Speed

The statistical wind speed data (**Figure 6.5**) shows that wind speed at Sayeedpur was comparatively higher than the area of Rangpur. Average wind speed remained maximum with 4.1 knots in April and 6.6 knots in March for Rangpur and Sayeedpur stations respectively. The minimum wind speed was 2.9 knots and 4.5 knots for Rangpur and Sayeedpur stations in the month of January and December accordingly.

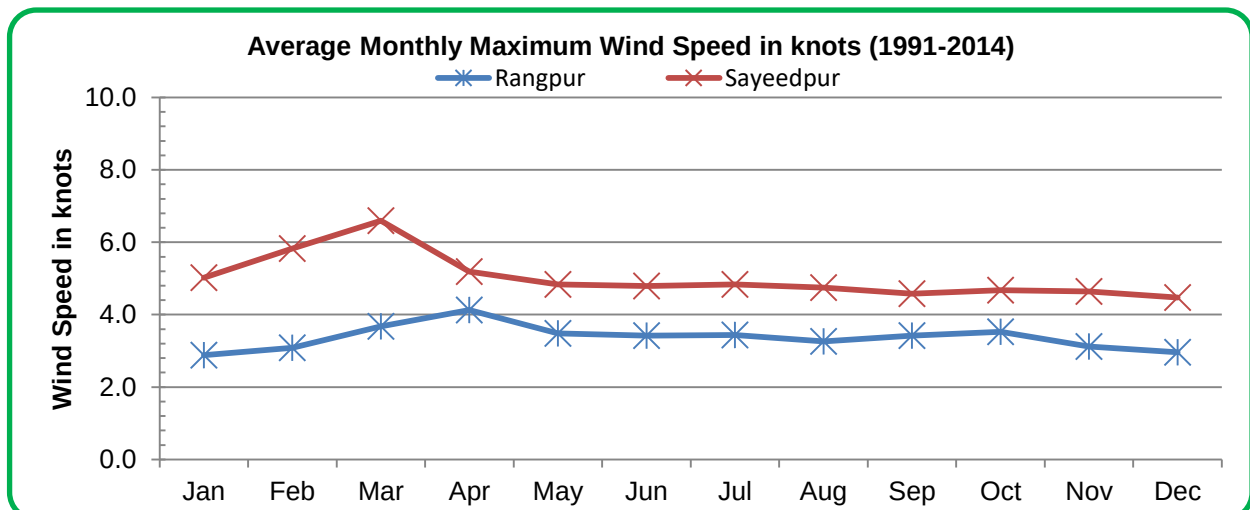


Figure 6.5: Average Monthly Maximum Wind Speed

Sunshine

The statistical sunshine data from 1990 to 2013 (**Figure 6.6**) shows that average sunshine remained maximum with 7.84 hours in the month of March. The minimum sunshine was 4.49 hours in the month of July in the area of Rangpur weather station.

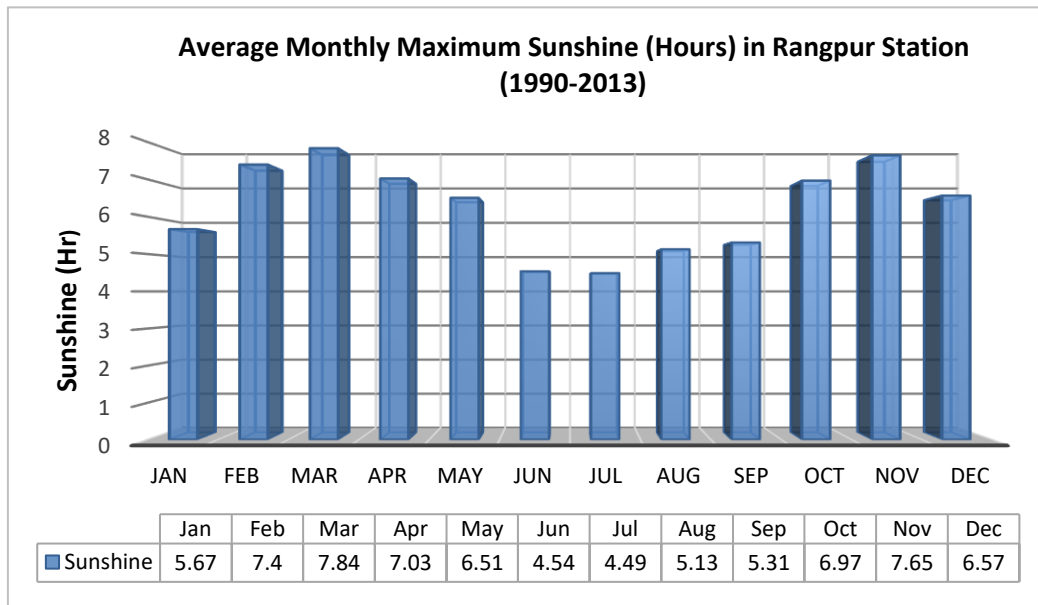


Figure 6.6: Average Monthly Maximum Sunshine

Cloud Coverage

The statistical cloud coverage data from 1990 to 2013 (Figure 6.7) shows that average cloud coverage remained maximum with 6.5 octas in the month of July. The minimum cloud coverage was 1.17 octas in the month of December in the area of Rangpur weather station.

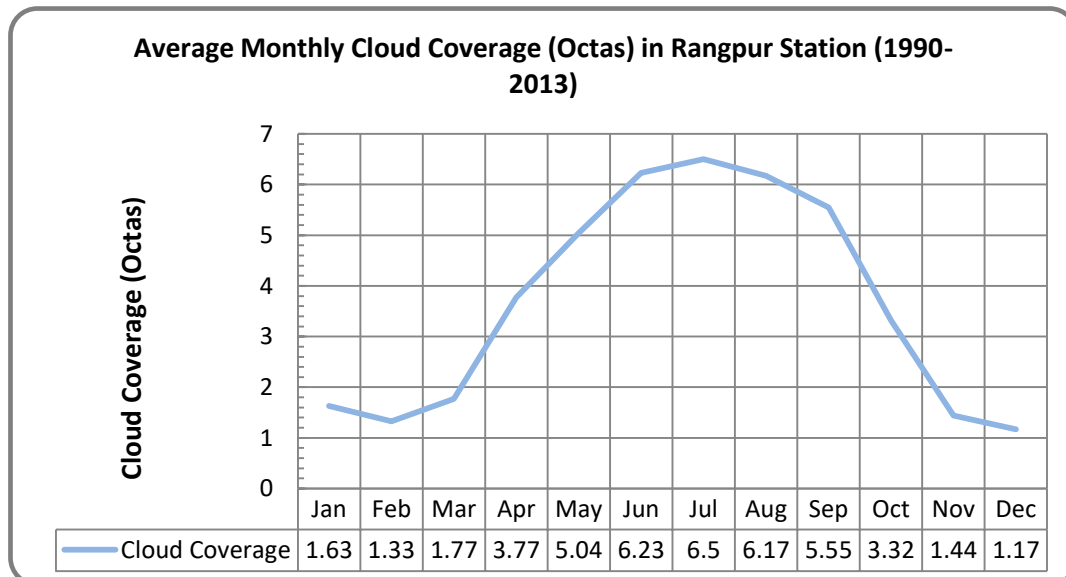


Figure 6.7: Average Monthly Cloud Coverage

6.2.2 Ambient Air Quality

Ambient air quality refers to the background air quality levels in a region, characterized by concentrations of various pollutants in the atmosphere. The presence of air pollutants and their concentrations depends on the type of polluting sources, and other factors that influence their flow and dispersion. In most cases vehicular emissions are the predominant source of air pollution. See **Figure 6.6** for air quality measurement process followed in the locality.



Figure 6.8: Air Quality Monitoring at Project Site

Ambient air quality measurements are essential to provide a description of the existing conditions or the baseline against which changes can be measured and to assist in the determination of potential impacts of the proposed Solar Mini-grid Power Plant air quality. Air quality test has been conducted on 21st February 2018 at the proposed project site and the test was analyzed by DSCL Environmental Laboratory. The test results (also see **Appendix B**) is given in the below **Table 6.1**. A methodology for analyzing the air quality sample is described in Appendix A. 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 measures parameter of the local ambient air does not exceed Bangladesh standard.

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

Parameter	Unit	Concentration at Project Site	Bangladesh Standard**	IFC/World Bank Standard	Duration (hours)	Weather Condition	Method of Analysis
PM ₁₀	µg/m ³	30.42	150	150	24	Sunny	Gravimetric
PM _{2.5}	µg/m ³	17.58	65	75	24		Gravimetric
SPM	µg/m ³	49.55	200	160	24		Gravimetric
SO ₂	µg/m ³	9.73	365	125	24		West-Geake
NO _x	µg/m ³	5.22	100	-	Annual		Jacob and Hochheiser
CO*	ppm	1	9	10 (WHO)	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 19th July 2005 vide S.R.O. No. 220-Law/2005.

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

Project Site GPS Coordination: Latitude - 25.49664° N, Longitude - 089.77097° E

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

6.2.3 Noise Level

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

The noise level of the surroundings of the project area is insignificant. The proposed site is presently using for agriculture and the anthropogenic disturbance is less. However, there is negligible sound pollution from the traffic movement on the nearby road. Noise level has been monitored at inside and outside of the project location (**Appendix C**) during day time (**Figure 6.9**). Results of the noise level monitored along with details of the sampling locations have been showed in **Table 6.2**. 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.



Figure 6.9: Noise Level Monitoring in the Project Area

Table 6-2: Noise Level at Different Locations of Project Area

SL	Location	GPS Location	Land Use Category	Time	Noise Level (dBA)
					(LAeq)
1	Project Site (Charsajai, Char Rajibpur, Kurigram)	25.49675°N 89.77075°E	Residential	10:04 am	51.57
2	Charsajai Masterpara	25.49778°N 89.77380°E	Residential	11:29 am	52.29
3	Kodalkathi Bazar, Kodalkathi, Kurigram	25.48731°N 89.76234°E	Commercial	14:00 pm	58.67
4	Kodalkathi Union Parishad Complex	25.48621°N 89.76436°E	Commercial	14:45 pm	62.32
5	Charsajai Sarkerpara, Kodalkathi	25.48900°N 89.76595°E	Residential	15:31 pm	54.17

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 , for silent area 55 dBA and for commercial area 65 dBA at day time
- Noise Level is the average noise recorded over the duration of the monitoring period

Abbreviation:

NM- Noise Measurement, dB- decibel

6.2.4 Physiography

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

1. Floodplains
2. Terraces
3. Hills

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

(20 primary units and 6 sub-units) based on an assessment of more recent and detailed data (SRDI, 1997).

The project lies in the northwestern part of the country and depends on the Teesta and Brahmaputra River for freshwater supply. The project area falls in the Old Brahmaputra Floodplain (4) physiographic unit (**Figure 6.10**).

- **Old Brahmaputra floodplain (4):** In 1787, a remarkable change in the course of the Brahmaputra took place. In that year, the river shifted from a course around the eastern edge to the western side of the Madhupur Tract. This new portion of the Brahmaputra is named Jamuna. The old course (old Brahmaputra) between Bahadurabad and Bhairab shrank through silting into a small seasonal channel only two kilometer wide. The old river had already built up high levees on either side over which the present river rarely spills. The Old Brahmaputra floodplain stretching from the southwestern corner of the Garo Hills along the eastern rim of the Madhupur Tract down to the Meghna exhibits a gentle morphology composed of broad ridges and depressions. The latter are usually flooded to a depth of more than one metre, whereas the ridges are subject to shallow flooding only in the monsoon season.

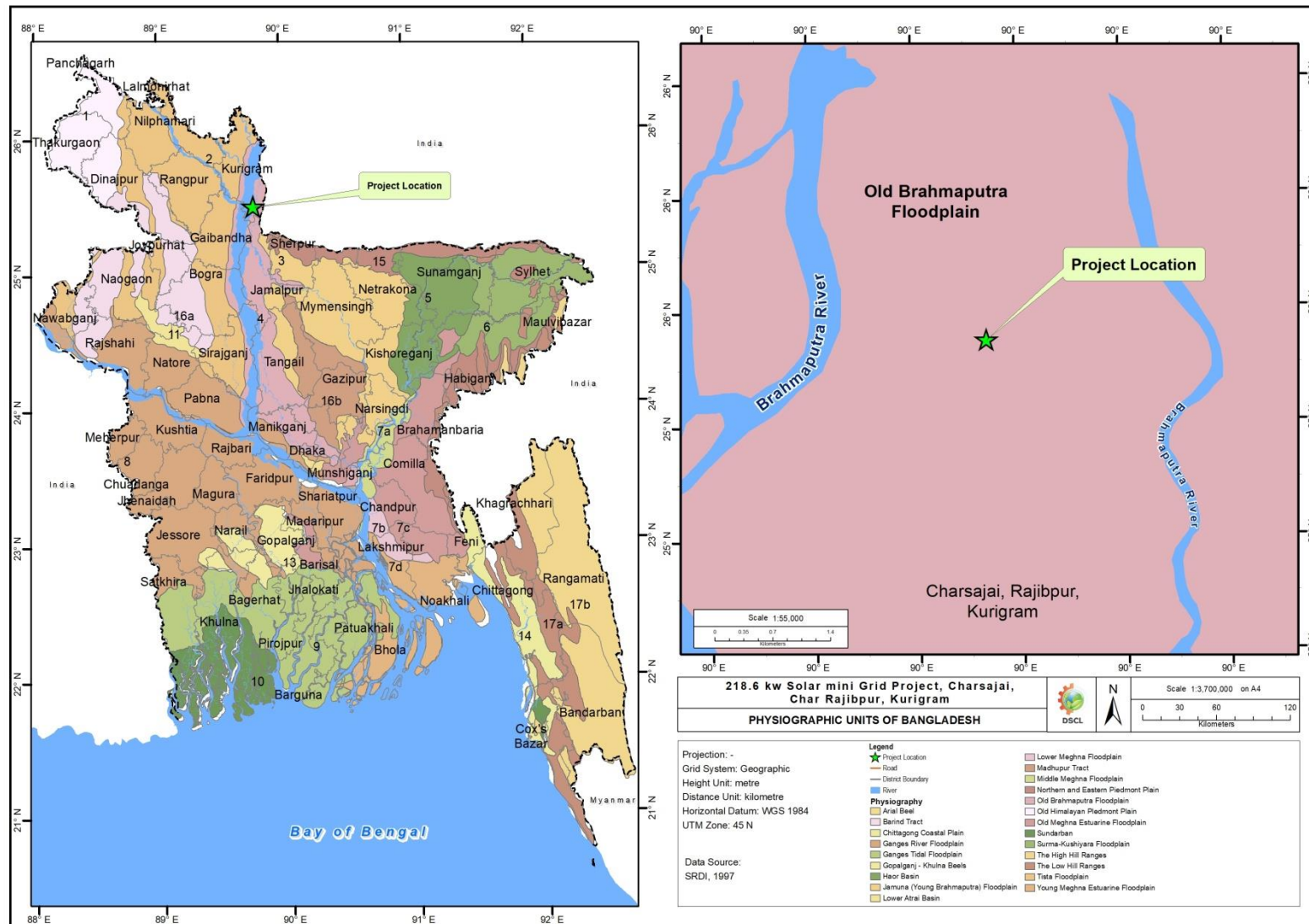


Figure 6.10: Physiographic Sub Regions of Bangladesh

6.2.5 Topography

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

The general topography of the project area is relatively flat. The topography of the specific project location is 10.85 – 14.94 m a.m.s.l (**Figure 6.11**). Topographically the cluster of the project location is almost flat, with many depressions, natural water bodies, bounded by the Rivers.

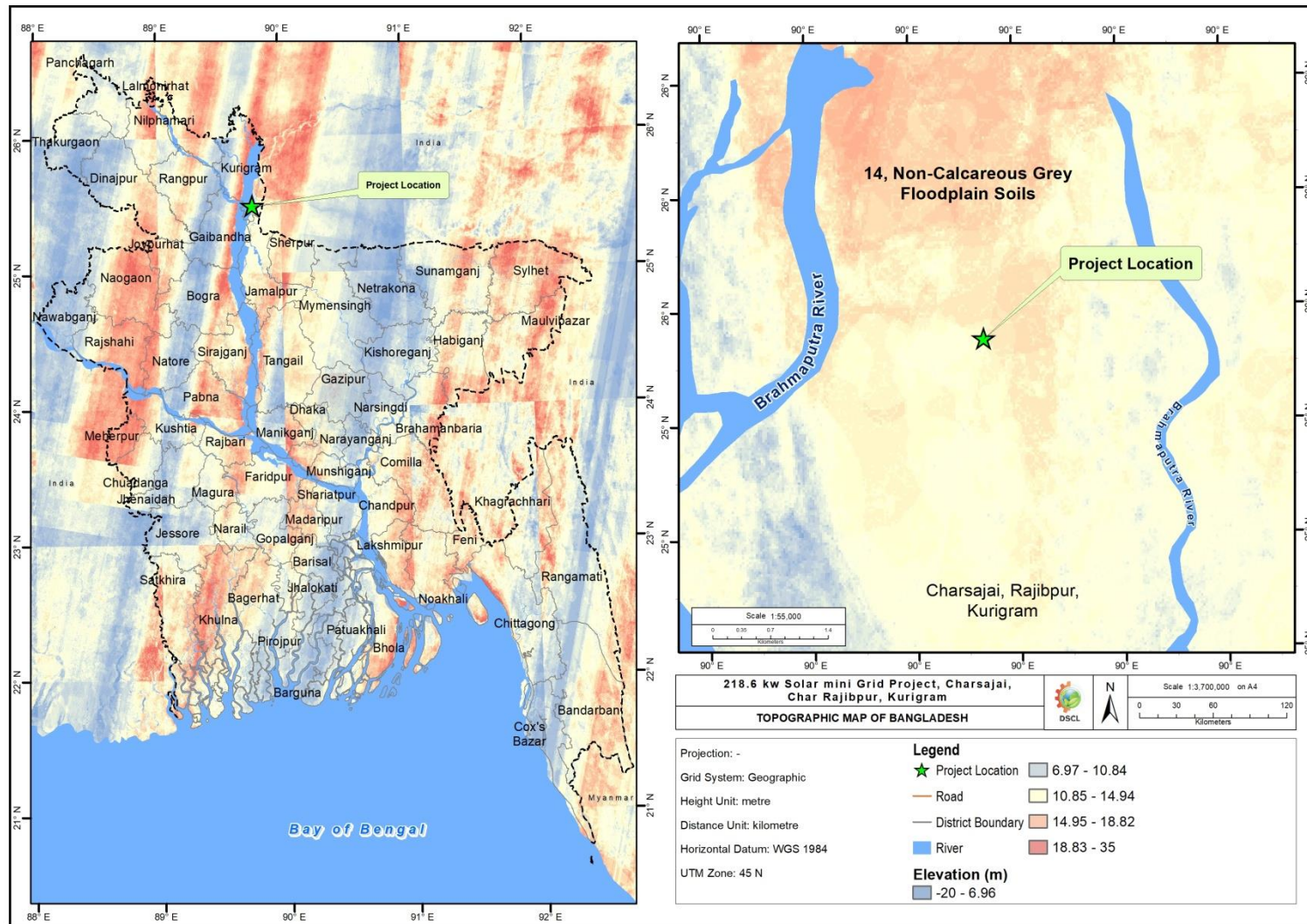


Figure 6.11: Topographic Elevation of the Project Area

6.2.6 Geology

Bangladesh is situated to the east of the Indian sub-continental plate. Nearly 85% of Bangladesh is underlain by deltaic and alluvial deposits of the Ganges, Brahmaputra, and Meghna river systems. The project area consists of Holocene alluvial deposits flood plain and predominantly consisting of fine sand, silts and clay. The site is on deep Cenozoic deposits that overlie Precambrian basement rock. The Precambrian rocks form the basement of all geological formations of Bengal Basin and shield areas. The materials deposited are a mixture of sediments transported by the old Brahmaputra and by the Jamuna (Brahmaputra) River. The generalized geological feature of the project area is shown in the geological map of Bangladesh (**Figures 6.12**).

