Initial Environmental and Social Examination Report

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Bangladesh: Muktagacha Solar Power Project

PART 1

Prepared by EQMS Consulting Limited for the Asian Development Bank (ADB).

INITIAL ENVIRONMENTAL AND SOCIAL EXAMINATION OF MUKTAGACHA SOLAR POWER PROJECT AT MUKTAGACHA, MYMENSINGH

FINAL REPORT

November 2024

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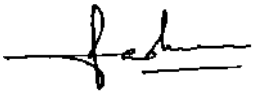

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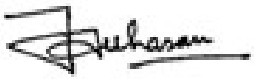

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDIXES

ACRONYMS AND ABBREVIATIONS

AAQ	Ambient Air Quality
AAQM	Ambient Air Quality Monitoring
AC	Alternating current
ADB	Asian Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AIS	Air-Insulated Switchgear
ANL	Ambient Noise Level
AoI	Area of Influence
APHA	American Public Health Association
As	Arsenic
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDT	Bangladeshi Taka
BFD	Bangladesh Forest Department
BFIDC	Bangladesh Forest Industries Development Corporation
BFRI	Bangladesh Forest Research Institute
BIWTA	Bangladesh Inland Water Transport Authority
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BNH	Bangladesh National Herbarium
BNRS	Bangladesh National REDD+ Strategy
BOD	Biological Oxygen Demand
BOO	Build-Own-Operate
Bos	Balance of System
BPDB	Bangladesh Power Development Board
BREB	Bangladesh Rural Electrification Board
BWDB	Bangladesh Water Development Board
CCKP	Climate Change Knowledge Portal
CCRA	Climate Change and Risk Assessment
CCTV	Closed-circuit Television
CO	Carbon Monoxide
COD	Commercial Operations Date

COD	Chemical Oxygen Demand
CPR	Common Property Resources
CPR	Common Property Resources
DC	Direct Current
DEM	Digital Elevation Model
DG	Director General
DOE	Department of Environment
EC	Environmental Clearance
ECAs	Ecologically Critical Areas
ECC	Environment Clearance Certificate
ECR	Environment Conservation Rules
EHS	Environment, Health and Safety
EMP	Environmental Management Plan
EQS	Environment Quality Standards
ERP	Emergency Response Plan
ESMP	Environmental and Social Management Plan
FGD	Focus Group Discussion
GAD Policy	The Gender and Development Policy
GBV	Gender-Based Violence
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiance
GII	Global Inclined Irradiance
GIS	Geographic Information System
GPS	Global Positioning System
GRC	Grievance Redness Committee
GRM	Grievance Redness Mechanism
GSB	Global Survey of Bangladesh
GW	Gigawatts
HFL	High Flood Level
HSE	Health Safety and Environment
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
LC	Least Concern
MSEL	Muktagacha Solartech Energy Limited

MWh	Megawatts-hours
NAPA	National Adaptation Program od Action
NDCs	Nationally Determined Contributions
NOC	No Objection Certificate
NOC	No Objection Certificate
NT	Near Threatened
NVRs	Network Video Recorders
NW	North-West
OHS	Occupational Health and Safety
PBBs	Poly Brominated Biphenyls
PGA	Peak Ground Acceleration
PHC	Prefabricated Hollow Concrete
PPE	Personnel Protective Equipment
PS	Performance Standard
PV	Photovoltaic
RCC	Reinforced Cement Concrete
RCPs	Representative Concentration Pathways
ROW	Right of Way
SCADA	Supervisory Control and Data Acquisition
SEAH	Sexual Exploitation, Abuse and Sexual Harassment
SRTM	Shuttle Radar Tropology Mission
TDS	Total Solid Dissolves
TL	Transmission Line
TOR	Terms of References
VMD	Video Motion Detection
WEEE	Waste Electrical and Electronic Equipment
Wp	Watt Peak

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Muktagacha Solartech Energy Limited (MSEL or the borrower) proposes to develop and operate a 20 MW AC Solar Photovoltaics (PV) Power Plant on 68 acres of land. The proposed Solar PV Power Plant is located at the Kashimpur and Mankon Union in Muktagacha town in Mymensingh division, Bangladesh. GPS coordinates of the solar plant area is 24°43'51.12" N 90°11 '53.12"E. The client intends to develop a utility – scale grid –connected, ground mounted solar PV power plant. The plant would provide a cost-efficient renewable energy source to supplement the existing energy provided by other sources to the grid. Based on the installation scale of the PV power plant and the voltage level of the surrounding grid, the appropriate voltage level for the PV power plant is 33KV, making it suitable to connect to the grid using a double-circuit three-phase line.

The plant would use a renewable method of generating electrical power by converting solar radiation into direct current electricity using silicon panels that exhibit the PV effect. Photovoltaic power generation employs solar panels composed of many solar cells containing silicone.

Table 0-1: Key Project Information

Project Company	Muktagacha Solartech Energy Limited, MSEL	
Type of Business	Solar Power Plant	
Project Location	Proposed Solar Power Plant	Union: Kashimpur and Mankon Upazila: Muktagacha District: Mymensingh
	Proposed Transmission Line Route	Union: Mankon, Basati and Ward-01, Upazila: Muktagacha District: Mymensingh
Solar Power Plant Configuration	29MWp DC/ 22.2MWAC Ground mount Solar PV Power Plant	
Contracted Plant Capacity	20 MW_{AC} Solar PV Power Plant	
AC/DC Ratio	1.21	
Solar Power Plant Land Area	Approximately 68 acres	
Project Cost	34.67 Million USD	

Transmission Line		As per the instruction from BPDB, the solar power will be connected to the grid via 33/11kV *Muktagacha* substation which is approximately 8 km northeast side from the proposed solar power plant site. MSEL plans to utilize a double-circuit power line configuration for their project. BREB will allocate an existing single circuit to MSEL for power evacuation purposes. For the additional circuit, MSEL will only need to install cables on existing poles, thus eliminating the need for new tower construction. To connect the power plant to the nearest existing pole for both circuits, MSEL will require an additional 200 meters of overhead transmission line. This will involve installing two new poles along the existing right-of-way of the access road to the solar power plant. BREB will determine the specific locations for these two poles, though the exact placement has yet to be finalized.
Major Component of Proposed Solar Power Plant	**Photovoltaic Modules**	Module: Monocrystalline Silicon Module Each Module Capacity (DC rating): 630 Wp Total Number of Module:46368 Module Manufacture: JA Solar Modules Model: JAM72D42-630/LB
	Photovoltaic Array	Installation Mode: Fixed Array Mounting Configuration: 2P Pitch (m): 7
	String	Modules per String: 28 String Count: 1659
	Inverters	Scheme: String Inverter Total Number of Inverters: 80 Inverter Model:SG320HX-20 Inverter Rating (KW): 300@51 DEG
	Transformer	Total Number of Transformer:8 Voltage: 0.8/33KV Capacity: 3MVA
Project Duration		20 years from COD
PV Cleaning Water Volume		2 liters/module
Water Supply Source		Ground Water
Operation and Maintenance		Muktagacha Solartech Energy Limited, MSEL

Source: Technical Feasibility Report, May 2024, MSEL, and Plant Layout Plan

According to Bangladesh Environment Conservation Rules (ECR), 2023 the aforesaid 20 MW solar power plant has been categorized as “Yellow” (Item 34: Solar Power Plant (1 MW to 50 MW) and

transmission line has been categorized as “Orange” (Item-31: Power, Oil and Gas Transmission line (up to 25 km). The overall project has been categorized as Orange. MSEL will utilize existing poles for extending the transmission line (string the cable) along the designated route, which is approximately 7.8 kilometers in length. To enable the interconnection between the solar power plant and the nearest existing transmission pole—located about 200 meters away—the project will necessitate the installation of two additional poles within the access road right-of-way/private land. As per MSEL, pole installation will be under Bangladesh Rural Electrification Board (BREB), while the installation of additional cables will be under MSEL. The project requires Site Clearance Certificate and Environmental Clearance Certificate from the Department of Environment (DOE).

Project site has a tropical climate. In winter, there is much less rainfall than in summer. In the period of 1989-2021, March to October is marked by a continuous increase in the temperatures. May is the hottest month in the past 32 years. The data analysis of 32 years shows that the monthly maximum temperature varies from 29.5°C to 38.1°C whereas the monthly minimum temperature varies from 4.7°C to 22.8°C. The lowest average temperature recorded in the past 32 years was in January 2003 (17.3°C). The highest average temperature reached 28.8°C in May 1989.

Monthly Average Relative humidity in the area is generally above 80% from May to December. The month of March is the driest with relative humidity around 73%. The wind direction in Mymensingh meteorological station is generally from North-West (NW) to Southeast (SE) direction.

During construction activities, there will be a minor impact to traffic from transporting construction materials. Moreover, at the time of the construction, waste will be generated from different sources. Solid and sanitation wastes can be managed environmentally through application of 3R, ensuring disposal of waste to dustbin and landfill (as is designated by local authority) and ensuring application of proper sanitation facility. Noise is a common issue in most of the construction activities, which can be mitigated by application of sound mitigation device and shifting of construction time, such as accomplishment of major noise generating activities during daytime.

There will be some impacts on local flora and fauna during site preparation, which can be mitigated by measures including replanting/re-introducing them. During construction work, fencing will be provided so that the surrounding areas will not be disturbed.

The scale of visual impacts can be mitigated by adopting fencing all around the project site and accomplishing the construction activities as early as possible. In consideration of the nature of construction activities, it can be said that there is limited scope of surface water contamination. Accident is a general concern for any construction activities, which is to be addressed with ensuring due awareness and providing required Personnel Protective Equipment (PPE) to the workers.

The project will deliver positive environmental impacts during operation phase. As it will be a renewable energy generation project. There will likely be a substantial change in the aesthetic view. Other than the occupational health and safety risks, the envisaged negative impact during operation and maintenance period will be mainly on ground water.

The site is at potential risk of flood hazards during the rainy season. MSEL has considered during design stage.

During the study period EQMS Team has conducted stakeholder consultation with Local Elite Person, UP Member, Landowner, Female Landowner, Department of Agriculture, Department of Fisheries, Department of Public Health and Engineering, NGO person, Headmaster of Educational Institute etc. Most of the respondents express positive perceptions towards the project. It has been noted from FGD, Community people believe this proposed project will enhance their quality of life by creating employment opportunity, business generation, tourism services etc. The EQMS Team also informed the participants about environmental impacts and mitigation of the proposed project. Apart from this direct benefit, there would be other direct beneficial impact on the national economy through foreign investment.

MSEL is considering the environmental and social compliance issues in its planning. The proposed project will maintain the standard of DOE, Bangladesh in its lifecycle. A Project Operation and Maintenance team has been established for project execution. Under this team the EHS responsible person and social responsible person have been appointed. This unit, EHS person and Social person will be responsible for implementing the Environmental and Social Management Plan (ESMP) as well as to ensure satisfactory monitoring and compliance on a regular basis as per obtained Environmental Clearance Certificate from Department of Environment (DOE).

CHAPTER 1

Introduction

1 INTRODUCTION

1.1 Project Background

Muktagacha Solartech Energy Limited, acting as the project borrower, is seeking project financing from the Asian Development Bank (ADB) for the development, construction, and operation of the Muktagacha Solar Power Project. The project entails establishing a 20MW Grid Tied Solar Power Plant including the construction of 200 m new overhead transmission line and installation of additional cable along the approximately 7.8 km existing overhead transmission line to connect the power plant to the existing Muktagacha substation owned by Bangladesh Rural Electrification Board (BREB), a state-owned entity responsible for rural electrification. The project will supply contracted electricity to the Bangladesh Power Development Board on a Build-Own-Operate (BOO) basis for a duration of 20 years. The plant will be in Nimuria, Muktagacha, Mymensingh, Bangladesh.

1.2 Nature and Objective of the Study

The overall objective of the IESE Study is to ensure that there is a focus on the issues that are most important for Project planning, decision-making and stakeholder interests. During the IESE Study, potential interactions between the Project, environmental and human resources/ receptors are identified, and prioritized in terms of their potential to cause impacts of concern. The IESE Study also has the benefit of identifying the areas which are not likely to be significantly affected by the development activities. The objectives of this IESE Study are, therefore, to:

- Identify the potentially significant environmental, health, safety, and social impacts and risks that will require further examination in the study.
- Identify the areas that are not likely to be significantly affected by the development of the Project.
- Assess environmental and social impacts associated with the development of the Project during construction, commissioning, and operation phases.
- Identify mitigating measures to address anticipated impacts and risks, and
- Plan the stakeholder engagement and consultations with relevant parties.

1.3 Scope of Work

Details of the scope of work pertaining to the IESE study have been as under:

- Evaluate the potential environmental and social impacts of the proposed project, considering environmental factors, involuntary resettlement, and the rights of indigenous peoples.
- Identify possible risks and vulnerabilities associated with the project's activities, including key elements such as the solar power plant and transmission lines.
- Develop practical and effective mitigation strategies to address these impacts and risks, focusing on environmental protection, biodiversity conservation, managing involuntary resettlement, stakeholder grievance mechanisms, and honoring indigenous peoples' rights.
- Ensure full compliance with the ADB's Safeguard and Social Policies, World Bank EHS Guidelines (general and sector-specific), national environmental and social regulations, and international best practices.
- Plan and implement stakeholder engagement and consultations with affected communities, NGOs, and relevant government authorities to integrate their concerns and feedback into the project design and execution.

1.4 Methodology

In order to attain the earlier mentioned scope of work, the studies would be based on the review of the available project-related information and including primary and secondary baseline environment and social data, prediction, and evaluation of impacts of significance. The following approach and methodology are used to complete the IESE study.

1.4.1 Kick-Off Meeting and Study Team Mobilization

After completion of the contract negotiation, the Team Leader of EQMS completed all logistic arrangements. Then a kick-off meeting has been held with the officials of the client. After the project kickoff meeting, a Request for Information/Checklist had shared with the Client by mentioning the data/information requirements from them to perform the study. The main purposes of the meeting were as follow:

- Understanding the project and major objectives of the project
- Identify continuous points of contract and finalization of logistics arrangements.
- To present key elements of the EQMS approach to fulfill all aspects of the project.

1.4.2 Desk Study and Literature Review

Based on previous experiences and the review of relevant literature associated with IESE studies of various projects and relevant laws, policies, and guidelines was reviewed. At the same time, relevant information associated with socioeconomic and cultural environments was reviewed. The following documents were considered for review and desk study literature, population census, topographical maps, hazards, vulnerability and disaster study, hydrological study, and other pertinent information about the project area. Based on the reviewed information, data gaps have been identified, and the methodology described in the following sections of this chapter was adopted to collect other relevant information required for the IESE study.

1.4.3 Reconnaissance Field Visits and Preliminary Consultations

EQMS experienced professionals have undertaken a preliminary field visit to gather environmental and socio-economic information in and around the proposed project location and established an environmentally sensitive area/ ecologically sensitive area.

1.4.4 Baseline Data Requirement and Collection Method

A. Physical Environment

- **Meteorology:** maximum & minimum temperature, rainfall, humidity, and wind, etc. of the project area were collected considering the nearest available meteorology station of the Bangladesh Meteorological Department.
- **Physiography:** physiographic environment of the project area was collected from the Soil Resource Development Institute, Food, and Agriculture Organization, and United Nations Development Program report.
- **Topography:** topography data were collected from the United States Geological Survey website.
- **Geology:** the geological setting of the project area was collected from the Geological Survey of Bangladesh, Bangladesh Space Research and Remote Sensing Organization, Bangladesh Petroleum Exploration Company, the United States Geological Survey website, and published books, journals, articles, etc.
- **Soil:** types of soil, texture, etc. were collected from the Soil Resource Development Institute, Department of Agriculture Extension, Food and Agriculture Organization, United Nations Development Program report, & published books, journals, articles, etc.

- **Groundwater:** groundwater data were collected from the Department of Public Health Engineering etc.
- **Land Use/Land Cover:** land use was evaluated using satellite images, google images, GPS surveys, etc.
- **Environmental Quality Data:**
  - **Air Quality:** monitoring data has been collected from project area.
  - **Water Quality (Surface and Ground):** Water sample has been collected from project area.
  - **Noise level:** monitoring data has been collected from project area.
- **Hazards, Vulnerability, and Disaster data:** flood, earthquake, cyclone, tornado, lightning, etc. have been collected from the Department of Disaster Management, Department of Environment, Flood Forecasting and Warning Center, Bangladesh Water Development Board, Bangladesh Red Crescent Society, and published literature. Discussions have been conducted with the local community to get primary data during site visits.

B. Biological Environment

Focus Group Discussion, Observation and Interviews, the main methodologies to collect baseline information on the Biological Environment of the project area. Observation in and around the project area has been done to observe forest and vegetation and wildlife habitats. The wildlife and birds in the area has been identified from observation, indirect evidence, and discussion with local people as well as by the literature review.

Ecological aspects like ecologically critical areas, protected areas, reserve forests, mangroves, wildlife sanctuaries, migratory bird staging areas, fishing zone, marine protected areas, critical and vulnerable species, habitat conditions, etc. has been collected from International Union for Conservation of Nature, Department of Forest, Department of Environment, Encyclopedia of Flora and Fauna of Bangladesh, Non-Government Organizations working with the relevant sector.

C. Socio-economic and Cultural Environment

- The socio-economic condition of the project area has been collected from the population and housing census published by the Bangladesh Bureau of Statistics. Primary data has also been collected from the socio-economic survey, individual consultations, focus group discussions with community and stakeholders. For the IESE study the following types of data have been collected, analyzed and triangulated for the preparation of socio-economic baseline of the proposed project.
  - Demographic Characteristics
  - Education and Literacy.
  - Community infrastructures and services (drinking water, transportation, electricity, telecommunication, etc.).
  - Local institutions and activities.
  - Places of cultural importance; historic, religious, or cultural sites in the project-affected area and the special occasions of celebrations/gatherings, including the relative importance of these sites (local, regional, or national).
  - Access to Social Institution
  - Social and Environmental Issues
  - Project Awareness to the Local People
- Agricultural resources such as farming practice, cropping pattern and intensity, cropped area, crop production crop damages, main constraints of crop production, etc. has been collected

from both primary and secondary sources (Department of Agriculture, Department of Agricultural Extension).

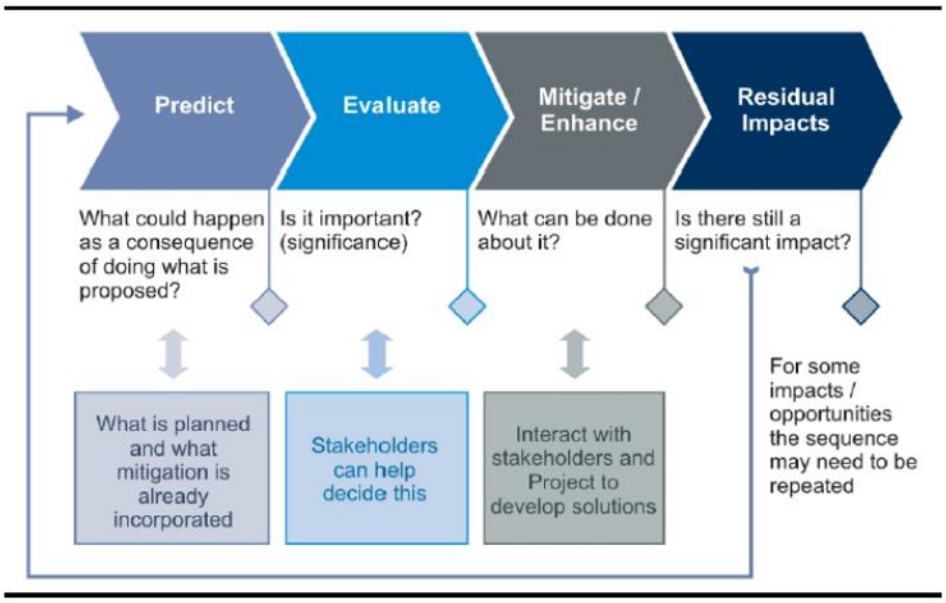
- Fisheries resources such as fishing-based livelihoods, income, etc. have been collected from secondary literature and through Focus Group Discussions (FGDs) and Key Informant Interviews (KII).
- Age and gender-segregated data has been collected from both primary and secondary sources to identify the impacts of Gender-Based Violence (GBV), Sexual Exploitation, Abuse and Sexual Harassment (SEAH), and vulnerable groups such as people living under the poverty level, physically challenged, etc. will be collected.
- Common Property Resources (CPR) of the study area have been identified and assessed.
- Ethnic profiles and existing vulnerabilities of project-affected communities (gender disaggregated if possible) have been considered.
- Vulnerable Groups such as people living under the poverty level, and physical challenges have been considered.
- Historical, Cultural, and Archaeological resources (including non-tangible cultural resources such as knowledge, belief, experience, traditional practices, etc.) in the study area and their area of influence have been identified by the study team during baseline data collection.
- **Land:** access requirements, land use, involuntary resettlement and/or negotiated land acquisition, details on land acquisition/lease (loss of lands, houses, livelihood, etc.), and resultant involuntary resettlement extent; review of the land take/lease process to assess any legacy or current/existing issues (like informal settlers, livelihood dependence, other usages etc.) on the allotted land with regard to compliance with ADB SPS SR2 and ADB's requirements regarding Negotiated Land Acquisition (i.e. willing buyer/seller) have been considered in baseline data collection.

1.4.5 Impact Identification, Evaluation, and Prediction

The IESE has evaluated potential impacts using a methodology based on the evaluation of the "significance" of identified issues and impacts on baseline parameters. Analysis of the baseline results and the incremental impacts of the project has been assessed in accordance with the national guidelines and standards and with reference to the ADB SPS, WBG Environmental, Health and Safety (EHS) Guidelines, including the General Guidelines and Guidelines for Electric Power Transmission and Distribution 2007. Social impacts have been assessed through the analysis of collected baseline data and available data found from the project proponent and secondary sources.

The impact assessment covers the full project lifecycle, including pre-construction, construction, operation/maintenance, and dismantling. The impact assessment involves the prediction, evaluation, and mitigation of impacts. Impact prediction takes into account control measures that are part of the project design. Additional mitigation measures aimed at further reducing predicted impacts is proposed where necessary or appropriate.

Figure 1-1: Impact Assessment Process for the IESE Study



The impacts have been identified and quantified for intensity using matrix techniques and evaluated as major, medium, minor, or insignificant impacts on the environment and communities in the study area. Aspects that have been considered in the impact assessment, for the whole lifecycle of the project, include land ownership and use, water quality, air, noise, ecology (terrestrial and aquatic), critical habitat, endemic and threatened species, waste (solid, liquid, and hazardous), landscape and visual, land acquisition and resettlement, traffic, flood, erosion, and other natural disaster risk, soil and groundwater, socio-economic, occupational and community health and safety, labor and working condition, GBV ad HIV/AIDS, etc. (but not limited). The environmental, ecological, socio-economic, and project information are to be collected to assess the potential impacts of the proposed activities. The issues among others to be studied included potential project impacts.

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

1.4.6 Mitigation Measures and Environmental and Social Management Plan

For each action with potential impacts, a mitigative measure and action to either prevent or minimize negative effects has been identified and a monitoring requirement has been specified. These have been compiled into a comprehensive Environmental and Social Management Plan which also identifies where and when actions will need to be undertaken and who will be responsible.

1.4.7 Analysis of Alternatives

A detailed analysis of alternatives study for the proposed project has been done considering important factors like site location, technology alternatives, power evacuation connection alternatives etc.

1.4.8 Risk Assessment & Emergency Response

The potentially hazardous areas of the project site have been identified and risk analysis has been done by the study team. Both the primary and secondary data relevant to the natural disasters/hazards were

collected during the site visit and from the desktop review. Protective measures are required to prevent the occurrence of any disaster suggested and an emergency response plan is prepared.

1.4.9 Stakeholder Consultation & Information Disclosure

Consultations with the stakeholders and local community have been done in and around the project area.

1.4.10 Grievance Redress Mechanisms

A grievance redress mechanism considering both informal and formal channels for resolving complaints about environmental and social performance, and worker/contractor-related grievances has developed pertaining to the project activities.

1.4.11 Climate-risk Vulnerability Assessment

The climate risk and vulnerability assessment for the project was carried out considering both physical and transitional risks.

1.4.12 Preparation of the IESE Draft Report

The EQMS expert team has prepared a draft IESE report and submitted the report to the client for review.

1.4.13 Finalization of the IESE Report

After receiving the comments from the client and ADB, the IESE report was updated according to the client and ADB review and the IESE report was finalized.

1.5 Limitations

This IESE report forms the key impact assessment of the proposed project. The followings are some of the limitations of the study:

- The evaluation of the project was constrained by the availability and adequacy of the data at hand. Some sections of this report relied on conceptual design and technical details due to limitations in available data.
- If the design of the project changes from that assessed due to design development, inclusion of new information, changing motivations or any other reason, the results of any impact assessment or possible mitigation measures provided in this report may be inconsistent.

1.6 The IESE Team

The composition of the IEE team is shown in **Table 1-1**.

Table 1-1: IESE Team Composition

S/N	Name	Position Assigned/Role
1	Md. Zahidul Islam	Senior Environmental Expert and Team Leader
2	Md. Mahfuzur Rahman	Senior Social Expert
3	Sadman K Monsur	Health and Safety Expert
4	Dr. K. M. Mijanur Rahman	Terrestrial Ecology Expert
5	A.B.M Ashraful Hoque Shovon	Aquatic Ecology Expert
6	Aminur Rahman	Land Acquisition/ Resettlement Expert
7	Israt Jahan Tonny	Environment Expert
8	Farhan Hassin	Social Expert

S/N	Name	Position Assigned/Role
9	Farah Shamima Sultana	Senior GIS and Remote Sensing Expert
10	Bipul Kumar Paul	GIS and Remote Sensing Expert

1.7 Structure of the Report

The IEE report consists of 12 chapters and the content is briefly described in this section:

0. **Executive Summary:** The executive summary provides an overview of the IESE report.
1. **Introduction:** The chapter describes the background of the study, brief description, scope of the study, approach and methodology, limitation, IESE study team combination, and structure of the report.
2. **Administrative and Legal Framework:** This chapter covers all the legal provisions, including environmental and social laws, applicable to the project. The chapter also covers all the national standards applicable to the project.
3. **Project Description:** This chapter provides a detailed description of the proposed project comprising project nature, location, layout, and project components. This chapter discusses the existing situation of the area. It also discusses the utility requirement and technological framework for the proposed project.
4. **Alternative Analysis:** This chapter describes systematic comparisons of feasible alternatives for the proposed project site, technology, and power evacuation alternatives.
5. **Environmental and Social Baseline:** This chapter covers the environmental baseline parameters on the physical environment (land use, topography, geology, physiography, geomorphology, agro-ecology, soil conditions, soil quality, natural hazards, meteorology, ambient air quality, ambient noise level, hydrology, surface water quality, and groundwater quality), biological environment, and socio-economic environment within the study area.
6. **Environmental and Social Impact Assessment and Evaluation:** This chapter covers the detailed impact of the proposed project on different environmental components during the construction and operation phase of the project.
7. **Environmental and Social Management Plan:** The chapter covers a comprehensive EMP including recommendations for its implementation during the pre-construction, construction, and operation phase of the project. The ESMP consists of the set of mitigation, management, monitoring and institutional measures to be taken during the implementation of the proposed project to eliminate adverse environmental impacts, offset them or reduce them to acceptable limits.
8. **Risk Assessment and Emergency Response:** This chapter outlines the possible hazards and risks associated with the proposed project and provides the necessary safety measure during emergency situation.
9. **Stakeholder Consultation and Information Disclosure:** This chapter presents information disclosure, consultation, and participation, comprises public consultations and disclosures conducted in the study area.
10. **Grievance Redress Mechanism:** The GRM is a formal structure for accepting, acknowledging, evaluating and responding to grievances. This chapter includes the GRM in the report.
11. **Climate Risk Vulnerability Assessment:** This chapter provides a climate risk assessment and vulnerability assessment of the study area.

12. **Conclusion and Recommendations:** This chapter presents the conclusion and recommendations of the report.

CHAPTER 2
Administrative and Legal Framework

2 ADMINISTRATIVE AND LEGAL FRAMEWORK

This chapter provides a legal and regulatory framework, covering national requirements as well as guidelines and standards to address the environmental and social risks of the proposed project and its components and to protect and conserve the environment from any adverse impacts. This chapter intends to discuss the regulatory context, which is directly related to environmental compliance, which must be adhered to by all parties involved in the project throughout the planning, construction, operation, and decommissioning.

2.1 Environment and Social-Related Legislation in Bangladesh

All legal provisions relevant to environmental protection applicable to the planning, construction, operation, and decommissioning of the proposed project are identified and summarized in Table 2-1 along with their applicability to the proposed project.

