Environment Impact Assessment (EIA)
of
Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant

At

Shambhuganj, Mymensingh, Bangladesh

Prepared by-

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ABBREVIATION

ADB	Asian Development Bank
AECL	Adroit Environment Consultants Limited
AER	Agro-Ecological Region
AQM	Air Quality Management
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CSMC	Construction Supervision and Monitoring Consultants
CAMS	Continuous Air Monitoring Station
DAE	Department of Agricultural Extension
DC	Deputy Commissioner
DOE	Department of Environment
ECR	Environment Conservation Rules 1997
EIA	Environmental Impact Assessment
EGB	Exhaust Gas Boiler
EMP	Environmental Management Plan
EPZ	Export Processing Zone
GIS	Geographic Information System
GOB	Government of Bangladesh
GPS	Global Positioning System
GT	Gas Turbine
GSTP	Gas Sector Development Program
HSD	High Speed Diesel
HRSG	Heat Recovery Steam Generator
IDCT	Induced Draft Cooling Tower
IEC	Important Environmental Component

IEE	Initial Environmental Examination
LGED	Local Government Engineering Department
MoEF	Ministry of Environment and Forests
MMSCFD	Million standard cubic feet per day
NAAQS	National Ambient Air Quality Standard
NEMAP	National Environment Management Action Plan
NGO	Non-Government Organization
NWMP	National Water Management Plan
PAP	Project Affected People
PCP	Project Concept Paper
PLF	Plant Load Factor
REB	Rural Electrification Board
RPCL	Rural Power Company Limited
SRDI	Soil Resource Development Institute
TBS	Town Border Station
TOR	Terms of Reference
ST	Steam Turbine
UNDP	United Nations Development Programme
WB	World Bank

GLOSSARY

Adverse impact: An impact that is considered undesirable.

Ambient air: Surrounding air.

Aquatic: Growing or living in or near water.

Bangla: Bengali language.

Baseline (or existing) conditions: The 'baseline' essentially comprises the factual understanding and interpretation of existing environmental, social and health conditions of where the business activity is proposed. Understanding the baseline shall also include those trends present within it, and especially how changes could occur regardless of the presence of the project, i.e. the 'No-development Option'.

Bazar: Market.

Beel: A 'back swamp' or depression. It can be either perennial or seasonal.

Beneficial impacts: Impacts, which are considered to be desirable and useful.

Biological diversity: The variety of life forms, the different plants, animals and microorganisms, genes they contain and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecological diversity.

Char: Newly accreted land: Land, sometimes islands, within main river channels and nearby mainland or in the estuary, subject to erosion and accretion.

Ecosystem: A dynamic complex of plant, animal, fungal and microorganism communities and associated non-living environment interacting as an ecological unit.

Emission: The total amount of solid, liquid or gaseous pollutant emitted into the atmosphere from a given source within a given time, as indicated, for e.g., in grams per cubic meter of gas or by a relative measure, upon discharge from the source.

Endangered species: Species in danger of extinction and whose survival is unlikely if the existing conditions continue to operate. Included among those are species whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are deemed to suffer from immediate danger of extinction.

Environmental effects: The measurable changes, in the natural system of productivity and environmental quality, resulting from a development activity.

Environmental Impact: An estimate or judgment of the significance and value of environmental effects for natural, socio-economic and human receptors.

Environment Management Plan (EMP): A Plan to undertake an array of follow-up activities which provide for the sound environmental management of a project/ intervention so that adverse environmental impacts are minimized and mitigated; beneficial environmental effects are maximized; and sustainable development is ensured.

Environmental Management: Managing the productive use of natural resources without reducing their productivity and quality.

Erosion: Process in which wind and water removes materials from their original place; for instance, soil washed away from an agricultural field.

Evaluation: The process of looking back at what has been really done or accomplished.

Fauna: A collective term denoting the animals occurring in a particular region or period.

Field Reconnaissance: A field activity that confirms the information gathered through secondary sources. This field study is essentially a rapid appraisal.

Flora: All of the plants found in a given area.

Habitat: The natural home or environment for a plant or animal.

Household: A household is identified as a dwelling unit where one or more persons live and eat together with common cooking arrangement. Persons living in the same dwelling unit having separate cooking arrangements constitute separate household.

Important Environmental Component (IEC): These are environmental components of biophysical or socio-economic importance to one or more interested parties. The use of important environmental components helps to focus the environmental assessment.

Khal: Small Channel, canal.

Land use: Types include agriculture, horticulture, settlement, pisciculture and industries.

Mauza: A Bangla word for the smallest government administrative area corresponding to village revenue unit.

Mitigation: An action, which may prevent or minimize adverse impacts and enhance beneficial impacts.

Negative Impact: Negative change from the existing situation due to the project.

Public involvement / Public consultation: A range of techniques that can be used to inform, consult or interact with stakeholders affected / to be affected by a proposal.

Reversible impact: An environmental impact that recovers either through natural process or with human assistance (e.g. cutting off fish migration by an embankment might be reversible at a later stage if a proper regulator is built).

Stakeholders: Those who may be potentially affected by a proposal, e.g. Local people, the proponent, government agencies, NGOs, donors and others, all parties who may be affected by the project or to take an interest in it.

Taka: Unit of Bangladeshi currency.

Terrestrial: Living on land.

Thana: Sub-district level of government administration, comprising several unions under district.

Union: Smallest unit of local self-government comprising several villages.

Upazila: Sub-district name. Upazila introduced in 1982.

Zila: Bengali word of district.

EXECUTIVE SUMMARY

1. Introduction

This report represents the results of Environmental Impact Assessment (EIA) of **Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP** at Shambhuganj, Mymensingh. To provide access to affordable and reliable electricity to all by 2021 as well as to comply with the policy of Government of Bangladesh (GOB) and to increase the production of electricity by using natural gas/HSD, RPCL intends to construct a 360 MW Dual Fuel (Gas/HSD) CCPP beside its existing plant premises. **Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP** project is a natural gas/HSD fired power generation plant with rated capacity of 360 MW. The proposed area of the power plant is located beside RPCL Power Plant Complex and the power plant energy production capacity is **360 MW**. The authority has applied for the Environmental Site Clearance Certificate from Department of Environment (DoE) by submitting the IEE and other documents. The **Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP** project shall be implemented by RPCL. The objective of this study is to provide an examination and assessment of the major environmental & social impacts to be created due to the project activity during its construction and operation phase. The study will also focus on the suggesting the possible mitigation measures for any adverse impacts and a management & monitoring plan to evaluate the affectivity of the mitigation measures.

This EIA report comprises 12 sections and the contents of these sections are summarized below.

2. The Project

Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant is a dual fuel power generation plant with rated capacity of 360 MW. The proposed area of the plant is located adjoining the RPCL existing 210 MW Mymensingh Power Station. The power plant will be designed for 360 MW dual fuel CCPP technology. The operation principle will be based on the national electricity demand of the region and country as well. Electricity generated in the power plant will be supplied to the 132 KV Grid sub-station within the power plant premises. Gas will be supplied by TITAS Gas Transmission and Distribution Company Limited to the power plant and the HSD will be supplied through the Railway route from Chittagong to Shambhuganj, Mymensingh or, Bhairab to Shambhuganj, Mymensingh. RPCL shall procure equipment of Gas Turbine, HRSG, Steam Turbine, Generator, and other major equipment / auxiliaries from renowned manufacturers / Vendors. The basic information of the project is given below:

➢ Name of the Project	Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant, Shambhuganj, Mymensingh, Bangladesh.
➢ Project Proponent	Rural Power Company Ltd. (RPCL)
➢ Project Location	Char Ishwardia, Shambhuganj, Mymensingh.
➢ Corporate Office	House: 19, Road: 1/B, Sector No-09, Uttara Model Town, Dhaka-1230, Bangladesh.

<table>
<tr><td>➢ Type of Business</td><td>Power Generation.</td></tr>
<tr><td>➢ Raw Materials</td><td>The raw materials of the project are HSD (High Speed Diesel)/ Gas as Fuel and water for steam production & cooling purpose.</td></tr>
<tr><td>➢ Type of Project</td><td>Combined cycle technology.
Closed-Circuit Cooling Systems (Hybrid Cooling Tower)</td></tr>
<tr><td>➢ Produced Product</td><td>Electricity, from 360 MW combined cycle power plant yearly 2,522,880,000 kW hour electricity will be produced.</td></tr>
<tr><td>➢ Coordinate of the Project site</td><td>
<table>
<tr><th>Sl. No.</th><th>Longitude</th><th>Latitude</th></tr>
<tr><td>1</td><td>90°24'59.97"E</td><td>24°45'44.49"N</td></tr>
<tr><td>2</td><td>90°24'56.60"E</td><td>24°45'47.72"N</td></tr>
<tr><td>3</td><td>90°24'56.88"E</td><td>24°45'50.89"N</td></tr>
<tr><td>4</td><td>90°25'2.03"E</td><td>24°45'56.11"N</td></tr>
<tr><td>5</td><td>90°25'5.47"E</td><td>24°45'51.73"N</td></tr>
<tr><td>6</td><td>90°25'6.73"E</td><td>24°45'52.15"N</td></tr>
<tr><td>7</td><td>90°25'8.39"E</td><td>24°45'49.62"N</td></tr>
<tr><td>8</td><td>90°25'7.12"E</td><td>24°45'48.90"N</td></tr>
<tr><td>9</td><td>90°25'6.49"E</td><td>24°45'49.59"N</td></tr>
</table>
</td></tr>
<tr><td>➢ By-product, if any</td><td>None</td></tr>
<tr><td>➢ Net Plant</td><td>360 MW</td></tr>
<tr><td>➢ Stack Height</td><td>Gas Turbine: 40 m, HRSG: 50 m.</td></tr>
<tr><td>➢ Annual</td><td>2,522,880,000 kWh</td></tr>
<tr><td>➢ Project Cost</td><td>Estimated Turnkey price: USD 324 Million</td></tr>
<tr><td>➢ Amount of circulation water & make up water</td><td>Cooling water: 22500 m3/hr. (Closed circuit cooling system)

Make up water: (125-150) m3 /hr. (Intake from Ground water)</td></tr>
<tr><td>➢ External Finance</td><td>85%</td></tr>
<tr><td>➢ Internal Finance</td><td>15%</td></tr>
<tr><td>➢ Total Area of Land</td><td>16.5 Acres</td></tr>
<tr><td>➢ Total Developed Land</td><td>16.5 Acres</td></tr>
<tr><td>➢ Employment</td><td>100 skilled personnel and unskilled manpower of about 40 persons.</td></tr>
<tr><td>➢ Fuel Requirement</td><td>Maximum gas requirement will be about 68 MMSCFD at 100% PLF & 54 MMSCFD at 80% PLF (396 MW).

Maximum Daily Liquid Fuel Requirement will be 1572 Ton at 100% PLF & 1258 Ton at 80% PLF (396 MW).</td></tr>
<tr><td>➢ Source of Fuel</td><td>Bangladesh Petroliam Corporation and TITAS Gas Transmission & Distribution Company Limited.</td></tr>
<tr><td>➢ Water source</td><td>Underground Water & River Water.</td></tr>
</table>

➢ Quantity of Liquid Waste	None

The proposed location of "Mymensingh 360MW Combined Cycle Power Plant Project" is within Char Ishwardia Mouza under Mymensingh district beside the existing Mymensingh 210MW Combined Cycle Power Plant of RPCL which is located on the bank of the old Brahmaputra River. Mymensingh City is about 1.2 km (aerial distance) south-west of the Project Site. The project site lies in 24°45'49.08"N & 90°25'2.02"E. The Brahmaputra bridge is on the south of the site, Mymensingh Jute mills ltd on the south and Mymensingh Railway Station is on the west side of the power plant site.

3. Policy and Legal Considerations

This EIA report has been prepared by following the methodology prescribed in the EIA guidelines for industries of DOE, ECA95 and ECR97, that are the main legislative documents relating to environment protection in Bangladesh. The report is also compliant with ADB's Environmental Safeguard Framework and WB group's operational policies and guidelines. Steps to consult potentially affected people by the project and to disclose the EIA report to the public have been taken for compliance with the Bank's policies of the EIA preparation, although these are non-mandatory as per national legislations. The environmental classifications for industrial projects in Bangladesh are based on "inclusion lists" given in the ECR97 with 'RED' being the highest category. Power Plant is listed in the '**Red Category**' in ECR97 (i.e., serial no.6 in the ECR97 Red list in Schedule-1.).

4. Baseline Environment

Baseline environment is concerned with existing physical, chemical and biological conditions of the area where the plant is going to be set up. The surface water, ground water, ambient air quality and noise level have been analyzed to evaluate the primary baseline of the area. The data from the monthly monitoring data of proposed **Mymensingh 360 MW dual fuel CCPP** have also been used to evaluate the monthly concentrations of $PM_{2.5}$ and PM_{10} in the project area.

In the vicinity of the plant, the main surface water body is the river Brahmaputra at 100 m from the site. The quality of the river water has been analyzed and found satisfactory. Ground water level exists at a moderate (Generally below 10.0 m) depth in the area. In common with other peri-urban or rural areas; birds like Crow, Salik, Chorui, doel, ghughu, Kokil, etc. are seen at times at the project site. There are no wildlife, natural forest and vegetation, endangered species of present in and around the plant site. There are a number of different types of trees like coconut, jack fruit, mango, mehogoni, krisnochura etc. around the plant site.

The climate of the region is of tropical monsoon type. According to Bangladesh Meteorological Department, the maximum temperature of 2013 at project site is 29.60° C in August, 2016 where average minimum temperature was 16.10 degree Celsius in January, 2013. Mean relative

humidity for an average year (2012) is recorded as 88% and on a monthly basis; it ranges from 65% in February to 81% in August. At normal times, the maximum and minimum wind speeds at Mymensingh are 3.2 Knots/hr. and 1.50 Knots/hr. respectively in 2012. The rainfall is mostly confined in the monsoon season i.e., between May to October. Highest rain fall were observed in Mymensingh area in 2015 (2084 mm), and lowest rainfall in 2012 (1479 mm).

The data from the DOE CAMS (continuous air quality monitoring stations) is not available near the project area; So, we took the nearest CAMS station at Gazipur station. The baseline levels for another criteria pollutant i.e., CO, NO_2 and SO_2 are compliant with NAAQS. Baseline noise levels measured during the study period around the plant site were found to be above 72-74 dBA in few places. The reason for the higher ambient noise level is caused by the existing gas turbine-based power plants located adjacent to the project. Since there is no homestead within the 50m radius of the proposed project, so, the noise emission from the project would not create any harm to the neighboring community.

5. Potential Impacts of the Proposed Project

The purpose of impact evaluation is to assign relative significance to the predicted impacts associated with the project, and thus determine the order in which impacts are to be avoided or mitigated. It should be noted that impact evaluation is somewhat subjective as the impacts can't always be quantified before the event. The following are the main objectives of impact evaluation: (i) Distinguish between impacts that are of most concern (need to be avoided/ mitigated) and those that are considered to be less important; (ii) Organize measures of significance in a way that allows a comparison of alternative project proposals; and (iii) Facilitate the communication of results to the concerned public and to decision makers. Key elements for assessing impact significance are: (i) Scientific and professional judgment; (ii) Disturbance/disruption of valued ecological systems; (iii) Degree of negative impact on social values and quality of life; and (iv) Public perception versus the scientific/professional opinion of the risks/benefits involved.

Identification of potential impacts due to the plant location, construction and operation of the plant has been done using a checklist. The checklist contains the environmental effects and impacts designated to stimulate the analysis and to consider broadly the possible consequence of contemplated actions. The significant impacts in different phases i.e., (i) due project location and design, (ii) construction phase and (ii) operation phase have been identified using the process. As the land development of the project has started now, there are some impacts for air quality, surface water quality and drainage pattern are concern. The impacts due to operation are most important, which are: (i) Air Emissions especially NO_2 and SO2 (ii) Noise, (iii) Water pollution, (iv) Occupational health, and (v) Emergency/disaster impact.

6. Prediction and Evaluation of Impacts

As the proposed power plant will utilize Natural gas/HSD as fuel, the pollutants of potential concern will only Oxides of Nitrogen (NOx) during the operation period of the project and Oxides of Sulphur (SOx) when operated by HSD. This pollutant has been examined to ensure the Bangladesh emission limit standard as well as IFC/WB, where appropriate, the required emission control techniques would be incorporated into the mitigation measures. The ground concentration of NO_x and SO2 emission have been determined by air emission dispersion modeling by using USEPA approved AERMOD model up to a distance of 10 km radius to the project site.

As explained above, the main potential environmental impacts, which may arise as a result of construction of the power plant, can be grouped as follows: (i) Atmospheric emissions and Air quality, (ii) Noise generation, and (iii) Water pollution and waste water disposal. These aspects have been examined and the findings are summarized below.

Atmospheric Emission and Air Quality: The proposed power station will be fired on natural gas or HSD. An air emission modeling has been done to identify the emission of SO2 and NOx from the proposed power plant. The proponent will also use 50m stack.

NO2 concentration During Gas & HSD Firing:

The NO2 concentration contour of 24 hour and annual average has been analyzed considering the gas or HSD firing period. The maximum of 24-hour concentration of NOx has been predicted 0.30-0.50 µg/m3 at a radius of 300m surrounding the project whereas the concentrations is below the 0.30 µg/m3 at all sides further down to the project up to 10 km from the project. The maximum annual concentration of NOx has been detected as 0.030-0.060 µg/m3 at a radius of 500m to 600m at the north, south & east side and up to 10km to the west whereas the concentrations is below the 0.030 µg/m3 at all sides further down to the project site.

There is no IFC/WHO and Bangladesh standard set for 24-hour concentration for NOx. The maximum yearly concentration of NOx has been detected (below 0.06 µg/m3) well below the IFC/WHO and Bangladesh standard at all sides at any radius around the project.

SO2 concentration during HSD firing:

The SO2 concentration contour of 24 hour and annual average of have been analyzed. The maximum of 24-hour concentration of SO2 will be 0.030-0.060 µg/m3 at a radius of 300m the north, south & east side and up to 10km to the west whereas the concentrations is below the 0.30 µg/m3 at all sides further down to the project site. The maximum annual concentration of SO2 has been detected as 0.030-0.10 µg/m3 at a radius of 600m to 700m at the north, south & east side and up to 10km to the west whereas the concentrations is below the 0.030 µg/m3 at all sides further down to the project site.

There is no IFC/WHO annual standard set for SO2 for the ambient air quality, the 24-hour concentration of SO2 have been found below the standard of IFC/WHO standard (0.10 µg/m3) and also below the annual Bangladesh standard (80 µg/m3) at all sides.

Liquid Discharge: The proposed power plant will not create any process liquid from the production process. An amount of 125-150 m^3/hr. water may be abstracted from deep tube well as makeup to the Plant water system. But the CCPP requires more than 150 m^3/hr., which may be drawn from the Brahmaputra river during rainy season (May-October). The power plant will have closed loop water cooling system for the main steam condensation unit of Steam Turbine in which 548 m^3/hr. of water will be required as make-up water in the circulating cooling system where approximately 22500 m^3/hr. water flows will be maintained in the close circuit cooling loop. In addition, 24 m^3/hr. waters will be needed for service water, HRSG blow down and other different uses and 101 m^3/hr. waters will be required for DM water system. The DM water after treatment will be fed to HRSG as makeup water. There will be around 20 m^3/hr. wastewaters will be generated from the different section of the plant as blow down and from domestic sources. The Hybrid Cooling Tower system has been proposed to be installed by the EPC Contractor in order to limit the ground water abstraction to 125-150 m^3/hr.

This wastewater will contain significant amount of pollution, which may impact the surface water quality. As mentioned earlier, around 20 m^3/hr. wastewaters will be generated from the different section of the project which will be treated in the Effluent Treatment Plant (ETP). The plant will use 125-150 m^3/hr. groundwater and additional quantity of makeup water will be drawn from river water, which will be treated in the clarifier and WTP prior to use in the plant. The wastewater will be stored in a collection tank and after controlling pH, TDS and suspended solids the water will be discharged into the river. The domestic liquid waste will be disposed through a septic tank with a soak pit. The project will have planned drainage system to discharge the surface runoff. The surface drainage network would be connected with an interceptor prior to discharge through natural water. The interceptor will trap all oily matter present in the water.

Noise: The noise impact generated by operation of the plant has been predicted by means of noise impact modeling. The results will be used to specify noise abatement measurers. Appropriate noise controls will be installed to keep the neighborhood impact due to noise emissions within the limit of DoE and international standards.

7. Environmental Management Plan (EMP)

In the context of a project, Environmental Management Plan (EMP) is concerned with the implementation of the measures necessary to minimize and offset the adverse impacts and to enhance beneficial impacts. Unless the mitigation and benefit enhancement measures are identified in EIA and fully implemented, the prime function of the EIA cannot be achieved. Thus,

the objectives of EMP for the present project are: (i) Identification of Monitoring requirements and Monitoring indicators; (ii) Mitigation measures to reduce or eliminate negative impacts; and (iii) Enhancement measures to maximize positive impacts. Environmental management plan has to be considered as part of the plant's overall management and it would be part of the plant operational manual.

Monitoring of the performance of a plant is very important and sometimes vital. For surveillance of the environmental performance of an industry and monitoring of the quality of the local environment, environment in the work-zone and the general impact zone have to be performed on a regular basis. A management set up has to be created for the environmental monitoring program which can ensure compliance with national environmental standards. To this end a committee (Environmental Management and Safety Committee) will be created with plant manager as head and with 2-4 other members. The committee must meet at least once in a quarter and take stock of the environmental status of the plant. The main emission from the plants (i.e., air emissions, noise and any other) are to be analyzed as per monitoring plan. A quarterly environmental monitoring report will be submitted to DOE, will also be placed on the company website for public awareness.

The cost of the Environmental Management Plan (EMP) will be divided into several parts to reflect the different phases of the project and the requirement of each phase. The cost of EMP must include the costs of the capacity building, public consultation and the quality control requirements for a period of 5 years of operation. An allocation will be made for EMP every year in budget estimated for the project.

8. Emergency Response and Occupational Health & Safety

Under the supervision of the 'Environment Management and Safety Committee', all plant personnel will have responsibilities assigned to them during emergency. The documented responsibility will be included in a program manual which can constitute a part of the plants operation manual. Compliance with the responsibilities should be monitored and if these are not carried out for any reason, corrective measures should be taken.

The plant management will prepare an occupational health safety policy manual which should be updated from time to time. The policy should be signed and dated by the Chief Safety Officer who may be the Plant Manager. The policy should be discussed with all the plant personnel. The Chief Safety Officer should periodically review the policy and re-issue the policy.

9. Alternative Analysis

The 'No Build' alternative in the present case would mean continued power deficiency, in the face increasing demand for industrial and economic growth which leads to poverty reduction. So, the 'No build' alternative is unacceptable, and the potential socio-economic benefits of

implementation of such a project far outweigh the adverse impacts, all of which can be controlled and minimized to an acceptable level.

The project site was owned by Rural Power Company Ltd. (RPCL), which was vacant thus involved no resettlement issues. After analysis various possible alternatives, this EIA finds the plant's environmental impacts at the selected site are acceptable if the management procedures delineated are properly implemented. Therefore, the site has been considered suitable for the plant.

10. Stakeholder Consultation and disclosure

Stakeholder consultations are very important and sensitive issues for setting up a new industry in any area of Bangladesh. The process was initiated with an open objective to ensure people's participation right from the planning stage of the project. More specially, this was aimed at improving the study taking into account opinions from the people of the impacted area Meetings with stakeholders consisted of community consultation meetings, focus group discussions, and in-depth interviews with men and limited focus-group discussions with women. There was a stakeholder meeting organized at Mymensingh DC office on 06.11.2017 by verbal notice and official notice. The consultation process was carried out in the Bangla languages. During these meetings a simple, non-technical, description of the project was given, with an overview of the project's likely human and environmental impact. The community consultations demonstrated that goodwill towards the project proponents indeed exists; approval for project activities by the communities was evident. The consultations were considered as a good gesture and appreciated, by the men and women. The stakeholders' consultation process will be continued in the operation phase of the plant, so that issues of public concern can be addressed.

The EIA report will be uploaded in the Company's website and a copy of EIA is kept at the plant for public review. The executive summary will be translated into Bangla and will also be made available to the public.

11. Grievance Redress Mechanism

The Project Management has established a procedure to answer to project-related queries and address complaints and grievances about any irregularities in application of the guidelines adopted for assessment and mitigation of environmental safeguards impacts. The complaints related to plant operation that may create inconveniences to agency/individual should be addressed based on consensus, the procedure will help to resolve issues/conflicts amicably and quickly without resorting to expensive, time-consuming legal actions. To ensure impartiality and transparency, hearings on complaints will remain open to the public. The GRC will record the details of the complaints and the reasons that led to acceptance or rejection of the particular cases. The GRC will keep records of all resolved and unresolved complaints and grievances and make them available for review as and when asked for by appropriate authority. However, it should be noted that the GRC process will not pre-empt and aggrieved person's right to seek redress in the courts of law.

12. Conclusion and Recommendations

The present draft EIA report finds that though there are certain adverse environmental impacts associated with the industrial unit under consideration, these are manageable.

The project is indispensable in view of the current energy shortage scenario in Bangladesh. The impact on the social environment is positive, given the job and business opportunities to be created for local residents as a result of implementation of the project. The project will help in the industrialization, accelerating socioeconomic growth, and improving quality of life. One of the most critical issues for the project is safety. This has been adequately addressed through compliance with national building code (BNBC) in the construction to ensure safety during natural disasters like earthquake and cyclone.

The project has been designed to comply with the country's environmental laws and regulations, especially on-air emissions, ambient air quality, wastewater effluent, and noise. The project management has taken steps to ensure that the plant meets the World Bank/ADB's environmental standards. Given the management measures and monitoring commitments by the RPCL for the project, environmental impact of the project will be manageable.

Given the proponent's commitments, actions undertaken for further measures to be adopted in due course of time as required, the **Mymensingh 360 MW dual fuel (Gas/HSD) CCPP** is going to be a nationally important and environmentally sustainable industrial venture.

CHAPTER -01
INTRODUCTION

1.1 Project Background

Electricity is the major source of power for country's most of the economic activities. It is the key ingredient of socio-economic development of the country. Adequate and reliable supply of electricity is an important pre-requisite for attracting both domestic and foreign investment. Reliable supply of electricity is a pre-condition for poverty reduction and economic development. In Bangladesh, more than 60% of total populations have access to electricity but reliable and quality power is still a faraway. To alleviate poverty in the face of resource limitations and high population density, Bangladesh requires an economic growth rate of more than 7% p. a. In order to achieve this growth rate, electricity growth needs to be achieved by 10%. By best utilizing the natural, human and agricultural resources the desired pace of GDP growth could be attained by increasing electricity generation at much higher rate, which is the key target for development.

The per capital electricity consumption in Bangladesh remains one of the lowest in the Asian region. Even though power has reached many urban areas, approximately 53,000 of the 68,000 villages are connected to electricity facility. The contribution of power sector to GDP ratio has been stagnant around 1.3% for last 5 years with the power generation being increased annually by 2.8% during this period. The majority of power produced in the country is used for commercial purposes. Hence, the electricity supply to households remains delicate which is also a politically sensitive issue. The demand for electricity in the rural areas has experienced significant growth over the years mainly driven by agriculture and small & medium enterprises.

Problems in the Bangladesh's electric power sector include delays in the planning and decision process to undertake new power plant project, availability of required financing, fuel, Land, and infrastructure facilities for transportation of heavy equipment machinery to the project site, availability of water etc. Overall, the country's generation plants have been unable to meet system demand over the past decade.

A recent survey reveals that power outages result in a loss of industrial output worth $1 billion a year which reduces the GDP growth by about half a percentage point in Bangladesh. A major hurdle in efficiently delivering power is caused by the inefficient distribution system. It is estimated that the total transmission and distribution losses in Bangladesh amount to one-third of the total generation, the value of which is equal to US $247 million per year.

Recognizing the need to improve the performance of the power sector, the government adopted PSMP-2010 and subsequently PSMP-2016, which outlined the reform process to gradually remove constraints in the sector through improvements in the sector and corporate

governance, introduction of competition, and public private partnerships. The PSMP envisaged the long-term structure of the power sector based on (i) separation of sector regulation and operation; (ii) autonomy and commercial orientation of the sector entities; (iii) separation of generation, transmission, and distribution; and (iv) increased private sector participation. Transmission assets would remain in the public sector, while generation and distribution assets would have both public and private ownership.

It is a well-recognized fact that each development activity has an impact on the natural molding of the environment. As development activities are of prime importance for the economic growth and fulfillment of basic needs of the society, the environmental aspects of development activities must be taken into account and due attention must be paid to protect the environment. The first step in this direction is to evaluate the probable impacts of the project on the surrounding environment so that suitable measures could be taken during early stages of the project to minimize negative impacts.

The socio-cultural roots of our present environmental crisis lie in the paradigms of scientific materialism and economic determinism, which fail to recognize the physical limits, imposed by ecological systems on economic activity. The economies must expand within ecosystems, which have limited regenerative capacities. Contrary to the neoclassical theory of continuous material growth, economic activities directly undermine the potential for development through over-exploitation of natural resources, and indirectly compromise future production through the discharge of residuals. The entrenchment with quantitative growth as a major instrument of social policy is thus quite paradoxical.

The emergence of the concept of sustainable development in recent years has brought in the general realization that social perceptions must shift towards ecological determinism so as to achieve qualitative growth within the limits of ecosystem carrying capacity. The carrying capacity-based planning process, innovative technologies for enhanced material and energy effectively of production and consumption, structural economic change towards less resource-intensive sectors, and preventive environmental management through increasingly interventionist policies are some of the strategies for reconciling developmental goals with ecological capabilities.

Proper location / sitting, its process and waste abatement and control are very important for a development activity to be environmentally sound. To ensure this, an **Environmental Impact Assessment (EIA**) is a very effective tool, which delineates what needs to be done to make a development activity suitably located and operate in an environment friendly way.

The EIA will, therefore, examine the technical aspects of the project activities, which are likely to interact with the surrounding environment. This EIA study will cover possible activities and impacts with the environment and community. The report will also provide a suggestive EMP along with certain mitigation measures plan with a view to reduce effect of the adverse impacts.

Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant got approval from the Bangladesh Government with requisite financing modalities for setting up this Power plant project.

1.2 Objective

This report presents the findings of an **Environmental Impact Assessment (EIA)** of the project namely **Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant.** Sophisticated machineries will be imported and will be installed for generating power in the power plant.

The objective of the study is to provide an examination and assessment of the principal environmental impacts of the industry. The outline of an environmental management plan also suggested with an indication of the extent of work to be done to keep the development and environment compatible. In this context, it should be noted that the term “environment” and its derivatives have been used in a wide sense, which covers not only physical and chemical aspect, but also the human dimension. The specific objectives of this EIA are to:

- ✓ Present a brief discussion on the EIA process and its role in the planning and implementation of development projects;
- ✓ Present a general description of the project and the process;
- ✓ Present a description of the pre-project environment;
- ✓ Delineate the significant environmental issues found and believed to be involved;
- ✓ Identify the environmental impacts of the project and quantify them to the extent possible;
- ✓ Suggest the plan for management of the environment, during the implementation and operation of the plant.

1.3 Study Area

The proposed power plant will be set up at Mouza of **Char Ishwardia**, **Shambhuganj, Mymensingh, Bangladesh**. There is a bridge named “Shambhuganj Bridge” at the South side of the project. Some settlements as well as agricultural lands are found on the North & West side of the project area. The river Brahmaputra is also located at the South West side of the project area at a distance of about 0.25 Kilometers. All infrastructure facilities like electricity, labor, telecommunication, etc. are available at the project site. Rural Power Co. Ltd. Mymensingh Power Station is situated in the South-East side adjoining to the project site.

1.4 Scope of Work

The description of the environment and social baseline conditions are made encompassing all relevant current baseline data on the environmental and social characteristics of the study area including physical, biological, ecological and social environments. In the backdrop of the

above scenarios, the relevant regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, land use control, land acquisition, compensation, etc. at every level are described.

In action to the above, an analysis was conducted of reasonable alternatives in meeting the ultimate objects of the project including the 'no action' alternative, alternative means of meeting the energy requirements, alternative means of delivering HSD, alternative methods of construction including cost and reliability factors.

Viewed against these, all significant impacts were identified and evaluated including atmospheric emissions and changes in ambient air quality, discharge of effluent and ambient water quality impacts, changes in ambient noise and local land use patterns, impacts due to land acquisition, impacts of the project and its activates on the community's access to social infrastructure (e.g. potable water, health centers, school, irrigation and extension services), and local developments.

Following identification of potential impacts, efforts have been taken to distinguish between positive and negative impacts, direct and indirect impacts including impacts from possible accidents and long-term impacts. Attempts are made to describe the impacts quantitatively in terms of environmental and social cost and benefits and assigning economic values where feasible.

Finally, an Environmental, Safety and Social Management Plan to mitigate negative impacts has been developed, including a detailed Environmental and Social Management Plan with feasible and cost-effective measures to prevent or reduce significant negative impacts to an acceptable level, and containing detailed implementation plans, monitoring indicators and clear allocation of responsibility among project sponsors construction contractors, government agencies, and community-based organization. Also, an Environmental and Safety Management Plan, focusing on mitigation measures to address the environmental and safety consequences associated with the project for both construction and operational phases has been prepared.

1.5 The EIA Team

Adroit Environment Consultants Ltd. (AECL) has prepared this report under the guidance and supervision of Dr. Nasir Uddin Khan. The total team composition and their expertise have been given in the table below:

Professional	Name	Expected Expertise
ESIA & Emission Modeling Expert	Dr. Nasir Uddin Khan	Highly experienced on conducting ESIA of various nature in home and abroad. Have vast experience on identifying different environmental impacts and suggesting mitigation measures for any project. Experienced on emission and noise modeling of various projects. Experienced on Project stakeholder

		engagement - Public consultation and Disclosure Plans.
Legal, Policy, Health & Safety Professional	Md. Zahedur Rahman	Highly experienced in identifying different environmental impacts and suggesting mitigation measures.
Power Plant Engineer	Md. Abdul Matin	Understanding the power plant configurations for environmental issues.
Socio-economist	Md. Humayun Kabir	Experienced on Social baseline studies, community needs assessment, Social and Community Health Impact Studies/Assessments etc.
Ecological Survey Specialist	Dr. Abdur Jabber	Experienced in aquatic flora and fauna analysis for different power projects
Project Liaison Officer	Md. Hasanul Islam	Experienced on conducting ESIA of various nature. Involved in baseline environmental study, identifying different environmental impacts, suggesting mitigation measures and environmental management plan for any project.
Field Investigator/ co-coordinator	Md. Johirul Amin	Make Liaison with all field staff and Consultants; allocate staff & resources to different places when necessary. Background of organizing site visits, surveys, liaison with community, public and govt. organizations, etc.
	Fariha Rahman	Make Liaison with all field staff and Consultants; allocate staff & resources to different places when necessary. Background of organizing site visits, surveys, liaison with community, public and govt. organizations, etc.
	Md. Saiful Islam	Make Liaison with all field staff and Consultants; allocate staff & resources to different places when necessary. Background of organizing site visits, surveys, liaison with community, public and govt. organizations, etc.
	Md. Shadman Toushif	Base line data collection, sample collection from site, sample preservation and laboratory analysis.
	Md. Murad Hossain	Base line data collection, secondary data collection, sample collection and site survey
	Nigar Shultana	Base line data collection, sample collection from site, sample preservation and laboratory analysis.

1.6 Limitations

An IEE/EIA/ESIA is generally carried out as an integral part of the Feasibility Study (FS) or together with it and before going into the final design phase and into the construction phase of a particular development project. If so than the findings of the EIA could be incorporated in the project design, overall planning and budget and that the project could be implemented accordingly. When an EIA is conducted separately as just an add-on, often it does not get due

importance in the overall implementation of the project, which undermines the role of the EIAs and can contribute to environmental damages.

In case of **Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP**, an IEE has been prepared at the initial stage of the project. Though the IEE was prepared as a separate document of Feasibility Study (FS), but all the Significant Environmental Impacts (SEIs) were identified in IEE for the above project and conclusions for site clearance were made accordingly. DoE has cleared the present site subject to undertaking an EIA and adoption of necessary and effective pollution control measures. So, this report has been prepared to fulfill the requirement of DoE and emphasizes have been given on the issues which has been considered to be significant in IEE and the conditions imposed in site clearance by DoE. Keeping all into consideration the present report delineates the environmental factors and conclusions are made accordingly.

Services performed by the consultant are conducted in a manner consistent with that level of care and skill generally exercised by members of the engineering and consulting profession. The report may not exhaustively cover an investigation of all possible aspects and circumstances that may exist. However, an effort is made to discover all meaningful areas under the stipulated time available.

In evaluating subject site, consultant relies in good faith on information provided by client's management or employees. Client management and /or employees will be responsible only for the data of Project machinery and related component. The Consultant assume that the information provided is factual, accurate and accepts no responsibility for any deficiency, misstatement or inaccuracies contained in this report as a result of omission or misrepresentation of any person interviewed or contacted. However, the consultant notifies the contradictions and errors in the data, where it seems appropriate.

It should be recognized that the information given in the report is time specific and with the passage of time the relevancy of data and analysis may suffer. Specific circumstances and condition of site can change due to which conclusion and opinions may also change.

1.7 Acknowledgement

The EIA Report has been prepared basically with the support from **Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP** and also from various government agencies and NGOs including Bangladesh Meteorological Department (BMD), Soil Resource Development Institute (SRDI), Bangladesh Bureau of Statistics (BBS), Bangladesh Water Development Board (BWDB), Department of Environment (DOE) and Department of Agriculture Extension (DAE), etc. We would like to say thanks to each organization and its employees for their contribution in conducting the study.

CHAPTER -02
POLICY AND LEGAL CONSIDERATIONS

2.1 Background

For protecting the environment from industrial pollution and environmental degradation, Government of Bangladesh has promulgated some policies, strategies, laws, rules & regulations and action plans. The clauses and requirements of these regulatory legislations and policy imperatives must be taken in to consideration for compliance by the proponents/operators of any industrial establishment in the country.

As an institutional arrangement, Government of Bangladesh has designated the “Department of Environment" (DOE) with the sole responsibility for the regulatory functions to enforce of the provisions of environmental laws, rules and regulations to prevent environmental degradation in the country. Under these legal provisions, the industrial entrepreneurs must take mitigation measures for protecting the environment from pollution impacts and must get ‘Environmental Clearance’ from DOE before setting up and running their industries. These rules are equally applicable to both new and the existing industries. There are some other sectoral rules related to the industrial projects, which predate environmental legislations. These legislations have become effectively obsolete with the promulgation of the ECA, 1995 and the ECR, 1997 and their subsequent amended versions.

Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP is committed to the protection of the environment through compliance of the existing environmental laws, rules and regulations of Bangladesh. The project authority is also keen to abide by the international conventions and standards for making the industry environment friendly. The environmental classifications for industrial projects in Bangladesh are based on "inclusion lists" given in the ECR97 with ‘RED’ being the highest. Power Plant is listed in the ‘**Red Category**’ in ECR97 (i.e., serial no.6 in the ECR97 Red list in Schedule-1). WB environmental categorization is based on potential impacts and according to WB criteria (OP/BP 4.01), this project has been classified in the **‘B’** category.

The prevailing national policies, strategies, laws, rules, action plans etc. on environment are discussed briefly in the following.

2.2 Policies

2.2.1 Industrial Policy 1991

The Industrial policy of 1991 contains the following clauses in respect of environmental protection

- To conserve ecological balance and prevent pollution during industrialization

- To take effective steps for pollution control and conservation of environment during industrialization

To ensure embodying of necessary pollution control and preventive measures by industrial investment project endangering environment.

2.2.2 National Environmental Policy 1992

Bangladesh National Environmental Policy (*GoB, 1992*) was approved in May 1992, and sets out the basic framework for environmental action, together with a set of broad sectoral action guidelines. Key elements of the policy are:

- Maintenance of the ecological balance and overall progress and development of the country through protection and improvement of the environment.
- Protection of the country against natural disasters.
- Identification the regulation of all types of activities which pollute and degrade the environment.
- Ensuring sustainable utilization of all-natural resources.
- Active association with all environmentally-related international initiatives.
- Environmental policy contains the following specific objectives with respect to the industrial sector.
- To adopt corrective measures in phases in industries that causes pollution.
- To conduct Environmental Impact Assessments for all new public & private industries.
- To ban the establishment of any industry that produces goods cause environmental pollution, closure of such existing industries in phases and discouragement of the use of such goods through the development and/or introduction of environmentally sound substitutes.
- To ensure sustainable use of raw materials in the industries to prevent their wastage.

2.2.3 National Conservation Strategy

National Conservation Strategy *(GoB/IUCN, 1992*) was drafted in late 1991 and submitted to the Government in early 1992. This was approved in principle; however, the final approval of the document is yet to be made by the cabinet. It underwent a number of modifications over the last five years and is waiting to be placed before the cabinet finally sometime in late September 1997. For sustainable development in industrial sector, the report offered various recommendations; some of those are as follows:

- Industries based on nonrenewable resources should be made to adopt technology which conserves raw materials, and existing industries should be given incentives to install technical fixes to reduce wastage rate.
- All industries, especially those based on imported raw materials, should be subjected to EIA and adoption of pollution prevention/control technologies should be enforced.

- No hazardous or toxic materials/wastes should be imported for use as raw material.
- Import of appropriate and environmentally sound technology should be ensured.
- Complete dependence on imported technology & machinery for industrial development should gradually be reduced so that industrial development is sustainable with local skills and resources.

2.2.4 National Environmental Management Action Plan (NEMAP), 1995

National Environmental Management Action Plan, also referred to as NEMAP (GoB, 1995) is a wide-ranging and multi-faceted plan, which builds on and extends the statements set out in the National Environmental Policy. NEMAP was developed to address issues and management requirements during the period 1995 to 2005 and sets out the framework within which the recommendations of the National Conservation Strategy are to be implemented.

NEMAP has the broad objectives of:

- Identification of key environmental issues affecting Bangladesh;
- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development;
- Improvement in the quality of life of the people.

One of the key elements of NEMAP is that sectoral environmental concerns are identified. In outline, the environmental issues of the industrial sector include the following:

- Pollution arising from various industrial processes and plants throughout the country causing varying degrees of degradation of the receiving environment (Air, Water, and Land).
- There is a general absence of pollution abatement in terms of waste minimization and treatment.
- Low level of environmental awareness amongst industrialists and entrepreneurs.
- Lack of technology, appropriate to efficient use of resources and waste minimization leading to unnecessary pollution loading in the environment.
- Economic constraints on pollution abatement and waste minimization such as the cost of new technology, the competitiveness of labor, and intensive production methods as compared to more modern methods.

- Concentration of industry and hence pollution in specific areas which exacerbate localized environmental degradation and exceed the carrying capacity of the receiving bodies.
- Unplanned industrial development has resulted in several industries located within or close to residential areas, which adversely affects human health and quality of human environment.
- Establishment of industries at the cost of good agricultural lands and in the residential areas.
- Lack of incentives to industrialists to incorporate emission/discharge treatment plant in their industries.

2.3 National Legislation

2.3.1 Environment Conservation Act 1995 (ECA 1995)

Formal concern at the national level, for the state of environment in Bangladesh can be traced back to at least Independence and passing of the Water Pollution Control Act in 1973. Under this a small unit was established in the Directorate of Public Health Engineering (DPHE) to monitor pollution of ground water and surface water.

In order to expand the scope of environmental management and to strengthen the powers for achieving it, the Government issued the Environmental Pollution Control Ordinance in 1977. The ordinance provided for the establishment of an Environmental Pollution Control Board, which was charged with formulating policies and proposing measures for their implementation. In 1982, the board was renamed as Department of Environmental Pollution Control (DEPC). Four divisional offices were established in Dhaka, Chittagong, Khulna and Bogra. A special presidential order again renamed the DEPC to the Department of Environment (DOE) and placed under newly formed ministry of Environment and Forest (MoEF) in 1989.

The national environmental legislation known as **Environmental Conservation Act, 1995 (*ECA'95*)** is currently the main legislative document relating to environmental protection in Bangladesh, which repealed the earlier environment pollution control ordinance of 1997 and has been promulgated in 1995. The main objectives of ECA'95 are:

- Conservation and improvement of environment, and
- Control and mitigation of pollution of environment.

The main strategies of the act can be summarized as:

- Declaration of ecologically critical areas, and restriction on the operation and process, which can be carried, out or cannot be initiated in the ecologically critical areas.
- Regulation in respect of vehicles emitting smoke harmful for the environment.

- Environmental clearance.
- Regulation of the industries and other development activities - discharge permit.
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes.
- Promulgation of standard limit for discharging and emitting waste.
- Formulation and declaration of environmental guidelines.

2.3.2 Environment Conservation Rules, 1997 (subsequent amendments in 2002, 2003,2010 and 2017)

A set of the relevant rules to implement the ECA' 95 has been promulgated (August 1997). The rules mainly consist of:

- The national Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities on the basis of pollution activities of the existing or proposed industries/development projects/activities.
- Procedure for obtaining environmental clearance;
- Requirement for undertaking IEE and EIA 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.

The Rules incorporate "inclusion lists" of projects requiring varying degrees of environmental investigation.

Green: Industries/development projects/activities are considered relatively pollution-free and therefore do not require an environmental clearance certificate from the DOE and no environmental study.

Orange: Industries/development projects/activities fall into two categories. Orange "A" is less polluted and Orange "B" is moderately polluted required to submit general information, a process flow diagram and schematic diagrams of waste treatment facilities along with their application to DOE for obtaining environmental site clearance and environmental clearance.

Red: Industries/development projects/activities are those which may cause 'significant adverse' environmental impacts and are therefore required to submit an EIA report. It should be noted that they might obtain an environmental site clearance on the basis of an IEE report, and subsequently submit an EIA report for obtaining environmental clearance along with other necessary papers.

Environmental standards in operation in Bangladesh also Promulgated under the Environment Conservation Rules 1997. There are standards prescribed for varying water sources, ambient air, noise, odor, industrial effluent and emission discharges, vehicular emission etc.

The Bangladesh standards intend to impose restrictions on the volume and concentrations of wastewater/solid waste/gaseous emission etc. discharged into the environment. In addition, a number of surrogate pollution parameters like Biochemical Oxygen Demand, or Chemical Oxygen Demand; Total Suspended Solids, etc. are specified in terms of concentration and/or total allowable quality discharged in case of waste water/solid waste. Additionally, specific parameters depending on the manufacturing process are specified such as phenol, cyanide, copper, zinc, chromium etc. Air emission quality standards refer mostly to concentration of mass emission of various types of particulate, sulfur dioxide, and oxides of nitrogen and in some cases volatile organic compounds and other substances.