- **Rangpur Saddle** represents Indian Platform and connects the Indian Shield with the Shillong Massif and the Mikir Hills. Shillong Massif is a large thrust block of the Indian Shield. In Rangpur Saddle the basement is the most uplifted and is covered with thin sedimentary deposits. In Madhyapara area of Dinajpur the basement is only 130m deep from the ground surface and is overlain by Dupi Tila Sandstone and Madhupur Clay of Plio-Pliocene age. Rangpur Saddle can be divided into 3 parts- Rangpur Saddle, Northern Slope of Rangpur Saddle and Southern Slope of Rangpur Saddle. It is evident from seismic data acquired out by OGDC (Oil and Gas Development Corporation) during 63-64 in Rangpur-Dinajpur districts that both the northern and the southern slopes of Rangpur Saddle are quite gentle. The basement plunges gently from Madhyapara towards the southeast up to the Hinge Zone, which is known as the Southern Slope of Rangpur Saddle. The tentative boundary of the Rangpur Saddle with the northern and the southern slopes has been marked at approximately 700m contour line on the basement. It separates the Bengal Foredeep and the Himalayan Foredeep. The Northern Slope of Rangpur Saddle also known as Dinajpur Slope, occupies the north western part of Rangpur-Dinajpur districts and gently slopes towards the Sub-Himalayan Foredeep with dips 3-4° which sharply increases in Tetulia area. The only well drilled in 1988 located on the north-western most tip of Bangladesh at Salbanhat by Shell for oil and gas exploration to probe a carbonate reef ended in basement with depth 2518m penetrating the Mio-Pliocene sequence without encountering Eocene Limestone. The nature of junction between the Dinajpur Slope and the Sub-Himalayan Foredeep is not clear (Banglapedia, 2012).

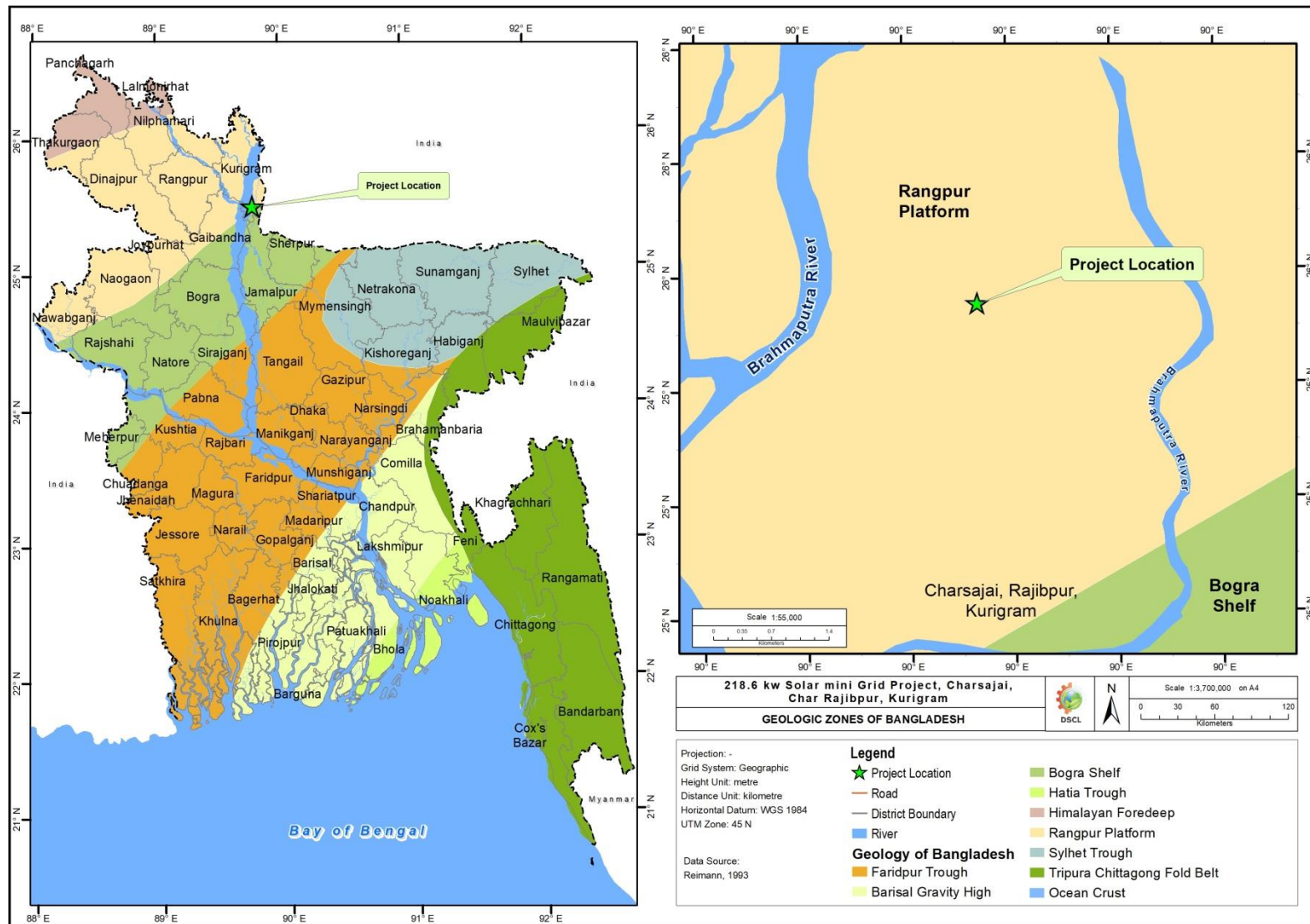


Figure 6.12: Geology of Bangladesh

6.2.7 Water Resources

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).

▪ Surface Water

The project area is surrounded several major surface water bodies which are Brahmaputra River, Halhali and Jinjiram etc. There are also significant numbers of natural water bodies around the project location. Most of the water bodies become waterless or contain minimum amount of water during the dry season and gets water in rainy season. People use the water from the river and ponds for washing, bathing and irrigation purposes. In the wet season, substantial amount of the land in the area is inundated due to flood. In the dry season local canals and channels provide water for irrigation for Boro cultivation and for growing winter crops.

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.

On 21st February 2018, surface water sample was collected by environmental team from a pond near the project area (**Figure 6.13**). The Department of Public Health Engineering (DPHE) analyzed the sample. The result (Appendix D) of the surface water sample and the GoB standards for fishing water (ECR, 1997) are shown in **Table 6.3**. The concentration level of DO was only within the acceptable limit.



Figure 6.13: Surface Water Sampling from the Project Location

Table 6-3: Results for Surface Water Field Sample

Water Quality Parameters	Unit	Concentration Present	Bangladesh Standard	Method of Analysis	LOQ
pH*	---	7.47	6.5-8.5	pH Meter	—
Electricity Conductivity (EC) at 25°C *	μS/cm	142.4	1200	Multimeter	—
Total Dissolved Solids (TDS)*	mg/l	71	-	TDS Meter	—
Biochemical Oxygen Demand (BOD)	mg/l	8	0.2	5 Days Incubation	—
Chemical Oxygen Demand (COD)	mg/l	24	4	CRM	—
Dissolved Oxygen (DO)	mg/l	4.16	6.0	Multimeter	—

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

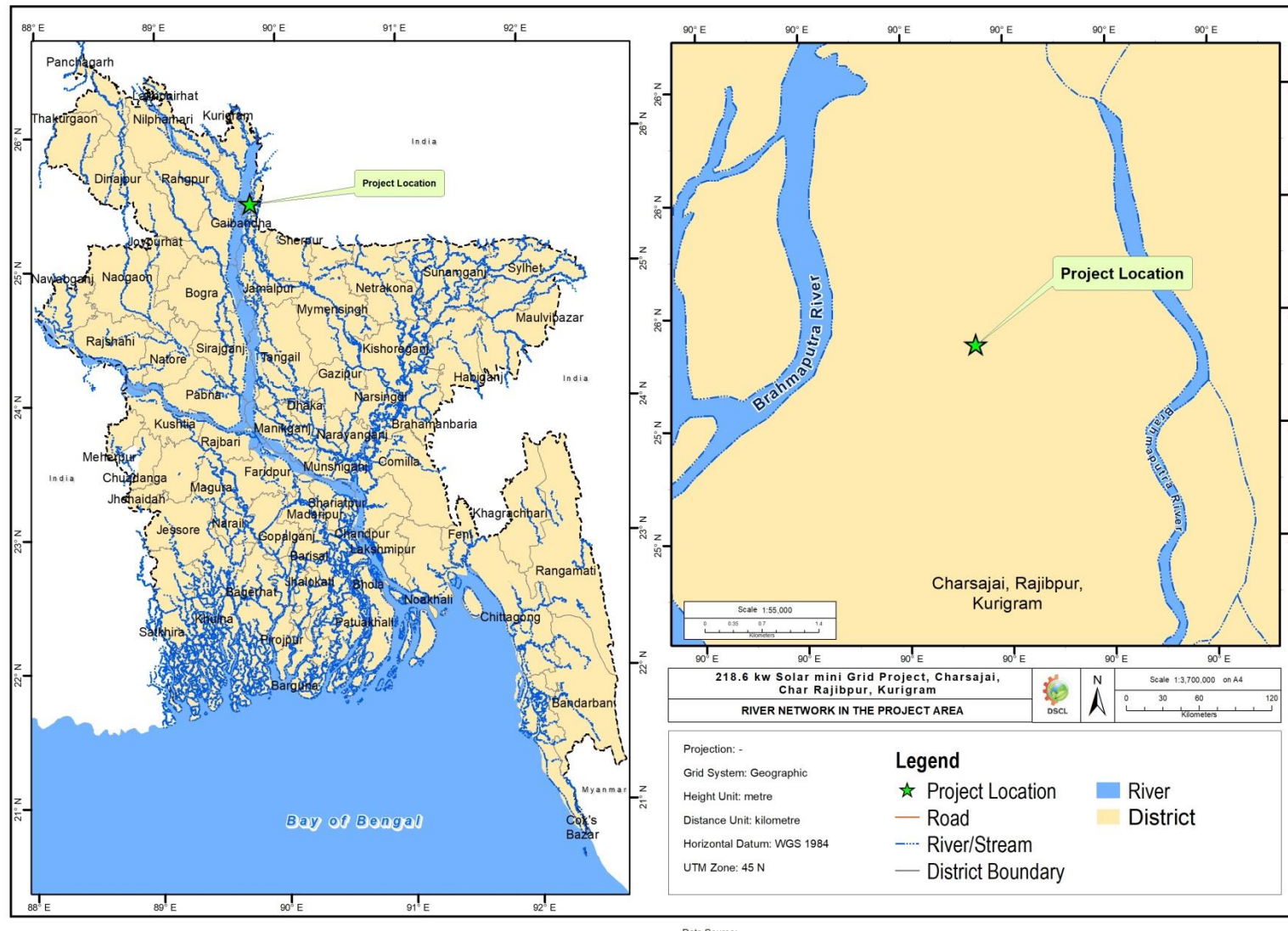


Figure 6.14: Water Bodies and River Network Map

▪ Groundwater

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

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

On 21st February 2018, groundwater sample was collected by environmental team from a tube well near the project area. The Department of Public Health Engineering (DPHE) analyzed the sample. The result (see **Appendix D**) of the groundwater sample and the GoB standards for drinking water (ECR, 1997) are shown in Table 6.4. All the parameters concentration levels are within the acceptable limit of Bangladesh drinking water quality standard set by DoE except for Chloride. The concentration levels of Chloride are not within the drinking water quality standard set by DOE. However, other three measured parameters are within the standard quality.



Figure 6.15: On-site Water Testing and Sample Collection

Table 6-4: Results for Groundwater Field Sample

Parameters	Unit	Concentration Present	Drinking Water Quality Standard, DOE	Method of Analysis
pH*	---	7.2	6.5-8.5	pH Meter
Electric Conductivity*	μS/cm	718	1200	Multimeter
Total Dissolved Solids (TDS)*	mg/l	553	-	TDS Meter
Alkalinity	mg/l	125	-	Trimetric
Arsenic (As)	mg/l	0.003	0.05	AAS
Chloride (Cl ⁻)	mg/l	46	150-600	Trimetric
Iron (Fe)	mg/l	0.34	0.3-1.0	AAS

* Onsite Test Using Field Test Kit

Source: Lab Analysis by DPHE

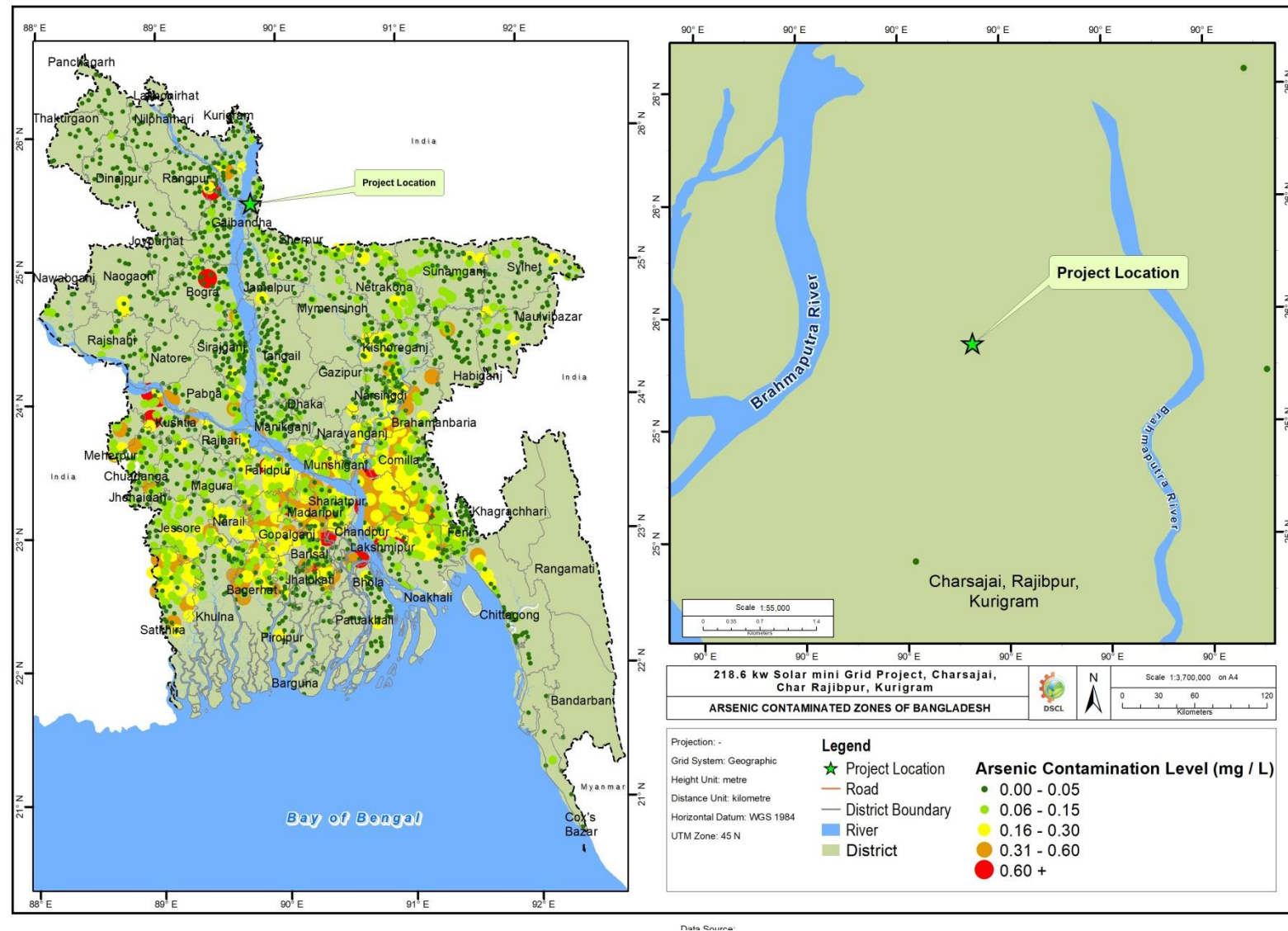


Figure 6.16: Arsenic Concentrations in Groundwater

6.2.8 Soil Quality

The soil of the project area is yet not classified and does not fall any of the category of Bangladesh soil types. However, the category of soil near the project location includes the following (**Figure 6.17**):

- ***Non Calcareous Grey Floodplain soils (14)***: Soils generally comprise a grey topsoil and a cambic B-horizon in the subsoil with a grey matrix or grey gleans. They extensively occupy Tista, Karatoya-Bangali, Jamuna, middle Meghna and eastern Surma-Kushiyara floodplains. However, there are considerable regional differences in the proportions occupied by individual soil textures. Silt loam texture is dominant in the Tista meander floodplain whereas silty clays are predominant in the Ganges tidal floodplain and in the Surma-Kushiyara floodplain. But the Jamuna floodplain has a more even distribution of silt loam, silty clay loam and silty clays. Most of these soils have been included in Eutric Gleysols. (Banglapedia, 2014).