Table 2-1: National Legal Provisions Applicable to the Proposed Project

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Environment Conservation Act, 1995, and its amendments in 2000, 2002 and 2010	Ministry of Environment, Forest and Climate Change	• Declaration of Ecologically Critical Areas (ECAs). • Obtaining Environmental Clearance Certificate (ECC). • Regulation for vehicles emitting smoke which is harmful to the environment. • Regulation of development activities from an environmental perspective. • Promulgation of standards for quality of air, water, noise, and soil for different areas and different purposes. • Promulgation of acceptable limits for discharging and emitting waste. • Formulation of environmental guidelines relating to the control and mitigation of environmental pollution, conservation, & improvement of the environment.	Applicable - According to the Act, *"no industrial unit or project shall be established or undertaken without obtaining an ECC from the DG".* Therefore, the provisions of the act apply to all the project life cycles. MSEL must obtain the Environmental Clearance Certificate (ECC) before commencing operations.
Environment Conservation Rules, 2023	Ministry of Environment, Forest and Climate Change	• National Environment Quality Standards for surface water (inland and marine/coastal), drinking water, sewage effluent, industrial effluents, liquid waste discharge standards industry-wise, etc. • Categorization of industries, development projects, and other activities based on actual and anticipated pollution load. • Procedure for obtaining Environment Clearance Certificate (ECC). • Requirements for undertaking IEE and EIA's as well as formulating EMP according to categories of industries/ development projects/activities. • Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.	Applicable - As the project falls under the **'Orange'** category and requires an Environmental Clearance Certificate (ECC) from the Department of Environment (DOE), it is stipulated that environmental quality standards and other relevant requirements must be complied with throughout the project's life cycle.
Environment Court Act, 2010 and its	Ministry of Environment, Forest and Climate Change Judiciary	• Establishment of one or more environmental courts in each district and one or more special magistrate courts in each district. • Also provides the jurisdictions of the environment court, the penalty for violating the court's order, trial procedure in special magistrate court, power	Applicable - The court has jurisdiction, under the provisions of the act, to conduct trials for offenses or

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
amendment in 2019		of entry and search, procedure for investigation, procedure, and power of environment court, authority of environment court to inspect, appeal procedure and formation of the environment appeal court.	claims for compensation under environmental law, and to impose penalties for violations, etc.
Noise Pollution (Control) Rules, 2006	Ministry of Environment, Forest and Climate Change	• The Rules have been established to manage noise-generating activities, which have the potential to impact the health & wellbeing of workers and the surrounding communities. • An area up to a radius of 100 meters around hospitals, educational institutions, offices, or similar types of institutions is designated as a silent area. The acceptable sound limit in the silent areas is 50 dB(A) for daytime and 40 dB(A) for nighttime. • The residential areas are primarily occupied by dwellings. The acceptable sound limit in residential areas is 55 dB(A) for daytime and 45 dB(A) for nighttime. • Mixed areas with a mix of residential, commercial & industrial land use. The acceptable sound limit in the mixed areas is 60 dB(A) for daytime and 50 dB(A) for nighttime. • Commercial areas are primarily occupied by businesses and officers. The acceptable sound limit in commercial areas is 70 dB(A) for daytime and 60 dB(A) for nighttime. • Industrial areas are used for industry or manufacturing. The acceptable sound limit in the industrial areas is 75 dB(A) for daytime and 70 dB(A) for nighttime. • An area between 500 meters from the last limit of a residential area for construction-related activity use of brick and stone crusher machine is prohibited and operation of mixture machine and construction-related machinery and equipment are prohibited from 7 PM to 7 AM. • The guidelines say exceeding the maximum noise level in certain areas is a punishable offense.	Applicable - The construction and operation activities of the project will generate noise within the project site and its surroundings, necessitating compliance with these rules.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Air Pollution (Control) Rules, 2022	Ministry of Environment, Forest and Climate Change	• Stipulate ambient air quality standards, emission standards for vehicles, emission standards for water vessels, gaseous emission standards applicable to industries or projects, odor standards, and standards for construction dust control. • Local government organizations, construction management authorities, and other relevant organizations shall comply with the standards and control methods specified in the rules. • Rules also provide for the prevention of air pollution from hazardous waste, excessive emissions of air pollutants, air quality monitoring and warning, data management, the establishment of a national executive committee for air pollution control, measures to prevent damage to ecosystems caused by air pollution, awards for contributions to air pollution control, and penalties for violations.	Applicable - Since the project entails pollution sources such as emissions from construction processes, materials transportation, and handling, it falls under the obligations of this act
Ecologically Critical Areas (ECAs) Management Rules, 2016	Ministry of Environment, Forest and Climate Change	• The ECA Management Rule, 2016 has enabled the government to form a “National Committee” headed by the Secretary of MOEFCC. • To implement the decision of the Directorate, a District, and Upazilla committee may be formed. For the conservation and development of the ecologically critical area, one or more teams may be formed. The responsibility of the team would be to implement the decision and planning of the Government to improve the Environment for Ecology. • The Rule also prohibited many activities and processes that are detrimental to the natural condition of habitat, tranquility, biodiversity, etc.	Not applicable - There are no ECA sites situated within a 10 km radius of the proposed project. Therefore, this rule does not apply to this project.
Biodiversity Act, 2017	Ministry of Environment, Forest and Climate Change	• The Act has enabled the government to form a "National Committee on Biodiversity". The functions of the committee are to conserve biodiversity, genetic biodiversity, identification of biodiversity-related important areas, heritage, etc. • The government is empowered to declare, in consultation with local communities and bodies and in coordination with concerned ministries or	Applicable- As the proposed project (Solar Power Plant) will be constructed in abandoned water bodies, it is expected to have some impact on the surrounding

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		departments, any place or area significant for its biological heritage as a "Biodiversity Heritage Site". • Prohibiting the taking of activities that may have an adverse effect on endangered animals or organisms, etc. No person shall take any such activity, viz (a) adversely affect or may affect endangered species; (b) adversely affect or may affect the environmental characteristics of the endangered ecological community; or (c) In accordance with the Ramsar Convention, the wetland may adversely affect or affect the environment and environmental characteristics of the declared area.	environment during both construction and operation. Under this Act, the project must ensure that no effluent is discharged directly into any waterbodies.
Forests Act, 1927 and its amendment in 1982, 1989, 2000 and 2018	Ministry of Environment, Forest and Climate Change	• The government can prohibit certain activities in the declared Reserved Forest area, causing any damage by negligence in felling any tree or cutting or dragging any timber; etc. • The act makes various provisions for the conservation of forests. • It defines the procedure to be followed for declaring an area to be a Reserved Forest, a Protected Forest, or a Village Forest. • It defines what a forest offense is, what acts are prohibited inside an RF, and penalties leviable on violation of the provisions of the act. • The act gives the government power to make any relevant rules to protect the forest. • Guidelines for social forestry practice. • Control and collection of timber and other forest products, and duties on those.	Not Applicable - As the proposed project area does not fall under any reserved forest, protected forest, or social forestry.
Wildlife (Conservation and Security) Act, 2012	Ministry of Environment, Forest and Climate Change	• Prohibition is related to capturing, killing, shooting, or trapping wildlife. No person shall hunt any wild animal without a license. • Determination of threatened flora and fauna in four (4) schedules. • Prohibitions, entry, and declaration procedure of protected areas (sanctuary, national park, community conservation area, safari park, eco-park, botanical garden, wild animal breeding center, landscape zone or	Not applicable - As there are no wildlife sanctuaries or eco-sensitive zones within a 10km radius of the proposed project.

Act/Rules/ Law/Ordinance	Responsible Agency-Ministry/Authority	Key Features/Remarks	Applicability
		corridor, buffer zone, core zone, special biodiversity conservation area, national heritage, memorial tree, sacred tree, and kunjaban, etc.). • No person, institution, or company shall establish or operate any industrial factory or brickfield within 2 (two) kilometers from the boundary of a sanctuary.	
Protected Area Management Rules, 2017	Ministry of Environment, Forest and Climate Change	• The legal basis for the management and co-management of forest-protected areas. • Structures, functions, and obligations of management of some of the protected areas, but excluding safari-park, zoo, botanical garden, private park, and wildlife fertility center from their application. • The Rules have 33 sections and provide a model for participatory co-management, consisting of forest-dependent communities, forest departments, civil administration, and civil society organizations. • The rules provide for financial benefits and income incentives to shareholders through participatory social forestry programs to be planted in buffer and landscape areas, and eco-tourism.	Applicable - Protected area is found within the 10 km radius of the proposed power plant site. The nearest National Park is Madhupur national park which is only 4.9 km away from the power plant site Therefore, this act is applicable.
Bangladesh Water Act, 2013	Ministry of Water Resources	• Any infrastructure or landfilling activities over any natural watercourses, stopping the natural flow creating obstacles, or diverting or attempting to divert the direction is strictly prohibited. • According to the provision of section 43, all the costs may be incurred for the removal of infrastructure or landfilling materials from the person liable for making infrastructure or carrying on landfilling activities. • Any area or any part of any land connected with water resources can be declared as a Water Stress Area. • Ensuring safe abstraction of water from aquifers & executive authority may subject to the lowest safe yield of surface and groundwater.	Applicable – As the project proposes to utilize groundwater for both construction and operational activities, obtaining a No Objection Certificate (NOC) from WARPO/ Union/ relevant committee will be required.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		• Any infrastructure shall not be established in the immediate premises of the flood control embankment and ensure the sustainability and protection of the control structure. • No person shall store, preserve, or divert the water of any water source in any natural or artificial reservoir.	
Bangladesh Water Rules, 2018	Ministry of Water Resources	• Provision of No Objection Certificate for the establishment of projects related to flood control and management project; surface water extraction, supply and use related project and part of the project; irrigation project using surface water; construction of hydraulic structures; water conservation project; flood-affected plain land and wetland development project; groundwater for industrial use; riverbank protection and river control; river excavation and dredging project; canal excavation and re-excavation project; fisheries development in surface water project; groundwater extraction, supply, & use related project & part of the project; and others project. • According to Clause-16 of the rules, a NOC should be taken from the DG of WARPO, District Committee/DC, Upazilla Committee/UNO, and Union Committee/Chairman based on the total investment of the specific project.	Applicable – Same as above
Solid Waste Management Rules, 2021	Ministry of Environment Forest and Climate Change	• It defines the responsibility of SWM regarding waste collection and transport in addition to waste treatment and disposal. • A provision of imposing fines on households or traders failing to segregate organic and inorganic waste from the primary sources. It also kept a provision to make a fine of a maximum of two lakh Taka for violating the rules or two years of imprisonment or both provisions. • To reduce air pollution from municipal solid waste incinerators a stack emission standard has been provided.	Applicable – As the project aims to manage solid waste effectively to minimize environmental, social, and economic problems.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Hazardous Waste (e-waste) Management Rules, 2021	Ministry of Environment Forest and Climate Change	• On June 10, 2021, Bangladesh's Department of Environment (DOE) published the Hazardous Waste (e-waste) Management Rules, 2021 under the Bangladesh Environmental Protection Act, 1995. The E-waste rule covers the products listed in the Schedule (home appliances, monitoring and control equipment, medical equipment, automatic machines, IT and communication equipment), and establishes obligations for manufacturers, assemblers, collectors, sellers, and consumers of the products. The main provisions of this regulation are as follows: • Manufacturers, traders, sellers, transporters, repairers, collection centers, recyclers, dismantlers, etc. of the subject products are required to register with a prescribed form to the DOE. When applying for registration, they shall also submit the Waste Electrical and Electronic Equipment (WEEE) management plan. • Registered manufacturers, recyclers, etc. shall obtain environmental clearance in accordance with the Bangladesh Environmental Conservation Rules, 2023. • Manufacturers have to establish individual or joint collection centers and set aside funds for the management of the Waste Electrical and Electronic Equipment (WEEE). • For fluorescent lamps and mercury incandescent lamps, if they cannot be recycled, they need to be handed over to collection centers for storage and disposal. • Manufacturers, importers, etc. shall meet the collection targets for the Waste Electrical and Electronic Equipment (WEEE) as specified in the Schedule (10% in the first year of the implementation, 20% in the second year, 30% in the third year, 40% in the 4th year, and 50% in the fifth year and thereafter). • In order to facilitate the proper management of the Waste Electrical and Electronic Equipment (WEEE), the name, address and contact information of the trader or seller as well as the information on the registered collection	Applicable- As the proposed project will generate various types of e-waste, including broken panels and batteries, during both the construction and operation phases.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		center shall be displayed on the product or on the product label, or this information shall be provided to consumers or large consumers. • Traders, sellers and collectors of the Waste Electrical and Electronic Equipment (WEEE) shall receive them from consumers at designated points and transport them to collection centers.	
National River Protection Commission Act, 2013	Ministry of Water Resources	• An act to establish a Commission for preventing illegal occupation of rivers, pollution of water and environment, pollution of rivers caused by industrial factories, illegal constructions, and various irregularities and ensuring multidimensional use of rivers for socio-economic development including restoration of the normal flow of rivers, proper maintenance thereof and making them navigable.	Not Applicable - As the proposed project is unlikely to have a significant pollution impact on the environment due to construction and operation activities. The river is more than 2.5km away from the power plant site and mitigation measures will be put in place in order to prevent any potential impacts on water.
Protection and Conservation of Fish Act, 1950, and its amendment in 1982 and Rules, 1985	Ministry of Fisheries and Livestock	• The act was enacted to provide for the protection and conservation of fish. Under the Act, the Protection and Conservation of Fish Rules were adopted in 1985. • No person shall destroy or make any attempt to destroy any fish by explosives, gun, bow, and arrow in inland waters or within coastal waters. During the Project intervention, it should be noted that if waste effluent is not treated then it may cause significant damage to the local fishery and thus violate the provision of the law. • No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents, or otherwise in inland waters. • Protection and conservation of fish in government-owned water bodies.	Not Applicable – As there is no inland surface water bodies (such as rivers, canals, or government-owned water bodies) in the project area and its surroundings. Also this act is not applicable for any private owned land

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
Imports and Exports (Control) Act, 1950	Ministry of Finance	• No goods of the specified description shall be imported or exported except following the conditions of a license to be issued by the Chief Controller or any other officer authorized on this behalf by the Government.	Applicable - As the machinery and equipment for the project will be imported.
Acquisition and Requisition of Immovable Property Act (ARIPA), 2017	Ministry of Land	• Current GOB Act, relating to acquisition and requisition of land. • According to the law, the affected person will get an additional 200% of the assessed value for land and an additional 100% for structures, trees, crops, and other assets. • This law deals with social and economic impacts as a consequence of land acquisition.	Not Applicable – The majority of the lands have been leased by the project developers, with only a small amount of land being purchased through the willing buyer-willing seller process.
Penal Code, 1860	Ministry of Law, Justice, and Parliamentary Affairs	• Valid provisions related to pollution management, environment protection, and protection of health and safety. Chapter XIV of the Penal Code provides offenses effective public health, safety, convenience, decency, and morals: • Section 277: Falling Water or Public Spring or Reservoir. • Section 278: Making Atmosphere Noxious to Health. • Section 284: Negligent Conduct with respect to Poisonous Substance. • Section 285: Negligent Conduct with respect to Fire or Combustible Matter. • Section 286: Negligent Conduct with respect to Explosive Substance.	Applicable – As the proposed project has some anticipated impact on the surrounding environment
Fire Prevention & Extinguish Act, 2003 and Rules, 2014	Ministry of Home Affairs	• Regulatory enactments in regard to the prevention, the successful extinguishing of fire, and also reduction of damages and consequences of fire. • States to obtain a license from the Director General of Fire Service and Civil Defense in case of any warehouse.	Applicable - As the project will established for generating electricity and supply through a transmission line, activities related to this

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
			project may cause fire accident.
Factories Act, 1965, and the Factories Rules, 1979 Bangladesh Labor Act, 2006, and amendments 2009, 2010, 2013 and 2018 Bangladesh Labor Rules, 2015	Department of Labor/Department for Inspection of Factories and Establishment/ Ministry of Labor and Employment	• Pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. • Provides health, safety, and well-being of the workforce during the project life cycle. • Children under 18 years are not allowed to be employed during the project life cycle. • Safety precautions regarding explosive or inflammable dust/gas, protection of eyes, protection against fire, work with cranes and other lifting machinery, and lifting of excessive weight. • Safety measures like appliances of first aid, maintenance of safety record books, rooms for children, housing facilities, medical care, group insurance, etc. • No building, wall, chimney, bridge, tunnel, road, gallery, stairway, ramp, floor, platform, staging, or other structure, whether a permanent or temporary character, shall be constructed, situated, or maintained in any factory in such a manner as to cause risk of bodily injury (Rule 38) of factory rules 1979, etc.	Applicable - It is mandated to prioritize the health, safety, and well-being of the workforce throughout the project life cycle. Additionally, it is stipulated that individuals under 18 years of age are not permitted to be employed during the project's duration, necessitating compliance with this regulation.
National 3R Strategy for Waste Management, 2010	Department of Environment	• The concept of this strategy is minimizing waste impacts in terms of quantity or ill-effects, by reducing the quantity of waste products with simple treatments and recycling the waste by using it as resources to produce the same or modified products. The principle of “3R” is stated as reducing waste, reusing, and recycling resources and products. • Reducing means choosing to use items with care to reduce the amount of waste generated.	Applicable - This strategy is applicable to the project for managing solid waste, aiming to minimize environmental, social, and economic issues.

Act/Rules/ Law/Ordinance	Responsible Agency- Ministry/Authority	Key Features/Remarks	Applicability
		• Reusing involves the repeated use of items or parts of items that still have usable aspects. • Recycling means the use of waste itself, as resources. • It suggests ISO 14001 or any other EMS structure that is significant for the development of strategies relevant to industry and its social and environmental setting. ISO 14001 is increasingly important in international trade.	
Antiquities Act, 1968, and Antiquities Preservation Rules, 1986	Department of Archaeology, Ministry of Cultural Affairs	• No person shall deal in antiquities except under and in accordance with a license granted by the Director. • No person shall remove any object of the immovable protected antiquity. • No person shall damage, alter, deface, or imperil immovable protected antiquity. • Any person preserving or storing any kind of movable antiquity without a license shall produce it to the Director on demand for verification of the source of its possession.	Not applicable - No archaeological or historic cultural sites are present on the project site and surroundings.

2.2 Environment and Social-Related Policies in Bangladesh

The main policies guiding environmental and social protection and conservation in Bangladesh are outlined in the following Table 2-2.

Table 2-2: Policies and Plans Relevant to the Project

Policy/Plans	Responsible Agency- Ministry/Authority	Key Features	Applicability
Renewable Energy Policy of	Ministry of Power, Energy and Mineral Resources	• The Renewable Energy Policy of Bangladesh was developed to harness the potential of renewable energy resources and dissemination the same in rural, peri-urban and urban areas.	Applicable- As the project is a solar power plant.

Policy/Plans	Responsible Agency-Ministry/Authority	Key Features	Applicability
Bangladesh, 2008		The objectives of renewable energy policy are to: • Harness the potential of renewable energy resources and dissemination of renewable energy technologies in rural, peri-urban and urban areas. • Enable, encourage and facilitate both public and private sector investment in renewable energy projects. • Develop sustainable energy supplies to substitute indigenous non-renewable energy supplies. • Scale up contributions of renewable energy to electricity production. • Scale up contributions of renewable energy both to electricity and to heat energy. • Promote appropriate, efficient and environment friendly use of renewable energy. • Train; facilitate the use of renewable energy at every level of energy usage. • Create enabling environment and legal support to encourage the use of renewable energy. • Promote development of local technology in the field of renewable energy. • Promote clean energy for CDM; and • Achieve the targets for developing renewable energy resources to meet five percent of the total power demand by 2015 and ten percent by 2020.	
National Environment Policy, 2018	Ministry of Environment, Forest and Climate Change	• Encourage collection and promotion of low carbon emission technology in the country. • Identifying and controlling all types of environmental pollution and degradation activities. • Ensure sustainable, long-term, and environmentally friendly use of all-natural resources. • To take PPP for the development of the environment. • Maintain and streamline the environmental policies and strategies among other policy strategies in the interest of sustainable development.	Applicable - The proposed project is likely to have some impact on the surrounding environment.

Policy/Plans	Responsible Agency-Ministry/Authority	Key Features	Applicability
		• Ensure the EIA and SEA are in all necessary sectors. • Act to reduce poverty through Environmental Protection. • Strengthen observations on proper compliance with environmental laws and regulations.	
Bangladesh Climate Change Strategy and Action Plan, 2009	Ministry of Environment, Forest and Climate Change	The BCCSAP aims to build a climate-resilient Bangladesh through: • Enhancing the capacity to respond to climate change. • Ensuring sustainable development while addressing climate challenges. • Reducing risks and impacts associated with climate change. The plan is structured around six strategic pillars: • Food security, social protection, and health. • Comprehensive disaster management. • Infrastructure. • Research and Knowledge Management. • Mitigation and low carbon development. • Capacity building and institutional strengthening.	Applicable - As the proposed project has the potential to generate air pollutants during both its construction and operation phases through the use of generators and other machinery. Additionally, the project's carbon footprint is relatively small compared to conventional energy sources.
National Forest Policy, 2016	Bangladesh Forest Department/ Ministry of Environment, Forest and Climate Change	• Manage all existing forests, wildlife, and other forestry resources, adhering to the principles of sustainable management and climate resilience. • Enrich degraded forest areas and enhance land areas under forest/ tree cover. • Produce a wide array of goods and ecosystem services for the benefit of Bangladesh's present and future generations.	Not applicable - As the proposed project area does not fall under any existing forests, reserved forest, protected forest, or social forestry.
National Water Policy, 1999	Ministry of Water Resources	• Protection and prevention of the natural environment for ensuring sustainable development.	Applicable –.

Policy/Plans	Responsible Agency-Ministry/Authority	Key Features	Applicability
		• Minimize disruption to the natural aquatic environment in streams and water channels. • Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding. • Water development projects should cause minimal disruption to navigation and, where necessary, adequate mitigation measures should be taken. • Full consideration of environmental protection, restoration, and enhancement measures consistent with NEMAP and the NWMP. • Ensure adequate upland flow in water channels to preserve the coastal estuary ecosystem threatened by the intrusion of salinity from the sea.	As the proposed project activities may pose a potential risk of contaminating groundwater, which will require mitigation.
National Fisheries Policy, 1999	Ministry of Fisheries and Livestock	• Provide provisions for the protection and conservation of fish in freshwater and brackish water bodies. • Preservation, management, and exploitation of fisheries resources in inland open water. • Fish cultivation and management in inland closed water. • Prawn and fish cultivation in coastal areas. • Preservation, management, and exploitation of sea fishery resources. • Conserve fish breeding grounds and habitats. • promote fisheries development and conservation in all water bodies.	Applicable- As fishing activities are carried out within the project area or its surroundings.

Policy/Plans	Responsible Agency-Ministry/Authority	Key Features	Applicability
National Agriculture Policy, 2018	Ministry of Agriculture	• Ensure food security and socio-economic development through the productivity of crops, boosting production and raising farmers' income, diversifying crops, producing safe foods and developing a marketing system, profitable agriculture & use of natural resources. • Increasing food availability, rights, and purchasing power by increasing crop productiveness and production. • Discourage the use of agricultural land for non-agricultural work to ensure sustainable food security. • Soil, water, flora, fauna, and overall environmental conservation and effective use initiative adoption.	Not Applicable –Project authority obtain permission from the Department of Agriculture (Appendix B: for establishment of this project in which this project site is identified as fallow land). However, there is .8 acres of land (within 76.4 acres) used for agricultural activities. But this activity is seasonal (one time) and rest of the time the area remain fallow.
National Land Use Policy, 2001	Ministry of Land	• To prevent arbitrary use of land. • To formulate guidelines for the maximum use of land according to the natural differences in different parts of the country. • In the case of land acquisition for urbanization and development projects or any other purpose, to ensure its best use by acquiring the least amount of land and to avoid the acquisition of excess land as required. • Arranging for the preservation of such lands, especially government Khas lands, which may be required in the future for various development activities. • To ensure that the use of land is compatible with the natural environment. • Making the best use of land to alleviate poverty and increase employment. • To play a helpful role in preventing the increase in the number of landless.	Not Applicable - The proposed project will be established on privately owned land.
National Tourism Policy, 2010	Ministry of Civil Aviation and Tourism	• Development of tourism resources of the country and their maintenance. • Two special sections of the policy focus on 'archaeological and historical sites' and 'conservation of wildlife'.	Not Applicable - As the proposed project establishment will not impact

Policy/Plans	Responsible Agency-Ministry/Authority	Key Features	Applicability
			any tourist spots, heritage sites, etc.
National Occupational Health and Safety Policy, 2013	Department for Inspection of Factories and Establishment/ Ministry of Labor and Employment	• Necessary measures to ensure workplace safety and health protection considering international Conventions/Declarations/ Recommendations/Instruments. • Review and updating of all laws relating to Occupational Health and Safety (OHS). • Inclusion of OHS issues in the policies and programs of all related Ministries and agencies. • Establish labor courts in the industrial zone so the workers and trade unions can have easy access to the courts for implementing the mandatory provisions of OHS. • Impose mandatory terms and conditions upon construction agencies to follow the OHS policies during govt. run construction works. • To ensure maximum safety standards during construction and implement all standards and regulations in an internal safety environment.	Applicable - As the policy concerns the occupational rights and safety of workers, ensuring a comfortable work environment and reasonable working conditions for all employees.

2.3 Environmental Standards

The appropriate national environmental standards will be applied under the ECR, 2023. The standards, commonly known as Environmental Quality Standards (EQS), are legally binding. There is a separate schedule for industry-specific standards, other than the general industrial emission and effluent standards. International standards will also be applied.

2.4 Administrative Setup Related to Environment and Social in Bangladesh

The MOEFCC is the nodal agency in the administrative structure of the GOB, overseeing all environmental matters relating to national environmental policy and regulatory issues in the country. The MOEFCC oversees the activities of the following technical/implementing agencies:

- Department of Environment (DOE)
- Bangladesh Forest Department (BFD)
- Bangladesh Forest Industries Development Corporation (BFIDC)
- Bangladesh Forest Research Institute (BFRI)
- Bangladesh National Herbarium (BNH)
- Water Resources and Planning Organization (WARPO)
- Bangladesh Inland Water Transport Authority (BIWTA)
- Ministry of Fisheries and Livestock (MOFL)
- Ministry of Labor and Employment (MOLE)
- Ministry of Law and Parliamentary Affairs
- Ministry of Land (MOL)
- City Corporation/Paurashava/Union Parishad.

2.4.1 Department of Environment (DOE), Bangladesh

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

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

2.4.2 Procedure for obtaining ECC from DOE, Bangladesh

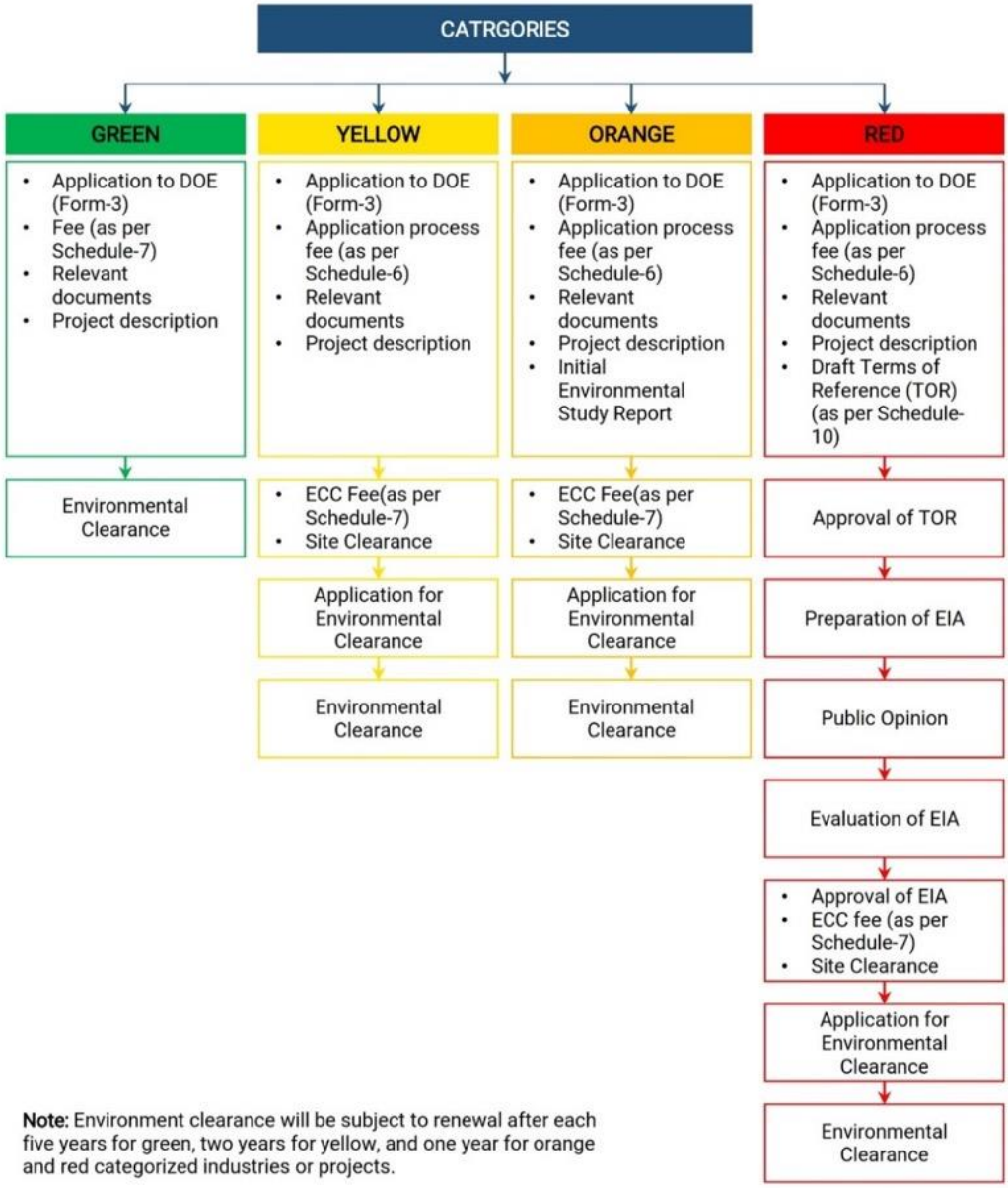
The applicability of environmental clearance and the process in Bangladesh is described in Figure 2-1 and Figure 2-2: . The EIA process consists of three stages, screening, and project description, approval of TOR, and detailed EIA:

- Projects categorized as Green and Yellow require no IEE or EIA but need a project description. However, the proponent has to submit an application in a prescribed format along with specified documents.

- Projects categorized as Orange require IEE for environmental clearance and in some cases, EIA may be required. IEE is to be submitted to the DOE along with an application in a prescribed format and other specified documents.
- Red category projects require EIA. A project description is required for the TOR approval. An EIA is required for location clearance and environmental clearance.

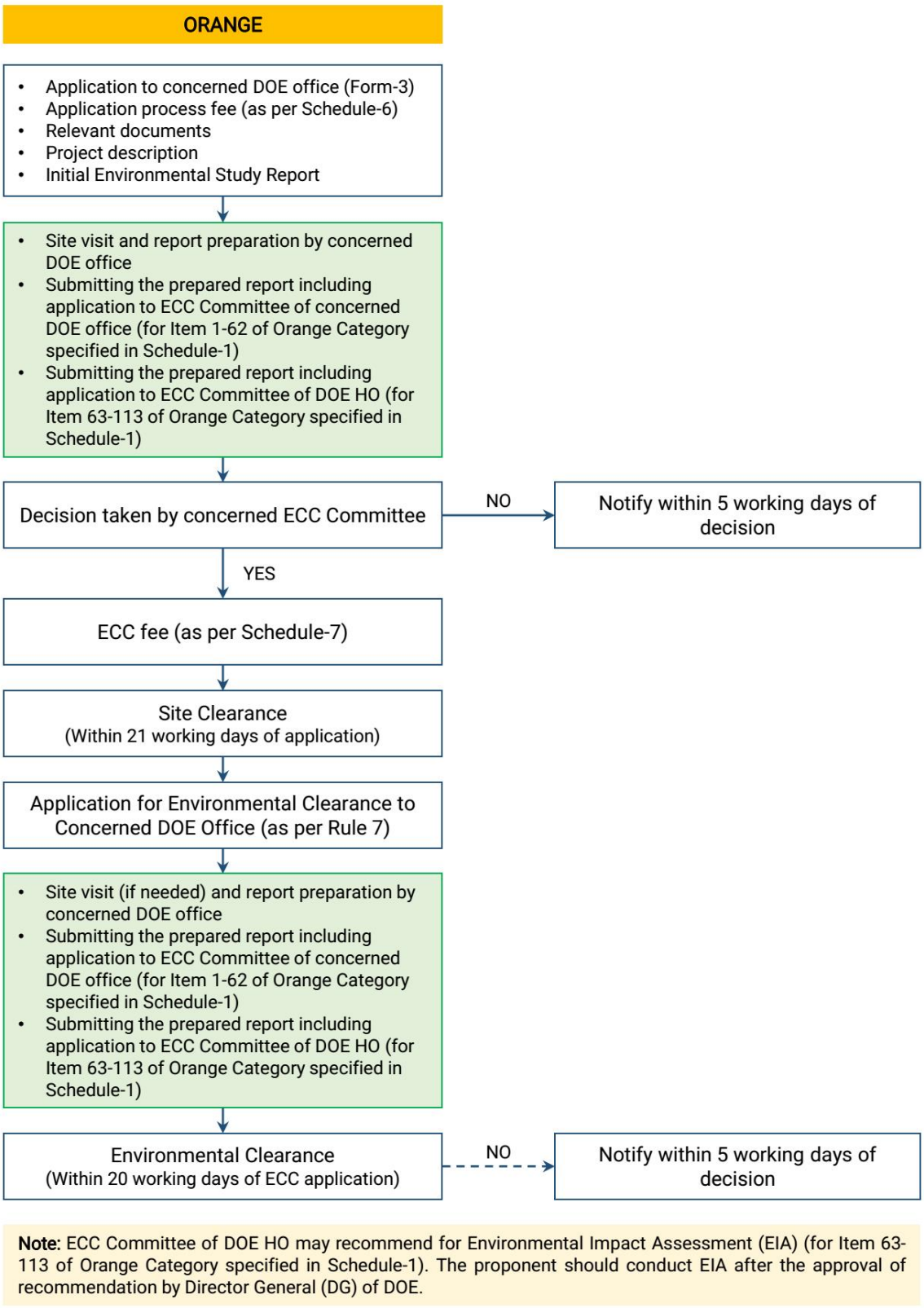
As per Schedule-1 of ECR 2023, the proposed project falls under the "Orange' Category and requires environmental clearance. The process of obtaining an Environmental Clearance Certificate for the proposed project is outlined in Figure 2-2: .

Figure 2-1: DOE Environmental Clearance Applicability and Procedure



Source: Department of Environment (DoE), Bangladesh

Figure 2-2: DOE Environmental Clearance Procedure for Orange Category (As per ECR 2023)



Note: ECC Committee of DOE HO may recommend for Environmental Impact Assessment (EIA) (for Item 63-113 of Orange Category specified in Schedule-1). The proponent should conduct EIA after the approval of recommendation by Director General (DG) of DOE.

Source: Department of Environment (DOE), Bangladesh 2023.

2.5 International Treaties, Conventions, and Agreements

In addition to compliance with National regulatory requirements, the proposed project will also adhere to the following regional and international conventions signed/acceded/ratified by Bangladesh.