The Bangladesh standards in general are less stringent compared to the developed countries. This is in view to promote and encourage industrialization in the country. The Bangladesh standards are not for any specific period of time. There is no provision for partial compliance too.

The ambient standard of water quality, air quality and noise are presented in Table 2.1 to Table 2.5 in the following page. Standards refer to discharges to freshwater bodies with values in parentheses referring to direct discharges to agricultural land.

Table 2.1: Inland Surface Water Quality Standards

Best practice-based Classification	P^H	BOD mg/l	DO mg/l	Total Coliform No./100
Source of drinking water for supply only after disinfecting	6.5-8.5	2 or less	6 or above	50 or less
Water usable for recreational activity	6.5-8.5	3 or less	5 or above	200 or less
Source of drinking water for supply after conventional treatment	6.5-8.5	6 or less	6 or above	5,000 or less
Water usable by fisheries	6.5-8.5	6 or less	5 or above	-
Water usable by various process and cooling industries	6.5-8.5	10 or less	5 or above	5,000 or less
Water usable for irrigation	6.5-8.5	10 or less	5 or above	1,000 or less

Source: ECR- Schedule 3

Table 2.2: Standards for Waste from Industrial Units

Parameters	Unit	Inland Surface Water	Irrigated Land
Biological Oxygen Demand (BOD_5) at 20^0 C	mg/l	50	100

Chemical Oxygen Demand (COD)	mg/l	200	400
Dissolve Oxygen (DO)	mg/l	4.5-8	4.5-8
Total Dissolved Solids (TDS)	µmho/cm	2,100	2,100
P^H		6-9	6-9
Suspended Solid (SS)	mg/l	150	200
Chloride	mg/l	600	600
Iron	µmho/cm	2	2

Source: ECR- Schedule 10

Table 2.3: Ambient Air Quality Standards

Air Pollutant	Standards	Average time
Carbon Monoxide (CO)	10 mg/m^3 (9 ppm) [ka]	8 hours
	40 mg/m^3 (35 ppm) [ka]	1 hour
Lead (Lb)	0.5 µg/m^3	Annual
Oxides of Nitrogen(NO_x)	100 µg/m^3 (0.053ppm)	Annual
Suspended Particulate Matter (SPM)	200 µg/m^3	8 hours
PM_{10}	50 µg/m^3 [kha]	Annual
	150 µg/m^3 [Ga]	24-hours
$PM_{2.5}$	15 µg/m^3	Annual
	65 µg/m^3	24-hours
Ozone(O_3)	235 µg/m^3 [kha] (0.12ppm) [Gha]	1-hour
	157 µg/m^3 (0.08ppm)	8-hours
Sulphur di Oxide (SO_2)	80 µg/m^3 (0.03ppm)	Annual
	365 µg/m^3 (0.14ppm) [ka]	24-hours

Source: ECR- Schedule 2 (Amended in 2005)

Abbreviation: ppm: Parts Per Million

Notes:

(Ka) Not to be exceeded more than once per year

(Kha) Annual average value will be less than or equal to 50 microgram/cubic meters

(Ga) Average value of 24 hours will be less or equal to 150 microgram/cubic meters for one day each year.

(Gha) Maximum average value for every one hour each year will be equal or less than 0.12 ppm.

At national level, sensitive areas include national monuments, health resorts, hospitals, archaeological sites and educational establishments.

Table 2.4: Standards for Gaseous Emission from Industries

Parameters for power plant (200MW-500 MW)	Standard value for HSD	Standard value for Gas
Particulate	100 mg/Nm^3	60 mg/Nm^3
Oxides of Nitrogen	180 ppm	40 ppm
Oxides of Sulfur	450 ppm	20 ppm

Source: ECR- Schedule 11-2017

Table 2.5: Ambient Noise Standards

Areas	Day Time (dB)	Night Time (dB)
Silence Zone: Zone A	50	40
Residential Area: Zone B	55	45
Mixed Activity Area: Zone C	60	50
Commercial Area: Zone D	70	60
Industrial Area	75	70

Source: ECR- Schedule 1 (Amendment in 2006)

The second column of limits values refer to day time (06.00 to 21:00) and the third column to night time (21.00 to 06.00). A silence zone is defined as an area within 100m, around hospitals or educational institutions.

2.4 Environmental Clearance

Formal EIA guidelines in Bangladesh are set out in “Rules and Regulations under the 1995 Environmental Protection Acts” as published in the official Gazette on August 27, 1997. Any proponent planning an industrial project is currently required under Paragraph 12 of the Environmental Protection Acts, 1995 to obtain “environmental clearance letter:” from the Department of Environment.

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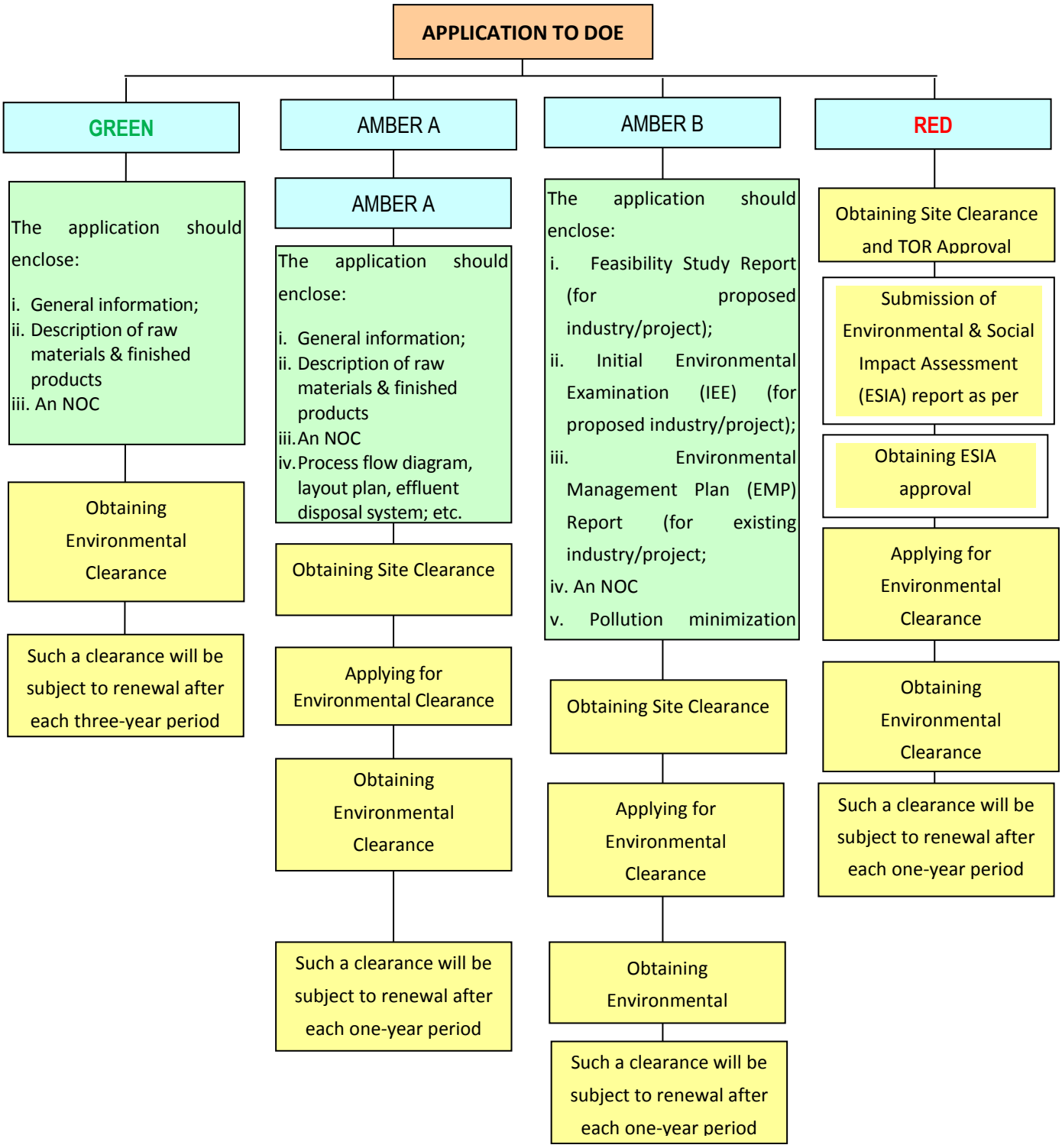
Environmental Protection Acts, 1995 to obtain "environmental clearance letter:" from the Department of Environment.

The first step to obtain environmental clearance is the project proponent to complete & submit an application form which may be obtained from the appropriate DoE regional offices as per the category. The application should have accompanied by other supporting documents (i.e. project profile, lay-out plan, NOC from local authority, Govt fees etc.) which will be reviewed by the divisional and district offices of DOE who has the authority to request supporting documents as applicable. The divisional office has the power to take decision on Green and Amber-A & B category projects and the Red category projects are forwarded to head office for approval. The proposed project will receive an environmental site clearance certificate at the beginning together with approval of TOR for EIA. Following the process of environmental site clearance, project proponent should have to submit EIA report for necessary approval for red category projects prior to obtain environmental clearance. The environmental clearance will be issued subject to the completion of the project and implementation of all the mitigation measures suggested in the EIA report or in the application. In case of Amber A or Amber B categories, the client won't need to submit EIA but obtain environmental clearance after implementation of the project and prior to the commercial operation.



2.5 Power Scenario and Master Plan in Bangladesh

Power and energy are vital factors that determine the growth path of a developing country like Bangladesh whereas; electricity is the major source of power for country's most of the economic activities. Consistent supply of power and energy can ensure development of the

economy. Nonetheless the huge demand supply gap prevailing in the power sector has turned out to be a hurdle for the economic expansion of the nation.

The per capita electricity consumption in Bangladesh remains one of the lowest in the Asian region, at present, only about 78% of the total population of Bangladesh has access to electricity. Even though power has reached many urban areas, approximately 53,000 of the 68,000 villages are connected to power. Further, one million retail electricity connections are pending. The contribution of power sector to GDP ratio has been stagnant around 1.3% for last 5 years with the power generation being increased annually by 2.8% during this period. The majority of power produced in the country is used for commercial purposes. Hence, the electricity supply to households remains delicate which is also a politically sensitive issue. The demand for electricity in the rural areas has experienced significant growth over the years mainly driven by agriculture and small & medium enterprises.

According to Bangladesh Power Development Board (BPDB) Power sector witnessed significant progress in power generation in the fiscal year 2016-17. During this fiscal year 1586 MW new capacity added from the newly installed power plants which raised the total generation capacity to 13,555 MW and annual increment of generation capacity was 9.62%. The highest peak generation was 9,479 MW and the total energy generated 57,276 GWh which was 4.90% and 9.74% higher than the previous year respectively. Due to gas shortage and inadequate new generation addition in the few years back, demand of electricity outpaced generation capacity caused persistent load shedding. In order to mitigate the demand-supply gap, an aggressive plan is prepared by the Government for new generation addition. As part of the plan, 34 power generation projects of capacity 12,061 MW are now under construction. The plan envisages around 17,752 MW new generation addition by 2021. BPDB has undertaken studies to project the electricity demand over the next 20 years up to 2030 under the Power System Master Plan Study 2010. According to the study the total demand would reach 33,708 MW assuming a 7% GDP growth over the time period. Now the biggest challenge for Bangladesh's economic growth is to ensure uninterrupted electricity supply to reduce the demand- supply gap for the growing industrial, agricultural and household needs.

Because of the critical nature, the Government of Bangladesh has given highest priority to the power sector to enhance the generation capacity. However, the timely implementation of above plans is a concern as there are issues with regards to availability of finance, competency of project sponsors and inherent bureaucracies and other bottlenecks in the system. Further, the demand estimates for power may also be understated to some extent. Strategies have been made to meet the investment requirement by involving private sector with Government through Public Private Partnership (PPP) initiatives. A successful IPP model has been designed with a lot of comforts and protection to investors.

It is a well-recognized fact that each development activity has an impact on the natural molding of the environment. As development activities are of prime importance for the economic growth and fulfillment of basic needs of the society, the environmental aspects of development activities must be taken into account and due attention must be paid to protect the environment. The first step in this direction is to evaluate the probable impacts of the project on the surrounding environment so that suitable measures could be taken during early stages of the project to minimize negative impacts.

The socio-cultural roots of our present environmental crisis lie in the paradigms of scientific materialism and economic determinism, which fail to recognize the physical limits, imposed by ecological systems on economic activity. The economies must expand within ecosystems, which have limited regenerative capacities. Contrary to the neoclassical theory of continuous material growth, economic activities directly undermine the potential for development through over-exploitation of natural resources, and indirectly compromise future production through the discharge of residuals. The entrenchment with quantitative growth as a major instrument of social policy is thus quite paradoxical.

The emergence of the concept of sustainable development in recent years has brought in the general realization that societal perceptions must shift towards ecological determinism so as to achieve qualitative growth within the limits of ecosystem carrying capacity. The carrying capacity-based planning process, innovative technologies for enhanced material and energy effectively of production and consumption, structural economic change towards less resource-intensive sectors, and preventive environmental management through increasingly interventionist policies are some of the strategies for reconciling developmental goals with ecological capabilities.

2.6 Institutional Structure of Power Sector in Bangladesh

Power Division is responsible for formulating policy relating to power and supervise, control and monitor the developmental activities in the power sector of the country. To implement its mandate, the Power Division is supported by a number of organizations, related with generation, transmission and distribution. The overall organizational structure and linkage is shown below:

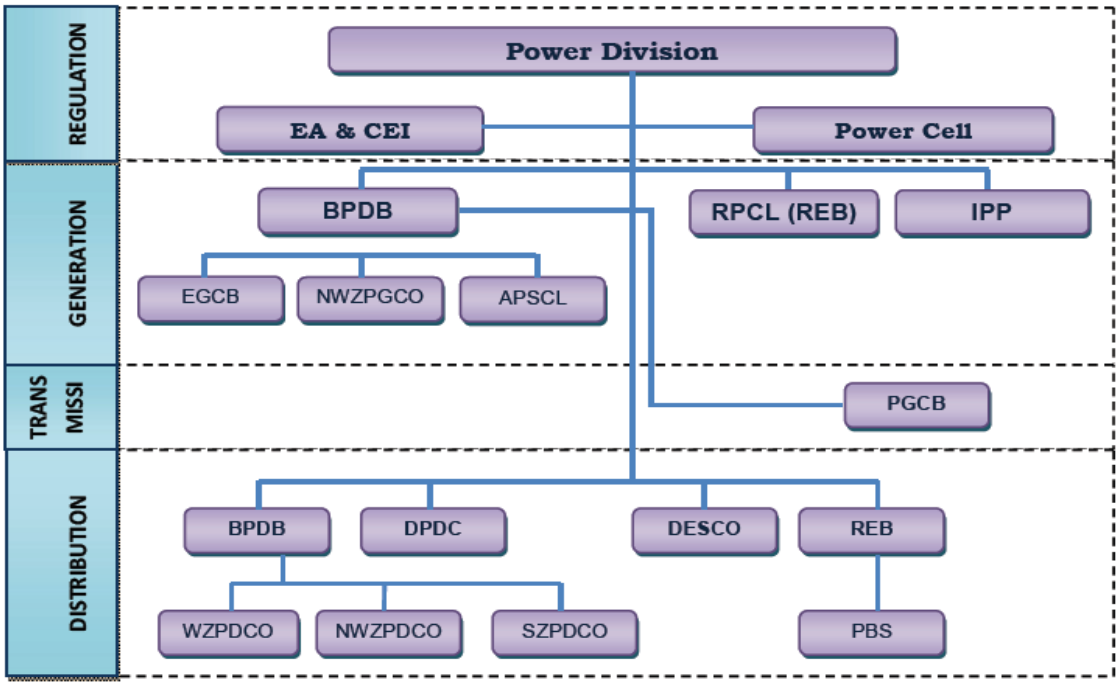


Figure 2.1: Overall organizational structure and linkage.

CHAPTER -03
PROJECT DESCRIPTION

3.1 Type and Category of The Project

Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant is a dual fuel power generation plant with net rated capacity of **360** MW. The proposed area of the plant is located adjoining the RPCL existing power station complex. The power plant will be designed for 360 MW production capacity which is dual fuel (Gas/HSD) CCPP technology. The operation principle will be based on the national electricity demand of the region and country as well.

Electricity generated in the power plant will be supplied to the 132 KV Grid sub-station within the power plant premises. Gas will be supplied by TITAS Gas Transmission and Distribution Company Limited to the power plant and the HSD will be supplied through the Railway route Chittagong to Shambhuganj, Mymensingh or, Bhairab to Shambhuganj, Mymensingh. RPCL shall procure equipment of Gas Turbine, HRSG, Steam Turbine, Generator, and other major equipment / auxiliaries from world renowned manufacturers / Vendors.

The area enjoys necessary infrastructure facilities, which include transport, electricity, telecommunication etc. For all construction activities for the plant, the provisions of Bangladesh National Building Code (BNBC) have been followed that include structural designs and seismicity tolerance. All the relevant social and environmental risks and potential impacts have been taken due care of as part of the assessment in compliance of the Performance Standards set by the guidelines set by DoE.

The basic data of the Rural Power Company Limited (RPCL) are furnished in Table-3.1

Table 3.1: Basic data on Rural Power Company Limited (RPCL):

➢ Name of the Project	Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant, Shambhuganj, Mymensingh, Bangladesh.
➢ Project Proponent	Rural Power Company Ltd. (RPCL)
➢ Project Location	Char Ishwardia, Shambhuganj, Mymensingh.
➢ Corporate Office	House: 19, Road: 1/B, Sector No-09, Uttara Model Town, Dhaka-1230, Bangladesh.
➢ Type of Business	Power Generation.
➢ Raw Materials	The raw materials of the project are HSD (**High Speed Diesel**)/ Gas as Fuel and water for steam production & cooling purpose.
➢ Type of Project	Combined cycle technology. Closed-Circuit Cooling Systems (**Hybrid Cooling Tower**)

<table>
<tr><td>➢ Produced Product</td><td>Electricity, from 360 MW combined cycle power plant yearly 2,522,880,000 kW hour electricity will be produced.</td></tr>
<tr><td>➢ Coordinate of the Project site</td><td>
<table>
<tr><th>Sl. No.</th><th>Longitude</th><th>Latitude</th></tr>
<tr><td>1</td><td>90°24'59.97"E</td><td>24°45'44.49"N</td></tr>
<tr><td>2</td><td>90°24'56.60"E</td><td>24°45'47.72"N</td></tr>
<tr><td>3</td><td>90°24'56.88"E</td><td>24°45'50.89"N</td></tr>
<tr><td>4</td><td>90°25'2.03"E</td><td>24°45'56.11"N</td></tr>
<tr><td>5</td><td>90°25'5.47"E</td><td>24°45'51.73"N</td></tr>
<tr><td>6</td><td>90°25'6.73"E</td><td>24°45'52.15"N</td></tr>
<tr><td>7</td><td>90°25'8.39"E</td><td>24°45'49.62"N</td></tr>
<tr><td>8</td><td>90°25'7.12"E</td><td>24°45'48.90"N</td></tr>
<tr><td>9</td><td>90°25'6.49"E</td><td>24°45'49.59"N</td></tr>
</table>
</td></tr>
<tr><td>➢ By-product, if any</td><td>None</td></tr>
<tr><td>➢ Net Plant Capacity</td><td>360 MW</td></tr>
<tr><td>➢ Stack Height</td><td>Gas Turbine: 40 m, HRSG: 50 m.</td></tr>
<tr><td>➢ Annual Production</td><td>2,522,880,000 kWh</td></tr>
<tr><td>➢ Project Cost</td><td>Estimated Turnkey price: USD 324 Million</td></tr>
<tr><td>➢ Amount of circulation water & make up water</td><td>Cooling water: 22500 m3/hr. (Closed circuit cooling system)

Make up water: (125-150) m3 /hr. (Intake from Ground water)</td></tr>
<tr><td>➢ External Finance</td><td>85%</td></tr>
<tr><td>➢ Internal Finance</td><td>15%</td></tr>
<tr><td>➢ Total Area of Land</td><td>16.5 Acres</td></tr>
<tr><td>➢ Total Developed Land</td><td>16.5 Acres</td></tr>
<tr><td>➢ Employment</td><td>100 skilled personnel and unskilled manpower of about 40 persons.</td></tr>
<tr><td>➢ Fuel Requirement</td><td>Maximum gas requirement will be about 68 MMSCFD at 100% PLF & 54 MMSCFD at 80% PLF (396 MW).

Maximum Daily Liquid Fuel Requirement will be 1572 Ton at 100% PLF & 1258 Ton at 80% PLF (396 MW).</td></tr>
<tr><td>➢ Source of Fuel</td><td>Bangladesh Petroliam Corporation and TITAS Gas Transmission & Distribution Company Limited.</td></tr>
<tr><td>➢ Water source</td><td>Underground & Surface Water.</td></tr>
<tr><td>➢ Quantity of Liquid Waste</td><td>None</td></tr>
</table>

3.2 Site Description

3.2.1 Location of the Project

The proposed location of "Mymensingh 360MW Combined Cycle Power Plant Project" is within Char Ishwardia Mouza under Mymensingh district beside the existing Mymensingh 210MW Combined Cycle Power Plant of RPCL which is located on the bank of the old Brahmaputra River. Mymensingh City is about 1.2 km (aerial distance) south-west of the Project Site. The project site lies in 24°45'49.08"N & 90°25'2.02"E. The Brahmaputra bridge is on the south of the site, Mymensingh Jute mills ltd on the south-west and Mymensingh Railway Station is on the south side of the power plant site. The proposed location of the Mymensingh 360 MW CCPP is about 130 km north of the capital city of Dhaka. The location of the proposed power plant is such that it is accessible from any part of the country by railways and highways. Heavy equipment and construction materials, machinery can be transported through water route specifically in the month of July & August. The project is well secured with boundary fencing and security post. Figure 3.2(a), 3.2(b), 3.2(c), 3.2(d) & 3.2(e) show all the details of the project.

3.2.2 Electrical Interconnection for power Evacuation

Power will be evacuated to the Power plant's 132 kV Substation and another new 132 kV substation will be build adjacent to the existing substation which is connected with the Mymensingh 132 kV Substation at Kewatkhali. Kishoreganj - Mymensingh 132 kV is around 5 km from the Project site. Mymensingh – Jamalpur 132 kV and Mymensingh – Netrokona 132 kV Transmission Lines are connected with the Mymensingh 132 kV Substation. Construction work of proposed RPCL's 132 KV Sub-station to Tangail 132 kV Transmission Line is in progress through which power output of 360 MW CCPP can also be evacuated. The details power evacuation process shown in Figure 3.1.

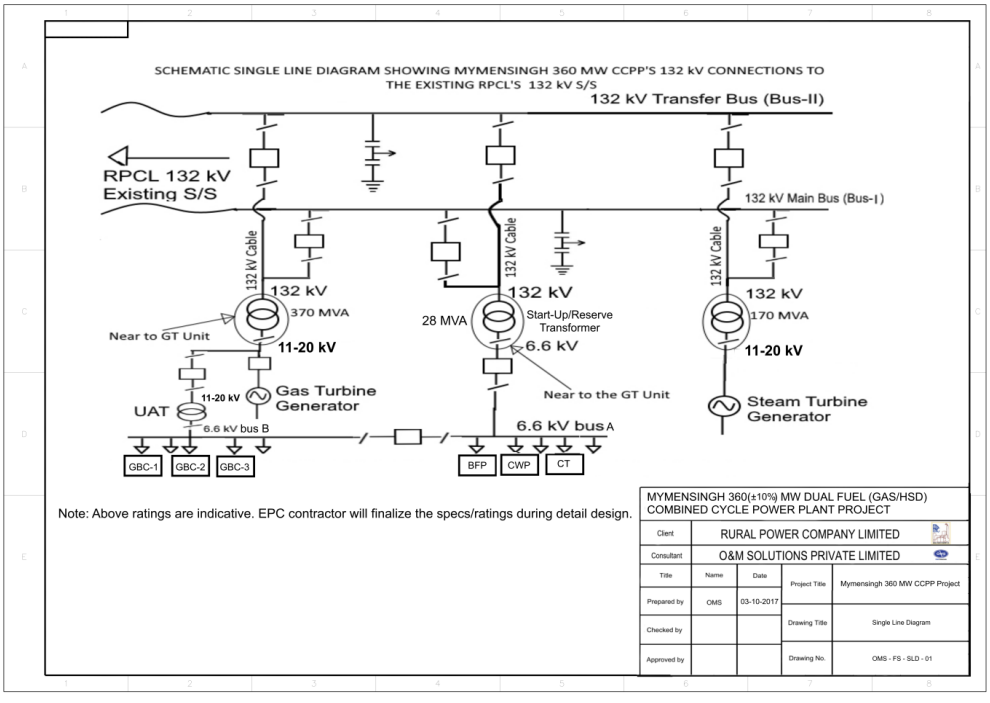


Figure 3.1: Power evacuation layout

Figure 3.2(a): Satellite Map of the Proposed Project

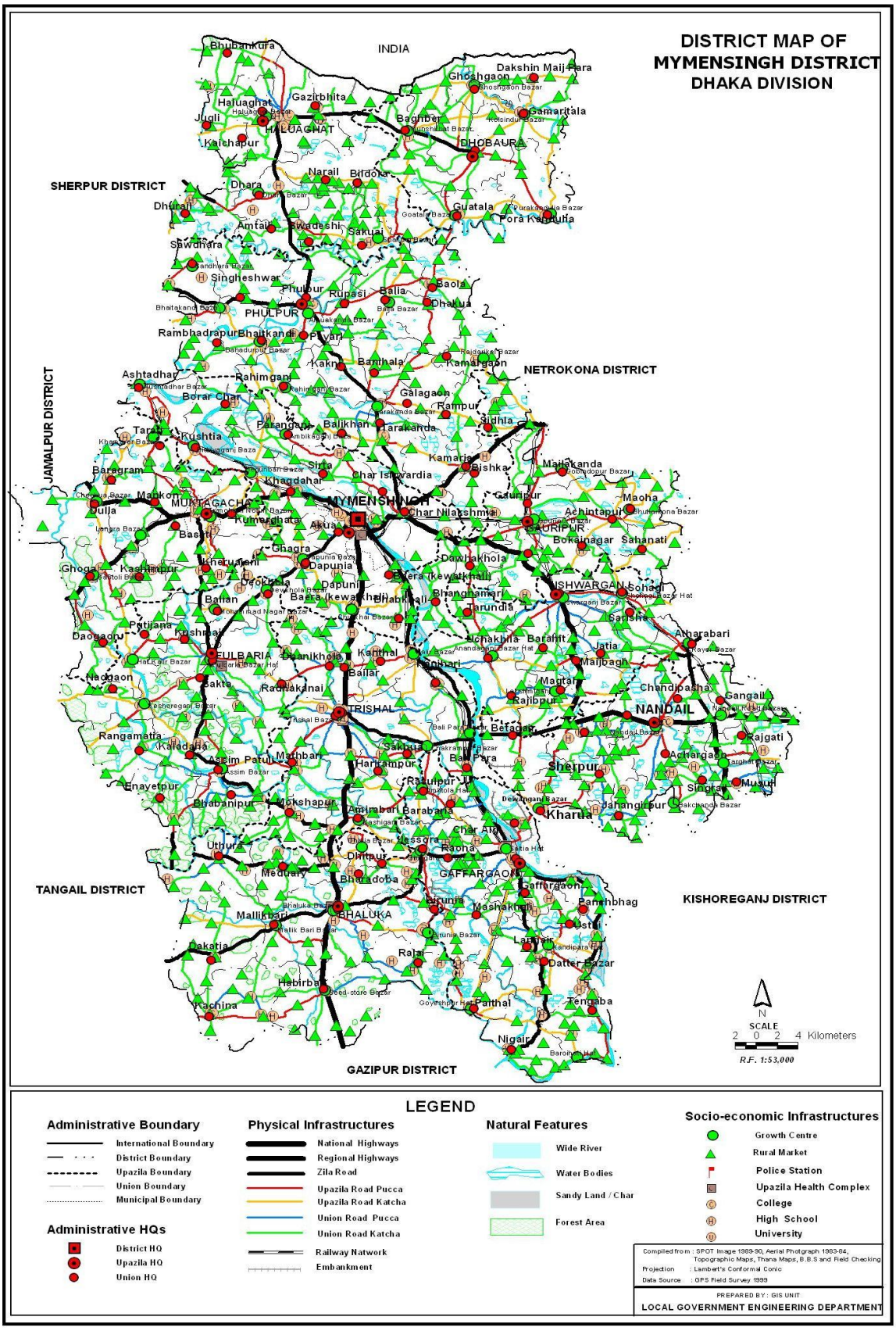


Figure 3.2(b): Mymensingh District Map

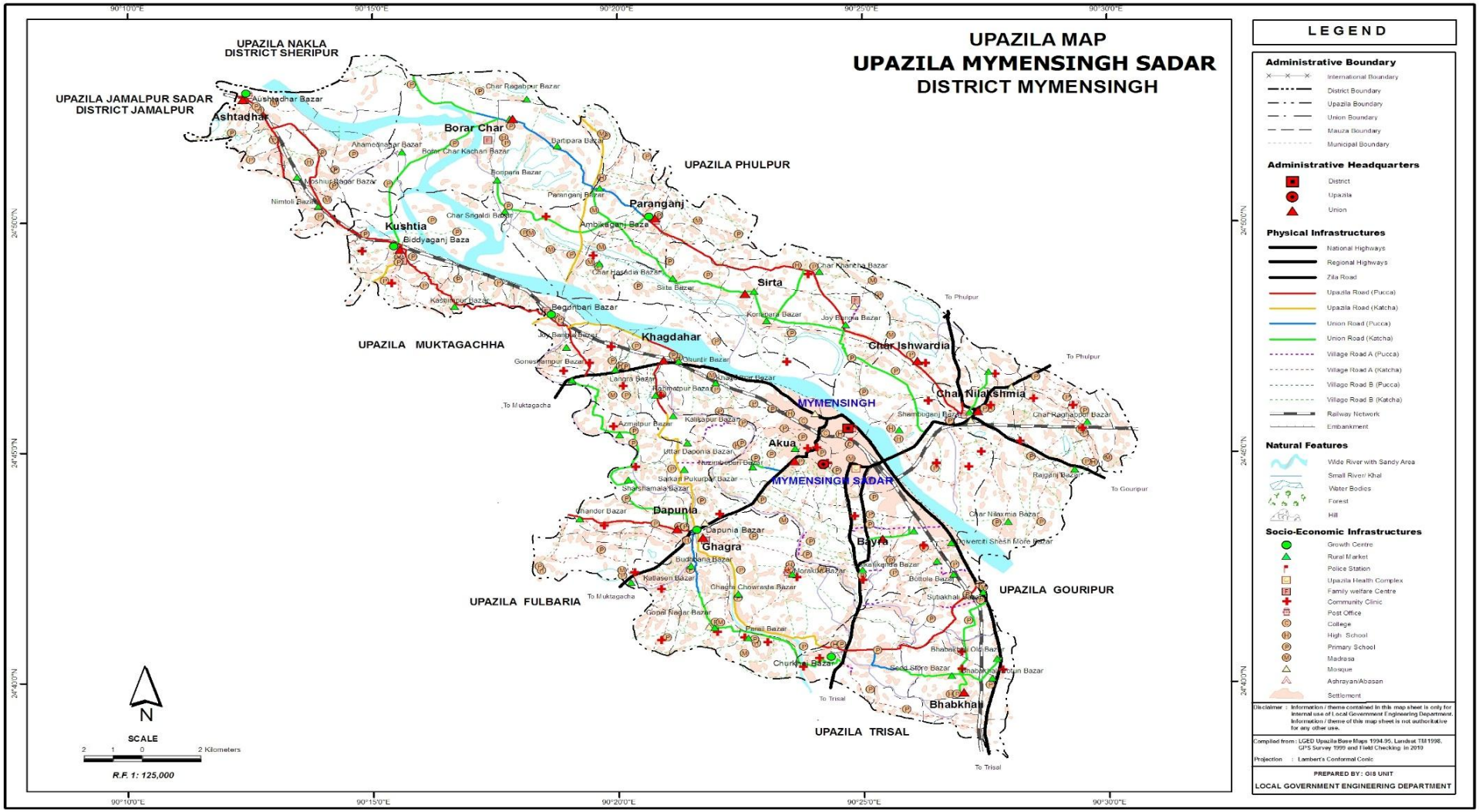


Fig 3.2(c): Mymensingh Sadar Upazila Map

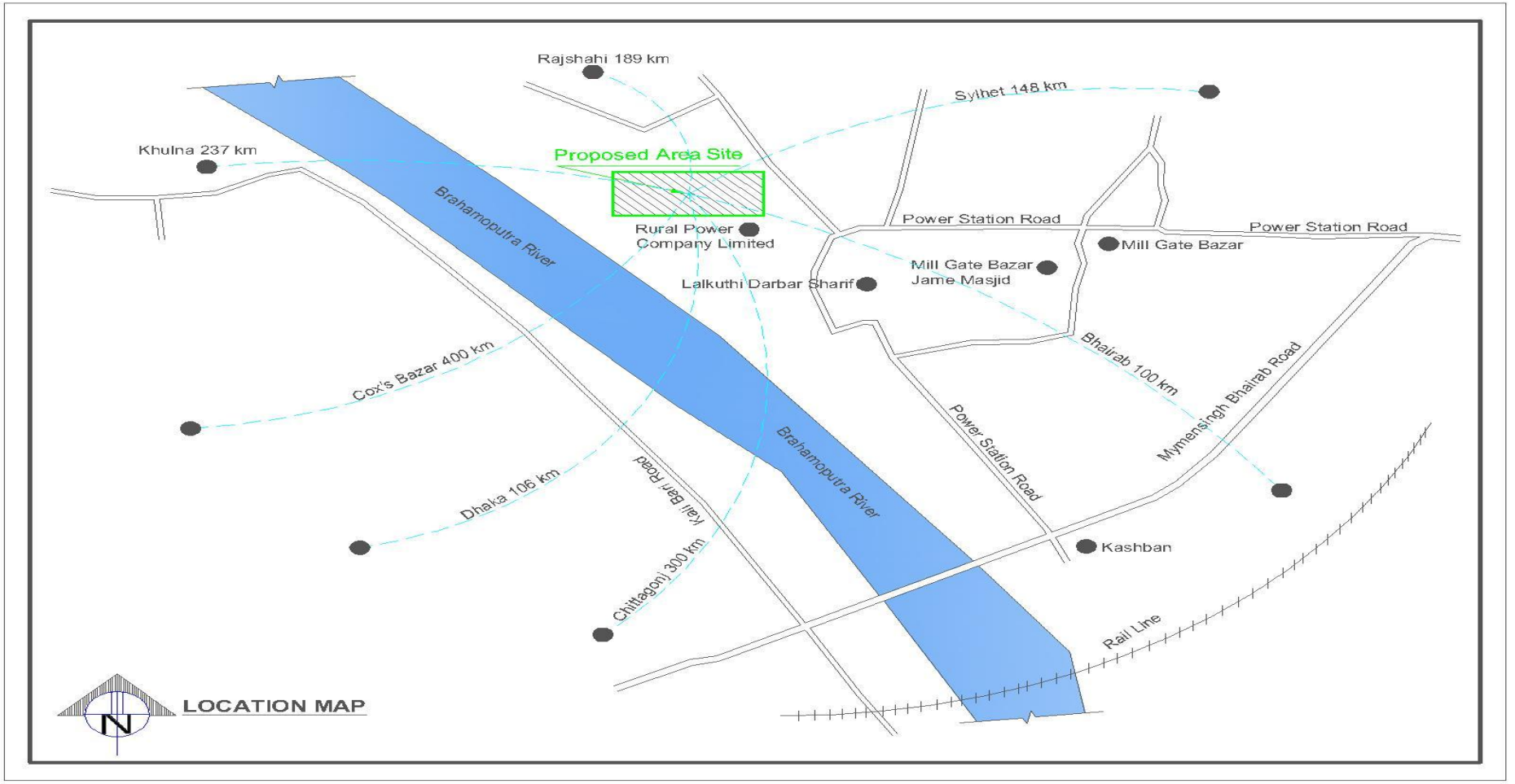


Figure 3.2(d): Location Map of the Proposed Project

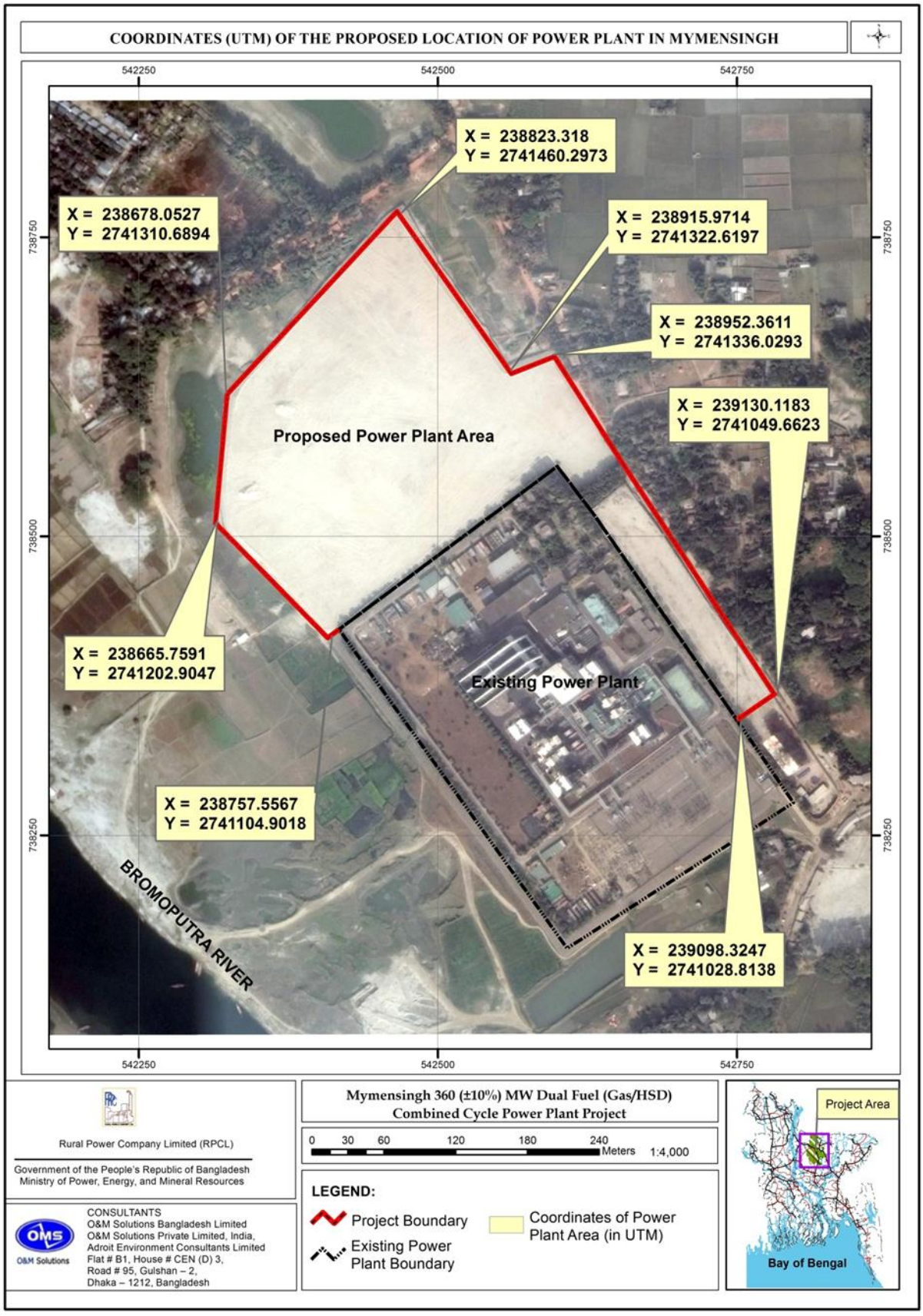


Figure 3.2(e): Layout Plan of the project with existing Power plant

3.2.4 Topography of the Site & Surrounding Land

The site has been selected by RPCL, which is adjoining to North-West area of existing Mymensingh 210 MW Combined Cycle Power Plant of RPCL at Shambhuganj. The total land area for the proposed 360MW Combined Cycle Power Plant is about 16.5 acres. The land (16.5 Acres) has already been acquired and developed by RPCL for the new combined cycle power plant project.

Reference height level of the existing power plant (MPS) is 13.929 m from Mean Sea Level (Based on the Benchmark datum of Survey of Bangladesh kept at 'Chinamor' on the Mymensingh-Netrokona highway. Reference height level of the existing power plant (MPS) in terms of PWD is 14.389 mPWD. Average Height of the project Land is 13.408 mPWD, Lowest Height of the project Land is 12.118 mPWD, Highest Height of the project Land is 13.99 mPWD and Designed Elevation is the project Land 14.99 mPWD.

All the land is totally developed by the project authority, surrounding land are cultivated land, also Brahmaputra River is located at the south side of the project area.

3.3 Fuel Availability and Supply

3.3.1 Natural Gas Availability

Based on the estimates on June, 2015 total recoverable proven and probable gas reserve of 26 gas fields of Bangladesh has been estimated at 27.12 TCF out of which estimated proven recoverable reserve (P1) is 20.60 TCF and the remaining reserve is 14.088 TCF. Up to June, 2015 as much as 13.032 TCF gas has been produced. Currently, 20 gas fields are in production and out of 136 wells located in these gas fields, 98 are on stream. In recent years, the demand for natural gas has seen a sharp rise outpacing supply. It may be noted that the country's gas requirement is mounting keeping pace with the growth in economic activity which is growing at and above 6 per cent per annum. However, to replenish the depleted resource and increase it to safe level to meet the future demand, massive exploration and drilling activities were launched on. In this scenario annual growth in natural gas is increasing by around 10 per cent every year.

3.3.2 Gas Supply to the Power Plant

The site falls under the gas distribution company 'TITAS Gas Transmission and Distribution Company Limited'. Maximum gas requirement will be about 68 MMSCFD at 100% PLF & 54 MMSCFD at 80% PLF (396 MW). The natural gas fuel supply pipeline route from Digharkanda point to the MPS is about 6.38 Km. Existing Gas pipeline dia is 8" for the 210 MW Power Plant, another 12" dia Gas pipe line will be constructed which would be laid parallel to the existing 8-inch pipeline route. This 7-km pipe line construction will be done by RPCL Receiving pressure of the station: 80-150 Psig. Detail of existing 8" dia pipe line and proposed 12" pipe line is shown in figure 3.2.

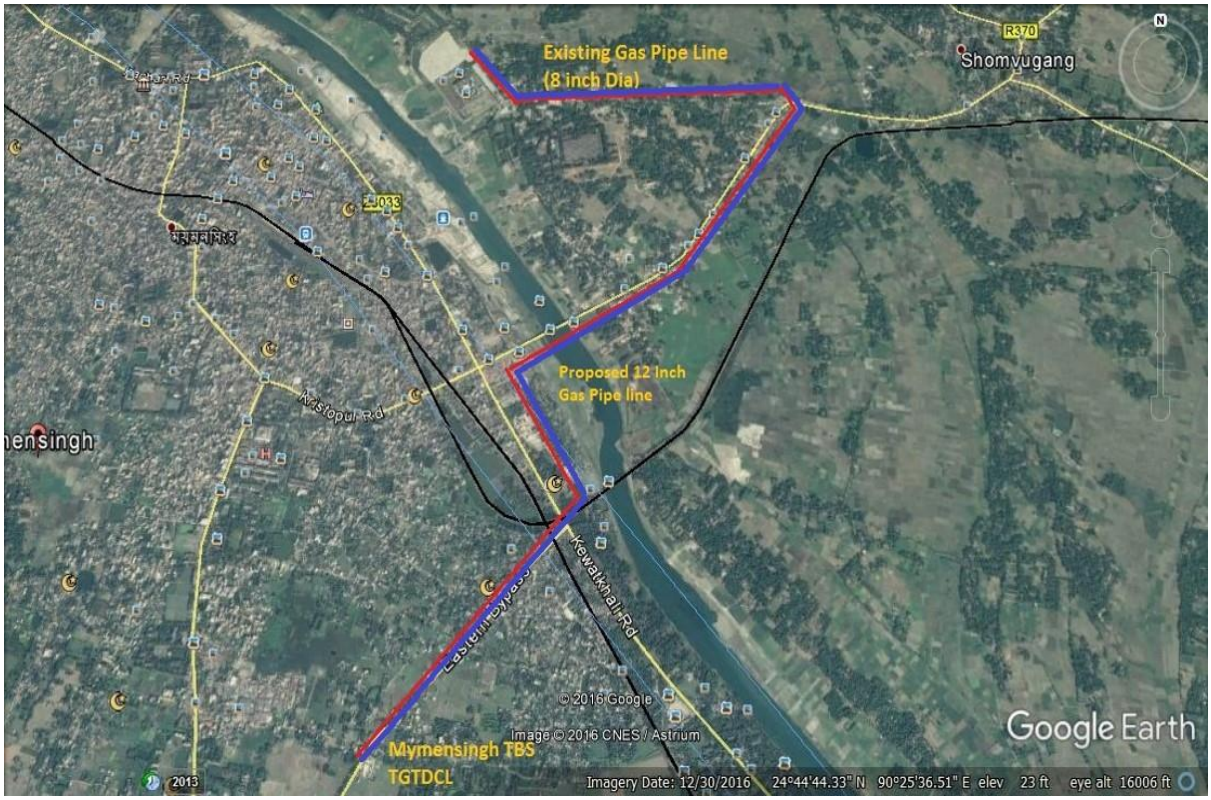


Figure 3.3: Gas supply pipe line existing 8" and proposed 12"

3.3.2.1 Gas specification

Gas specification is shown in bellow

Table 3.2: Gas specification

Component		Minimum Volume (%)	Maximum Volume (%)
Methane	:	90.00	98.00
Ethane	:	0.00	6.00
Propane	:	0.00	5.00
Butane	:	0.00	3.00
Pentane & Higher	:	0.00	0.00
Hydrogen Sulphide	:	0.00	2.00
Carbon di-oxide	:	0.00	3.00
Nitrogen	:	0.00	1.00
Inert (the total combined Nitrogen, Oxygen, Carbon di-oxide and any other inert compound)	:	0.00	5.00

3.3.2.2 HSD specification

HSD specification is shown in bellow

Table 3.3: HSD specification

Component	HSD Firing % by Volume
Carbon di oxide (CO2)	4.56
Nitrogen (No & N2)	70.30
Water vapor (H2 O)	12.16
Oxygen (O2)	12.14
Argon	0.82
Sulphur Di Oxide (SO2)	0.0026

3.3.3 HSD Supply to the Power Plant

Bangladesh Petroleum Corporation (BPC) is a statutory organization of the Government under the Ministry of Energy & Mineral Resources Division engaged to supervise, coordinate and control all the activities relating to import, store, marketing, distribution of petroleum products in the country and to develop/ establish infrastructure facilities. BPC provides implementation and supervision for marketing, sales and storage of fuel oil eminently and to supply fuel oil continuously in root level area of the country during whole year. BPC acts as managing agent for signing of agreements with firms or companies for petroleum import, storage, distribution and marketing in the country. Maximum Daily Liquid Fuel Requirement will be 1572 Ton at 100% PLF & 1258 Ton at 80% PLF (396 MW). There will be three main storage tanks of 5000 MT capacity each and one additional tank of 2,000 Ton to facilitate HSD storage capacity for about 15 days operation of the CCPP.