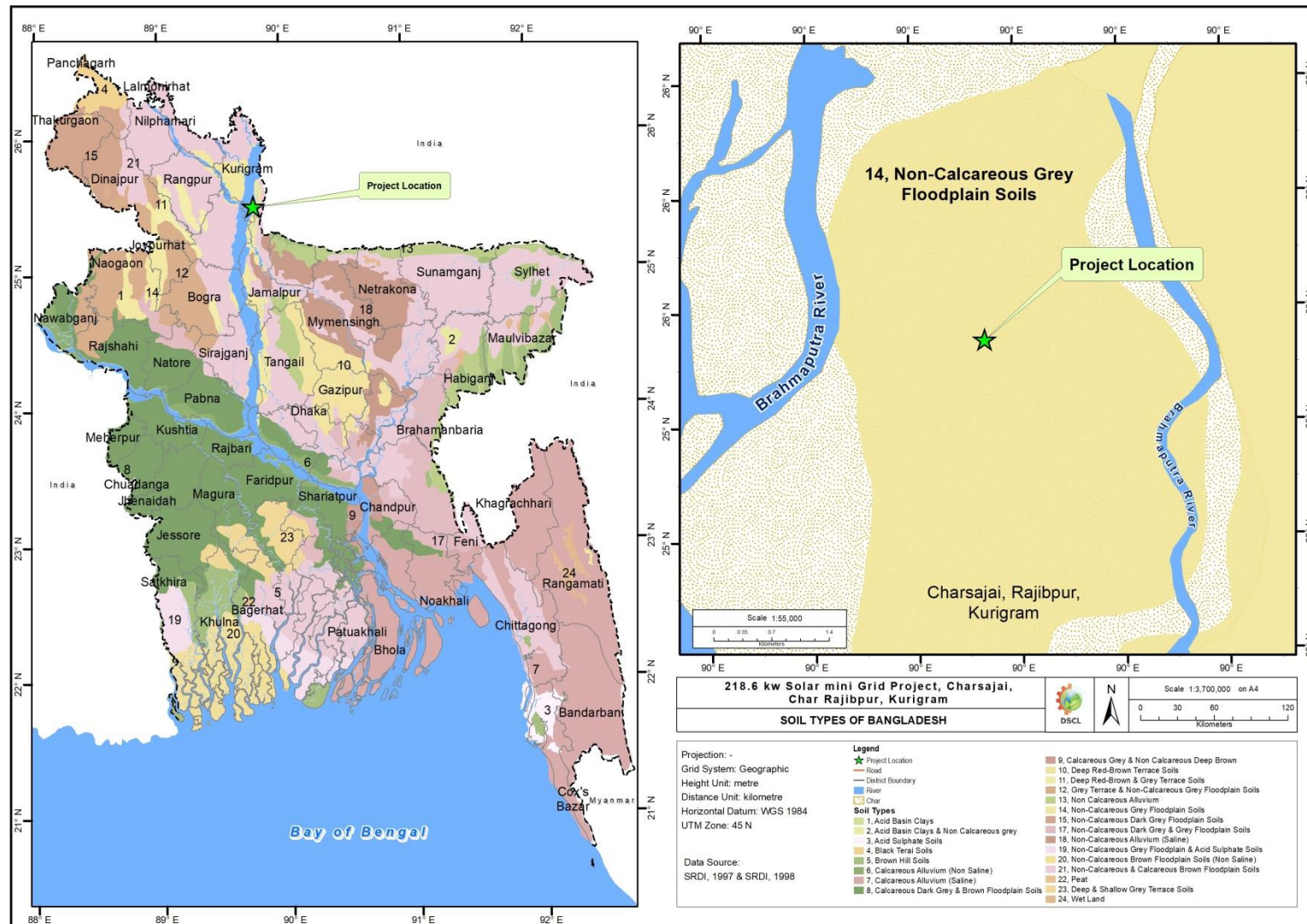


Figure 6.17: General Soil Categories of Bangladesh

6.2.9 Agro-ecological Zones within the Project Area

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.

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

The most recent assessment was completed by the Soil Resource Development Institute (SRDI, 1998) which classified Bangladesh into 30 AEZs. The project area contains the below AEZ (refer Figure 5.20), namely:

- i. **Active Brahmaputra-Jamuna Floodplain (7):** This region comprises the belt of unstable alluvial land along the Brahmaputra-Jamuna rivers where land is constantly being formed and eroded by shifting river channels. It has an irregular relief of broad and narrow ridges and depressions. The area is occupied by sandy and silty alluvium, rich in weatherable K minerals that are slightly alkaline in reaction. Six general soil types occupy the area. Organic matter status is low and fertility status is low to medium. (Banglapedia, 2014).

The nature and soil characteristics of this zone influence the crops and cropping patterns within the region.

6.2.10 Seismicity

Bangladesh is situated in one of the most tectonically active regions in the world. Here is where three major plates meet (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate). The project area is located over the Indian Plate, which is moving north. However due to the location of relevant plates, fault lines and hinge zones, Bangladesh itself is divided into three seismic zones (**Table 6.5**), 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 5.18), project area falls in the zone I. It means the project area is prone to high seismic intensity. There is no evidence of major earthquakes in the project areas in the past.

Table 6-5: Seismic Zonation 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

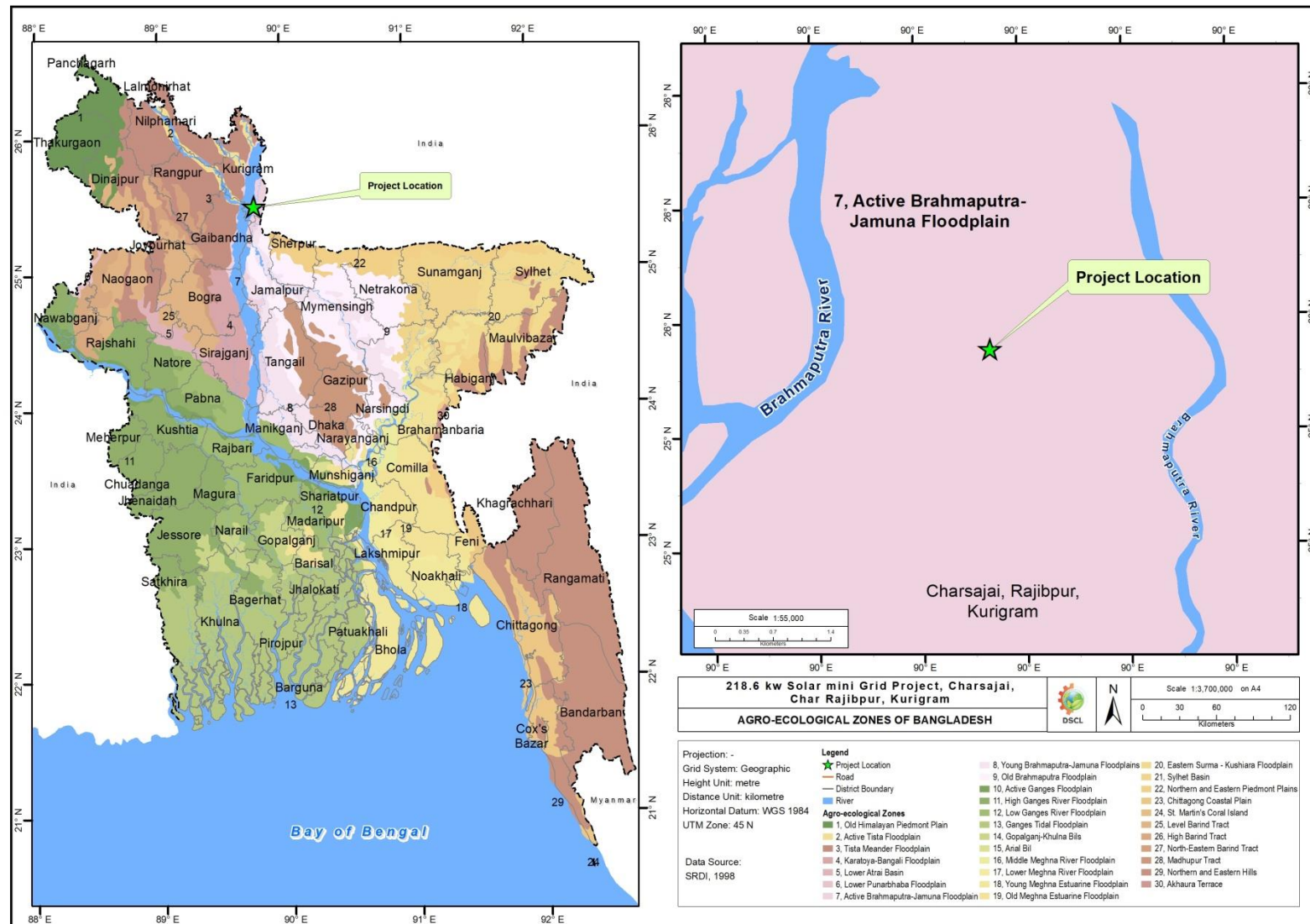


Figure 6.18: Agro-ecological Zones of Bangladesh

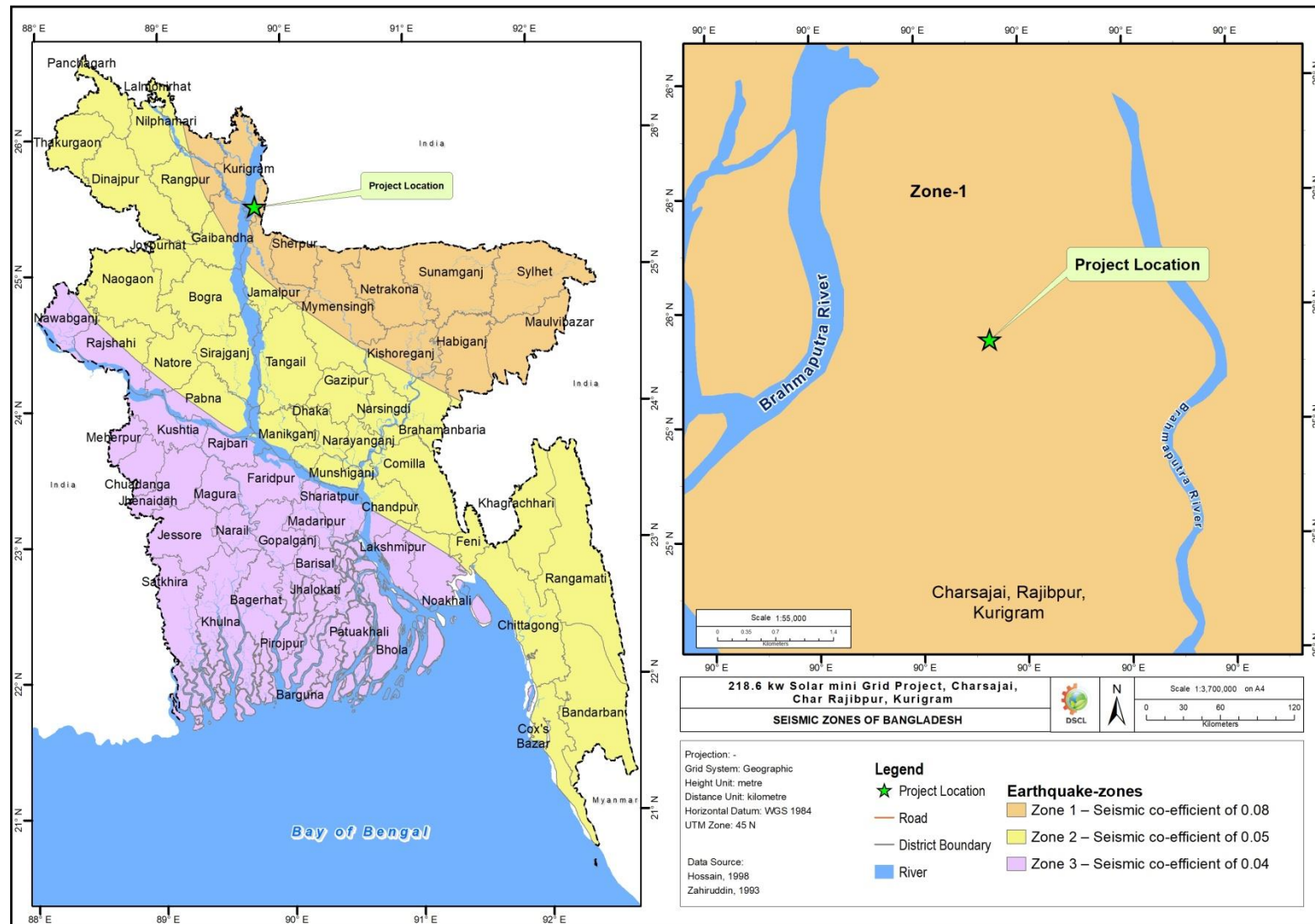


Figure 6.19: Seismic Zones within Bangladesh
 (Source: Hossain, 1988 & Zahiruddin, 1993)

6.3 Climate Change and Natural Disaster

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

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

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

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

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

6.4 Biological Environment

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

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

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

6.4.1 Bio-ecological Zones

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

Each of the ecosystems has many sub-units with distinct characteristics as well. IUCN Bangladesh in 2002 classified the country into twenty-five bio-ecological zones (**Figure 6.20**). The project area falls below the bio-ecological zone.

- **Major Rivers (Bio-ecological zone 11):** Bangladesh consists mainly of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, Ganges and Meghna rivers. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly catkin grass for example). Dense growth of catkin grass can accelerate silt deposition on chars. Many of the species' natural distribution, migration and storage are primarily functioned via these rivers into other wetland ecosystems (GoB-IUCN, 1992). A diverse range of waterfowls are directly or ecologically dependent on these rivers and its associated ecosystems. However, it is quit alarming that, with the exception of few species of turtles, all other river biodiversity is threatened with extinction (IUCN, 2002f).

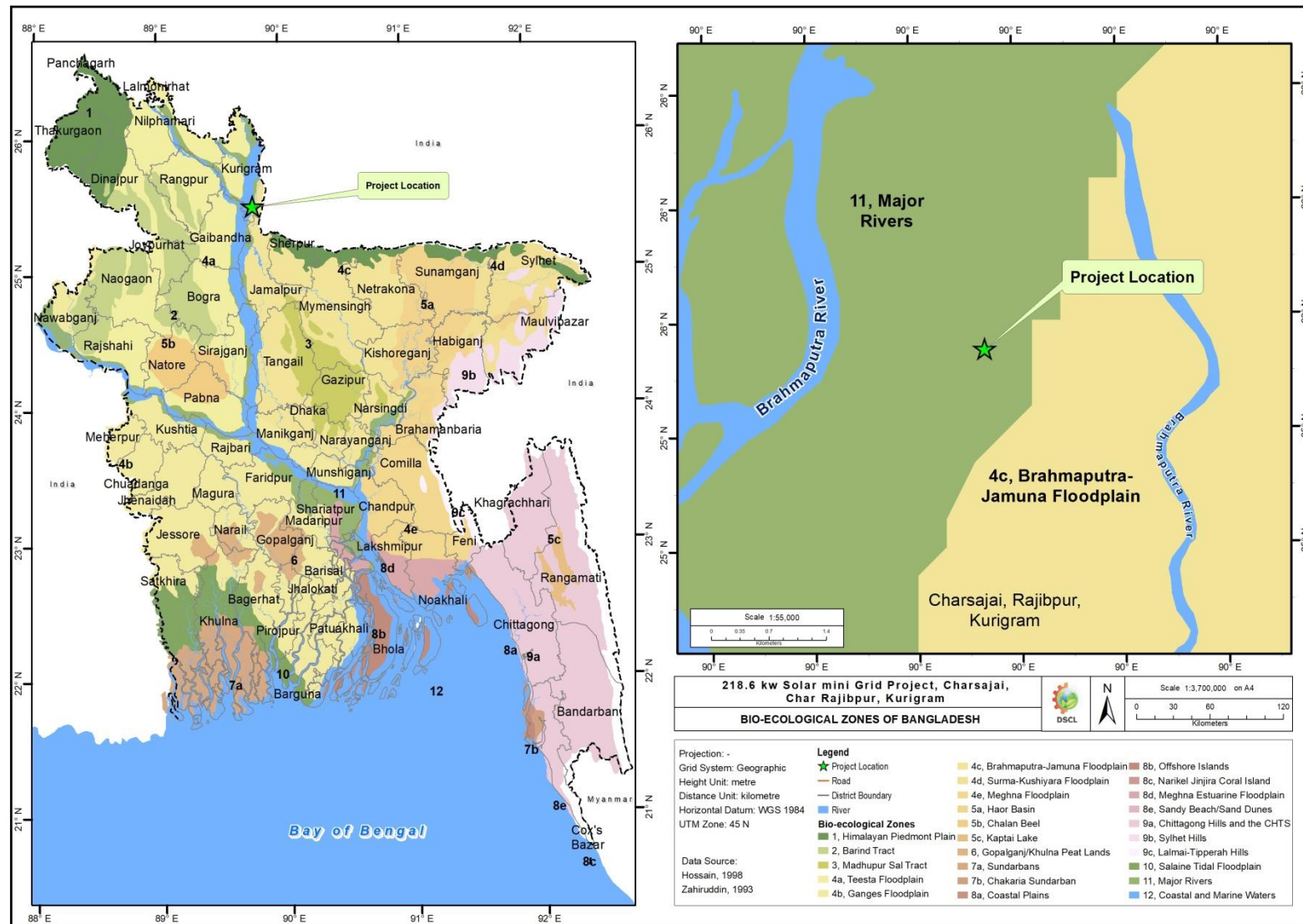


Figure 6.20: Bio-ecological Zones of Bangladesh

6.4.2 Terrestrial Ecosystem

The status of terrestrial floras and faunas at the project site were assessed from visual observations, review of literature, and information documented by other agencies. The project area consists of several ecological subsystems e.g. open agricultural land, homesteads, and roadside vegetation. The open agriculture land ecosystem dominates the area providing widespread habitat types for various species of flora and fauna under flooded and non-flooded conditions. The vegetation covers of agricultural lands are different crop species, weeds and other herbaceous plants species. The faunal species in the agriculture land and roadside bush ecosystems include birds, amphibians, fishes, snakes rodents and few mammals. The homestead ecosystem provides the main tree covered areas within rural Bangladesh including the project site. 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.

6.4.2.1 Flora

The project influence area (PIA) is highland with mixed vegetation. Crops, vegetables are cultivated at the surrounding mainly include rice, wheat, Robi crops and variety of homestead vegetables. A sizeable number of fruit trees with economic value have been observed in the PIA. The fruit trees include jackfruit, mango, litchi, banana, coconut, blackberry etc. and timber trees include Mehegoni, Neem, Koroi etc. Considerable number of trees and bushes in the PIA site provide habitat for birds and other animals. Eucalyptus has been found a lot in number during field visit. The composition of plant community includes low growing grasses, trees, herbs and shrubs. The data collected from the field survey and suggests that the predominant species are those of cultivated vegetables and trees. A detailed list of terrestrial floral species found in the project area is shown in **Table 7.1**.