- United Nations Convention on Biological Diversity (UN-CBD), 1992
- Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat, 1971 (Ramsar Convention)
- United Nations Convention to Combat Desertification (UNCCD), 1994
- United Nations Framework Convention on Climate Change (UNFCCC), 1992
- Kyoto Protocol, 1997
- Paris Agreement, 2015
- Vienna Convention on the Protection of the Ozone Layer, 1985
- Stockholm Convention on Persistent Organic Pollutants, 2001
- Montreal Protocol on Substances that Deplete the Ozone Layer, 1987
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, 1989
- Convention on International Trade in Endangered Wild Fauna and Flora Species, 1973
- Convention on the Conservation of Migratory Species of Wild Animals, 1979
- Convention on the Protection of World Cultural and Natural Heritage, 1972
- Convention on the Elimination of All Forms of Racial Discrimination, 1978
- Convention on the Elimination of All Forms of Discrimination against Women, 1979
- Optional Protocol to the Convention on the Elimination of Discrimination against Women
- Convention on the Rights of Persons with Disabilities, 2006
- Convention on the Rights of the Child, 1989
- International Covenant on Economic, Social, and Cultural Rights
- International Covenant on Civil and Political Rights
- Convention concerning the Prohibition and Immediate Action for the Elimination of the Worst Forms of Child Labor.
- Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families
- International Convention on Oil Pollution Preparedness, Response, and Cooperation, 1990

2.6 ADB’s Safeguard Policy Statement, 2009

In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS builds upon ADB's previous safeguard policies on the Environment, Involuntary Resettlement, and Indigenous Peoples, and brings them into one consolidated policy framework with enhanced consistency and coherence, and more comprehensively addresses environmental and social impacts and risks. The SPS also provides a platform for participation by affected people and other stakeholders in the Project design and implementation.

The SPS applies to all ADB-financed and/or ADB-administered Projects and their components, regardless of the source of financing, including investment Projects funded by a loan; and/or a grant; and/or other means, such as equity and/or guarantees. ADB works with borrowers and clients to put into practice the requirements of SPS.

2.7 ADB Social Protection Strategy 2001

The Social Protection Strategy of 2001 is a set of policies and programs designed to reduce poverty and vulnerability by promoting efficient labor markets, diminishing people's exposure to risks, and enhancing their capacity to protect themselves against hazards and interruption/loss of income. The five components identified for social protection include labor markets, social insurance, social assistance, micro and area-based approaches and/or child protection.

2.8 ADB Gender and Development Policy 1998

The Gender and Development Policy (GAD Policy) of ADB is aimed at integrating gender issues in the Bank's macroeconomic sector and project work. The GAD strategy is based on consideration of social justice, gender equity and on substantial evidence that investments in women are vital to achieving economic efficiency and growth. The key elements of the GAD Policy include the following:

- Gender Sensitivity: to observe how ADB operations affect women and men and to take into account women's needs and perspective in planning its operations.
- Gender Analysis: to assess systematically the impact of a project on men and women, and on the economic and social relationship between them.
- Gender Planning: to formulate specific strategies that aim to bring about equal opportunities for men and women.
- Mainstreaming: to consider gender issues in all aspects of ADB operations, accompanied by efforts to encourage women's participation in the decision-making process in development activities.

Agenda Setting: to assist DMC governments in formulating strategies to reduce gender disparities and in developing plans and targets for women's and girls' education, health, legal rights, employment, and income-earning opportunities.

CHAPTER 3

Project Description

3 PROJECT DESCRIPTION

3.1 Project Overview

Muktagacha Solartech Energy Limited (MSEL or the Borrower) will develop, construct, and operate a 20 MW AC Solar Photovoltaics Power Plant on 68 acres of land. This project will also involve the construction of 200 m new overhead transmission line and installation of additional cable along the approximately 7.8 km existing overhead transmission line to connect the power plant to the existing Muktagacha substation owned by Bangladesh Rural Electrification Board (BREB), a state-owned entity responsible for rural electrification. The proposed PV Solar Power Plant is located in Muktagacha upazila in Mymensingh division, Bangladesh.

The client intends to develop a utility – scale grid – connected, ground mounted solar photovoltaic (PV) power plant project. The plant would provide a cost-efficient renewable energy source to supplement the existing energy provided by other sources to the grid. Based on the installation scale of the photovoltaic power plant and the voltage level of the surrounding grid, the appropriate voltage level for the photovoltaic power plant is 33KV, making it suitable to connect to the grid using a double-circuit three-phase line.

The plant would use a renewable method of generating electrical power by converting solar radiation into direct current electricity using silicon panels that exhibit the photovoltaic effect. Photovoltaic (PV) power generation employs solar panels composed of many solar cells containing silicone.

The plant capacity would be 29 MWp DC that would be transformed to 22.2 MW AC. The system would include the installation of the fixed array, where the module tilt angle is 16 degrees. In the plant, 625Wp monocrystalline silicon cell is selected as the solar cell module and a 300KW inverter is selected for the capacity of the inverter. The inverter will be connected to the boost substation after the first stage boosting through the local boosting transformer in the photovoltaic field, and then connected to the power system after the second stage boosting through the main transformer is proposed to be adopted for photovoltaic boost system, to deliver electrical energy economically, and reliably to the grid. Table 3-1 shows the key project information of the proposed project.

Table 3-1: Key Project Information

Project Company	Muktagacha Solartech Energy Limited, MSEL	
Type of Business	Solar Power Plant	
Project Location	Proposed Solar Power Plant	Union: Kashimpur and Mankon Upazila: Muktagacha District: Mymensingh
	Proposed Transmission Line Route	Union: Mankon, Basati and Ward-01, Upazila: Muktagacha District: Mymensingh
Proposed Solar Plant Configuration	29MWp DC/ 22.2MW$_{AC}$ Ground mount Solar PV Power Plant	
Contracted Plant Capacity	20 MW$_{AC}$ Solar PV Power Plant	
AC/DC Ratio	1.21	
Solar Power Plant Land Area	Approximately 68 acres	

Project Cost		34.67 Million USD
Transmission Line		As per the instruction from BPDB, the solar power will be injected into the grid via 33/11kV *Muktagacha* substation which is approximately 8 km northeast side from the proposed project site. MSEL plans to utilize a double-circuit power line configuration for their project. BREB will allocate an existing single circuit to MSEL for power evacuation purposes. For the additional circuit, MSEL will only need to install cables on existing poles. At present, there is a total of 264 poles along the transmission line route from solar power plant to Muktagacha substation. To connect the power plant to the nearest existing pole for both circuits, MSEL will require an additional 200 meters of overhead transmission line. This will involve installing two new poles along the existing right-of-way of the access road to the solar power plant. BREB will determine the specific locations for these two poles, though the exact placement has yet to be finalized.
Major Component of Proposed Solar Power Plant	**Photovoltaic Modules**	Module: Monocrystalline Silicon Module Each Module Capacity (DC rating): 630 Wp Total Number of Module:46368 Module manufacturer: JA Solar Module Model: JAM72D42-630/LB
	Photovoltaic Array	Installation Mode: Fixed Array Mounting Configuration: 2P Pitch (m): 7
	String	Modules per String: 28 String Count: 1659
	Inverters	Scheme: String Inverter Total Number of Inverters: 80 Inverter Model:SG320HX-20 Inverter Rating (KW): 300@51 DEG
	Transformer	Total Number of Transformer:8 Capacity: 3MVA
Project Duration		20 years from COD
PV Cleaning Water Volume		2 liters/module
Water Supply Source		Ground Water
Operation and Maintenance		Muktagacha Solartech Energy Limited, MSEL

Source: Technical Feasibility Report, May 2024, MSEL, and Plant Layout Plan

3.2 Project Site

Muktagacha Solartech Energy Limited (MSEL or the Borrower) will develop, construct, and operate a 20 MW AC Solar Photovoltaics Power Plant on 68 acres of land. MSEL has already owned 54.96 acres

of land through lease and purchase. As per the latest information provided by MSEL, 51.95 acres (76.40%) of land has been taken from 110 landowners for lease for 22 years, and 3.01 acres (4.43%) have been purchased from 27 local people through a willing buying and willing selling process. Their purchase work is still ongoing with 6 local people for 3.47 acres (5.10%) of land. Moreover, they are also trying to purchase 9.57 acres of land (14.07%) more from approximately 10 landowners. The land inside the project boundary is at least 4m to 25m elevated from mean sea level (source: DEM, 2024). Currently, concrete poles have been positioned at regular intervals around the proposed power plant area to designate its boundaries. Land requirement for the project is shown in Table 3-2.

Table 3-2: Land Requirement for the Project

Component	Location (Union)	Land Area requirement (acres)	Previous landowner
Transformer Area (total 8)	Both in Nimuria (4) and Raghunathpur (4)	1.16	Private
Substation/MCR	Nimuria	0.4	Private
Barrak room	Nimuria	0.12	Private
Warehouse	Nimuria	0.15	Private
Others (Dorm, kitchen)	Nimuria	0.13	Private
Solar plant installation	Both in Nimuria and Raghunathpur	60	Private
Road	Both in Nimuria and Raghunathpur	2.64	Private
Weather Station	Nimuria	0.4	Private
Transmission line (each pole)	Nimuria	8 km 300 mm dia/2 sq ft	Transmission line will utilize existing BREB posts within existing road right of way. Additional 2 poles at the existing right of way of the access road of the solar power plant will be installed. BREB has not finalized the specific location yet.
Security Cabin & security post in the boundary area	Both in Nimuria and Raghunathpur	0.6	Private
Temporary project component and facilities, and vacant Area	Both in Nimuria and Raghunathpur	2.4	Private
Total		**68 acres**	

Source: MSEL, 2024

According to GIS and Drone Survey (2024) on proposed solar power plant area, the majority of the land is wetland, occupying 46.9 acres (61.4%) and is not utilized for agriculture or fish farming. The remaining land is used for seasonal agriculture and fish farming, covering 0.8 acres (0.9%) and 26.7 acres (37.7%) respectively. Up until 20 years ago, the area remained largely the same; however, at that time, there was no water hyacinth, and locals used to cultivate Boro paddy, a local variety of rice suitable for low-lying areas that can withstand flooding. About 15 years ago, water hyacinth completely overtook the area, and the cost of removing these aquatic plants became prohibitively high due to their invasive nature and exponential growth. Considering the high cleaning costs, utilizing this land for growing paddy became economically unfeasible, leading the locals to abandon the area.

The boundaries of the proposed solar power plant area are –

- **North:** Residential Area and Road
- **South:** Pond and Agricultural Land
- **East:** Pond and Agricultural Land
- **West:** Road and Agricultural land

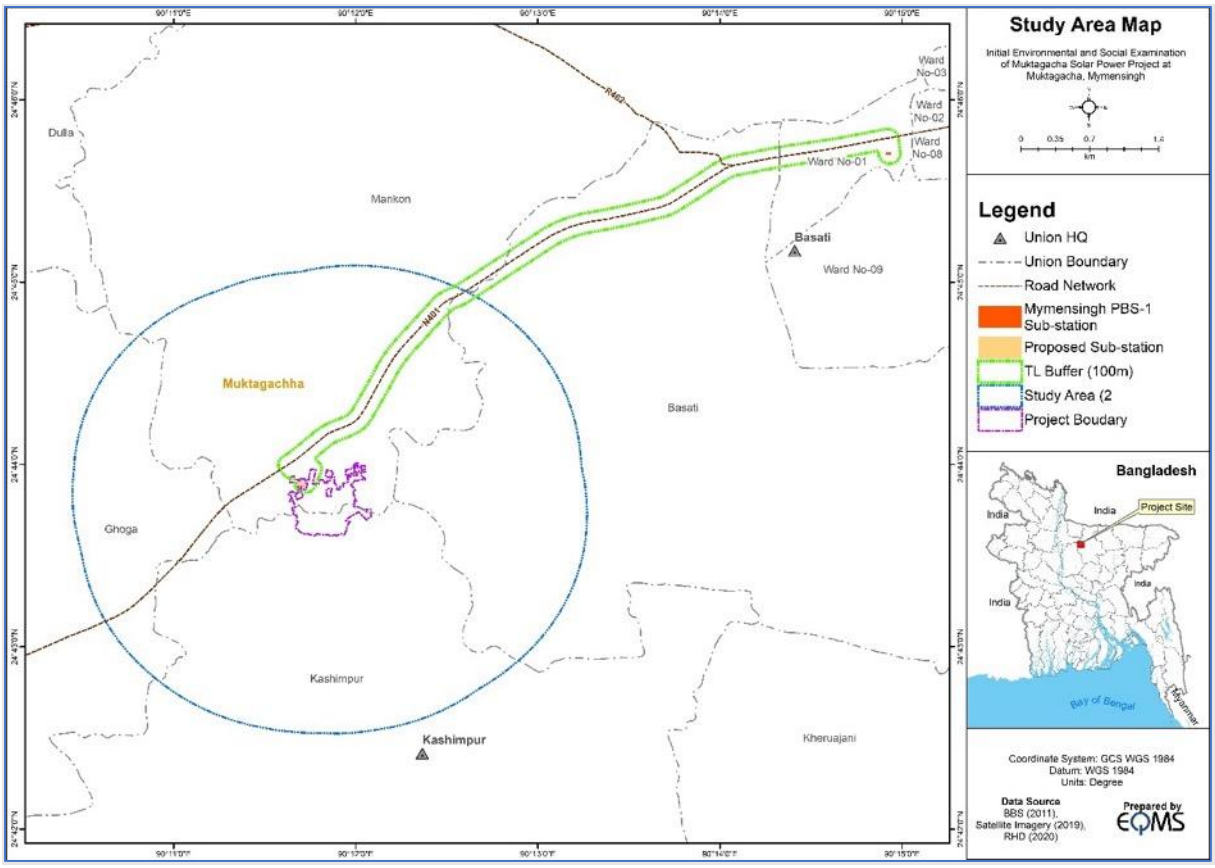
Tabular presentation of the geographical location of the power plant site and transmission line route is given in Table 3-3.

Table 3-3: Tabular Representation of the Geographical location of the Project

Power Plant Boundary		Transmission Line Route	
North	24°43'58.36"N 90°11'46.36"E	Start Point (proposed substation of the solar power plant)	24°43'58.25"N 90°11'45.19"E
South	24°43'35.14"N 90°11'52.60"E		
East	24°43'47.71"N 90°11'38.47"E	End point (33 KV Muktagacha Substation)	24°45'45.42"N 90°14'56.20"E
West	24°43'51.23"N 90°11'59.86"E		

The location of the proposed project site is shown in Figure 3-1

Figure 3-1: Location Map of the Project Area



Source: EQMS, 2024

As per Technical Feasibility Report May 2024, the general slope of the terrain of the proposed solar plant is from northwest to south east direction. The general slope of the terrain will effectively channelize any flow towards the downstream (south east direction) of the plant boundary. However, during site visit it has been noted that currently, there is no water drainage system in the proposed project area. There was a drainage system from the proposed project land to the Dorar Khal through which the rainwater passed. The total length of the drain was around 1 to 1.5 km. But due to the new agricultural lands, fish farms and buildings being constructed there, the drainage system got blocked. According to consultations with local residents about 15-20 years ago, during excessive flooding, barriers were removed to prevent the surrounding areas from being inundated and to allow the floodwater to flow naturally through the canal.

Right now as there is no canal, channel or drainage system to pass the water.

As per Contour Survey Report, July 2023 there is another water body present which is about 1024 m NW from the power plant site. The water level at the areas is about 10.63 m. This canal is the closest one to the power plant which has flow. However, there is no existing connection between the power plant site and this canal.

Figure 3-2 shows the selective photographs of the Project Site. Figure 3-3 and Figure 3-4 show contour survey map of the existing water system around the project site.

Figure 3-2: Selective Photographs of the Project Site

Residential Area near north side of the project area

Agricultural field

Aquaculture ponds

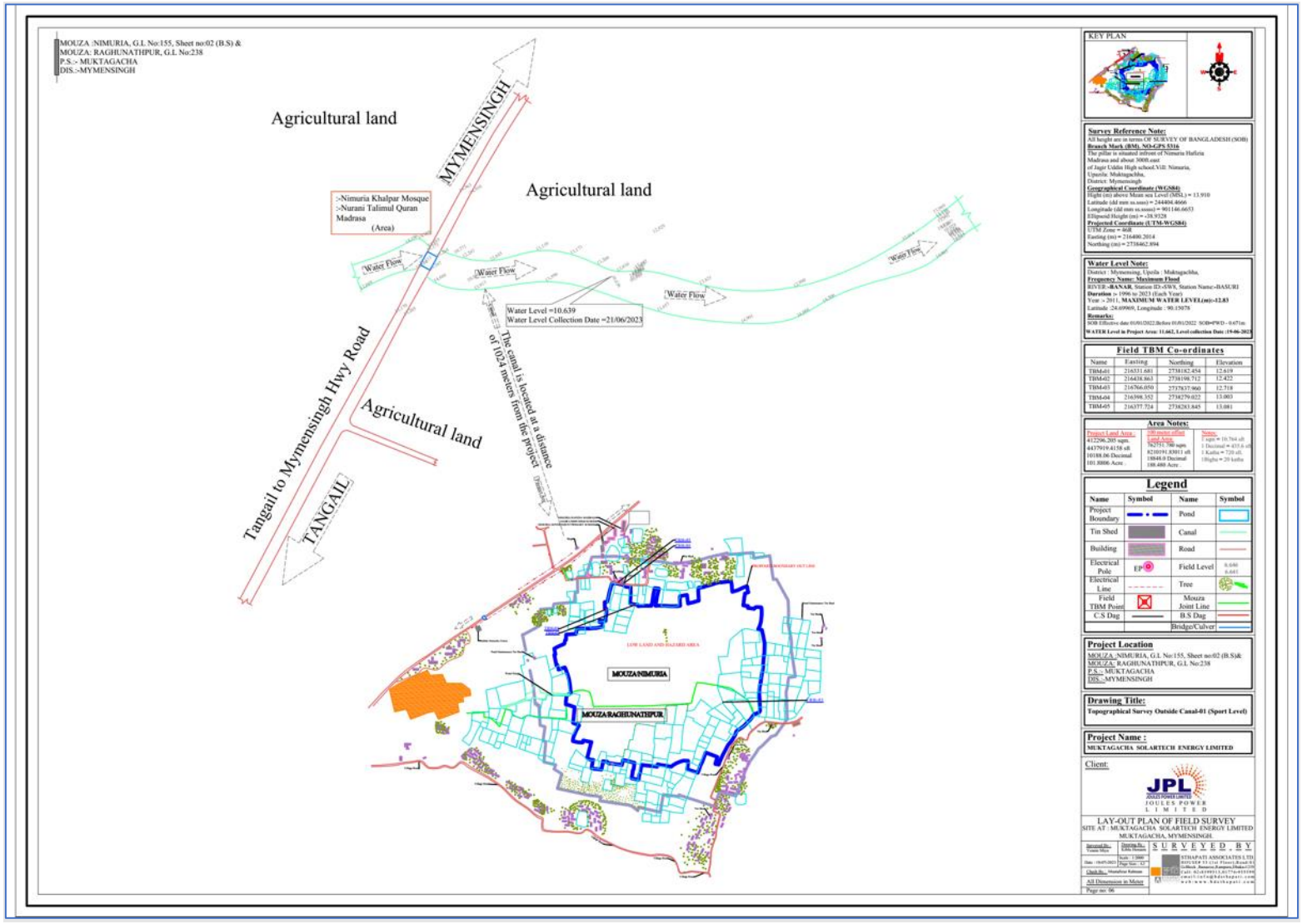
Water hyacinth grows on *beel* area

Transmission line route

Dorar Khal (through which rainwater passed) situated at East South East location from the project site

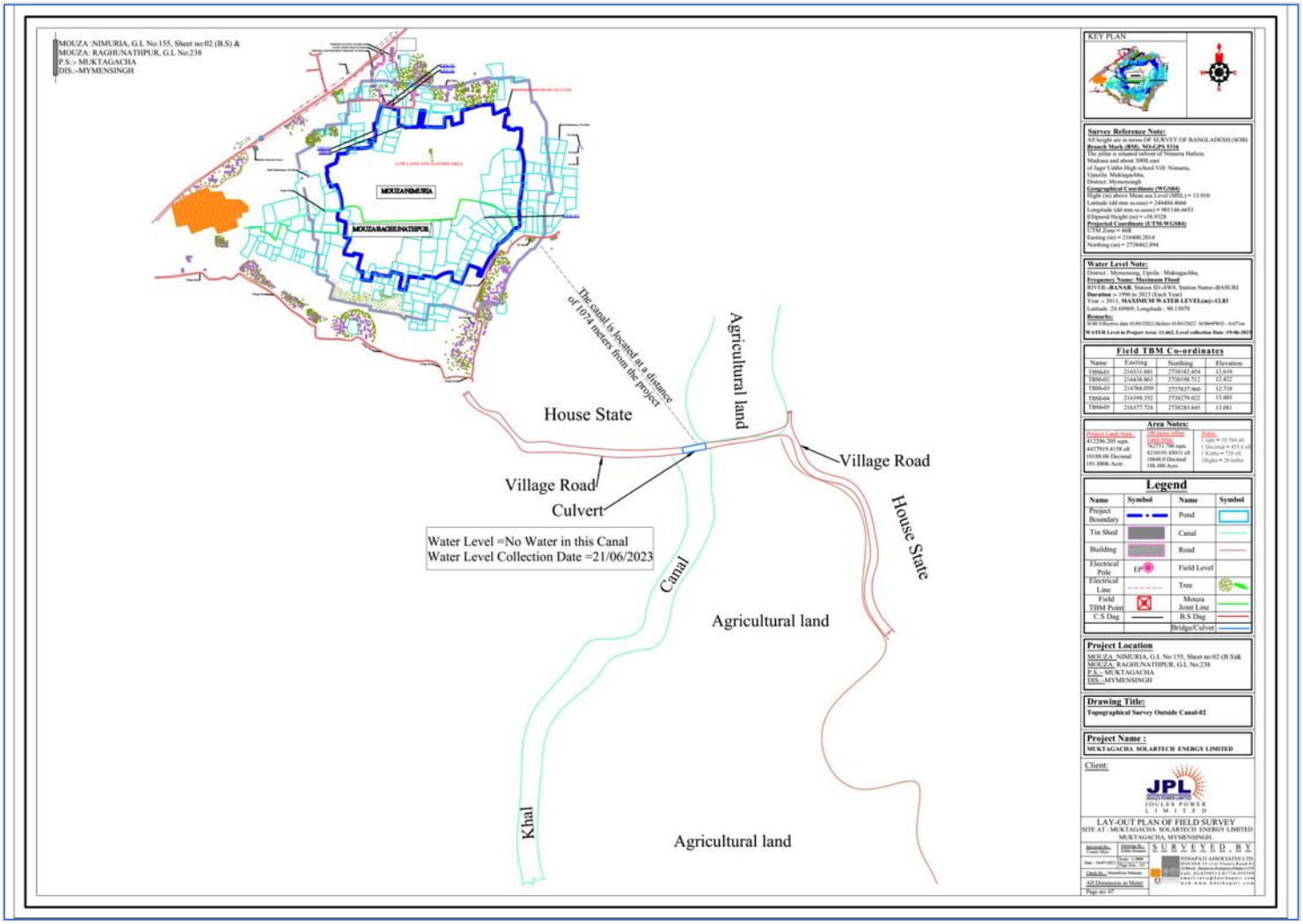
Source: EQMS Field Study Team, April 2024

Figure 3-3: Map of the Outside Canal-01 (Existing Water System, Nimuria End)



Source: MSEL, May 2024

Figure 3-4: Map of the Outside Canal -02 (Existing Water System: Raghunathpur End/Dorar Khal)



Source: MSEL, May 2024

3.2.1 Access to the Site

The site is accessible from Nimuria and Raghunathpur end from National highway (N401). As per discussion with the project authority, the project will use Nimuria end road as a power plant site access road. At Nimuria end, the site is accessible via an existing 3m wide approach road from highway road (N401) to access the site. The present condition of the project site approach road is given in Figure 3-5.

Figure 3-5: Present Condition of the Project Site Road

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Approach towards site</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Approach towards site</td><td>Approach (towards N401)</td></tr>
</table>

Source: Field Study Team, April 2024

3.2.1.1 Highway

The project site is accessible from Dhaka through Tangail-Mymensingh Highway (N401). The site is about 140km away from the city of Dhaka, the capital of Bangladesh. This is a relatively developed highway road near the site, and the highway is on 226m from the northwestern boundary of the project site. The N401 road is an asphalt concrete road. The condition of the highway (N401) is good and ensures good connectivity of this part of the Upazila to the neighboring districts viz. Rajshahi and Dhaka. The present condition of the existing highway road is given in Figure 3-6.

Figure 3-6:Access Road: National Highway (N401) Road

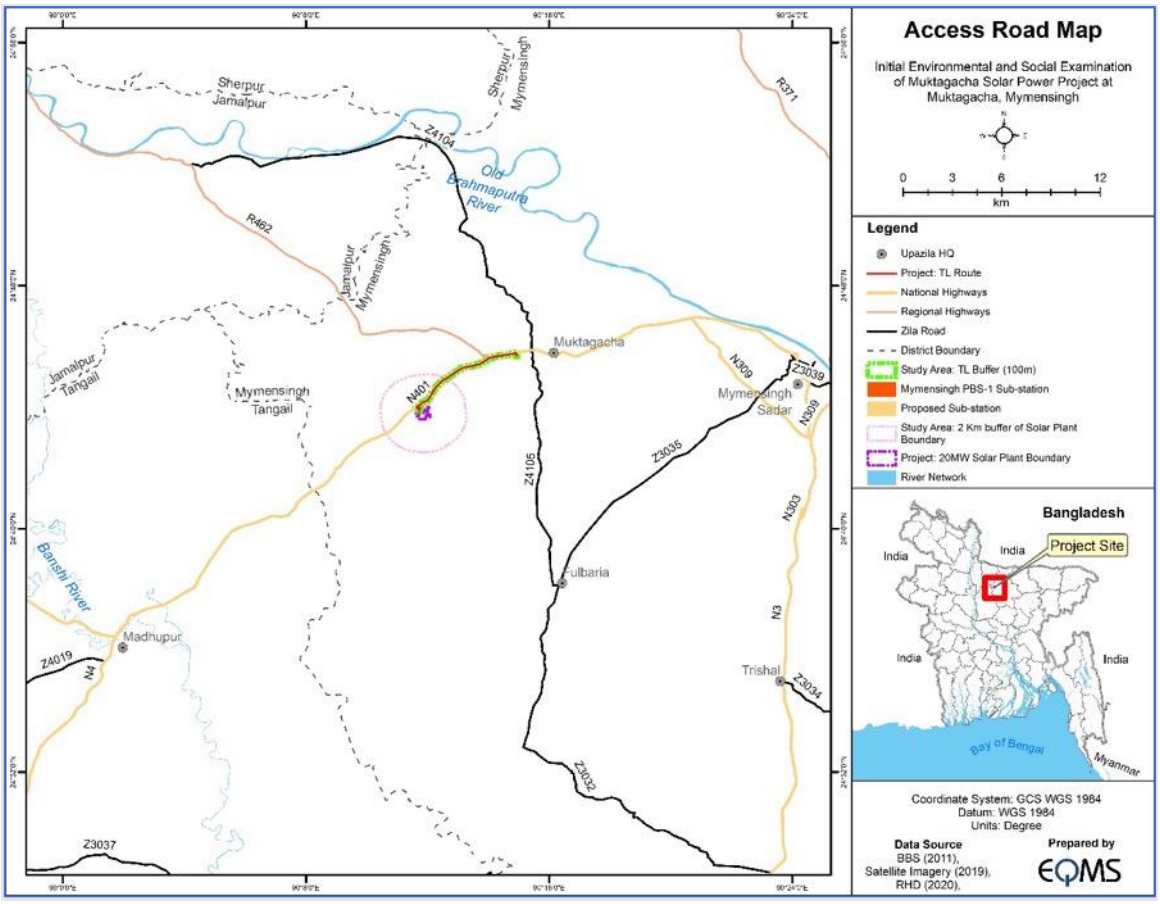


Figure 3-7: Present Condition of the National Highway (N401)

Source: Technical Feasibility Report, May 2024

3.2.1.2 Railway

There is no direct or nearest connection between the project site to the railway station. The nearest station is Mymensingh railway station. The approximate ariel distance is about 18km. This route will not be used for any kind of project activities.

3.2.1.3 River Transportation

135 meters wide *Shitalakshya* River is located at a distance of 12.5km from the northeast plant boundary. This route will not be used for any kind of project activities.

3.2.2 Key Features of Site and Surroundings

The details of the site setting, and surroundings of the proposed project site are given in Table 3-4.

Table 3-4: Salient Features of the Project Site and Surroundings

SL#	Particulars	Details
1.	GPS Coordinates of the Power plant site	24°43'51.12" N 90°11 '53.12"E
2.	Administrative Location	Union: Kashimpur and Mankon, Upazila: Muktagacha District: Mymensingh
3.	Climatic Condition	Temperature: The data analysis of 32 years shows that the monthly maximum temperature varies from 29.5°C to 38.1°C whereas the monthly minimum temperature varies from 4.7°C to 22.8°C. Humidity: Monthly Average Relative humidity in the area is generally above 80% from May to December. Rainfall: The annual average of total rainfall is recorded as 2205.9 mm/year.
4.	Area of the Project	Approximately 68 acres
5.	Nearest Water Bodies	The nearest river is Shitalakshya about 12.5 km away from the power plant site.
6.	Nearest Highway	The nearest highway is the Tangail-Mymensingh highway which is about 226m NW from the power plant t site.
7.	Nearest Railway Station	The nearest railway station is Mymensingh station, which is about 18 km away from the power plant site
8.	Archeological Site	The nearest archeological site is the Muktagacha Shiva temple, which is about 6.75 km from the proposed solar power plant site.
9.	Protected Areas (Pas)	No reserve or protected forest area was found in the study area. The nearest National Park is Madhupur national park which is only 4.9 km away from the power plant site.
10.	Ecologically Critical Area (ECAs)	The nearest ECA from the proposed project site is Tanguar haor which is 91.17 km away from the proposed power plant
11.	Ramsar Sites	The nearest Ramsar Site is the Sundarbans Reserve Forest (92km)
12.	Important Bird Areas (IBAs)	The nearest IBA is Madhupur National Park (5km)
13.	Seismicity	As per the Bangladesh National Building Code (BNBC) 2020, the project site is situated in Zone-4 (seismic coefficient is 0.36 g)

SL#	Particulars	Details
14.	Risk	Flooding, Seismicity/Earthquake, Lightning
15.	Socio-economic factors	No resettlement and rehabilitation

3.3 Project Component

The project component during construction and operation phase mainly includes the:

- Construction Phase facilities will be mainly temporary and will be removed before COD:
  - **Site office:** For the site office setup, MSEL plan is to use two container offices with the following specifications: These containers will serve as temporary offices for project managers, engineers, and administrative staff working on-site. Total two (02) container will be deployed. Dimension of each container will be length of 40ft (12.2 meters), a width of 8ft (2.44 meters), and a height of 8.5ft (2.59 meters) The container offices will be equipped with the necessary amenities to facilitate the day-to-day operations and project management activities. These facilities are office room, sanitary facilities, kitchen etc.
  - **Storage Area:** One container will be used for storage area. Storing of construction materials, tools, and equipment etc. Dimension of the container will be 19' 4" long x 7' 9" wide x 7' 10" high.
  - **Labour Shed:** A plot of rented land, measuring approximately 0.3 acres (30 decimals), will be used for temporary labor housing. A dormitory will be constructed to accommodate thirty (30) workers and twenty (20) security personnel. This dormitory will feature essential amenities, including four washing facilities and one cooking facility. The dormitory will have dimensions of 75 feet by 15 feet. This will be semi pucca house.
  - **Other Facilities:** Sanitary facilities, medical facility (first aid box), security facility, drinking water facility, CCTV camera coverage (construction site, residential area, office area), electricity coverage and safety signage to facilitate the day-to-day operations and project management activities.
- Operation Phase Facilities:
  - **Main Component:** solar power plant (PV module, inverter, module mounting system etc.) and overhead transmission line.