3.4 Power Generation Method

The Project will be implemented on turnkey basis. Generated power will be evacuated at 132 KV Power Station Sub-Station Bus, which is connected with the existing Mymensingh 132 KV Grid sub-station at Kewatkhali.

The following parameters are to be considered in plant design: Sub-Tropical Monsoon.

- Temperature: 5 deg C to 45 deg C.
- Relative Humidity: 60% to 98%.
- Annual Rain Fall: 120 cm to 345 cm.
- Wind Velocity: 225 km/hr.
- Basic Seismic Coefficient (zone III): 0.28 (As per BNBC 2015, Earth quake zoning map).

In Figure 3.4 total process flow diagram of Mymensingh 360 MW CCPP is shown below.

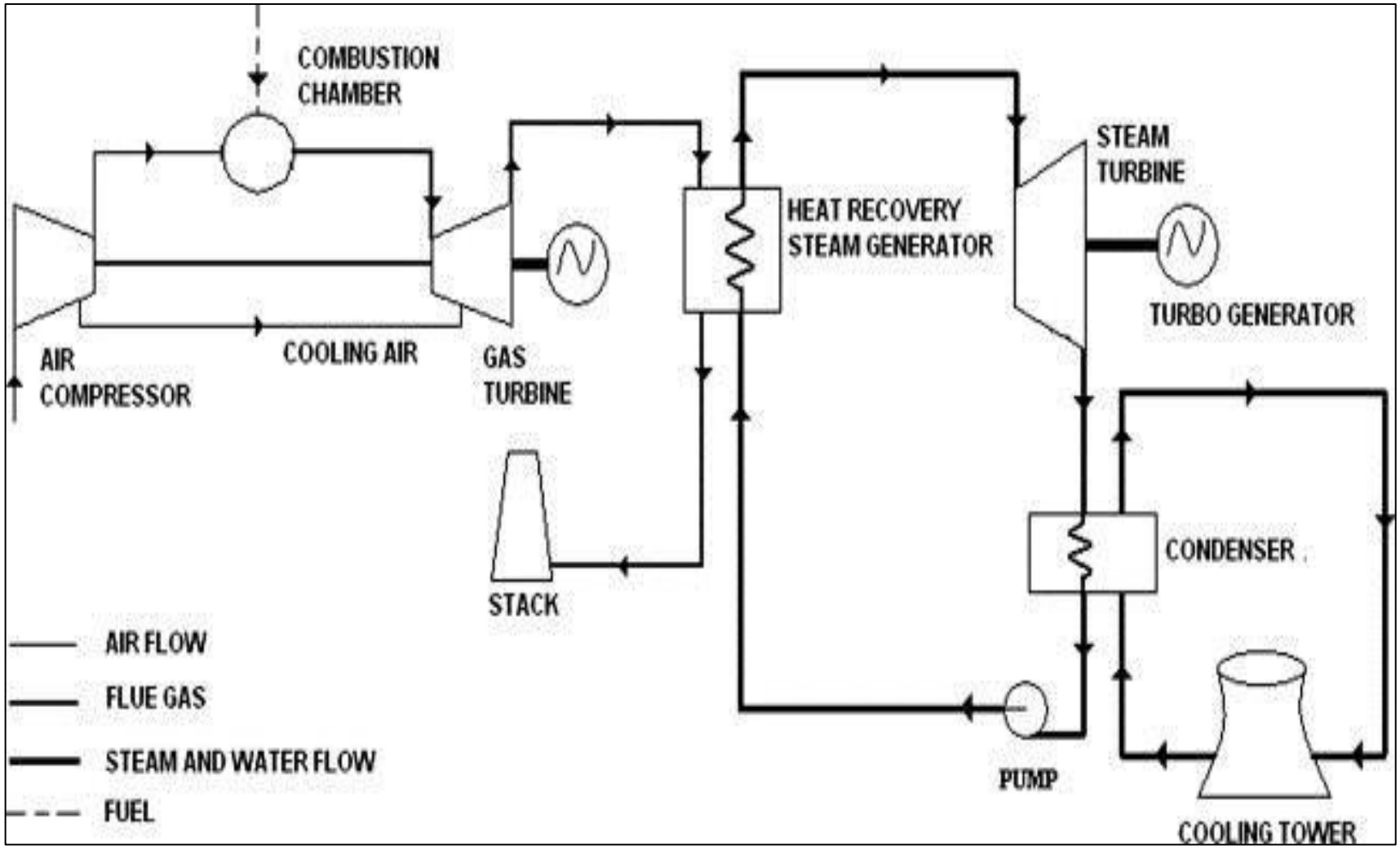


Figure 3.4: Process Flow Diagram of Mymensingh 360 MW dual fuel (Gas/HSD) CCPP.

3.5 Prime Mover Details and production process

The equipment / machinery to be provided shall be of proven type and design, having total net output at site condition (35 ºC, 1.013 bar, 98% relative humidity) of 360 MW consists of following Plant configuration.

Configuration (1:1:1)

One (1) heavy duty industrial type gas turbine generator, one (1) heat recovery steam generator and one (1) unit of steam turbine generator unit.

Number of units in the 1:1:1 Configuration:

a) Gas turbine unit: One (1)

b) Heat recovery steam generator: One (1)

c) Steam turbine unit: One (1)

This 360 MW will be produced from Gas turbine (GT) and Steam turbine (ST), net output of **240** MW produced from Gas turbine (GT) and **120** MW will be produced from Steam turbine (ST).

Heat Recovery Steam Generator(s)

- One Lot of heat recovery steam generator (s) [Vertical Type] of dual pressure steam cycle suitable to utilize exhaust gas from the gas turbine unit including followings.
- The steam drum and heat transfer sections which consist of the Economizer, Evaporator and Super-heater of the steam generator.
- Any other equipment/material/system required for HRSG completed in all respect.

Note: Supplementary firing for HRSG shall not be considered.

Steam Turbine Generating Unit(s)

One (1) unit of steam turbine of mixed flow and condensing unit, and it shall be equipped with the following accessories.

a) Inlet stop valve (s) with coarse and fine mesh steam strainer.

b) Control valves with necessary bypass system.

c) High pressure steam bypass valve with actuator and position feedback de-vice.

d) Motorized drain valve for turbine casing, Gland steam, seal system and above/below stop valve seats.

e) Automatic gland steam seal system.

f) Shaft packing vent system with blower and gland condenser.

g) Turbine exhaust hood water spraying system and motorized vacuum breaker valve.

h) Steam turbine control.

i) Hydraulic system with duplex pumps, coolers, filters and integral fluid conditioning unit.

j) Over-speed governor with solenoid trip.

k) Lube oil system with tank, shaft driven main lube oil pump, AC auxiliary lube oil pump, DC emergency pump, Jacking oil pumps, coolers, valves, oil conditioner, vapor extractor, gauges, pressure and temperature control devices.

l) Closed circuit cooling water system, Aux. cooling water system with AC motor and pump of adequate capacity.

m) Steam jet Ejectors in the air extraction system.

n) Turning-gear, motor operated with provision for automatic engaging and man-ual cranking.

o) Insulation and lagging.

p) Foundation plates and bolts.

q) Piping

Emergency Diesel Generating Set

There will be one (1) set of emergency diesel generating set (required capacity 1500 KVA, **400 V**) supplying power to essential auxiliaries complete with ancillary equipment in the event of emergency situations.

Natural Gas Booster Compressors

The plant shall require centrifugal type gas booster compressors (Integral Gear Design), as the supply pressure of natural gas would be only 80~150 psig.

The capacity of the compressors has to be 3 x 60% for maximum gas requirement of the plant including auto changeover system without interrupting operation of the plant with rated pressure & flow and at all modes of operation & at any temperature prevailing in the site of the GTG unit.

The gas booster compressors have to be centrifugal type, 6.6 KV motor driven. Appropriate sealing & cooling system shall have to be provided including all necessary ancillaries and auxiliaries.

Note: Gas Booster Compressor is to be supplied for this project either from Atlas Copco or from Man Turbo or proven / reputed GBC manufacturers.

3.6 Cooling System

Close Circuit Cooling System

Where a power plant does not have abundant water, it can discharge surplus heat to the air using recirculating water systems which mostly use the physics of evaporation.

Cooling towers with recirculating water are a common visual feature of power plants, often seen with condensed water vapor plumes.

Most power plants with recirculating cooling are cooled by water in a condenser circuit with the hot water then going to a cooling tower. This may employ either natural draft (chimney effect) or mechanical draft using large fans (enabling a much lower profile but using power). The cooling in the tower is by transferring the water's heat to the air, both directly and through evaporation of some of the water.

For this project **Hybrid Cooling Tower** will be used. Circulating water is **22500 m3/hr**. and make up water is **(125-150) m3/hr**. Source of water is ground and river water.

Hybrid Cooling Tower

Circulating water (Condenser cooling water and cooling water for closed loop heat exchangers) will be cooled by Hybrid Cooling Tower. Additional 25% of cooling tower cell to be kept as standby.

Condenser cooling water and cooling water for closed loop heat exchangers is supplied by 2 x 100% or 3 x 60% capacity horizontal/ vertical, circulating water pumps located in the pump house adjacent to hybrid cooling tower basin. Auto Changeover system among the pumps shall be provided.

The pumps shall be installed in the pit below minimum water level of cooling tower basin. A circulating water pump house shall be provided.

A manual operated butterfly valve shall be provided at each circulating water pump discharge and suction.

Motor operated vent valves shall be provided at the top of condenser water box to vent and shut the air automatically.

A motor operated reversing valve shall be provided for condenser backwash purpose. EOT crane shall be provided in circulating water pump house.
Ground water will generally be used as raw water source for plant water system to produce demi water, makeup water for cooling tower basin and to closed loop cooling water systems after appropriate chemical treatment, service water, unforeseen demand etc.

The Ground water intake for makeup water should be **125-150 m3/hr.**

Detail drawing and system will be designed by the EPC contractor according to proposed plant requirement.

- **Closed Circuit Hybrid Cooling Towers with PHE**
  Standard closed-circuit cooling tower ranges have originally been designed to receive the plume abatement coil option; these ranges are then referred to as Closed Circuit Hybrid Cooler range. Their efficiency is ensured by a finned tube coil combined with a valve for adjusting the water spray on the exchange surface (packing). This water flow regulation over the exchange surface is a market exclusivity, JACIR patent.

  Therefore, the combination of the air desaturation by air outlet warming up, and the reduction of the water spray on the packing, ensures the complete plume suppression. Beyond the plume suppression itself, this system can provide water savings on average of 35%. The closed-circuit hybrid towers are perfectly adapted for operating without glycol in winter. Their design makes access and cleaning very easy and ensures performance durability.

- **Closed Circuit Hybrid Cooling Towers with Coil**
  By fitting a fin cooling package to the VK closed circuit cooler, a dry cooling element is combined with wet cooling and thus achieves a higher dry cooling performance compared with the classical evaporative cooler. This model of the VK with hybrid design is used when the cooling load is to be discharged air-cooled at cool ambient temperatures without having to forego the low re-cooling temperature at high ambient air temperatures.

3.7 Lubricating Oil System

TG shall have a complete self-contained lubrication oil system. The system shall cater to the lubrication requirements of the bearings, requirements of turbine turning gear during start-up and shutdown and jacking oil requirement during turning gear operation. In addition, it shall also supply oil to the generator seals under emergency condition. The system shall specifically include the following:

a) Centrifugal / gear type, main oil pump directly driven by turbine or separate motor operated as per main equipment supplier standard practice with capacity to cater lube oil for bearings & emergency seal oil requirement. Further, 1x100% AC auxiliary oil pump for start-up, shut down of TG unit and as standby to main oil pump for automatic operation, having capacity to cater to lube oil, jacking oil & turning gear oil requirement.

b) 1x100% DC emergency oil pump for meeting lube oil requirements of bearings during emergency, with automatic starting on low lube oil pressure pre-set value.

c) 1x100% each AC and DC motor jacking oil pumps shall be provided to lift the rotor at the bearing during turning gear operation.

d) Each unit shall be provided with an oil tank of sufficient capacity so chosen that the full quantity of oil circulating through the system is retained for a controlled time ensuring thereby proper sedimentation & air removal, fitted with non-corrodible strainers, level indicators & necessary manholes. 2x100% duty vapor extraction fans driven by motors shall also be provided.

e) Adequate number (3X50% capacity or 2x100% capacity) of oil coolers shall be provided for cooling the lubricating oil. The cooling medium shall be DM water (condensate quality).

f) Oil purification system per unit shall be permanently connected to the piping system for each TG unit for purifying 20% of the total oil charge in the system per hour on a continuous bypass basis. Each unit shall be complete, self-contained with centrifuge or static type oil conditioner, explosion-proof motors, motor-driven feed pumps, heaters etc.

g) A centralized common lube oil storage and purification system consisting of a central purifier (capacity and type same as unit purifier), two central oil tanks, two transfer pumps (for dirty and clean oil) shall be provided. This is for storing and purifying oil from unit oil tanks and also for adding new oil to the system and also for transferring the fresh oil to the unit oil tanks.

3.8 Oil Water Separator

An oil water separator (OWS) is a piece of equipment used to separate oil and water mixtures into their separate components. There are many different types of oil-water separator. Each has different oil separation capability and are used in different industries. Oil water separators are designed and selected after consideration of oil separation performance parameters and life cycle cost considerations. "Oil" can be taken to mean mineral, vegetable and animal oils, and the many different hydrocarbons.

Oil water separators can be designed to treat a variety of contaminants in water including free floating oil, emulsified oil, dissolved oil and suspended solids. Not all oil separator types are capable of separating all contaminants. The most common performance parameters considered are:

- Oil droplet size (in the feed to the separator)
- Oil density

- Water viscosity (temperature)
- Discharge water quality desired
- Feed oil concentration and the range of oil concentrations likely
- Feed oil water flow (daily and peak hourly)

3.9 Main Plant Equipment

- Gas Turbines and Auxiliaries
- Heat Recovery Steam Generator and Auxiliaries
- Steam Turbine and Auxiliaries
- HV Substation
- Microprocessor Based Distributed Control System
- 132 kV Switchgear and Transformers
- Unit Auxiliary Transformer, Station Transformers and Associated Equipment
- Start Up/ Reserve Transformer and Associated Equipment
- Steam, Condensate System and Condensate Extraction Pumps
- Feed Water System, De-aerator Tank and Boiler Feed Pumps
- Condenser On-Load Tube Cleaning System
- Air Extraction System
- Lube Oil and Governing Oil System
- Turbine Control Fluid System
- Gland Steam System
- Governing/ Regulation System
- Cooling Tower and Fans
- WTP & Chemical Plant
- Circulating Water Pump
- Gas Booster Compressor and Auxiliaries
- Emergency Diesel Generator
- Deep Well Pump
- Effluent Treatment Plant (ETP)
- Main Fuel Tank and Fuel Day Tank (HSD)
- Natural Gas Metering and Regulating Station

3.10 Temporary jetty and River Bank Protection

1. Temporary Jetty and water intake facility will be built on near the Proposed power plant, which is located south-west side of existing power plant. This temporary jetty will be only used for heavy equipment transportation during construction work. After finishing the construction work this temporary jetty will be removed from that area.

2. During high flood, project might be affected by Old Brahmaputra River. Therefore, bank protection will be required along the bank of the Old Brahmaputra River of the project area. According to Bangladesh Flood Forecasting and Warning Center, (BWDB) the River highest water level (RHWL) of river Old Brahmaputra Mymensingh is 13.71 (mPWD) and Danger Level is 12.50 (mPWD).
3. Topographic survey reports and analysis for the Project area is given below:

Reference height level of the existing power plant (MPS) is 13.929 m from Mean Sea Level (Based on the Benchmark datum of Survey of Bangladesh kept at 'Chinamor' on the Mymensingh-Netrokona highway. Reference height level of the existing power plant (MPS) in terms of PWD is 14.389 mPWD. Average Height of the proposed project Land is 13.408 mPWD, Lowest Height of the project Land is 12.118 mPWD, Highest Height of the project Land is 13.99 mPWD and Designed Elevation is the 360 MW CCPP project Land 14.99 mPWD.

3.11 Heavy Machinery Transportation Through River

The length of Old Brahmaputra River is 145 Km starting from Bahadurabad (Jamuna River) point to Mymensingh 210 MW Combined Cycle Power Plant at Shambhuganj, which has been surveyed by the Consultant. Details of the report has been presented in the Feasibility report. As an outcome of the consultant survey of the Old Brahmaputra River, Heavy Equipment Transportation during project execution may be carried out through river route especially in the rainy season (July-August) with the support of dredger cruising together with the Barge carrying heavy machinery.

3.12 Liquid Fuel Transportation

- HSD transportation for power plant operation shall be through railway route from Bhairab to Shambhuganj, Mymensingh **OR** from Chittagong to Shambhuganj, Mymensingh.
- There exist HSD storage facilities in Chittagong having large capacity of liquid fuel. But the problem lies with the requirement of huge no's railway wagons and long travel (400 Km) time from Chittagong to Shambhuganj and relevant cost implications.
- HSD storage facilities at Bhairab, one Tank with capacity of 900 Tons, which cater the fuel requirement of local industries / transports HSD requirement.
- A joint Committee constituted by Railway with the senior officials of Railway, RPCL and Consultant with a view to assess facilities / establishment those need to be developed at Bhairab and Shambhuganj for HSD transportation to the power plant site.
- Fuel (HSD) will be transported to the main fuel tank of the power plant through oil pipe line and fuel forwarding pump station at Shambhuganj Railway Station site.

- ❖ Minutes of the joint committee report signed on 21 September 2017 may please be referred relating to the onward planning activities of HSD transportation to the power plant site.

3 km HSD fuel supply map is shown in bellow:

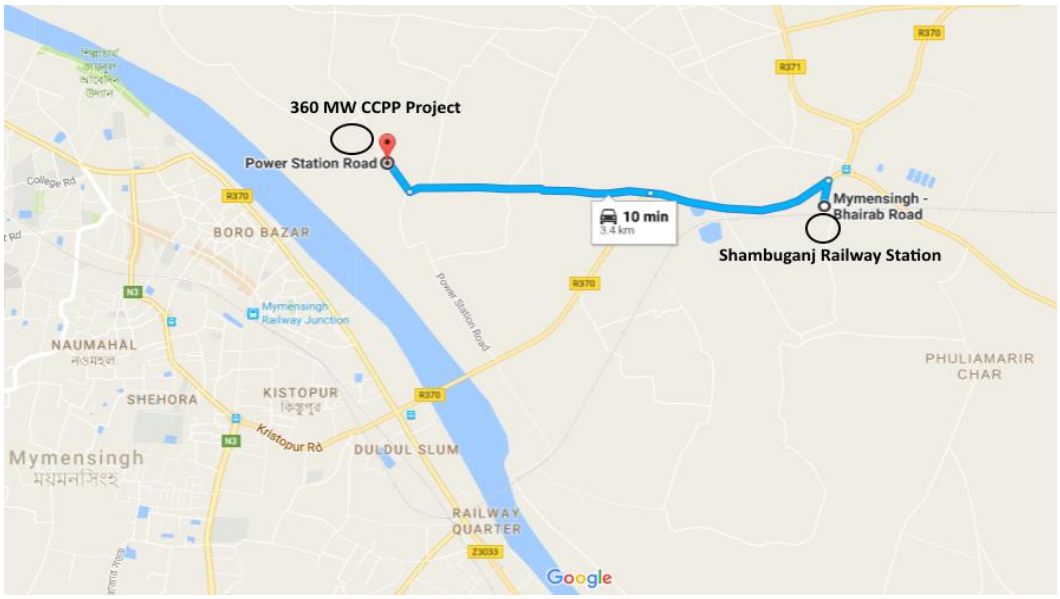


Figure 3.5: HSD fuel supply map

3.13 Major System of The CC power Plant

- One Gas Turbine, Generator and auxiliaries.
- One Steam Turbine, Generator and auxiliaries.
- One Heat Recovery Steam Generator consists of dual pressure boiler with HP and LP drum, economizer, evaporator, super-heaters, along with down comers and connecting piping, etc.
- One 40-meter height bypass stack and one 50-meter height main stack.
- Condensate system, Double pass Surface condenser with cooling water passing through tubes and steam around it in steam space.
- There are two sets of closed cycle cooling systems for combined cycle plant, which are the power plant CCW system and the ST condenser CCW system.
- Feed water system consists of De-aerator, Boiler Feed Water Pumps.
- One (1) Circulating Water System, Consist of Mechanical Draft Cooling Tower, Main Cooling Water Pumps, Auxiliary Cooling Water Pumps, Chemical Dosing System
- Compressed Air System will provide as the compressed air needed for instrumentation users, general service users and so on.
- Natural Gas Supply System consist of gas scrubber, gas filter separators, gas compressor and auxiliary equipment, gas after-cooler, etc.

- Fire protection system consists of motor driven fire pump, diesel driven fire pump, Jockey fire pump.
- Service and potable water system consists of Service transfer pumps, Potable water tank.
- HVAC System consist for Steam Turbine building, Gas Turbine building, Central Control building, DM plant, CEMS room and etc.
- Closed cooling water system consists of Heat exchanger and surge tank, Pumps, Pipes and valves, Instrumentation.
- Raw water treatment system consists of, Deep well and Pumps, Aeration Pool, Clarifier, De-iron filter, Pipe, Valve and Pumps.

Electrical System consists of:

- 132 KV system and relevant switchgear/ auxiliaries
- 11-20 KV system and relevant switchgear/ auxiliaries
- 6.6/0.415KV system and relevant switchgear/ auxiliaries
- 11-20 KV / 6.6 kV unit auxiliary transformer
- 11-20 KV / 132 kV Step Up transformer
- 6.6/0.415KV station service transformer
- Generator circuit breaker for GTG
- Generator circuit breaker for STG
- 11-20 KV isolated phase bus for GTG
- 11-20 KV isolated phase bus for STG
- DC220V system & essential UPS system
- Grounding and lightning protection system
- Small power system
- HV/ MV Power Cables
- Control Cables
- Communication system

❖ Instrumentation and Control System: I&C system consists of Microprocessor based Distributed control system, all necessary Instrument, control valve, control drivers, Continuous emission monitoring system (CEMS), fire detection and alarm system, CMMS system and CCTV system.

3.14 Plant Water System

1. The Ground water / River water will be used for circulating cooling water system.
2. Closed Circuit Cooling System will be used for the cooling purpose of the proposed power plant.
3. Total water system of the power plant is shown in details.

Emergency Oil Collection System

There is one emergency oil basin near the transformer area. When emergency occurs, transformers oil will be drained to an emergency oil basin for storage so the fire can be controlled. The system is designed as follows:

The nominal capacity of the emergency oil pond is 160 m3; the useable capacity of the emergency oil pond is 135 m3. There will be additional oil collection system for the secondary containment area for the fuel oil tank farms. The oil collection pit will be connected to the tank overflow lines and spill collection from secondary containment floor.

Oily waste water system

Oily wastewater of main power building, maintenance shop, transformers and fuel tank farm area rainwater drain etc. will be collected to an oily wastewater tank and pumped to oily wastewater separator, then discharged into sewage water system when satisfy the effluent standard. There are two sets of oily wastewater separator to be provided.

Basic design data for this system shall be as follows:

a) Maximum design flow rate: 5~8m3/d
b) Oily wastewater tank capacity: 20m3
c) Oily wastewater separator capacity: 5m3/h
d) Running period: run based on the Oily wastewater tank's level
e) Outlet water quality: oil<5mg/L (Bangladesh standard oil<10mg/L)

Industrial Waste Water Treatment System

The wastewater from various sources will be collected and treated separately as per its kinds before discharged. The following kinds of wastewater are considered.

a) Chemical wastewater (including oil, chemicals, metals, and suspended matters)
- Wastewater discharged from chemical processes such as demineralization
- HRSG blow down
- Drains from GT/ST and HRSG equipment areas
- Wastewater from the fuel treatment plant
- Wastewater irregularly discharged from the processed, such as HRSG chemical cleaning and HRSG wet-conservation, GT water wash

b) Sanitary,
c) Rainwater,
d) Another domestic wastewater

Shall be pre-treated by using the Wastewater Storage Ponds and temporary equipment prior to the treatment in the Wastewater Treatment Plant. If necessary, the waste from pre-treatment processes and the waste from GT water wash shall be drained to separate holding tanks for off-site disposal. The treated wastewater shall be monitored at the final discharge pit and together discharged to the river via cooling water discharge way. The chemical wastewater shall be treated by adequate wastewater treatment process to meet applicable environmental requirements.

3.15 Other Systems of The Plant

- Potable Water System Extension: The new system will be interconnected to the existing potable water distribution network.
- Sanitary Sewage System: Sanitary sewage water will be treated by septic tank and meet the local effluent standard prior to final discharged into the river outside the plant eventually or it will be used for water requirement of green belt, which will be required from environment control.
- Rainwater Discharge System: The system will collect rain water and discharge into Cooling Tower pond (make up water pond).
- Emergency Oil Collection System: There is one emergency oil basin near the transformer area and one oil collection pit for fuel oil secondary containment area. When emergency occurs, transformers oil will be drained to an emergency oil basin for storage so the fire can be controlled.
- Oily Waste Water System: Oily wastewater of main power building, maintenance shop and transformers rainwater drain, fuel oil secondary containment drains, etc. will be collected to an oily wastewater tank and pumped to oily wastewater separator, then discharged into sewage water system when satisfy the effluent standard.

- Chemical System: The Chemical section includes the following subsystem:

1. Water Demineralization Plant
2. Chemical Dosing System
3. Steam and Water Sampling System
4. Waste Water Treatment System
5. Circulating Water Treatment System
6. Condensate Water Treatment System

- Water treatment system: The water treatment system process will consist of:

1. Cleaning Water
2. Activated Carbon Filter
3. Cation Exchanger
4. De-carbonator
5. Intermediate Water Tank
6. Intermediate Water Pump
7. Anion Exchanger
8. Mixed Bed Ion Exchanger
9. Demineralized Water Tank
10. Demineralized Water Pump
11. Plant Users

- Chemical Dosing System: The chemical dosing system for HRSG is consists of:
  1. Ammonia Dosing System
  2. Hydrazine Dosing System
  3. Phosphate Dosing System
- Steam and Water Sampling System: To monitor the steam and water quality continuously, ensure the safety, steam and water analysis system will be provided. The equipment will be set centrally in main plant. System provide on line reading in control room in DCS panel.
- Industrial Waste Water Treatment System or Effluent Treatment System: The wastewater from various sources will be collected and treated separately as per its kinds before discharged. The following kinds of wastewater are considered.
  1. Chemical Wastewater (including oil, chemicals, metals, and suspended matters)
  2. Wastewater Discharged from Chemical Processes such as Demineralization
  3. HRSG Blow Down
  4. Drains from GT/ST and HRSG equipment areas
  5. Wastewater from the Fuel Treatment Plant
  6. Wastewater irregularly discharged from the processed, such as HRSG chemical cleaning and HRSG wet-conservation, GT water wash
  7. Sanitary,
  8. Rainwater,
  9. Another Domestic Wastewater.

- Chemical wastewater: The regeneration wastewater shall be discharged into two (2) neutralization pits, and fully mixed and neutralized, and then normally transferred to the clear water pit. The chemical wastewater shall be treated by adequate wastewater treatment process to meet applicable environmental requirements.
- Circulating water treatment system: To prevent microbe, cetacean cling in condensate and pipes, Bactericide dosing system will be set. In the system, Sodium hypochlorite is fed to the circulating water continuously to kill bacterium. To prevent fouling in circulating water treatment system, scale inhibition will be used.
- Condensate water treatment system: To prevent the metallic corroding in the condensate water and the effect of unit start-shut frequency, a de-iron filter should be set for ensuring the water quality.

3.16 Energy Absorption Plan

The average yearly gross electrical generation from the 360 MW CCPP of the power plant is estimated to be at a PLF of 80% which is typical for this type of generating plant. Auxiliary power consumption is considered approximately 4.2% of gross plant output, which is typical for the power plant of this size.

3.17 Plant Operational Control and Instrumentation

Distributed Control System:

- The instrument and control system provided with a microprocessor-based Distributed Control System (DCS) with state of art Man-Machine Interface (MMI) and other analog instruments and control devices.
- It will perform the functions of monitoring, control, alarm, protection and interlock, diagnosing, and maintenance guidance, event recording of steam generator and auxiliaries, steam turbine generator and auxiliaries and the balance of plant systems with a hierarchically distributed structure to meet all requirements at various operational conditions.

Operation Philosophy:

- The main plant system like boiler, turbine, generator and auxiliaries, will be operated through the operator consoles in the Central Control Room (CCR).
- With the exception of auxiliary systems like waste water treatment, chlorination and ac & ventilation all drives will be remotely operable from the operator's console in the central control room.

3.18 Project Execution

1. It is envisaged to synchronize the unit and put into commercial operation in 30 months, reckoned from the zero date of the Project contract effectiveness (i.e. handing over developed site to EPC contractor and related clearances, permits from various Govt agencies).

2. A single Turn-key contract for completion of the project for GTG, BTG and BOP, civil & building work, engineering & design and construction, erection, Installation, Testing & commissioning work of 360 MW CCPP project complete in all respect.

3. The site development has already been completed by RPCL. However, compactness of the Project site and Road as necessary for transportation of Heavy Equipment /Machinery inside the Project area is bestowed on the EPC Contractor's scope.

3.19 Operational Setup

1. O&M Organization: The key operation and maintenance people can be managed with the combination of trained O&M people personnel of the client and the EPC contractor. During warranty period the EPC Contractor shall provide hands on job training to the client personnel.

2. Operation Philosophy: Combined Cycle Plant would be operated in accordance with dispatch schedule, and grid code provisions. Sliding pressure operating regime for the Steam Turbine unit and HRSG would be utilized for achieving better heat rate at part load operations.

3. Maintenance: The maintenance plan would focus on plant performance, improvement of reliability, reduction of operation and maintenance costs, relationship of operating mode with operation and maintenance costs and remaining plant and component life.

4. Training: Training would be provided on plant system/equipment specifically on safe integrated operation and maintenance procedures, adopting best health & safety procedures etc.

3.20 Details of Operating Cycle:

Plant operation is grossly 80%-time base load, 40% time it will operated by HSD and 40% time it will be operated by Gas depending on the availability of each type of fuel category.

CHAPTER - 04

ENVIRONMENTAL BASELINE STUDIES

4.1 General Consideration

Baseline condition of environment states the present status of different components of environment in absence of the project. The main objective of examining the present environment is to provide an environmental baseline against which potential impacts from construction and operational phases of any project can be compared. A second important function of establishing a baseline for parameters such as air and water quality is to ensure that any problems arising from existing sources are not erroneously attributed to the project under study. In the present study, the different environmental components examined for setting baseline conditions of the project area, are physio-chemical, biological and socio-economical. In physio-chemical component, parameters included are land, water quality, air quality, climate, and noise.

4.2 Physical condition

The RPCL intends to build and operate a Dual Fuel Power Plant in Shambhuganj, Mymensingh. The proposed power plant will be constructed to produce 360 MW electricity with modern machinery. The total land area of this project is 16.5 acres.

Some of the notable features of the surroundings are:

- There is a plan of plantation of trees of various species outside the proposed project premises. These trees when grown up to certain height will act as a greenbelt and also will increase the aesthetic value of the environment. Like other parts of Bangladesh domestic animals and a few common birds are seen.
- Here are no wild-life, natural forest and vegetation, endangered species present in and around the plant site;

4.2.1 Land Form and Soil Classification

Most of the area of Bangladesh is a vast, low-lying alluvial plain, sloping gently to the south and southeast. According to Bangladesh Agricultural research council's Agro-Ecological Zoning map of Bangladesh, the proposed project area falls in the Old Brahmaputra river flood plain.

This area has a typical meander floodplain landscape of broad ridges and basins. Soils of this region are silt loams and silty clay loams on the ridges and silty clay loam to heavy clays on lower sites. General soil types predominantly include calcareous dark grey and calcareous brown floodplain soils. Organic matter content is low in ridges and moderate in the basins. General fertility level is medium.

4.2.1.1 Topography

Reference height level of the existing power plant (MPS) is 13.929 m from Mean Sea Level (Based on the Benchmark datum of Survey of Bangladesh kept at 'Chinamor' on the Mymensingh-Netrokona highway. Reference height level of the existing power plant (MPS) in terms of PWD is 14.389 mPWD. Average Height of the project Land is 13.408 mPWD, Lowest Height of the project Land is 12.118 mPWD, Highest Height of the project Land is 13.99 mPWD and Designed Elevation is the project Land 14.99 mPWD.

district consists of this type of land. Beside this, southern part of Mymensingh is lowland usually experiences 1-1.5m stagnant water during monsoons and this may rise to 3–4m (Huq and Shoaib, 2013). Thus, overall a unique combination of waterbodies i.e. haor, beels, canals etc. and hilly lands (in some part of northern region) persists in the area.

4.2.1.2 Geology

The geological profile of Mymensingh is heterogeneous. This is usually characterized as noncalcareous dark grey flood plain soil. Most of the soil comprises of silty to clay texture (Khan and Hasan, 2015). Thus, the northern part of Mymensingh is occupied by Dihing formation since Pliocene to Pleistocene age, this includes pebble and boulder beds. The sand fraction is dominated by quartz on an average 70–90% of these rocks. Feldspar (mainly alkali) and mica contents are generally low viz. 1–10% and less than 5%, respectively (Huq and Shoaib, 2013). Generally, presence of heavy minerals i.e. Zircon, Tourmaline, Kyanite, Staurolite and Andepidote are within 3%. The total content of easily weather able minerals, i.e., Feldspar plus Biotitics, is generally less than 10%. Exceptionally in northern part of Mymensingh, few places contain higher trace of Feldspar i.e., up to 15% (Huq and Shoaib, 2013). Fulbaria Upazila is classified as upper clay and silt layer, composite aquifer and main aquifer. Upper layer is extended form 0.3m to 31.5m below the ground surface with an average thickness of 21.82m (Habib, 1999). Then, the second layer is composed of fine, medium and medium to fine sand with an average thickness of 24.37m and the third layer (main aquifer) can be found with a depth of ranging from 24m to 69.5m below the ground level (UNDP, 1982; Basunia et al., 2015). On the other hand, rest of the Upazila of Mymensingh also show this heterogeneous characteristic, for instance Trishal, and Muktagacha upazilas are composed of clay, silty clay, fine sand layers and hard clay, medium course to coarse sand layers successively. On a regional basis the lithological profile of study area is composed of clay, clay with fine sand, fine sand, medium sand, fine to medium sand and coarse sand (UNDP, 1982; Ahmad et al., 2009; Mojid, 1993). In the study area i.e. northwest and southeast part of Mymensingh district is of dense sand dominating region extended up to approximately 20m below the ground level.

4.3 Bounding the Impact Area

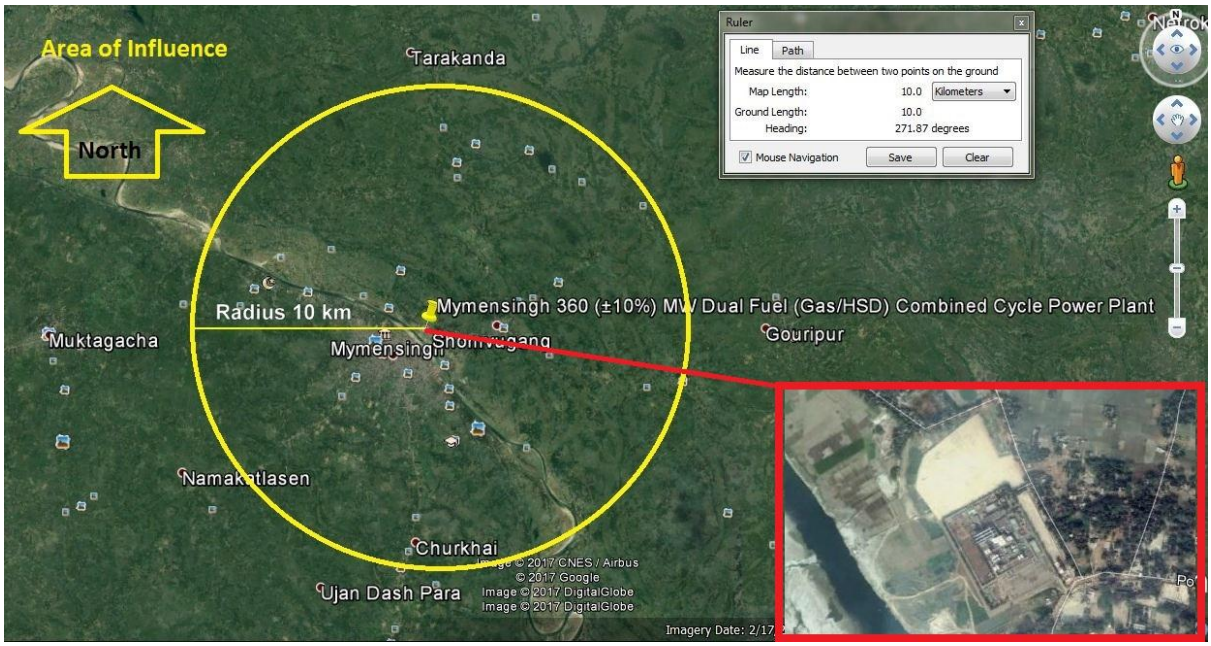


Figure 4.1: Study Area (Source: Google Map)

The study area will cover the entire area of the project, which belongs to **RPCL** project at Shomvugang, Mymensingh sadar, Bangladesh. The River Brahmaputra is situated at the South side adjacent to the project. For the ease of current EIA study, the study area has been kept limited to the surrounding areas, which falls within the 2 Km radius of the proposed site. This almost covers the area falls under Mymensingh sadar Upazila of Mymensingh District. Primary and Secondary data has been generated and collected for conducting Baseline Study. **Figure 4.1** above shows the study area.

4.4 Climate

The climate here is tropical. In winter, there is much less rainfall than in summer. The temperature here averages 25.3 °C. The rainfall here averages 1765 mm. July is the warmest month of the year. The temperature in July averages 28.5 °C. In January, the average temperature is 18.4 °C. It is the lowest average temperature of the whole year. There is a difference of 467 mm of precipitation between the driest and wettest months. The average temperatures vary during the year by 10.1 °C., The climate is characterized by a change of four seasons: pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November) and dry season (December to February). High air temperature is observed all throughout the year; daily air temperature variations are insignificant; air humidity is high with abounding rains. Typical parameters of the weather elements, as recorded for the period of last few years of observations (2012-2016) at Mymensingh Meteorological Station are presented in **table 4.1 to 4.4** below.

4.4.1 Rainfall

Annual rainfall of Mymensingh is about 1765 mm and approximately 80% of it occurs during the monsoon. Average monthly rainfall during monsoon period varies between 350mm to 500mm. Maximum monthly rainfalls during this period (2012-2016) recorded 559 mm in August 2014.

The rainfall follows the general climate pattern with the highest rainfall in the summer month of June to September and minimum rainfall in the cooler and drier months of November to March. It is evident that extreme rainfall events occurred during the monsoon (June-September). Average monthly rainfall values for Mymensingh area from the year 2012 to 2016 are presented in **Table -4.1**. Figure 4.2 shows the yearly rainfall data from 2012 to 2016 whereas highest rain fall were observed in Mymensingh area in 2015 (2084 mm), and lowest rainfall in 2012 (1479 mm).

4.4.2 Relative Humidity

As would be expected, relative humidity during the wet season is significantly higher than those occurring at other period of the year. This is well depicted by the data as shown in the **Table - 4.2** for relative humidity of Mymensingh during the period of 2012–2016. **Figure 4.4** also describes that the relative humidity is same during the period 2012-2016.

4.4.3 Wind Speed

Monthly Prevailing Wind Speed and Direction in Knots of Mymensingh for the period of 2012-2016 are presented in **Table - 4.3**.

Table 4.1 Monthly Average Rainfall in the project area (2012- 2016)

Year	Rainfall in mm (Mymensingh)												
	Total	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2016	1968	15	08	47	111	326	391	518	106	409	32	01	00
2015	2084	15	19	01	203	212	502	329	413	308	78	04	00
2014	1934	00	42	24	78	160	342	303	559	410	16	00	00
2013	1739	00	18	21	69	308	267	318	343	132	263	00	00
2012	1479	18	00	01	202	85	241	409	238	221	45	19	00

Source: BMD

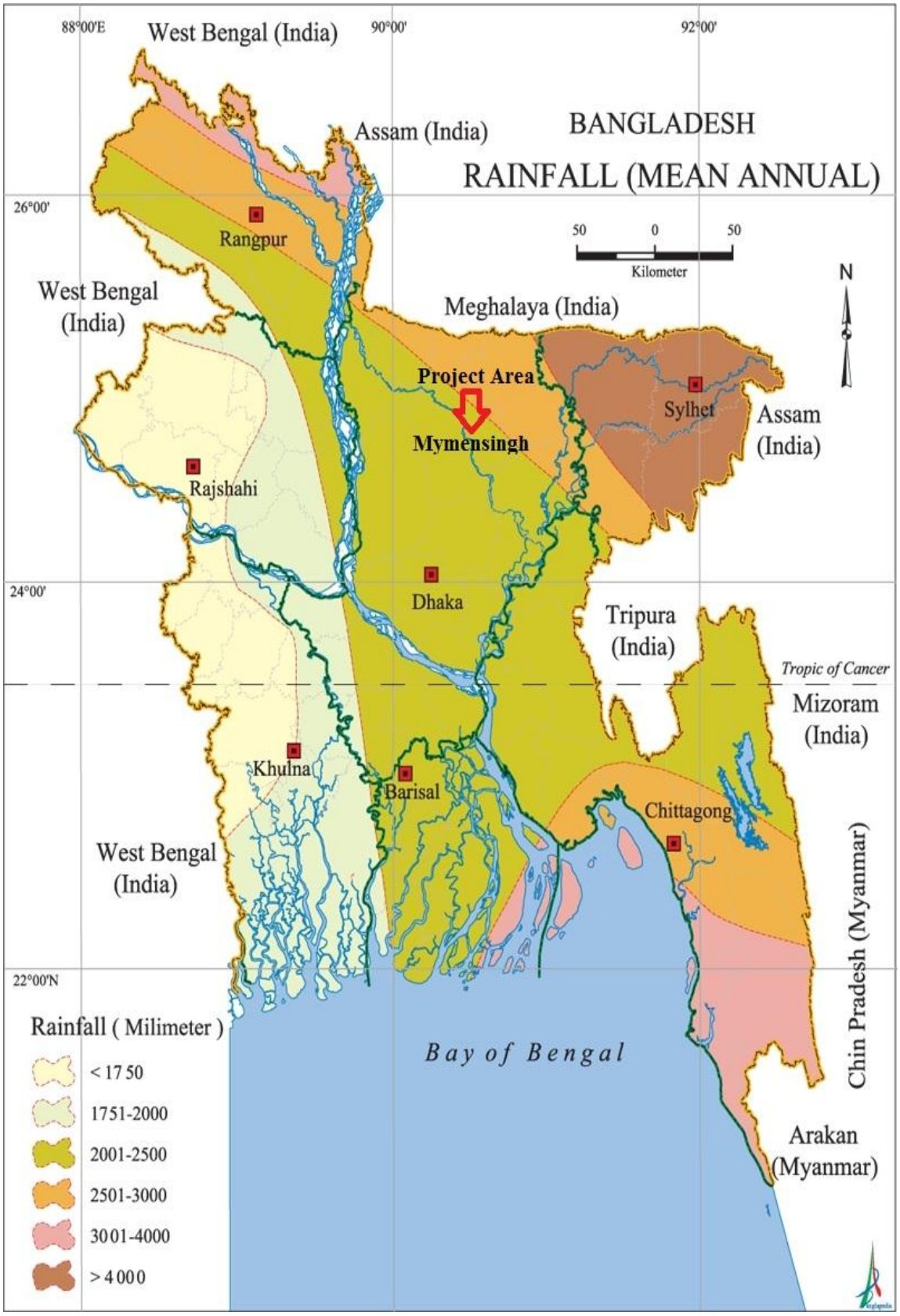


Figure 4.2: Rainfall Scenario in Bangladesh (Source: banglapedia.org)

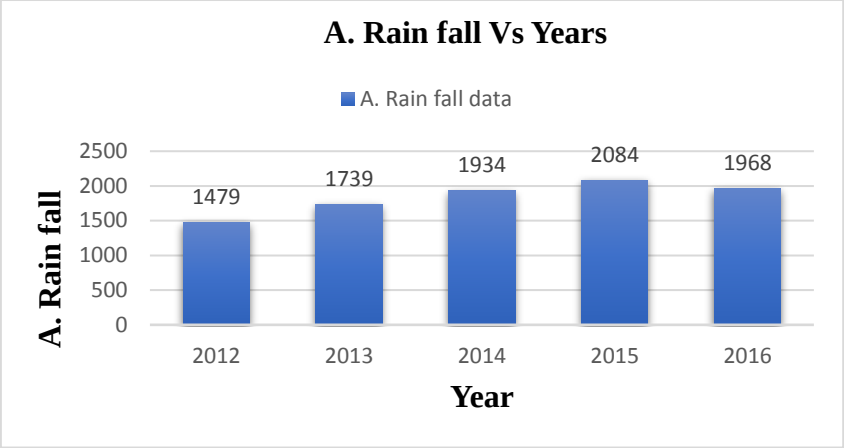


Figure 4.3: Year wise rainfall data

Table 4.2 Average Monthly Relative Humidity of the Project Area (2012- 2016)

Year	Monthly Mean Humidity in %(Mymensingh)												
	Annual	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2016	81	84	79	75	81	80	83	86	80	87	83	81	80
2015	81	82	78	74	80	80	85	84	87	85	82	81	82
2014	81	82	76	72	73	79	84	84	87	86	83	81	86
2013	80	78	70	74	77	84	82	83	85	85	85	81	82
2012	81	79	71	73	80	77	85	86	85	85	82	81	88

Source: BMD 2016

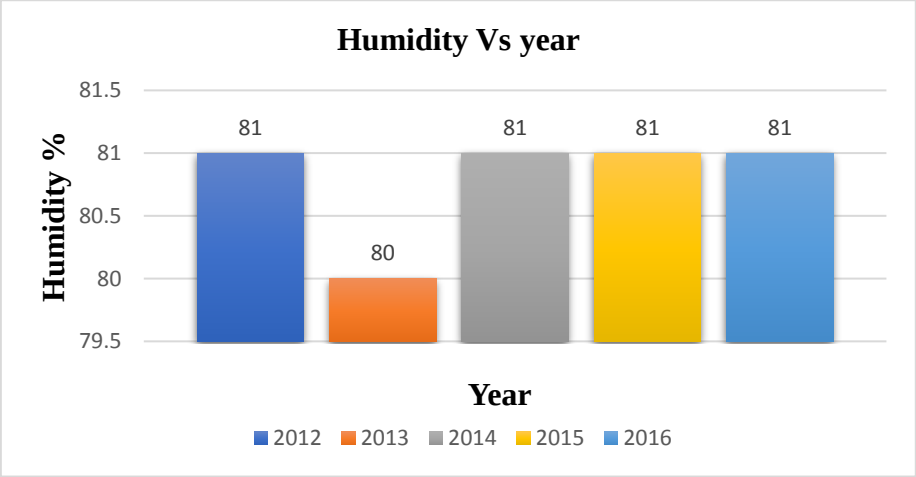


Figure 4.4: Year wise Humidity data

4.4.4 Ambient Air Temperature

The temperature of the country has the relationship with the period of rainfall. In general, winter seasons coincide with the period of lowest rainfall. **Table 4.4** shows the monthly average maximum and minimum temperature at Mymensingh for the period 2012 -2016. During this period, maximum average temperature of 29.60 degree Celsius was observed in August, 2016 where average minimum temperature was 16.10 degree Celsius in January, 2013. Rainfall pattern in the project area likely to be more or less similar that of Mymensingh. **Figure 4.5** shows the graphical representation of ambient air temperature.