Table 6-6: List of Plants in the Project Area

Common Name	Scientific Name	English Name	Family
Aam	<i>Mangifera indica</i>	Mango	Anacardiaceae
Begun	<i>Solanum melongena</i>	Brinjal	Solanaceae
Dhan	<i>Oryza sativa</i>	Rice	Poaceae
Durbaghash	<i>Cynodon dactylon</i>	Bermuda grass	Gramineae
Dholkalmi	<i>Ipomoea carnea</i>	Pink morning glory	Convolvulaceae
Eucalyptus	<i>Eucalyptus oblique</i>	Eucalyptus	Myrtaceae
Jaam	<i>Syzygium cumini</i>	Java Plum	Myrtaceae
Jambura	<i>Citrus maxima</i>	Pomelo	Rutaceae
Kola	<i>Musa sapientum</i>	Banana	Musaceae
Koroi	<i>Albizia procera</i>	Persian silk tree	Fabaceae
Kathal	<i>Artocarpus heterophyllus</i>	Jackfruit	Moraceae
Kalmilata	<i>Ipomoea aquatic</i>	Water spinach	Convolvulaceae
Khejur	<i>Phoenix dactylifera</i>	Date palm	Arecaceae
Kul	<i>Ziziphus mauritiana</i>	Chinese date	Rhamnaceae
Lau	<i>Lagenaria siceraria</i>	Bottle Gourd	Cucurbitaceae

Common Name	Scientific Name	English Name	Family
Lebu	<i>Citrus sp.</i>	Lemon	Rutaceae
Lichu	<i>Litchi chinensis</i>	Litchi	Sapindaceae
Morich	<i>Capsicum annuum</i>	Chilli	Solanaceae
Narikel	<i>Cocos nucifera</i>	Coconut	Arecaceae
PalongShak	<i>Spinaciaoleracea</i>	Spinach	Chenopodiaceae
Peyara	<i>Psidiumguajava</i>	Guava	Myrtaceae
Pepe	<i>Carica papaya</i>	Papaya	Caricaceae
Supari	<i>Areca catechu</i>	Betel tree	Piperaceae
Taal	<i>Borassusflabellifer</i>	Palm	Areaceae
Tulsi	<i>Ocimum sanctum</i>	Holy basil	Lamiaceae
Tomato	<i>Solanumlycopersicum</i>	Tomato Plant	Solanaceae
Mula	<i>Raphanusraphanistrum</i>	Radish	Brassicaceae
Aakh	<i>Saccharumofficinarum</i>	Sugarcane	Poaceae
Pat	<i>Corchoruscapsularis</i>	Jute	Mallows

6.4.2.2 Fauna

The diversified habitat and ecosystem in the project area support various types of animals as given in **Table 7.2**. 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. A total of 21 species are identified during field survey among them 3 Amphibian, 3 Reptilian, 9 Avian faunas and 6 Mammalian faunas

Table 6-7: List of Fauna Identified in and around the Project Area

Scientific Name	English Name	Local Name
Class: Amphibia		
<i>Bufo melanostictus</i>	Common toad	Kuno bang
<i>Rana tytleri</i>	Brown frog	Pana bang
<i>Uperodonglobulosus</i>	Balloon frog	Belun bang
Class: Reptilia		
<i>Chitraindica</i>	Indian narrow-headed soft shell turtle	Kocchop
<i>Kachugatectum</i>	Indian roofed turtle	Kari kata
<i>Gecko gecko</i>	Wall lizard	Tokkhok
Class: Aves		
<i>Milvusmigrans</i>	Black kite	Bhubonchil
<i>Bubo bubo</i>	Eagle owl	Pecha
<i>Ploceusphilippinus</i>	Baya weaver	Babui
<i>Anasplatyrhynchos</i>	Duck	Hash
<i>Corvussplendens</i>	House crow	PatiKak
<i>Alcedoatthis</i>	Common Kingfisher	ChotoMaachranga
<i>Picidae</i>	Woodpecker	Kath Thokra
<i>Streptopeliachinensis</i>	Spotted Dove	TilaGhughu
<i>Columba livia</i>	Domestic Pigeon	Kobutor
<i>Eudynamysscolopaceus</i>	Asian Koel	Koel
Class: Mammalia		
<i>Bos Taurus</i>	Cow	Goru
<i>Bubalusarnee</i>	Wild Water Buffalo	Mohish

Scientific Name	English Name	Local Name
<i>Capra aegagrus</i>	Goat	Chagol
<i>Feliscatus</i>	Cat	Biral
<i>Canisfamiliaris</i>	Dog	Kukur
<i>Rattusrattus</i>	Rat	Indur

6.4.3 Protected Areas and Red Book Species

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

In and around the project no environmentally protected areas were found. Construction impacts on the rate of deforestation, loss of habitat, habitat fragmentation, and interruption of wildlife migration patterns are not anticipated. **Figure 6.21** shows that no environmental sensitive area is present around the project region.

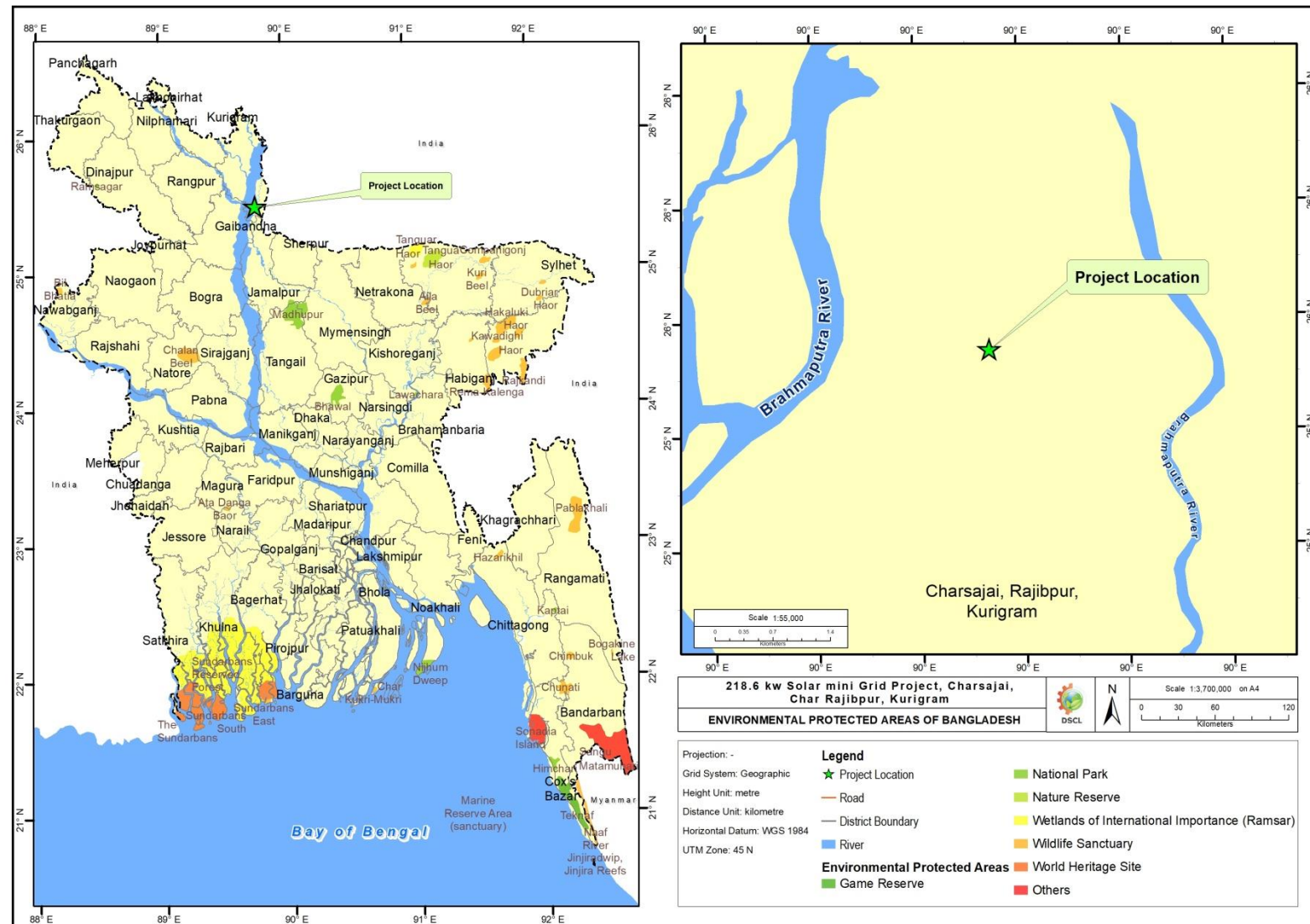


Figure 6.21: Environmental Protected Areas of Bangladesh

7 DESCRIPTION OF THE SOCIAL CONDITIONS

7.1 Socioeconomic Conditions

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

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

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

- Literature review;
- Focus Group Discussion (FGD); and
- Questionnaire Survey.

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

There is one local market (Haat) within 1 km of the proposed project site. As per survey, there are 788 households, 104 shops, 11 schools, mosques, Madrashes & offices, 2 rice mills, 1 saw mill, and 20 irrigation pumps. There are also schools, madrasahs and mosques in the proposed location. The range of profession includes business, farmer, service etc.

It is to be noted from survey that, 296 households (59%) currently have electricity by SHS and 202 households (41%) by Kerosene. It has been also observed in the results of the surveys that 97.5% shops and 98.5% households are interested in having electricity from the proposed solar mini-grid project. Besides, 45.73% of the respondents earn less than BDT 10,000 per month and another 42.17% of the respondents earn between BDT 10,001-20,000 per month. The remaining earns more than BDT 20,000 per month. From the survey it can also be noted that most of the households are within 500m radius of the project site. Notably, during the site visit, the local farmers expressed their willingness to avail electricity from the Project for irrigation purposes.

7.2 National Context

Bangladesh has experienced steady economic growth and improvement in macroeconomic stability during recent years, particularly in the past decade. This has been despite numerous natural disasters and external forces such as the global economic crisis. Rates of poverty have fallen from 57 percent in 1990 to 40 percent in 2005. The average growth of gross domestic product (GDP) between 2001 and 2007 was over 6 percent (World Bank, 2007). In addition,

Bangladesh has made great strides towards achieving many of the Millennium Development Goals (MDGs), including meeting the MDGs for gender parity in education and universal primary enrolment ahead of time.

Despite the improving track record, around 56 million people remain living below the poverty line. As such Bangladesh faces considerable challenges, including from ongoing natural disasters such as cyclones and floods, and from the potential impacts from climate change.

Development of socio-economic indicators for Bangladesh are provided in Table 8.1

Table 7-1: Key Socio-economic indicators for Bangladesh

Key Indicator	Value
GDP (US\$ billions), 2008	79.0
GDP per capita (US\$), 2002	351
Exports of goods and services (% of GDP), 2002	14.3%
Imports of goods and services (% of GDP), 2002	19%
Agriculture (% of GDP), 2007	18.9%
Industry (% of GDP), 2003	28.5%
Services (% of GDP), 2003	52.6%
Population living below national poverty line, UNDP (2005)	40.0%
Life expectancy (2006)	
- Male	65.6
- Female	70.0
Total fertility rate (births per woman ages 15-49), 2007	2.39
Adult literacy rate (% age 7 and above), 2007	
- Male	59.4%
- Female	52.7%
Population with sustainable access to improved sanitation (%),2000	48%
Population with sustainable access to water source (%),2000	97%

(Sources: United Nations Development Program, 2004; Bangladesh Bureau of Statistics, 2008; Bangladesh Bureau of Statistics, 2009)

7.3 Administrative Information

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

The proposed project is located beside Brahmaputra River at Charsajai (5 no. Ward) of Kodalkathi Union at Char Rajibpur of Kurigram district. The Global Positioning System (GPS) coordinate of the project site is 25.49664° N, 089.77097° E. The proposed plant is bounded by agricultural land in two sides; in addition the north and east side of the project area is having some residential dwellings. The total land of the proposed project is about 120 decimal (equivalent to 4 bighas).

7.4 Demographic Information

With an estimated 164.4 million inhabitants and an annual population growth rate of 1.4%, Bangladesh is considered to be 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 8.2** and **8.3**). The demographic information is collated from Population Census, 2011 by Bangladesh Bureau of Statistics (BBS).

Table 7-2: Demographic Profile of the Char Rajibpur

Upazila	Households	Population			Sex ratio (M/F)	Average size of household	Density per sq. km
		Both	Male	Female			
Char Rajibpur	17310	73373	35372	38001	93	4.24	661

Source: BBS, 2011

Table 7-3: Demographic Profile of the Project Area

Union	Area (Acre)	Population			Literacy Rate
		Both	Male	Female	
Kodailhati	6199	11710	5413	6297	93

Source: BBS, 2011

7.4.1 Household Size

Comparison of the data collected during household surveys found that the average household size of these villages was 4.2 members per household. Males (88%) headed the majority of households.

A socio-economic study was undertaken in Kodailhati Union within 1km radius of the project

**Figure 7.1: Interview with households**

site. The high impact zone has been considered as households within 500m radius from the center of the project site and the low impact zone as between 500m to 1km radius (**Figure 8.1**).

According to the household survey, the **Table 8.4** shows that the average household size is

4.3 in all impact area (i.e. the average number of persons per household). Overall, the average household size in the Project area is lower than the national average radius household size, which is 4.4 persons (BBS, 2011).

Table 7-4: Average family size and sex ratio of household members of study area

Study Area	Average Family Size (number)	Sex Ratio
High	4.4	110
Low	4.0	78
All	4.2	94

7.4.2 Gender Distribution

The sex ratio of the population is defined as the number of males per 100 females. In the country as a whole the sex ratio has remained fairly constant at around 106 since 1981, with the reported ratio for 2001 being 106.6. However, there is a significant urban-rural difference in sex ratios; 117.2 for the urban areas as opposed to 103.6 for rural areas. This difference can mainly be attributed to male labor migration to urban areas, specifically in the 20-29 age brackets and to a lesser degree in the 30-34 age bracket (BBS 2003). The sex ratio of the project area is 93.

7.4.3 Age Distribution of the Population

Age distribution of the population in all impact zone obtained from survey data shows that 4.7% of the population is children (0-4 years), 22.8% are adolescents in the 5-14 years old group, 35.6% are 15-30 years of age, 22.2% are of age 31-45, 13.3% are of age 46-60 and the remaining 2.7% are above 60 years. In the high impact zone, 18.3% population is aged between 46-60 years whereas it is 12.1% in the low impact zone.

7.4.4 Religion

According to Banglapedia, 2015 the majority of people of Char Rajibpur are Muslim with a population of 63745. The number of Hindu people is 260. The number of Buddhists, and others living in the area are 8 and 9 respectively. The percentage of population distribution by religion is showed in the below table.

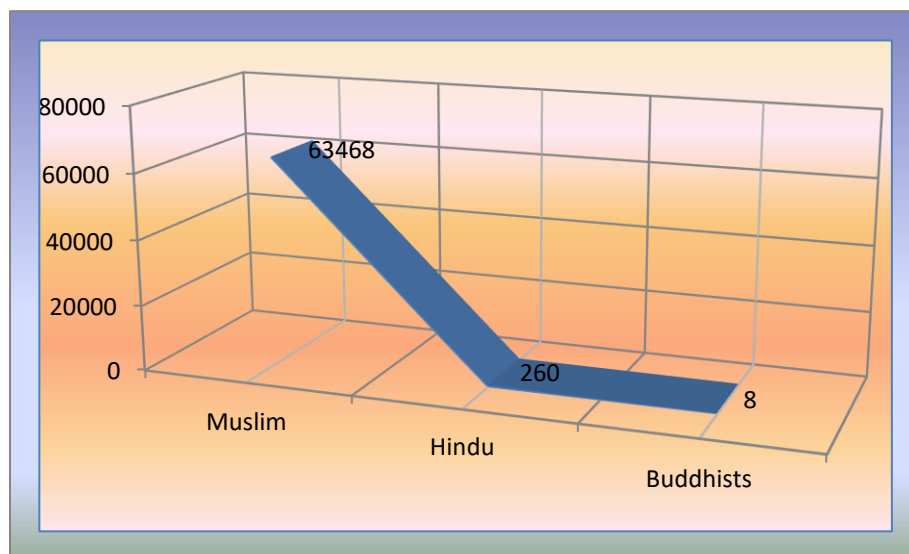


Figure 7.2: Population Distribution by Religion of Char Rajibpur
Source: Banglapedia, 2015

7.5 Land Use and Ownership

Lands at the project area are used for agriculture, fisheries, agro-forestry, homestead, homestead forestry and vegetation, animal husbandry, etc. The area at where the project is proposed characterized by an agricultural ecosystem. By far the most predominant land use in the Project area is agricultural constituting more than 75 percent of the land use. Other major non-agricultural land uses include rural settlements (12%), water bodies (8%) and mud flats (5%).

Approximately 17.6 percent of households surveyed were found to own arable land, and of these landowners 7.5 percent owned less than 1 acre and 6.1 percent owned between 1 and 2 acres. Of the 32.1 percent of households that own homesteads, more than 98.7 percent own less than 1 acre. Approximately 12.6 percent of households surveyed owned land used for ponds, and 27.2 percent owned land used for orchards. Of all households surveyed more than 90 percent had some form of ownership of land used for food production.

7.5.1 Cropping Patterns

The Project area is located beside Brahmaputra River and therefore rice paddy is a substantial crop. The main paddy grown in the Project Area is AUS (cultivated from February to June), Aman (cultivated from mid-July to mid-December) and Boro (irrigated and cultivated in the winter). Wheat, jute, wheat, mustard, sugarcane, potato, pulse, brinjal, vegetables, arum, till (sesame), betel leaf, betel nut, wheat, sugarcane, mustered, bottle gourd are also grown within the Project area. Fruits like jackfruit, litchi, palm, banana, lemon, black berry and water melon are often grown in smaller amounts and in close proximity to dwellings.

Of the household surveyed approximately 63 percent grew some form of paddy, with Amon being the most commonly grown (49%). Crop rotation was seen to be prominent with 57% either having a rotation twice or three times a year. Further, based on the primary crop intensity and pattern 3.6% do not have a crop rotation pattern with a singular crop dominated by Amon. Of those who crop rotated twice (11.3%), 4.8% was of Amon and Aus and 48.6% of people surveyed rotated their crop three time, which 48.4% was made up of Amon, Aus and Rabi.

7.6 Literacy and Educational status

The average literacy rate and educational institutions Average literacy 25.64%; male 31.18%, female 20.66%. Educational institutions: college 2, secondary school 9, primary school 75, madrasa 5. Noted educational institutions: Char Rajibpur Degree College (1987), Char Rajibpur Pilot High School (1964), Kodaikati Sadakat Hossain High School (1973), Char Rajibpur Model Government Primary School (1928), Char Rajibpur Alim Madrasa (1963), Nayar Char Fazil Madrasa (1975). The number of different educational institutions are listed in the below table (Table 8.5 and Table 8.6).