Auxiliary Component: UPS, oil filled auxiliary transformer, control room, battery room, main control room. Warehouse and maintenance shed, guard barrack, etc. Details of the operation phase components given below:

3.3.1 20MW$_{AC}$ Power Plant

The proposed 20MWAC plant is a utility scale grid interactive PV plant. It will be ground mounted solar panel. MSEL is planning to install their proposed solar park (PV-based power plant) at 68 acres of land. For simulation, JA make PV modules with 625Wp panel and Sun grow string inverter (SG320HX-20) are considered. The performance ratio of the system is 84.35%. The simulation result shows an annual energy yield of 42,221.12 KWh for the first year.

The main components of the grid connected solar plant are PV modules, inverters, module mounting system, step up transformer, grid connected interface etc. Moreover, inside the project boundary warehouse, guesthouse, substation, will be developed.

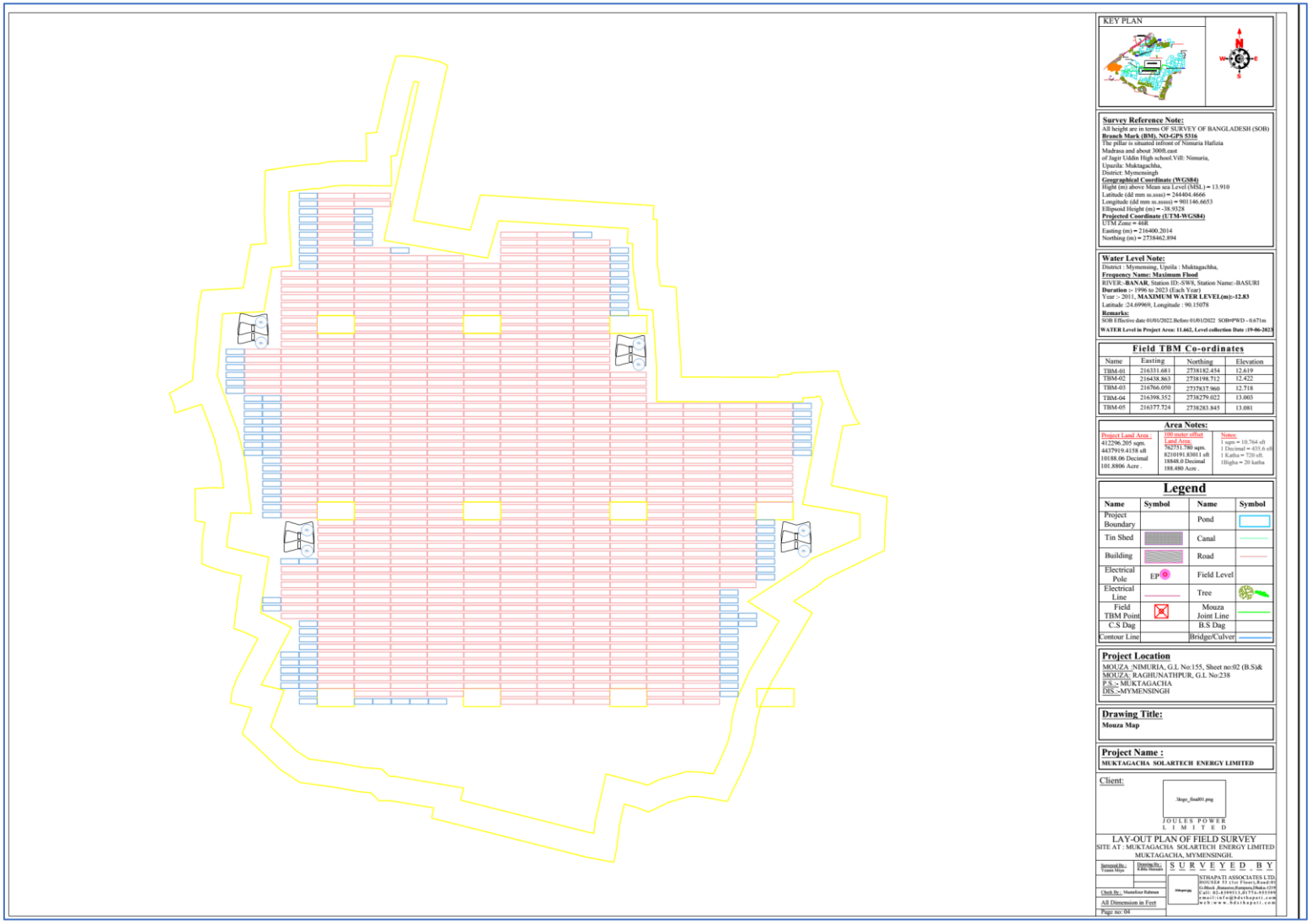
- **Module Selection:** In the plant, 46368 pieces JA make 625/630 Wp monocrystalline silicon photovoltaic modules will be used.

- **Inverter:** String inverter scheme is adopted at the current stage of the project. String inverter concept uses multiple inverters for multiple strings of modules. String inverters are being used as they can cover a very wide power range and can be manufactured more cheaply on a production line than central inverters. Additionally, they provide MPPT on string level, with all strings being independent of each other. String inverters can be placed close to PV array, which leads to shorter DC cable length and lower DC cable loss. 80 sets of inverters have been selected for the project. There will be isolated transformers in the grid-connected inverter. The String inverter signals will be monitored through the SCADA System through PLCC Communication.
- **Module Mounting System (MMS):** Considering the Global tilted Irradiation, specified yield, module mounting structure cost, ground coverage ratio, economy, maintenance and other factors, a fixed installation method is adopted for the project at the current stage. Therefore, the optimum fixed tilt angle of the cell module in this project is determined to be 16 degrees. The total pile height will be 4.5 m, in where total Height of pile above the (High flood level) HFL is considered 0.7 m Also, the foundation for the MMS will consist of prefabricated hollow concrete (PHC) piles, which will be supplied by a PHC pile manufacturer.
- **Step up transformer:** The output from inverters generally requires a further step-up in voltage to reach the AC grid voltage level. The step-up transformer takes the output from the inverters to the required grid voltage depending on the level of power evacuation. A total of 8 transformers with capacity of 3MVA each is proposed for this project.
- **Electrical Substation/Main Control Room (MCR):** MSEL plant to install a Electrical substation/Main Control Room (MCR). It functions as a key component in managing and distributing the electrical power generated by the solar panels. The Substation will be located on the North side of the PV Plant. The Switchyard interconnects the PV Plant with to existing Muktagacha Substation through a double over head transmission line. The PV substation will be equipped the 33kV MV switchgear panel and the metering panel located on the PV site. The 33kV MV switchgear will be equipped with the incomer feeders, four feeders from the smart transformers stations, an auxiliary transformer and a spare feeder. In the output
- **PV Connector:** Two types of connectors will be required. One is an MC4 connector. This type of connector will be made of polycarbonate materials and zone resistant, halogen-free, dustproof, non-conductive, UV resistant, ammonia resistant and inflammable. Connectors shall be suitable for an ambient temperature range of -40°C to 90°C and the upper limiting temperature shall be 105°C when connected. Another one is Y connector. Y connectors s Shall be hermetically sealed pre-assembled over molded type ready to plug with module connectors. Maximum designed temperature shall be considered as 90°C and humidity of 95%.
- **Earthing:** It shall be provided for all telecommunications and electronic facilities.
  - PV module earthing and components shall be considered as per module manufacturer guideline.
  - The earthing system for solar array shall consist of earth mat/Earth grid to be laid at the depth of 600 MM below the ground. Earth mat shall be a mesh of interconnected bare Cu wire or Cu strip laid in the solar farm for the purpose of earthing/grounding.
  - The earthing network within the PV plant shall be of bare Cu wire or strip. Each piece of equipment shall be earthed through a suitably sized earthing conductor. Each piece of equipment shall be earthed through an additional protective conductor for equipotential bonding.

- All the earthing stations shall be provided with test links and located at 150mm above ground level in an easily accessible position for testing.
- Lightning arrestors earthing system shall be interconnected to main earth grid for equipotential bonding.

Each MV transformer/Smart Transformer Station shall have a minimum of four dedicated earthing stations. All the cable trays installed shall be earthed after every 2mtrs. Figure 3-8 shows the plant layout map.

Figure 3-8: Plant Layout Map



Source: MSEL, November 2024

3.3.2 Auxiliary Power System

Auxiliary power system for this project will be for the auxiliary loads such as indoor and outdoor lighting, fan, AC, Barrack Room, Warehouse, 110V DC converter units, and SCADA monitoring system and UPS etc… This comprises of dedicated auxiliary transformer connected to the 33kV switchgear located at MCR with suitable protective equipment.

In this project each Smart Transformer Station shall have its own auxiliary power supply system comprising of Auxiliary Transformer, UPS, AC distribution board will be covered in Smart Transformer Station. Distribution boards shall be of form 3B.

3.3.3 Energy Yield Assessment

Sgurr Energy, the appointed firm for conducting feasibility study has computed the annual energy yields for 29MWp DC/ 20MWac Solar PV plant using the basic designs and indicative layout. N-type Monocrystalline PV module technology with String inverters and fixed tilt type Module mounting structure was used for designing the project.

P50 Energy Yield Predictions

This section presents the independent energy yield prediction for the 20MWAC solar PV Plant with JA Solar PV modules and Sungrow inverters. Table 3-5 summarizes the solar PV power plant, the available resource, the losses and the predicted P50 yields.

Table 3-5:Energy Yield Prediction for Proposed 20 MWac Solar PV Plant

SL#	Energy Yield Prediction for 20MW$_{AC}$ PV Plant	
1.	DC Capacity (MW$_P$)	29.02
2.	Installed AC Capacity (MW$_{AC}$)	22.20
3.	Contracted AC Capacity (MW$_{AC}$)	
4.	Pitch (m)	7.0
5.	Tilt Angle (°)	16
6.	**Solar Resource (SolarGIS data)**	
7.	Annual global horizontal irradiation (kWh/m2)	1623.2
8.	Global irradiation incident on collector plane (kWh/m2)	1725.10
9.	Transposition factor	1.06
10.	**Losses**	
11.	Horizon Shading	0.00%
12.	Incident Irradiation Below Threshold	0.00%
13.	Near Shading	1.70%
14.	Incident angle	0.14%
15.	Soiling	2.00%
16.	Reflection on Front Side	-0.02%
17.	Gain from Bifaciality	-2.30%
18.	Low irradiance	-0.16%
19.	Module temperature	5.07%
20.	Electrical Shadings	0.11%

SL#	Energy Yield Prediction for 20MW$_{AC}$ PV Plant	
21.	Module quality	0.00%
22.	First Year Degradation	1.00%
23.	Module mismatch for front side irradiation	0.50%
24.	Module mismatch for rear side irradiation	0.22%
25.	DC ohmic	0.49%
26.	Inverter performance	1.18%
27.	AC ohmic	1.04%
28.	Inverter Transformer	2.11%
29.	Power Transformer	0.00%
30.	MV Cable Loss	1.12%
31.	Transmission line loss	0.00%
32.	Auxiliary Consumption 0.40	0.40%
33.	Plant + Grid Unavailability	1.00%
34.	Unused Energy (Grid Limitation)	1.28%
35.	**First Year P50 Energy Yield (MWh/annum)**	**42,221.12**
36.	**First Year Specific Yield (kWh/kWp)**	**1,455.15**

Source: Feasibility Report, May 2024

3.3.4 Power Evacuation and Transmission Line

The electricity generated by the Solar Power Plant will be transmitted to the current 33/11kV Muktagacha substation of BREB situated in Muktagacha, Mymensingh. The distance from the Muktagacha substation to the proposed solar PV plant is approximately 8 km, which is within the acceptable range for the 33kV voltage level considering the capacity of 20MWac. Muktagacha 33/11kV substation is linked to the 132/33kV Mymensingh substation through the Muktagacha feeder, which is roughly 18km away (source: Feasibility Report, May 2024).

The power will be evacuated through switching substation of solar power plant. MSEL plans to utilize a double-circuit power line configuration for their project. BREB will allocate an existing single circuit to MSEL for power evacuation purposes. For the additional circuit, MSEL will only need to string cables on existing poles. The power will be transmitted via an overhead transmission line, following the established route originating from the Muktagacha substation (see Figure 3-11). There is a total of 264 poles along this route. To facilitate the connection of the power plant to the nearest existing pole for both circuits, MSEL will require an additional 200 meters (Figure 3-11) of overhead transmission line. This will involve installing two new poles along the existing right-of-way of the access road to the solar power plant. BREB holds the authority will determine the specific locations for these two poles, though the exact placement has yet to be finalized.

In the context of transmission line stringing, bracket will be required to hold or secure components such as insulators or conductors during the stringing process.

Power Distribution Overview within the power plant site: A dedicated internal connection within the plant will be developed to channel power from the Inverter Control Room to the Main Control Room. From there, the power will be distributed as required, and will be managed and controlled for optimal operation of the plant. Distribution lines within the plant site will be installed underground to ensure safety and reliability.

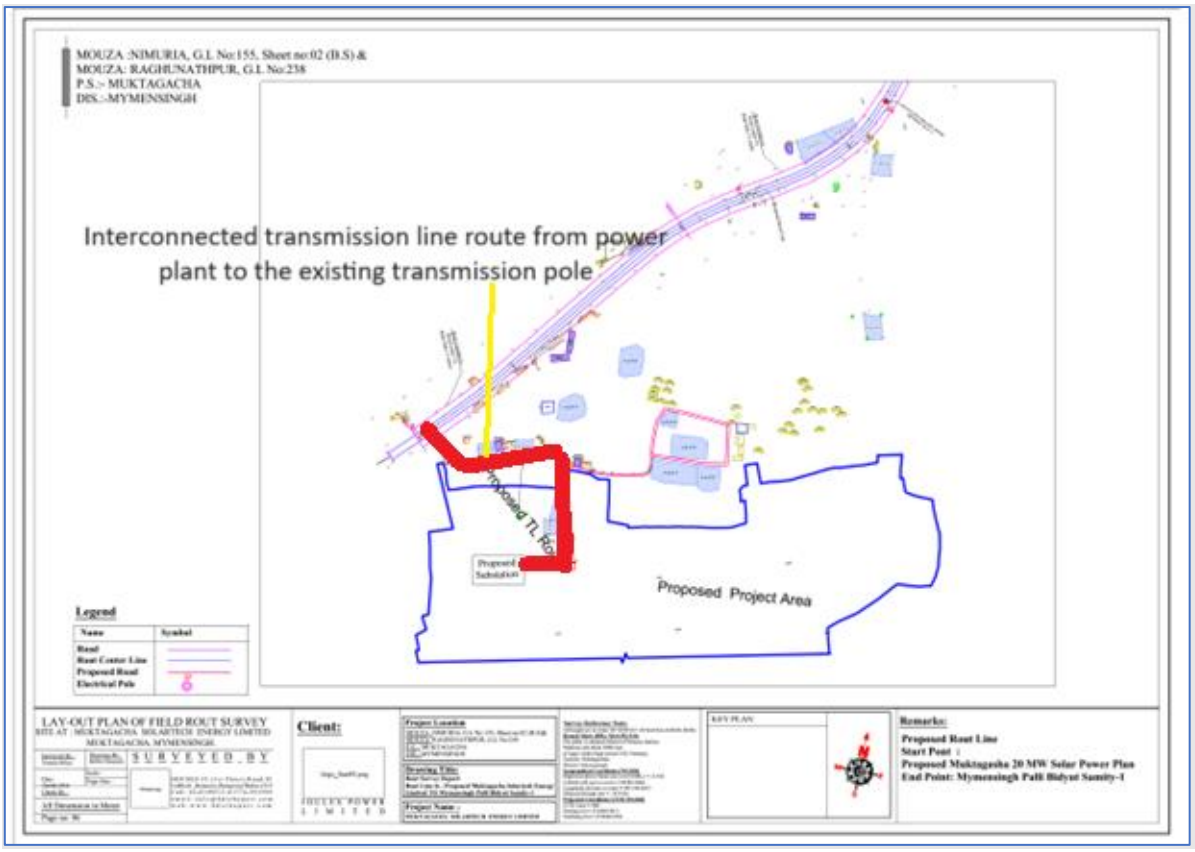
Additionally, there is the possibility of constructing a new line bay in the switchyard of the Muktagacha 33/11KV Substation, Figure 3-9 shows the existing transmission line route and proposed bay terminal area.

Figure 3-9: Existing Transmission Line Route and Proposed Bay Terminal Area at 33/11 KV Substation

	
Existing transmision line route situated on the right side from power plant site to the Muktagacha Substation	Proposed bay terminal area at 33/11 KV substation

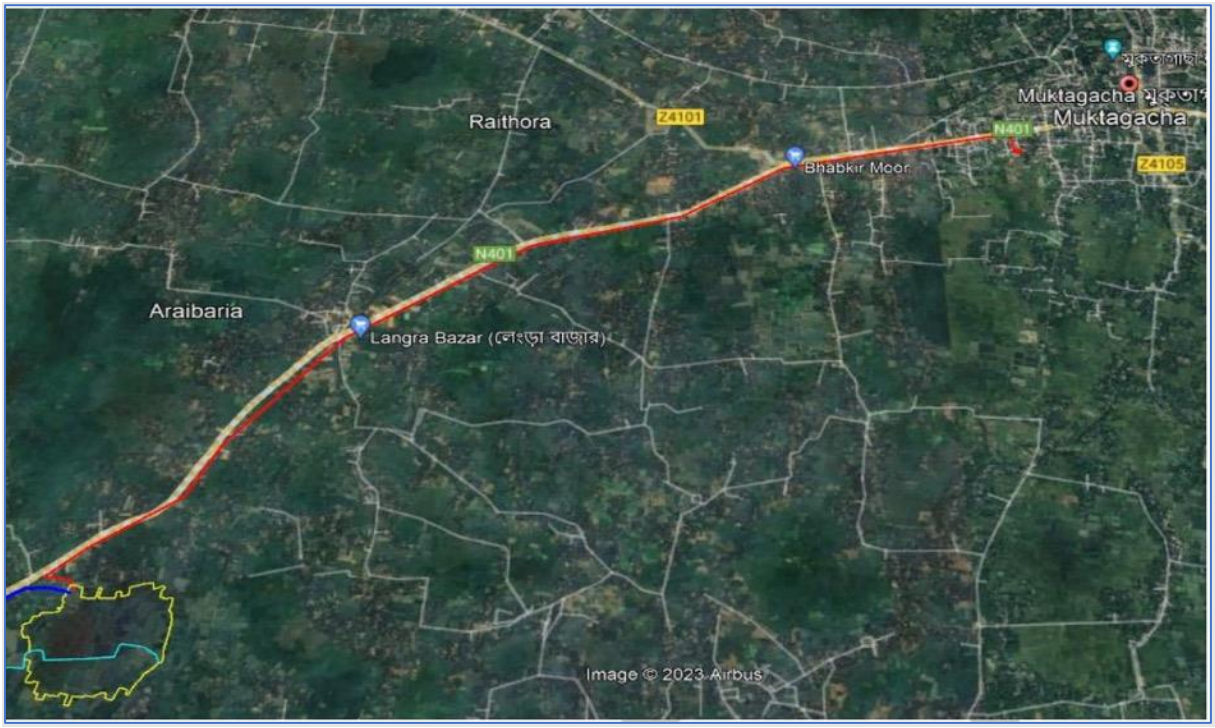
Source: EQMS Field Survey, May 2024

Figure 3-10: Proposed Additional Transmission Line Route from Solar Power plant to Nearest Transmission Tower (200m)



Source: MSEL, 2024

Figure 3-11: Proposed Transmission Route from Solar Power Plant to the Muktagacha Substation



Source: Feasibility Report, May 2024

3.3.4.1 Power Evacuation Process

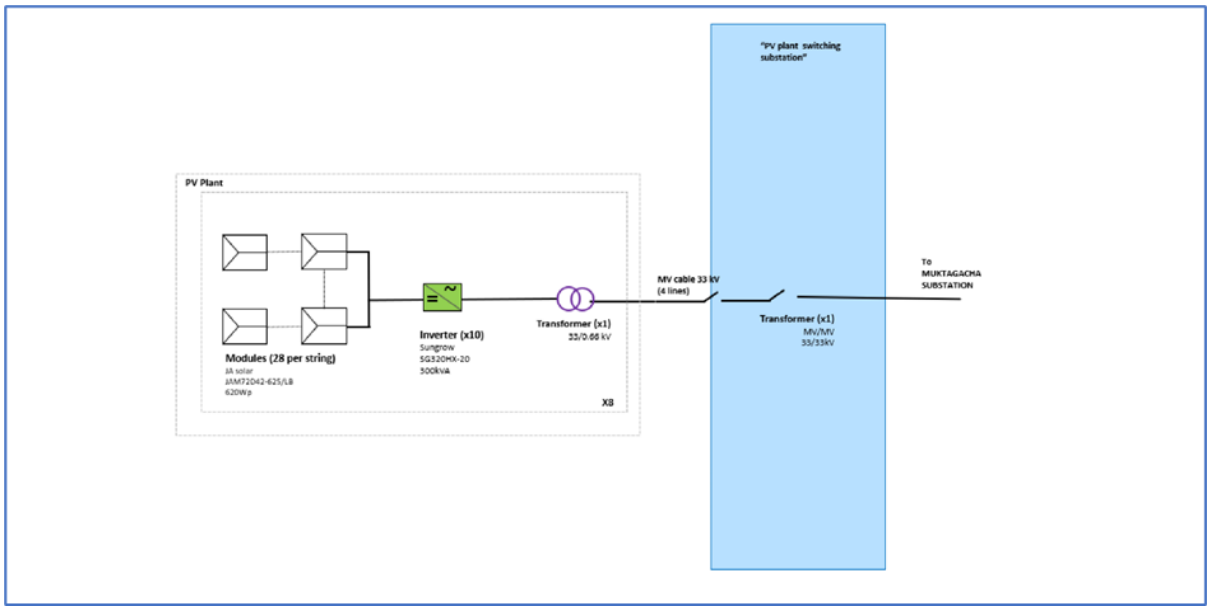
In a PV system the modules are arranged in series to create strings, the connection of modules in series is made on the modules themselves. For this project, all the strings of the solar array will be consisting of 28 PV modules. In order to obtain higher current values, photovoltaic strings will be connected in parallel in the PV inverter. Each inverter collects twenty or twenty-one strings.

The PV inverter will convert the Direct Current (DC) into Alternating Current (AC) and export the energy in a voltage of 0.8 kV. Each group of inverters will be connected to LT panel of a smart transformer station where the energy of ten (10) inverters will be collected. From the LT panels the energy will pass to the LV/MV transformer (3,000 kVA @ 51C) to step up the output voltage (0.8 kV) from the inverter to the Medium Voltage (33kV).

The Smart transformer station or Power Stations will be composed of one LV/MV transformer (0.8/0.8/33 kV), MV switchgears, LT panels, auxiliary power supply services and communication panels. Each power station has rated power 3.0 MVA. The Power Stations will be interconnected through the MV collector system to the Electrical PV Substation.

The MV collector system has been designed in radial configuration. The 8 Power Stations will be interconnected through 4 MV circuits to collect the produced energy of each Power Station. The MV lines will be collected in a switching substation through underground cable where will be installed the MV switchgear panel and the metering panel equipment for the PV plant. From this electrical substation the energy export will be conducted to Muktagacha Substation through a double over head transmission line with gross beak conductors. In the following figure it is shown the technical scheme of the PV plant with the basic electrical configuration.

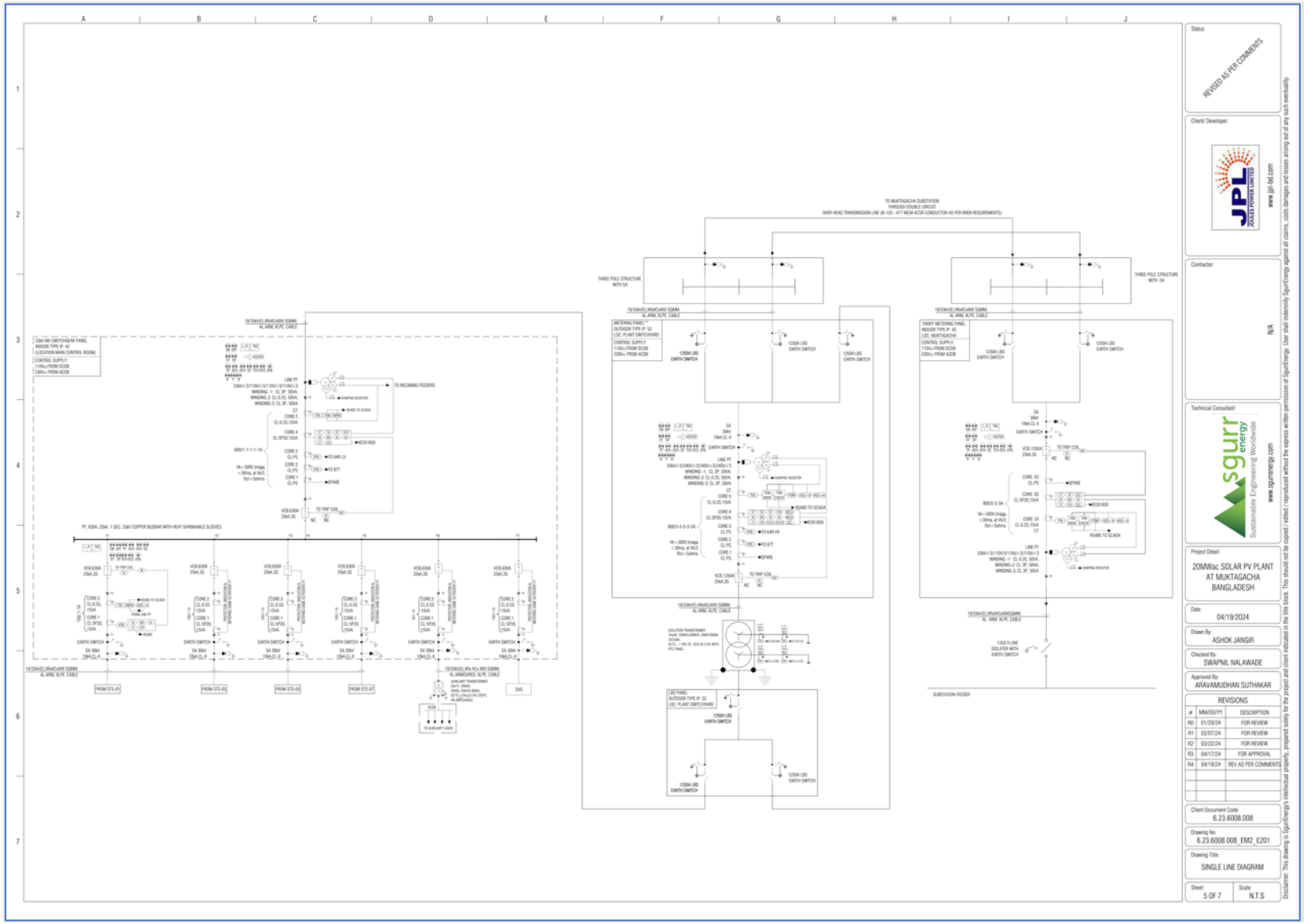
Figure 3-13: Technical Scheme of the PV Plant with Basic Electrical Configuration

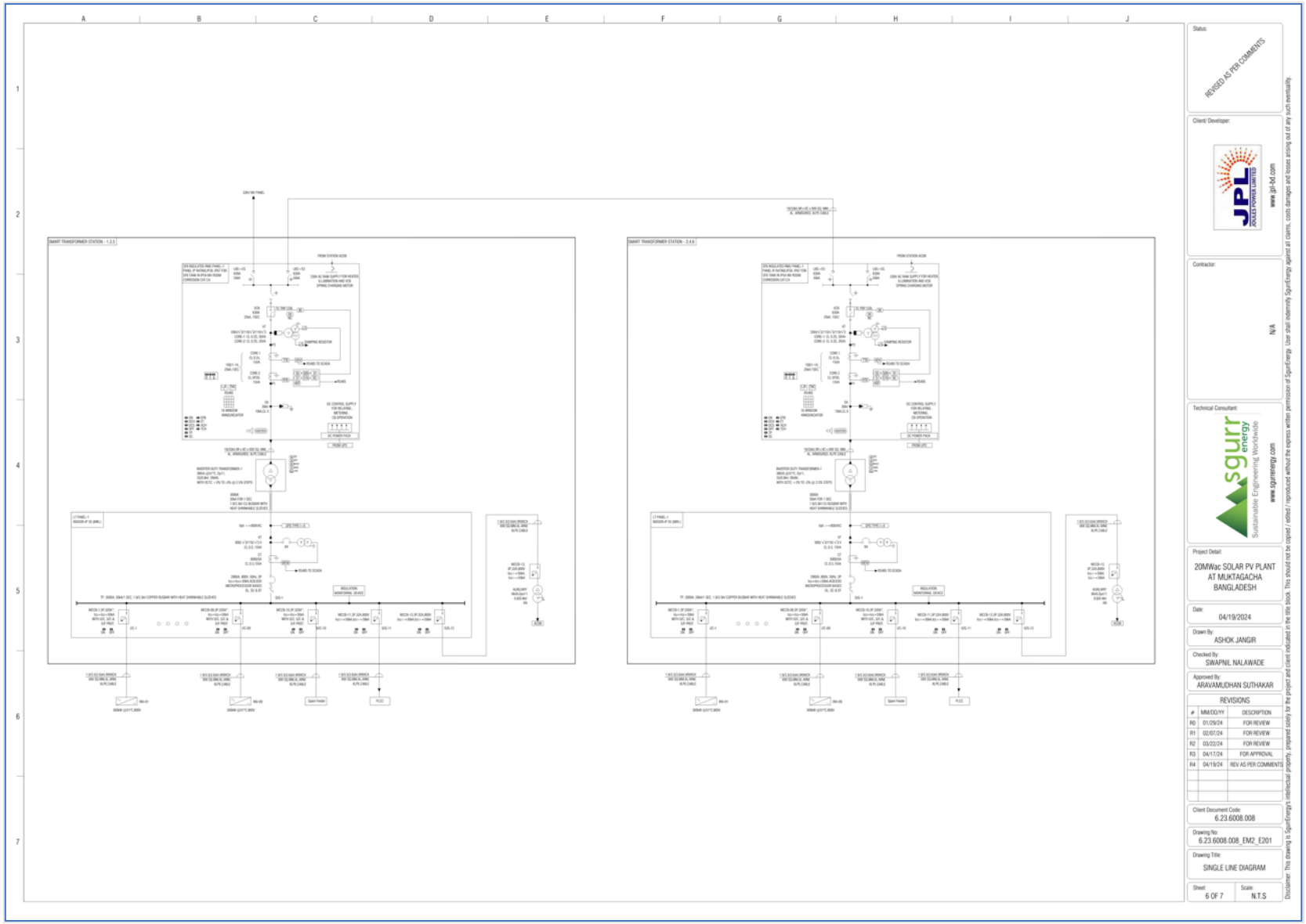


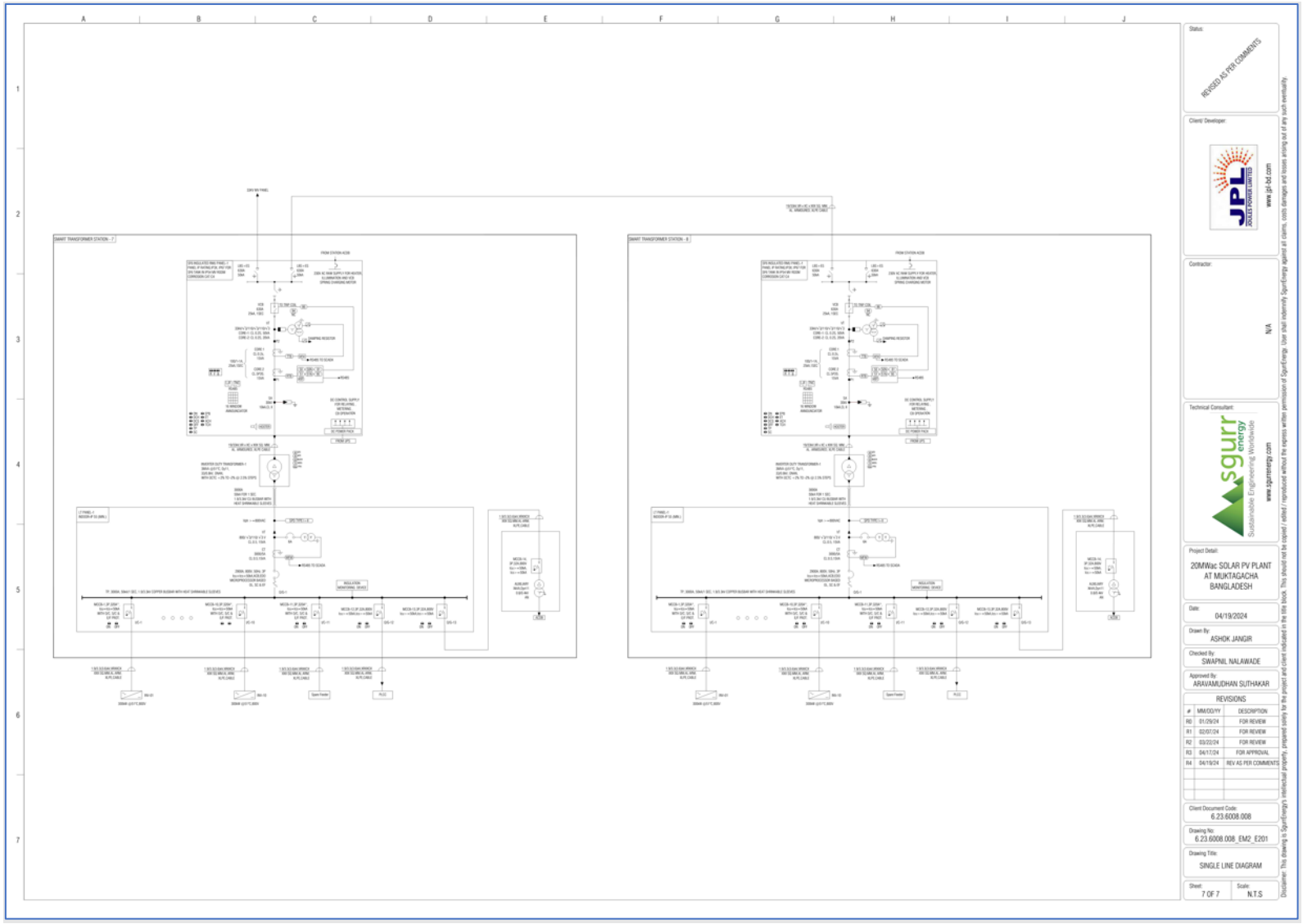
To measure the power generated from the proposed project, the energy meter will be installed at the interconnection point of 33 kV incoming line from the proposed project and 33 kV bus of BREB's Muktagacha 33/11 kV substation.