Table - 4.3 Monthly Prevailing Wind Speed and Direction in Knots of Mymensingh (2012- 2016)

Year	Monthly Prevailing Wind Speed and Direction in Knots of Mymensingh												
	Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2016	Wind Speed (Knots)	2.5	1.8	2.4	3.7	2.5	2.2	2.6	2.8	2.0	1.9	1.7	1.8
	Wind direction	W	E	E	E	E	SE	SE	SE	SE	E	E	NW
2015	Wind Speed (Knots)	1.9	1.9	2.3	2.6	3.2	3.2	3.1	2.5	1.9	2.5	1.6	1.8
	Wind direction	W	E	W	E	E	E	E	E	E	E	E	E
2014	Wind Speed (Knots)	1.9	2.6	3.0	2.7	2.7	2.6	2.7	2.6	1.8	1.3	1.6	1.7
	Wind direction	W	W	W	E	E	SE	E	SE	E	E	E	W
2013	Wind Speed (Knots)	1.5	1.7	2.4	2.4	3.3	2.5	2.4	2.3	1.8	1.8	1.5	1.7
	Wind direction	NW	W	W	E	E	SE	SE	SE	S	E	W	E
2012	Wind Speed (Knots)	1.7	2.7	1.8	2.9	2.4	2.2	2.2	2.0	1.8	1.9	2.4	1.4
	Wind direction	W	W	E	E	E	E	SE	E	SE	S	W	W

Source: BMD 2016

Table - 4.4 Monthly Ambient Temperature of the Project Area in year (2012-2016)

Year	Monthly average Dry Bulb Temperature in degree Celsius of (Mymensingh)												
	Average	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2016	25.5	17.1	21.8	25.1	28.2	27.3	29.1	28.5	29.6	28.4	27.7	23.0	20.0
2015	24.9	17.9	20.7	23.9	25.6	27.9	28.4	28.7	28.7	28.8	27.0	23.1	18.3
2014	24.9	17.3	19.2	24.0	27.5	28.4	29.0	29.2	28.4	28.4	26.9	23.0	17.9
2013	24.9	16.1	21.3	25.1	26.9	26.9	29.4	29.0	28.5	28.7	26.6	21.9	18.4
2012	24.7	17.1	20.1	24.7	26.1	28.8	28.4	28.6	29.0	28.6	26.8	21.8	16.9

Source: BMD 2016

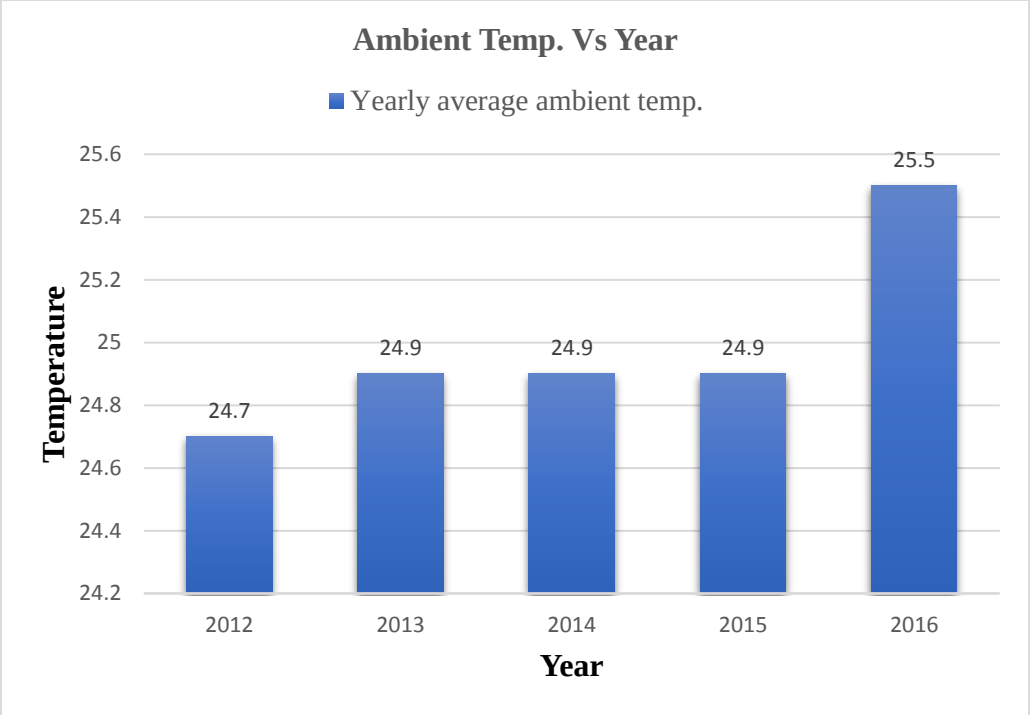


Figure 4.5: Year wise ambient temperature data

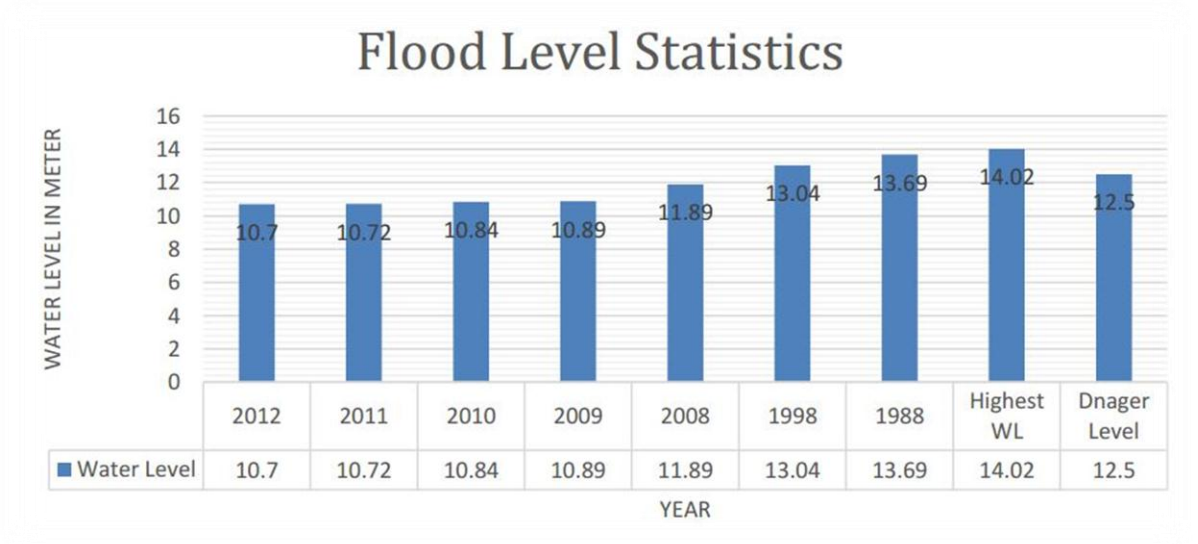
4.5 Hydrology

4.5.1 Surface Water of Project Area

Water supply of the Mymensingh is largely dependent on ground water abstraction from underlying aquifer system. Mymensingh is located beside Brahmaputra river. Mymensingh region has developed by deposition of Brahmaputra river system. As other parts of the country this area also receives sufficient amount of rainfall and there is a good availability of ground water, which is being, used by hand pumps for drinking and domestic purposes. Most of the water bodies in the area are ponds and some of these ponds are generated due to excavation of earth. Mymensingh town and its north western and north-east side is at comparatively elevated other than south east and south-western side. There are some low-lying flood plain areas, which remain under water during flood period (July-October).

4.5.2 Flood Scenario of Mymensingh Area

Flood level regarding 2008 to 2012 and major flood hazard of 1988 and 1998 and recorded highest flood level as well as danger level has been shown in maps. Flood information has been collected from Bangladesh Water Development Board. In **Figure 4.6** Flood level statistics shows that, 14.02m is highest water level and 12.5m is danger level for flood. Flood level information during 1988 to 2012 at shows that, flood level has been degrading year by year and in 2012 flood level was 10.7 meter which was lowest in last 24 years record. Flood in 1988 and 1998 crossed danger level of flood and reached at 13.69 and 13.04-meter water level. In **Figure 4.8** details flood scenario of Bangladesh are represent.



(Source: Annual Flood Report, 2008-2012, Bangladesh Water Development Board)

Figure 4.6: Flood level statistics of different years (Mymensingh)

4.5.3 Water Quality

4.5.3.1 Surface Water

The Brahmaputra River is the only surface water body adjacent to the project site. The river carries run-off water from adjoining areas, which might contain some pollutants. Water was collected from the river and analyzed in AECL Laboratory. The water quality of limited parameters of the ditch near the project site as analyzed is given below in **Table 4.5**.

4.5.3.2 Ground Water

Ground water level exists at a moderate (Generally below 7-11 m) depth, which is being recharged mainly by infiltration of rainwater. The ground water zoning map is shown in **Figure 4.9**. Ground water is the source of water for domestic use in this area. Usage of ground water for irrigation is limited here. The recharge capacity of the ground water level seems to be adequate.

Groundwater level shows a declining trend in Mymensingh district. Based on the field information during 1999-2017, this was found that the seasonal influence on ground water level persists and, on an average, the yearly maximum lowering happens in the month of March. Eighteen years annual lowest groundwater level shows overall a deletion trend. (**Figure 4.7**)

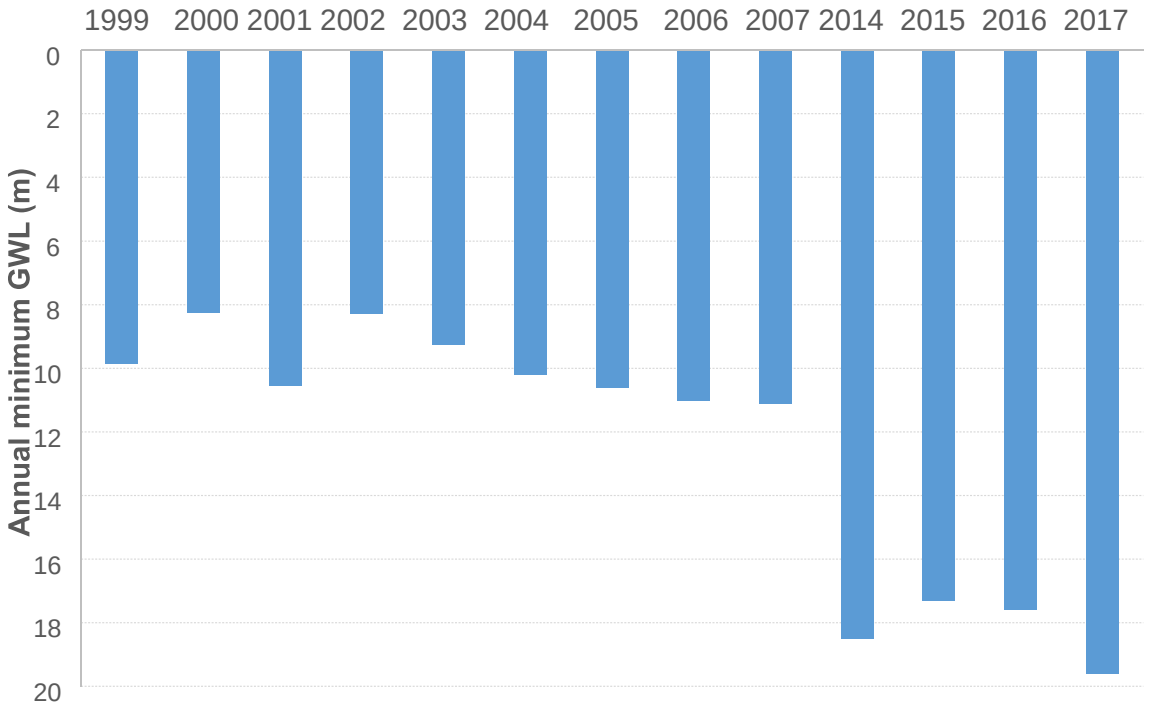


Figure 4.7: Year wise observed lowest ground water level (Hussain et al., 2016 and data source DPHE)

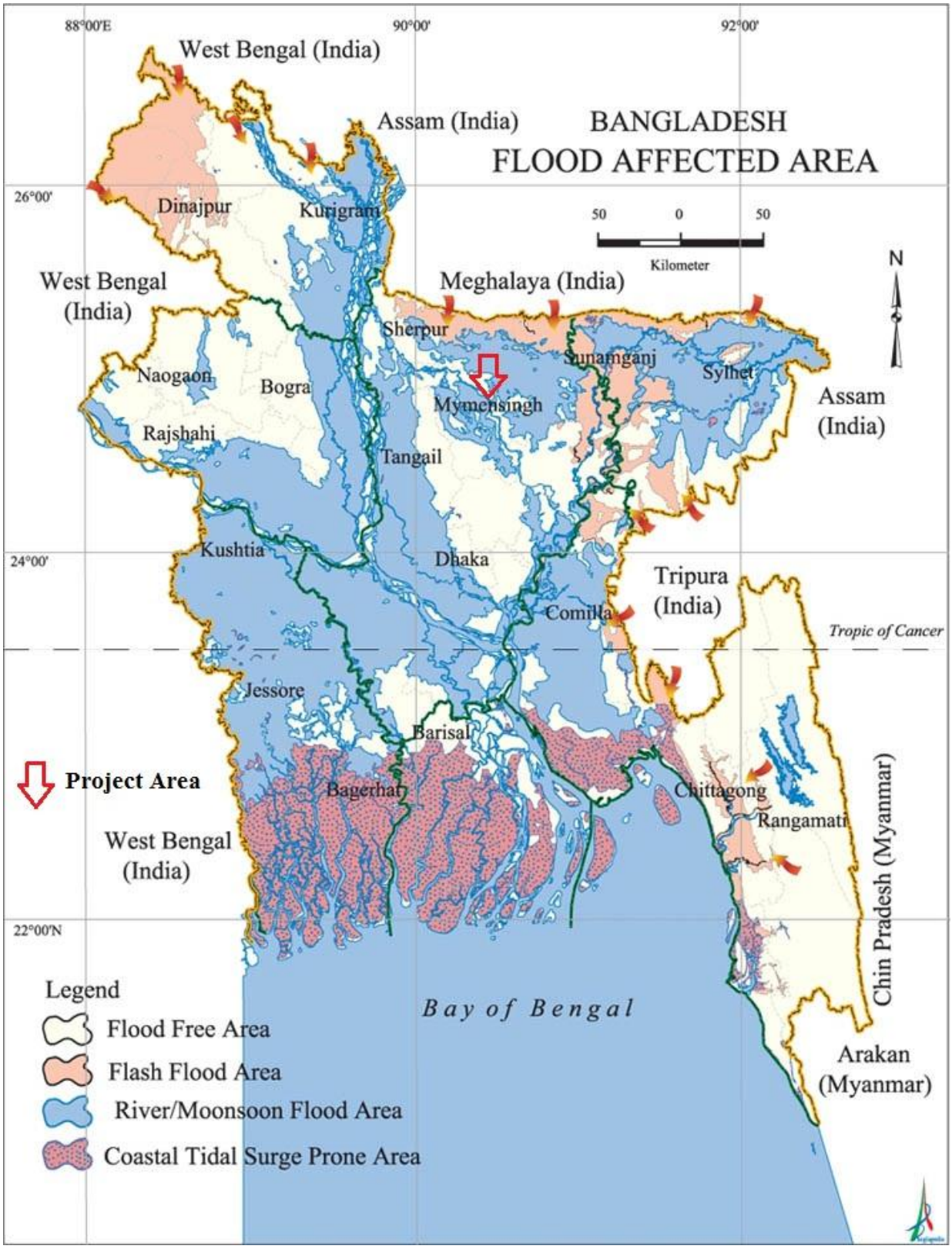


Figure 4.8: Flood Senior in Bangladesh (source: banglapedia.org)

Table-4.5: Surface Water quality (limited parameters) of the Brahmaputra River

SL No.	Name of Parameters	Concentration Present	DoE (Bangladesh) Standard *1997	IFC /World Bank Standard	Unit	Method of analysis
1.	pH	7.80	6.5-8.55	6-9	-	pH Meter
2.	DO	6.82	5-upper than 5	NF	mg/L	DO meter
3.	TDS	95	1000-5000	NF	mg/L	TDS meter
4.	Conductivity	47.3	NF	NF	µS/cm	Conductivity Meter
5.	Temperature	28.3	40	NF	^{0}C	Mercury filled thermometer
6.	TS	2.4	NF	NF	mg/L	Dried at 103-105
7.	Nitrate	<1	10	NF	mg/L	Potentiometry
8.	Phosphate	<0.2	NF	NF	mg/L	Photometric
9.	BOD_5 at 20^{o}C	2.8	6 or less then 6	50	mg/L	5-Day BOD test

Source: AECL Lab (sample collected on 30th May, 2017 and reporting on 7th June, 2017)

* DoE Inland Surface water quality standard, NF-not found.

To determine quality of ground water, water sample was collected from a nearby tube well of the existing plant of the RPCL and analyzed for different parameters. The results show that all the parameters remain within the allowable limit of drinking water value as per as Environmental Quality Standards for Bangladesh. The parameters which have been analyzed during this study are presented below in **Table 4.6**.

4.6 Air Quality

Air quality in the Mymensingh and its neighborhoods is deteriorating both from natural and manmade causes. It is one of the most dangerous and common kind of environmental pollution that is reported in most industrial towns and metropolitan city in Bangladesh. Major atmospheric pollution is caused by man induced activities like - burning fossil fuels, industrial processors, construction works and agricultures, transportation industry.

In the rural areas, however the ambient air quality is relatively good. It is assumed that accepting the small areas near the urban growth center air quality in the most of the area would be far below the Environmental Quality Standards of Bangladesh. National Ambient air quality standards (NAAQS) are defined in ECR'97. The ultimate aim of the NAAQS is the compliance in all areas in the country for the protection of health and wellbeing of the population. DOE have eleven CAMS stations, CAMS-4 (Gazipur) is the nearby station of Mymensingh, ambient air quality parameters are monitored on a regular basis by the DOE

using CAMS (Continuous Air Monitoring Stations). The CAMS data of November 2017 of Gazipur, is given in the **Table 4.7** below.

Table-4.6: Ground Water quality (limited parameters) of Project Site (Mymensingh)

SL No.	Name of Parameters	Concentration Present	DoE (Bangladesh) Standard *	WHO Standard	Unit	Method of analysis
1.	pH	**7.95**	6.5-8.5	6.5-8.5	-	pH Meter
2.	DO	**7.62**	6	NF	mg/L	DO meter
3.	TDS	**138**	≤1000 mg/L	NF	mg/L	TDS meter
4.	Conductivity	**68.9**	NF	250	µS/cm	Conductivity Meter
5.	Temperature	**26.2**	(20-30) ºC	NF	^{0}C	Mercury filled thermometer
6.	TS	**<1**	NF	NF	mg/L	Dried at 103-105
7.	Nitrate	**10**	10	50	mg/L	Potentiometry
8.	Phosphate	**0.3**	6	NF	mg/L	Photometric
9.	BOD_5 at 20ºC	**<0.2**	0.2	NF	mg/L	5-Day BOD test

Source: AECL Lab (sample collected on 30th May, 2017 and reporting on 6th June, 2017)

* DoE Inland Surface water quality standard, NF-not found.

Table 4.7: CAMS data for the project area (CAMS-4, Gazipur,2017).

Sample Location	Ambient air quality parameter	Unit	Analysis method	Average Concentration present (24 hours basis)	Bangladesh (DoE) Standard
Near project area (Gazipur)	**$PM_{2.5}$**	µg/m^3	**Gravimetric**	133	65 µg/m3 24 hours
	PM_{10}	µg/m^3	**Gravimetric**	**169**	150 µg/m3 24 hours (c)
	SO_2	ppb	**West-Gaeke**	DNA	365 µg/m3 (0.14 ppm) 24 hours (a)
	NO_x	ppb	**Jacob and Hochheiser**	DNA	100 µg/m3 (0.053 ppm) Annual

Source: Ministry of Environment and Forests, February 2017.

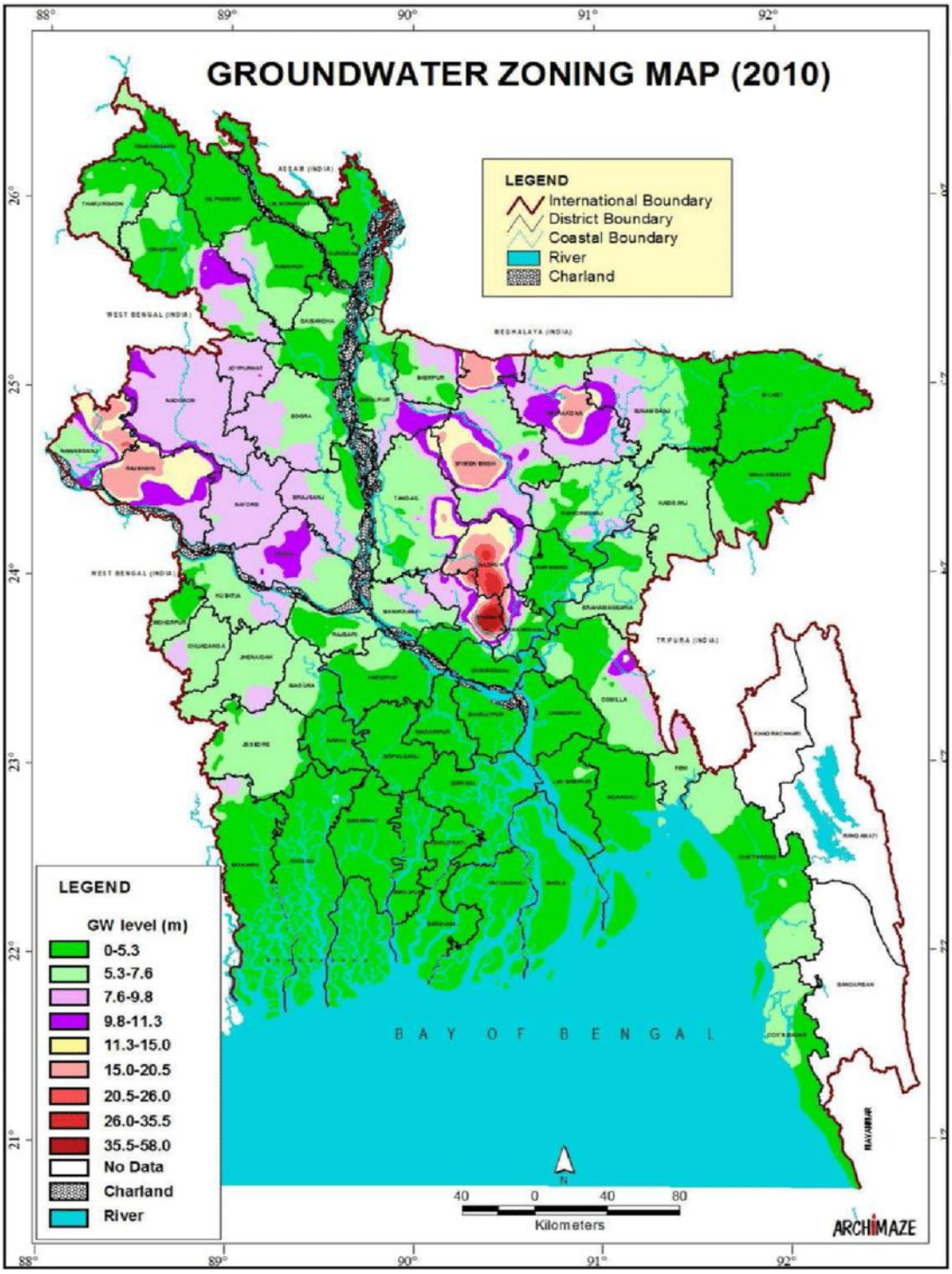


Figure 4.9: Ground Water Zoning Map of Bangladesh (Source: academia.edu)

Since there is no CAMS station available from DOE near the project area, the CAMS- 4 (Gazipur) is far away, moreover and Gazipur area is densely industrially populated, a month-long air quality monitoring has been conducted by AECL team at site (at 3 locations around

the project area) for different parameters during 30th May -5st June, 2017 which are shown in **Table 4.8**.

Table-4.8: Air Quality Data of nearby Location of Proposed Site

SN	Sample Description	$PM_{2.5}$	PM_{10}	SPM	SO_2	NO_X	O_3	VOC
	Method of analysis	Gravimetric	Gravimetric	Gravimetric	West-Geake	Jacob and Hochheiser	O_3 Meter	VOC Meter
	Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	ppm
	Test Duration (Hours)	**8**	**8**	**8**	**8**	**8**	**8**	**8**
	Bangladesh (DoE) Standard	**65**	**150**	**200**	**365**	**100**	**157**	**NYS**
	IFC /World Bank Standard	**75**	**150**	**NF**	**125**	**200**	**160**	**NF**
01	Concentration present in Project area (Inside Power Station) Location Coordinate: N24⁰45'46.85"; E90⁰25'3.93"	**38.8**	**95.9**	**180.3**	**8.7**	**9.7**	**0.017**	**7.3**
02	Concentration present in Nikunja Residential area(Patgudam) Location Coordinate: N24⁰44'42.39"; E90⁰25'13.57"	**25.2**	**73.9**	**86.0**	**8.9**	**9.4**	**0.007**	**6.5**
03	Concentration present in Gopalpur Bazar Location Coordinate: N24⁰48'25.2"; E90⁰26'33.92"	**10.9**	**49.9**	**101.8**	**7.6**	**8.6**	**0.004**	**8.5**

Source: AECL Lab

$PM_{2.5}$ - Fine Particulate Matter (EAD<2.5µm)
PM_{10} - Particulate Matter (EAD<10µm)
SO_2 - Sulfurdioxide
NO_X- Oxides of Nitrogen
EAD- Effective Aerodynamic Diameter

Though the PM concentration in the CAMS data (Gazipur) was found above the NAAQS but the field data show that the concentrations of $PM_{2.5}$, PM_{10}, NO_x and SO_2 are within the limit compared to the NAAQS. For the gaseous pollutants, the levels obtained are also within NAAQS. As a matter of fact, Gazipur is densely populated industrial area as a result the PM concentrations were high but Mymensingh is still rural in nature and not much industrial activities that could contribute air pollution. An air shed where NAAQS annual average values of pollutants in consideration are within the limit is referred to as a non-degraded air shed. So, as per the Environmental, Health & Safety guidelines (for Thermal power plant) of IFC/WB 2008, the fuel quality standard for non-degraded air shed would be applicable in the present

case. This would mean that for the plant (i.e. with power level > 50 MW), the sulfur level in HSD has to be lower than 2% or there should be some mechanism in the plant to reduce the emission to this equivalent concentration if fuel with higher level sulfur is to be used. The plant will use HRSG and as a result, there will be significant reduction in NOx and SO_2.

4.7 Noise Level

The most sophisticated machineries will be installed in Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant**,** which will produce little significant noise. It is suggested that the proponent should create a green belt around the project site, administrative building and other services buildings, which would reduce the noise level significantly. The ambient noise level data were collected from different sides of the project by noise level meter and they are given below in **Table 4.9**.

Table 4.9: Ambient Noise Quality Analysis (6/11/2017,11.40 AM)

SN.	Site Location	Concentrations present (LA_{eq}) dBA.
1	Main gate of the existing power plant	74.3
2	A market near to the existing plant around 200m	75.4
3	East side of the existing power plant	74.8
4	North side of the existing power plant	73.8
5	South side of the existing power plant	74.2
6	Proposed power plant	72.5
DoE (Bangladesh) Standard for Industrial area		**75**
IFC/International Standard for Industrial/Commercial Zone		***70***

Source: AECL Lab (sample collected on 6th November, 2017 and reporting on 7th November, 2017)

All units are in (LA_{eq}) dBA

4.8 Soils

Most of the area of Bangladesh is a vast, low-lying alluvial plain, sloping gently to the south and southeast. According to Bangladesh Agricultural research council's Agro-Ecological Zoning map of Bangladesh, the proposed project area falls in the Old Brahmaputra - Yamuna Floodplain. This region comprises of 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 basins. This area is occupied by permeable silt loam to silty clay loam soils on the ridges and impermeable clays in the basins which are neutral to slightly acidic in reaction. General

soil types include predominantly Grey Floodplain soils. Organic matter content is low in ridges and moderate in basins. The physiographic and Agroecological map of Bangladesh is shown in **Figure 4.10** & **Figure 4.11**. Within this area, elevations are less than 5m above sea level, which is shown in **Figure 4.12**.

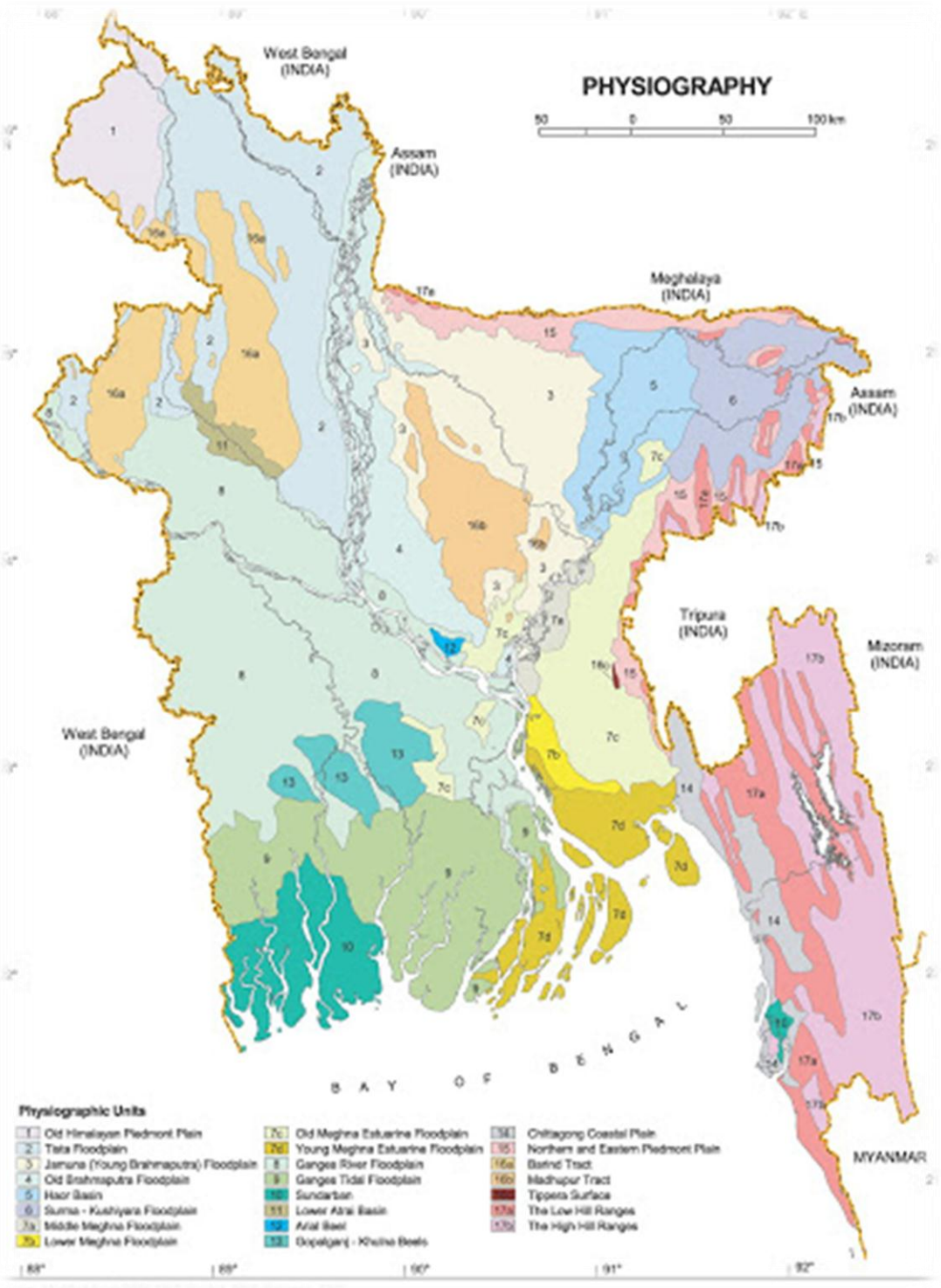


Figure 4.10: Physiographic Map of Bangladesh (Source: banglapedia.org)

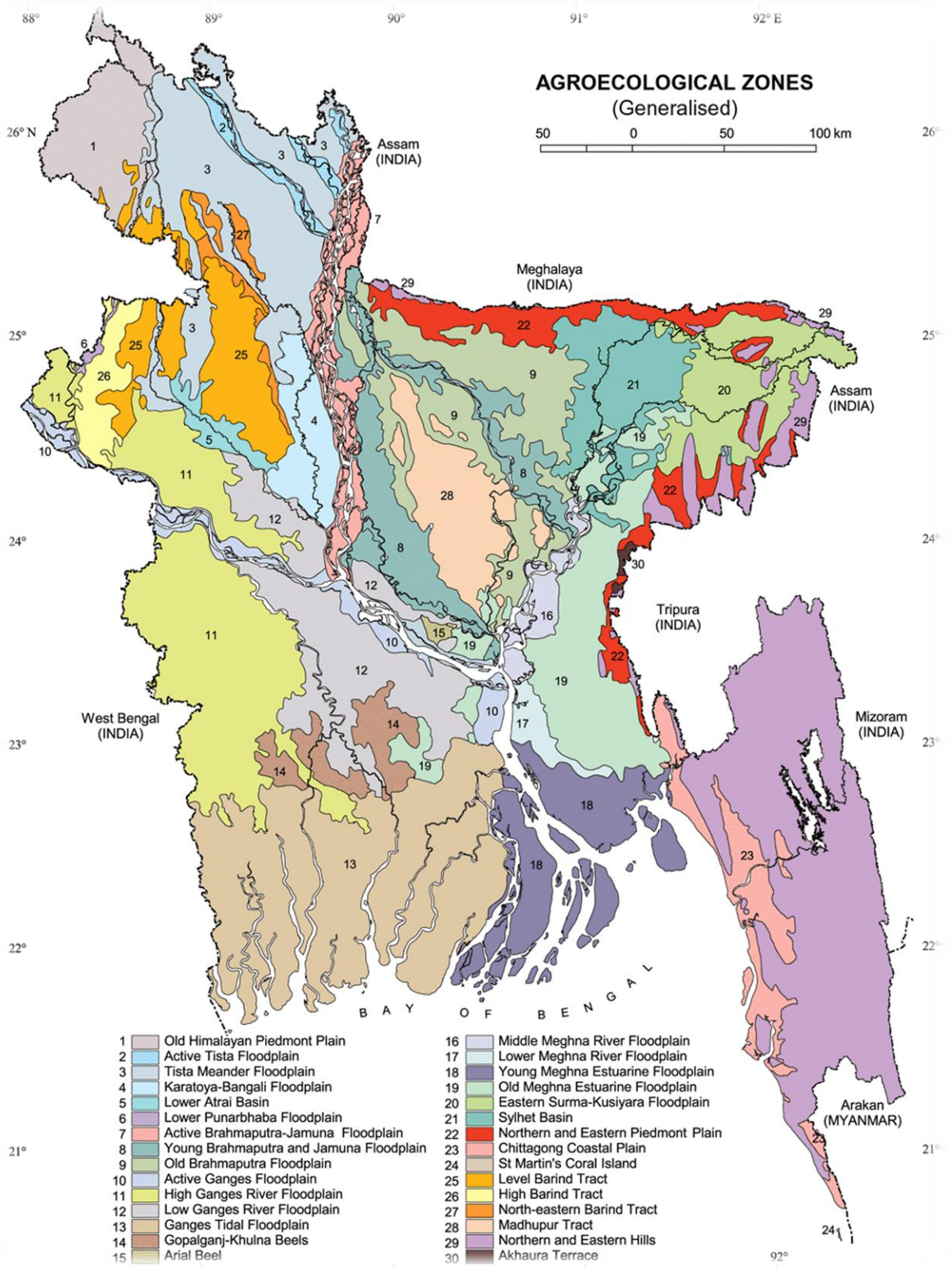


Figure 4.11: Agroecological Map of Bangladesh (Source: banglapedia.org)

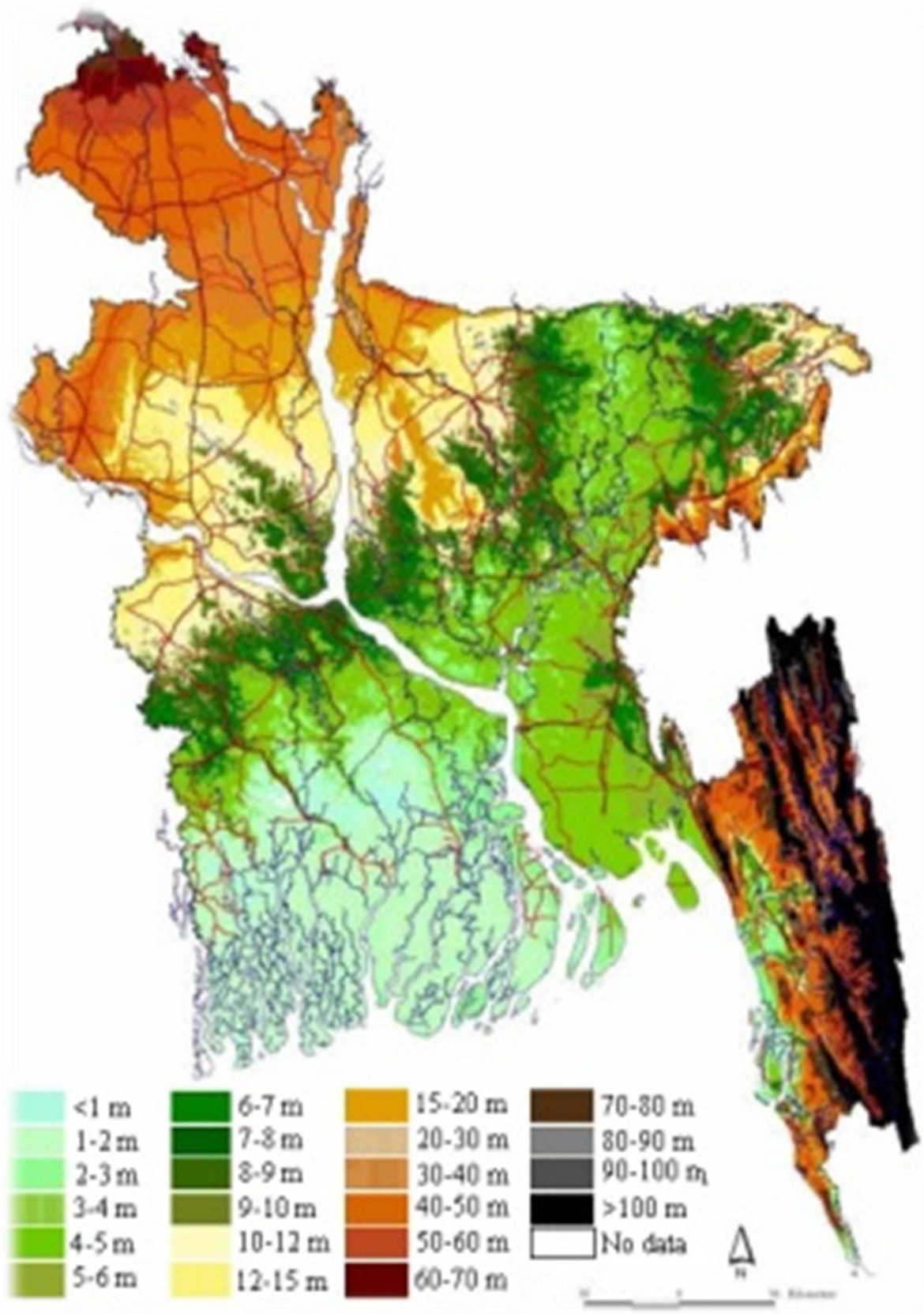


Figure 4.12: Topographic map of Bangladesh

4.9 Seismicity

Bangladesh, a densely populated country in South Asia, is located in the north-eastern part of the Indian sub-continent at the head of the Bay of Bengal. Tectonically, Bangladesh lies in the north-eastern Indian plate near the edge of the Indian craton and at the junction of three tectonic plates – the Indian plate, the Eurasian plate and the Burmese micro plate. These form two boundaries where plates converge– the India-Eurasia plate boundary to the north forming the Himalaya Arc and the India-Burma plate boundary to the east forming the Burma Arc (**Fig. 4.13**). Active faults of regional scale capable of generating moderate to great earthquakes are present in and around Bangladesh. These include the Dauki fault, about 300 km long trending east-west and located along the southern edge of Shillong Plateau (Meghalaya- Bangladesh border), the 150-km long Madhupur fault trending north-south situated between Madhupur Tract and Jamuna flood plain, Assam-Sylhet fault, about 300 km long trending north east southwest located in the southern Surma basin and the Chittagong-Myanmar plate boundary fault, about 800 km long runs parallel to Chittagong-Myanmar coast (**Fig. 4.14**).

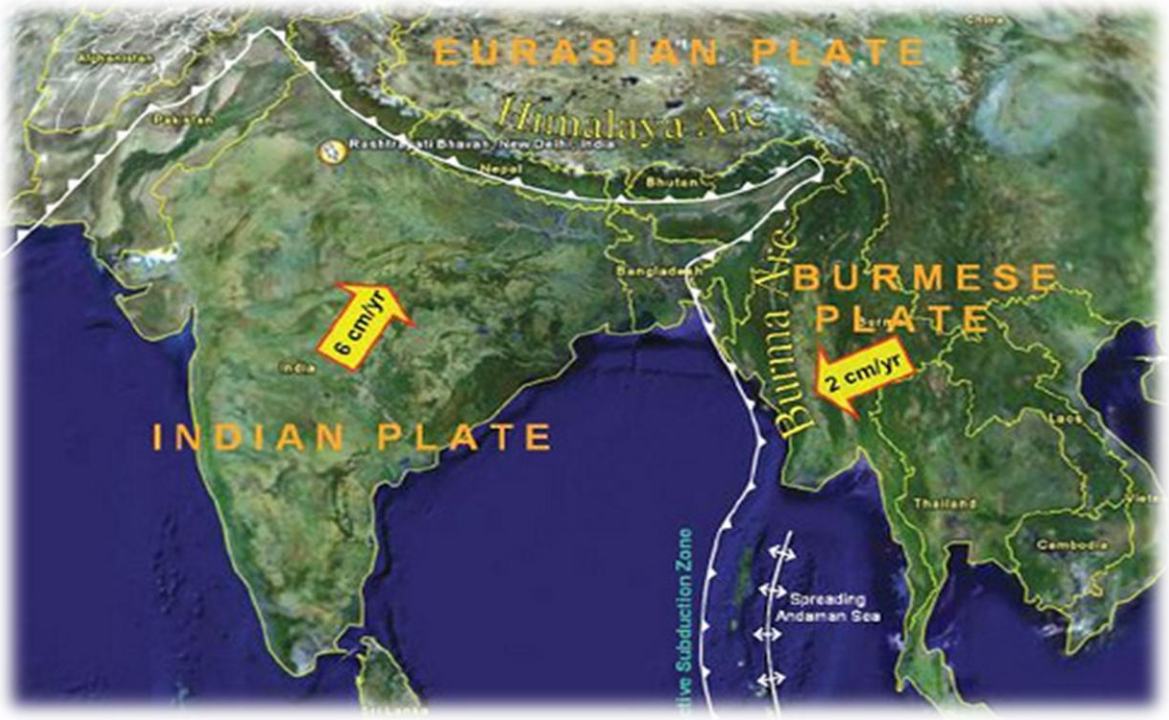


Figure 4.13: Regional tectonic setup of Bangladesh with respect to plate configuration

The Chittagong- Myanmar plate boundary continues south to Sumatra where it ruptured in the disastrous 26 December 2004, 9.3 earthquake (Steckler et al. 2008). These faults are the surface expression of fault systems that underlie the northern and eastern parts of Bangladesh. Another tectonic element, the 'Himalayan Arc' is characterized by three well defined fault systems (HFT, MBT and MCT) that are 2500 km long stretching from northwest

syntaxial bend in Pakistan in the west to northeast syntaxial bend in Assam in the east. It poses a great threat to Bangladesh as significant damaging historical earthquakes have occurred in this seismic belt (Bilham et al., 2001; Mukhopadhyay et al., 2004 and Mullick et al., 2009). The tectonic set-up and the plate motions together place Bangladesh potentially vulnerable to earthquake.