Table 7-5: Number of Educational Institutions in Char Rajibpur Upazilla

Educational Institutions	Number
College	2
Secondary School	9
Primary School	75
Madrasha	5

Source: Banglapedia, 2015

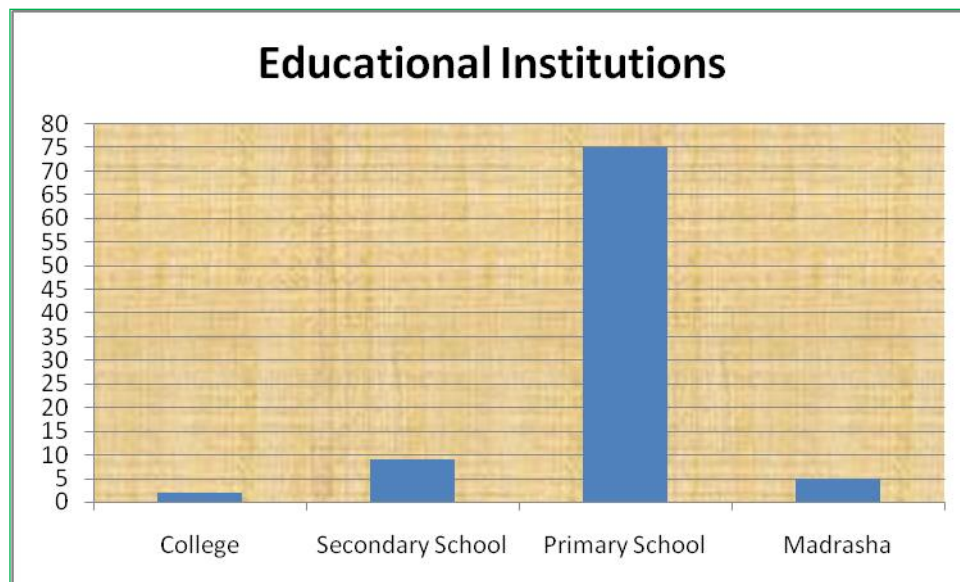


Figure 7.3: Educational Institutions in the Project Area

7.7 Occupational Patterns

Livelihoods encompass systems of accommodation and settlement, income-generation and resource use, as well as systems of social interaction, cooperation and mutual support. Recent reports on socio-economic development in Bangladesh refer to the changing nature of rural livelihoods with most households being shown to be pursuing a diversified range of activities for their livelihoods. Therefore, information provided below on occupational status collected through household surveys provides more of a broad insight into livelihood strategies in the Project area.

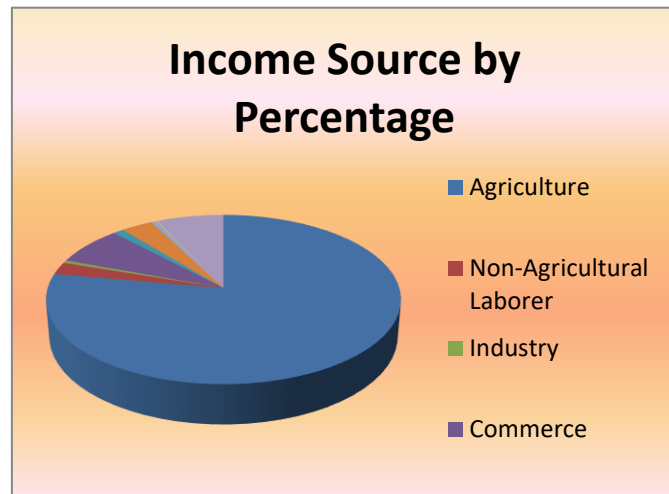
7.7.1 Occupation and Employment

Most people in the Project area are either underemployed or unemployed, though most people disguise their unemployment by minor involvement in economic activities. Being underemployed is defined as *“the condition whereby a person’s employment is considered inadequate in terms of time worked, income earned, productivity or use of his/her skills and the person is looking for additional work in conformity with his/her education or skill to augment income.”*

Livelihoods allow people to secure the necessities of life, such as food, water, shelter and clothing. Engaging in livelihoods activities involves acquiring the knowledge, skills, social network, raw materials, and other resources to meet individual or collective needs on a sustainable basis. The island people are typically involved in activities such as agriculture, livestock breeding, fishing and trade. Income provides the basis for food security and self-reliance, contributing towards general stability, prosperity and peace. The percentage of income sources is described in the below table (**Table 8.6**).

Table 7-6: Percentage of Income Source of Char Rajibpur Upazilla

Income Source	Percentage (%)
Agriculture	77.76
Non-Agricultural Laborer	2.36
Industry	0.51
Commerce	7.36
Transport & Communication	1.07
Service	3.34
Construction	0.47
Religious Service	0.11
Rent & Remittance	0.09
Others	6.93



Source: Banglapedia, 2015

For the majority of the surveyed people and their household members, their place of occupation is within their own land in the project area. The household heads in the surveyed are engaged in different types of primary occupation such as service, business, handicrafts, fishing, work in abroad etc. The survey reveals that the highest percentage (26.6%) of the workforce in all impact zones is engaged in household work. 21.8% of the population in all impact zones is engaged in different types of business in the surveyed area.

7.8 Economic Status

The analysis of the households' economic situation has been focused on accessibility and affordability of food, clothing, educational facilities, medical facilities, transport facilities etc.

With respect to availability of food, it is considered "satisfactory" by 42.4% of the households under the survey. Food availability is considered "good" by 48.7% of the households in the study area. The situation with respect to clothing is considered "satisfactory" by 48.4% of the respondents and considered "good" by 51.5% of the respondents in the study area. As for housing /accommodation facilities, they are found "satisfactory" by 41.8% of the respondents, 52.1% of the respondents found them "good" and 7.1% of the respondents found them "unsatisfactory". Educational facilities are considered "good" and "satisfactory" by 43.3% and 52.3% of the respondents, respectively. Medical facilities are generally considered "satisfactory" by 52.5% of the respondents in the study area whereas 38.4% of the respondents found them "unsatisfactory". However, transportation facilities were scored as "satisfactory" by 48.5% of the respondents, while only 8.1% considered them as "unsatisfactory". Entertainment facilities are considered "satisfactory" by 51.8% of the respondents whereas 32.0% of the respondents found them "unsatisfactory" in the study area.

7.9 Settlement Pattern and Housing

The settlement patterns observed during field visits reflected the rural nature of the Project area, with scattered villages surrounded by agricultural fields and seasonally surrounded by floodplain. In the villages, a homestead is often occupied by an extended family and typically consists of a few houses and outbuildings, surrounded by fruit trees.

The majority of households surveyed within the Project Area owned their own home (92.0%). Of those not owning their own home, alternative arrangement included living in a house owned by relatives or being a tenant.

7.10 Transports and Communications

The project area is connected with the main land by waterways. Charsajai can be accessed by boat from Kartimari Bazar which is in Char Rajibpur Upazila of Kurigram District. It takes almost forty minutes to reach at Charsajai from Kartimari Bazar Ghat by boat. In order to reach Kartimari Bazar one has to start from Dhaka by private or public transportation. In a private microbus, our team reached Kartimari Bazar in around 10 hours. After reaching at Kartimari Bazar, horse cart is used to reach project location which is another forty to fifty minutes journey. The Project location is on Charsajai, which is an island. Local boat transport to and from Charsajai is only possible by River.

7.11 Poverty

Almost all the families of Charsajai are engaged with some earning activities. During the field visit it was observed that people usually go to the town or further for better income. Female usually remain at home and do the household work. Among the employed people most are working in agricultural field, some work in industry outside char and rest are doing service (**Figure 8.4**).

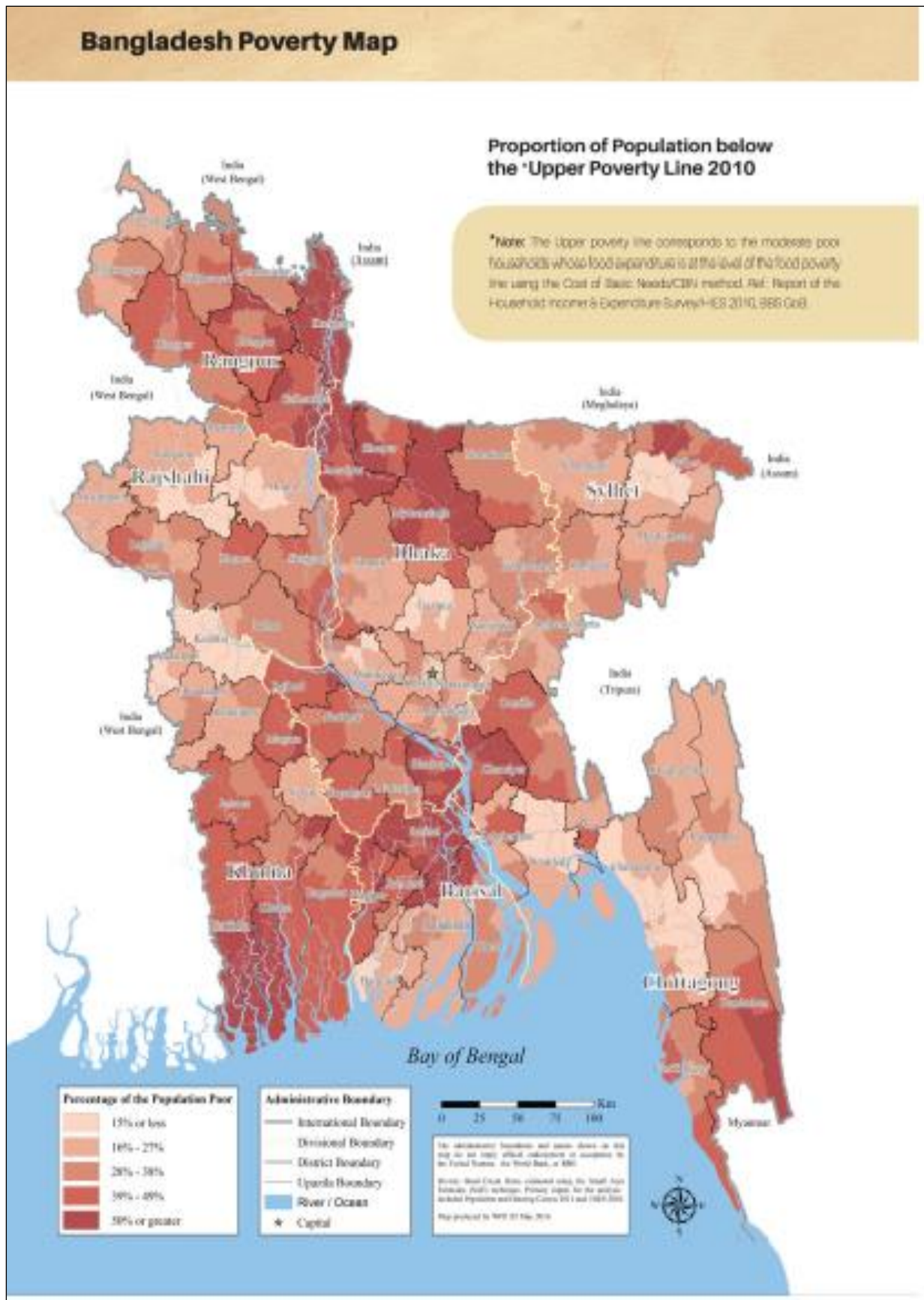


Figure 7.4: Poverty Map of Bangladesh (BBS/WFP/ World Bank-2010)

7.12 Survey of Environmental Issues

Environmental problems that are perceived by the respondents in the study area includes water pollution, air pollution, noise pollution over population, deforestation, diseases, poor sanitation, arsenic contamination of ground water, sedimentation of water bodies etc.

According to the survey, the most pressing problem is air pollution in terms of the percentages of responses. The survey reveals that, air pollution has been mentioned by 38% followed by water pollution (12%), and Burning fuel, trees and agriculture residue (5.5%). Besides, health and sanitation problem and over population have also been mentioned by 5.5% and 21.9% respectively as low status of problem. The survey also reveals that 17.1% of the households mentioned noise pollution as moderately impacted problem in the study area (Figure 7.5).

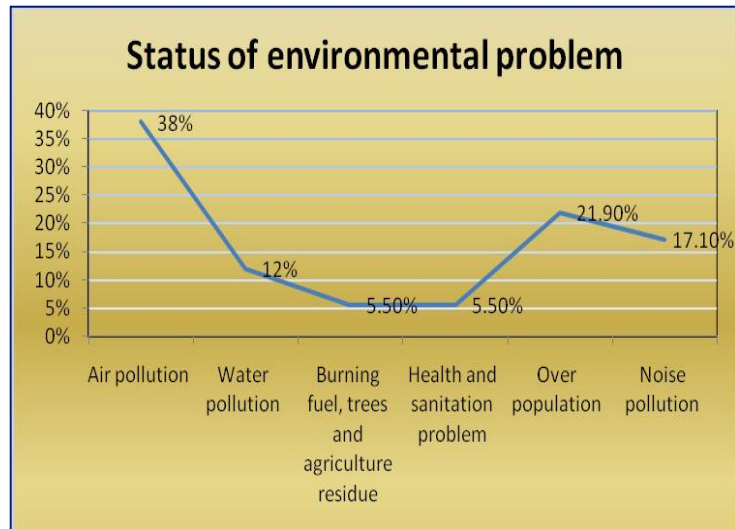


Figure 7.5: Status of environmental problem

7.13 Respondents' Awareness and Perception about the Proposed Project

7.13.1 Respondents' Awareness about the Project

The survey reveals that 72.0% respondents in the study area are generally aware and have heard of the proposed project. The survey also reveals that, rests of the 28.0% of the respondents do not have knowledge about the proposed project.

7.13.2 Perceived Positive Impacts of the Project

Respondents also perceived that various benefits were expected to result from the implementation of the project. These benefits, as perceived by the respondents, include; creation of employment opportunity, access to roads, enhanced socio-economic conditions, and overall national development in the area.

According to the survey, creation of employment opportunities is perceived as a beneficial effect of the project for 78.0% of the respondents. The implementation of the project will lead to national development, according to the opinion of 83.0% of the respondents. Enhanced local socio-economic activities and access to road infrastructure in the local area have been mentioned as positive outcomes of the project by 36.0% and 88.0% of the respondents respectively.

7.14 Recreational Activities

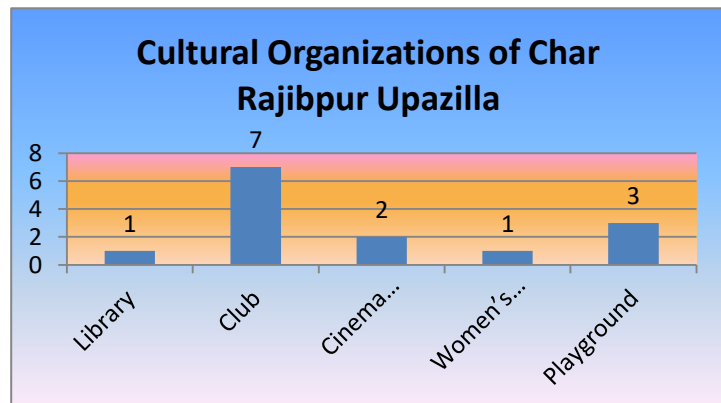
The social need for recreation has been identified as compulsory. The Charsajai island people have very limited access to recreational activities. There is no such dedicated place or regular activities as recreational purpose. However, there are some houses have bought television but all the people do not have ability to buy the valuable means of recreation. Additionally, without having access to electricity the available television is not worthy at all in some times.

Because of the lacking of electricity people in this area are not interested to establish any recreational center at all.

Table 7-7: Cultural Organizations of Char Rajibpur Upazilla

Cultural Organizations	Number
Library	01
Club	07
Cinema Hall	2
Women's Organization	1
Playground	3

Source: Banglapedia, 2015



7.15 Archaeological and Cultural Resources

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

7.16 Important Environmental and Social Features (IESFs)

The socio-cultural aspects include the educational institutions, hospitals/health centers, religious structures, cultural structures, burial grounds, market places, water bodies, etc., few of which would be affected directly and indirectly through implementation of the project. Such sites could be termed as Important Environmental and Social Features (IESFs) in relation to project activities and, hence, need to be dealt carefully during the construction phase. Locations of major IESFs in the project area are shown in the Figure 8.17. A detail list of the cultural and sensitive areas located within 1 km radius of the project area is presented in **Appendix E**.

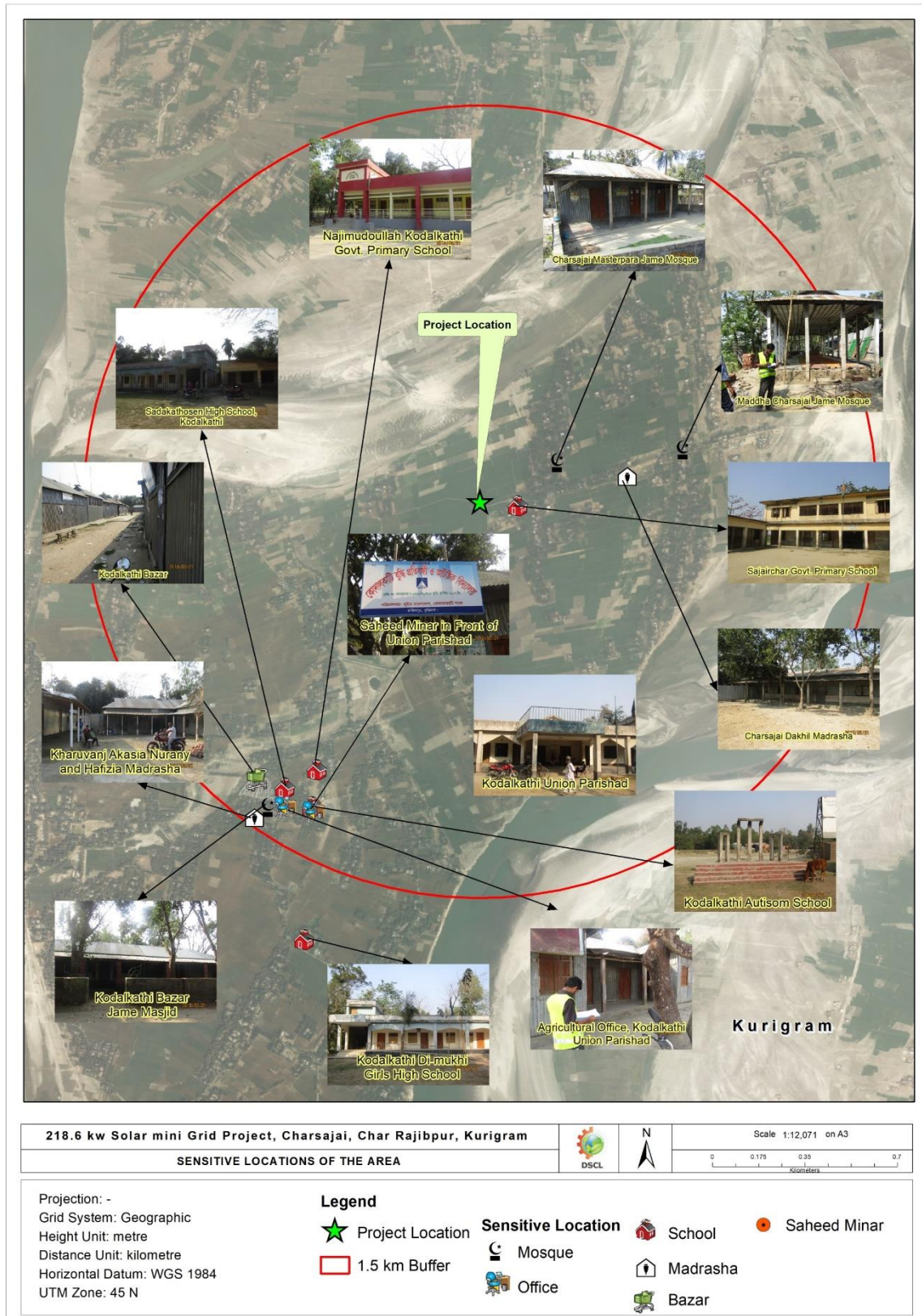


Figure 7.6: Cultural and Sensitive Structures within 1 km Radius of the Project Location

8 PUBLIC CONSULTATION AND DISCLOSURE

8.1 General

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 EIA good practice and is a statutory requirement of the national EIA 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 EIA requirements with affected people and is designed to be both fair and inclusive. Consultation activities have been conducted during the environmental survey of the EIA in February 2018.