The electric power to be generated by the project will be evacuated through 33 kV bus of BREB's Muktagacha 33/11 kV substation by constructing necessary electrical interconnection facility i.e., 33 kV double circuit line (around 8km) and of 2 nos. of 33 kV bays at Muktagacha 33/11 kV Substation. Bays will allow for the isolation of individual circuits for incoming power from solar power plant to the 33 KV Muktagacha Substation. Figure 3-12 shows the single line diagram of the internal evacuation system.

Figure 3-12: Single Line Diagram




Status:
REVISED AS PER COMMENTS
Client/ Developer:
JPL
www.jpl-bd.com
Contractor:
N/A
Technical Consultant:
sgurr energy
Sustainable Engineering Worldwide
www.sgurrenergy.com
Project Detail:
20MWac SOLAR PV PLANT AT MUKTAGACHA BANGLADESH
Date:
04/19/2024
Drawn By:
ASHOK JANGIR
Checked By:
SWAPNIL NALAWADE
Approved By:
ARAVAMUDHAN SUTHAKAR
REVISIONS
| MM/DD/YY | DESCRIPTION
R0 | 01/29/24 | FOR REVIEW
R1 | 02/07/24 | FOR REVIEW
R2 | 03/22/24 | FOR REVIEW
R3 | 04/17/24 | FOR APPROVAL
R4 | 04/19/24 | REV AS PER COMMENTS
Client Document Code:
6.23.6008.008
Drawing No:
6.23.6008.008_EM2_E201
Drawing Title:
SINGLE LINE DIAGRAM
Sheet:
6 OF 7
Scale:
N.T.S
Disclaimer: This drawing is SgurrEnergy's intellectual property, prepared solely for the project and client indicated in the title block. This should not be copied / edited / reproduced without the express written permission of SgurrEnergy. User shall indemnify SgurrEnergy against all claims, costs damages and losses arising out of any such eventuality.



Source: MSEL, 2024

3.4 Project Requirements

3.4.1 Construction Materials and Heavy Equipment

Various types of construction materials of different quantities will be required for the construction of proposed project. A list of approximate quantity of the materials required in the project is presented in the Table 3-6.

Table 3-6: List of Materials during Construction Phase

SL#	Construction Materials	Unit	Quantity	Source
1.	Cement	bags	42,000.0	Local market meeting specifications
2.	Sand	cft	2,600,000.0	Local market meeting specifications
3.	Stone	cft	100,000.0	Local market meeting specifications
4.	Steel	ton	800.0	Local market meeting specifications
5.	Bricks	million	6	Local 1st Class Bricks

Source: MSEL, 2024

Other than these, PHC pile, rod, fencing, fasteners and anchors (nut-bolts) and geo sheet will be sourced from local market.

3.4.2 Heavy Equipment

Construction machinery and equipment (chain dozer, roller machine, excavator, drum truck, forklift, crane, pile drive machine, tractor for pile carrying, wheel loader, hydra crane, heavy duty welding machine etc.), telecommunication and internet services, office equipment etc. will be required during the construction phase. These services will be sought from local source.

3.4.3 Land and Site Leveling & Grading

The total land requirement for the solar farm would be 68 acres. MSEL has already owned 54.96 acres of land through lease and purchase. As per the latest information provided by MSEL, 51.95 acres (76.40%) of land has been taken from 110 landowners for lease for 22 years, and 3.01 acres (4.43%) have been purchased from 27 local people through a willing buying and willing selling process. Their purchase work is still ongoing with 6 local people for 3.47 acres (5.10%) of land. Moreover, they are also trying to purchase 9.57 acres of land (14.07%) more from approximately 10 landowners.

GIS-based LULC time series data indicated that the area's land use and land cover remained consistent in type from 2003 to 2024. In 2003, the majority of the area (93.1%) was characterized as *beels*, which decreased to 71.3% by 2012 and further to 54.0% by 2024. Agricultural land, which made up 6.9% in 2003, increased to 26.0% by 2012. There were no aquaculture practices at the site in 2003, but by 2024, 45.3% of the area had been converted to aquaculture ponds for fish production.

As per Feasibility Report, May 2024, around 89.93 % of the total land has a slope below 3°. Around 3.57% of the land has a slope greater than 10° that may require appropriate land treatment (land levelling and grading) for the installation of PV module mounting structures if the required capacity cannot be accommodated. Based on the results obtained from slope analysis, the land will require grading for aligning module mounting structures. Also, this land leveling and grading will be done for the internal road, warehouse, guest house, substation and barrack. Also, the MSEL is planning to install pile each of the facilities, above that RCC (Reinforced Cement Concrete) foundation to avoid the risk of flooding.

The right of way for the transmission line and the right of way for access thereto over routes for construction purposes will not need to be acquired as it is already a developed transmission line of BREB. Only two poles will be required to install at the access road ROW to provide interconnection from solar power plant to the existing transmission pole, which does not require any physical or economic displacement. Moreover, as per MSEL, pole installation will be under BREB, MSEL will only stringing the transmission line follow the existing route.

3.4.4 Water

This project will use deep tube well water as the water supply source for the construction, operation and decommissioning phase. During construction phase at least 5000 liter/daily water will be used for labor bathing, drinking and sanitary purpose. During operation phase, water usage would be mainly for the cleaning of PV panels, and domestic use. There will be ten cleaning cycles each month, with a full panel cleaning every three days, using 2 liters of water per panel per cleaning. Cleaning will be required from October to May, as the remaining months are considered the rainy season. Therefore, at least 115333 liters of water will be required for panel cleaning PV cleaning purpose and aproximately 667 litter will be required for domestic purpose each day. During decommissioning 5000-liter daily water will be required.

Additionally, nine water storage tanks (round tank), each with a capacity of five thousand liters, will be installed to store groundwater. The typical size of each of this tank will be 7 ft by 7 ft.

3.4.5 Electricity

Electricity for the construction phase will be provided through a dual-source system comprising generator power and the Bangladesh Rural Electrification Board (BREB) supply. BREB will serve as the primary source of electrical power for the project.

The BREB connection will be established from the nearest 11kV overhead transmission line. This 11kV line will be routed through a total of six poles, which will be installed along the access roadside to the construction site. The placement of these poles will be planned in such a manner that it avoids the need for land acquisition and does not impact any public property.

Once the 11kV line reaches the construction site, it will be transformed to a lower voltage of 400V using a step-down transformer to meet the operational requirements of the construction activities. The transformer will facilitate the conversion of high-voltage electricity to a more manageable voltage level suitable for use on-site.

After the completion of the construction activities, the six temporary utility poles will be dismantled and removed. Pole installation will be under BREB.

In case of a breakdown or shortage in the BREB line, the generator will be used. Additionally, generators will be used during welding work. A total of three generators will be required during construction phase. Each generator will have a capacity of 25 KW. The requirement of electricity during construction is about 500KW daily. During operation the project will meet its own demand. During decommissioning a minimum electricity will be required.

3.4.6 Fuel

Fuel will be required for the machinery running as well as backup diesel generator during the construction period and it will be sourced from the local market.

In this project, there shall be a 3MVA of 8 main transformers, and in general the insulation oil quantity of a single main transformer shall be about 21 tons.

3.4.7 Lightning Protection System Arrangement

As per lightning risk assessment and calculation April 2024, the site has risk of lightning. Lightning arrangement will be provided at the main control room, smart transformer area, and field area to avoid risk related to it. Considering the higher lightning flash density at the site location, lightning protection system has been considered in the design. In accordance with IEC 62305-2 and to consider Level II protection for main control and smart transformer area to consider Level IV protection for the PV Field Area. Lightning arrangements in these areas have been discussed below as stated in the lightning risk assessment and calculation report.

- **Main Control Room:** Two numbers of Conventional Type Copper rod (Air Terminal) is envisaged for MCR building. It shall be located, such as its height will be 2 meter above the object to be protected.
- **Smart Transformer Station:** Two numbers of Conventional Type Copper rod (Air Terminal) is envisaged for two Smart transformer Station placed nearby. It shall be located, such as its height will be 2 meter above the object to be protected.
- **PV Field Area:** PV plant field direct lightning protection is provided by 15 number of ESE type LA of height 5mtr above the object to be protected. ESE type lightning arrestor earth pits will be connected in Tripod arrangement.

During construction appropriate numbers of LPS will be installed to avoid such risk.

3.4.8 PV Plant Lighting (Illumination System) Arrangements

A suitable lighting system will be maintained to ensure security and proper visibility throughout the project area. Energy-efficient bulbs, like LEDs or others, will be used, providing varying levels of illumination based on specific needs. The areas in where lightning will be provided given below:

- Main control Room and other associated building shall be provided with LED light fittings.
- All the main and internal roads connected to main control room and Smart transformer stations shall be provided with LED based external lighting system strategizing site security and maintenance requirements, utmost care should be taken for avoiding any shading effect due to the lighting poles.
- Entire periphery of the solar PV plant shall be provided with external lighting with LED based streetlights that shall provide a minimum illumination of 5 lux at the center of two poles. Complete external lighting system shall be powered from the auxiliary power supply system of the plant.
- Adequate emergency light shall be fed from UPS in MCR.
- Smart transformer stations shall be provided with adequate lighting fixtures comprising of high efficiency LED lighting bulbs.

For all PV plant area average illumination Lux levels for different locations is shown in below:

Table 3-7:PV Plant Area Average Illumination Lux level for Different Location

SL#	Area / Location (if applicable)	Required Lux Level (Average)
1.	Control Room	300
2.	Control Room - CRP	300
3.	Control Panel rear side	150
4.	Control Desk	300
5.	SCADA / Communication	300

SL#	Area / Location (if applicable)	Required Lux Level (Average)
6.	Battery Room	100
7.	LV AC & DC Room	150
8.	Switchgear room (33kV)	300
9.	UPS / Battery Charger	200-300
10.	Office, Conference rooms & Reception	300
11.	Toilets	100
12.	Corridors / Stairs	100
13.	Store Room	100
14.	Workshop /Repair	300
15.	Testing Room	400
16.	Access area / Platform (Outdoor)	50
17.	Car Park	20
18.	Cable Gallery / Room/Cellar	70
19.	HVAC Rooms/ AC plant	150
20.	DG Room (Outdoor)	20
21.	Outdoor Switchyard	20
22.	Switchyard bays	20
23.	Transformer Area	100
24.	Pathways	20
25.	Main Roads	20
26.	Gate House	200
27.	Watch Towers	200
28.	Fire Pump / Fire equipment room	200
29.	Smart transformer station/ LV Panel Station	200
30.	Smart transformer station outdoor lighting	20

Source: Technical Specification-BOS System, April 2024

A proper lighting system will be provided during construction as well.

3.4.9 PV Plant Vigilance System (CCTV) Arrangement

CCTV systems will be installed to ensure effective surveillance across various areas and to provide records for post-event analysis. Monitoring screens and Network Video Recorders (NVRs) will be located in the main gate security room and the MCR SCADA room. Infrared (IR) illuminator cameras will activate for night vision when required and this will with camera in built. The cameras will cover areas of the solar PV plant, including entry and exit gates, the smart transformer station, the main control room, and the switchyard/transformer yard, with exact locations determined during detailed engineering. Dome cameras will be used indoors, while outdoor and PTZ cameras will be employed outside. All camera systems will feature built-in alarm input and output capabilities. The NVRs will store

data for a minimum of 60 days and will be controllable remotely. They will support video motion detection (VMD) recording and have options for event, alarm, and schedule recording, accommodating up to 16 alarm inputs. The CCTV System shall consist of the following elements:

- CCTV Cameras both Dome type and PTZ type mounted as required.
- Digital Video Recorders to Record the CCTV images on Hard Disk.
- 45" color monitors for online viewing of data from different cameras.
- Joystick or pushbutton type keyboard for performing control function of PTZ cameras.

(Source: Technical Specification-BOS System, April 2024)

3.4.10 Firefighting Arrangement

The entire plant shall be equipped with suitable fire protection and fighting systems for the entire plant area as per the international safety standards and local fire authority requirements. Firefighting of transformers and other electrical equipment as required shall be in accordance with NFPA 70 and NFPA 15 guidelines. Wherever required, latest Bangladesh fire safety codes/ standards shall be followed for building fire protection and prevention. The Power Transformer shall be equipped with a nitrogen type fire extinguishing system.

(Source: Technical Specification-BOS System, April 2024)

3.4.10.1 Fire Extinguishers:

Portable type fire extinguishers conforming to relevant national standard shall be provided as means of dealing effectively and immediately with fire caused from oils, solvents, gases, paints, varnishes, electrical wiring and all flammable liquids and gases. System shall comply with required insurance norms. The following type of portable fire extinguishers shall be provided in the PV array area, Smart transformer stations and main control room.

- DCP type fire extinguisher 10kg capacity.
- CO2 operated hand portable extinguisher 9kg capacity.
- Foam type hand portable extinguisher 9kg capacity.
- Fire Extinguisher Balls of 0.75 to 2.43kg capacity.

Fire extinguisher balls of suitable capacity shall be provided at strategic locations in MCR and ICRs.

Additionally, two 30-35 liters CO2 operated trolley mounted fire extinguishers having a minimum jet range of 8m shall be provided. These shall be placed in the main control room and other strategic Smart transformer stations which are located far away from the main control room to ensure quick response. All the fire extinguishers shall be subject to anticorrosive treatment and shall be painted and marked as per the requirement of relevant standards.

Fire Buckets: Fire buckets shall be provided in all Smart transformer stations and main control room with fine sand and fixed on angle iron frames as required by local authorities. Fire buckets shall be painted red with an additional handle at the bottom. Adequate sand pit locations to be provided by the EPC Contractor at strategic locations. All outdoor fire buckets shall be installed on stand with canopy (Source: Technical Specification-BOS System, April 2024)

During construction suitable types of fire extinguishers will be provided.

3.4.11 Flood Prevention and Water Drainage System

As per the Feasibility Report, 2024 the project is susceptible to Pluvial flooding. Pluvial flooding is the risk of flooding due to the impact of rainfall. The direct application of the effective rainfall to the catchment areas of the natural drains and within the project site would affect the detailed hydraulic behavior of the flows in and around the plant site.

As per discussion with the project team, they are planning to install MMS by increasing the overall pile height above High Flood Level (HFL) in order to keep the modules, auxiliary facilities and other electronic equipment's above water at any given instance.

There will be no drainage system developed as the nearest water body (which has flow) is at the Raghunathpur and which is about 1.2km and there is no direct connection from it to the project site. Rather than, MSEL will follow the natural process, as 60% of the site land remains submerged for nearly nine months and then gradually the water level decreases. It will remain the same during project operation.

3.4.12 Weather Monitoring System (WMS)

Two WMS will be installed within the project boundary. Weather station shall be a standalone system with various sensors mounted on a 3m pole / tripod with required cross arm assembly, a dedicated data logger integrated to the SCADA system. The weather Station shall have the capability of recording and storing environmental data without any power supply for two (2) days. Weather station will have its own battery as a standby source that can be charged by conventional power supply. If not single-phase UPS power supply to the weather station shall be provided. The following parameters will be covered by the WMS:

- Global horizontal irradiance (GHI) using a "Secondary Standard" pyranometer.
- Global inclined irradiance (GII) using a "Secondary Standard" pyranometer.
- Ambient temperature and Relative Humidity using a shielded thermometer.
- Wind speed and direction using an anemometer and a wind vane.
- Barometric Pressure using a sensor.
- Soiling Station
- Rainfall using a rain gauge.
- Thermistors for measuring the Module temperature.
- Cloud Cover Sensor

(Source: Technical Specification-BOS System, April 2024)

3.4.13 Waste Management

During the project implementation phase various types of solid, liquid, and hazardous waste will be generated. Waste generated from different phases and its management practices addresses in the below table.

Table 3-8: Different type of Waste and Management Practices

SL#	Waste Type	Project Phase	Management Practice
1.	Food Waste	Construction and Operation Phase	To be stored in dedicated waste bins Disposed in designated dumping ground of Muktagacha Pourashava through local waste handler.
2.	Solid and Hazardous (construction material like metal piece, wire piece, unused concrete, Spoil: *unused excavated soil*, broken bricks, glass, ceramic, demolition waste, e waste, chemical can etc.)	Construction and demolishing	Segregated and stored at the separate designated area as per category hazardous non-hazardous. Non-hazardous: to be disposed through supplier/third party vendors for reuse/recycle or dispose. Hazardous: Chemical drum, Broken PV module, disposed circuit braker

SL#	Waste Type	Project Phase	Management Practice
3.	Solid and Hazardous (paper, metal, cartoon, polybag, plastic, broken wire, drum, e waste, battery, broken PV module, broken circuit breaker etc.)	Operation	or batteries will be disposed of by specialized waste management company approved by Govt.
4.	Sewage	Construction and Operation	Install soak pit with indicator for sewage handling. When the soak pit is filled up, it will be handled by an authorized waste handler for dispose it in proper manner

Source: MSEL, 2024

3.4.14 Workforce

The workforce requirements during the construction and operation phase vary to meet the project requirements.

- During Construction: approx. 100 to 150
- Operation: at least 40 to 50
- Decommissioning: at least 100

3.4.15 Operation and Maintenance

Project Implementation Unit (see Figure 3-13) has been established by MSEL for the project execution. This project implementation unit will be responsible for both construction and operation. The project will be commercially operated for 20 years. Construction activities will be handled by EPC contractor and monitored by MSEL. The operation phase will be handled by the MSEL. Organogram of the EPC contractor is shown in Figure 3-14. Project will require two types of maintenance. scheduled maintenance and unscheduled maintenance during operation phase.

- **Unscheduled maintenance** will be carried out in response to failures and any defects in plant equipment. This type of maintenance is considered to be expensive since defective equipment can damage other parts and cause multiple damages.
- **Scheduled maintenance** will be planned to prevent faults from occurring as well as keeping the plant operating at its optimum level. Scheduled maintenance of the PV plant should be based on the technology selected, environmental conditions at site, warranty terms of plant equipment and seasonal variation. Schedule maintenance involves Equipment and PV Frequency schedules check. These include Transmission line, Switchyard Structure, 33 KV insulator, MV panel, C distribution box (Auxiliary Panel), Auxiliary Transformer, Inverter duty transformer, LT panel, PV module and structure, Ups battery, PV module cleaning. Etc.

Figure 3-13: Project Implementation Unit

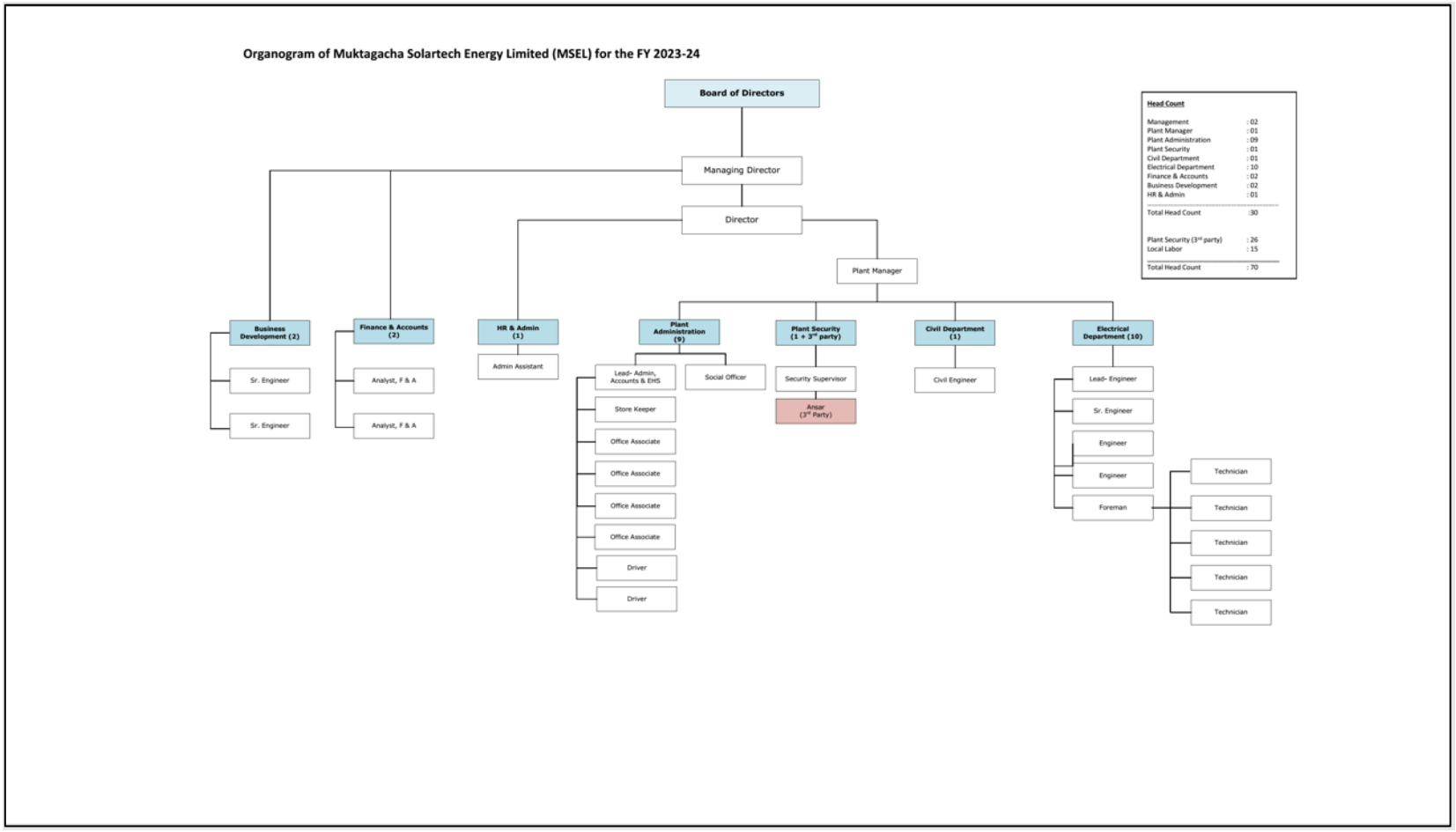
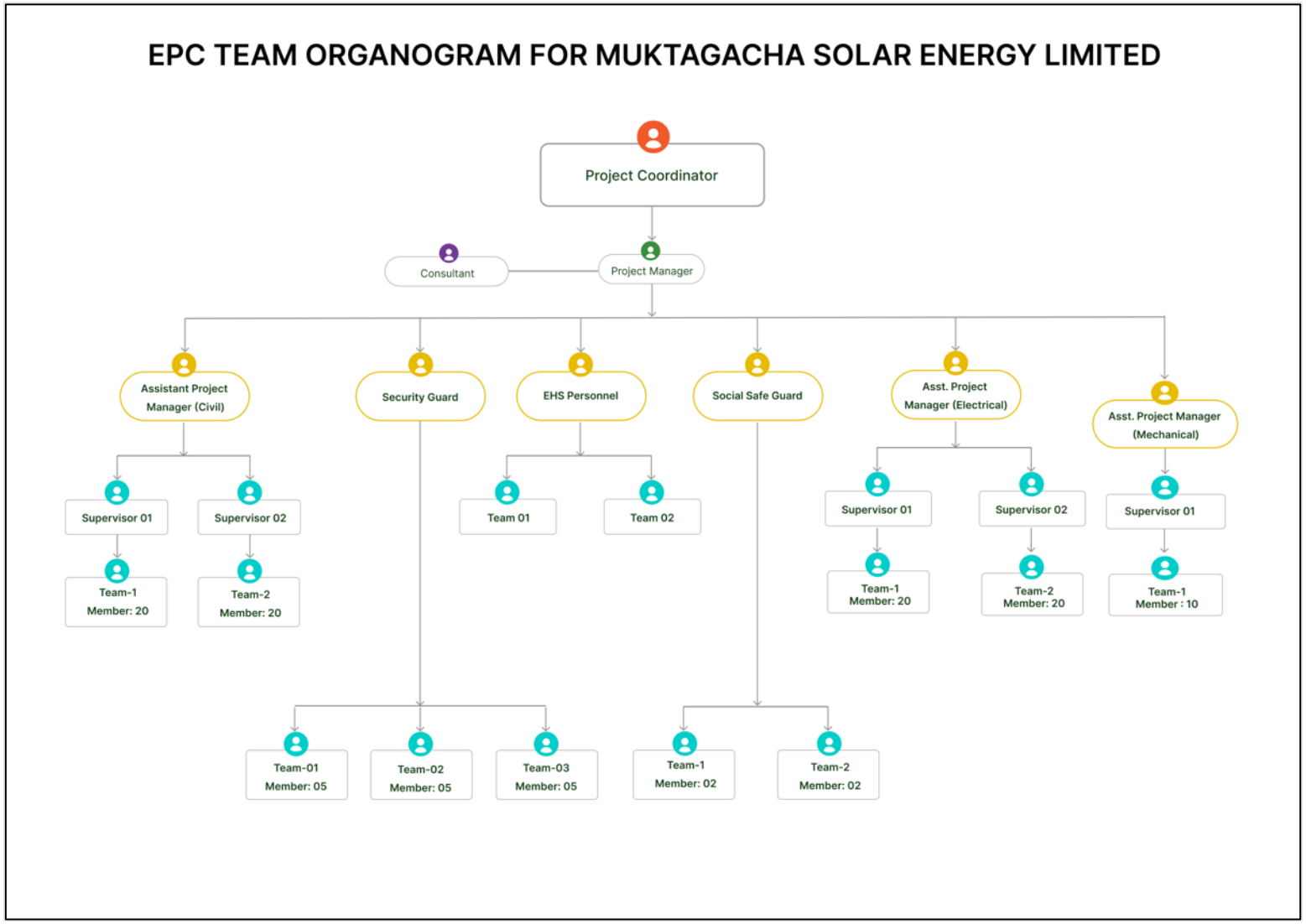


Figure 3-14: EPC Team Organogram



3.5 Project Activities

For the establishment of any projects, it requires to conduct various activities in different phases of the project. The anticipated activities that will be carried out during the pre-construction, construction, operation and decommissioning phase of the proposed project are given in Table 3-9.

Table 3-9: Activities during Pre-construction, Construction Operation and Decommissioning Phase

Project Phase	Activities
Pre-construction Phase	The following major activities to be undertaken during the pre-construction phase of the proposed project: – Selection of sites; – Land lease and purchase; – Site surveys as topographic, geotechnical investigations, solar radiation and yield study, electrical grid studies, geo-morphological studies, etc.; – IESE study; – Preparation of layout plan, design and drawings; – Design and finalization of contractors; – Contractor Mobilization; – Site Preparation including temporary fencing, cutting of trees and clearing of vegetation, land leveling and grading. – Upgrading the existing access road. – Obtaining all necessary approvals/clearances;
Construction Phase	The following major activities to be undertaken during the construction phase of the proposed project: – Construction of temporary site office, temporary labor accommodation & storage facilities and internal roads. – Installation of the temporary facilities: security camera, post & light – Construction material delivery. – Development of internal road (Geo bag filling and placing); – Construction of sub-station, inverter station, office, rest buildings and others. – Foundation laying for module mounting structures (PHC pile installation); – Laying of internal electrical connections; – Installation of deep tubewell and water line. – Development of the water storage tank – Installation of inverter and transformers; – Installation of Module; – Stringing of transmission lines (project substation to Muktagacha substation); – Maintenance and replacement of vehicles and equipment. – Use of utilities like power, water, fuel etc.; – Solid and liquid waste generation from the labor camp and construction site and disposal; – Demobilization of the construction equipment;

Project Phase	Activities
	– Monitoring of mitigation measures for environmental and social impact; and – Overall project construction and management.
Operation Phase	The following major activities to be undertaken during the operation phase of the proposed project: – Cleaning of PV modules; – Control of vegetation viz. weeds, water hyacinth etc. within the site and those immediately surrounding it; – Routine inspection of all PV modules and associated structures viz. cables, transformers, inverters, mounting structures, etc.; – Operation and maintenance of ancillary facilities such as power substations; – Inspection and maintenance of internal site pathways/access roads; – Domestic, solid, and other non-hazardous waste handling, storage, and disposal; – Hazardous material and waste storage; – Maintenance and replacement of equipment (solar panel, inverters, mounting structures, circuit breakers, batteries, cable, etc.); – Implementation of CSR activity. – Use of utilities for facilities; and – Monitoring of ESMP, and HSE.
Decommissioning Phase	The following major activities to be undertaken during the decommissioning phase of the proposed project: – Dismantling of infrastructure and replacement of dysfunctional equipment and installations. – Waste disposal. – Monitoring of ESMP, and HSE.

Source: EQMS, 2024

3.6 Project Cost

The estimated cost for the project is 34.67 million USD.

3.7 Project Compliance Status

Project compliance status up to July 2024 is attached in Appendix G

CHAPTER 4

Alternative Analysis

4 ALTERNATIVE ANALYSIS

Identification and assessment of feasible alternatives to project design and implementation are among the main components of environmental impact assessment procedures. Alternatives illustrate and contrast the environmental implications and consequences of different options available to achieve the proposed objective. In this way, both the proponent and the authorities who must consider granting the authorization, are put in a position where all involved are able to make informed choices or decisions.

The selection of preferred alternatives is based on scores of factors including cost, schedule of delivery, environmental and social impact, and the cost for their redressal. The drivers that affect potential alternative options and scenarios include the availability of project sites, current technologies; design changes that need to be introduced, operational situation, capital & recurrent costs, environmental & social issues, their potential impacts, and costs of mitigation. The “No Project” alternative situation is taken into account to demonstrate the need of the Project. In consideration of the different drivers, potential alternatives within the Project are restricted to the following aspects:

- No Project Option;
- Alternative Method of Power Generation;
- Location Alternative;
- Power Evacuation Connection Alternative; and
- Technology Alternatives

4.1 No Project Option

The no-development option simply means that the Government of Bangladesh does nothing to address the purpose and need for the power generation and transmission. The most significant outcomes of this approach would be a negative impact on current electricity supplies and the possibility of complete blackouts at times of high demand. The demand for electricity in Bangladesh is projected to reach 34,000 megawatts (MW) by 2030 and if the “No Project” is to have its way, the country will have to slow down the growth rate of its economy and all its development projects will come to a standstill.