Mymensingh is situated in the central part of the country on the bank of the Old Brahmaputra River and at the southern tip of the Madhupur Tract dating back to the Pleistocene age. The Madhupur Tract is an area of recent uplift within the delta and the surface of the tract is in general higher on the west, sloping very gently eastward to disappear beneath younger sediments (Fergusson, 1863; Morgan and McIntire, 1956). Mymensingh is surrounded by the old Brahmaputra floodplain in the north and east, by the Ganges-Meghna flood plain in the south and by the Jamuna flood plain in the west. Mymensingh is slightly elevated above the surrounding floodplains and represents mostly flat land with minor undulations. Topographically Mymensingh is of low relief with many low depressions. According to Alam (1988), the Madhupur Tract is structurally controlled. The Pleistocene sediments of Madhupur Tract have been affected by numerous episodes of faulting. These faults are probably the branch out surface faults from the low dipping western extension of Burma Arc detachment fault. Mymensingh lies within 50 to 500 km distances from the seism genic faults and sits on the Burma Arc detachment fault.

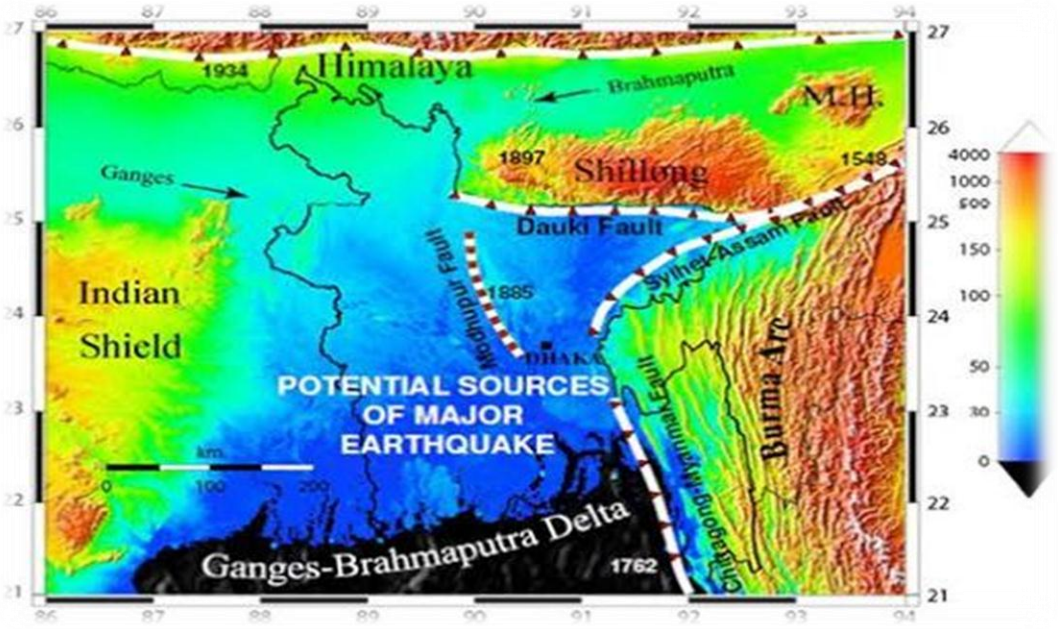


Figure 4.14: Digital Elevation Model (DEM) of Bangladesh and surroundings showing geological faults – potential sources of major earthquakes in Bangladesh.

On the basis of distribution of earthquake epicentres and morphotectonic behaviour of different

tectonic blocks Bangladesh has been divided into Four generalized seismic zones (**Figure 4.16**). Zone-II & Zone-III comprising the central part of Bangladesh represents the regions of recent uplifted Pleistocene blocks of the Barind and Madhupur Tracts, and the western extension of the folded belt. The zone II consists of the regions of recent uplifted Pleistocene blocks of the Barind and Madhupur and the western extension of the folded belt and the Bask coefficient for this zone is 0.20. Mymensingh area within the middle of Dhaka and Sylhet falls in seismic zone II & III of the seismic zoning map of Bangladesh. **Figure 4.15** shows the Tectonic Framework of Bangladesh.

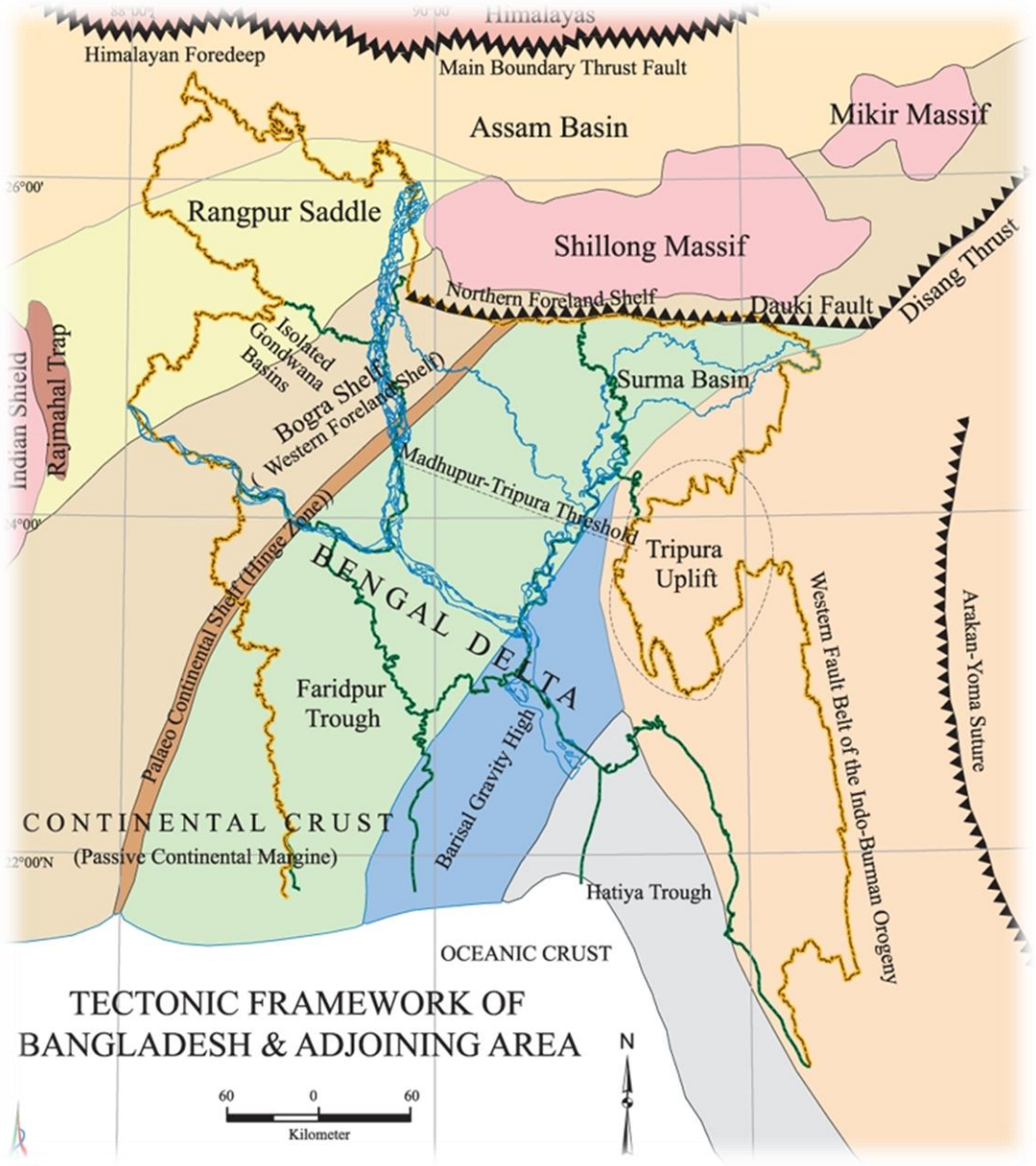


Figure 4.15: Tectonic Framework of Bangladesh (Source: banglapedia.org)

Figure 4.16: Earthquake Zoning Map of Bangladesh

Table 4.10: Seismic Zonation of Bangladesh

Zoning	Area Mercalli Scale	Co-efficient
I	Khulna and Barisal division including Chapai-nobabgong and Rajshahi district.	0.12
II	Dhaka, Bagura, Noakhali, Comilla, Dinajpur, Thakurgaon, Ponchogor and Sundorban.	0.20
III	Chittagong Zone, Norsindhi, Gazipur, Tangail, Gaibandha, Rangpur, Kurigram and Lalmonirhat.	0.28
IV	Sylhet division, Maymansingh, Serpur, Netrokona, Jamalpur.	0.36

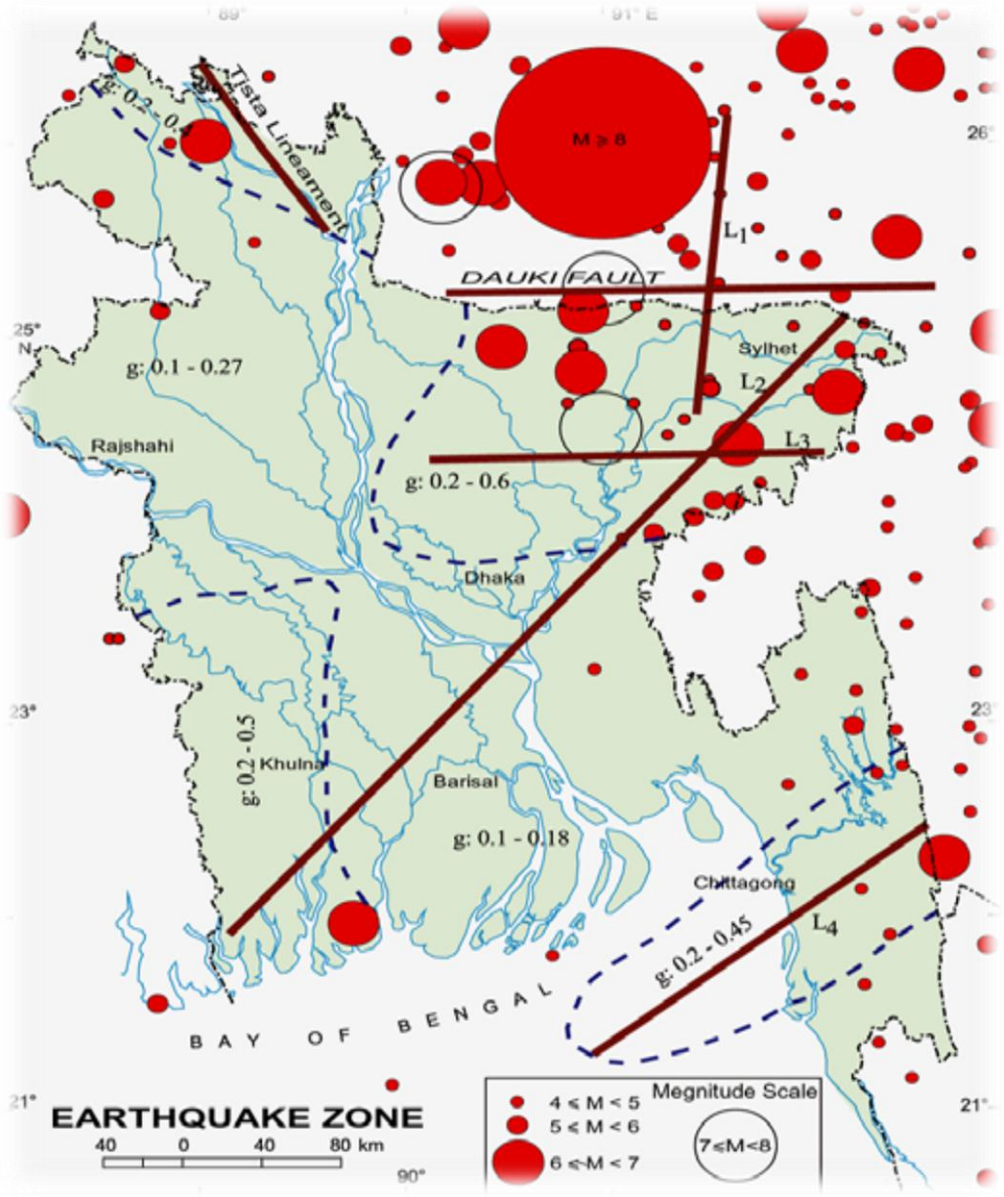


Figure 4.17: Seismic Activity of Bangladesh

Table 4.11: Major earthquake affect in Bangladesh

1548 Earthquake – Assam
The first known earthquake in Bangladesh was a "terrible one" and destroyed both Sylhet and Chittagong in 1548 (Rizvi, 1970; Iyengar, et al., 1999; Banglapedia, 2003), The details of the earthquake and the damage are not available but it opened numerous ground fissures and caused liquefaction in Assam, Sylhet, Tripura and in the Meghna floodplains. It is assumed from the descriptions in the reports that the 1548 earthquake epicenter was somewhere in Assam or Nagaland. Though no reports were made on the effects of this earthquake in Chittagong, it can nevertheless be well imagined that the intensity was V to VI in Chittagong.
1642 Earthquake – Assam
This earthquake was more severe than the 1548 earthquake (Rizvi, 1970). It probably occurred in the Assam-Sylhet region, but might have shaken Chittagong with moderate intensity.
1762 Earthquake – Chittagong
The earthquake of 1762 was very destructive and violent. It was felt all over Bengal and Arakan and it originated somewhere along the Chittagong-Myanmar coast on 2 April. It damaged vast areas of Chittagong, Chittagong and Myanmar (Oldham, 1883: Rizvi, 1969: Martin and Szeliga, 2010). Rizvi (1969) writes: "The earthquake on April 2, 1762 proved very violent at Chittagong and along the eastern bank of Meghna as far as Chittagong. At Chittagong, the rivers and jhils were agitated, and raised high above their usual levels, leaving, when they receded, their banks were strewn with dead fish. The shocks were accompanied by subterranean hollow noises and were so severe that a number of houses were thrown down by which 500 persons, it is said, lost their lives". Based on the degree of damage of the ground surface, its aerial extent and comparing with the 2004 Sumatra earthquake, the magnitude of the 1762 earthquake was 8.5+ on the Richter scale. The intensity of this earthquake in Chittagong was MM VI.
1775 Earthquake
Very little is known about this earthquake. This earthquake was severe in Chittagong with no loss of life (Rizvi, 1969, Banglapedia, 2003).
1787 Earthquake – Sirajganj
The earthquake of 1787 changed the course of the rivers and the ground shaking at the

epicentral region was probably MM X. No report was available of the effect of this earthquake in Chittagong. However, from the level of physiographic changes at Sirajganj and Chittagong being 100 km away to the southeast, it may be said that the ground shaking intensity in Chittagong was MM VI to VII.

1812 Earthquake – Chittagong

In 1812 two earthquakes visited Chittagong—on 10April and 11 May. The epicenters of these earthquakes are unknown, but might have been close to Chittagong. The earthquakes jolted Chittagong violently and damaged a number of houses and several buildings at Tejgoan (Rizvi, 1969). The degree of ground shaking had a MM intensity of VIII.

1822 Earthquake – Kishoreganj

An earthquake of magnitude 7.1 on the Richter scale jolted Chittagong and other parts of Bangladesh on 3 April 1822 at approximately 10:30 local time with severe damage reports coming in from Mymensingh (Martin and Szeliga, 2010). The epicenter of the earthquake was located about 70 km northeast of Chittagong near Kishoreganj. The tremor was followed by three minor aftershocks. The ground shaking in Chittagong was believed to be VI on MM intensity scale.

1842 Earthquake – Rajshahi

A major earthquake occurred on 11 November 1842 with magnitude Mw 7.3 shook most of Bangladesh, including Chittagong (Martin and Szeliga, 2010). The maximum damage was reported from Pabna. The epicenter of the earthquake was located 190 km west-northwest of Chittagong near Rajshahi. The intensity of ground shaking in Chittagong was MM V.

1845 Earthquake – Sirajganj

Chittagong experienced three strong earthquakes on 23 July, 26 July and 6 August 1845. All three tremors were felt strongly in Bengal and lower Assam (Martin and Szeliga, 2010). The first quake occurred at approximately 4:30 am local time on 23 July and had a magnitude of 5.9. This was followed by a second tremor at approximately 2:00 am local time on 26 July that had a magnitude of 6.1. The third one was the strongest (Mw 7.1) and it occurred on 6 August at approximately 11:30 pm local time. The epicenters of the first two were centered on Sirajganj about 100 km northwest of Chittagong. The third quake was 265 km north of Chittagong located in lower Assam. No damaged at Chittagong was reported from these earthquakes. The ground shaking intensity at Chittagong was MM V to VI.

1846 Earthquake – Mymensingh

A strong earthquake was felt in Mymensingh on 18 October 1846 at 2:00 pm local time. The earthquake was preceded by three foreshocks on 16 October (11:10 am) and 17 October (6:10 am, 11:20 am). Buildings were destroyed in Muktagacha and Sherpur while in Mymensingh many structures, including the mosque, the church and many government buildings were damaged. Several prisoners were injured by falling debris at the jail in Mymensingh (Martin and Szeliga, 2010). The epicenter of the tremor was located 150 km north of Mymensingh near Phulpur of Mymensingh. The earthquake had a magnitude of 6.2 on the Richter scale. Though no reports of damage were available for Mymensingh, it shook the city with MM intensity VI.

1865 Earthquake – Chittagong

Chittagong was strongly jolted and plaster was reported to be dislodged from buildings from the earthquake of 1865 that occurred on 14 December at approximately at 6:45 pm local time (Martin and Szeliga, 2010). Reports of damage published in the print media (Bengal Hurkaru, 1865, December 18- December 22; Englishman, 1865, December 16- January 4) suggest the epicenter was probably in Chittagong. Several aftershocks were felt until 18 December. Another earthquake, triggered in north Bengal on 19 December at approximately 9:30 pm local time, also shook Chittagong severely. An eyewitness in Chittagong noted, “It nearly threw us off our editorial chair” (Englishman, 1865, December 16- January 4). The MM intensity for both the earthquakes was believed to be VI to VII.

1885 Earthquake – Bengal

This earthquake, known as the Bengal Earthquake, occurred on 14 July 1885, and is one of the most seven earthquakes. The earthquake was followed by eleven aftershocks during the period 21 July to 5 September 1885 (Middlemiss, 1885). Though no exact figures for the casualties in Chittagong caused by this earthquake are available, it was truly one of the major earthquakes in Bangladesh. The quake hit at 6:25 am local time and was centered just 50 km northwest of Chittagong near Manikganj. It is believed to have occurred on the Madhupur fault. The earthquake had a magnitude 7 on the Richter scale. Middlemiss (1885) notes, “Taking its rise in Bengal, this earthquake of the 14th July was felt with violence throughout the province. It extended westwards into Chota Nagpur and Behar, northwards into Sikkim and Bhutan, and eastwards into Assam, Manipur and Myanmar. The area over which it was sensibly felt may be roughly laid down as 2,30,400 square miles. An irregular ellipse drawn through Daltongunge (in Palamow), Durbhanga (in Behar), Darjeeling, Sibsagar, Manipur and Chittagong will give the external boundary of that area. Within this, again, another irregular figure may be drawn through Calcutta, Sitarampur, Monghir, Purnea, Siligori, the Garo hills, Chattack and Barisal, which will enclose an area over which the shock was felt with such considerable violence as to shake loose objects, rattle windows, and produce small cracks in double-storied houses. Finally, we have another figure within this bounded by

Rampur, Bogra, Sherpur (Mymensingh district), Mymensing, Chittagong and Pabna, where destruction to buildings is greatest and loss of life occurred".

1897 Earthquake – Great Indian

This earthquake is known as the Great Indian Earthquake and was triggered on 12 June 1897 at 17:11 BST. It is one of the most powerful and destructive earthquakes in recorded history. The quake was located in the western part of the Shillong Plateau about 200 km north of Chittagong. It probably originated from the reactivation of Dauki fault, (Szeliga et al., 2010), although Bilham and England (2001) place it on the Oldham fault on the north side of the Shillong Plateau. The magnitude is estimated from its surface effects and their spatial distribution suggests it was 8.7 on the Richter scale. The shock was preceded by a rumbling underground noise which lasted for about 3 minutes (Johnson, 1988). The actual earthquake lasted about two and a half minutes in Shillong. This noise was compared with the tremendous rumbling noise like a thousand ships' engines thumping away in the midst of a storm at sea. The shocks were so severe and prolonged that most buildings were leveled to the ground (Moore, 1910). The earthquake left an area of 3,90,000 sq.km. in ruins and was felt over 6,50,000 sq.km. From the Myanmar to Delhi. Alarge number of ground fissures and vents were observed. The epicentral area, including parts of Bangladesh, witnessed many secondary effects like ejection of water and sand, rotation of pillars, rise in river height, and liquefaction of soils and sinking of houses. Hundreds of aftershocks—some very heavy and some light—were felt in Chittagong over a period of two months. At Bordwar tea estate, a week after the great shock, the surface of a glass of water standing on a table was in a constant state of tremor.At Tura, a hanging lamp was kept constantly on the swing for three days. At least 1,626 people were killed. Extensive damage from shaking and liquefaction occurred in Assam, Meghalay and Bangladesh (Oldham, 1899; Ambraseys and Bilham, 2003). The great earthquake of 1897 did much damage in Chittagong city, but luckily it caused comparatively little loss of life. Ground fissures and sand veins were also occurred at many places in the city. The earthquake intensity at Chittagong was VIII+ on MM scale. Shaheen Medical Hall, a temple known as Nazir's Math, Shahbagh, and the house occupied by Mrs. Stansbury – all collapsed and five persons were killed, including two foreigners, beneath the ruins, while nine other houses, including the residences of the Commissioner, the Collector, the Judge, and the Civil Surgeon, were rendered uninhabitable. The amount of damage to buildings published in the print media was different from the government statement.

1918 Earthquake – Srimangal

Often referred to as the Srimangal earthquake, this massive quake was centred 70 km southeast of Mymensingh and 100 km northeast of Chittagong near Kishorganj. It was preceded by a series of light to moderate foreshocks. The earthquake occurred at 4:22:07

pm local time and had a magnitude 7.6 on the Richter scale. Its depth of focus was 14 km. The earthquake was strongly felt throughout Bangladesh and the degree of ground shaking in Chittagong was MM VII. The earthquake caused considerable damage to buildings in Chittagong.

1923 Earthquake – Meghalaya

A major earthquake with magnitude Ms 7.1 occurred on 9 September 1923 at 22:33:42 BST. The epicenter was located 180 km north-northeast of Chittagong in southern Meghalaya near the Bangladesh-India border. The earthquake causes heavy damage at Mymensingh and was felt all over Bangladesh with aMM intensity VI at Chittagong.At least 50 people were killed in the Mymensingh district in northern Bangladesh. Damage occurred in Mymensingh and to a lesser extent at Agartala, Guwahati and Kolkata.

1930 Earthquake – Dubri

This earthquake is known as the Dubri earthquake. It was triggered on the early morning of 2 July 1930 at 03:53:34.4 BST with aftershocks of magnitude 6. The epicenter was located 230 km north of Chittagong in northwestern Shillong Plateau near Dabigiri, Meghalaya. The earthquake was felt widely in Bangladesh with MM intensity V+ at Chittagong.

1934 Earthquake – Bihar-Nepal

This is a well-known Bihar-Nepal earthquake that occurred on 15 January 1934 at 14:43:25 BST and caused widespread damage in Bihar and Nepal. At least 8,519 people were killed in Nepal (Pandey and Molnar, 1988) and 7,253 deaths were reported in adjoining parts of India (Dunn et al., 1939). The epicenter was in eastern Nepal close to Bihar-Nepal border and had magnitude 8.4 on the Richter scale. The epicentral distance was 500 km northwest of Chittagong. The tremor was felt all over Bangladesh with MM intensity VI in Chittagong.

1943 Earthquake – Assam

This earthquake occurred on 10 October 1943 at 23:23:17 BST. A major earthquake shook northeast India and had a magnitude of 7.2 on the Richter scale. The epicenter was centred in Hojai, Assam, 365 km northeast of Chittagong. Little is known about this tremor as it occurred during World War II when the threat of Japanese aggression on the eastern border of British India was extremely high. It was widely felt in Bangladesh and northeastern India. Also moderately felt in Nepal, southern Tibet and in parts of Myanmar (Ambraseys and Douglas, 2004). The felt intensity at Chittagong was believed to be MM V to VI.

1950 Earthquake – Assam

This tremor is often referred to as the 1950Assam Earthquake and was the sixth largest earthquake of the 20th century. It had a magnitude of 8.4 on the Richter scale and struck a relatively sparsely populated region in Arunachal Pradesh near the Indo- Chinese border. The epicentral distance from Chittagong was 800 km northeast. The earthquake triggered on 15 August 1950 at 20:09:28.5 BST and felt all over Bangladesh with MM intensity IV at Chittagong. Water bodies in Chittagong remained in a state of agitation for an hour due to the effect of long period seismic waves from this distant earthquake.

1954 Earthquake – Monipur-Myanmar Border

Chittagong experienced shock from a major earthquake that occurred on 22 March 1954 at 00:12:17 BST. The epicenter of the tremor was centered in northern Myanmar near Monipur-Myanmar border, 480 km east-northeast of Chittagong. The earthquake had a magnitude estimated Ms 7.7. It was felt widely in Bangladesh with MM intensity V in Chittagong. Many city dwellers awoke and ran out in panic. No damages were reported but seismic seiches were observed in water bodies at Chittagong.

1977 Earthquake – Bangladesh-Myanmar Border

A moderate earthquake occurred on 12May 1977 at 18:20:00 BST with magnitude of 5.7 on the Richter scale that jolted Chittagong with MM intensity III. The epicenter of the quake was located 340 km southeast of Chittagong near Bangladesh-Myanmar border with focal depth of 40 km. It was strongly felt at Bandarban where people attending a political rally rushed outdoors in panic. Many buildings in Chittagong developed cracks and numerous people were injured, some after jumping from buildings.

1988 Earthquake – Bihar-Nepal

Many people in Chittagong were awakened in the early hours of 21 August 1988 at 05:09:09.56 BST by the shaking of high rise buildings from a strong earthquake. This earthquake occurred in eastern Nepal bordering Bihar, about 510 km northwest of Chittagong. The earthquake had a magnitude of 7.8 with focal depth of 57 km that killed 998 people and caused severe damage to buildings in Nepal and Bihar. The tremor was felt in most parts of Bangladesh. Seismic seiches were also observed in many water bodies that capsized numerous boats including a ferry on the Jamuna River killing two people and leaving nearly thirty missing (Bangladesh Observer, August 22, 1988). The felt intensity at Chittagong was MMV.

2001 Earthquake – Chittagong

The residents of Chittagong city experienced two consecutive shocks in a second. The first

shock was due to the arrival of P-wave followed by the arrival of S-wave as second shock. This was an earthquake triggered at the southern periphery of the city. The earthquake occurred on 19 December 2001 at 1:54:07.96 pm local time. The epicenter was centred 11 km south of Curzon Hall across the Burigonga River at Kalakandi. The earthquake had magnitude estimated 4.5 on the Richter scale and had hypocentral depth of about 10 km. The duration of shaking was 21 seconds. The earthquake was felt at Chittagong, Munshiganj, Chittagong, Comilla, Gazipur, Laxmipur, Rajshahi and as far as Rangpur. Strong tremors were felt (MM V-VI) in Chittagong city, and many people rushed out of their homes and offices in panic.

2003 Earthquake – Borkol

Known as the Borkol earthquake, occurred in the early morning of 27 July 2003 at 5:18:17.96 am local time. This quake killed three people, injured 25 people and damaged about 500 buildings in Chittagong and the Chittagong Hill Tracts. Power supply to some areas was cut as a transformer exploded at the Modunaghat Grid Sub-station in Hathazari, Chittagong. The epicenter was situated 217 km southeast of Chittagong at the eastern bank of Kaptai reservoir. It had a magnitude measured Mw 5.7. Chittagong shook with MM intensity IV. Many people were awakened, especially residents of upper floors of high rise buildings.

2004 Earthquake – Sumatra

Known as the Sumatra earthquake that initiated on the morning of 26 December 2004 at 06:58:53 BST off the west coast of north Sumatra. It had a magnitude measured Mw 9.3 with focal depth of 30 km. It was one of the deadliest natural disasters in recorded history, having generated devastating tsunamis that struck along the coasts of most landmasses bordering the Indian Ocean, killed about 2,30,000 people in fourteen countries including 2 people in coastal Bangladesh. The epicentral distance was 2,350 km south of Chittagong, but the rupture propagated northward for 1,200 km reaching much closer to Bangladesh. The tremor was felt all over Bangladesh.

2008 Earthquake – Manikganj

A minor earthquake jolted Chittagong and surroundings on the evening of 20 March 2008 at 7:15:51.35 pm local time and created considerable panic among the city dwellers. The earthquake had a magnitude measured 3.8 on the Richter scale with focal depth of 35 km (NEIC, DUEO). The epicenter was situated in Manikganj 41 km west-northwest of DUEO. It was believed to be originated from the Madhupur fault. The Bengal Earthquake of 1885 had also occurred in the same region.

2008 Earthquake – Mymensingh

Known as Mymensingh earthquake, this temblor occurred in the middle of the night of 27 July 2008. The epicenter was located 12 km northeast of Mymensingh city and 120 km north of Chittagong. It had a magnitude estimated 5.1 on the Richter scale and a focal depth of 17 km (NEIC). Apart from Mymensingh where the earthquake caused panic, tremors from this earthquake were felt in many parts of the Chittagong. The ground shaking was MM V at Chittagong.

2008 Earthquake – Chandpur

A light earthquake with couple of aftershocks jolted Chittagong on the evening of 20 September 2008 just before Iftar. It caused tremendous panic among the city dwellers. The epicenter was 50 km southeast of Chittagong near Kachua of Chandpur. The magnitude was 4.5 on the Richter scale with a focal depth of 10 km (NEIC, DUEO). The tremor was strongly felt in Chittagong with MM intensity V.

2009 Earthquake – Bhutan

Known as eastern Bhutan earthquake. A strong earthquake occurred on the day of Eid-ul-Fitr, 21 September 2009 at 14:53:06 BST. The epicenter was situated in eastern Bhutan, 410 km northeast of Chittagong. It originated from the Main Central Thrust (MCT). This distant quake had a magnitude Mw 6.1, but shook most of Bangladesh including Chittagong while people were celebrating Eid-ul-Fitr. The ground shaking at Chittagong was MM V. People at upper floors of high rise buildings were panicked; some came out of their houses and offices in fear. Small and light objects fell down.

2009 Earthquake – Bay of Bengal

The residents of Chittagong woke up at midnight of 10 August 2009 and many ran out of their houses in fear. A major earthquake that occurred on early 11 August 2009 at 01:55:35.61 BST rocked Bangladesh. The epicenter was located in Bay of Bengal between north Andaman Island and Myanmar coast, 1100 km south southeast of Chittagong. The earthquake was originated from a 300 km long seismic gap of active subduction zone of Indian and Burmese plates between the locations of the 2004 Sumatra and 1762 Chittagong earthquakes. It had a magnitude Mw 7.5 with focal depth of 4 km (NEIC). The quake was strongly felt in most parts of Bangladesh including Chittagong. Residents of upper floors in high rise buildings woke up. Many people panicked and ran out of their houses for safety (The New Nation, 12August 2009; The Independent, 12 August 2009). A tsunami warning was issued for Bangladesh coast but withdrawn after few hours (The Independent, 12 August 2009). However, no casualty or damage was reported. The intensity of ground shaking at Chittagong was MM V.

2010 The Tremon

Occurred on 10 September night at 11:30 pm local time. The tremor was felt in Dhaka and its surrounding areas with magnitude 4.8. The epicenter was 45 km southwest from Dhaka.
2011 The Tremon
Occurred on 6:30 pm local time with magnitude 6.8. It lasted for 2 minutes. The tremor felt was strong enough in Capital city Dhaka and the districts of northern part of Bangladesh the epicenter was 500 norths from Dhaka in Indian Sikkims's capital Gangtok.

4.10 Cyclonic Activity

Cyclone a tropical storm or atmospheric turbulence involving circular motion of winds, occurs in Bangladesh as a natural hazard. The tropics can be regarded as the region lying between 30'N latitude and 30'S latitude. All the tropical seas of the earth with the exception of the south Atlantic and southeast Pacific give birth to deadly atmospheric phenomena known as tropical cyclones. On an average, 80 tropical cyclones are formed every year all over the globe.

The term cyclone is derived from the Greek word 'kyklos' meaning coil of snakes. The British-Indian scientist and meteorologist henry piddington coined the word 'Cyclone' to represent whirling storms expressing sufficiently the tendency to circular motion in his book The Sailor's Horn-book for the Law of Storms, published in 1848. Other meteorologists of the world immediately accepted the term and it is still current today. Satellite pictures of cyclones show that the nomenclature is very appropriate. Technically a cyclone is an area of low pressure where strong winds blow around a center in an anticlockwise direction in the Northern Hemisphere and a clockwise direction in the Southern Hemisphere. Cyclones occurring in the tropical regions are called tropical cyclones and those occurring elsewhere are called extratropical cyclones.

Tropical cyclones are usually destructive and affect Bangladesh and its adjoining areas. Tropical storms are called hurricanes in the American continent, typhoons in the Far East and cyclones in the South Asian subcontinent. In the West, hurricanes are identified with human names such as Mitchel, Andrew, Carol, Dorothy and Eve. In the South Asian region, no such nomenclature is in use. The term 'cyclone' is at times applied to a mid-latitude depression but is now increasingly restricted to a tropical depression of the hurricane type, especially when it occurs in the Indian ocean. A cyclone is called Tufan in Bangla, from the Chinese 'Tai-fun'.

Bangladesh is part of the humid tropics, with the Himalayas on the north and the funnel-shaped coast touching the bay of Bengal on the south. This peculiar geography of Bangladesh brings not only the life-giving monsoons but also catastrophic cyclones, nor 'westers, tornadoes and floods. The Bay of Bengal is an ideal breeding ground for tropical cyclones. Cyclones are usually formed in the deep seas and hence their study has been very difficult. It is only with the advent of the Space age that weather satellites have provided valuable

information about them. Direct studies of cyclones with aircraft reconnaissance are also being carried out by advanced countries. However, only a beginning has been made in Bangladesh towards the understanding of cyclones.

Classification

Cyclones in Bangladesh are presently classified according to their intensity and the following nomenclature is in use: depression (winds up to 62 km/hr.), cyclonic storm (winds from 63 to 87 km/hr.), severe cyclonic storm (winds from 88 to 118 km/hr.) and severe cyclonic storm of hurricane intensity (winds above 118 km/hr.).

Cyclones in the Bay of Bengal

Because of the funnel shaped coast of the Bay of Bengal, Bangladesh very often becomes the landing ground of cyclones formed in the Bay of Bengal. The Bay cyclones also move towards the eastern coast of India, towards Myanmar and occasionally into Sri Lanka. But they cause the maximum damage when they come into Bangladesh, west bengal and Orissa of India. This is because of the low flat terrain, high density of population and poorly built houses. Most of the damage occur in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore islands of Bhola, Hatiya, Sandwip, Manpura, Kutubdia, Maheshkhali, Nijhum Dwip, Urir Char and other newly formed islands.

From 1981 to 1985, 174 severe cyclones (with wind speeds of more than 54 km/hr) formed in the Bay of Bengal. The month-wise occurrence is as follows: 1 in January, 1 in February, 1 in March, 9 in April, 32 in May, 6 in June, 8 in July, 4 in August, 14 in September, 31 in October, 47 in November and 20 in December. It is apparent from the above figures that severe cyclones occur mostly during pre-monsoon (April-May) and post-monsoon (September-December) periods and they are the ones which cause the most destruction. From the **Figure 4.18 & 4.19** we see that southern part of Bangladesh is affected by cyclone. Selected project site is upper part of the country, so this project is safe from cyclonic activity.

4.11 Riverbank Erosion

Riverbank Erosion is an endemic and recurrent natural hazard in Bangladesh. When rivers enter the mature stage (as in the case with the three mighty rivers, ganges, brahmaputra and meghna) they become sluggish and meander or braid. These oscillations cause massive riverbank erosion. Every year, millions of people are affected by erosion that destroys standing crops, farmland and homestead land. It is estimated that about 5% of the total floodplain of Bangladesh is directly affected by erosion. Some researchers have reported that bank erosion is taking place in about 94 out of 489 upazilas of the country. A few other researchers have identified 56 upazilas with incidence of erosion. At present, bank erosion and flood hazards in nearly 100 upazilas have become almost a regular feature. Of these, 35 are severely affected. In **Figure 4.20** we see main rivers like Padma, Jamuna, Meghna and Brahmaputra are highly causes erosion.

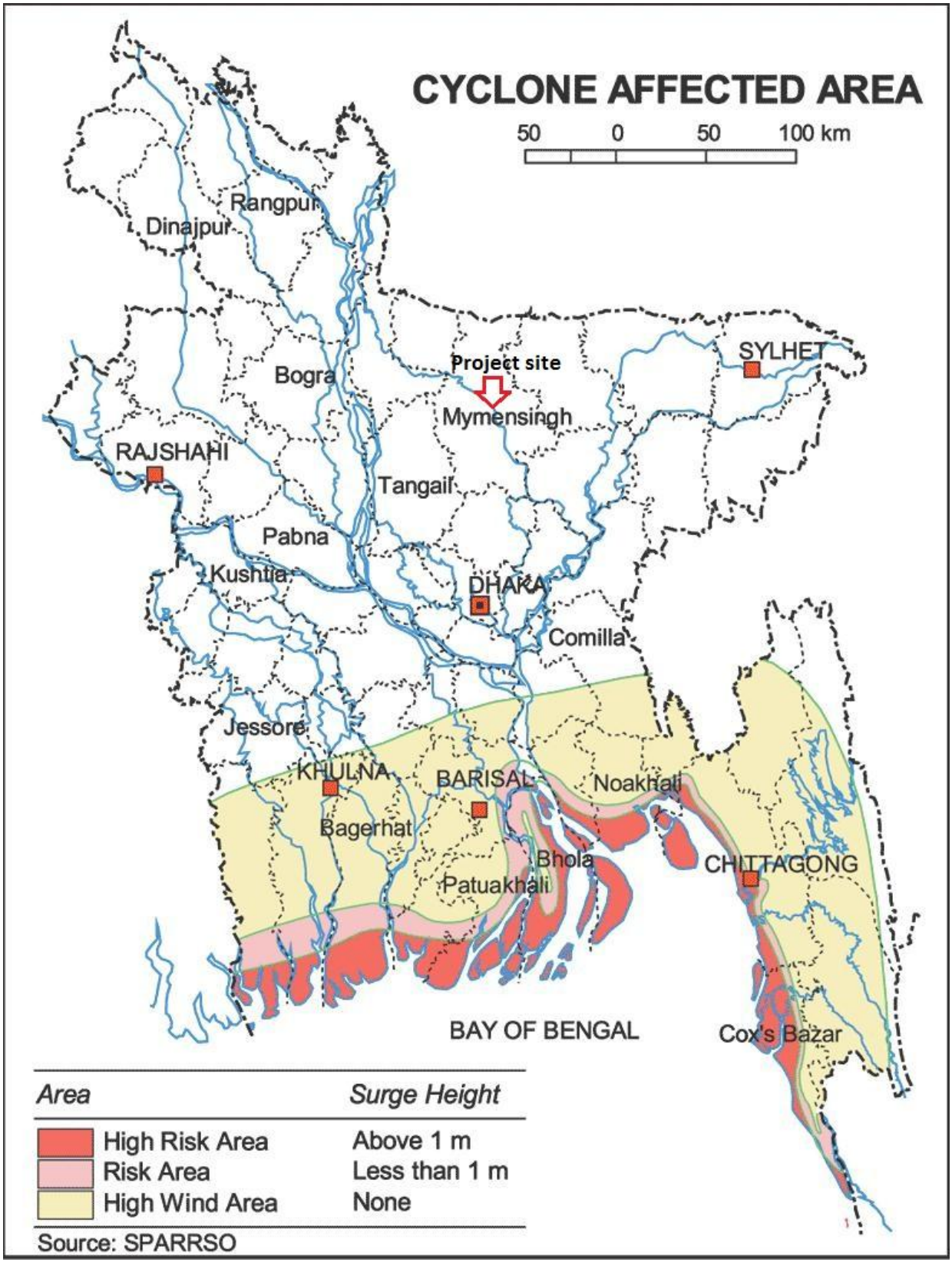


Figure 4.18: Cyclone affected area of Bangladesh (Source: banglapedia.org)

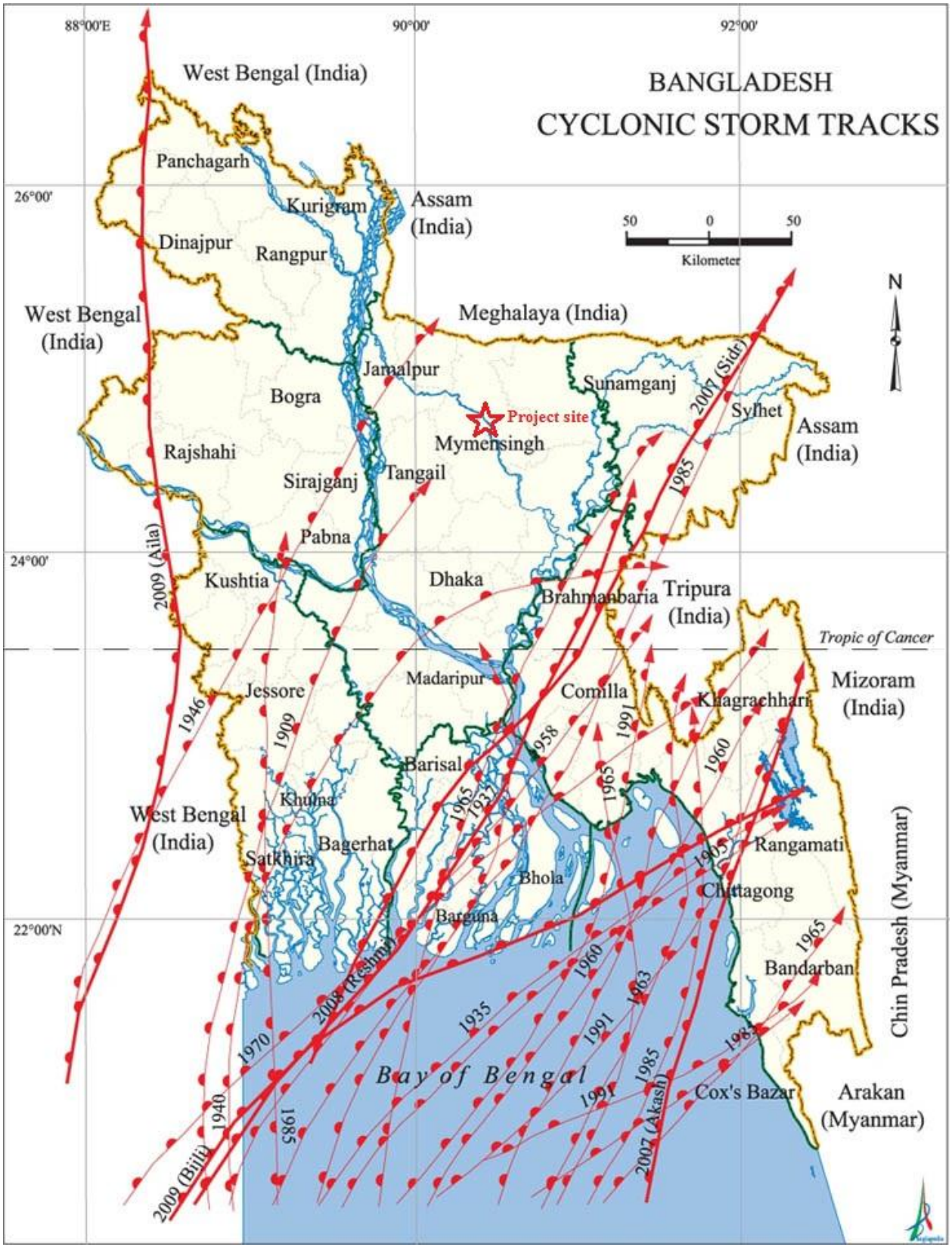


Figure 4.19: Cyclonic storm tracks of Bangladesh (Source: banglapedia.org)

Figure 4.20: Bangladesh river erosion prone areas (Source: banglapedia.org)

4.12 Biological Resources

Flora and Fauna

General Consideration

Forests, pasture lands, rivers, surface water and other water bodies, etc. are the most important natural ecosystems. They are the foundation on which conservation of biological diversity depends. Biological diversity, which refers to genetic variation as well as to the diversity of human populations and ecosystems, is a resource that belongs not only to regions and to nations but also to all of humankind. Although it is a renewable resource, it can be irreversibly destroyed. Future uses of this resource (medicine, plant breeding. etc.) cannot be foreseen at present, although they will certainly be extensive in scope, and they even are crucial to the survival of humankind.

It is extremely rare to encounter completely natural areas nowadays. On the other hand, both extensive and local use of natural flora and fauna can be regarded as normal occurrences in natural ecosystems. Although the transition from hunting and gathering to settle agriculture in established ago-ecological zones is complete almost everywhere, traditional forms of resource use continue to play an important role in the lives of rural populations. Current pressure due to increase production and extend the area of land under cultivation is leading to more intensive use of remaining predominantly natural areas. This results in environmental stress and rapid loss of biological diversity, as well as permanent conversion of land to agricultural use.