8.2 Objectives

The objective of stakeholder 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 EIA process and implemented all through the study period.

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.

8.3 Consultation with Various Stakeholders

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.

Through the project preparation stage extensive consultations/FGDs have been arranged during the conduct of the EIA surveys. The details of FGDs are given in the following Table 9.1. The findings of these of these FGDs are summarized in Table 9.2 and the details of these FGDs are given in **Appendix F**.

Table 8-1: Details of FGDs

FGD No.	Type of Participants	No. of Participants
01	Farmer, service holder, businessmen, Students	15
02	Farmer, service holder, businessmen, teacher	15
03	Farmer, service holder, businessmen, Students	16
Total		46

**Figure 8.1: Photos of Focus Group Discussions (FGD)****Table 8-2: Summary of the FGDs**

Questions to the Groups	Participants opinion, comments and suggestions
Are you aware about the activities of the Solar Mini grid Power Plant project? If yes, what are they?	Yes, the project proponent has shared this information with us. The owner will establish Solar Power Plant and 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 give less environmental impact because the project area is surrounded by boundary wall.
Any air pollution in the area due to the project area due to the project activities? If yes, how to mitigate?	The air quality will not anticipate significantly because of construction activities. Through 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 beside some residential dwellings so there is minor possibility of anticipated impact but proper care about battery, 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 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.

Questions to the Groups	Participants opinion, comments and suggestions
	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 open place.
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 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?	Hence, the area is char land; the area is flood affected area especially during high flood time. During monsoon period low lying areas are flooded. But the developer filled the land about 5 feet from the normal plinth level. 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. The educational institutions will be able to teach computer lesson to their students after having electricity. School digitalization will be possible. 24 hour electricity service will enhance business improvement, irrigation through water pump, ice factory for fish market and rice mills.

Questions to the Groups	Participants opinion, comments and suggestions
Do you have any recommendation before the implementation of this project?	The project proponent should consider more households under the grid as well as the electricity generation should be increased. They have to give attention on business sector such as electricity in market area and for irrigation rather than to households. Most of the households in this area are using solar panel individually for electricity generation. After going to the grid of new solar power plant our present solar panel would be a concern. As we do not know much about it so it is not possible for us to treat the waste properly. Some of us would be able to sell this to other households but the project proponent could take necessary actions on it particularly for the old panels. Monthly charge of using electricity from the solar mini grid should be affordable for the local people.
Are you in favor of this project? Why?	Yes, It is a dream project for us. We appreciate the initiative. This project in the long run will help to develop the economic and social condition in this area.

9 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

9.1 General

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

9.2 Impact Magnitude

The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria. These magnitude categories are defined in **Table 9.1**.

Table 9-1: Parameters for Determining Magnitude

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

9.3 Sensitivity of Receptor

The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of features on the site or the surrounding

area. Each detailed assessment has defined sensitivity in relation to the topic. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table 10.2**.

Table 9-2: Criteria for Determining Sensitivity

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

Assigning Significance: Following the determination of impact magnitude and sensitivity of the receiving environment or potential receptors, the significance of each potential impact has been established using the impact significance matrix shown below in **Table 10.3**.

9.4 Summary of Assessed Impacts

The project's potential impacts on the key environmental parameters have been assessed and their significance determined using the methodology described in Section 9.2 above. A summary of the potential impacts of the project on the key environmental parameters and significance of these impacts are presented in Table 10.4, 10.5 and 10.6 for different phases of this project; the potential impacts are discussed in the subsequent sections.

Table 9-3: Significance of Impact Criteria

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

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

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

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

9.5 Corridor of Impact (Col)

The corridor of the proposed Impact (Col) 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 the DoE guideline considered an area of 5km radius around the site. However, in this project the buffer zone area have been considered as core impact zone and 1km as buffer zone for better understanding.

9.6 Pre-construction Phase

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

9.6.1 Land Use / Land-filling

Impact

The Project site location does not conflict with any of the relevant governmental entities formal planning context. The proposed project site is situated on the lower ground and it needs about 7 feet soil filling. The project initiator has bought this land from the owner with a good value so there is no conflict in land use for the project purpose. 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 proposed solar power plant will be in the agricultural land which might ultimately degrade surrounding agricultural land as well. There will be some major impacts due to land-filling: Pollution from overflow of filled earth (dredged materials); Erosion from the filled materials and side slope of filled lands.



Figure 9.1: Land Filling in the Project Area

Mitigation

The project developer is to take responsibility of minimizing environmental impact on the surroundings by following the project's environmental management plan (EMP). 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.

9.6.2 Flood Hazards

Impact

The Project site is subject to potential risk of local flood hazards during the rainy season. According to the local people, the highest flood level experienced was around 4.5-5 feet in 1998. The flood occurred recent year had a flood level of 3.5-4 feet. Such risks must be taken into consideration throughout the planning phase of the Project as they could inflict damage to the Project and its various components.

Mitigation

The project area is in a risk of flooding due to its topography, rainfall storm pattern, soil type, etc. and the area needs to be protected from potential floods. The project developer should undertake a flood risk study which will generally aim to determine flood quantities within the project area and to estimate peak flood to determine the peak flow for the return period of 50 years. 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.

9.7 Construction Phase

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

9.7.1 Impacts of Transmission Line

Impact:

The biggest impact of transmission line is loss of vegetation cover and destruction of habitat for wildlife. However, according to the baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present. As a result, construction activities are not anticipated to pose any risks on the terrestrial ecology within or in the vicinity of the project site. However, it may cause temporary disturbance to resident birds with ground nests due to noise, dust and particulate emissions, and possible illegal hunting by construction workers. Moreover, reptiles present within the project site may temporarily move to adjacent locations during construction activities, however are expected to return back as construction is completed.

Again, if the excavations for the lines are done through agricultural lands, the agricultural production will be hampered. And which in the long run will negatively affect the economy.

And lastly the excavations may cause harm to the utility lines like electric lines, telephone lines, and sewerage distribution lines.

Mitigation

- 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.
- Implement proper compensation if any agricultural land is harmed.

- Should plan the layout in such a way that no utility lines are hampered and minimum vegetation and agricultural lands are disturbed.

9.7.2 Visual Amenity

Impact

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

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. Also, 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

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

9.7.3 Water Resources

Impact

Surface water quality in the adjacent rivers, canals and ponds might insignificantly degrade during construction stage due to disposal of solid wastes, sewage effluent, and dredged materials, accidental spillage of petroleum products, cement, and noxious chemicals. The problem will be more dangerous if the construction work will continue even in the monsoon when the flood occurrence is very high. There will have no major impacts on ground water quality due to the construction of the proposed project.

Mitigation

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

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

9.7.4 Noise

Impact

Construction activities for the proposed project 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.

Mitigation

The following identifies the mitigation measures to be applied by the Contractor / Connectia Ltd. 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).

9.7.5 Air Quality

Impact

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

Mitigation

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

- 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.

9.7.6 Soil

Impact

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

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

Mitigation

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

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

9.7.7 Terrestrial Ecology

Impact

The activities anticipated during the construction phase will include earthworks, excavations, grading, site leveling, asphaltting, paving and the operation of construction machinery and equipment. However, according to the baseline description, the project area does not encompass natural systems, which means that no significant flora and fauna are present.

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

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

Mitigation

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

- 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.

9.7.8 Waste Generation

Impact

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

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

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

Mitigation

All waste generated at construction site will be managed as per Contractor's Waste Management procedures. Domestic wastewater generated at site will be collected in septic tanks. These shall be transported to the nearest approved municipal wastewater handling facility, and solid wastes shall be disposed of in a secured area for trash.

9.7.9 Employment Opportunities

Impact

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

Recommendation

Contractor as far as practicable will recruit construction workers from amongst the locals where possible, and shall maintain gender equity while employing the locals. 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/labour shed for local people to sell their products or to provide additional services to the workers.

9.7.10 Health and Safety

Impact

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

Mitigation

The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

9.7.11 Traffic

Impact

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

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

Mitigation

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

9.7.12 Archaeology and Cultural Resources

Impact

The field visits conducted at the project site and it is concluded that there is no anticipated impact from construction on these receptors; therefore, the impact assessment process for this receptor has yielded the low significance.

Mitigation

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

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

9.8 Operational Phase

Due to increased activities and efficient operational systems, there will be some impacts on the environmental set-up in the project area, which are discussed hereunder. In order to achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, in order to reap the full environmental benefits of the activities and ensure environmental enhancement it would be necessary to implement the following which are beyond the purview of this project.

9.8.1 Visual Amenity

Impact

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

Mitigation

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

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

9.8.2 Water Resources

Impact

The surface water bodies may get 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.

Groundwater may get 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

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.

9.8.3 Noise

Impact

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

In addition, noise generated from inverters is only heard when distance is close (i.e. within 1-2 m, however, as distance increases, noise will be greatly reduced, not to mention that they do not generate noise during night time. The most significant noise source of this solar power plant is from the backup diesel generator (150 kVA). To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants. Photovoltaic (PV) systems make no noise and cause no pollution in operation. Solar energy is clean, silent, and freely available.

Mitigation

These noise impacts are not considered to significantly harm animals nor cause impacts on a population level. However, the noise from diesel generator needs to take action for mitigation. The project proponent should establish the generator inside an insulated room to keep the environment free from sound pollution. Noise barrier should also be given around the generator room as a mitigation measure from noise pollution. 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.

9.8.4 Air Quality

Impact

No emissions are expected to be released during the operation phase, due to the fact that 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. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance.

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

Mitigation

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

Service and maintenance is very important as to have a battery system to run efficiently and with least possible replacement of batteries and related environmental impacts. Only purchase batteries from a source that can ensure that used batteries can be returned for environmental friendly recycling. Alternatively replaced batteries must be recycled locally.

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.

9.8.5 Soil

Impact

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

Mitigation

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

9.8.6 Terrestrial Ecology

Impact

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

Mitigation

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

9.8.7 Waste Generation

Impact

Lead-Acid Battery: One of the most important components of solar mini-grid power plant is Lead-acid battery. Improper disposal and recycling of lead acid storage batteries result in lead sulfate contamination in lands and water bodies. Through percolation, lead sulfate can contaminate groundwater and transfer up the food chain.

Waste generated during operation phase will be limited to wastewater from maintenance and cleaning activities in addition to domestic waste (due to workers domestic activities).

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.

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

The lead-acid battery which will be used in the project has a 7-years warranty. During entire life-time these will only need to be refilled with water sometimes. After the life period is ended each battery will be collected by the supplier-manufacturer and will be duly recycled. However, a proper temporary storage facility is needed for the wasted batteries to avoid potential lead contamination. A contract with third party for battery recycling has been signed.

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.

9.8.8 Employment Opportunities

Impact

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

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.

9.8.9 Health and Safety

Impact

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:

- Entering of lead (Pb) 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
- Electrocutation of workers
- Electromagnetic radiation from PV modules

Entering of lead into human body from lead-acid battery: 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. In addition, there is an impending threat for the workers due to the inhalation of lead fumes. Long exposure to lead pollution may result in the adverse impact to nervous system and causes headaches, dizziness, irritability, memory problems, and disturbance in sleep. It can affect the digestive system and cause nausea, vomiting, constipation, appetite loss, and abdominal pain. Lead also affects formation of blood and can result in anemia. Too much lead can also cause miscarriages and stillbirths when pregnant women are exposed to lead. In men, the sperm can be affected and this may result in infertility.

Acid hazard during battery handling: The potential risk of workers being damaged by acid who are handling lead-acid battery is apparent. Connectia Limited will not store any acid in the project site as the batteries will need only to be refilled with water sometimes. However, acid spilling during watering process or acid splash on to the workers body is not deniable.

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.

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.

Electrocution of Workers: Risk of electrocution of workers during performing duties in a power plant is always present. Faulty electrical equipment, electric short circuits, exposed electrical wires may be the chief sources of electrocution. Damaged PV modules with exposed high voltage conductor also present high risk of electrocution.

Electromagnetic radiation from PV modules: The strength of electromagnetic fields produced by photovoltaic systems do not approach levels considered harmful to human health established by the International Commission on Non-Ionizing Radiation Protection. Moreover, the small electromagnetic fields produced by photovoltaic systems rapidly diminish with distance and would be indistinguishable from normal background levels within several yards.

Mitigation

The project developer shall ensure all risks from operation activities to be assessed and to establish specific work procedures for tasks during operation phase including all safety prevention and mitigation measures to avoid non-conformance events.

The Contractor, under the supervision of developer, will be committed to ensure all health and safety measures are in place to prevent accidents and/or reduce the consequences of non-conformance events. The contractor shall ensure all prospect risks during construction phase are assessed and all prevention and mitigation measures are in place accordingly. The contractor shall ensure all workers during construction comply with safety producers through training, awareness and supervising. Moreover, the contractor shall provide all appropriate resources (Personnel Protective Equipment) onsite to ensure providing first aid for personnel in case of occurrence emergencies.

9.8.10 Traffic

Impact

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

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.

9.9 Decommissioning Phase

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

9.9.1 Visual Amenity**Impact**

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

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.

9.9.2 Noise**Impact**

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

Mitigation

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

9.9.3 Air Quality**Impact**

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

Mitigation

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

9.9.4 Soil

Impact

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

Mitigation

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

9.9.5 Terrestrial Ecology

Impact

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

Mitigation

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

9.9.6 Waste Generation

Impact

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

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

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

PV modules and others: PV modules wastes 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.

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

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

Mitigation

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

- Ensure that hazardous materials are stored in proper areas and in a location where they cannot reach the land in case of accidental spillage. This includes storage facilities that are of hard impermeable surface, flame-proof, accessible to authorized personnel only, locked when not in use, and prevents incompatible materials from coming in contact with one another.
- Maintain a register of all hazardous materials used and accompanying Material Safety Data Sheet (MSDS) must present at all times. Spilled material should be tracked and accounted for;
- If spillage on soil occurs, spill must be immediately contained, cleaned-up, and contaminated soil disposed as hazardous waste;
- Proper decommissioning and recycling of solar panels both ensures that potentially harmful materials are not released into the environment and reduces the need for virgin raw materials. In recognition of these facts, the photovoltaic industry is acting voluntarily to implement product take-back and recycling programs at the manufacturing level.

9.9.7 Employment Opportunities

Impact

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

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

Recommendation

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

9.9.8 Health and Safety

Impact

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

Mitigation

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

9.9.9 Traffic

Impact

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

Mitigation

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

9.10 Summary of Anticipated Impacts

Table 9.4, Table 9.5 and Table 9.6 below present a summary of the anticipated impacts during the planning and construction, operation, and decommissioning phase of the Project.

Table 9-4: Summary of Anticipated Impacts during the Planning and Construction Phase

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Land-filling/ Earthworks	Soil erosion from the fill material, changes in existing landscape.	Short term	Local	Reversible	Certain	Medium	Severe	Moderate Negative	Moderate Negative
Landscape and Visual	Visual and landscape impacts due to presence of elements typical of a construction site such as equipment and machinery.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Transmission Line	May hamper the vegetation and forest covers, existing agricultural land and utility lines.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Land use	Project could conflict with formal land use set at the planning level for the area. In addition, project could conflict with actual land use as it could provide value to locals.	No anticipated impact.							
Geology and Hydrology	The Project site is a <i>Char</i> land and surrounded by rivers and thus there is a potential risk of local flood hazard within the site during the rainy season and especially during flash flood events	Long term	Local	Irreversible	Likely	Medium	Severe	Moderate Negative	Moderate Negative
	Risk of soil and groundwater contamination during the various construction activities from improper housekeeping activities, spillage of hazardous	Could be long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	High Positive

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	material, random discharge of waste and wastewater.								
Biodiversity	Construction activities could disturb existing habitats (flora, fauna, and avifauna) and any threatened or endangered species which might be present within the Project site. In addition, other impacts could be from improper management of the site (e.g. improper conduct and housekeeping practices).	Long term	Local	Irreversible	Certain	Minor	Mild	Low Negative	High Positive
Air Quality	Construction activities will likely result in an increased level of dust and particulate matter emissions which in turn will directly impact ambient air quality.	Long term	Local	Reversible	Certain	Medium	Mild	Low Negative	High Positive
Noise	Possible noise emissions to the environment from the construction activities which will likely include the use of machinery and equipment such as generators, hammers, and compressors and other activities	Long term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative
Waste Generation	Improper management and handling of hazardous and non-hazardous waste during construction.	Short term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative

Environmental Attribute	Likely Impact– Planning and Construction Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Socioeconomic	The Project is expected at a minimum to provide job opportunities for local communities. This, to some extent, could contribute to enhancing the living environment for its inhabitants, elevate their standards of living, and bring social and economic prosperity to local communities.	Not applicable.							
Health and Safety	There will be some generic risks to workers health and safety from working on construction sites, as it increases the risk of injury or death due to accidents.	Short term	Local	Could be irreversible	Likely	Medium	Mild	Moderate Negative	Low Negative

Table 9-5: Summary of Anticipated Impacts during the Operation Phase

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Landscape and Visual	The Project is expected to be visible within the immediate vicinity and up to some long distance around the Project site only and thus is likely to create visual impacts related to interaction with surrounding landscape.	Long term	Local	Reversible	Likely	Medium	Low	Low Negative	Low Negative
	Potential for glare caused by minimal sunlight reflected off the PV panel modules which in turn could affect nearby receptors.	Long term	Local	Reversible	Likely	Medium	Mild	Low Negative	Low Negative
PV panels, Battery	The most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance.	Long term	Local	Reversible	Likely	High	Severe	High Negative	Moderate Negative
Backup Generator	The most significant noise source of this solar power plant is from	Long term	Local	Reversible	Certain	Medium	Mild	Moderate Negative	Low Negative

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	the backup diesel generator (150 kVA). To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants.								
Geology and Hydrology	Risk of soil and groundwater contamination during the various operational activities from improper housekeeping activities, spillage of hazardous material, random discharge of waste and wastewater. However, 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
Biodiversity	Impacts limited to improper management of the site (e.g. improper conduct and housekeeping practices).	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	Moderate Positive
Air Quality	Solar power plants have very low air emissions of air pollutants such as sulfur dioxide, nitrogen oxides, carbon monoxide, volatile organic compounds, and the	Long term	Local	Could be irreversible	Likely	Minor	Low	Low Negative	High Positive

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	greenhouse gas carbon dioxide during operations.								
Noise	The only significant noise source from the operation activities which will likely include the use of backup generators to ensure continuous power supply.	Long term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Socio-economic	The Project is expected at a minimum to provide job opportunities for local communities. This, to some extent, could contribute to enhancing the living environment for its inhabitants, elevate their standards of living, and bring social and economic prosperity to local communities.	Not applicable.							
Occupational and Community Health and 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
	Trespassing of unauthorized personnel into the Project site could result in potential risks from several hazards of the various Project components (e.g. electric shock, thermal burn hazards, exposure to chemicals and hazardous materials, etc.).	Long term	Local	Could be irreversible	Likely	Medium	Mild	Low Negative	Moderate Positive

Environmental Attribute	Likely Impact– Operation Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	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.								