It is the professional opinion of the IESE team that the no-development option is unrealistic, and, indeed, following this approach would result in the stagnation or cessation of many Government strategies that have been planned and implemented. Due to the negative consequences of the no-development option, it has been discarded from further consideration in this IESE.

4.2 Location Alternative

The location of this Power Plant has already been selected and the Site clearance of which has been provided by the DoE. The location of site has been shown in the Plant layout during approval of that Site clearance Application. As such, there is no scope of changing the location of the Project. MSEL choose this area.

4.2.1 Selection of 20 MW Solar Plant Location

The selection of the plant location has been based on the following considerations:

- Available Land Area: The total land required for the plant will be 68 acres. As per NOC from Department of Agriculture, and Feasibility Study report, most of the land in the solar plant area is wet land, not used for agriculture or fish cultivation. The rest of the land is used for seasonal agricultural purposes and fish farming purposes. Other than the seasonal farming, the land area remains fallow most of the time.
  Development solar project is requiring large amount of land, and due to land scarcity in the country, seeking an alternative site for establishing the solar power plant area is difficult.

Conserve to the above, the land is fallow in nature, and MSEL propose to develop 20 MW solar plant on this available land.

- Approach Road: The plant site is accessible from Dhaka through Tangail-Mymensingh Highway (N401). The site is about 140km away from the city of Dhaka, the capital of Bangladesh. This is a relatively developed highway road near the site, and the highway is on 226m from the northwestern boundary of the site. The N401 road is an asphalt concrete road. The condition of the highway (N401) is good and ensures good connectivity of this part of the Upazila to the neighboring districts viz. Rajshahi and Dhaka.
- Solar Resources: The data thus obtained from SolarGIS for the Bangladesh site indicates an annual daily mean of 4.399kWh/m2 global horizontal irradiation that can be expected for the plant location, which is good for solar power plant operation.
- Environmental Risk: One concern is the removal of trees, which can affect local ecosystems and biodiversity. To minimize this impact, only the minimum number of trees necessary will be cut down, which have shading effects.
- Grid Availability: As per the instruction from BPDB, the solar power will be injected into the grid via 33/11kV Muktagacha substation which is approximately 8 km from the solar plant. Transmission network is already developed into this route from plant to Muktagacha substation. It only requires stringing a line from plant to the Muktagacha substation.

4.2.2 Selection of Sustainable Interconnected Transmission Line ROW

MSEL has selected three interconnected transmission line (TL) routes for power evacuation from solar power plant to the nearest transmission pole of the BREB. However, as per MSEL, all three routes will pass through agricultural fields and ponds, which may necessitate land acquisition, tree removal, and could have other environmental impacts. Taking this into account, MSEL finalized a transmission line route that requires only two poles to be installed at the approach road (ROW), ensuring no physical or economic displacement. Afterward, this line will connect to the existing transmission network.

Figure 4-1: Proposed Three Alternative Interconnected Transmission Line Route

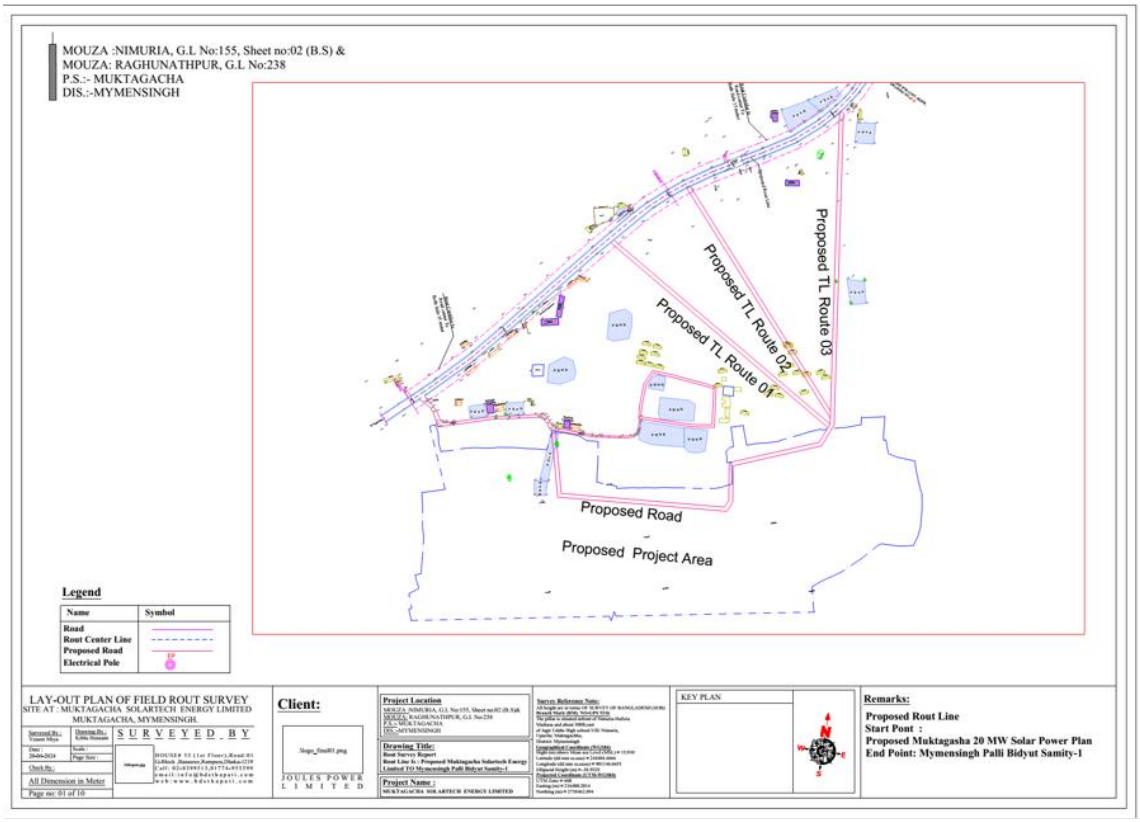
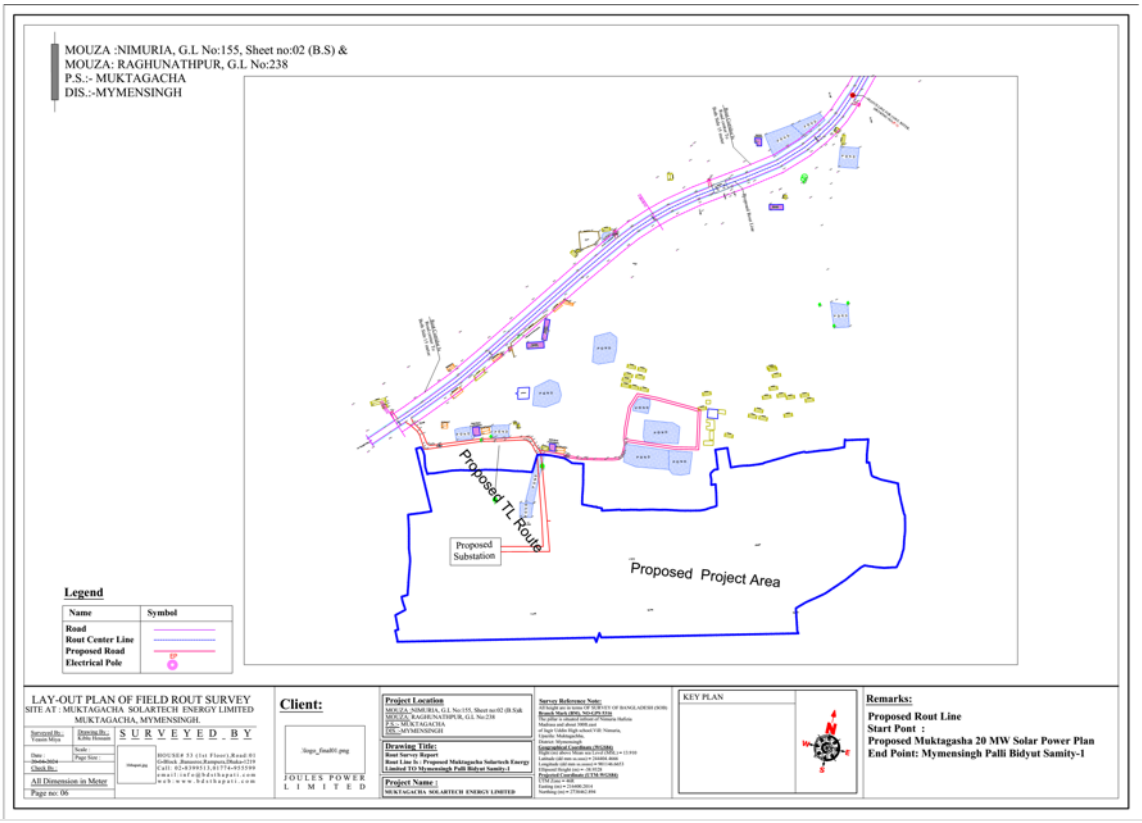


Figure 4-2: Sustainable Interconnected Transmission Line Route



There are other components of the Project for which alternatives are analyzed and presented in the following selections.

4.3 Power Evacuation Connection Alternative

The proposed 20 MW AC power plant is a utility – scale grid – connected, ground mounted solar photovoltaic (PV) power plant project. The electricity generated by the Plant will be transmitted to the substation. As per Feasibility Report, May 2024, two substations have been considered for power evacuation. i.e. Ramchandrapur and Muktagacha substation, located at a distance of ~1.5km and ~8km respectively. A comparative summary of power evacuation connection has shown in Table 4-1.

Table 4-1:Comparative Summary of the two substations

Description	Option-1	Option-2
Name of GSS	33/11kV Ramchandrapur Substation	3/11kV Muktagacha Substation
Latitude: **Longitude:**	24°43'31.97"N 90°11'2.16"E	24°45'42.38"N 90°14'56.01"E
Distance from site	1.5kM approx.	7.5kM approx.
Transmission Line losses	To be finalized during detailed engineering	To be finalized during detailed engineering
Transformers Details	10/14 MVA x 1 nos	Line 1 - 10/14 MVA x 1 nos. (NEW) Line-2-3.3/4.1 MVA x 3 nos. (OLD)

Description	Option-1	Option-2
Facility for Bay extension and HT panel installation.	- Available. However, confirmation to be considered from BREB. - Space available in control room for installation of CRP and metering panel.	- Clear space is not available in substation area. Existing system modification need to be done.
Present loading on the GSS	10-14MVA	10-14MVA

Source: Feasibility Report, May 2024

Considering the above factors and following the preliminary assessment, 33/11kV Ramchandrapur to be most feasible to evacuate power from the proposed 20MWac solar PV plant. However, it was informed by the Developer that the power injection will be done at *Muktagacha* substation as per the instruction of BPDB.

4.4 Alternate Method of Power Generation

Harnessing solar energy is an eco-friendly process, with an inexhaustible solar resource and minimal pollution. There are minimal fuel requirements for operational activities. Solar energy has a short development timeframe (development period), more predictable energy output and low maintenance costs as compared to some other forms of renewable energy sources. The below Table 4-2 elaborates upon the environmental advantages and disadvantages of various power generation systems.

Table 4-2: Advantage and Disadvantage of Power Generation Systems

System	Advantage	Disadvantage
Thermal Power	• Large-scale production potential. • Moderate gestation period. • Wider distribution potential.	• High fossil fuel consumption. • Large quantities of water required for cooling. • High volume of emissions from operation. • Accumulation of fly ash (in case of coal). • Upstream impact from mining and oil exploration. • GHG emissions estimated as 228gCeq/kWh.
Hydropower	• GHG emission estimated as low as 1.1gCeq/kWh for run of river projects. • Do not create any waste by- products during conversion process. • Some hydropower facilities can quickly go from zero power to maximum output. Because hydropower plants can generate power to the grid immediately, they provide essential back-up power during major electricity outages or disruptions.	• Site-specific, dependent on reservoir/river, etc. • Long gestation period. • Alteration of river flow regime. • Adverse social and ecological impacts due to inundation and downstream effects.

System	Advantage	Disadvantage
Nuclear Power	• GHG emissions as low as 2.5gCeq/kWh. • Low fuel cost. • The production of electric energy is continuous. A nuclear power plant generates electricity for almost 90% of annual time. It reduces the price volatility compared to other fuels. • Do not emit smoke particles or gases.	• Availability of fuel source. • Hazards associated with. radioactive material • Disposal of waste is expensive, as wastes are radioactive in nature. • High cost of project. • Long gestation period. • Risk of fallout and meltdown scenarios and its impacts on the local populace and environment.
Wind Power	• Pollution levels are insignificant. • Inexpensive power generation. • Inexhaustible wind resource. • GHG emissions as low as • 2.5gCeq/kWh for the production chain.	• Bird and Bat hit issues in certain areas. • Site-specific, dependent on wind pattern. • Expensive installation.
Solar Power	• Pollution levels are insignificant. • Inexpensive power generation. • Inexhaustible solar resource. • GHG emissions as low as 8.2gCeq/kWh for the production chain.	• Large land requirement. • Site-specific, dependent on solar insolation.

4.5 Technology Alternatives

4.5.1 PV Module Technology Analysis

In order to analyze the best-suited PV technology for the Solar PV plant, N-Type monocrystalline half cut cell with Tunnel Oxide Passivated Contact (TOPCon) and Hetero Junction solar (HJT) PV modules technology has been evaluated during feasibility study. The criteria that have been looked into are technology, power rating, solar cell efficiency, operating voltage, temperature coefficient, power tolerance, dimension, nominal power guaranty, fill factor etc. Table 4-3 shows the technical specification of the PV Modules and Table 4-4 performance matrix of the PV module technology.

Table 4-3: Technical Specification of the PV Modules

Technology	HJT	TOPCon	CdTe	P-Type Mono PERC
Model No	RSM132-8-685BHDG	JKM-610N-78HL4-BDV	FS-6445	RSM132660BMDG
Technology	HJT	TOPCon	Thinfim	P-Type Mono
Nominal power (PMPP)	685	610	445	660
Voltage at PMAX (VMPP)	41.56	45.60	185.70	38.23
Current at PMAX (IMPP)	16.50	13.38	2.40	17.27

Technology	HJT	TOPCon	CdTe	P-Type Mono PERC
Open circuit voltage (VOC)	49.56	55.31	220.40	45.89
Short circuit current (I SC)	17.56	14.03	2.56	18.28
Efficiency (%)	22.12	21.84	18.00	21.27
Maximum System Voltage	1500	1500	1500	1500
Dimensions (length × breadth × width) (mm)	2.384 x 1.303 x 0.035	2.465 x 1.134 x 0.030	2.009 x 1.232 x 0.049	2.384 x 1.303 x 0.035
Module area (m2)	3.10	2.80	2.48	3.10
Weight (kg)	38.50	34.6	34.5	38.50
Temperature coefficient at PMA	-0.24% / ºC	-0.30% / ºC	-0.32% / ºC	-0.34% / ºC

Source: Feasibility Report, May 2024

Table 4-4: PV Module Technology Performance Matrix

Technology / Model	Specific Production (kWh/kWp)	Performance Ratio (%)	Capacity Utilization Factor (%)
HJT – Risen, 685Wp	1467.1	88.1	22.5
TOPCon - Jinko, 610Wp	1441.9	86.6	22.1
CdTe – First Solar 445Wp	1425.0	85.6	21.9
P-Type Mono PERC – Risen 660Wp	1432.0	86.0	22.0

Source: Feasibility Report, May 2024

Based on the PV module technology performance matrix and technology evaluation HJT seems superior, however some availability issues considering project timeline, some N type PV modules (TOPCon - Jinko, 610Wp) evaluated. Table 4-5 shows the N type module make and performance matrix.

Table 4-5: N Type Module Make and Performance Matrix

Module make and rating	Specific Production (kWh/kWp)	IAM Loss (%)	Low irradiation loss (%)
Risen 580Wp	1499	0.30	-0.14

Module make and rating	Specific Production (kWh/kWp)	IAM Loss (%)	Low irradiation loss (%)
Jinko 630Wp	1494	0.37	-0.20
JA 625Wp	1498	0.19	-0.18
Astro energy 630Wp	1487	0.34	0.35

Source: Feasibility Report, May 2024

Risen 580Wp and JA solar 625Wp provide almost similar yield while JA may perform slightly better in lower irradiation. In addition to that, higher wattage of JA may help the MSEL in saving overall Balance of System (BoS) cost, if it intends to opt JA 625Wp instead of Risen 580Wp modules. For this project JA make JA make PV modules with 625Wp (JAM72D42-625/LB) has been selected.

4.5.2 Inverter Selection

Two types of inverters, central and string inverter, have been analyzed. Both the inverter topologies have their own advantages and disadvantages. Inverter selection was based on some criteria such as: inverter capacities, PNOM ratio is the ratio between the rated installed PV Plant and the inverter AC output, Performance, Power quality, Module technology, MPP range, Grid code, Installation location, Modularity, Protection, Internal consumption, Product reliability, Maintainability and serviceability, System availability, Monitoring/recording/telemetry etc.

Based on the abovementioned criteria and site location and site condition, string inverters has been selected.

Pros of Strin Inverter:

- String inverters can be placed close to PV array, which leads to shorter DC cable length and lower DC cable loss.
- The price has been reduced.
- Simpler to maintain.
- Prove to yield optimum cost to benefit results and achieve higher system redundancy.
- Kept as spare and can be replaced with a faulty inverter.
- Easier to replace or upgrade single inverters rather than the whole system, potentially reducing waste and the need for system-wide upgrades.

4.5.3 Module Mounting System (MMS) Technology Analysis

As there are multiple types of MMS options available, it is important to assess the pros and cons of each type of MMS. Table 4-6 presents a comparison between different types of MMS options available:

Table 4-6: Generation Comparison with Various types of MMS

Parameters	Fixed tilt	E-W type	MMS Single axis tracker
GTI (kWh/m2)	1726.5	1619.2	1907.8
Bifacial gain (%)	2.88%	0	25.83
Specific Yield (kWh/kWp/Annum)	1470	1388	1649
PR (%)	85.2	85.7	86.4
AC CUF (%)	21.93%	20.71%	24.60%

Parameters	Fixed tilt	E-W type	MMS Single axis tracker
Module Mounting Structure Cost	Low / Medium	Low / Medium	High
Ground Coverage Ratio (GCR)	Medium	High	Low
Installation and Maintenance	– Simpler to install, which reduces the environmental impact associated with construction activities – Fewer moving parts mean generally less maintenance and lower resource use for repairs.	– Installation is more complex than fixed-tilt systems but less so than single-axis tracking. – Requires some maintenance for tilt adjustments, though not as intensive as tracking systems.	– Involves more complex installation processes due to the need for tracking mechanisms. – Tracking systems have more moving parts and require more frequent maintenance, which can increase resource use and operational costs.
End-of-Life Considerations	– Recyclability: Materials such as steel and aluminum are generally recyclable. – Disposal: Simpler structure can make disposal and recycling processes straightforward.	– -Recyclability: Similar to fixed-tilt systems, materials can be recycled, but slightly more complex structures may impact disposal processes. – End-of-Life: Management practices can help mitigate waste and environmental impact.	– Recyclability: Materials used in tracking systems are also recyclable, though the increased complexity can make recycling more challenging. – Disposal: Higher complexity in design can affect the disposal process, requiring more effort for effective recycling.

From the result of the analysis presented in Table 6-6, it is evident that single axis tracker will yield in maximum generation. However, the single axis tracker has higher CAPEX and OPEX costs and it has lower ground coverage ratio which means it requires more land to accommodate the desired capacity and also the installation and maintenance is high, give more effort to at disposal stage . Fixed tilt and E-W type MMS have medium and high GCR respectively. The materials used in fixed-tilt systems, such as aluminum and steel, are generally recyclable, which can help reduce the environmental impact at the end of their life compared to E-W type. For this project, Fixt tilt MMS has been selected.

4.6 Design Alternatives

MSEL is planning to ground mounted solar panel. As project site is susceptible to Pluvial flooding, MSEL is considering in design alternative in MMS by increasing the overall pile height above High Flood Level (HFL) in order to keep the modules, auxiliary facilities and other electronic equipment's above water at any given instance and to avoid hazard from flood.

CHAPTER 5

Environmental and Social Baseline

5 ENVIRONMENTAL AND SOCIAL BASELINE

The baseline conditions define the physical and biological conditions that prevail in the project study area. It includes information on receptors and resources that were identified during the field visit as having the potential to be affected by the project, as well as have an impact on the sustainability of the project.

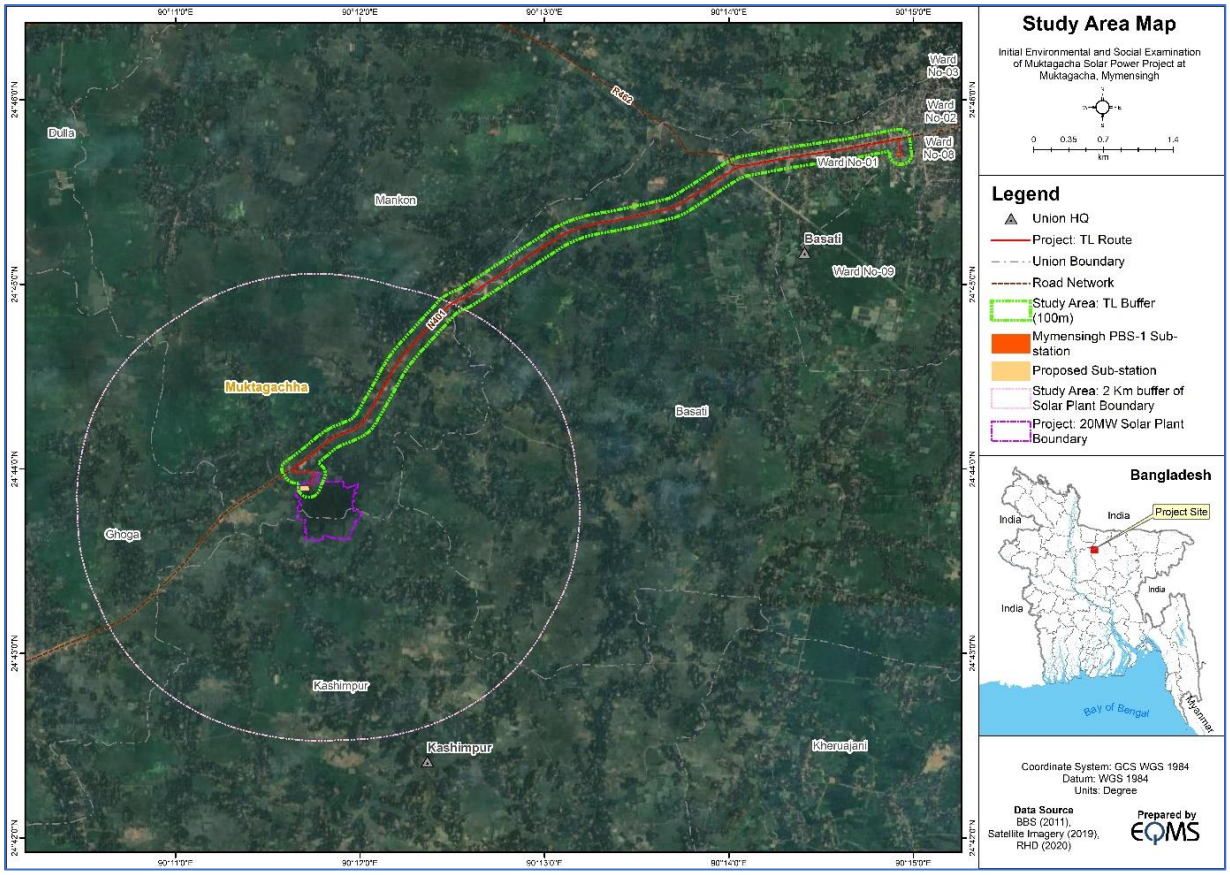
This provides an overview of environmental baseline conditions within the project area and its surroundings, including topography conditions, geological conditions, climate and meteorology, air, water and quality, noise, land use, and biodiversity. This information is to assess the quality of the existing environment as well as to assess potential impacts caused by the project in both construction and operation phases and to provide mitigation measures and monitoring programs to reduce adverse impacts.

5.1 Site Details

5.1.1 Project Location

The GPS coordination of the proposed solar power plant is 24°43'51.12" N 90°11 '53.12"E. The tentative area of the proposed power plant is about 68 acres. The site location is delineated in Figure 5-1

Figure 5-1: Site Location Map for the Proposed Project



Source: EQMS, 2024

5.1.2 Important Features in and around the Project Site

The following IFs have been identified. All the distance is measured from the solar power plant boundary.

Table 5-1:Important Features around the Proposed Power Plant Site

SL#	Items	Direction	Distance in m (approx.)	GPS Coordinates
1.	Nimuria Mosque	NNW	110.68 m	24°44'1.63"N 90°11'43.95"E
2.	Nimuria Government Primary School	N	823 m	24°44'25.69"N 90°12'8.09"E
3.	Nimuria Bazar	N	478 m	24°44'16.01"N 90°12'2.33"E
4.	Nimuria Graveyard	N	330 m	24°44'11.40"N 90°11'58.19"E
5.	Nimuria Shaheb-bari Jam-e-Mosque	WNW	373 m	24°44'7.03"N 90°11'33.89"E
6.	Bachukhali Bazar	NW	512 m	24°43'48.22"N 90°11'19.54"E
7.	Raghunathpur Dakhil Madrasha	SSE	712 m	24°43'19.42"N 90°12'10.68"E
8.	Raghunatpur Northpara Jam -e -Mosque	SE	220	24°43'31.14"N 90°12'0.71"E
9.	Gopinathpur Jam-e-Mosque	ESE	620	24°43'36.01"N 90°12'25.66"E

Source: EQMS, 2024

Table 5-2: Important Features around the Proposed Transmission Line Route

SL#	Items	Direction	Distance in m (approx.)	GPS Coordinates
1.	Nimuria Mosque	NE	52.10 m	24°44'1.63"N 90°11'43.95"E
2.	Nimuria Government Primary School	N	19.33 m	24°44'25.69"N 90°12'8.09"E
3.	Nimuria Bazar	N	13.24 m	24°44'16.01"N 90°12'2.33"E
4.	Nimuria Graveyard	NE	35 m	24°44'11.40"N 90°11'58.19"E
5.	Langra Bazar	NE	13.26 m	24°44'54.53"N 90°12'32.77"E

SL#	Items	Direction	Distance in m (approx.)	GPS Coordinates
6.	Old Langra Bazar Jam-e- Mosque	NE	37.09 m	24°43'48.22"N 90°12'32.32"E
7.	Langra Bazar Alim Madrasha	NW	55.55 m	24°44'56.98"N 90°12'32.05"E
8.	Riajul Jannat Graveyard	NE	42.78 m	24°45'12.98"N 90°13'3.18"E
9.	Al Hakim Islamik Institute	NW	54.15 m	24°45'18.83"N 90°13'6.39"E
10.	Khan Auto Rice Mill	NW	19 m	24°45'21.63"N 90°13'21.93"E
11.	Cheru Mondal Markas Mosque	NE	8.6 m	24°45'24.04"N 90°13'38.99"E
12.	Baitul Mamur Jam e Mosque	NE	23.68	24°45'42.71"N 90°14'22.52"E
13.	Fusion Auto Bag Industries	NW	32.17 m	24°45'30.05"N 90°13'52.16"E
14.	Green Agro Vet	NE	12.84 m	24°45'32.94"N 90°13'55.54"E
15.	Maroof Filling Station	NW	24.38 m	24°45'39.50"N 90°14'5.78"E
16.	Monirambari Govt. Primary School	NW	23.48 m	24°45'40.95"N 90°14'22.30"E

Source: EQMS, 2024

5.2 Study Area and Methodology

This section describes the existing environmental and social baseline of the AOI which includes the power plant and a 2 km radial area around the boundary of the plant site, and transmission line route and area of 100 m on either side of overhead lines. These have been considered as study area. This includes relevant components of the physical, biological, and socio-economic environment.

The objectives of describing the environmental settings of the AOI are:

- To understand the project needs and environmental characteristics of the area; and
- To assess the quality of the existing environment, as well as the environmental impacts of future developments being studied.

5.2.1 Area of Influence

A 2 km radial zone around the solar power plant site and area of 100 m on either side of overhead lines have been considered initially to ascertain the presence of sensitivities/ sensitive receptors in this

region. **Figure 5-1**shows the project area of influence. Further to this, the AoI with respect to the environmental and social resources was considered based on the following reach[1] of impacts:

Air Quality

- Impact on ambient air quality from vehicle exhaust- - typically 100 m from the transmission line area- up to 2 km of the power plant site.
- Air pollutants disperse from the project site- up to 2 km from the solar power plant
- Dust falls- typically up to 200 m from construction activities

Noise Level

- Noise impact area (defined as the area over which an increase in environmental noise levels due to the project can be detected) - typically 100 m from the transmission line area- up to 2 km from the power plant site and 500 m from the access road.

Water Quality

- In the power plant site the nearest surface water body which has flow is almost 1.2 km NW at Nimuria end and other surface water bodies like pond, bills are situated within 2 km of project boundary. So, there will be minimum impact on surface water body.
- The project is proposed to use ground water during the project implementation period. Groundwater in a 2 km radius of the project footprint is considered.

Flora and Fauna (Terrestrial and Aquatic)

- The areas are immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence, and project-related activities. This kind of disturbance has been estimated to occur within the project footprint and surrounding areas of about 100 m to 2 km from the activity areas considering both solar power plant and transmission line.

Socio-economic/Social

- The AOI for social receptors was fixed to include a 2 km radial zone for solar power plant and area of 100 m on either side of overhead lines which have been developed based on the reconnaissance site visits and stakeholder consultations with the local community.

Based on the above discussion, the AoI for the environmental and social baseline was limited to 2 km from the solar power plant and 100 m on either side of overhead lines.

5.2.2 Methodology

The baseline data is collected through primary and secondary sources of information with reference to the scope of work. This data is collected through a concerted effort of:

- Primary monitoring of key environmental parameters like air, water, soil, noise, and traffic. The primary monitoring was carried out by the EQMS team.
- Information about geology, geomorphology, topography, physiography, agroecology, soil types, and prevailing natural hazards like floods, earthquakes, cyclones, etc. have been collected from literature reviews and authenticated information made available by government departments.

[1] Distance based on the nearest sensitive receptors.

- Meteorological data such as temperature, rainfall, wind direction, and humidity for a long-term basis (1989 to 2021) of the Mymensingh Meteorological Station has been obtained from Bangladesh Meteorological Department (BMD).
- Surveys have been carried out to understand and record the biological environment prevailing in the area and the same has been verified against published information and literature.
- The socio-economic environment has been studied through consultation with various stakeholders in the study area. Additionally, socio-economic data have been obtained from household surveys and the Bangladesh Population and Housing Census.

5.3 Physical Environment

5.3.1 Physiography

The physiography of Bangladesh is characterized by two distinctive features: a broad deltaic plain subject to frequent flooding, and a small hilly region crossed by swiftly flowing rivers. In the context of physiography, Bangladesh may be classified into three distinct regions (a) floodplains, (b) terraces, and (c) hills each having distinguishing characteristics of its own. The physiography of the country has been divided into 24 sub-regions and 54 units.[2]

The project site belongs to the physiographic unit of Jamuna (Young Brahmaputra) Floodplain.