Opening up natural areas in order to exploit their resources with modern technology frequently leads to additional forms of resource use. For example, forests opened up to commercial forestry are more exposed to uncontrolled over exploitation, as well as being subjected to ecological stress by migrants who practice agriculture.

Both extensive resource use over large areas and selective, intensive use of every favorable site can severely damage an ecosystem. Small-scale operations preservation of remaining natural areas and resource use in harmony with nature are important if the resources of a region are to be managed in an ecologically appropriate manner. Proper monitoring is needed in order to obtain reliable information about significant changes in an ecosystem.

Every region needs areas set aside to preserve ecological balance (nature reserves, of natural vegetation, fallow land) in order to conserve its biological diversity. The form, extent and location of these areas must be carefully evaluated in each individual case.

Because many different products in predominantly natural areas are not traded in great volume and do not appear in statistics on trade, their immediate value to the local population is often underestimated. The use of such areas is often of great economic importance to the poorer segments of rural populations. Intense exploitation of such areas is therefore usually accompanied by corresponding social consequences and social costs, even when it appears

reasonable on economic grounds.

Many predominantly natural areas are of environmental and economic value beyond their own borders. Forests, for instance, guarantee safe and regular supplies of water because they protect headwaters. The protective function of forests is often recognized only after its neglect has produced negative consequences (deforestation that leads to erosion, landslides, sedimentation in reservoirs, floods).

Intensification of resource use in harmony with nature should be based primarily on indigenous knowledge and modes of production established in the local culture. There is a need to undertake scientific studies in this area since information based on such studies is presently lacking. Locally established responsibility for conservation of natural resources requires appropriate local rights of use. These rights must be regulated by grass-roots organizations.

Regarding the ecological setting of the area has been already mentioned, the area in mostly high and wet ecosystem with forest and other forms of greenery quite at abundance. There had been extensive field survey during the study to assess and also quantify to a certain extent the flora and fauna richness. These concentrated among others, on the wildlife (reptiles, amphibians, mammals and birds), separately on fishes and a floral species (Grass, shrubs, timber/fuel wood trees and fruit trees). Findings of the survey have been presented in **Table 4.12 to Table 4.14**, respectively in the following pages.

As this is obvious from the above-mentioned tables, the area is quite rich in flora and fauna. However, many of those are quite common for different other areas in Bangladesh. The already existing industries in the study area not just brought, some of the utility services, but have also provided with a different look of infrastructure setting in the area. This is still not something, which can be called aesthetically unacceptable or directly detrimental to the floral growth of the area. However, the industrial activities along with their discharges may prove quite detrimental to both flora and fauna in the area eventually, provided no appropriate corrective measures are taken.

Flora

The proposed project is in a rural setting with greenery. This includes homesteads, horticulture, roadside plantation, natural vegetation, and agricultural crops. Besides highland (elevated) afforestation and homesteads, the remaining area is mostly lowland and generally interconnected with certain manmade barriers and kacha roads here and there.

Due to roadside plantations and certain homestead forests, the area is rich with floral diversities. Different fruit, fuel wood trees along with various shrubs are abundant. Among the trees, the most widely available ones are Shilkoroi, fulkoroi, Mehagani, Shimul, etc. Also, there are some fruit trees such as Mango, Coconut, Jackfruit, Battle nut, guava etc.

Aquatic flora is divided into three major types - tree, shrub and herb. Aquatic floral species

grow in rivers, canals, ditches, seasonal wetland and low lying agricultural lands in submerged, free-floating, or rooted floating states. Common aquatic floral species in the study areas include Water hyacinth - Eichhorniacrassipes, Khudipana - Lemnaperpusilla, and Kalmi - Ipomoea aquatica.

Fauna

Fishes

Fish is still reasonably available in the area, given the overall and increasing scarcity of fish in the country. Small fishes, which are very popular also in overall Bangladesh, are available and caught and used widely, particularly during early monsoon and pre-winter season. Among reptiles, narrow headed soft-shell turtle deserves special mention. Among birds, Bok, Salik, Finge etc. deserve special mention.

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

Amphibians

Mostly Toads and frogs- two species are prominent.

Mammals

These include fruit bat, Squirrel, field and house mousses, and flying fox. No major mammal species of national significance are present in this area.

Birds

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

Table 4.12: Faunal Species in the project area.

Scientific Name	English Name	Local Name
Reptiles		
Enhudrisenhydris	Smooth Water Snake	PainnyaShap/ Huriya
Hemidactylus	House Lizard	GodaTikTiki
NajanajaKaouthia	Narrwo headed Softshell	
Chitraindicad	Turtee	ChitraKatchap
Amphibians		
Bafomelanostictus	Common Toad	Bang
RanaCyanophyctis	Skipper Frog	Bang

Mammals		
Callosciurus sp.	Squirrel	Kat Biral
Cynopterusspinex	Short nosed fruit Bat	Badur
Funumbaluspennanti	Squirrel	Kat Biral
Herpestes Auropuncatus	Mongoose	Bheji
Musbooduga	Field Mouse	Idur
Musmusculus	House Mouse	NengtiIdur
Pteropusgiganteus	Gaint Flying Fox	BoroBadur
Birds		
Alcedoatthis	Common Kingfisher	Machranga
Copsychussaularis	Robin	Doel
Corvussplendens	House Crow	Kak
Egrettaalbe	Great Egret	BoroBak
Egrettagazetta	Small Egret	ChhotoBak
Dirrurusadsimilies	Black Drongo	Fingry
Passer domesticus	House Sparrow	Choroi

Table 4.13: Floral Species in the Study Area

English Name	Scientific Name	Local Name	Main Name
Grass			
Grass	Spontaneum Saccharum Cynodondactylon	Khar Gash (KaichiKash, Dubla etc.)	Fuel/Covering Soil Binder
Trees			
Lichi	Lichichinensis	Lichu	Fruit
Mango	Mangiferaindica	Aam	Fruit, Timber
Date Palm	Phoenix	Khejur	Fruit, Timber
Balck Berry	sylvestrisSyzygiumcu	Jam	Brown sugar
Jackrfuit	miniheterophyllus	Khatal	Fruit, Timber
Coconut	Cocosnucifera	Narikel	Fruit, Timber
Papya	Carica Papaya	Pape	Fruit, Fuel
Gauva	Psidiumguajva	Piara	Fruit
Banana	Musa Sepientum	Kala	Fruit Fuel
Wood Tree (Timber/Fuel wood) Mehagani, Shal, Shilkoroi, Shimul	Shorea Robusta AlbiziaproceraSalmal iamalabaricum	Shilkoroi Silk cotton	Fuel, Timber Fuel, Timber Fuel, Pillow
Aquatic Flora (Herb)	Eichhorniacrassipes Lemnaperpusilla Ipomoea aquatica	Kachuripana Khudipana Kalmi	Herb Herb Herb

Table 4.14: Fish Species in the Study Area

Fish Group	Scientific Name	Local Name
Prawn	Macrobrachium malcolmsoni	Icha
Cat Fish	Mystus vittatus	Tengra
	Mystus vittatus	GolishaTengra
	Walla goattu	Boal Pangash
Major Carps	Labeo rohita	Rui
	Catla catla	Catla
	Cirrhinus mrigala	Mrigel
Minor Carps	Puntius sophore	Puti
Snakehead	Channa punctatus	Taki
Eel	Mastacem belusarmatus	Bain
Others	Amblypharyn godonmola	Mola
	Pscudeutropi cusatberinoides	Batasi

4.13 Socioeconomic Baseline Description

As part of the Environmental Impact Assessment (EIA) of the proposed Power Plant project, an environmental baseline study was carried out in areas surrounding the project site i.e. Boro bazaar and RPCL power plant area. This has been done on the basis of several surveys around the locality as well as Sadar Upazila of Shomvugang area. Bangladesh Bureau of Statistics (BBS), Banglapedia, concerned books and periodicals were also consulted.

4.13.1 Administrative Areas

Mymensingh Sadar is located at *24.7500°N 90.4167°E*. It has 104,567 units of household with a total area of 388.45 km². The River Brahmaputra just crosses near the Mymensingh city. More than hundred years ago the river around 5-10 km wide and now it is carrying only a seasonal flow, not an ever-flowing river. A huge land has been recovered from this riverbed for a hundred years as named 'CHARS' is a big part of Mymensingh and as it was riverine land regular seasonal flood water namely from the GARO hills of Meghalaya Of India flashes up to these CHAR's. Flood is somewhere seasonal reasons for refreshing fertility of land and a trend of native fishes add some protein budget assistance in this poor CHAR villages. Mymensingh Sadar has 20 Unions/Wards, 213 Mauzas/Mahallas, and 173 villages. **Figure 3.1(a) & 3.1(b)** shows the administrative areas of Mymensingh and Mymensingh sadar also **Figure 4.21** shows the administrative areas of Bangladesh.

4.13.1.1 Land Use

From the figure 4.21 we see around 50% of land are cultivable land and rest of them are agro fisheries zone. The city is covered by around 15% of land. Details are shown in figure 4.21.

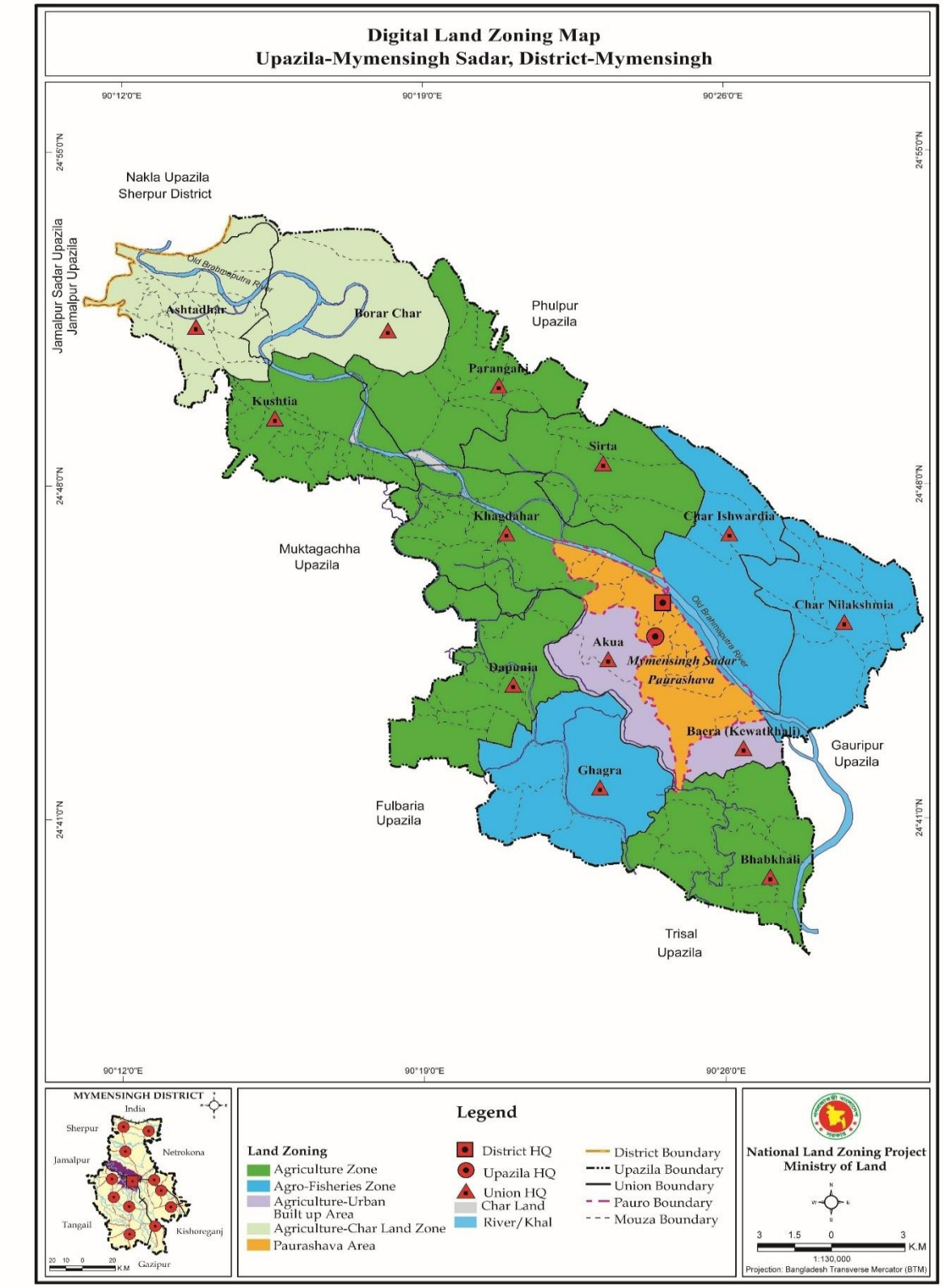


Figure 4.21: Land zoning map of Mymensingh sadar

4.13.2 Demographic Characteristics of the Project Area

4.13.2.1 Population

Total population of Mymensingh sadar Upazila within the project area is 7,75,733 of which 51% are male and 49% are female. The project site is situated in Shomvugang. Total Population of Mymensingh 4489726; male 2297302, female 2192424; Muslim 4289789, Hindu 168135, Buddhist 27999, Christian 330 and others 3473 [Source Population and Housing Census 2011 Bangladesh Bureau of Statistics]. Indigenous communities such as garo, and hajong belong to this district.

4.13.2.2 Household

The number of household of Mymensingh Sadar Upazila is 1,67,472. The pattern of housing in this area are of pacca, semi-pacca, semi-permanent building (i.e. walls are made of 5-inch brick with corrugated iron sheet roofing) and some of the houses are made of mud wall with different roofing. In case of Shomvugang, the number of household is about 2050; 38.67% of the households are pacca, 50% semi-pacca and 11.33% kacha [Source Population and Housing Census 2011 Bangladesh Bureau of Statistics]. The homestead areas are relatively medium.

Figure 4.22: Administrative Areas of Bangladesh (Source: banglapedia.org)

4.13.2.3 Literacy

According to the Banglapedia within the study area have an average literacy rate of Mymensingh district is 43.5% both male and female. The literacy rate among the Mymensingh sadar Upazila is 51.7 % and male are 53.9%, female is 49.6%, [Source Population and Housing Census 2011 Bangladesh Bureau of Statistics].

4.13.3 Utility Services in the Project Area

4.13.3.1 Sources of Drinking Water

Tube well is the main source of drinking water source for the people in the study area. Only at district headquarters and some Upazila headquarters, there are piped water supply is available by Department of Public Health Engineering (DPHE). But safe drinking water is still not available to many of the households in the area. These residents depend on wells, pond as their source of drinking water. Also, many people use river water as a drinking water.

4.13.3.2 Electricity

Electricity in rural Bangladesh is still a relatively scarce commodity, which many households cannot afford even if available at their locality. But in case of Shomvugang village, about 85% of the households in the project area have the electricity facility provided by REB. The town had its own power generation system which was established in pre-partition India. The powerplant was called Bati Kall was situated near the District Court and generated DC electricity using petroleum. Toward the end of the 1960s, Mymensingh was connected to the national power supply grid with a distribution station at Kewatkhali. a 60MW powerplant is established at Kewatkhali. Recently Rural power co. ltd established a 210 MW (4 gas turbine 35 MW and one 70 MW steam turbine) combine cycle power plant besides the Brahmaputra river at Shomvugang.

4.13.3.3 Health

District Hospitals and Upazila Health Complexes are located at each district and Upazila of the project area. There are also a large number of private clinics located in each district town, which are within a few kilometers from the project area. But such kinds of health facilities are totally unavailable in Shomvugang area where the project site is situated.

4.13.3.4 Waste Disposal

There are some facilities for garbage or hazardous waste dumping in each municipality area of the district. There is some facility exists for garbage or hazardous waste dumping in the total project area.

4.13.3.5 Emergency Services

There is one firefighting station located at Mymensingh Sadar Upazila.

4.13.4 Occupation and Source of Income of Population

As in other parts of the country, the majority of the population in project area is engaged in agriculture. Altogether 22.1% of the population is engaged in Agriculture. Agricultural laborers are of 13.27% of the population. 4.5% of the population is engaged in wage labor, only 2.9% of the population are engaged in fishing, 4.37% of the population are engaged in weaving, 12.2% of the population is engaged in business. 18.54% of the population is engaged in different services and the others are involved in handloom, transport etc. in the Mymensingh district. In Mymensingh Sadar, 45% people are engaged in agriculture & agricultural laborers are of 22%; 11% people are engaged in wage labor and about 10% of service holders are found. About 5% of the population is engaged in fishing. Many people are working abroad from this area as in our study about 7% people are immigrants or working abroad.

4.13.5 Ethnic and Religious composition of the Population in the Project Area

Total Population of the Mymensingh sadar area is 674452; male 350372, female 324080; Muslim 631018, Hindu 41948, Buddhist 1245, Christian 93 and others 148. Indigenous communities such as garo, Koch and hajong belong to this Upazila.

CHAPTER -05

POTENTIAL IMPACTS OF THE PROPOSED PROJECT

5.1 General Considerations

In case for most industrial projects, potential negative impacts sometime could be far more numerous than beneficial impacts. The regional and national economic benefits associated with the implementation of any development project are considered to fall outside the scope of an EIA, and therefore not considered here. However, it is generally expected that these long-term benefits will ultimately trickle down to the local population and will make a contribution to an improvement in the quality of life.

Likewise, the indirect benefits of strengthening of technical capabilities of local persons through association with foreign experts and other training elements that may form part of a project have been considered to fall outside the scope of ESIA.

5.2 Scoping of Impacts

The potential impacts due to implementation of Project are identified by using simple checklists. This method is described below:

5.2.1 Checklist

Checklist is comprehensive lists of environmental effects and impacts indicator designed to stimulate the analysts to think broadly about possible consequences of contemplated actions (Munn, 1979). **Table 5.1** represents the checklists developed for the present plant. In this checklist, actions, which may affect at the various stages of the project activities, are listed and the degrees of Significant Environmental Impacts (SEIs) are shown. The terms none, minor, moderate and major are used in the checklists to evaluate the magnitude of SEIs. In the checklist, both the construction and operational phases of the proposed development are considered separately in order to distinguish the short term and long-term impacts. As can be observed from the checklists, major environmental components, which will be adversely affected by activities of the project, are air, noise & water quality and socio-economic environment. All these impacts will arise in operation phase of the project. It should be noted that identification indicated in the Checklist relates to the significant level of impact.

Table 5.1: Checklists of Mymensingh 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant

Project Phase	Action Affecting Environmental Resources & Values	SEIs without Mitigation Measures				Type		Comments
		None	Minor	Medium	Major	Adverse	Beneficial	
Plant Location	Land value depreciation	x						No land value changes anticipated
	Loss of and displacement from homestead land	x						No loss of and displacement from homesteads land; no impact
	Loss of and displacement from agricultural land	x						Loss of and displacement from Agricultural land will not occur; no impact
	Damage to nearby operation	x						No impact anticipated
	Disruption to drainage pattern		x			x		Land development may create problems in local drainage pattern, minor impact
	Inadequacy of buffer zone		x			x		Buffer strip is absent
	Encroachment into precious ecological	x						No precious ecological issues; no impact
Construction Stage	Run off erosion		x			x		Filling would create runoff erosion during rainy season
	Worker accident		x			x		Irregularly may occur in construction period

Project Phase	Action Affecting Environmental Resources & Values	SEIs without Mitigation Measures				Type		Comments
		None	Minor	Medium	Major	Adverse	Beneficial	
	Sanitation diseases hazard			x		x		Concentration of labor force create un-hygienic condition
	Noise/vibration hazard		x			x		Piling/equipment installations create noise
	Traffic congestion		x			x		Carrying of construction materials will create traffic congestion
	Blockage of wildlife passage	x						No wildlife in the area; no impact
	Employment			x			x	Major employment opportunity during construction
Operation Stage	Pollution from liquid discharge			x				Oily liquid waste may generate due to blow down of close loop cooling, medium impact
	Pollution from solid waste		x			x		No significant solid waste; minor impact
	Air quality				x	x		Air pollution from stack emission, major impact
	Occupational health hazard			x		x		Inherently will occur, medium impact
	Odor hazard	x						No obnoxious odor will be generated; no significant impact

Project Phase	Action Affecting Environmental Resources & Values	SEIs without Mitigation Measures				Type		Comments
		None	Minor	Medium	Major	Adverse	Beneficial	
	Traffic congestion		x			x		Movement of additional traffic may be needed: minor impact
	Noise hazard				x	x		Heavy noise generation is expected; major impact.
	Employment				x		x	Major Employment opportunity during operation

CHAPTER -06
PREDICTION AND EVALUATION OF IMPACTS

6.1 General Considerations

The Impacts, which are likely to be occurred in the different phases of the project, are identified in section 5.0. In this section, evaluation of these impacts was done mentioning their origin and characteristics along with their possible mitigation/enhancing measures. At the end of each sub section, status of residual impact is also mentioned.

6.2. Adverse Impacts and Mitigation

6.2.1 Impact due to Project Location/Pre-construction Phase

6.2.1.1 Land Acquisition

Impact Origin

As discussed earlier the Proposed Project will require 7.00 acres of land. Land acquisition could affect the environment and peoples by the following ways

i. Loss of Homestead land

ii. Loss of Agricultural Land

iii. Cultural, historical and Aesthetic Loss

iv. Loss of sensible places

v. Corruption and partiality during acquisition and Reacquisition process, etc.

Mitigation Measures

The proposed project didn't require any relocation of homestead and land acquisition as the proposed plant would be set up on the land of Rural Power Company Ltd. (RPCL). The entire land was fallow & vacant land in nature. There are no homestead land falls inside the proposed project site. There was no cultural, historical and aesthetic interest in the project land and no loss of sensible place. So, the above-mentioned impacts are negligible.

6.2.1.2 Loss and Displacement from Agricultural Land

Impact Origin

The land was flat and low lying in nature. There was no agricultural growth in that piece of land and RPCL authority has developed the land to build the proposed power plant. So, there is no loss of agricultural land hence agricultural product in the country.

Mitigation Measures

Since there is no loss of agricultural land, no mitigation measures needed in this regard.

6.2.1.3 Disruption of Earth Surface

Impact Origin

As mentioned earlier that land filling has already done and site is properly developed to provide protection against flood. The land development process was done by sand filling through dredging pipes. The sand was collected from the river Brahmaputra. The dredged sand was carried out to the required area for filling. This average depth of land filling will be about 12 ft. from its original level which will not disrupt the natural surface of earth and obstruct the natural drainage system of the area.

Mitigation Measure

According to the plan, **Rural Power Company Limited (RPCL)** will not create any water logging and drainage problem as the **RPCL** authority collects the soil to develop the area by carried sand from river Brahmaputra. Cross drainage works should be constructed to bypass the surface water and other discharges.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.1.4 Change in Landscape

Impact Origin

A landscape is a subjective concept that cannot be precisely quantified. However, in general, any project when not designed considering the local landscape, then it creates visual intrusion to the people. The proposed project may change the local landscape to some extent.

Mitigation Measure

Any built up part of the plant should be designed considering key criteria of landscape like coherence, readability, hierarchy and stability. It is understood that **Rural Power Company Limited (RPCL)** will have a modern architectural view, which does not provide any significant visual intrusion. One simple way by which the altered green area can be turned into its original visual quality is the plantation of trees around the project area.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.2 Impacts during Construction

6.2.2.1 Disruption of Earth Surface-Site preparation and Clearing and Earthworks

Impact Origin

Each development project more or less requires site preparation. The preparation works generally done during construction stages includes

- Biomass Removal
- Biomass Disposal
- Property removal
- Construction of access road
- Cutting and filling operation
- Soil Export and Import
- Drainage works etc.

The impacts generally arise from the above activities are as follows:

- Noise
- Fugitive dust
- Runoff and flooding
- Soil erosion: Land erosion along the uncovered space due to soil removal and excavation.
- Water Pollution through runoff and sedimentation
- Social concerns
- Infrastructure disruption
- Safety Concerns

However, the proposed site is of the nature that it will cause negligible impacts in the pre-construction stages. The site will require some land filling. The proposed site has no homestead land so impact from property removal activities is negligible.

Mitigation Measures

Cutting and filling operation should be kept minimum. The proponent should ensure construction of proper drainage facility. Regular water sprinkle should be used to minimize fugitive dust emission. Safe working procedures should be ensured by the contractor. Undertaking construction work during dry seasons. The heavy equipment should be operated at day time.

6.2.2.2 Impacts on Air Environment

Impact Origin

The air quality in the project area may slightly deteriorate for the time being during construction. The major construction activities from which air emission mostly dust emission may occur are;

- Poorly paved service lane;
- Ground excavation;
- Delivery of building materials to site;
- Handling and mixing of cement

Poorly Paved Service

The access road to the proposed project should be perfectly paved. Dust nuisance from unpaved or partly paved road is of concern because: -

- There will be increased traffic driving in and out of the proposed site to deliver construction material;
- If soil moisture content becomes very low; it could create increasing quantity of loose particulate matter on road surface;
- There could be no or little vegetation cover to act as dust trap.

Ground Excavation

Site preparation in readiness for construction work may require vegetation clearance stripping off of overburden material, ground leveling and compaction. These activities will open-up the ground to wind action and thus potentially resulting in dust generation. This is because: -

- Vegetation clearance will directly expose the ground to agents of erosion;
- Stripping off of overburden material will loosen soil aggregates thus making them easily susceptible to wind action;
- Removal of tree stumps and roots will weaken soil bounding and thus can easily be blown by wind.

Delivery of Building Materials to Site

Construction materials such as building blocks, cement, sand, steel bars, stone/brick chips will be bulky and thus will require to be delivered on site by a fleet of trucks driving in and out of the construction site. During this exercise dust is likely to be generated from the following:

- Handling of cement which is dusty by nature of the way it is;

- Handling of sand, stone/brick chips may contain loose dust particles;
- Site clearing of area of holding ballast, building blocks and sand will expose the site to wind action;

Handling and Mixing of Cement

The powdery nature of cement will be a potential source of dust especially during handling and mixing it with other materials such as sand and gravel. Cement dust will likely be of concern during: -

- Opening-up of cement bags and emptying the cement in order to mix with other construction material;
- During loading and offloading of cement.

6.2.2.2.1 Potential Environmental Impacts of Dust

Dust produced will potentially negatively affect the following:

1) Employees generally construction workers;

2) Immediate neighbors and general public; and

3) Vegetation.

1. Effects of Dust to Employees

Cement dust can affect plant employers in the following way

- Eye irritation;
- Skin irritation;
- Impairment of normal sweating of the skin as it blocks pores on the skin;
- Chocking of the throat;
- Respiratory difficulties;
- Difficulty in breathing;
- Potential course of chest complication and ailment.

2. Dust Impacts to Immediate Neighbors and General Public

- Reduced visibility; emission of high particulate matter to the environment will reduce local visibility;
- Continuous exposure of people to dust will likely affect one's eye sight that can potentially result in an outbreak of eye infection;

- Chest related aliment; continuous exposure of people to dust will likely result in chest complications and respiratory disorders.

3. Dust Impacts to Vegetation

- Dust settling on plant leaf surface will block leaves stoma hence interfering with normal respiration of the plants;
- Dust settling on plants will reduce the evapo-transpiration of plants and animals such as butterflies, caterpillars, grasshoppers who feed of foliage will be affected as the dust settled on foliage will render the foliage unpalatable;
- Heavy dust settling on plant matter will impair on normal growth of the plant; and
- Heavy dust settled on plants will choke and kill plants.

6.2.2.2.2 Proposed Mitigation Measures

Following mitigation measures are proposed to minimize the air pollution during the construction stage: -

- The Project Proponent should ensure the complete paving of the service road
- Regular sprinkling of water to be done on open surface and dust grounds until paving is done;
- Transport of materials in tarpaulin- covered trucks
- The sand and other such dispersible material will be stored at site for minimum working period.
- Removal of soil/mud from trucks and other appliances prior to leaving the project area.
- Storage of top-soil in a safe space and creation of top-soil on filled land utilizing this preserved soil
- Selective cutting of trees in the site should be carried out. Only trees which on exact proposed position of the building should be cleared any other vegetation outside proposed building position should be maintained;
- Plantation of trees in the construction yard as quickly as possible. Any open area should be planted with appropriate vegetation (trees, flowers and grasses);
- Project management and contractor to enforce strict use of personal protective clothing;
- Complains of dust related ailments among employees and neighbors to be given access to medical attention.

- The equipment design will be chosen for least suspension of dust/sand into atmosphere.
- The construction activity will be carried out during day time only.

The emissions are temporary and not expected to contribute significantly to the ambient air quality and will be within prescribed limits for rural residential regions by National Ambient Air Quality Standards.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.2.3 Impacts on Acoustic Environment

Noise is likely to be generated from the following activities/areas:

- During ground preparation;
- During assembly of building materials on site;
- During construction of the various components of the proposed power plant.

A brief elaboration of each of the potential source/cause of noise is as follows: -

Ground Preparation

Ground preparation is another activity that will potentially result in noise nuisance. Activities of ground preparation that are likely to result in noise nuisance include: -

- Use of heavy machinery such as excavators, caterpillars in ground excavation will be a source of noise nuisance; and
- Transportation of excavated earth material from site by use of dump trucks will result in noise nuisance. The noise will be mainly from the trucks.

Assembly of Building Materials

Building materials to be used in construct site will first be gathered and assembled on site. These include building blocks, timber, steel bars, sand, gravel, cement. Possible courses of noise nuisance when assembling construction material on site include: -

- Offloading of building materials on site especially steel bars, gravel and building blocks can result in noise;
- Trucks ferrying in building materials can be a source of noise;
- Employees involved in offloading of building material can be a source of noise.

Construction of the Various Components of the Proposed Power Plant

Construction of the civil work structures for the proposed power plant will be labor intensive. This will involve engaging a large workforce, also during construction some machines and equipment will be in use. Possible sources of noise during construction work may include the following: -

- Loud talking, shouting and conversation among employees;
- Noise from equipment such as cement mixers;
- Noise from machines such as welding machines and wood working machines;
- Increased machine and equipment activity on site.

6.2.2.3.1 Potential Environmental Impacts of Noise

Impacts of noise will potentially affect the following: -

a. Immediate neighbors; and

b. Employees.

a. Impacts of Noise to Immediate Neighbors

- Continuous exposure of neighbors to noise nuisance may result in noise induced hearing lose;
- Noise nuisance may reduce concentration of neighbors in their private matters.

b. Noise Impacts to Employees

- High noise level will force employees to shout laud when communicating to one another;
- Exposure of employees to high noise level (above 85dB) continuous for 8hours per day may result in noise induced haring lose;
- Exposure of ear to peak sound level instantaneously may result to deafness.

6.2.2.3.2 Proposed Mitigation Measures for Noise Nuisance Management

- Noisy construction works to be limited to daytime hours
- Immediate neighbors to be notified in writing on the date of commencement of construction work at least one month in advance;
- All employees likely to be exposed to ear noise to be provide with ear protectors;

- The project Proponent and contractors to ensure strict enforcement on user of ear protectors;
- Where applicable and possible exceptionally noisy machines to be fitted with noise reduction devices;
- Any employee who may complain about ear related pain and or complication while at work to access medical attention at the expense of the contractor or project proponent;
- Fitting noise machines with noise reduction devices;
- Providing suitable hearing protection to all workers exposed to noise levels above 85dB(A);

The noise impacts will be local; limited to the premises and very short – term.

6.2.2.4 Sanitation Hazard & Drinking water

Impact Origin

The health of the project personnel, construction workers and laborers living at the base camp could be impacted if arrangement of sanitation and drinking water is not ensured adequately and properly. During construction stage, lot of local labors will work and hence they would generate considerable amount of human waste. These are the potential source for spread of diseases, as various insects will play dominating role in the spread of diseases. There are chances for the spread of water borne diseases also.

Mitigation Measures

Proper sanitation system should be provided and at the same time, regular, proper and safe disposal of human waste should be ensured. Contractors and workers should obey appropriate means of waste removal and sanitation measures. Adequate number of toilets and bathrooms should be made for the workers, and proper disposal system of sewage waste should be implemented for sanitation purpose and the workers should be aware to practice those facilities.

The project activities shall make higher demand on the local utilities and service facilities particularly potable water, health and sanitary facilities. There should be sufficient number of tube-wells for drinking purpose.

Residual Impact

If, the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.2.5 Overland Drainage and Impact on Surface Water

The potential impacts on local hydrology are principally those of altered patterns as a result of onside construction and earthwork activities. The proposed project will affect natural drainage, surface and ground water quality if not managed the construction works properly. There could be Siltation of water system or drainage from uncovered piles of soil

Proposed Mitigation Measures

- Surface drainage shall be controlled to divert surface runoff away from the construction area;
- Laying barrier net;
- Undertaking construction work during dry seasons;
- Completed areas should be restored/re-vegetated as soon as practicable;
- Temporary silt-trap or digging of pond toward siltation prevention;
- Stockpiling of spoil soil at a safe distance from the drainage system;
- Utilizing spoil soil in land-fill;
- Strict supervision should be maintained to avoid blockage of natural creeks during the construction period, and;
- Containment of sanitary waste should be adequately disposed of to avoid surface and ground water contamination;
- Making provision for temporary disposal of wastes inside construction yard and disposal of solid wastes in an appropriate manner;
- Adequate provision has to be retained for the treatment and disposal of cuttings, drilling fluids and other chemicals and lube oil wastes generated during drilling, testing and commissioning stage;

6.2.2.6 Social acceptability of Construction workers to the host communities

The differences in the cultures of workers (in case hiring is required) and local community may create some problems. In the rural area, the local people especially the religiously conservative section of the community will not accept the foreign workers in general.

Mitigation measures

The project proponent and his organization have practice of working with the workers of different cultures. It is recommended to aware the foreign workers (if any) about the social & religious actability in the area so that they could maintain those when they will have in touch with local community.

6.2.2.7 Accidents or Occupational Health Hazard

Impact Origin

Under controlled situation, accident is not expected. However, occasionally it occurs during construction works. Accident may occur during earth cutting, casting, construction works and installation of heavy machinery. The protection of head, eye, ear, and hand, foot of the workers, laborers and project personnel could be affected if proper and adequate arrangement is not ensured.

Mitigation Measures

The workers should wear PPE (Personal Protective Equipment), safety goggles, and other necessaries.

6.2.2.8 Increase in Vehicular Traffic in the Area

Increase in vehicular traffic in the area is likely to be experience during construction phase of the power plant. During the construction phase, increase in vehicular traffic in the area is likely to be because of-

Trucks ferrying construction material to site;

Trucks ferrying waste material from site; and

Ferrying in of construction tools and equipment.

6.2.2.8.1 Potential Negative Environmental Impacts Likely to Result from Increased Vehicular Traffic in the Area

- Possible traffic congestion of local roads and lanes;
- Possible of occasional experience of delays on the said local roads;
- Increased number of vehicles on local roads will result in increased wear and tear of local roads thus reducing lifespan of affected roads;
- Cost of maintaining local roads will increase;
- Pedestrians and cyclists using local roads will have to exercise more care with increase of vehicular traffic on the said roads; and
- There will be an increase of exhaust emission from vehicles, which will pollute local atmospheric air.

6.2.2.8.2 Proposed Mitigation Measures to Mitigate Increase in Vehicular Traffic in the Area

The following measures can be put in place to mitigate possible negative impacts likely to result from increase in vehicular traffic in the area:

- Management to provide for adequate internal parking, for all vehicles coming to the plant premises;
- Management to pave the dilapidated service road with tarmac or more durable material;
- All users of said roads to always observe traffic rules this will give pedestrians and cyclist their space and safety while using the road; and
- Marking of the roads to be clearly done.

6.2.2.9 Impact due to HSD Transportation

Impact Origin

The proponent will arrange the supply and delivery to the facility of required quantities of HSD for use as fuel. RPCL is responsible for fuel receiving, handling and transportation up to the facility. All arrangements required for the supply of liquid fuel to the facility including necessary arrangement, pipe line up to the storage facility, fuel measuring system, internal fuel supply system, fuel heating and purification/treatment system as per requirement of the offered plant will be installed by the proponent at its own cost and responsibility.

Mitigation measures

The RPCL HSD storage facility will be designed so that there is no chance to spill HSD and mixing the HSD with surface water body. The unloaded area should have hard standing floor with sealed drainage ended up to oil water separator. The HSD storage tanks should be double skinned and have secondary containment 110% bigger than the storage capacity so that the HSD could be retained in the containment area in case of any emergency failure.

6.2.3 Impact during Operation Stage

Operation of the project may potentially affect quality of life, air, noise, water, land and flora, fauna and human by increase in air, noise and water pollution, increase in hazardous waste generation, pollution from spillage/surface runoff, disturbance to flora and fauna, by loss of trees resulting from increased assess, increase in land values, threatening agriculture, etc. Environmental issues during the operational phase primarily include the following:

- Air emission (Significant)
- Noise generation (Significant)

- Hazardous waste generation (Minor)
- Water use and waste water discharge (Minor)
- Health and Safety

An in-depth analysis of each of the potential negative impacts is as follows.

6.2.3.1 Impact on Air quality

Impact Origin

Emission from the gas turbine stack and HRSG stack may affect the ambient air quality. Unburned fuels from the turbine operation may affect the air quality. The situation aggravates when the fuel (here Gas/HSD) contains high percentage of impurities like sulfur, NO2 water, metals, MCR (micro carbon residue) etc. The high temperature of flue gases also impacts the air quality in terms of thermal pollution. The combustion of heavy fuels for power Generation inevitably results in emission of particulate and gaseous pollutants to the atmosphere.

As the proposed power plants would be fired with dual fuel. Considering 80% operating load, the power plant will be operating 50% by natural gas and 30% by HSD. Considering this, the power plant will be emitting particulate matter, nitrogen oxides and sulfur dioxide.

Sulfur dioxide (SO2) Emissions from the power plant

SO_2 is a colorless gas. It smells like burnt matches. It can be oxidized to Sulfur trioxide, which in the presence of water vapor is readily transformed to Sulfuric acid mist. SO2 can be oxidized to form acid aerosols. SO2 is a precursor to Sulfates, which are one of the main components of respirable particles in the atmosphere.

Health Effects

Health effects caused by exposure to high levels of SO2 include breathing problems, respiratory illness, changes in the lung's defenses, and worsening respiratory and cardiovascular disease. People with asthma or chronic lung or heart disease are the most sensitive to SO2. It also damages trees and crops. SO2, along with nitrogen oxides, are the main precursors of acid rain. This contributes to the acidification of lakes and streams, accelerated corrosion of buildings and reduced visibility. SO2 also causes formation of microscopic acid aerosols, which have serious health implications as well as contributing to climate change.

Nitrogen Oxides (NOx) Emissions from the Proposed Plant

Nitrogen gas, normally relatively inert (nonreactive), comprises about 78% of the air. At high temperatures and under certain other conditions it can combine with oxygen in the air, forming several different gaseous compounds collectively called oxides of nitrogen (NOx). Nitric oxide (NO) and nitrogen dioxide (NO2 - the criteria pollutant) are the two most important. Major

source of nitrogen oxides in the proposed power plant include the fuel combustion in power plants.

Health Effects

Certain members of this group of pollutants, especially nitrogen dioxide (NO2), are known to be highly toxic to various animals as well as to humans. High levels may be fatal, while lower levels affect the delicate structure of lung tissue. In experimental animals this leads to a lung disease that resembles emphysema in humans. As with ozone, long-term exposure to nitrogen oxides makes animals more susceptible to respiratory infections. Nitrogen dioxide exposure lowers the resistance of animals to such diseases as pneumonia and influenza. Humans exposed to high concentrations suffer lung irritation and potentially lung damage. Increased respiratory disease has been associated with lower level exposures.

The human health effects of exposure to nitrogen oxides, such as nitrogen dioxide, are similar to those of ozone. These effects may include:

- Short-term exposure at concentrations greater than 3 parts per million (ppm) can measurably decrease lung function.
- Concentrations less than 3 ppm can irritate lungs.
- Concentrations as low as 0.1 ppm cause lung irritation and measurable decreases in lung function in asthmatics.
- Long-term lower level exposures can destroy lung tissue, leading to emphysema.

Children may also be especially sensitive to the effects of nitrogen oxides.

Other Effects

- Oxides of nitrogen also can:
- Seriously injure vegetation at certain concentrations. Effects include:
- Bleaching or killing plant tissue.
- Causing leaves to fall.
- Reducing growth rate.
- Deteriorate fabrics and fade dyes.
- Corrode metals (due to nitrate salts formed from nitrogen oxides).
- Reduce visibility.

Oxides of nitrogen, in the presence of sunlight, can also react with hydrocarbons, forming photochemical oxidants. Also, NOx is a precursor to acidic precipitation, which may affect both terrestrial and aquatic ecosystems.

Particulate Matter

Amount of PM emission can be substantial from HSD plants, which is generally estimated as 1.50 g/kWH. With this level of emission, the emission from the plant will be 50 lbs./hr. As a non-attainment area for PM (table 4.13), the addition of the present plant (i.e. 360 MW) would not make substantial difference to the PM levels as there are power plants with an aggregate capacity of 598 MWe (details in Chapter 3) in the air shed. So, PM issue has not been examined in detail as it is small compared to the cumulative PM emission in the air shed. Moreover, the project will use the exhaust temperature in the HRSG boiler to reuse the heat in steam turbine for generating additional electricity which will also bring down the PM concentration significantly.

Carbon monoxide and carbon dioxide Emissions from the Proposed Plant

Carbon monoxide is generated when incomplete combustion takes place. The emission of carbon dioxide depends on the fuel burn and the carbon content in the fuel. The proposed power station is a dual fuel-based project with modern and optimum designed cycle efficiency in order to maximize the MW output and less consumption of fuel and water, CO & CO2 emission per unit of fuel burnt will be smaller amount compare to other power stations.

Mitigation Measures

A. Stack Emission

SO2 Emission

The emissions of SO2 are dependent on the sulfur content of the fuel. When the project will be operated by natural gas, SO2 emission will not be an issue at that period but the project will be operated 30% operating hours by HSD. The project authority will use HSD with approximated sulfur content of less than 0.50% (as per BPC) which is below the allowable limit of IFC/WB Environmental Health& Safety Guideline 2008, is 1% or less Sulfur content for the SO2 emission of liquid fuel oil power plant in non-degraded air shed. There is no standard set in the Bangladesh ECR 1997 for the SO2 emission for the liquid fuel fired power station. So we should consider the standard of IFC/WB guideline in this situation. The project will use the exhaust temperature in the Heat Recovery Steam Generator (HRSG) and Steam Turbine for the combined cycle operation which will bring down the exhaust temperature from 450 ^{0}C to 110 ^{0}C which also bring down the SO2 concentration significantly. So, this power project will not require further Flue Gas De-Sulpharisation plant.

NOx Emission

The stack emission data from the HSD/Gas combustion turbine generator shows that NOx emission from the turbine will be below 25 ppm or 51 mg/Nm3 (15% O2), which is lower than the IFC/WB guideline NOx emission limit for liquid fuel-fired combustion turbine power plants

of 50 MW above located in non-degraded air shed is 74 ppm or 152 mg/Nm3 (15%O2) and for gas fired power project is 25 ppm or 51 mg/Nm3 (15%O2).

There is no standard set in the Bangladesh ECR 1997 for the NOx emission for the liquid fuel fired power station. So, we should consider the standard of IFC/WB in this situation. The ambient NO2 level is low (table 4.14) and considering small contribution to cumulative emission in the air shed, the NOx level is not expected to exceed the NAAQS.

B. Ambient air quality

An effect on ambient air quality has been assessed based on air emission dispersion modeling. In this study, the SO2 and NOx emissions for the combustion turbine exhaust of Gas/HSD turbine discharged through stack were modeled to obtain maximum possible downward ground concentration. USEPA AERMOD view version 9.4.0 model was used to estimate emission concentration from the plant. The exhaust specifications and stack parameters for the proposed Gas/HSD turbine were used as input to AERMOD model. The individual stack data was used as point source of SO2 & NOx emissions and the results are the summation of the emission sources. The parameters and corresponding values are summarized in the table 6.1 below:

Table 6.1: Summary of the exhaust specifications and model input data

Parameters	Quantity
No. of generators	2 (1 Gas Turbine Generator & 1 steam Turbine Generator)
No. of Stacks	2 no's
By-Pass Stack height	40 m
Main Stack Height (HRSG)	50 m
Stack inside diameter (m)	As per EPC Design (5.60 m)
Stack exit velocity	25 (m/s)
Exhaust temperature (GT)	544ºC
Exhaust temperature (HRSG) Gas firing	99ºC
HSD firing	144ºC (417 ºK)
Exhaust Energy (MM Ki/hr.)	1219 MM Ki/hr.
NOx (ppmvd) at Baseload (@15% O2)	25 (8.4 gm/sec)
SO2 emission rate (mg/Nm3)	Gas firing: 8, HSD firing= 55 (9 gm/sec)
PM emission rate (lbs./hr.)	Gas firing: 20, HSD firing: 40
Ambient temperature (K)	35ºC
Fuel Consumption	Natural Gas: 63.22 MMSCFD, HSD: 1416 ton/day

The model assumes the stack tip downwash with receptors on flat terrain and no flagpole receptor heights. The NOx and SO2 concentration contour have been analyzed with 500 m interval with a radius of 5000 m from the point source.

NO2 concentration During Gas & HSD Firing:

The NO2 concentration contour of 24 hour and annual average of have been analyzed during the gas or HSD firing period. The maximum of 24-hour concentration of NOx has been predicted 0.30-0.50 µg/m3 at a radius of 300m surrounding the project whereas the concentrations is below the 0.30 µg/m3 at all sides further down to the project up to 10 km from the project. The maximum annual concentration of NOx has been detected as 0.030-0.060 µg/m3 at a radius of 500m to 600m at the north, south & east side and up to 10km to the west whereas the concentrations is below the 0.030 µg/m3 at all sides further down to the project site.

There is no IFC/WHO and Bangladesh standard set for 24-hour concentration for NOx. The maximum yearly concentration of NOx has been detected (below 0.06 µg/m3) well below the IFC/WHO and Bangladesh standard at all sides at any radius around the project.

SO2 concentration during HSD firing:

The SO2 concentration contour of 24 hour and annual average of have been analyzed. The maximum of 24-hour concentration of SO2 will be 0.030-0.060 µg/m3 at a radius of 300m the north, south & east side and up to 10km to the west whereas the concentrations is below the 0.30 µg/m3 at all sides further down to the project site. The maximum annual concentration of SO2 has been detected as 0.030-0.10 µg/m3 at a radius of 600m to 700m at the north, south & east side and up to 10km to the west whereas the concentrations is below the 0.030 µg/m3 at all sides further down to the project site.