Table 9-6: Summary of Anticipated Impacts during the Decommissioning Phase

Environmental Attribute	Likely Impact– Decommissioning Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
Geology and Hydrology	Risk of soil and groundwater contamination during the various decommissioning activities from improper housekeeping activities, spillage of hazardous material, random discharge of waste and wastewater.	Short term	Local	Could be irreversible	Likely	Medium	Low	Moderate Negative	Low Positive
Air Quality	Decommissioning activities will likely result in an increased level of dust and particulate matter emissions which in turn will directly impact ambient air quality.	Short term	Local	Reversible	Certain	Medium	Low	Moderate Negative	Low Negative
Noise	Possible noise emissions to the environment from the decommissioning activities which will likely include the use of machinery and equipment such as generators, hammers, and compressors and other activities.	Short term	Local	Reversible	Likely	Medium	Mild	Moderate Negative	Low Negative
Infrastructure and utilities	Of particular importance related to infrastructure and utilities is the final disposal of the panels at the end of their lifetime. Final disposal of panels, which may contain hazardous material, needs to ensure that existing waste facilities would be able accept such solar modules. In addition, it is also important to investigate	Long term	Local	Reversible	Likely	High	Severe	High Negative	Low Negative

Environmental Attribute	Likely Impact– Decommissioning Phase	Impact Assessment							
		Duration	Spatial Extent	Reversibility	Likelihood	Magnitude	Sensitivity	Significance Prior to Mitigation	Significance After Mitigation
	other disposal options such as buy back and recycling programs.								
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

10 ENVIRONMENTAL MANAGEMENT PLAN

10.1 General

The project developer is committed to achieving and maintaining environmental standards, such that Bangladesh environmental regulations are met, and potential adverse environmental impacts resulting from the project activities are minimized as practicably as possible. This will be achieved through appropriate project planning and methods of Project operation.

Implementation of on-going environmental monitoring programs will enable the assessment and modification, if required, of the Environmental Management program.

10.2 Objectives

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

The key objectives of the EMP are summarized below:

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

Overall, this EMP 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.

10.3 Environmental Management Plan (EMP)

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

Table 10-1: Environmental Management Plan (EMP)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
Pre-construction Phase						
Land Use / Land-filling	The proposed plant will degrade surrounding agricultural land.	Fence the proposed area so that the surrounding agricultural land will not be disturbed. Land-filling for side slope of filled lands should be done only within the boundary line of the project to avoid damage to adjacent agricultural land, crops, trees or any other properties. In case of damage by any construction activity, adequate compensation should be paid to the owner in time	Quantity of land use	Consideration of minimum use of agricultural land.	Project developer	▪ National Land use Policy, 2001 ▪ National Environmental Policy, 1992 ▪ National Environmental Management Action Plan, 1995 ▪ Industrial Policy, 1986 ▪ Private Sector Power Generation Policy of Bangladesh, 1996 ▪ Policy Guideline for small Power Plants in Private Sector, 1997
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						
Transmission Line	Impact on vegetation, agricultural lands and utility lines	▪ Minimum vegetation covers and agricultural lands should be used. ▪ Planning in such a way that no utility line is hampered.	Weekly	Consideration of minimum forest covers and agricultural land use and consideration of not overlapping the utility lines.	Contractor	▪ 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

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
						Policy Guideline for small Power Plants in Private Sector, 1997
Earthworks	Soil erosion from the fill material, changes in existing landscape.	- The contractor shall ensure that the fill material is collected from only the approved sources and not from any illegal dredging site. - Construct the retention wall properly so that erosion will not happen. - Make sure that the filling material is not collected from the agricultural land.	Weekly	The fill material is collected from the approved sources.	Contractor	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997
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
Air Quality	- Dust generation due to construction activities. - Exhaust Emissions due to operation of construction plant and machinery.	- Setting an appropriate site speed limit to reduce dust generation from vehicles travelling over unmade surfaces. - During construction dust generated on unpaved roadways and work areas should be controlled by the application of water on an "as needs" basis. - Unnecessary handling of dusty materials will be avoided such as minimizing drop heights when loaders dump soils into trucks. - Train workers to handle construction materials and debris during construction to reduce fugitive emissions. - Ensure adequate maintenance and inspection of vehicles to minimize exhaust emissions. Not running engines for longer than is necessary.	Daily	- No visible dust plumes originating From construction sites. - Regular machineries maintenance records.	Contractor	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000 - Bangladesh Climate Change Strategy and Action Plan (2008)

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
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)
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)
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.	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
		- 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				
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	The contractor to ensure that all trucks and vehicles accessing the facility are operated by licensed operators.	Continuously	No complains or concerns from traditional users of the area's roads	Contractor	

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	and from the site through the surrounding road network	▪ 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.		routes are received during the construction activities. ▪ No incidents or accidents (collisions) are recorded		
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. ▪ 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. ▪ 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; ▪ 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.	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
		- 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 - 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. - First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site. - Emergency evacuation response shall be prepared by the contractor and relevant staff shall be trained through mock-up drills. - Ensure all equipment is suitable for jobs (safety, size, power, efficiency, ergonomics, cost, user acceptability etc.), provide the lowest vibration tools that are suitable and can do the works. - 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.				
Operation Phase						

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
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
PV panels, Battery	The most significant source of soil pollution is the damage of battery and PV panels in case of major accidents. These contain chemicals and may be harmful for soil quality. There will be environmental impacts of emission of greenhouse gas, Ozone depletion, photochemical smog, eutrophication and acidification and also health effects on people due to battery maintenance. Besides the lead-acid battery and wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic	Service and maintenance is very important as to have a battery system to run efficiently and with least possible replacement of batteries and related environmental impacts. Only purchase batteries from a source that can ensure that used batteries can be returned for environmental friendly recycling. Alternatively replaced batteries must be recycled locally. 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. The project proponent should check these devices regularly and have to replace the damaged and expired or bad devices. However, if possible, the damaged and expired devices should be maintained properly and recycled.	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	▪ Environmental Pollution Control Ordinance, 1977 ▪ Environmental Conservation Rules (ECR), 1997 ▪ Environment Court Act, 2000

Aspect	Key Potential Impact	Mitigation Measures	Frequency	Performance Indicator	Responsibility	Legal Requirements
	wastes and stationary wastes of office works etc.					
Backup Generator	The most significant noise source of this solar power plant is from the backup diesel generator. To ensure smooth electric supply the project proponent will run diesel generator in case of any disharmony. The diesel generator will create discomfort sound level around the project area which may affect to the surrounding inhabitants.	However, the noise from diesel generator needs to take action for mitigation. The project proponent should establish the generator inside an insulated room to keep the environment free from sound pollution. Additionally, the generator should be upwardly enclosed with the noise reduction canopy. Noise barrier should also be given around the generator room as a mitigation measure from noise pollution. 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.	Continuously	Compliance with DoE Regular machineries maintenance records.	Project Developer	- Environmental Pollution Control Ordinance, 1977 - Environmental Conservation Rules (ECR), 1997 - Environment Court Act, 2000
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)
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.	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
		The worker inside the project area should use earmuffs during the operation of diesel generator.				
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	- Expired lead-acid battery and potential threat to environment. - Solid wastes from PV modules which contains toxic metals. - Besides the lead-acid battery and wasted PV modules few other solid wastes generated during the operational stage. These include end-of-life solar PV modules, electrical wastes, metallic wastes and stationary wastes of office works etc.	- 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
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
Health and Safety	- Entering of lead into human body from lead-acid battery - Acid hazard during battery handling - 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 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.	- 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	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
	- 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.	expertise, emergency response and evacuation procedure, in addition to training for personnel's. - Adequate first aiders shall be on site in accordance with Bangladesh Labour Law requirements. - First aid kit with adhesive bandages, antibiotic ointment, antiseptic wipes, aspirin, non-latex gloves, scissors, thermometer, etc. shall be made available by the contractor on site.				
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, EIA 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 8, no impacts with high significance are anticipated to take place during decommissioning of the project since all facilities will be removed, solar power plant decommissioned, and PV panels will be dismantled and sent for recycling or disposal. - The main mitigation and monitoring measures to minimize or reduce the environmental and social impacts during decommissioning are anticipated to be similar to those identified for the construction phase. - Therefore, to avoid repetition, please refer to Table 9.1 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.						

10.4 Environmental Monitoring Plan

10.4.1 General

Environmental monitoring is an essential tool for environmental management as it provides the basic information for rational management decisions. The purpose of the monitoring program is to ensure that the envisaged purposes of the project are achieved and result in desired benefits to the target population. To ensure the effective implementation of the mitigation measures, it is essential that an effective monitoring program be designed and carried out. Compliance monitoring will be conducted in accordance with the environmental mitigation measures and monitoring plan provided with this report (**Table 10.2**).

10.4.2 Objectives

The objective of environmental monitoring during the construction and operation phases is to compare the monitored data against the baseline condition collected during the study period to assess the effectiveness of the mitigation measures and the protection of the ambient environment based on national standards. The main objectives of the pre-construction, construction and operation phase monitoring plans will be to:

- Monitor the actual impact of the works on physical, biological and socioeconomic receptors within the project area for indicating the adequacy of the EIA;
- Recommend mitigation measures for any unexpected impact or where the impact level exceeds that anticipated in the EIA;
- 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 EIA 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 EMP and recommend improvements, if and when necessary;

Table 10-2: Environmental Monitoring Plan

Environmental Components	Parameters/ Units	Standards/ Guidelines	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	Once	Contractor	Connectia
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	Connectia
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Surface water quality standard by DoE	Once	Contractor	Connectia
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Groundwater quality standard by DoE	Once	Contractor	Connectia
Construction Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DoE	Once	Contractor	Connectia
Dust	Dust control	Air quality standard by DoE	Once	Contractor	Connectia
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	Connectia
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF	Once	Contractor	Connectia
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF	Once	Contractor	Connectia
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	Connectia
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	Connectia
Health and	▪ Check quality of food and accommodation at	Monitoring	Regularly	Contractor	Connectia

Environmental Components	Parameters/ Units	Standards/ Guidelines	Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Safety	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 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	1/year (5 year)	Connectia	DOE/IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	1/year (5 year)	Connectia	DOE/IDCOL
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by DOE	1/year (5 year)	Connectia	DOE/IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by DOE	1/year (5 year)	Connectia	DOE/IDCOL
Accident and Public Safety	Record of accidents, different level of disabilities/fatalities.	None Specific	-----	Connectia	DOE/IDCOL
PV panels, and Battery	Chemicals		1/year (5 year)	Connectia	DOE/IDCOL
Soil Quality	Heavy metals		1/year (5 year)	Connectia	DOE/IDCOL
Decommissioning Stage					
Air Quality	SO ₂ , NO _x , CO, SPM, PM _{2.5} , PM ₁₀	Air quality standard by DOE, Bangladesh	Once	Contractor	Connectia /IDCOL
Dust	Dust control	Air quality standard by DOE	Once	Contractor	Connectia /IDCOL
Noise Level	dB(A)	Noise Pollution Control Rules (2006)	Once	Contractor	Connectia /IDCOL

Environmental Components	Parameters/ Units	Standards/ Guidelines	Period/ Frequency/ Sampling, No/year	Responsibility	
				Implementation	Supervision
Water Quality	Surface water: pH, TDS, DO, COD, BOD ₅	Water quality standard by MoEF	Once	Contractor	Connectia /IDCOL
	Groundwater: pH, Alkalinity, Fe, Cl ⁻ , TDS, As	Water quality standard by MoEF	Once	Contractor	Connectia /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	Connectia /IDCOL
Waste	- Check storage, transportation, disposal, handling of hazardous waste - Careful and proper handling of PV panels and batteries - Waste and effluents to be collected and disposed safely from camp. - Wastes and garbage from worker sites to be disposed safely	Monitoring	Weekly	Contractor	Connectia /IDCOL
Health and Safety	- Check safe water supply, hygienic toilet at camps, construction of drain at camp sites; - 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	Connectia /IDCOL

10.5 Environmental Budget

The estimated budget for implementation of the mitigation and monitoring measures proposed in the EMP is presented in **Table 10.3**. The overall costs of the EMP will comprise:

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

The total budget is estimated as BDT 600,600. 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 10-3: Environmental Budget for Solar Mini-grid Power Plant Project

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
PRE-CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	30,000	30,000
Noise	Measuring ambient noise level	No.	3	7,000	21,000
Water Quality	Surface water quality measurement	No.	1	8,000	8,000
	Groundwater quality measurement	No.	1	9,000	9,000
SUB TOTAL (PRE-CONSTRUCTION STAGE)					68,000
CONSTRUCTION STAGE					
Air Quality	Measuring air quality	No.	1	30,000	30,000
Noise	Measuring ambient noise level	No.	3	7,000	21,000
Water Quality	Surface water quality measurement	No.	1	8,000	8,000
	Groundwater quality measurement	No.	1	9,000	9,000
Soil	Maintenance cost in soil conservation	Lump sum			40,000
Dust Management	Water sprayer / watering	Covered in Engineering Cost			
Waste disposal and management	Disposal and management of construction waste and solar panels of individual households	Lump sum			50,000
Construction Safety	General Safety (provision of PPE like ear muffs, gloves etc.)	Lump sum			10,000
Health	Health check-up camps for construction workers	Camp	-	10,000	10,000
SUB TOTAL (CONSTRUCTION STAGE)					178,000
OPERATION STAGE					
Air Quality	Monitoring air quality	No.	5 (1/2 year)	30,000	150,000
Noise	Monitoring ambient noise level	No.	5 (1/2 year)	7,000	35,000
Water	Monitoring surface water quality	No.	5 (1/2 year)	8,000	40,000
	Monitoring ground water quality and levels	No.	5 (1/2 year)	9,000	45,000
SUB TOTAL (OPERATION STAGE)					270,000

Component	Item	Unit	Quantity	Rate (in BDT)	Amount (BDT)
ESTABLISHMENT and TRAINING					
Training	Environmental training and awareness	Lump sum	As per training details	20,000	20,000
Management Information System		Lump sum	-	10,000	10,000
SUB TOTAL (ESTABLISHMENT and TRAINING)					30,000
SUB TOTAL (Pre-construction, Construction, Operation, establishment and training)					546,000
CONTINGENCIES @ 10 % on total Environmental Costs					54,600
GRAND TOTAL (in BDT)					600,600

11 ENVIRONMENTAL AND SOCIAL BENEFIT

11.1 Introduction

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

Solar mini-grids are an ideal alternative to grid electricity in remote villages that do not have grid connectivity. And because mini-grids are independent entities, they can also be controlled and managed without presenting threats to the conventional grid. Such distributed energy systems also provide more reliable electricity, as any outages or interruptions to electricity supply can be quickly identified and corrected. One of our most effective power generation solutions is the Mini-Grid. It is a very reliable, independent, cost effective solution with low operation and maintenance costs.

It is also a centralized solution, which means it acts like a small power plant, utilizing a local electricity distribution network and saving the hassle of installing and maintaining hundreds of small consumer systems. This makes it a very efficient and convenient solution for municipalities, governments, NGOs and investors who want to transform the lives of people in remote communities.

It is a particularly beneficial solution for areas lacking access to national grid electricity or where chances of connecting to the grid are low. Indeed, a hybrid Mini-Grid power system functioning as an autonomous entity can provide almost the same quality and services as the national grid. The solution is for 24 hours a day, 365 days a year, using battery storage to provide service at night and on rainy days.

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

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

11.2 Energy and Climate Concern

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

In addition, the burning of fossil fuels results in carbon dioxide emissions; a primary greenhouse gas emitted through human activities, which contributes to global warming. The main human activity that emits CO₂ is the combustion of fossil fuels for electricity production and transportation. Concurrently, global climate change has become an issue of concern and

so reducing greenhouse gas emissions have also emerged as primary issues to be addressed as the world searches for a sustainable energy future.

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

11.3 Energy and Livelihood Concern

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 found various productive uses for it.

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.

11.4 Energy and Economy Concern

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

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

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

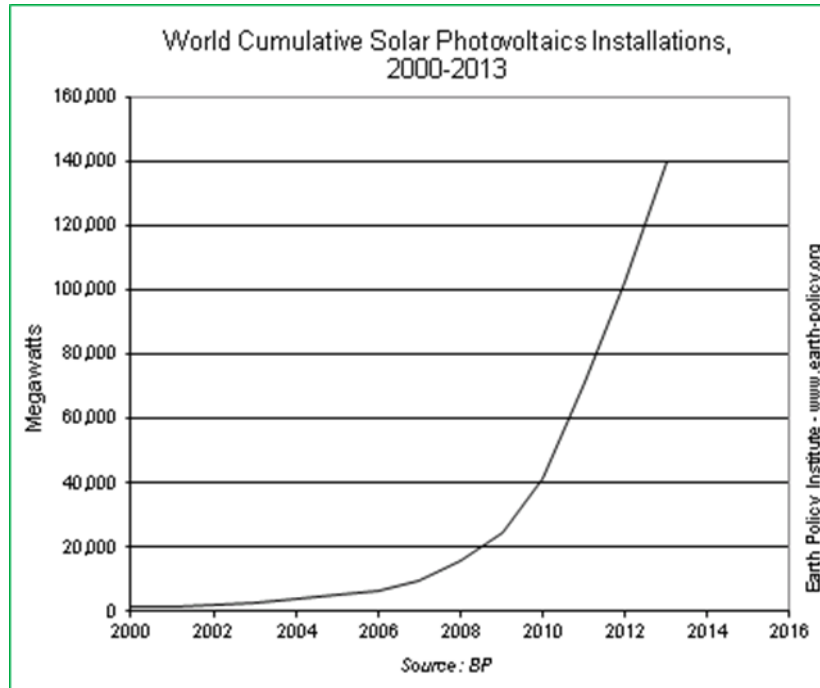


Figure 11.1: Trends of World Solar Energy Growth

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

12 CONCLUSION

12.1 Conclusion

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

Primarily the national economy will be benefitted by the project. Benefits in the project area will be in significant except for some short terms employment and business opportunities during the construction phase. However, the needs of the solar photovoltaic power plant are obvious and for that, the livelihood of the area will be developed. Developed livelihood will directly influence the growth of economy of the area.