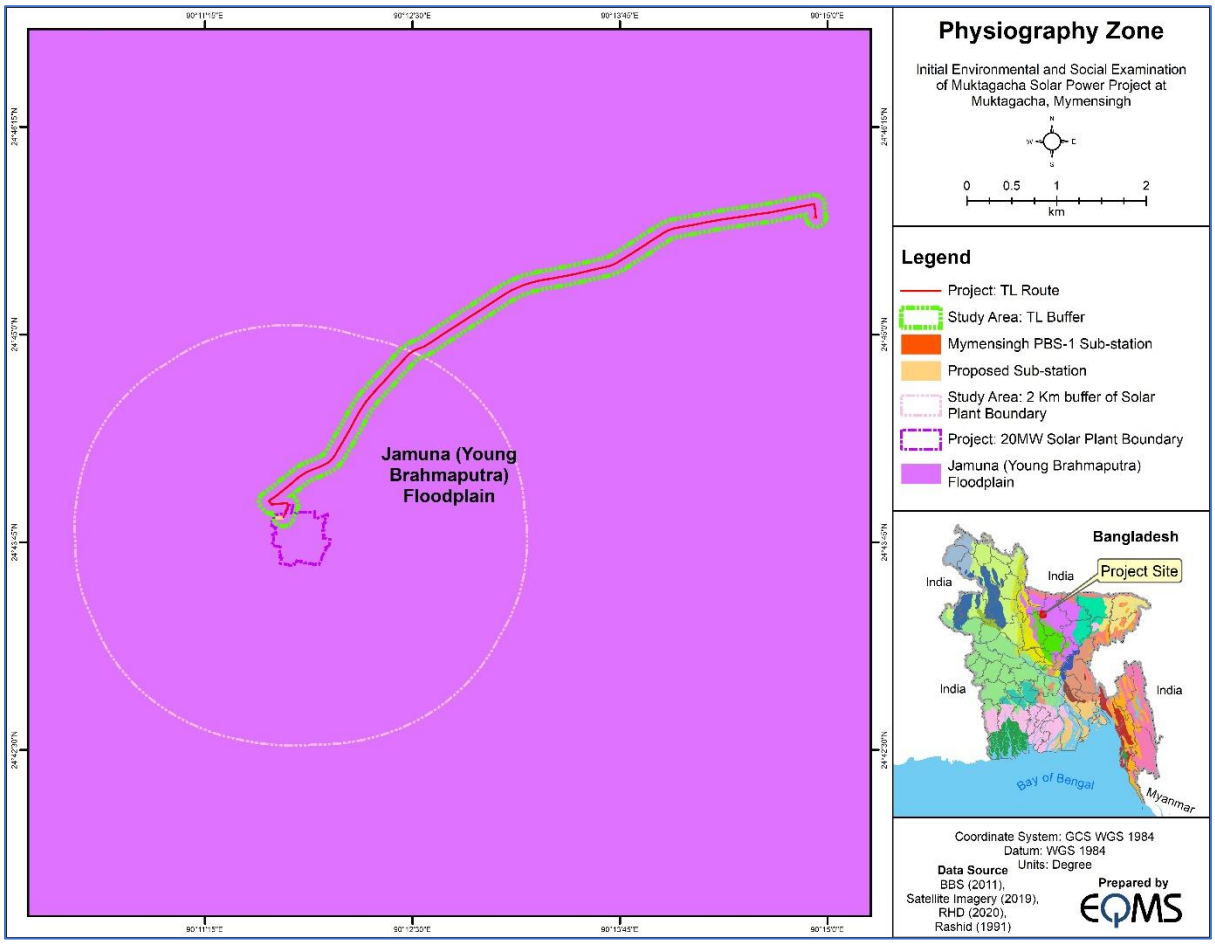
Jamuna (Young Brahmaputra) floodplain A dual name is used for the mighty Brahmaputra, because the Jamuna channel is comparatively new, and this course must be clearly distinguished from that of the older Brahmaputra. Before 1787, the Brahmaputra's course swung east to follow the course of the present Old Brahmaputra. In that year, apparently, a severe flood had the effect of turning the course southwards along the Jenai and Konai rivers to form the broad, braided Jamuna channel. The change in course seems to have been completed by 1830. Due to the upliftment of the two large Pleistocene blocks of Barind and Madhupur, the zone of subsidence between those turned to a rift valley and became the new course of the Brahmaputra and came to be known as the great Jamuna. Both the left and right banks of the river are included in this sub-region. The Brahmaputra-Jamuna floodplain can again be subdivided into the Bangali-Karotoya floodplain, Jamuna-Dhaleshwari floodplain and chars.

The right-bank of the Jamuna - once a part of the Tista floodplain is part of the bigger floodplain. Several distributaries of the Jamuna flow through the left-bank floodplain, of which the Dhaleshwari is by far the largest and sub-classed, namely, the Jamuna-Dhaleshwari floodplain. The southern part of this sub-region was once a part of the Ganges floodplain. Along the Brahmaputra-Jamuna, as along the Ganges, there are many chars. In fact, there are more of them along this channel than in any other river in Bangladesh. There is a continuous line of chars from where this river enters Bangladesh to the off-take point of Dhaleshwari river. Some of the largest ones have point bars and swales. The elevation between the lowest and highest points of these accretions may be as much as 5m. The difference between them and the higher levees on either bank can be up to 6m. Some of the ridges are shallowly flooded but most of the ridges and all the basins of this floodplain region are flooded more than 0.91 m deep for about four months (mid-June to mid-October) during the monsoon.

The physiography map of the study area is given in Figure 5-2)

[2] Banglapedia. (2022, March 18). *Physiography*. https://en.banglapedia.org/index.php/physiography

Figure 5-2: Physiography Map of the Study Area



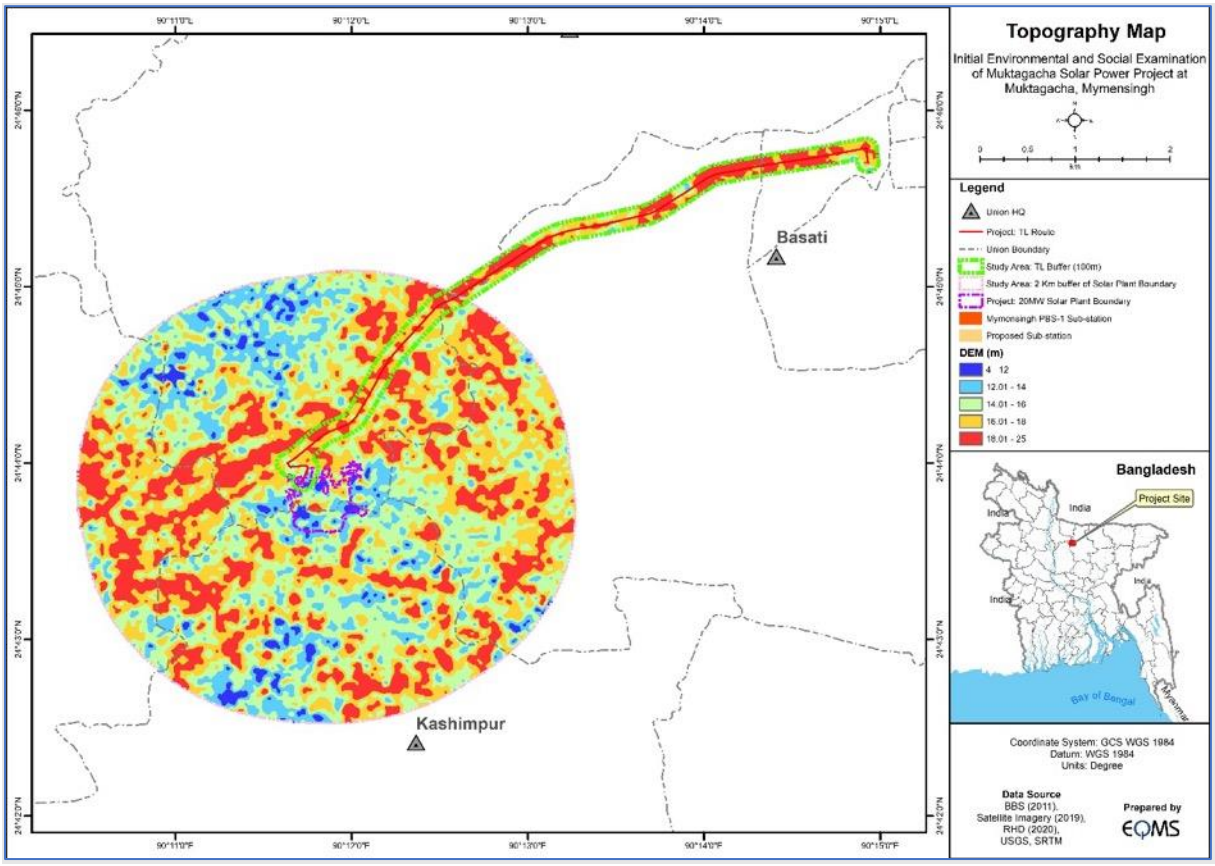
Source: Rashid, 1991

5.3.2 Topography

Topography is a 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. All the relevant information is extracted from the Shuttle Rader Topography Mission (SRTM) DEM only. The elevation within the solar plant site varies around 4m to 25m above MSL. It is noticed that around 13.27% of acres have elevations between 12.01m and 14 m, 32% of areas have elevations between 14.01 m and 16 m, 30.39% of acres have elevation between 16.01 m and 18 m, and 22.1% of acres have been elevation between 18.01 m and 25 m. However, only about 2.25% of areas are above the 4-12 m. The elevation within the transmission line route varies around 12.01 to 25 m above MSL.

The topography map of the study area is given in Figure 5-3.

Figure 5-3: Topography Map of the Study Area



Source: USGS Earth Explorer

5.3.3 Geology

The geology profile of Bangladesh is reflective of the country's location, as Bangladesh is a riverine country. The geological evolution of Bangladesh is related to the uplift of the Himalayan mountains and outbuilding of deltaic landmass by major river systems having their origin in the uplifted Himalayas. This geology is mostly characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments was deposited as a mega delta built out and progressed towards the south. The floodplains of the Ganges, the Brahmaputra (Jamuna) and the Meghna Rivers cover approximately 40% of Bangladesh.

The geology of Bangladesh mainly falls under the following:

a) The stable Precambrian Platform in the northwest – occupies Rajshahi, Bogura, Rangpur and Dinajpur areas and is characterized by limited to moderate thickness of sedimentary rocks above a Precambrian igneous and metamorphic basement. This unit is geologically stable in relative terms and has not been affected by fold movement.

b) Geosynclinal Basin in the southeast – occupies areas of greater Dhaka, Faridpur, Noakhali, Sylhet, Cumilla, Chattogram, and the Bay of Bengal. It is characterized by the huge thickness (maximum of about 20 km near the basin center) of clastic sedimentary rocks, mostly Sandstone and shale of Tertiary age.

c) The Hinge Zone – a narrow northeast-southwest trending zone, separates the above two units almost through the middle of the country. It is also known as the Eocene hinge zone.

According to the Geological Survey of Bangladesh (GSB), the proposed project area falls mainly in the “Chandina Alluvium” geological unit area and then Alluvial silt and clay and Madhupur clay residuum.

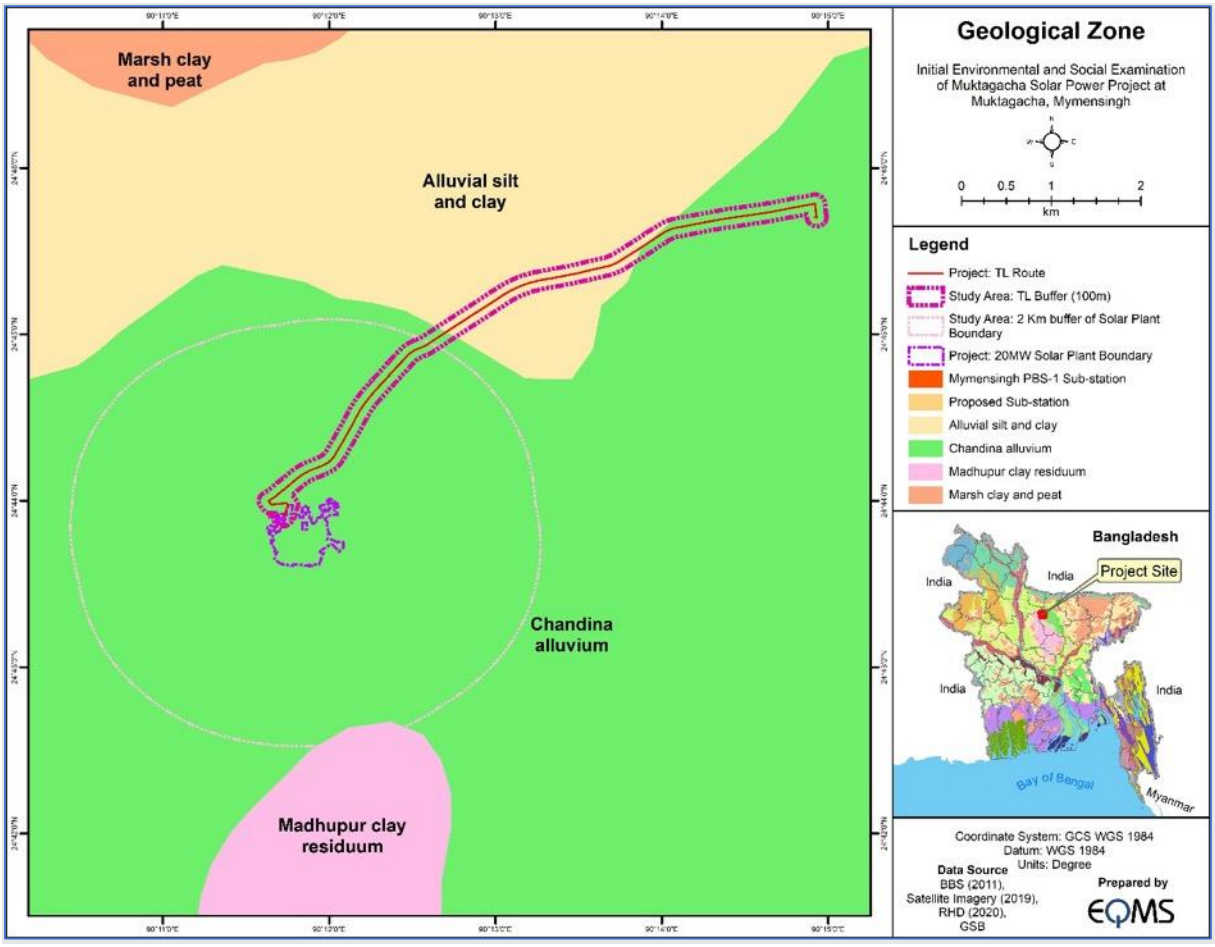
Chandina Alluvium: It is yellowish-brown or grey to reddish-grey silt to clay. More consolidated than active flood-plain sediments (asl, asc). Upper 0.5 m is generally oxidized. Unit is generally above the present normal flood level; underlies the Tipper surface Of Morgan and McIntire (1959) and Cole man (1968). Includes Highland alluvium (Alam, 1988) and some Holocene slope wash deposit adjacent to higher Radiocarbon and dates indicate deposition ceased during the Middle Holocene. Streams are locally entrenched, indicating that some areas are being actively uplifted. see Bakr (1977).

Alluvial silt: It is light- to medium-grey, fine sandy to clayey silt. Commonly poorly stratified; average grain size decreases away from main channels. Chiefly deposited in flood basins and interstream areas. The unit includes small back swamp deposits and varying amounts of thin, interstratified sand deposited during episodic or unusually large floods. It is the most abundant clay mineral. Most areas are flooded annually. Included in this unit are thin veneers of sand spread by episodic large floods over flood-plain silts. Historic pot- trey, artefacts, and charcoal (radiocarbon dated 500-6,000 years B.p.) found in upper 4 m.

Madhupur clay Residuum: It is light yellowish- grey, orange, light to brick-red, and greyish-white, micaceous silty clay to sandy clay; plastic and abundantly mottled in upper 8 m:' contains small clusters of organic matter. Sand fraction dominantly quartz; minor feldspar (orthoclase greater than plagioclase) and mica; sand content increases with depth. Dominant clay minerals are kaolinite and illite. Iron manganese oxide nodules concentrated in zones, calcium carbonate nodules rare. Locally, a cohesive, 35-cm-thick iron oxide zone is preserved near the surface of residuum. Unoxidized clay coatings occur along root tubes, burrows, vugs, cavities, and fracture planes. Gradational contact with underlying sand. The density of incised streams is greater and drainage networks more complex than on Barind surface.

The geological map of the study area is presented in Figure 5-4.

Figure 5-4: Geology Map of the Study Area



Source: Geological Survey of Bangladesh, 1991

5.3.4 Land Use

Land use/cover inventories are an essential component of land resource evaluation and environmental studies due to the changing nature of land use patterns. The land use study of the proposed project and its 2 km buffer was undertaken with the following objectives:

- To study the land use in the 2 km radius areas of the proposed project site and provide inputs for environmental planning of the proposed project by analyzing the existing land use scenario.
- To establish the existing baseline scenario using a GIS database and drone survey for the incorporation of thematic information on the different physical features including water bodies, settlements, transport networks, administrative boundaries, etc.

5.3.4.1 Land Use Interpretation of the Power Plant Site

The land use of the study area is presented in Table 5-3 and Figure 5-5.

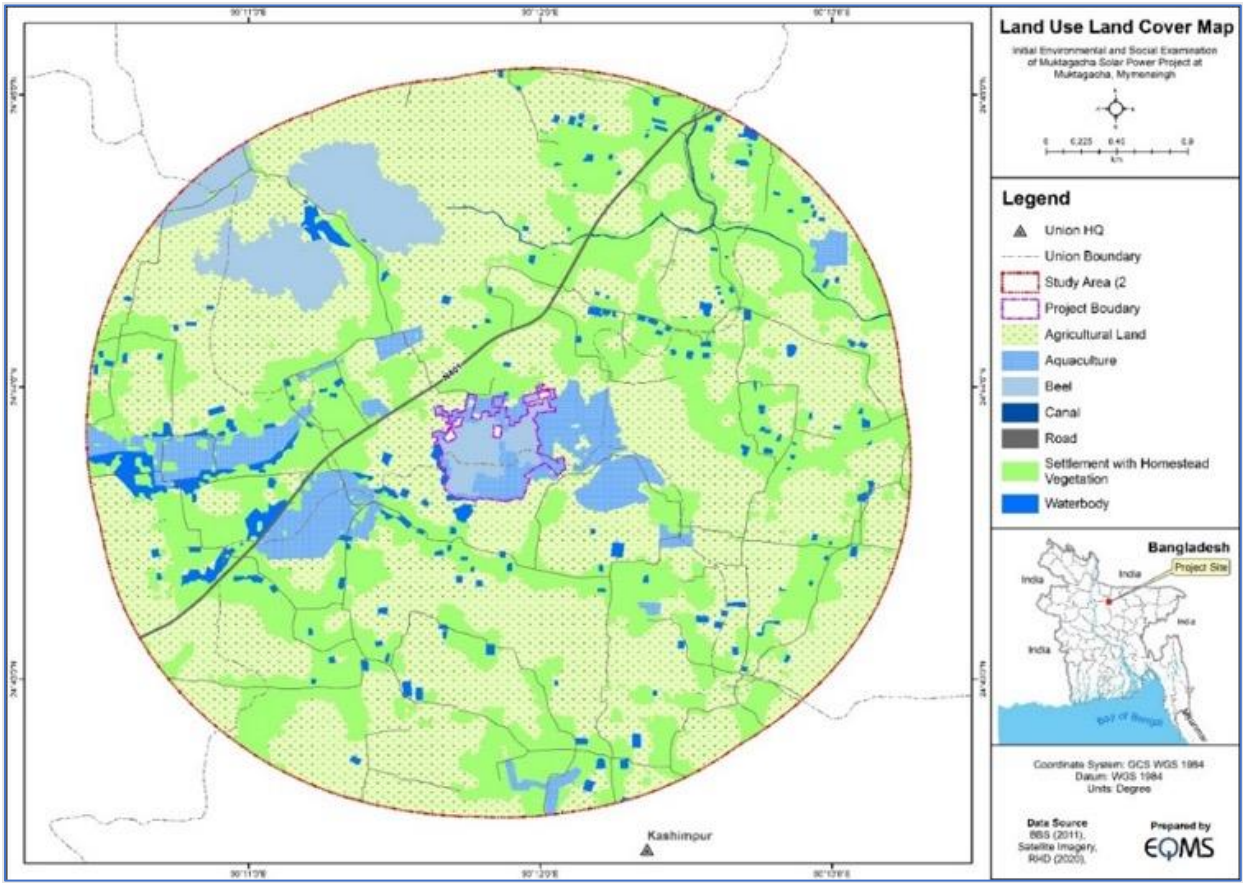
Table 5-3: Land Use Pattern for the Study Area (2km)

SN	Type	Area (Acres)	Percentage
1.	Agricultural Land	2411.43	53.93
2.	Aquaculture	258.37	5.78
3.	Beel	237.70	5.32

SN	Type	Area (Acres)	Percentage
4.	Canal	8.14	0.18
5.	Road	52.67	1.18
6.	Settlement with Homestead Vegetation	1384.65	30.97
7.	Waterbody	118.45	2.65

Source: GIS Mapping and Interpretation of Satellite Imagery by EQMS

Figure 5-5: Land use map of the Study Area

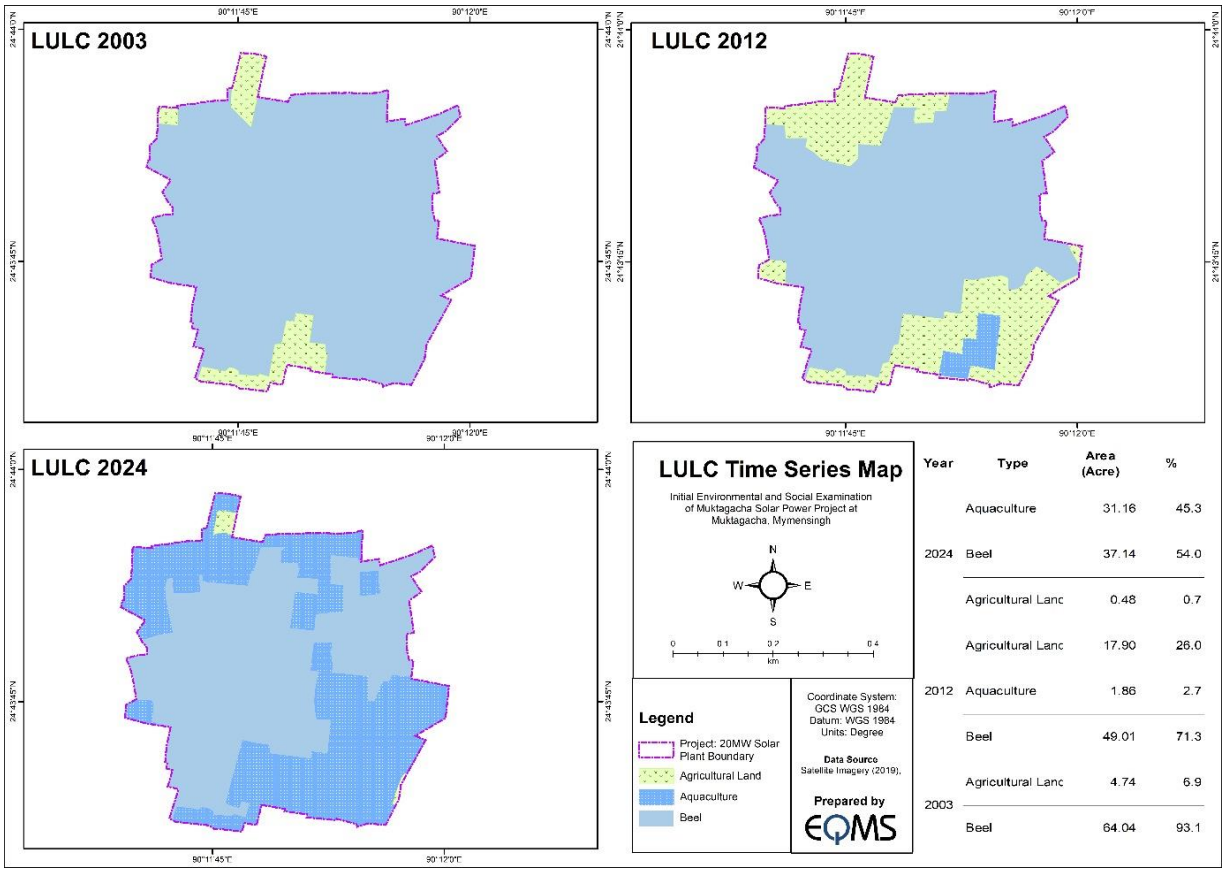


Source: GIS Mapping and Interpretation of Satellite Imagery by EQMS

5.3.4.2 Historical Land Use in the Power Plant Area

GIS-based LULC time series data indicated that the area's land use and land cover remained consistent in type from 2003 to 2024. In 2003, the majority of the area (93.1%) was characterized as *beels*, which decreased to 71.3% by 2012 and further to 54.0% by 2024. Agricultural land, which made up 6.9% in 2003, increased to 26.0% by 2012, then decreased to 0.7% by 2024. Moreover, MSEL obtained NOC from Department of Agricultural Extension for the establishment and operation of the project, which identified this power plant development land as fallow land. There were no aquaculture practices at the site in 2003, but by 2024, 45.3% of the area had been converted to aquaculture ponds for fish production. Figure 5-6 provides a visual representation of the land change patterns over time at the project site.

Figure 5-6: Land use Pattern Change Time Series (2003, 2012,2024)

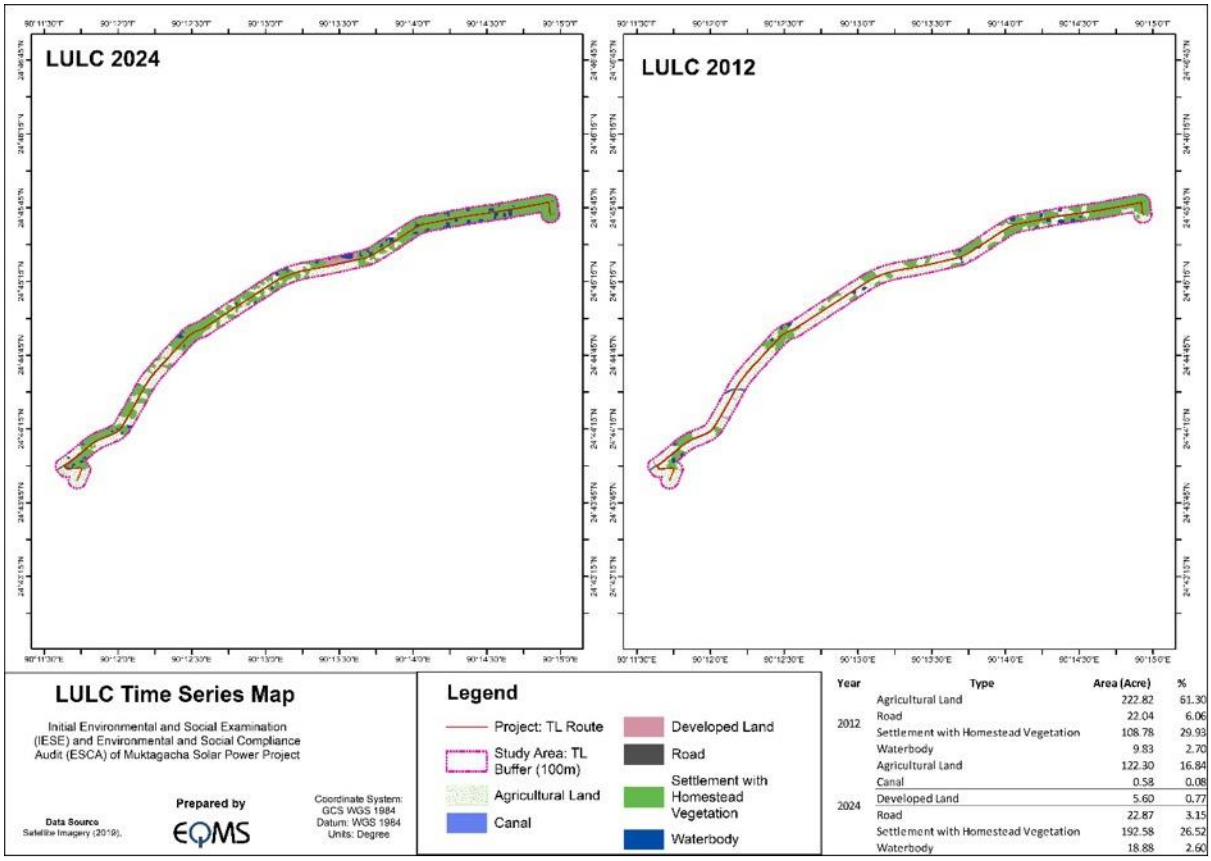


Source: GIS and Drone Survey Data, 2024

5.3.4.3 Land Use Pattern in the Transmission Line Route (2012-2024)

GIS-based LULC time series data of the Transmission line route considering 100 m buffer either side of the road indicated that the area's land use and land cover remained consistent in type from 2012 to 2024. In 2012, the majority of the area (61.30%) was characterized as agricultural land, which decreased to 16.84% by 2024. Settlement and homestead vegetation, which made up 29.93% in 2012, decreased to 26.52% by 2012. There were some development activities that happened on the transmission line route area (buffer area) which cover almost 0.77% during 2024. Water body exist on the transmission line route. The transmission line route being used as road from 2012 to 2024. Figure 5-7 provides a visual representation of the land change patterns over time 2012 to 2024 at the transmission line route.

Figure 5-7:Land use Patter Changes Over the Time 2012 to 2024 (100 m buffer area)

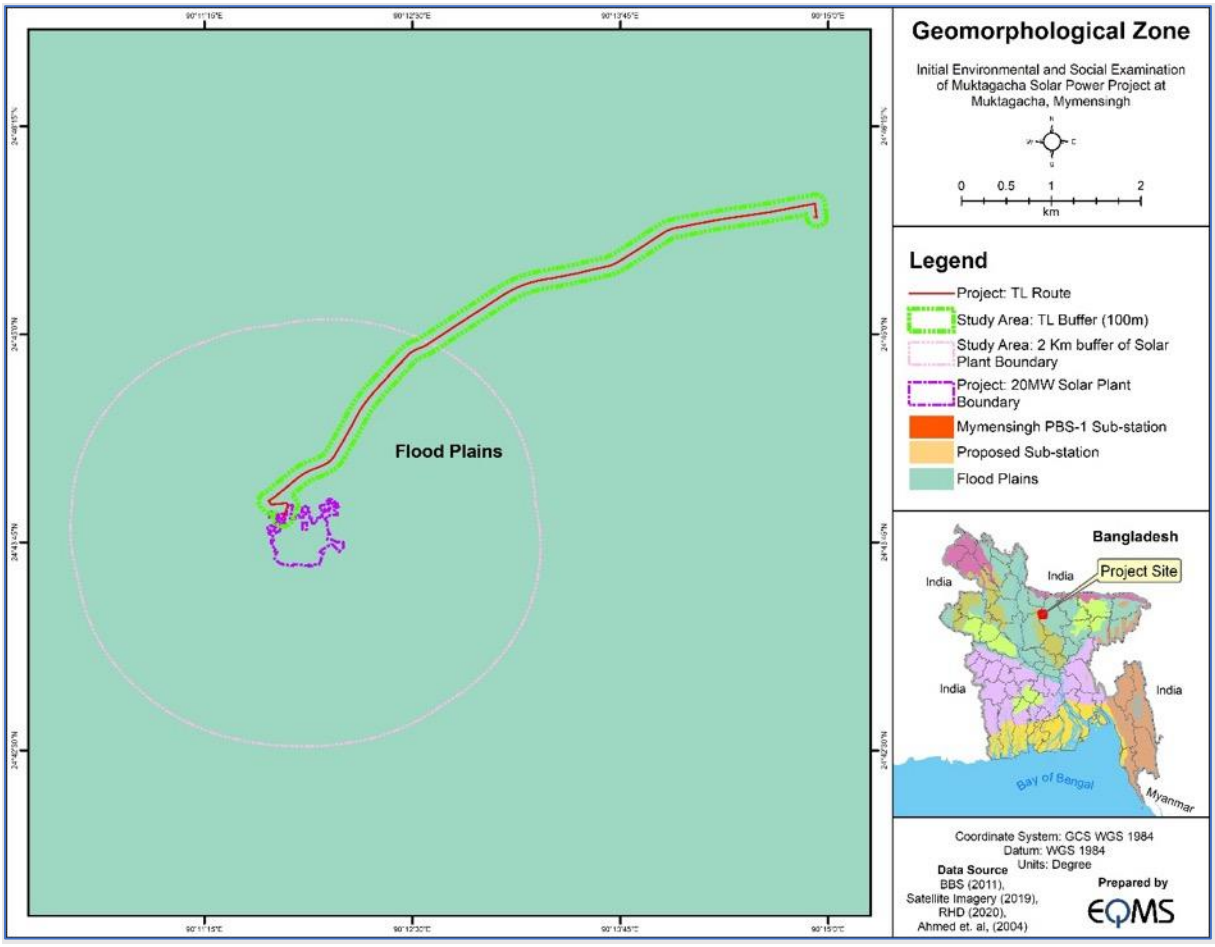


5.3.5 Geomorphology

There is three geomorphologic division of Bangladesh for its soil formation. These are a) Tertiary Hills, b) Pleistocene Uplands, and c) Holocene Plains (Deltaic Plain). According to the Geological Survey of Bangladesh (GSB), the project area falls under the geomorphic unit of "**Flood plains**".