There is no IFC/WHO annual standard set for SO2 for the ambient air quality, the 24-hour concentration of SO2 have been found below the standard of IFC/WHO standard (0.10 µg/m3) and also below the annual Bangladesh standard (80 µg/m3) at all sides.

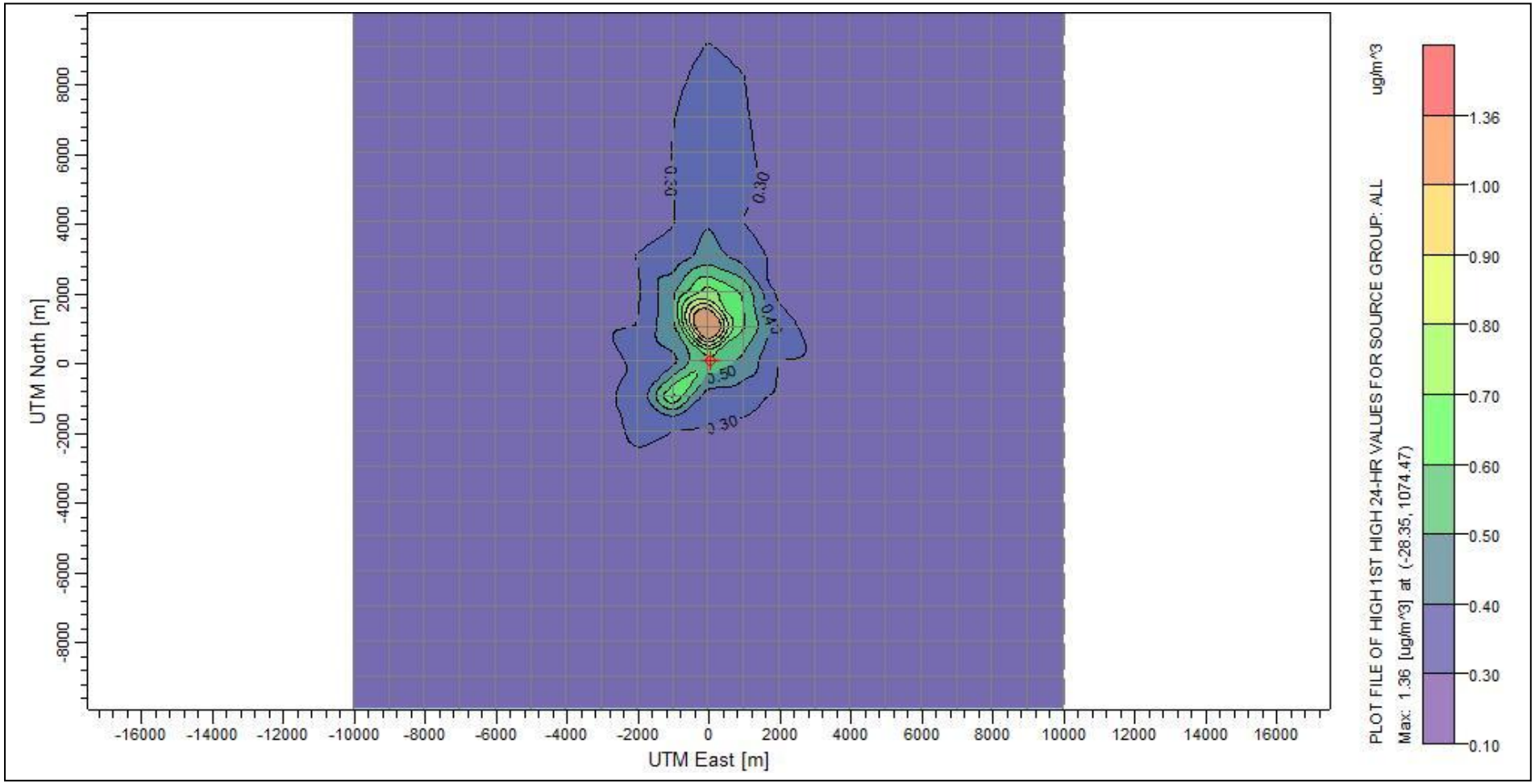
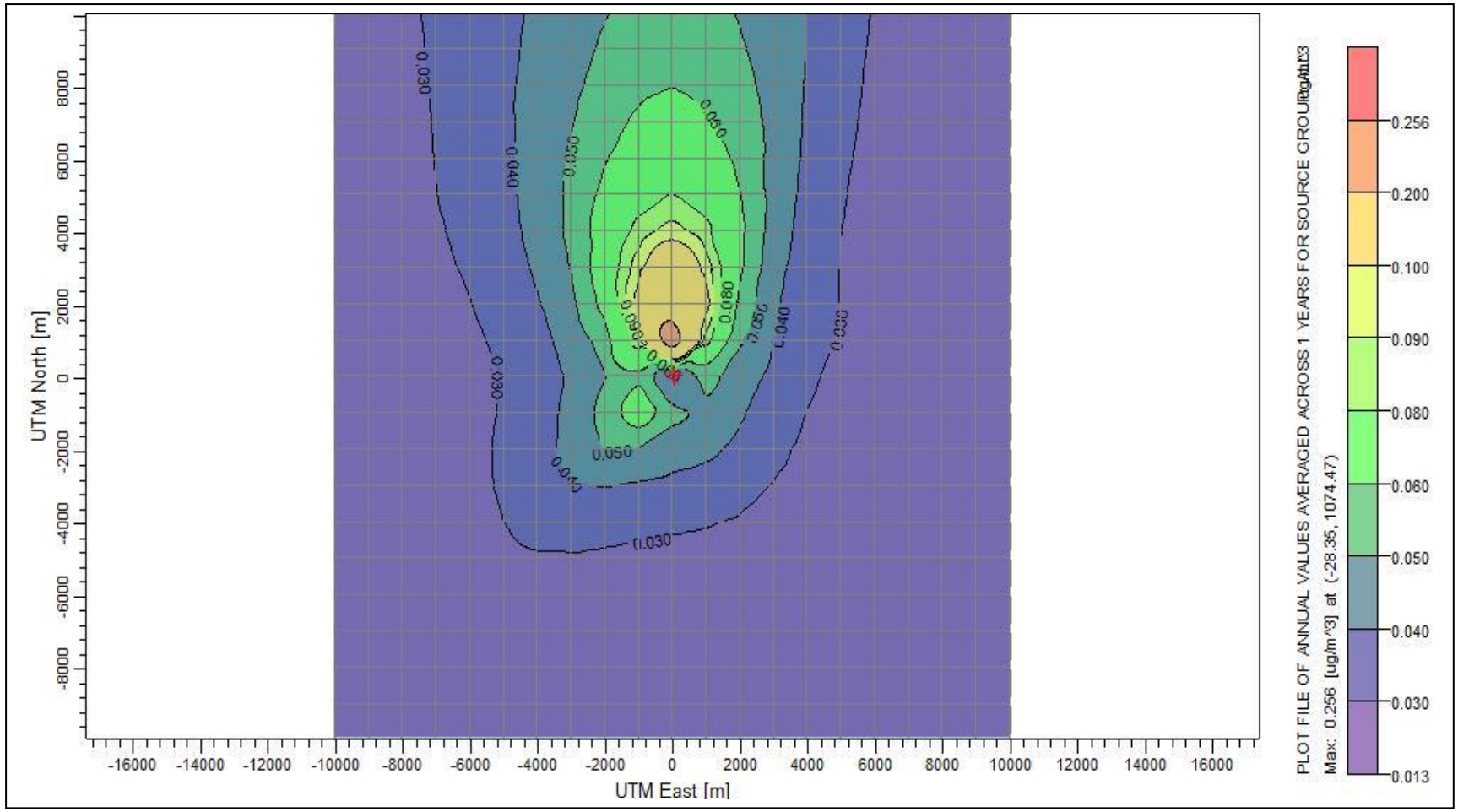


Figure 6.1: Emission contour map showing the NOx concentration (24 hour average) at 10000m surrounding the project location



6.2: Emission contour map showing the NO_2 concentration (Annual average) at 10000m surrounding the project location

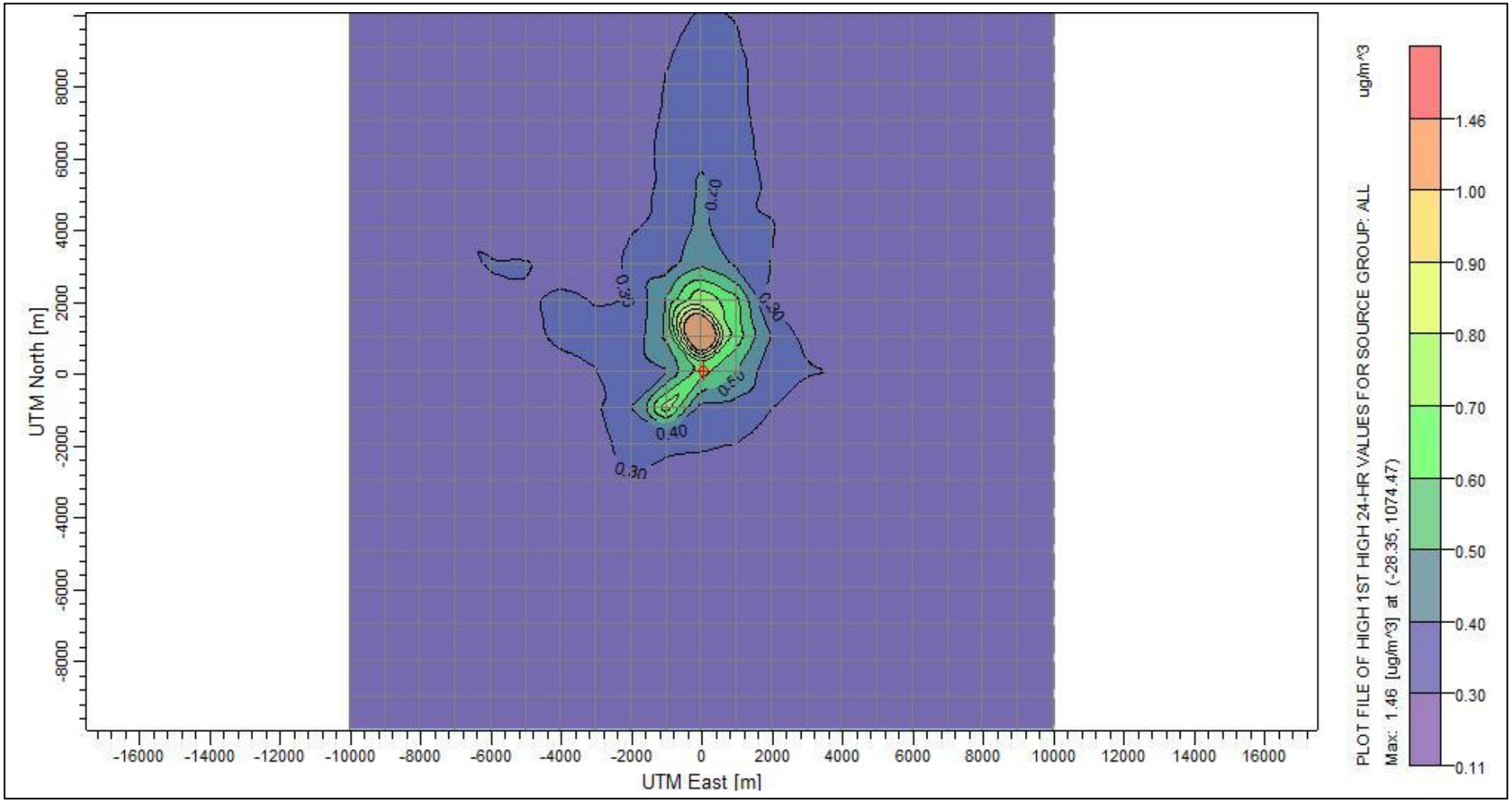


Figure 6.3: Emission contour map showing the SO2 concentration (24-hour average) at 10000m surrounding the project location

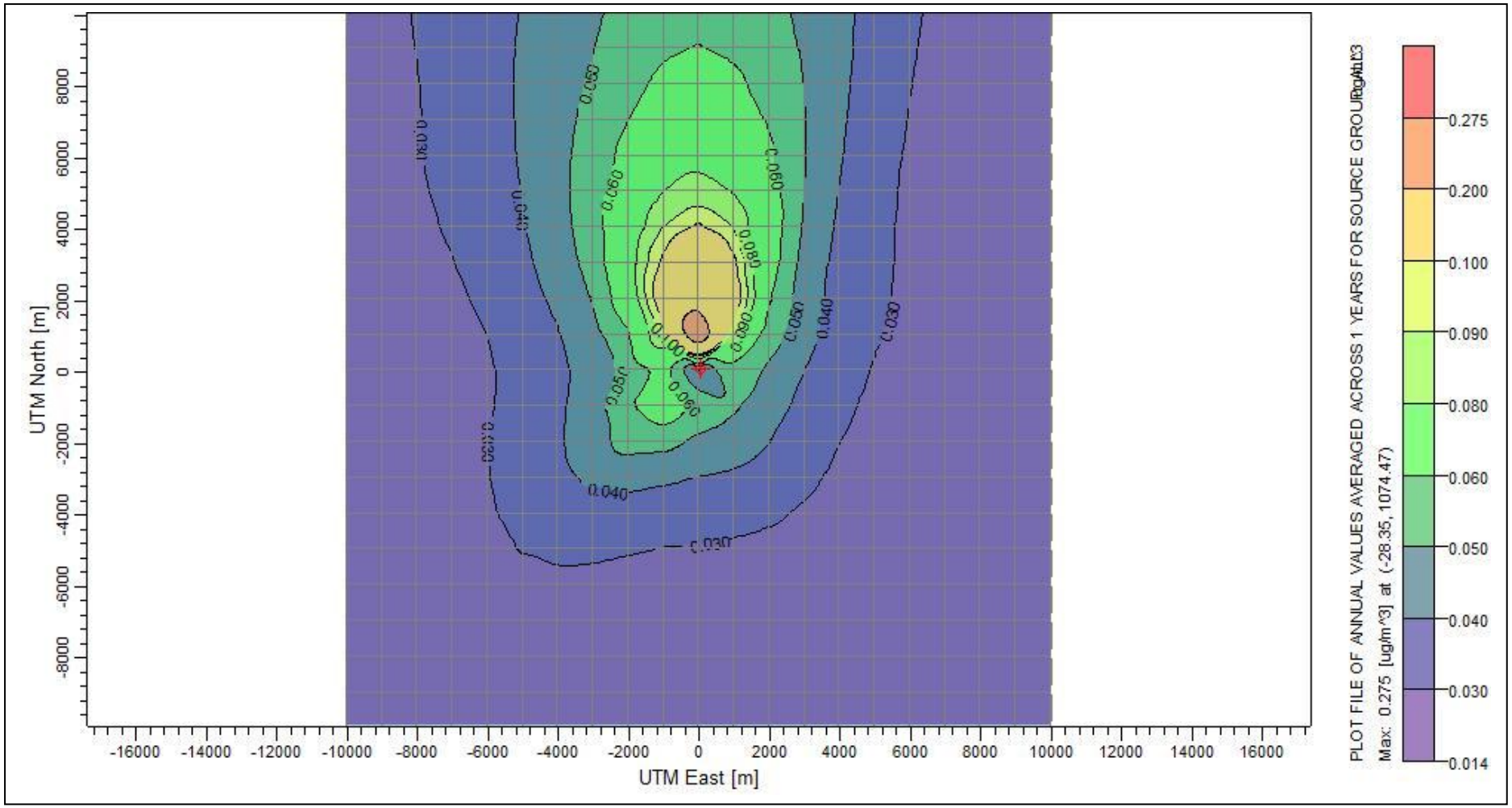


Figure 6.4: Emission contour map showing the SO2 concentration (Annual average) at 5000m surrounding the project location

Residual Impact

It is clear from above study that the project proponent will adopt necessary options suitable to their needs meeting the national standards. Adoption of measures set out above is not expected to provide total mitigation, because no machine works at 100% efficiency. After adopting proper mitigation measures to maintain national/international standards, **Rural Power Company Limited (RPCL)** will emit some residual pollutants, which can affect the environment in the long run. The cumulative residual pollutants can create an adverse situation in the ambient air quality. So, this situation can be overcome by determining the exact level of treatment and maintaining it by following the management plan properly, which is required to maintain the normal ambient air quality of the area.

6.2.3.2 Impact due to Liquid Discharge

Impact Origin

The Proposed power plant will not create any process liquid from the production process. The power plant will have closed loop water cooling system for the main steam condensation unit of HRSG system in which (125-150) m^3/hr. of water will be required as makeup water in the circulating cooling system where the 22500 m^3/hr. water flow will be maintained in the close circuit cooling loop. In addition, 24 m^3/hr. waters will be needed for service water, HRSG blow down and other different uses and 101 m^3/hr. waters will be required for DM water system. The DM water after treatment will be fed to different cooling system and steam boiler in the plant as makeup water. There will be around 20 m^3/hr. wastewaters will be generated from the different section of the plant as blow down and from domestic sources. This wastewater will contain significant amount of pollution, which may impact the surface water quality.

Mitigation Measures

The cooling water will be used in a close loop system having no discharge. As mentioned earlier, around 20 m^3/hr. wastewaters will be generated from the different section of the project which will be treated in the Effluent Treatment Plant (ETP). The plant will use (125-150) m^3/hr. groundwater and river water which will be treated in WTP prior to use in the plant. The wastewater will be stored in a collection tank and after controlling pH, TDS and suspended solids the water will be discharged into the river. The domestic liquid waste will be disposed through a septic tank with a soak pit. The project will have planned drainage system to discharge the surface runoff. The surface drainage network would be connected with an interceptor prior to discharge through natural water. The interceptor will trap all oily matter present in the water.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.3.3 Impact due to Solid Waste

Impact Origin

The operation of the plant itself would not generate any solid waste. Solid waste generated by the people working at the proposed site is paper, cartoons, bags, boxes, office wastes, pallets, empty drums etc. along with negligible quantity of domestic waste. There will have waste Air filters and waste rugs be generated occasionally which need to be properly disposed.

Mitigation Measures

All solid waste will be segregated properly. Some solid waste has secondary demand and sold to the secondary dealers. Other solid wastes will be disposed to the safe places carefully. The air filters and waste rugs should be collected in a safe place and should be disposed to the land fill.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.3.4 Impact due to HSD and Lubricating Oil

Impact Origin

The proposed project will be operated by natural gas and in some extent by HSD, so, there is HSD preheating and treatment system in the project before feeding the HSD to the turbine . This will end up with some oily sludge& water. Moreover, the project will use lubricating oil in the cooling system from where insignificant amount of used lubricating oil would be generated from the plant. The generated waste oil will be stored in a sealed tank.

Mitigation Measures

The oil storage of the project (fresh and used) should be done on hard standing floor and roofing with a secondary containment facility of 110% bigger than the allowable maximum storage capacity. The oily water sludge would be treated by Pure Bilge Oily water cleaning system, where clean water would be discharged with the oil content below Bangladesh national standard (below 10mg/l) and sludge thus collected and the waste lubricating oil will be supplied /sold to the venders for recycling. These vendors or the Lube Oil Re-cycling facilities should be approved by DoE. As there is no chance of mixing and disposal of oil onto land or water, so there is no mitigating measure to be suggested.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.3.5 Noise and Vibration Impacts

Impact Origin

A. Turbine & HRSG room noise:

The turbine & HRSG room will have internal noise level of around 85 dBA at 1m distance from the turbine and generators as RPCL will use dual turbocharged system turbine which will be minimized by sophisticated acoustic power house building design so as to minimize the noise emission up to standard.

B. External noise emission:

The average plant noise level will be estimated as 65 dBA after emitting from the stack.

Mitigation Measures

A. Turbine & HRSG room noise abatement:

Necessary noise abatement measures will be taken as required avoiding adverse noise & vibration impact on the neighborhood. In particular, significant noisy components such as the generators and turbines are enclosed in buildings acoustically designed, providing **Styrofoam filler in between hollow brick & acoustic block walls both side** (sandwich type) of the Styrofoam filter around the power house building. The following are the noise abatement capacity of the material which would be used for noise abatement for the turbine & HRSG room noise:

It is estimated that the Styrofoam filter and brick wall will absorb noise as following:

Material	Thickness, mm	Approximated noise absorption capacity, dBA
Styrofoam (Acrylic -Poly-Methyl-Meta- Acrylate (PMMA)	100	90
Brick with or without plaster	150	40
	Total	130

It is estimated that the noise abatement measures of the power house building will be capable to absorb around 130dBA noise from the turbine & HRSG room, but the maximum turbine & HRSG room noise is around 85 dBA near the turbines & generators, which is lower enough to minimize the turbine & HRSG room noise by the acoustic enclosure and it is expected that the noise emission from the turbine & HRSG room would be within the limit. Moreover, turbine anti vibration mounting will also be used at the bed of all power generation units to prevent the vibration.

B. External noise emission:

For the measurement of the noise dispersion to the surrounding area from the external noise emission sources, a noise modeling simulation has been done by using CUSTIC-3.2 noise modeling software. The model has calculated the noise from the stack. The result of the modeling has been given below.

Table 6.3: Result of Noise Modelling

Radius, (m)	20	50	100	200	300	500
Output Sound power level in dB	33.77	28.94	22.51	16.89	11.26	5.63

Fig 6.5: Plot of output noise power level in dba vs. Radius in meter

The modeling result shows that the power plant will produce max noise 33.77dBA within 20m radius and minimum 5.63 dBA in 500m radius respectively during running condition of the project. There are few homesteads at the southeast side of the project within the 200m radius of the proposed project where the noise contribution from the project would be around 16.89 dBA.

The following are the World Bank and Bangladesh standard for the ambient noise:

Table 6.4: World Bank and Bangladesh standard for ambient noise

Standard	Zone	Day time dBA	Night time, Dba
World Bank EHS Guideline 2007	Residential, Institutional, educational	55	45
	Industrial, commercial	70	70
Bangladesh ECR, 1997	Residential area	55	45
	Mixed area	60	50
	Commercial	70	60
	Industrial	75	70

The RPCL project will be established in an area where there are existing power project already established. The day &night time average noise was found during the baseline study below the standard of industrial/commercial zone of WB & Bangladesh. But noise generation from the power project was found below 60 dBA at a distance of 100m away from the project. Since the project itself will contribute little amount of noise to the surrounding atmosphere, it is expected that the cumulative noise would meet the standard of industrial area of Bangladesh standard.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.3.6 Occupational Health

Impact Origin

The proposed project will employ around 140 people during its operational period. The workers who work inside the plant will face occupational health hazards due to different operational processes. Safe and good occupational health status of the employees and workers is important for only the persons working in the plant, but also for the better plant operation and maintenance.

Mitigation Measures

Protective clothing, earplug, helmets, shoes and accessories should be provided to the workers specially who will work in the power house building and turbine & HRSG room. Adverse impact on worker's safety would be minimized by implementing an occupational health program. Regular medical checkup would be done to ensure the soundness of health

of employees and workers. Pollution control measures would duly adopt if necessary, including noise and air pollution.

Residual Impact

Provided that the mitigation measure indicated above is fully implemented, residual impact to be very insignificant.

6.2.3 Socio-economic Impacts

The **Rural Power Company Limited (RPCL)** will contribute to cover the increasing demand of electricity which is a beneficial operation factors, e.g. for producing industries. Site development will not lead to the loss of any jobs; instead will create new job opportunities for the local workers. On the other hand, during the construction activities of the **Rural Power Company Limited (RPCL** jobs and income opportunities will be created and as such per capita income will be enhanced in this area. For operation, a number of long-term skilled and unskilled personnel will be required which will create employment opportunities for the local inhabitants also.

Since there was no habitation located inside the proposed site, resettlement would not be necessary for the project. But migration will be increased due to creating new job opportunities in the plant area. People in the neighborhood are expected to get benefit from the employment that would be generated and from the increased business activities during construction period. There is no religious, cultural or historic place near the site, so the noise and air pollution during construction of the project would not create any potential impact. People of the surrounding area will be benefited by the development of local small businesses due to the increase of migration in the area.

6.3 Beneficial Impacts and Enhancement

6.3.1 During Construction

Impact Origin

During construction period, the plant will create job opportunities for approximately 300 of skilled, semi-skilled and unskilled labors. However, the impact will be a relatively short duration, being restricted locally to the construction period. In addition to this, all construction sites attract small traders, who supply food and other consumable to the work force. Although the numbers of people who benefited in this way are relatively small, the impacts on individuals can be disproportionately high compare to the other local people.

Benefit Enhancement Measure

Although labor recruitment is a matter of construction contractor who has the right to determine whom he shall not employ, but still the project proponent shall encourage him to hire local people wherever possible and to give preference to employment of the land less people.

6.3.2 During Operation Phase

Impact Origin

The most significant positive impact of the plant would be the generation of electricity, which will reduce the gap between supply and demand of electricity. The other important positive impact of the plant would be the employment of personnel for the operation of the plant. The project envisages employing 140 skilled and unskilled personnel during its operational phase. Apart from the positive impacts other beneficial impacts include benefit to local economy due to employment, community development, etc.

Benefit Enhancement Measure

Although labor recruitment is a matter of company who has the right to determine whom he shall and shall not employ, but still the project proponent should take initiative to employ local people wherever possible and to give preference to employment of the jobless people.

6.4 Decommissioning

6.4.1 General principles for Environmental Management During Decommissioning

At this project of the project planning & implementation process, the necessity for and timing of the decommissioning of the **Rural Power Company Limited (RPCL)** is not known. Therefore, only general principles of decommissioning are detailed below. These principles must be required to be revisited and supplemented in the event of decommissioning of the power plant.

On decommissioning of the power project, RPCL will:

- Ensure that all sites not only vegetated are vegetated as soon as possible after operation ceases with species appropriate to the area.
- All structures, foundations, concrete, and tarred areas are demolished, removed and waste material disposed of at an appropriately licensed waste disposal site.
- All disturbed areas are compacted, sloped and contoured to ensure drainage and runoff and to minimize the risk of erosion.
- All hazardous materials should be kept separate, documented and disposed to the safe recycling or disposal site.

A detail decommissioning and restoration of site plan should have to be developed prior to the decommissioning of the project.

CHAPTER -07

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

7.1 General Considerations

In the context of a project, Environmental Plan is concerned with the implementation of the measures necessary to minimize or offset adverse impacts and to enhance beneficial impacts. Unless the mitigation and benefit enhancement measures that identified in the ESIA, are fully implemented, the prime function of ESMP cannot be achieved. All the measures are said to be successful when they comply with the Environmental Quality Standard (EQS) of Bangladesh. Thus, the objectives of ESMP for the present project would be

- Mitigation measures to reduce or eliminate negative impacts
- Enhancement measures to maximize positive impacts
- Monitoring requirement and
- Monitoring indicators

Feasible and economically expedient measures are planned to be implemented at EMP which can reduce to a reasonable level and/or exclude possible essential negative consequences of environmental impact.

At ESMP, in particular:

- expected adverse environmental impacts at construction stage and operation are identified and generalized;
- impact reduction measures are described;
- interrelation with existing impact reduction plans are established;
- parameters subject to measurement, monitoring methods to be applied, places of supervision, frequency of measurements are specified.

The environmental and social management plan includes the following elements facilitating it's timely and effective realization:

- management system - reflects implementation mechanism of ESMP;
- roles and responsibilities - identify persons responsible for realization of measures on impact reduction and monitoring;
- impact importance assessment - is intended for timely reveal of aspects invoking particular measures on impact reduction;
- environmental and social management plan includes the list of actions on impact decrease, monitoring, and also amount of expenses for their realization.

Each of these elements is described below in details.

7.2 System of environmental and social management

For effective implementation of recommendations on impact reduction it is necessary to organize a system of environmental and social management.

The model of the management system consists of four basic components:

- planning includes development of particular actions and procedures on their realization;
- introduction and functioning - are direct realization of actions;
- checks and correcting actions include monitoring of environmental objects and control over execution of actions;
- analysis includes reporting and efficiency assessment of the introduced actions.

The system of environmental and social management assumes conformity to the Standard of environmental management system ISO 14001 according to which constant improvement of the developed model (periodic updating with entering necessary revisions) is necessary. It is important to note, that special attention during management is paid to interaction with stakeholders, including submission of reporting and processing notes and offers received.

7.3 Roles and Responsibility

For realization of ESMP, it is necessary to identify persons responsible for performance of impact decrease/prevention actions, and also those responsible for control over the given actions and to define their role at all stages of the project implementation.

Table 7-1: Responsibilities for EMP Implementation

Organization	Responsibility
Mymensingh 360 MW dual fuel (gas/HSD) combined Cycle power plant project at Shambhuganj, Mymensingh, Bangladesh.	➢ Overall responsibility for environmental performance of 360 MW CCPP. ➢ Decision-maker on applicable policies to the 360 MW CCPP. ➢ Oversight supervisory role during the construction phase. ➢ Overall responsibility for ESMP implementation during the operation phase. ➢ Review reports of the Independent Environmental Monitoring Consultant. ➢ Approves changes to the ESMP, as necessary, as part of an adaptive approach to environmental and social management of the 360 MW CCPP. ➢ Responsible for working with stakeholders in Different issues. ➢ Develop a health, safety & environmental unit, headed by the Project Environmental Officer to implement ESMP responsibilities ➢ Management, implementation, monitoring and compliance of the ESMP, ESIA, and any approval conditions, including construction supervision and performance of all 360 MW CCPP staff, contractors and subcontractors. ➢ Review of ESMP performance and implementation of correction actions, or stop work procedures, in the event of breaches of ESMP conditions, that may lead to serious impacts on local communities, or affect the reputation of the project. ➢ Ensure effective communication and dissemination of the content and requirements of the ESMP to contractors and subcontractors. ➢ Assisting the contractor with implementation of ESMP sub-plans. ➢ Monitoring of ESMP and ESIA performance. ➢ Ensuring compliance to all project social commitments, including implementation of the social management and resettlement plans. ➢ Report on environmental performance to DOE as required. ➢ Prepare environmental reports summarizing project activities, as required. ➢ Representing the project at community meetings. ➢ Ensuring effective community liaison and fulfilling commitments to facilitate. ➢ public consultation throughout the project cycle. ➢ Monitoring of downstream impacts of Brahmaputra river and any reports of downstream decreased fish yields.
Supervising Engineer	➢ Preparation and implementation of the Environmental Supervision Plan during construction. ➢ Preparation and implementation of the Environmental Monitoring Plan during construction. ➢ Supervision of contractor performance on implementation of the Construction and Work Camp Management Plan. ➢ Reporting any incidents or non-compliance with the ESMP to the PMU.

	➢ Ensuring adequate training and education of all staff involved in environmental supervision. ➢ Making recommendations to the RPCL (PMU) regarding ESMP performance as part of an overall commitment to continuous improvement.
Construction Contractor	➢ Preparation and implementation of the Construction and Worker Camp Management Plan. ➢ Prepare and maintain records and all required reporting data as stipulated by the ESMP, for submission to the Supervising Engineer & Consultant ➢ Ensure that all construction personnel and subcontractors are informed of the intent of the ESMP and are made aware of the required measures for environmental and social compliance and performance. ➢ During construction, maintain traffic safety along access roads, with special emphasis on high traffic areas.
Independent Environmental Monitoring Consultant	➢ Report to RPCL and DOE on project compliance with environmental and social commitments in the ESMP, ESIA and other applicable standards.
Local Authorities	➢ Local authorities, communities and individuals shall take part in the supervision of both the ESMP and ESIA, where applicable.

7.3.1 Construction stage

General construction management and control over conducting technological process during construction works will be assigned to the contractor and RPCL project management. The contractor, in turn, concludes contracts with subcontract organizations performing works at the construction site. The RPCL authority bears responsibility under Project Implementation unit (PMU) for selection and assessment of subcontract organizations. Control functions over contract organizations activity in the field of labour safety, industrial safety and preservation of the environment are also assigned to the Consortium.

7.3.2. Operation phase

RPCL Management will be responsible to operate the power project under Operation & Maintenance unit (O&M) during the operation phase and will be responsible to maintain the environmental and social standard of the project.

7.4 Mitigation/Benefit Enhancement Measures

For effective and environment friendly operation of a project, a set for guiding tools and suggestions are necessary which need to be followed at various stages of plant installation, operation and maintenance. This plan generally has various components of management depending on the type of project or plant activity and types of discharge and their pollution potential. This Environmental and Social Management Plan (ESMP) once prepared forms the basis of environmental management actions from the part of the project authority may need

modification or up-gradation because of changes in the plant operation or accurate pollution load/environmental problems detected afterwards.

All beneficial and adverse impacts which may likely to occur at different phases of the project have been identified in section 6.0. Predictions, evaluation, aspect of mitigation and benefit enhancement measures have also been discussed concurrently with impacts prediction and evaluation. In view of the earlier discussion summary of recommended mitigation and benefit enhancement measures are presented in Table 7.2.

Table 7.2: Identification of Impacts, Mitigation measures, Monitoring and Management during Construction period

Issue/Impact	Mitigation Measures	Implementation Schedule	Monitoring	Responsibility		Monitoring Indicators	Type and Frequency of Reporting/ monitoring	Management and Training
				Implementation	Supervision			
Air Quality: Dust emissions caused by construction activities, construction vehicle movements, and transport of construction materials.	practices including: • appropriate sitting and maintenance of stockpiles of materials so as to minimize dust blow; • minimizing drop heights for material transfer activities such as unloading of materials; • construction phase to begin with construction of access roads; • roads will be kept damp via a water browser; • roads will be compacted and graveled if necessary; • site roads will be maintained in good order; • regulation of site access; • sheeting of lorries transporting construction materials and soil; • enforcement of vehicle speed limits on nonmetal roads to <20 km/h.	Before construction and during construction	A continuous visual inspection is needed. Measurements and analysis of different pollutants to be made on a continuous basis by a trained staff or third-party consultant and the report to be submitted to the RPCL authority.	Implementation of Good Site management practices shall be the responsibility of all contractors on site under supervision of the RPCL nominated Project Manager.	RPCL Project Manager in collaboration with the Consultant's Site Manager & third-party consultant	SPM, PM10, NO2, SO2 & CO.	Monthly reporting of summary results and submitted to the RPCL and any other concerned authorities. (e.g. DOE, ADB, etc.).	RPCL responsible for the management of the air quality monitoring system. Submission of monthly summary reports to DOE and any concerned authorities. Basic training of persons employed to operate and maintain the monitoring system. RPCL to ensure all contractors and subcontractors working on site are aware of ESMP and all employees are given basic induction training on good

								construction and site management practice.
Aquatic Environment: Construction of the intake structure and water discharge structure. Increased suspended sediment and pollutant loads, permanent loss and disturbance to aquatic flora and fauna.	The following measures will be taken: • Construction Method Statement to be produced by the Contractor; • dredged areas limited to minimum area required; • disposal of dredged sediments to an agreed site; • all works will be made clearly visible using flags, beacons and/or signals; • bank area will be reinstated following construction.	During construction of intake and discharge structures	Continuous visual inspection During dredging sediment and surface water will be monitored at two locations (upstream and downstream) Water sample should be collected from two locations, unless preliminary monitoring campaign shows strong variations in water quality.	Implementation of Good Site Management practices shall be the responsibility of all contractors on site under supervision of the RPCL the Project Manager.	RPCL Project Director in collaboration with the Consultant's Site Manager & third-party consultant.	Temp., PH, COD. BOD, TSS, TDS, DO, oil & grease etc.	Monthly reporting of summary results and submitted to the RPCL and any other concerned authorities. (e.g. DOE, ADB, etc.).	RPCL to ensure that all contractors and subcontractors working on site are aware of ESMP and all employees are given basic induction training on good construction and site management practice. These mitigation Measures must be a condition of any construction contracts.
Contamination of the aquatic environment as a result of construction activities on land e.g. spillages, disposal of liquid wastes; surface run-off, exposure	Mitigation activities will include the following: • no discharge of effluents into the river- all effluents shall be collected and removed off site for treatment by approved firms or disposed after proper treatment at site; • development of a site drainage plan which reduces flow Velocity and sediment load;	During construction	Continuous visual inspection will be conducted. Surface water run-off. Sewage effluents. Earth, mud and Debris depositions on roads.	Implementation of Good Site Management practices shall be the responsibility of all contractors on site under supervision of the RPCL Project management.	RPCL Project Director in collaboration with the Consultant's Site Manager & third-party consultant.	Liquid effluents from the outfall for Temp., PH, COD. BOD, TOC, DO, TSS, oil & grease etc.	Quarterly reporting of summary results and submitted to the RPCL and other concerned authority, e.g. DOE, ADB, etc., if required.	RPCL to ensure all contractors and subcontractors working on site are aware of ESMP and all employees are given basic induction training on good construction and site

of contaminated soils.	• protection of temporary stockpiles of soil from erosion by using a reduced slope angle where practical, sheeting and by incorporating sediment traps in drainage ditches; • maintenance of well kept construction site.		Water sample should be collected from the outfall, unless preliminary monitoring campaign shows strong variations in water quality.					management practices.
Noise: Increased noise in the project area as a result of the use of noisy machinery and increased vehicle movements.	Implementation of good site practices including: • enforcement of vehicle speed limits; • strict controls of vehicle routing; • diesel turbine construction equipment to be fitted with silencers; • limited noisy construction activities at night; • prohibition of light vehicle movements at night; • use of protective hearing equipment for workers.	During construction	Monthly monitoring and supervision by RPCL is required to ensure the implementation of good site management practices by all contractors during construction.	Implementation of Good Site Management practices shall be the responsibility of all contractors on site under supervision of the RPCL project management.	RPCL Project Director in collaboration with the Consultant's Site Manager & third-party consultant.	Noise complaints register to identify concerns. Check the noise level using noise measuring devices.	RPCL will produce a monthly log of valid complaints and actions taken. Monthly reporting of summary results and submitted to the RPCL and any other concerned authorities, e.g. DOE, if required.	RPCL to ensure all contractors and subcontractors working on site are aware of ESMP and all employees are given basic induction training on good construction and site management practices.
Flora and Fauna Site Clearance-Vegetation removal and	• Good site management practices will be observed to ensure that disturbance of habitats off-site are minimized.	During construction.	Periodic inspection and supervision by RPCL is required to ensure the	Implementation of Good Site Management practices shall be the responsibility of	RPCL Project Director in collaboration with the Consultant.	Good conservation of floral wealth.	Quarterly reporting No. of floral species conserved	RPCL to ensure all contractors and subcontractors working on site are aware of

Habitat disturbance.	• Specific mitigation measures include restricting personnel and vehicles to within construction site boundaries, lay down areas and access roads.		implementation of good site management practices by all contractors during construction.	all contractors on site under supervision of the RPCL project management.			or planted, if any.	ESMP and all employees are given basic induction training on good construction and Site management practices.
Soils and Hydrology: Site clearance, excavation and disposal of material, exposure of potentially contaminated soils, spillage or leakage of substances on land, movement of equipment and vehicles on site.	The potential impacts are largely dependent on management of the construction site and activities. The following mitigation measures will be implemented: • development of effective site drainage systems; • restriction of access only to construction site areas; • disposal of waste materials unsuitable for reuse on-site, (e.g. for landfilling) at appropriately licensed sites; • provision of oil and suspended solid interceptors; • management of excavations during construction to avoid the generation of drainage pathways to underlying aquifers; • provision of impermeable bases in operational areas to prevent absorption of spillages.	During construction.	Daily visual inspection is required to ensure the implementation of good management practices during construction.	Implementation of Good Site Management practices shall be the responsibility of all contractors on site under supervision of the RPCL project management.	RPCL Project Director in collaboration with the Consultant.	• site drainage. • access only to construction site areas. • waste materials. • oily waters. • drainage pathways. • potential spillage in Operational areas. Visual Inspection	Quarterly reporting of summary results submitted to the RPCL and any other concerned authorities (e.g. DOE, if required.	RPCL to ensure all contractors and subcontractors working on site are aware of ESMP and all employees are given basic induction training on good construction and site management practices.

Socio-Economic Environment: Positive impacts identified.	All activities related to the construction of the new plant will take place within the area belonging to RPCL, i.e. there will be no off-site activities or associated land acquisition during construction. Transmission lines & gas line will connect the new power plant to the existing substations and RMS. The entire labor force will be daily commuters; thus, no worker housing or associated facilities will be erected on site during construction. The contractors will be responsible for relevant temporary water / toilet facilities during construction and the need to provide appropriate services will be specified in their contracts.	During construction.	Record local employment provided by the project.	RPCL Project management	RPCL Project Director in collaboration with the Consultant.	Workers satisfaction as measured by staff interviews and complaints reported. Visual Inspection	Quarterly reporting	Responsibility of RPCL.
Traffic and Transport: Disruption, noise and increased air pollution due to	Standard good practice measures will be implemented as follows: • adherence of abnormal load movements to prescribed routes, outside peak hours and advance	During construction.	Monitoring traffic entering the site during morning & evening peaks to ensure the implementation of good site management	Implementation of Good Site Management practices shall be the responsibility	RPCL Project Director in collaboration with the Consultant.	Increased congestion Travel time (compared to reasonable	Quarterly reporting of summary results submitted to the RPCL and any	RPCL to ensure all contractors and subcontractors working on site are aware of ESMP and all employees are

increased traffic, light loads and abnormal loads. Traffic Management Plan of the project is given as the Annexure-14(a).	publication of movements if required; • construction shifts will be staggered; • scheduling of traffic to avoid peak hours on local roads; • transportation of construction workers by contract bus.		practices by all contractors during construction.	of all contractors on site under supervision of the RPCL project management.		daily commute) Visual Observation	other concerned authorities (e.g. DOE, if required.	given basic induction training on good construction and Site management practices.
Archaeology: Potential chance finds of archaeological remains during construction.	The project site does not lie on, or in the immediate vicinity of any known archaeological areas of interest. If remains are found RPCL is committed to: • cease activities and consult archaeological department; • protection in situ if possible; • excavation of areas where protection not feasible;	During construction.	Supervision of construction activities.	RPCL project management will allocate responsibilities in accordance with the construction site plan.	RPCL Project Director in collaboration with the Consultant.	Visual observation	Quarterly reporting of summary results And submitted to the RPCL and any other concerned authorities (e.g. DOE, if required	RPCL to ensure that all workers on site are aware of the importance of archaeological remains and must report any potential finds immediately.
Natural Disasters Flash flooding.	Good engineering design will incorporate the following mitigation measures: • drainage system designed to direct flood water from main	During construction.	No monitoring measures are envisaged.	RPCL project management	RPCL Project Director in collaboration with the Consultant.	Visual observation	Quarterly reporting of summary results submitted to the RPCL and any other concerned	RPCL to ensure that all workers on site receive training in emergency preparedness and response procedures.

	plant areas into the river and direct potentially contaminated waters through the oil interceptor.						authorities (e.g. DOE, if required	
Solid Waste Management	Good practice measures such as the following: (1) all waste taken off-site will be undertaken by a licensed contractor and RPCL will audit disposal procedure; (2) collection and segregation of wastes and safe storage; (3) recording of consignments for disposal; (4) prior agreement of standards for storage, management and disposal with relevant authorities. It is of highest importance that final disposal of wastes shall be strictly adhered to environment friendly disposal Contract. RPCL will plan a decommissioning plan for the disposal of old units.	During construction.	Periodic inspection is required to ensure the implementation of good management practices during construction.	Implementation of Good Site Management practices shall be the responsibility of all contractors on site under supervision of the RPCL project management	RPCL Project Director in collaboration with the Consultant	Management contract in place	Quarterly reporting of summary results submitted to the RPCL and any other concerned authorities (e.g. DOE, if required	RPCL to ensure all contractors and subcontractors working on site are aware of ESMP and all employees are given basic induction training on good construction and site Management practices.
Occupational Health & Safety	Good local and international construction practice in Environment, Health and Safety (EHS) will be	During construction.	Daily inspection is required to ensure the implementation of EHS Policies, plans and	Implementation of good site management	RPCL Project Director in collaboration with the	Management procedures in place.	Daily inspection Quarterly reporting of	RPCL to ensure all contractors and

	applied at all times and account will be taken of local customs, practices and attitudes. Measures include: • implementation of EHS procedures as a condition of contract all contractors and subcontractors; • clear definition of the EHS roles and responsibilities for all construction companies and staff; • management, supervision, monitoring and record-keeping as set out in plant's operational manual; • pre-construction and operation assessment of the EHS risks and hazards; • completion and implementation of Fire Safety Plan prior to commissioning any part of the plant; • provision of appropriate training on EHS issues for all workers; • provision of health and safety information; • regular inspection, review and recording of EHS performance;		practices during construction.	practices and the EHS policies shall be the responsibility of all contractors on site under the supervision of the RPCL project management.	Consultant.	Workers health and safety as measured by number of incidents.	summary results submitted to the RPCL and any other concerned authorities (e.g. DOE, if required	sub-contractors for workers on site include reference to the requirement of the ESMP and are aware of the EHS policies of the project. All employees will be given basic induction training on EHS policies and practices. Contractors are responsible for ensuring that a Fire Safety Plan, is prepared and implemented prior to commissioning of any part of the plant under supervision of RPCL project management.

	• maintenance of a high standard of housekeeping at all times.							