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

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

12.2 Recommendations

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

The EMP, 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 EMP through his own Site Specific Environmental Management Plan which will adopt all of the conditions of the EMP. This ensures that all potential bidders are aware of the environmental requirements of the project and its associated environmental costs.

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

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APPENDIXES

Appendix A: Air Quality Test Result



DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	218.6 kW Solar Mini Grid Project, Charsajai, Char Rajibpur, Kurigram
Sampling Location	Charsajai, Char Rajibpur, Kurigram.
GPS Coordination	25.49664°N; 89.77097°E
Description of sample	Ambient Air Quality
Sample Collector	Collected by DSCL Personnel
Sample ID	AAQ_01
Sampling Date	21 February 2018

Test Result of Ambient Air Quality Analysis

Parameter	Unit	Concentration at Project Site	Bangladesh Standard**	IFC/World Bank Standard	Duration (hours)	Weather Condition	Method of Analysis
PM ₁₀	µg/m ³	30.42	150	150	24	Sunny	Gravimetric
PM _{2.5}	µg/m ³	17.58	65	75	24		Gravimetric
SPM	µg/m ³	49.55	200	160	24		Gravimetric
SO ₂	µg/m ³	9.73	365	125	24		West- Geake
NO _x	µg/m ³	5.22	100	-	Annual		Jacob and Hochheiser
CO*	ppm	1	9	10 (WHO)	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 19th July 2005 vide S.R.O. No. 220-Law/2005.

Test Performed By:

Tonmoy Pandit

Jr. Environmental Specialist



Checked By:

Tanzia Sharmin

Deputy Manager

(Water & Environment)

Development Solutions Consultant Ltd.

House# 734 (5-B), Road# 10, Avenue# 04

DOHS Mirpur, Dhaka-1216, Bangladesh. Tel: +8804478035444

Email: dsc@dsclbd.com Web: www.dsclbd.com

Appendix B: Noise Level Test Result



DSCL

Multidisciplinary Development Consultants

DSCL Environmental Laboratory

Name of the Project	218.6 kW Solar Mini Grid Project, Charsajai, Char Rajibpur, Kurigram
Sampling Location	Project Site, Charsajai Masterpara, Kodalkathi Bazar, Kodalkathi Union Parishad Complex, Charsajai Sarkerpara.
Description of sample	Noise Level
Sample Collector	Collected by DSCL Personnel
Sampling Date	21 February, 2018

Noise Level Analysis

Location	GPS Location	Land Use Category	Time	Noise Level (dBA)
				(LAeq)
Project Site (Charsajai, Char Rajibpur, Kurigram)	25.49675°N 89.77075°E	Residential	10:04 am	51.57
Charsajai Masterpara	25.49778°N 89.77380°E	Residential	11:29 am	52.29
Kodalkathi Bazar, Kodalkathi, Kurigram	25.48731°N 89.76234°E	Commercial	14:00 pm	58.67
Kodalkathi Union Parishad Complex	25.48621°N 89.76436°E	Commercial	14:45 pm	62.32
Charsajai Sarkerpara, Kodalkathi	25.48900°N 89.76595°E	Residential	15:31 pm	54.17

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, for silent area 55 dBA and for commercial area 65 dBA at day time
- Noise Level is the average noise recorded over the duration of the monitoring period

Abbreviation:

NM- Noise Measurement, dB- decibel

Test Performed By:**Tonmoy Pandit**

Jr. Environmental Specialist


Checked By:**Tanzia Sharmin**

Deputy Manager

(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 C: Surface Water Test Result

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
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Lab Memo: 549/ CC, DPHE, CL, Dhaka. Date: 12-03-2018

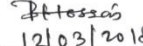
Physical /Chemical/ Bacteriological Analysis of Water Sample

Sample ID: CEN2018030044	Sample Receiving date: 25-02-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 25-02-2018	Sample Source: Surface Water
Sent by: Tonmoy Pandit, Jr. Environmental Specialist, DSCL, Dhaka-1216.	Dist: Kurigram, Upa: Char Rajibpur
Care Taker: DSCL (Sample : SW_KG)	Union:, Vill.: Charsajai
Sample Collection date:	Date of Testing: 25/02/2018-08/03/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Biochemical Oxygen Demand (BOD)	0.2	8	mg/L	5 days Incubation	-
2	Chemical Oxygen Demand (COD)	4.0	24	mg/L	CRM	-
3	Dissolved Oxygen (DO)	6.0	4.16	mg/L	Multimeter	-

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

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  12-03-18 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  12-03-18 নতুন বিশেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Chief Chemist Signature:  12/03/2018 মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা। 2.) Name: Designation:
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Appendix D: Groundwater Test Result

	Government of the People's Republic of Bangladesh Office of the Chief Chemist Department of Public Health Engineering Central Lab, 38-39, Mohakhali C/A, Dhaka-1212 Phone: 88-02-9881927, Fax: 88-02-9882003, Email: wqmsc_central_lab@yahoo.com	
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Lab Memo: 549/ CC, DPHE, CL, Dhaka.

Date: 12-03-2018

Physical /Chemical/ Bacteriological Analysis of Water Sample

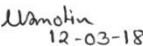
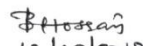
Sample ID: CEN2018030045	Sample Receiving date: 25-02-2018
Ref. Memo No: DSCL/2018/Nill & Dated: 25-02-2018	Sample Source: Ground Water
Sent by: Tonmoy Pandit, Jr. Environmental Specialist, DSCL, Dhaka-1216.	Dist: Kurigram, Upa: Char Rajibpur
Care Taker: DSCL (Sample : GW_KG)	Union:, Vill.: Charsajai
Sample Collection date:	Date of Testing: 25/02/2018-08/03/2018

LABORATORY TEST RESULTS:

Sl.#	Water quality parameters	Bangladesh Standard	Concentration present	Unit	Analysis Method	LOQ
1	Alkalinity	-	125	mg/L	Titrimetric	-
2	Arsenic (As)	0.05	0.003	mg/L	AAS	0.001
3	Chloride	150-600	46	mg/L	Titrimetric	-
4	Iron (Fe)	0.3-1	0.34	mg/L	AAS	0.05

Comments: Sample was collected & Supplied by client.

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

Test Performed by: 1.) Name: Mahabuba Sabina Motin Designation: Sample Analyzer Signature:  12-03-18 2.) Name: Md. Saiful Alam Khosru Designation: Sample Analyzer Signature:  12.03.18 নমুনা বিশ্লেষক জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা	Countersigned/Approved by: 1.) Name: Md. Biplab Hossain Designation: Chief Chemist Signature:  12/03/2018 2.) Name: Designation: মোঃ বিপ্লব হোসেন চীফ কেমিস্ট জনস্বাস্থ্য প্রকৌশল অধিদপ্তর কেন্দ্রীয় পরীক্ষাগার মহাখালী, ঢাকা
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Appendix E: Important Sensitive Locations in the Project Influenced Area

Name	Location		Description	Photo
	N	E		
Charsajai Govt. Primary High School	25.49649°	89.77237°	One and Two storied Building is used for academic activities of Charsajai Govt. Primary High School.	
Charsajai Masterpara Jame Mosque	25.49702°	89.77390°	One Storied tin shed building Mosque	
Charsajai Dakhil Madrasha	25.49470°	89.77652°	One storied tin shed building is used for academic activities of Charsajai Dakhil Madrasha	

Name	Location		Description	Photo
	N	E		
Maddha Charsajai Jame Mosque	25.49827°	89.77864°	One storied tin shed Mosque	
Kodalkathi Bazar	25.48729°	89.76237°	Central Bazar of Charsajai Village Peoples.	
Sadakathosen High School, Kodalkathi	24.17820°	90.43740°	One storied two shed building is used for academic activities of Sadakathosen High School, Kodalkathi.	

Name	Location		Description	Photo
	N	E		
Najimudoullah Kodalkathi Govt. Primary School	25.48760°	89.76461°	One storied building is used for academic activities of Najimudoullah Kodalkathi Govt. Primary School	
Saheed Minar in front of Kodalkathi Union Parishad	25.48638°	89.76449°	Saheed minar in Union Parishad, Kodalkathi	
Kodalkathi Union Parishad	25.48615°	89.76446°	Kodalkathi Union Parishad. It can be also called as Village Court.	

Name	Location		Description	Photo
	N	E		
Kodalkathi Autisom School	25.48634°	89.76440°	A tin shed building is used for academic activities of Kodalkathi Autisom School.	
Union Parishad Agricultural Office, Kodalkathi	25.487632°	89.76431°	Agricultural Office, Kodalkathi Union Parishad.	
Kodalkathi Di-mukhi Girls High School	25.48181°	89.76400°	One storied two building is used for academic activities of Kodalkathi Di-mukhi Girls High School	

Name	Location		Description	Photo
	N	E		
Khajurvanj Akasia Nurany and Hafizia Madrasha, Kodalkathi	25.48601°	89.76223°	Two-three tin shed house is used for academic activities of Khajurvanj Akasia Nurany and Hafizia Madrasha, Kodalkathi	
Kodalkathi Bazar Jame Mosque	25.48635°	089.76275°	One storied tin shed building Mosque.	

Appendix F: Details of FGDs with Attendance List

CONSULTATION NO- 1

SITE: CHARSAJAI GOVT. PRIMARY SCHOOL UNION: KODALKATHI, UPAZILA: CHAR RAJIBPUR, DIST: KURIGRAM.

GPS Coordination: 25.49650 °N, 89.77199 °E

DATE: 21st February 2018.

TIME: 01:00 PM TO 01:30 PM.

Outcome of the Consultation

A consultation meeting was held during 1:00 pm to 1:30 pm on 21st February 2018 at Charsajai Govt. Primary School beside the proposed project site. All the participants were local people from several professions. Total 15 (fifteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

During the consultation the participants appreciated the new project explaining their desires and expectations. The project will increase and improve the quality of their life. No major impact will take place due to the implementation of this project. Most of the people argued that they are willing to endure the negative impact to some extent for the sake of this project which they believe will improve their livelihood.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of hazardous or chemical waste materials to the surroundings.
- Air pollution from the constructional materials and machineries will create minor problem. Contractor should spray water during material transportation and use cover for air pollution sources if possible.
- Waste management because of the project implementation should be monitored and the proponent has to take responsibility of this management.
- More local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

Solar Mini Grid Project, Kurigram

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 01 Date 21.09.18 Time 1.00

Location: Charsajai, Char Rajibpur, Roumari, Kurigram

GPS Location: 25° 49' 50" N 90° 52' 10" E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	শ্রীমতী সন্ধ্যা দেবী		ঘরোয়া		
2	শ্রীমতী সন্ধ্যা দেবী		ঘরোয়া	01716096112	
3	শ্রীমতী সন্ধ্যা দেবী		ঘরোয়া	01724263454	
4	শ্রীমতী সন্ধ্যা দেবী		ঘরোয়া	01718-582719	
5	শ্রীমতী সন্ধ্যা দেবী	৬৬	ঘরোয়া	01959093994	
6	শ্রীমতী সন্ধ্যা দেবী	২৬	ঘরোয়া	0192642317	
7	শ্রীমতী সন্ধ্যা দেবী	২৮	ঘরোয়া	01903631369	
8	শ্রীমতী সন্ধ্যা দেবী	২০	ঘরোয়া	01710761326	
9	শ্রীমতী সন্ধ্যা দেবী	৪৬	ঘরোয়া	01710191964	
10	শ্রীমতী সন্ধ্যা দেবী	০২	ঘরোয়া	01916035984	
11	শ্রীমতী সন্ধ্যা দেবী	২৬	ঘরোয়া	017187782	
12	শ্রীমতী সন্ধ্যা দেবী	২২	ঘরোয়া	0182462022	
13	শ্রীমতী সন্ধ্যা দেবী	২৪	ঘরোয়া	0178210577	
14	শ্রীমতী সন্ধ্যা দেবী	৩০	ঘরোয়া	01736175068	
15	শ্রীমতী সন্ধ্যা দেবী	৪০	ঘরোয়া	01913323034	

FGDs Completed By Toomay Roudit

Signature [Signature]

CONSULTATION NO- 2

**SITE: KODALKATHU BAZAR, UNION: KODALKATHI, UPAZILA: CHAR RAJIBPUR ,
DIST: KURIGRAM**

GPS Coordination: 25.48729 °N, 89.76232 °E

DATE: 21st February 2018

TIME: 02:30 PM TO 03:00 PM.

Outcome of the Consultation

A consultation meeting was held during 02:30 pm to 03:00 pm on 6th February 2017 at Kodalkathi Bazar, not so far from the project site. The consultation meeting was conducted with the teachers and academic members of the school. Total 15 (fifteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how indiscriminate use of natural resources causes social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect improved technology and good management practice to minimize the problem.

Additionally, they highlighted the digitalization of education system. To cope with the country's education system and digital Bangladesh, electricity will play a vital role to develop and increase this Char's literacy rate. Computer lab can be set up for providing better education.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might and proper management plan would help to mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of waste materials to the surroundings.
- Air pollution from the construction materials and emission from machineries might create minor problem but this is acceptable for their better future.
- The capacity of this project should be extended to add more business and agricultural entities into the grid connection.
- The existing solar panel of every individual household should be collected sometimes with little payments from the owner for proper disposal or management by the project proponent or any responsible authority.
- Monthly charge of using electricity from the solar mini grid should be local people's affordable rate.
- More local employment need to be created in the future project construction and operation phases which can be a good option for livelihood development.

Solar Mini Grid Project, Kurigram

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 02 Date 20.2.2018 Time 2.25

Location: Kathakathi Bazar, Char Rajibpur, Kurigram

GPS Location: 25.48 729°N 089.86232°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	মোঃ মাহমুদুল কামাল	৪৪	কৃষক	০১৭৭৩২৬৭৭৭	
2	মোঃ মাহমুদুল আলী	৬৬	স্ব.স.স. মিস্ট্র	০১৮৩৭১৬৬৭৭	
3	মোঃ মোঃ হাফিজ	৪৭	স্ব.স.স. মিস্ট্র	০১৭৭৭৫২২৭৭	
4	মোঃ আব্দুল হকিম	৬০	কাজশাখা	০১৭১৭৫২২৭৭	
5	মোঃ নাসির	২৩	কৃষক	০১৭৭৭৬৭৭৭৭	
6	মোঃ মাহমুদুল	৬০	কৃষক	০১৮৬৭৭৭৭৭৭	
7	মোঃ মাহমুদুল আলী	৬৬	কৃষক	০১৭৭৭৭৭৭৭৭	
8	মোঃ মাহমুদুল	৬৬	কৃষক	০১৭৭৭৭৭৭৭৭	
9	মোঃ মাহমুদুল	৬৬	কাজশাখা	০১৭৭৭৭৭৭৭৭	
10	Md. Rangul Miah	২৭	Teacher	০১৭৭৭৭৭৭৭৭	
11	মোঃ মাহমুদুল আলী	৬৬	কাজশাখা	০১৭৭৭৭৭৭৭৭	
12	মোঃ মাহমুদুল	৪৭	কাজশাখা	০১৭৭৭৭৭৭৭৭	
13	মোঃ মাহমুদুল	৬৬	কাজশাখা	০১৭৭৭৭৭৭৭৭	
14	মোঃ মাহমুদুল	৪৬	কাজশাখা	০১৭৭৭৭৭৭৭৭	
15	মোঃ মাহমুদুল	৪৬	কাজশাখা	০১৭৭৭৭৭৭৭৭	

FGDs Completed By-----

Signature-----

CONSULTATION NO- 3

SITE: KODALKATHI UNION PARISHAD, UNION: KODALKATHI, UPAZILA: CHAR RAJIBPUR, DIST: KURIGRAM.

GPS Coordination: 25.48608°N, 89.76443°E

DATE: 21st February 2018

TIME: 04:00 PM TO 04:30 PM.

Outcome of the Consultation

A consultation meeting was held during 04:00 pm to 04:30 pm on 21st February 2018 at Kodalkathi Union Parishad, within 1 km radius from the project site. The consultation meeting was conducted with the local people from different occupations. Total 16 (sixteen) people participated in the meeting. In consultation meeting; environmental and social issues were examined. The main focus was to dig out information on how does indiscriminate use of natural resources cause social and environmental degradation or benefit by implementing the proposed project with using several natural resources. The issue on potential impact of construction works has also been raised.

Most of participants appreciated because of the benefit from the proposed project. They also discussed about noise, water and soil pollution issue that are evolving because of existing the future possibilities. They expect improved technology and good management practice to minimize the problem.

Additionally, some of the participants emphasized twenty four hours electricity service on business improvement, irrigation through water pump, ice factory for fish market, rice mills and mobile network tower for better tele-communication. Most of the households in this area are using solar panel individually for electricity generation. After going to the grid of new solar power plant their present solar panel would be a concern. As they do not know much about it so it is not possible for us to treat the waste properly. Some of us would be able to sell this to other households but the project proponent could take necessary actions on it particularly for the old panels. Monthly charge of using electricity from the solar mini grid should be local people's affordable rate.

Suggestions:

- There should be effective mitigation measures in order to reduce noise pollution. Improved technology might and proper management plan would help to mitigate the noise pollution.
- Surface water and soil pollution should be controlled by monitoring the runoff of waste materials to the surroundings.
- Air pollution from the construction materials and emission from machineries might create minor problem but this is acceptable for their better future.
- The capacity of this project should be extended to add more business and agricultural entities into the grid connection.
- The existing solar panel of every individual household should be collected sometimes with little payments from the owner for proper disposal or management by the project proponent or any responsible authority.

Solar Mini Grid Project, Kurigram

Focus Group Discussions (FGDs)

List of Participants

Focus Group No. 03 Date 29.2.2018 Time 3.15
 Location: Union Parishad, Kodalkathi, Char Rajibpur, Kurigram
 GPS Location: 25.48608°N 89.76443°E

SL No.	Participant's Name	Age	Occupation	Telephone No.	Signature
1	বাবু চন্দ্র ফারুক	৫৭	বাড়ি	০১৭২২০৮২৮	
2	মহালা	৫০		০১৭৪৫৬০৪৫৪	
3	মহালা	৩০	বাড়ি	০১৭২৪৫৫৭২	
4	মোঃ মিল্লু মিল্লু	৬৫	বাড়ি	০১৭৩১২৪৭৬০	
5	মুন্সি মিল্লু	৫০	বাড়ি		
6	মুন্সি মিল্লু	৫৫	বাড়ি	০১৭২৪৭০৭৫২০	মুন্সি মিল্লু
7	মুন্সি মিল্লু	৫৫	বাড়ি	০১৭৩৩২৭৬৭৭	
8	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৬০৩৫৭৪৫	
9	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৩৩৩৭৭৭	
10	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৫৭০৬৭৭৩	
11	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৩৩৩৭৭৭	
12	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৩৩৩৭৭৭	
13	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৩৩৩৭৭৭	
14	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৩৩৩৭৭৭	
15	মোঃ মিল্লু মিল্লু	৫৫	বাড়ি	০১৭৩৩৩৭৭৭	

16. মোঃ মিল্লু মিল্লু
 FGDs Completed By Toonmoy Boudi

Signature