The flood plains of the Ganges, the Atrai, the Brahmaputra-Jamuna, the Old Brahmaputra, and the Meghna rivers cover approximately 40% of Bangladesh. The elevation of the major part of the flood plain ranges from 3 to 5 meters. The flood plain covers the central, north and northeastern part of the country. The Brahmaputra-Jamuna Flood Plain is located between the Barind and Madhupur Tracts. Elevation of this surface is 29 m in the north and about 6 m in the south. In 1887, 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 and changed from a meandering river to a braided river. The Old Brahmaputra degenerated into a small seasonal channel and rarely spills over the previously built-up levees. The Ganges Flood Plain extends from the western border of the country, south of the Barind Tract, as far east where it merges with the Jamuna Flood Plain. The Meghna Flood Plain merges with the southern part of the Old Brahmaputra Flood Plain in the northwest and with the Sylhet Depression in the north. The landform of the flood plain is characterized by natural levees distributed in a mottled pattern which forms shallow depressions and small ridges. The maximum height of the levees is 30 m above the sea level. There are numerous small depressions (beels/haors) in the flood plain. The levee of the rivers gently slopes towards these depressions. Silty clay, clay, sandy silt with local peat beds are the major constituents of the flood plain area.
The geomorphology of the study area is given in Figure 5-8

Figure 5-8: Geomorphology Map of the Study Area



Source: Ahmed et al., 2004

5.3.6 Agro-ecology

Agroecological Zone land areas are recognized on the basis of hydrology, physiography, soil types, tidal activity, cropping patterns, and seasons. An agroecological zone indicates an area characterized by homogeneous agricultural and ecological characteristics. The agroecological zones of Bangladesh have been identified on the basis of four elements such as physiography, soils, land levels in relation to flooding, and agro climatology. Bangladesh has been tentatively divided into 30 agroecological zones[3].

The proposed project site belongs to "**Old Brahmaputra Floodplain**" and "**Young Brahmaputra and Jamuna Floodplain**".

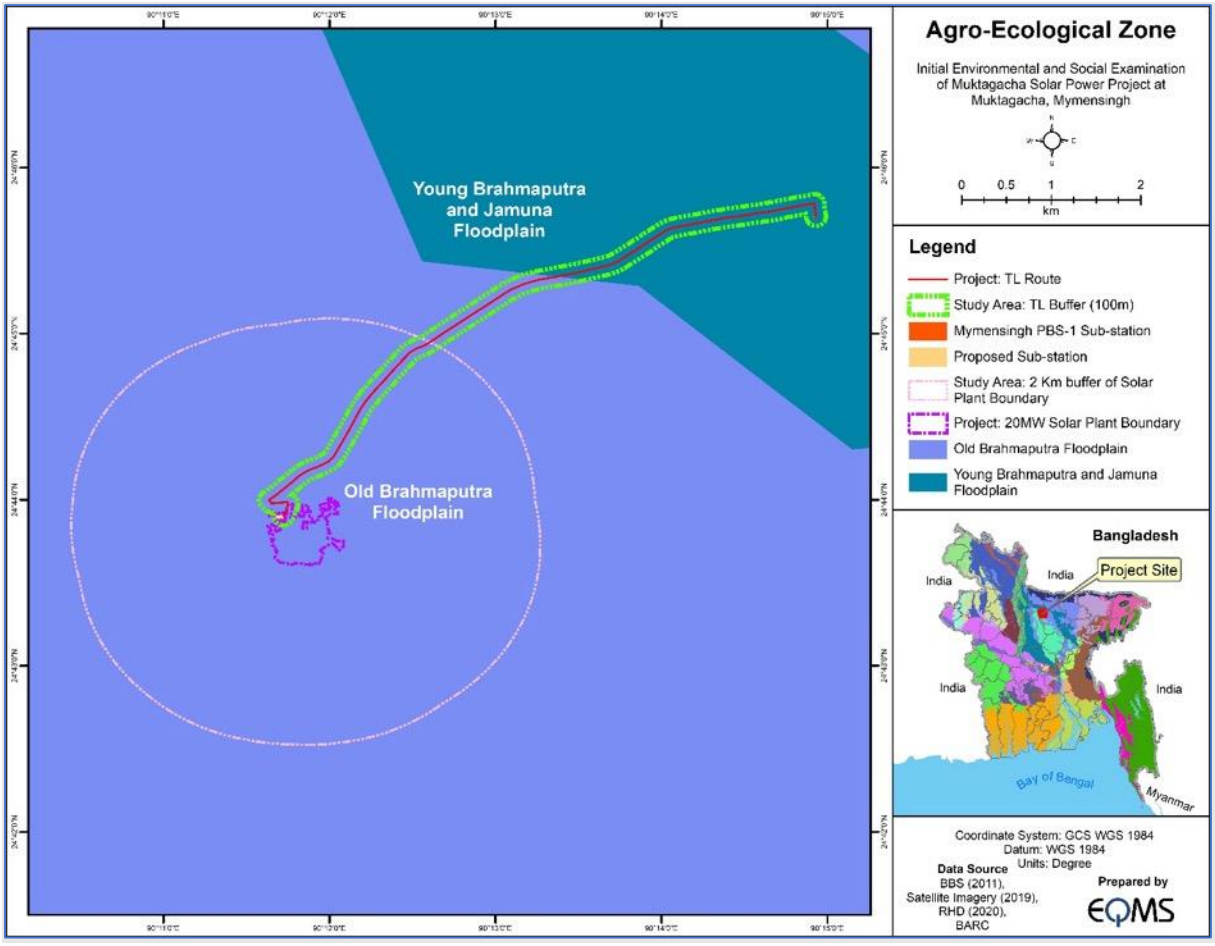
Old Brahmaputra Floodplain (7,230 sq km) this region occupies a large area of Brahmaputra sediments before the river shifted to its present JAMUNA channel about 200 years ago. The region has broad ridges and basins. Relief is irregular, especially near the old and present river channels. The soil of the area is predominantly silt loams to silty clay loams on the ridges and clay in the basins. Organic matter content is low on the ridges and moderate in the basins, topsoil's moderately acidic but subsoils neutral in reaction. General fertility level is low.

[3] FAO-UNDP. (1988). Land Resources Appraisal of Bangladesh for Agricultural Development Report 2: Agroecological Regions of Bangladesh.

Young Brahmaputra and Jamuna Floodplain (5,924 sq km) the region comprises the area of Brahmaputra sediments. It has a complex relief of broad and narrow ridges, inter-ridge depressions, partially in filled cut-off channels and basin. This area is occupied by permeable silt loam to silty clay loam soils on the ridges and impermeable clays in the basins, neutral to slightly acid in reaction. General soil types include predominantly grey floodplain soils. Organic matter content is low in ridges and moderate in basins. Soils are deficient in N, P, and S but the status of K and Zn are reasonable.

The map of the agro-ecological region is given in Figure 5-9.

Figure 5-9: Agro-ecological Zone of the Study Area



Source: Bangladesh Agricultural Research Council (BARC)

A major part of Bangladesh is on the delta formed by the three major rivers Brahmaputra, Ganges, and Meghna. Regarding soil formation, two distinct conditions occur in Bangladesh: alternating seasonal wet or inundated and dry conditions, as prevalent on most of the floodplain areas, and intermittently wet or moist or dry conditions, as on the upland areas of hills and terraces. This is due to the variation of agroclimatic parameters in different seasons. The soil formation process differs significantly between floodplain, hill, and uplifted terraces.

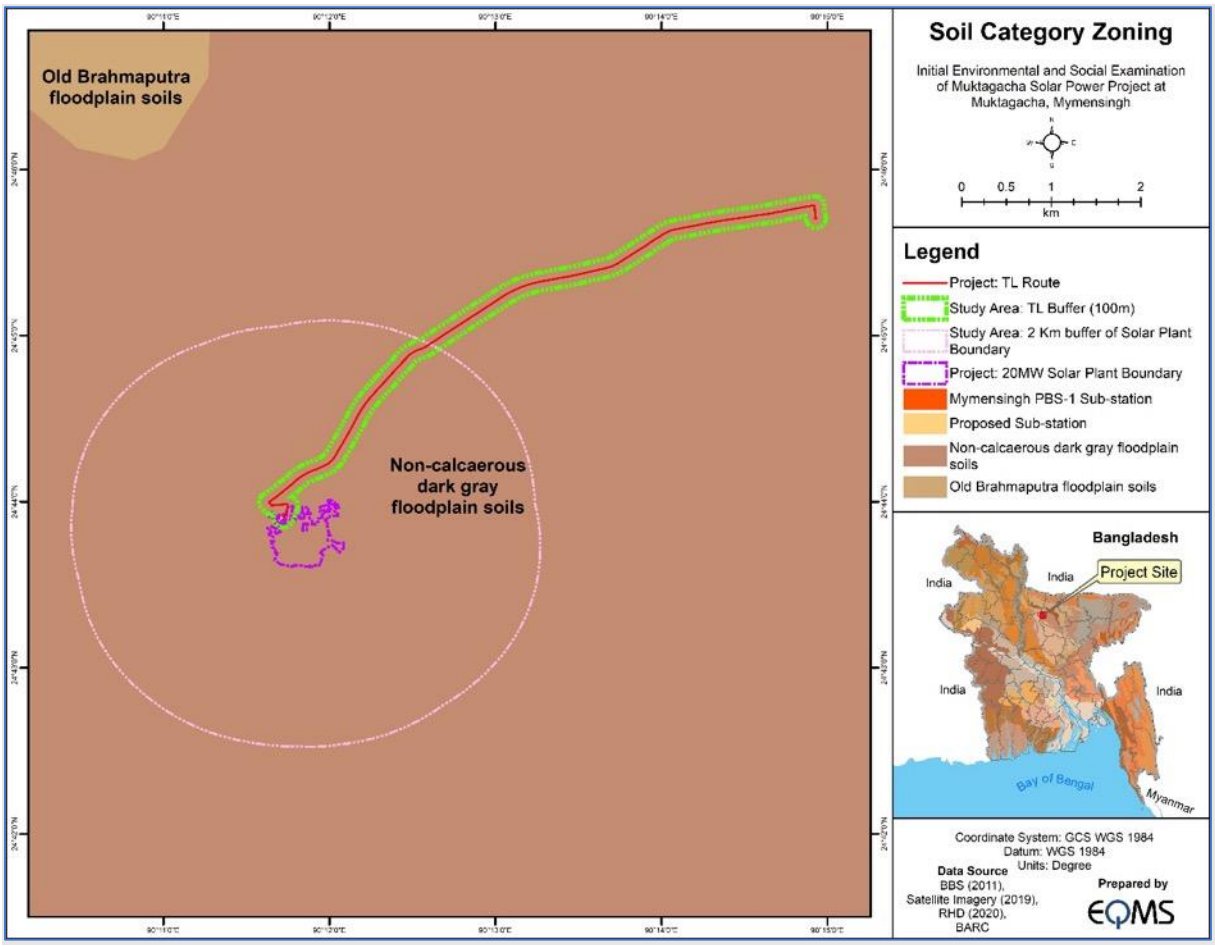
The proposed project site belongs to "**Noncalcareous Dark Grey Floodplain**" soils.

These are the second-most extensive soils in the country. They do not contain lime in any layer within 125 cm of the surface. These soils occupy the Old Brahmaputra and Old Meghna estuarine floodplains, and locally the Tista, Karotoya–Bangali, Lower Atrai, Young Brahmaputra, and Lower Meghna River floodplains, and some basins on the Old Himalayan piedmont plain. They are differentiated from the noncalcareous grey floodplain soils by having dark grey instead of grey subsoil coatings, and from

calcareous dark grey floodplain soils in being noncalcareous throughout the profile. The topsoil have surface layers 5–10-cm thick overlying a plow pan about 5-cm thick. These layers vary from grey to dark grey and have rusty iron stains along root channels and cracks. The soil is medium to very strongly acidic in reaction when dry and neutral in the reduced condition. The subsoil usually is 20–45-cm thick. The upper part of these soils is dark grey having oxidized mottles. They have a strong coarse prismatic structure, but clay soils have an angular blocky structure. The subsoils are slightly acidic to moderately alkaline in reaction. The topsoil is much lighter in texture than the subsoil. The ridges are silt loam or silty clay loam, whereas basins are silty or clay in texture. The texture of the substratum usually is lighter than the subsoil. The substratum usually is neutral to moderately alkaline in reaction. The agricultural potential of these soils is highest on shallowly flooded ridge soils and lowest in deep basin centers.

The soil map of the proposed project area is given in Figure 5-10

Figure 5-10: Soil Map of the Study Area



Source: Bangladesh Agricultural Research Council (BARC)

5.4 Meteorology

5.4.1 Climate

Bangladesh is located in the tropical monsoon region and its climate is characterized by high temperature, heavy rainfall, often excessive humidity, and fairly marked seasonal variations. From the climatic point of view, four distinct seasons[4] can be recognized in Bangladesh.

[4] Brammer, H. (1996). The Geography of the Soils of Bangladesh. University Press Limited, Dhaka, Bangladesh.

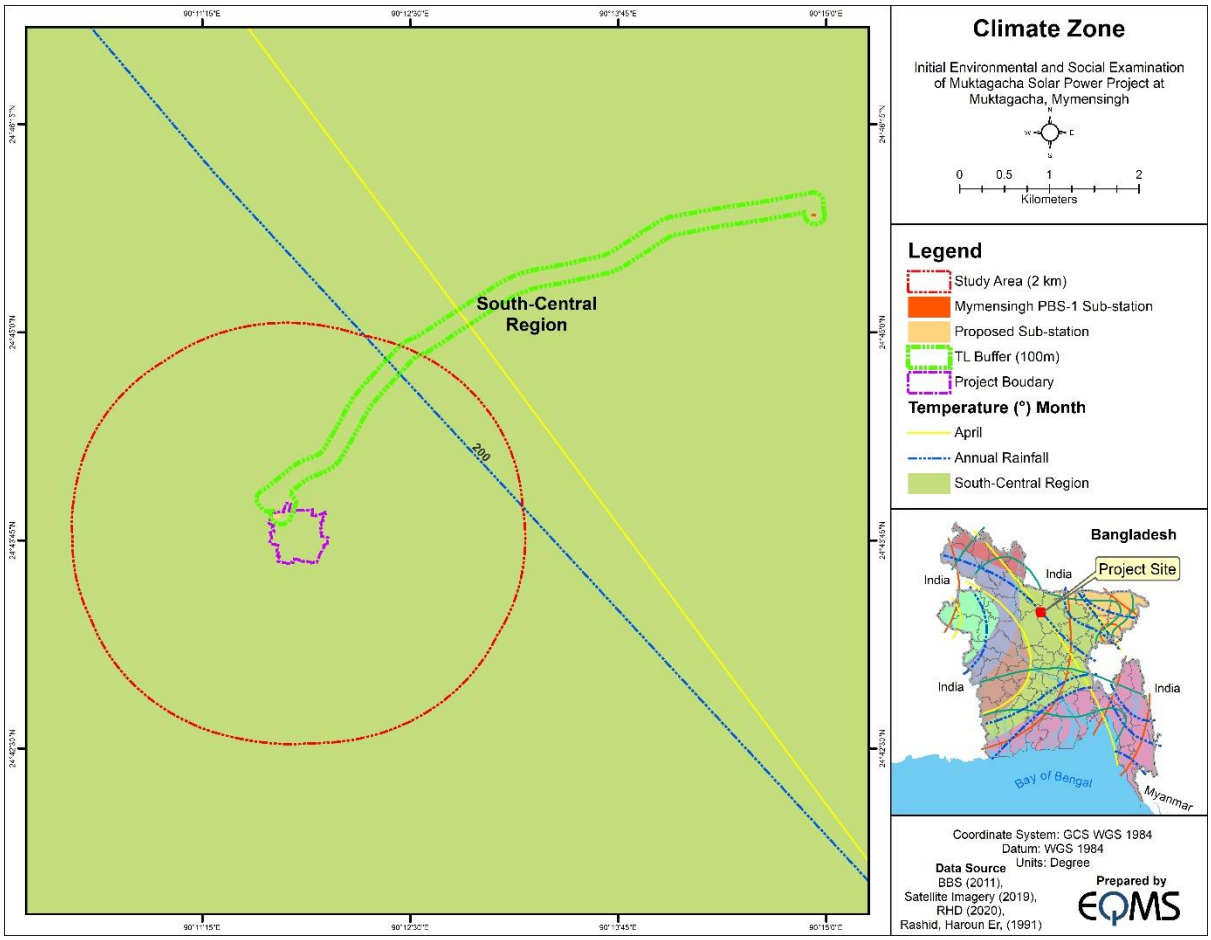
1) **Pre-Monsoon Season (March to May):** Characterized by the highest temperatures of the year – up to 36°C. Some rainfall may occur, with tropical cyclones occasionally affecting coastal areas.
2) **Monsoon Season (June to September):** Period of highest rainfall (up to 80% of the annual rainfall),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

Despite the general predictability of the seasons in Bangladesh, local conditions may still vary widely across the country. As such, Bangladesh can be divided into seven climatic sub-zones based on differences in a range of factors including rainfall, temperature, evapotranspiration, and local seasonality (Rashid, 1991). According to the climatic sub-regions of Bangladesh, the proposed project area is located in the South-Central Region.

The climatic sub-regions of the study area are shown in Figure 5-11. The climatic data for the study area was obtained from the Bangladesh Meteorological Department (BMD)[5].

[5] Bangladesh Meteorological Department is the authorized Government organization for all meteorological activities in Bangladesh. It maintains a network of surface and upper air observatories, radar and satellite stations, agro-meteorological observatories, geomagnetic and seismological observatories, and meteorological telecommunication system.

Figure 5-11: Climatic sub-regions of the study area



Source: Rashid, H. E. 1991[6]

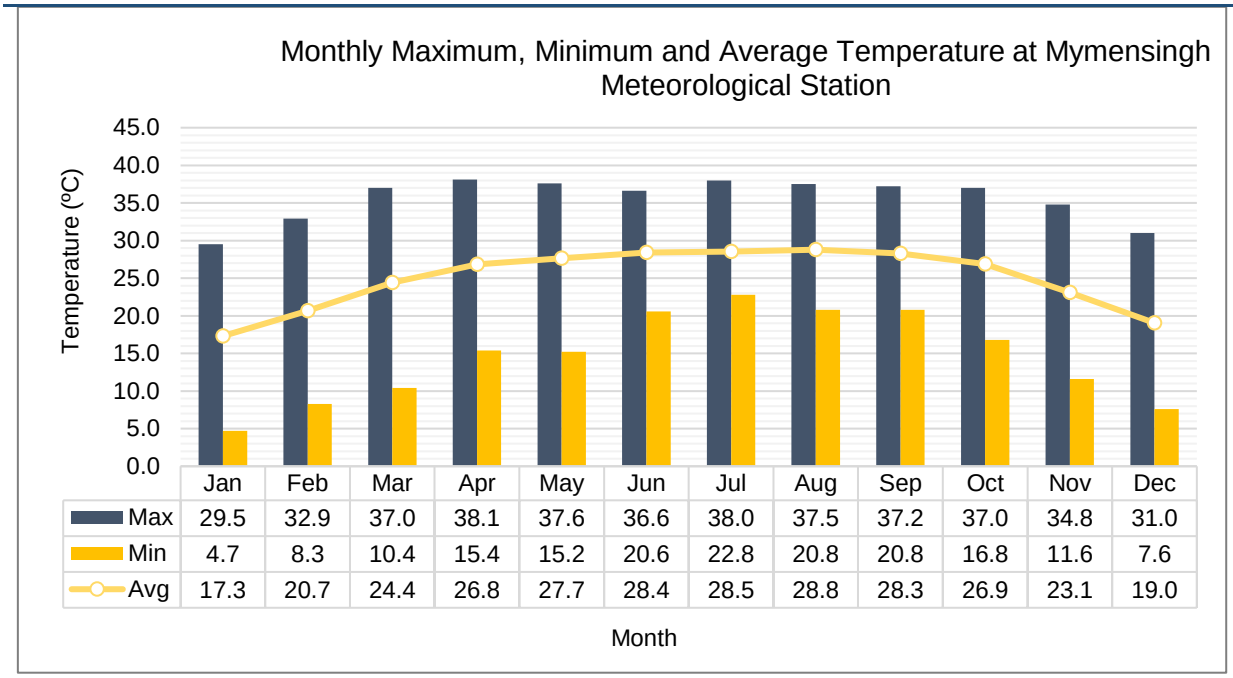
There is a meteorological station in Mymensingh District. The nearest meteorological station from the proposed project site is at Mymensingh Meteorological Station, which is about 24 km from the project site.

5.4.2 Temperature

The variation of maximum, minimum, and average temperature recorded at the Mymensingh weather station is shown below in Figure 5-12. The data analysis of 32 years shows that the monthly maximum temperature varies from 29.5°C to 38.1°C whereas the monthly minimum temperature varies from 4.7°C to 22.8°C. The lowest monthly average temperature recorded in the past 32 years was in January 2003 (17.3°C). The highest monthly average temperature reached 28.8°C in May 1989. Throughout the year, the highest temperatures are generally from March through October and the lowest temperatures are from December to January (Figure 5-12).

[6] Rashid, H. E. (1991). *Geography of Bangladesh*. The University Press Ltd.

Figure 5-12: Temperature Variation at Mymensingh Station (1989 to 2021)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	29.5	32.9	37.0	38.1	37.6	36.6	38.0	37.5	37.2	37.0	34.8	31.0
Min	4.7	8.3	10.4	15.4	15.2	20.6	22.8	20.8	20.8	16.8	11.6	7.6
Avg	17.3	20.7	24.4	26.8	27.7	28.4	28.5	28.8	28.3	26.9	23.1	19.0

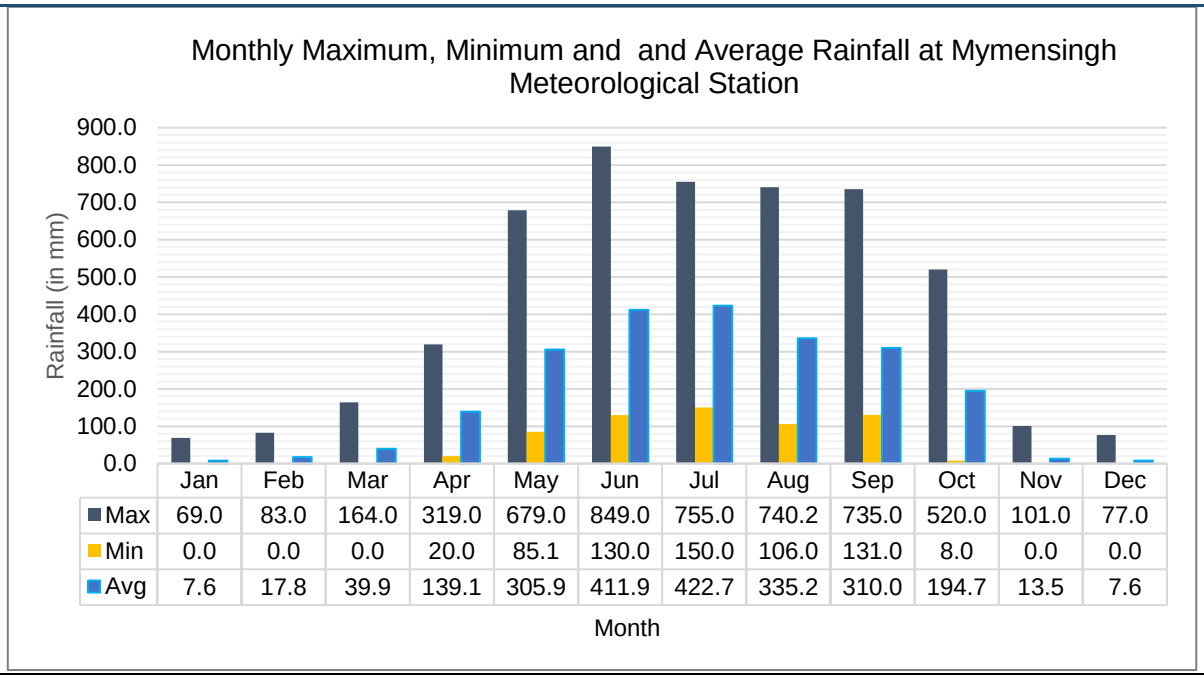
Source: Bangladesh Meteorological Department (BMD), 2024

5.4.3 Rainfall

About 80% of the rainfall occurs over six months (May to October) with June to August getting the maximum rainfall. Minimum rainfall is reported from November to February whereas average showering does occur in March, April, and November. The last 32 years' data of the Mymensingh meteorological station shows that the annual average of total rainfall is recorded as 2205.9 mm/year. According to the analysis of the historical data, the highest annual total rainfall is recorded as 3312 mm in 1991 and the lowest annual total rainfall is recorded as 1520 mm in 2012. The peak one-day highest rainfall is 314 mm recorded in October.

The variation of monthly average rainfall of the last 32 years of Mymensingh weather station is shown in Figure 5-13

Figure 5-13: Rainfall Variation at Mymensingh Station (1989 to 2021) in mm



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	69.0	83.0	164.0	319.0	679.0	849.0	755.0	740.2	735.0	520.0	101.0	77.0
Min	0.0	0.0	0.0	20.0	85.1	130.0	150.0	106.0	131.0	8.0	0.0	0.0
Avg	7.6	17.8	39.9	139.1	305.9	411.9	422.7	335.2	310.0	194.7	13.5	7.6

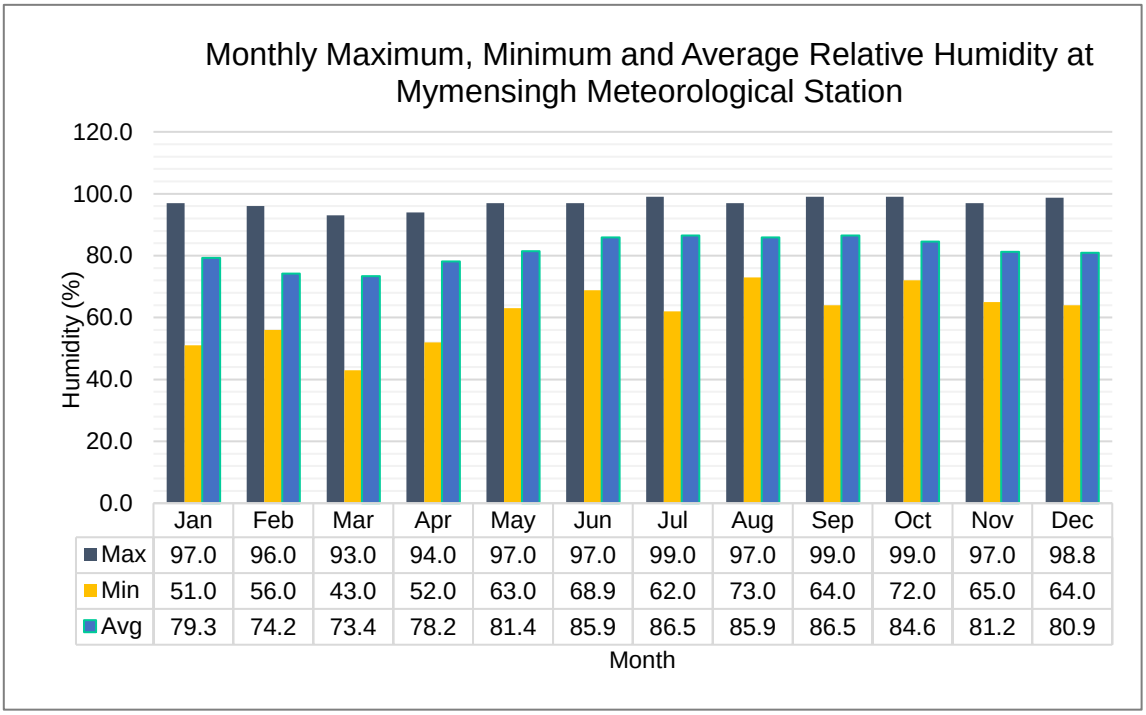
Source: Bangladesh Meteorological Department (BMD)

5.4.4 Relative Humidity

Due to the heavy rainfall and proximity to the Bay of Bengal, the humidity levels in the proposed project area remain high. Humidity is also responsible for the fluctuation of temperature in the region. The monthly average relative humidity varies from 73.4% to 86.5% in the project area. Humidity remains high in the monsoon and post-monsoon seasons and comparatively low in the winter season. Monthly Average Relative humidity in the area is generally above 80% from May to December. The month of March is the driest with relative humidity around 73%.

The monthly average humidity of the last 32 years of Mymensingh weather station is shown in Figure 5-14.

Figure 5-14: Monthly Average Relative Humidity at Mymensingh Station



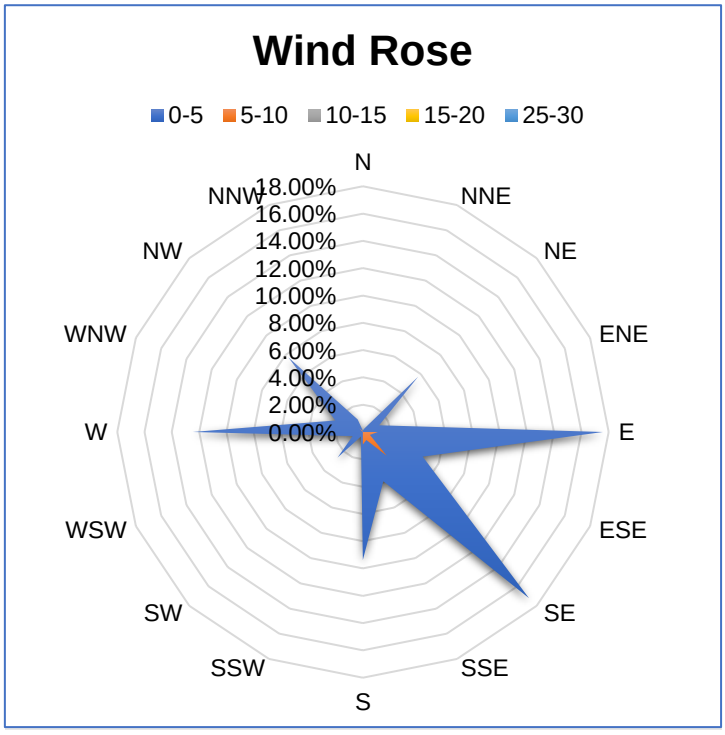
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	97.0	96.0	93.0	94.0	97.0	97.0	99.0	97.0	99.0	99.0	97.0	98.8
Min	51.0	56.0	43.0	52.0	63.0	68.9	62.0	73.0	64.0	72.0	65.0	64.0
Avg	79.3	74.2	73.4	78.2	81.4	85.9	86.5	85.9	86.5	84.6	81.2	80.9

Source: Bangladesh Meteorological Department (BMD

5.4.5 Wind Direction

The wind direction in Mymensingh meteorological station is generally from South-East (SE) to North-West (NW) direction. Annual wind roses are shown in Figure 5-15.

Figure 5-15: Annual Wind Rose diagram at Mymensingh Met Station (2019- 2021)



Source: Bangladesh Meteorological Department (BMD)