Table 7.3: Identification of Impacts, Mitigation measures, Monitoring and Management during Operational period

Issue/Impact	Mitigation Measures	Implementation Schedule	Monitoring	Responsibility		Monitoring Indicators	Type and Frequency of Reporting/ monitoring	Management and Training
				Implementation	Supervision			
Air Quality Emissions from stack are not expected to exceed standards.	Mitigation measures have already been included in the design of the plant and, no further mitigation measures are proposed.	Life time of plant operation.	Automatic monitoring of stack emissions for NOx & SO2 to be installed in the stacks.	The analyzer stations will be owned and operated by RPCL	RPCL Top Management & EHS department	Stack emissions of NOx & SO2 concentration.	Continuous Hourly data acquisition. Quarterly reporting to RPCL. Reports are to be available to any of the concerning Authorities Quarterly reporting to RPCL.	Records must be kept and summary data (including any deviations from DOE and World bank standards) will be submitted to the DOE and ADB as regular basis.
Ambient air quality affected	RPCL will implement the mitigation measures suggested	Life time of plant operation.	Conduct ambient air quality monitoring for NOx, SO2, PM10 &	Third party monitoring	RPCL Top	Ambient air pollutants concentrations	Reports are to be available to any of the	Quarterly reporting by RPCL to

by emissions from the power plant.	in the ESIA report. If ground level concentrations are found to be above the local and World Bank standards, options for further mitigation will be discussed.		PM2.5 at different locations around the project site.		Management & EHS department Third party inspection.	(at least PM10, PM2.5, NOx, and SO2).	concerning Authorities	Government and ADB etc. (or more frequently if required) highlighting key features and comparing results with air quality standards and prediction in ESIA report
Aquatic Environment Discharge of process and cooling water.	The design of the intake and discharge water structures have already been incorporated with measures to reduce impacts. In addition, good site management practices including the following will be implemented: 1) proper treatment of contaminated water or cooling water before discharge to natural water body.	Life time of the Plant	Prepare a monthly water quality monitoring program at the upstream & downstream of the river including: 1) quality of all water prior to discharge (temperature, pH, COD, BOD, TSS, oil & grease and residual chlorine.	RPCL Project management. Third party monitoring supervised by the RPCL Management	RPCL management & EHS department.	Basic parameters as per the ECR 1997	Monthly reports Prepared by RPCL or third party. Reports are to be available to any of the concerning Authorities	Records will be kept and compared on regular basis against Bangladesh and World Bank standards and impacts predicted in ESMP. RPCL to ensure that all employees are given basic induction training on the requirements of the ESMP, good

	2) no disposal of solid wastes into the discharge structure; 3) regular maintenance of site drainage system to ensure efficient operation; 4) all discharges will comply with local and World Bank guidelines.							site management practices and H&S procedures.
Noise Quality	Specific design mitigation measures to minimize noise impacts include: • gas turbines, steam turbine generators; air compressors, pumps and emergency diesel turbine s are enclosed in the Buildings with proper acoustic design;	Life time of the plant operation.	When the plant is fully operational, noise audit measurements are to be carried out at noise sources and at the fence of the power plant as well as at noise receptors around the plant.	RPCL Project management. Third party monitoring supervised by the RPCL Management	RPCL management & EHS department.	Power plant to comply with ESMP suggestions.	Monthly noise reports Prepared by RPCL or by third party. Reports are to be available to any of the concerning Authorities	Should any complaints be received regarding noise, these will be logged and the RPCL EHS team will investigate the problem. RPCL to ensure that all employees are given basic induction training on the requirements of the ESMP, good

								site management practices and EHS procedures.
Flora and Fauna: Disturbance to habitats as a result of noise, vehicle and personnel movements.	The following mitigation measures will be implemented: • restrict personnel and vehicle movements to access roads and within boundaries of site only; • control of noise during operation.	Life time of the plant.	No monitoring is envisaged.	RPCL Project management	RPCL management & EHS department.	Good plantation	Yearly report prepared by RPCL or by third party.	RPCL to ensure that all employees are given basic induction training on the requirements of the ESMP, good site management practices and EHS procedures.
Visual Impact Visual image of Power plant from surrounding areas.	The visual effect of the power plant will be improved through: • creation of landscaped boundary along the fence of the power plant. • Planting sufficient number of trees around the project site	Life time of the plant.	No monitoring is envisaged.	RPCL Project management	RPCL management & EHS department	Improved visual image		Management to consider the landscaped areas to maximize visual image and habitat creation. RPCL to manage and maintain proper landscaped areas.

Soil and Hydrology: Spillage of oils, chemicals or fuels on site.	Good site management measures as described in the ESMP, under aquatic environment will minimize any potential risks. As part of this, regular checks of bunds and drainage systems will be undertaken to ensure containment and efficient operation.	Life time of the Plant	The RPCL authority will continuously monitor application of ESMP and good site management.	RPCL Project management	RPCL management & EHS department	Quality of bunds and drainage systems. Efficiency of operation.	Yearly report prepared by RPCL EHS department Reports are to be available to any of the concerning Authorities	RPCL to ensure all employees will receive related training.
Solid Waste	Good practice measures undertaken during the construction phase will be continued into the operation phase. It is of highest importance that final disposal of wastes shall be strictly adhered to environment	Lifetime of the plant	Continuous monitoring is required to ensure the implementation of good management practices during operation.	RPCL Project management	RPCL management & EHS department	Efficient waste collection and disposal system should be done by either RPCL or Contractor in place.	Quarterly reports from the EHS to RPCL management. Reports are to be available to any of the concerning Authorities	RPCL to ensure all employees are given basic induction training on good operation and site management practices.

	friendly disposal contract.							
Occupational Health and Safety, Risks and Hazards	The stand mitigation that has been suggested in the ESMP report will be implemented and followed on site.	Lifetime of the Plant	Regular on-site training. Regular staff checks, system checks and field tests of emergency procedures by on-site management.	RPCL Project management	RPCL management & EHS department.	Management procedures in place. Workers health and safety status, incidents, injuries, slip, trip, falls and near misses are properly documented.	Quarterly reports from the EHS to RPCL management. Reports are to be available to any of the concerning Authorities	RPCL to ensure that all employees are given basic induction training on EHS policies and procedures, Emergency Preparedness and Response Plan.
Repair and maintenance schedules for the turbines and cooling system	The gas turbine, steam turbine and cooling system require repair and maintenance schedules for the turbines and cooling system to maximize life cycle and operation efficiency.	Lifetime of the Plant	• As per the manufacturer's schedule the gas turbine set needs timely minor, hot gas path and major inspection at specific time interval. • The repair and maintenance of steam turbine and cooling water system will be done	RPCL Project management	RPCL management & EHS department.		The GT unit needs a major inspection after 100000 Equivalent Operating Hours and 8 minor inspections within the time as per schedule. 3 times Hot Gas Path Inspection is also required	RPCL to conduct the inspection with specialists as per schedule.

			according to the manufacturer's recommendation and as required.				as per schedule.	

7.5 Monitoring Plans and Schedules

7.5.1 During Construction Phase

The environmental monitoring program should be carried out as an integral part of the project planning and execution. It must not be seen merely as an activity limited to monitoring and regulating activities against a pre-determined checklist of required actions. Rather it must interact dynamically as project implementation proceeds, dealing flexibly with environmental impacts, both expected and unexpected. For this purpose, it is recommended that the Project Director (PD) for this specific project should take the overall responsibility of environmental management and monitoring. The PD will form a team with required manpower and expertise to ensure proper environmental monitoring, as specified in Table 7.4 below, and to take appropriate measures to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. The PD through its team will make sure that the Contractor undertake and implement appropriate measures as stipulated in the contract document, or as directed by the PD to ensure proper environmental management of the project activities. It should be emphasized that local communities should be involved in the management of activities that have potential impacts on them (e.g., traffic congestion in the surrounding areas). They should be properly consulted before taking any management decision that may affect them. Environmental management is likely to be most successful if such decisions are taken in consultation with the local community.

Table 7.4 summarizes the potentially significant environmental impacts during construction phase, the measures needed to eliminate or offset adverse impacts and enhance positive impacts.

Table 7.4 Potentially significant environmental impact during construction phase and mitigation measures

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Influx of Workers	• Generation of sewage and solid waste	• Construction of sanitary latrine and septic tank system (one latrine for 20 persons) • Erecting “no litter” sign, provision of waste bins/cans, where appropriate • Waste minimization, recycle and reuse • Proper disposal of solid waste (in designated waste bins)	Contractor (Monitoring By RPCL)
	• Possible spread of disease from workers	• Clean bill of health, a condition for employment • Regular medical check-up of workers	
Transportation of equipment, materials and personnel; storage of materials	• Increased traffic/navigation • Generation of noise, especially affecting the nearby residential areas	• Scheduling of deliveries during after regular working hours • Protecting local community from traffic hazard during construction phase, with installation of proper traffic sign and warnings	Contractor (Monitoring by RPCL)

	• Deterioration of air quality from increased vehicular movement, affecting people in the surrounding areas	• Keeping vehicles under good condition, with regular checking of vehicle condition to ensure compliance with national standards	
	• Wind-blown dust from material (e.g., fine aggregate) storage areas	• Watering unpaved/dusty roads (at least twice a day; cost estimate provided) • Sprinkling and covering stockpiles • Covering top of trucks carrying materials to the site and carrying construction debris away from the site	
Construction activities, including operation of construction equipment	• Generation of noise from construction activities (general plant and access road construction), especially affecting the local resident	• Use of noise suppressors and mufflers in heavy equipment • Avoiding, as much as possible, construction equipment producing excessive noise during at night • Avoiding prolonged exposure to noise (produced by equipment) by workers • Creating a buffer zone between the neighbouring community and construction site	Contractor (Monitoring by RPCL);
	• Deterioration of air quality from wind-blown dust and possible use of equipment, such as stone (aggregate crushers)	• Not using equipment such as stone crushers at site, which produce significant amount of particulate matter • Keeping construction equipment and generators in good operating condition • Using equipment, especially generators with high levels of emission control. • Immediate use of construction spoils as filling materials • Immediate disposal/sale of excavated materials • Continuous watering of bare areas	
	• Generation of construction Waste	• Hauling of construction debris away from the site and their appropriate disposal in a designated disposal site	
	• Accidents	• Regular inspection and maintenance of equipment • Environmental health and safety briefing • Provision of protective gear	
	• Spills and leaks leading to soil and water contamination with hydrocarbon and PAHs	• Good house keeping • Proper handling of lubricating oil and fuel • Collection, proper treatment, and disposal of spills	
	• Employment of work/labour force	• Local people should be employed in the project activities as much as possible.	

7.5.2 Operation Phase

Most of the environmental parameters will experience beneficial effects during the operation phase of the power plant project. Efforts should be made to enhance these beneficial impacts, which may include incentives for proper growth of more projects in the area. The plant management authority of RPCL should be responsible for overall environmental monitoring during the operation phase of the project.

Table 7.5 summarizes the potentially significant environmental impacts during operation phase, the measures needed to eliminate or offset adverse impacts and enhance positive impacts.

Table 7.5 Potentially significant environmental impact during operation phase and mitigation measures

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Power Generation	• Emission from the power plant	• Using stack as specified in the design • Using low nitrogen oxide burners, as specified in the design • Installation of stack emission monitoring equipment for major pollutants. An in-house Continuous Air Monitoring Station (CAMS) may be considered. • In stack design due consideration should be given to proper insulation • Planting of trees around the project site, especially along the south and south-east boundary of the project site	RPCL
	• Generation of noise	• Provision of silencers for generators and turbines • Planting of trees around the project site • Regular plant maintenance • Regular noise monitoring, especially at the project boundary and residential quarters located nearby • Use of ear-muffs and ear-plugs by plant personnel working in the generator and turbine facilities of the plant	
Water Consumption	• Depletion of groundwater resources	• Regular monitoring of groundwater level	RPCL
Surface Water Abstraction	• Scarcity of river water during off monsoon	• Regular monitoring of surface water level and river water quality at the upstream and downstream of the discharge point	RPCL
Waste Generation	• Inappropriate disposal of sewage causing environmental pollution • Generation of solid waste including sludge from demineralizer.	• Good housekeeping • Proper construction and maintenance of wastewater disposal system for the plant premises. • Ensuring proper storage, treatment, and disposal of all solid waste • Monitoring of effluent quality from treatment plant • Monitoring of river water quality and discharge water quality	RPCL

	• Possible water Pollution		
Occupational Health & Safety of workers	Non-ionizing radiation, Heat, Noise, Confined spaces, Electrical hazards, Fire and explosion hazards, Chemical hazards, Dust, sanitation, safe drinking water etc	• Regular health check-up of workers • Proper PPE should be provided to protect from the heat, electric shock and noise protection, • Regular awareness and training should be provided for fire safety & chemical hazard, • Safe drinking water should be provided	RPCL
Turbines and cooling system inspection	Machine performance may deteriorate with time.	• As per the manufacturer's schedule the gas turbine set needs timely minor, hot gas path and major inspection at specific time interval. Schedule for GT maintenance has been added • The repair and maintenance of steam turbine and cooling water system will be done according to the manufacturer's recommendation and as required.	RPCL

7.6 Monitoring Parameters

7.6.1 Construction Period

There are two types of monitoring during construction, 1) Visual Monitoring and 2) Analytical Monitoring. The following are the visual monitoring, it's parameters and monitoring frequency for the RPCL 360 MW CCPP:

1. Visual monitoring and observation

Table-7.6: Monitoring plan during construction phase of the project (Visual)

Issue	Key aspects	Monitoring Frequency	Responsibility
Traffic volume	Incoming & outgoing traffic, traffic movement records	Monthly	EPC Contractor/ Consultant
Site Security	Proper fencing, isolation of site from general access, marked passage for workers and visitors	,,	,,
Personal Protective Equipment	Ensure every single person involved in the construction activity wear proper PPE	,,	,,
Incident record & reporting	Documented record of all incident, accident, near misses etc. and its remedial process.	,,	,,
Solid waste	Quantity of solid waste, segregation and disposal process	,,	,,
Oily waste generation & disposal system	Quantity of oily waste, storage and disposal process	,,	,,

Worker's health	Monitoring process of worker's health	,,	,,
Complain from neighbours	Any significant complain from neighbours and its remedial procedure	,,	,,
Safety orientation & training of workers	Frequency of training & orientation of workers for safety	,,	,,
Sanitation & drinking water facility to workers	Availability of safe drinking water and sanitation to the workers	,,	,,
Site Drainage	Maintaining proper drainage	,,	,,

2. Analytical Monitoring during construction

Table-7.7: Monitoring plan during construction phase of the project (Analytical)

Issue	Parameters	Monitoring Frequency	Responsibility
Ambient air Quality	PM_{10} and $PM_{2.5,}$ SO2 and NOx	Monthly	EPC Contractor/ Consultant
River water	Water temp., DO, BOD_5, COD, Oil and Grease and heavy metals (Cr, Cd, Pb)	Monthly	,,
Groundwater	Groundwater level, p^H, TDS, Ammonia, Nitrate, Phosphate, As, Fe, Mn and Coliforms	Once in 6 months	,,
Soil quality	Cr, Cd, Pb and Oil and Grease	Once in 12 months	,,
Noise level	Noise at different locations	Monthly	,,
Drinking water	p^H, Ammonia, Nitrate, Phosphate, As, Fe, Mn and Coliforms	Monthly	,,

7.6.2 Operational Period

The following are the monitoring parameters and monitoring frequency for the RPCL 360 MW CCPP during operation:

Table 7.8 Monitoring plan during operational phase of the project

Issue	Parameters	Monitoring Frequency
Stack emissions	NOx, SOx, SPM, O2 and temperature	Continuous
Ambient air quality	CO, SOx, NOx, PM10, PM2.5,	Once in 3 months
Effluent quality	pH, DO, Sulfate, TSS, TDS, BOD, COD, Total N, Total P	Once in 3 months
Groundwater	pH, Colour, Turbidity, TDS, Ammonia, Nitrate, Phosphate, As, Fe, Mn and Coliforms; Groundwater level	Once in 6 months
Noise level	Noise at different locations	Once in a month

Vegetation	Number and Condition	Once a year
Occupational health and safety	Health status and safety	Once in 6 months
Turbines and cooling system inspection	Machine condition and operation performance	The GT unit needs a major inspection after 100000 Equivalent Operating Hours and 8 minor inspections within the time as per schedule. 3 times Hot Gas Path Inspection is also required as per schedule.

7.6.3 Monitoring cost

The proposed monitoring parameters and the frequency to be monitored in accordance with the monitoring plan have been presented in Table 7.7 & Table 7.8 during the construction and the operation of the proposed project respectively. The estimated cost of environmental monitoring and training program during the construction phase and operation phase has been given in. Table 7.9, Table 7.10 & Table 7.11.

Table 7.9 Cost estimate for environmental monitoring other measures during construction

Item	Parameter	unit cost (Taka)	Unit per year	Total cost per year (Taka)
Visual	Visual monitoring	100000.00	12	1200,000.00
Ambient air Quality	CO, NOx, SOx, PM10 and PM2.5	25000.00	12	300,000.00
River water	Water temp., DO, BOD5, COD, Oil and Grease and heavy metals (Cr, Cd, Pb)	30000.00	12	360,000.00
Groundwater	Groundwater level, pH, TDS, Ammonia, Nitrate, Phosphate, As, Fe, Mn and Coliforms	30000.00	12	360,000.00
Soil quality	Cr, Cd, Pb and Oil and Grease	50000.00	2	100,000.00
Noise level	Noise at different locations	10000.00	26	260,000.00
Process waste	Solid waste	5000.00	52	260,000.00
Health	Health status of the workers	20000.00	6	120,000.00
	Total Cost			29,60,000.00

Table 7.10 Cost estimate for environmental monitoring during operational phase

Item	Parameter	unit cost (Taka)	Unit per year	Total cost per year (Taka)
Stack emissions	NOx, SOx, SPM, O2 and temperature	30,00000.00		30,00000.00
Ambient air quality	CO, NOx, SOx, PM10, PM2.5,	30000.00	04	120,000.00
Effluent quality	pH, DO, Sulfate, TSS, TDS, BOD, COD, Total N, Total P	30000.00	04	120,000.00

Groundwater	pH, Color, Turbidity, TDS, Ammonia, Nitrate, Phosphate, As, Fe , Mn and Coliforms; Groundwater level	30000.00	02	60,000.00
Noise level	Noise at different locations	10000.00	12	120,000.00
Vegetation	Number and Condition	25000.00	01	25000.00
Occupational health and safety	Health status and safety	25000.00	02	50,000.00
	Total cost			34,95,000.00

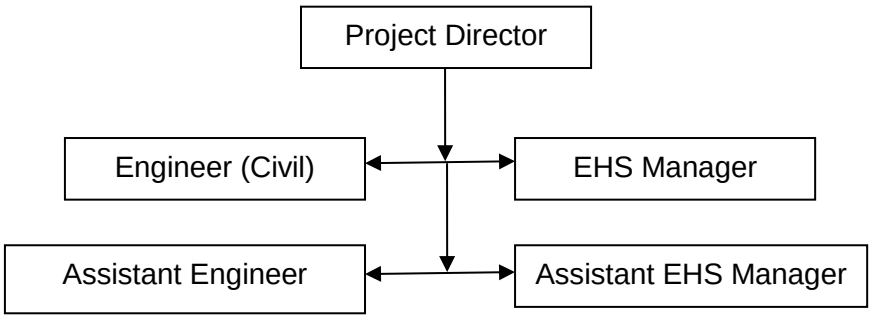
Table 7.11 Cost estimate for training during operational phase

Item	Number	unit cost (Taka)	Total cost per year (Taka)
Safety and occupational health	02	200,000.00	400,000.00
Environmental management system	02	300,000.00	600,000.00
Total cost during operational phase			10,00,000.00

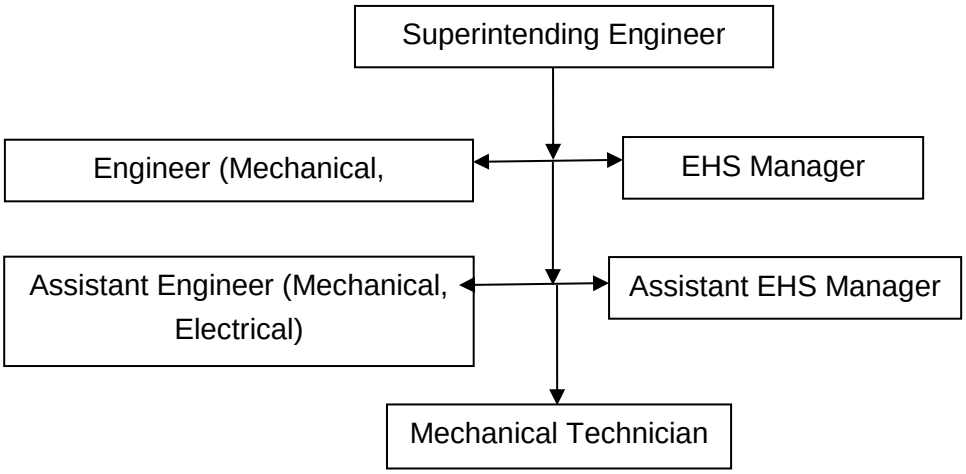
7.6.4 Resources and Implementation

The environmental parameters to be monitored during the construction and operational phases along with the monitoring schedule have been presented in the previous sections. The responsibilities for the implementation of the proposed monitoring plan may be entrusted with the external contractor in association with the RPCL personnel and under the direct supervision of the RPCL management. It is very important to make sure that the potentially significant impact during both the construction and operation phases are properly addresses through adaptation of the proposed mitigation and enhancement measures. It is equally important to undertake environmental monitoring during both the construction and operation phases according to the proposed monitoring plan. These should therefore be made integral part of the proposed power plant project. The following are the management team of RPCL who will be responsible for the monitoring program of the proposed project during the construction and operation period;

Team for Environment monitoring and ensuring compliance during construction



Team for Environment monitoring and ensuring compliance during operation



7.7 ESMP Monitoring and Review

The environmental unit of the RPCL shall periodically review, monitor and audit the effectiveness of the ESMP, including all sub-plans. The audit program should adequately cover the scope, audit frequency and methods that are typically required for large infrastructure projects. The frequency of audits should reflect the intensity of activities (typically more common during construction), severity of environmental and social impacts and non-compliances raised in prior audits.

7.7.1 Review of the ESMP

The environmental unit of the RPCL shall review the ESMP & ESIA to assess its effectiveness and relevance as follows:

- A full review shall be undertaken annually;
- Following a reportable incident, or a significant non-compliance; and
- Following an addition, up-date or change order to the ESMP, or a sub-plan.

The review of the ESMP should consider the following:

- Adequacy of data collection, analysis and review;
- Reporting;
- Non-compliances; and
- Corrective actions implemented.

The ESMP shall also be reviewed periodically to evaluate environmental controls and procedures to make sure they are still applicable to the activities being carried out. Reviews will be undertaken by the RPCL Environmental Unit as follows:

- The full ESMP shall be reviewed at least annually;
- Relevant parts of the ESMP shall be reviewed following a reportable incident;
- Relevant parts of the ESMP shall be reviewed following the receipt of an updated sub plan;
- Relevant parts of the ESMP shall be reviewed on request of stakeholders, Contractor, Supervising Engineer, World Bank/DOE or the host communities.

The review shall include analysis of the data collection and analysis of data, monitoring reports, incident reports, complaints/grievances and feedback from stakeholders, community reports, consultation meeting minutes and training records to evaluate the effectiveness of ESMP procedures. Site visits, interviews and other auditing methods may also be used.

7.8 Safety Mitigation Plan

Safety Management System

Safety is an integral part of the company's work. It is part of the company's operations and there to protect employees, clients, property, the environment and the public. There are many costs to accidents and unsafe work practices. The greatest costs are human cost. Protecting employees also protects their friends, families, fellow workers, management, the public and the environment from the far-reaching effects of serious accidents. In addition to protecting lives, a safety program contributes to employee morale and pride because employees participate in identifying safety needs and developing safe work procedures.

Visitors to the worksite may also face legal action if they knowingly disobey safety rules. In addition, the company may face legal action and fines for violations of regulatory requirements. Those individuals who do not fulfill their safety responsibilities will become accountable for any problems their negligence creates and may be liable under the law.

Everyone employed by a company is responsible for maintaining the safety program. Managers and supervisors are responsible for identifying safety needs, communicating safety hazards, investigating hazardous conditions and accidents, providing training, supply or wearing appropriate safety and personal protective equipment, and ensuring all equipment is properly maintained and meets legislated safety standards. Their role is supported by input from all employees.

All company employees are responsible for obeying all safety rules, following recommended safe work procedures, wearing and using personal protective equipment when required, participating in safety training programs and informing supervisors of any unsafe work conditions. Everyone has the right and responsibility to refuse to do work when unsafe conditions exist. By fulfilling safety responsibilities, workers will share the benefits of a safety place.

The company must have its own safety management and mitigation plan and policy. Listed below are the important features that need proper attention of company management.

Company Safety Policy

The company must have its own safety policy. The safety policy should be updated from time to time. The policy should be signed and dated by the chief safety officer. The policy should be discussed with all personnel. The chief safety officer should periodically review the policy and re-issue the policy.

Safety Responsibilities

All personnel should have safety responsibilities assigned to them. The documented responsibility should be included in the program manual. Compliance with the responsibilities should be monitored and if these are not carried out for some good reason, corrective measures should be taken.

Management Communication

The management should decide how it communicates periodically with the personnel regarding safety. A site schedule for conducting site tasks should be developed; this should be included in the safety program manual. Documentation of site tours should be retained for verification.

Inspections

A list of all work sheets, equipment, vehicles and work practices requiring inspection should be developed. Checklists and schedules should be developed as part of the inspection program. A system for correcting deficiencies noted during the inspection process must be developed. The system should prioritize deficiencies noted so that serious hazards are dealt with immediately.

Personnel Protective Equipment (PPE)

The work site should be assessed to determine what personal protective and safety equipment is needed and the equipment must be available. A maintenance schedule must be developed for PPE and records for maintenance retained on file. Employees must be trained in fitting, care, maintenance and use of PPE.

Detailed rules and procedures identifying company and legislative requirements and expectations must be communicated to all employees and contractors. They serve as a reference and describe the minimum standard by which business is conducted. Most important rules and procedures ensure consistency in the performance of tasks by all employees. The current rules should be reviewed and assessed as to whether they are appropriate for the operation/facility/employees. The formulated rules must be communicated to the workers

effectively, and workers must ensure that they understand the rules and have no difficulty to comply with the rules.

Standard Work Procedure

The intent of standard work procedures is to ensure consistency in the performance of hazardous work and it must form the minimum standards by which specific tasks are performed. Workers must have clear understanding of the procedures they are required to follow. A system for periodic review of procedures must be developed. The employees involved in the work will be given an opportunity to suggest steps that would provide for continuous improvement to the procedures. The work procedures shall also ensure that all hazardous tasks have been accounted for. Procedures and codes of practice have to be developed for hazardous work. To determine compliance with safety and hazard issues while performing a task by a worker, efforts should be made to ensure the following:

- Confirm that employees affected by these tasks participate in the development of safe work procedures,
- Confirm that the employees are involved in the maintenance of safe work procedures,
- Interview workers to determine if they know what tasks have work procedures, where these procedures are located and generally what makes up to content,
- Review records to ensure that employees receive training on hazardous work procedures and codes and practices,
- Where practical, observe employees performing critical tasks to confirm use of standard work procedures and codes of standards.

Emergency Procedures

Emergency procedures will identify who does what and when in the event of an emergency. Responsibility for who is in charge of the co-ordination of emergency actions shall be identified. The procedures shall be easily referenced, concise and understandable. All employees shall be aware of the content and location of the procedures. The content lists associated with the procedures will be current. The procedures will be updated and tested on a regular basis. The training record and level of training gained by an employee shall be verified so as to ensure his first aid training. Subcontractor employees will also be trained in first aid. The following are the important events that need emergency procedures.

- Fire
- Injury/death
- Leakages and other releases of hazardous substances
- Natural disasters

Safety Orientation and Training

Initial safety training is one of the most important aspects of any safety program. All employees and contractors must receive some level of basic training, specific to the facility and nature of the job. It must be ensured that appropriate orientation is given to:

- Employees
- Contactors
- Sub-contractors
- Visitors

The orientation shall also include a review of the following:

- Company safety policy and procedures
- Specific job hazards
- Safety precautions
- Job responsibilities
- Regulatory requirements
- Company enforcement policy, and
- Worker right-to-know and authority to refuse unsafe work.

Reporting Incidents and Accidents

All accidents and near-miss incidents shall be investigated to determine what caused the problem and what action is required to prevent a recurrence. Employees required to perform investigations shall be trained in accident investigation techniques. The incident/accident investigation should be a fact-finding exercise rather than faultfinding. The investigations will focus on collection of evidence to find out the “root cause” of the incident. The recommendations of the investigation report are implemented in phases.

Power plant construction and operation facilities have been and will continue to be designed to comply with the legal elements of both national and international standards, legislation, codes of practice and design specifications, and best practices. As a part of this process, measures to minimize the probability of releases and reduce potential impacts through selection of alternative processes to be considered as an integral part of the development.

Mitigation should reflect the intent and regulatory framework outlined in the GoB Environmental policy and in applicable World Bank Operational Directives. The purpose of impact mitigation and counter measures is to avoid creating negative impacts wherever possible, to minimize impacts where they may be unavoidable, and to generate opportunities for improvements or positive impacts where appropriate.

Protective Equipment

The main reason for protecting workers is to eliminate or reduce the possibility of injury. The Occupational Health and Safety Act (USA) requires that every worker shall "wear or use such personal protective clothing, equipment or devices and is necessary for his or her protection from the particular hazards to which he or she is exposed".

There are some people who resist wearing protective clothing or devices, and will only wear protective equipment when forced to do so. This is not the right attitude to take for the worker's own safety. The consequences of an accident to his quality of life can be major. He can also lose his life. Personal protective equipment provides the worker with a measure of protection, but for it to be really effective; it must be accompanied by the right attitude towards during his job the right way. The wearing of personal protective equipment does not guarantee that he won't get injured. However, when coupled with a good safety attitude it will reduce the likelihood and severity of accidents.

Body Parts That Require Protection

The body and its internal organs can be seriously injured, by any violent impact with an object. A direct blow to any part of a worker's body, even with protection, can easily result in some injury, either major or minor. The following eight areas or parts of the body require protection:

1. Head 2. Arms 3. Eyes 4. Chest 5. Hearing 6. Legs 7. Hands 8. Feet

The worker's head houses his brain, which controls all the motor and sensory functions of his body. Any blow to his head, no matter how slight, can be very dangerous and result in injuries ranging from dizziness to total disability and even death. One of our most valuable senses is light. One must protect his eyes from the dangers of flying objects, bright light and chemicals. Without eyes, one would live a life in total darkness. Hearing damage is not often a result of an accident, unless someone has had a head injury. A more common problem is hearing loss which can occur one exposed to noise levels above the exposure limits, as outlined in the Noise Regulation. In Table 7.12 Occupational Exposure Limits are described with a maximum permitted duration in the following page. Without hearing protection in a sound level of 100 dB maximum permitted duration is 1 hour/day.

Table 7.12: Occupational Exposure Limits (Without hearing protection)

Sound level (dB)	Maximum Permitted Duration (hours per day)
85	8
90	4
95	2
100	1
105	2

110	1/4
115	1/8
Greater Than 115	0

The longer one is expected to high noise levels, the greater the potential hearing loss. Hearing loss associated with exposure to noise tends to be gradual. It may take several years before one can realize that for some reason he has difficulty hearing normal conversation. Hearing is a valuable asset that should be preserved, so the worker can have a full and productive life. In Table 7.13, Safety hazard prevention, control and mitigation measures are described for particular event.

Table 7.13: Safety Hazard Prevention, Control and Mitigation Measures

Event	Prevention, Control and Mitigation Measures
General Instruction of Workers	❖ Personal and continuous visual supervision of the worker who is not competent to perform the job. ❖ Workers to be conversant on the codes and standards of safety. ❖ Workers must be confident that they have adequate training on handling or unsafe hazards material.
Maintenance of Equipment	❖ Employer shall ensure that all equipment used on a work site is maintained in a condition that will not compromise the health and safety of workers using or transporting the equipment. ❖ Will perform the function foe which it is intended or was designed ❖ Is of adequate strength for that purpose ❖ Is free from potential defects.
Traffic Hazard	❖ Where there is a danger to workers from traffic, an employer shall take appropriate measures to ensure that the workers are protected from traffic hazards. ❖ Ensure that workers who are on foot and who are exposed to traffic hazards on traveled rural roads wear reflective vests or alternative clothing that is cleanly distinguished. ❖ Where the operator of vehicle does not have a clear view of the path to be traveled on a work site, he shall not proceed until he receives a signal from a designated signaler who has a clear view of the path to be traveled. ❖

Event	Prevention, Control and Mitigation Measures
Illumination	❖ Ensure that illumination at a work site is sufficient to enable work to be done safely. ❖ Where failure of the normal lighting system would endanger workers, the employer shall ensure that emergency lighting is available that will generate sufficient dependable illumination to enable the workers to a) Leave the work site in safety b) Initiate emergency shutdown procedures c) Restore normal lighting
House keeping	❖ Ensure that each work site is clean and free from stepping and tripping hazards ❖ Waste and other debris or material do not accumulate around equipment, endangering workers
Falling Hazards	❖ Ensure that where it is possible for a worker to fall a vertical distance greater than 3.5 meters the worker is protected from the falling by guard rail around the work area a safety net fall arresting device
Overhead power Lines	❖ Ensure that no worker approaches and that no equipment is operated and no worker shall approach or operate equipment, within 7 meters of a overhead power line.
Sanitary facilities & drinking Water	❖ Ensure that an adequate supply of drinking fluids is available at the work site. ❖ Ensure that work site is provided with toilet facilities in accordance with the requirement of general health protection guidelines.
Working proper clothing	❖ Ensure that where is a possibility that a worker or worker's clothing might come in to contact with moving parts of machinery, the worker: a. wears close-fitting clothing b. confines or cuts short his head and facial hair c. avoids wearing jewelry or other similar items
Head protection	❖ Ensure that during the work process adequate alternative means of protecting the workers head is in place.
Eye protection	❖ Where there is a danger of injury to or irritation of a worker's eyes, his employer shall ensure that the worker wears property fitting eye protective equipment.

Event	Prevention, Control and Mitigation Measures
Foot protection	❖ Where there is a danger of injury to a worker's feet, ensure that the worker wears safety footwear that is appropriate to the nature of the hazard associated with particular activities and conditions.
Respiratory protective Equipment	❖ Where the worker is exposed to hazards gases, gums, vapors, or particulates appropriate respiratory protective equipment to be supplied.
Transportation of water	❖ A worker in a vehicle shall not allow any part of his body to produce from the vehicle where this action creates or may create danger to the worker. ❖ A worker shall ensure that no equipment or materials for which he is responsible is carried in the compartment of a vehicle in which another worker is traveling unless it is so placed and secured as to prevent injury to himself and other workers.
Testing & commissioning	❖ Mobilize test rigs at site ❖ Ensure that the test equipment is in good condition ❖ Ensure other equipment and facility conforms to the approved specification of test. ❖ Public notice to be served before testing.

CHAPTER -08
EMERGENCY RESPONSE AND DISASTER MANAGEMENT PLAN

8.1 Emergency Response

The initial response to an incident is a critical step in the overall emergency response. Like all other Industries and installations, Power generation facilities must have adequate measures against accidents or incidents to meet the emergency. The purpose of having an Emergency Response Plan (ERP) is to:

- Assist personnel in determining the appropriate response to emergencies.
- Provide personnel with established procedures and guidelines.
- Notify the appropriate Company Emergency Response Team personnel and regulatory/ Govt. agencies.
- Manage public and media relations.
- Notify the next-to-kin of accident victims.
- Promote inter-departmental Communications to ensure a “Companywide” Co-ordinated emergency response.
- Minimize the effects that disruptive events can have on company operations by reducing recovery times and costs.
- Respond to immediate requirements to safeguard the subtending environment and community.

Generally, the initial response is guided by three priorities Ranked in importance these priorities are:

1. People
2. Property
3. Environment

Emergency Response Procedures will identify who does what and when in the event of an emergency. Responsibility for who is in charge and their coordination of emergency actions

shall be identified. Nature of Emergency & Hazardous Situations may be of any or all of the following categories:

I. Emergency

- ❖ Fire,
- ❖ Explosion,
- ❖ Electric shock
- ❖ Medical emergency,

II. Natural Disasters

- ❖ Flood,
- ❖ Earthquake/ cyclone,
- ❖ Storm/ typhoon/ tornados, and
- ❖ Cloud burst lightning.

III. External Factors

- ❖ Food poisoning/water poisoning,
- ❖ Sabotage, and
- ❖ War.

8.1.1 Six Steps in Emergency Response

Step-1)

a) Determine the potential hazards associated with the incident, substance or circumstances and take appropriate action identify the type and qualities of dangerous goods involved and any known associated hazards.

b) Determine potential hazards stemming from local conditions such as inclement weather water bodies etc. and ensure that the initial response team is aware of these conditions.

Step-2)

Determine the source/cause of the event resulting to the emergency and prevent further losses.

Step-3)

Conduct an assessment of the incident site for any further information on hazards or remedies.

Step-4)

Initiate redress procedures.

Step-5)

Report the incidence its nature because impact applied redress procedures and any further assistance required etc. to the appropriate company, government and/or land owner.

Step-6)

Take appropriate steps with respect to hazards to wildlife, other resources and addressing public and media concerns and issues, as applicable. Response priorities are to protect human lives, property and the environment.

8.1.2 Reporting Incidents and Accidents

All accidents and near-miss incidents shall be investigated to determine what caused the problem and what action is required to prevent a recurrence. Employees required to perform investigations shall be trained in accident investigation techniques. The incident/accident investigation should be a fact-finding exercise rather than faultfinding. The investigations will focus on collection of evidence to find out the “root cause” of the incident. The recommendations of the investigation report are implemented in phases.

8.1.3 Approaches to Emergency Response

For this project, emergency response systems should be in place to deal with dangerous goods uncontrolled releases of dust and gaseous emission, natural calamities fires burn and injuries. There are to be trained emergency response teams, specific contingency plans and incidence specific equipment packages in place to cope with these types of emergencies. In case of an emergency incident occur, immediate action must be taken to mitigate the impacts.

In order to minimize the possibility of injury to the responders and others it is important that emergency responders follow a specific sequence of actions as stepped out in the preceding paragraphs.

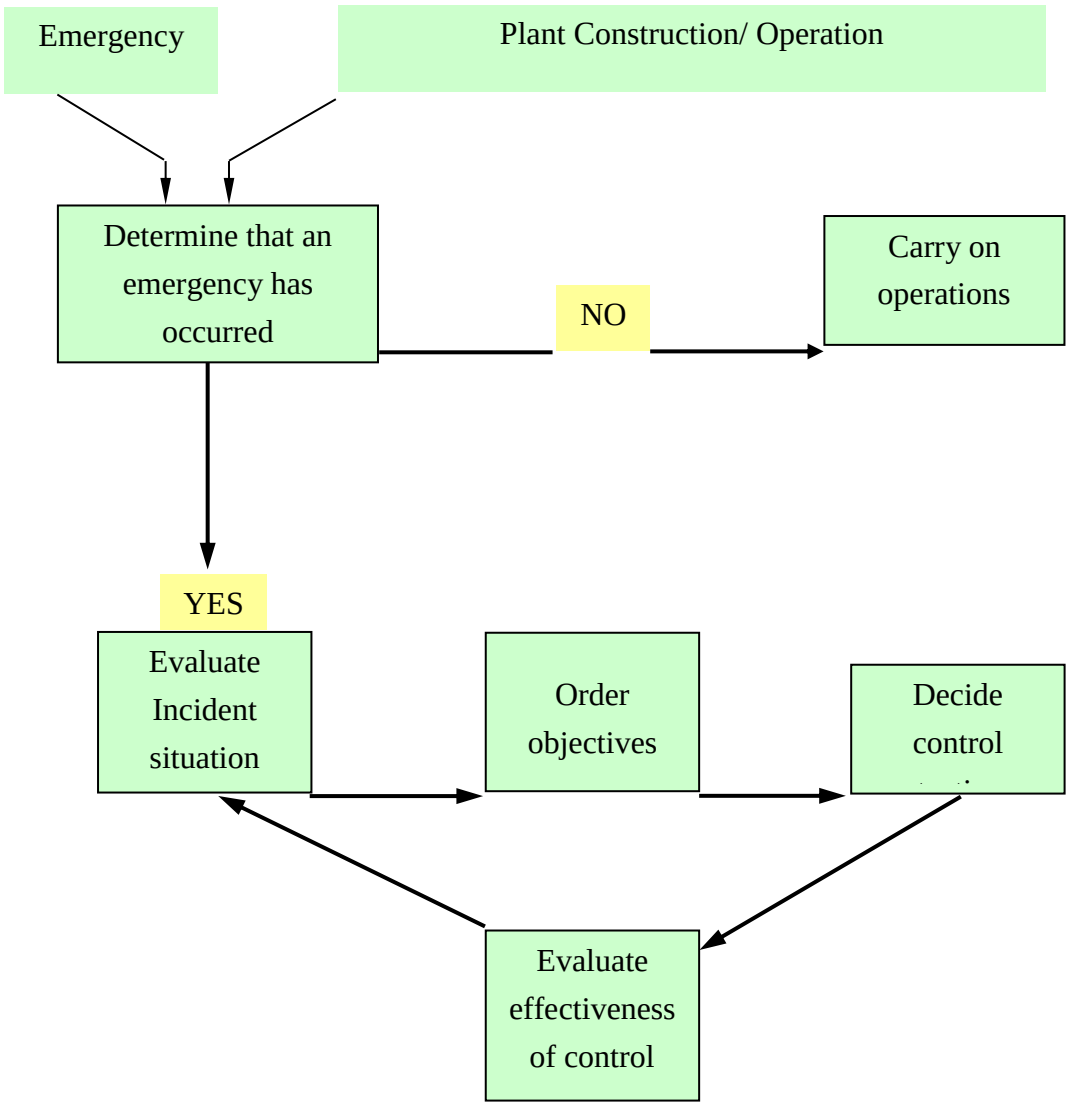


Figure-8.1: Illustrates an Example System Approach to Plant Construction & Operations.

8.2 Disaster Management Plan

In normal operation of the plant, when all environmental protection equipment works according to design specification, then there would be no environmental problems for the present plant.

Disaster (to certain degree) may occur if the environmental protection equipment fails to work at normal condition. This situation may arise for any of the following causes-

- When plant runs at abnormal situation e.g. if emission level increases than its normal level or if the turbine s give unwanted noise than normal level
- If liquid waste over flows and pollutes the surroundings

Therefore, appropriate management plan should have to be taken by the project proponent to prevent any unwanted disaster in the plant. In this regard, there should be a provision to stop the production immediately during any process failure as discussed above.

The disaster management plan should consist of preventive measures including, among others, the following.

- Formulation and strict implementation of safety codes and measures;
- Periodic inspection of safety relief valves provided with pressure vessels and equipment;
- Preventive maintenance;
- Aware the workers about electric shock
- Declaring the factory, a “no smoking zone”
- Mock drills by the firefighting cells/ groups
- Provision and inspection of firefighting equipment and fire hydrant system in all the sections;
- Proper training of the employees about the importance of codes;
- Training the employees and the residents of the surrounding villages about the actions to be taken during an accident, disaster etc.

It is imperative to develop entire facility environment policy and display necessary documentation for ease in accessing information. Some of these documents include:

- Emergency contacts;

- Emergency response procedures for fires

The facilities operations and monitoring are carried out under the management and help from both the employees and relevant government lead agencies. In order to take care of any hazards the following control should be adopted:

- All safety precautions and provisions covering the general cleanliness of the entire facility down to, ventilation, lighting, sanitary, waste collection, smoke detector, heat detector, sand bucket, water bucket, fire blanket, first aid box provision, adequate fire extinguishers and site security by fencing.

8.3 Environment, Health and Safety (EHS)

Health and safety aspects of the entire facility should be given due attention. Protective devices as provided should continuously be used within the unit's operations to ensure the safety of the natural resources and boat owners is guaranteed.

The maintenance of Material Safety Data Sheets (MSDS) will be followed to ensure safety all section of the facility that chemicals are utilized.

An Environment, Health and Safety register is essential for monitoring of performance of the entire facility community in relation to the environment. The management will use this as a self-auditing tool. This register should include:

- Fire extinguisher servicing records
- EHS meeting schedules and training records
- Electrical installations
- Generator inspection and maintenance records
- Waste disposal records
- Inventory records (fuels, paints, cleaning agent
- Emergency response procedure.
- Record off all incidents, accidents, near miss etc.

8.4 Fire Hazard& Fire Evacuation Plan

Fire hazards such as large quantities of fuel, combustible/flammable liquids, electrical hazards, combustible dusts, and warehousing are common in electric power generating plants. Although fires are not a daily occurrence, they usually will cause severe property damage and business interruption. Sometimes the fire protection equipment systems have not received attention since they were installed. If these systems are needed, however, they are counted upon to perform reliably and protect vital plant equipment from fire. Fire protection systems are a combination of mechanical and electrical components and, like power generation equipment, need regular attention.

In addition, some people in charge of fire protection do not have an adequate knowledge of necessary inspection and testing frequencies, or they use the minimum frequencies prescribed by their authority having jurisdiction. For example, some jurisdictions only require annual water flow alarm tests on sprinkler systems, a frequency which is considered inadequate by most fire protection professionals.

The information contained in this part is based on the current standards established by the National Fire Protection Association (NFPA); the most widely used in North America, and generally accepted guidelines. Most fire protection systems are designed and installed according to these standards. Unfortunately, information on inspection, testing and maintenance is not contained in a single standard but is contained within the various system-specific standards, making it cumbersome and difficult to obtain an overview of the tasks which need to be accomplished.

Other codes and standards such as UBC, UFC, BOCA, OSHA and MSHA also address fire protection, but their contents are usually based on NFPA documents and may not address testing/maintenance requirements. Members on the NFPA technical committees comprise a wide range of fire protection expertise and include representatives from manufacturers, testing laboratories, users, authorities having jurisdiction and insurance companies. Adherence to NFPA standards will satisfy most jurisdictions and insurance companies. Suitable fire protection and detection systems shall be provided designed to the requirements of National Fire Protection Association (NFPA) standards. Gas detection systems and alarms shall also be included.

Fire protection shall consist of wet pipe, automatic deluge systems, hydrants, CO_2 gas flooding systems, and portable extinguishers of CO_2 and dry powder in sufficient quantities.

Areas to be covered by fixed protection installations shall be included but not be limited to:

- All oil filled transformers
- Turbines
- Lube oil system
- Cable areas
- Storage areas.

The turbines are to be protected against fire by a CO_2 total flood system within the enclosures. The only other significant fire risks are associated with the lube oil systems on the gas turbines, cable areas, stores and with oil contained within transformers. Such systems will be protected from fires by water deluge sprays. All necessary systems are required to be fire 'protected' with suitable extinguishing agents. Additional protections are to be provided by a ring main and hydrant system with hose/equipment cabinets located at strategic points. This ring main shall be provided with suitable section valves located in valve pits.

The firefighting water will be taken from the fire tank and will be pumped by a dedicated electric pump with a diesel-powered back-up pump available in case of electrical failure. Pressure in the firefighting mains is maintained using an electric jockey pump.

A site wide fire and gas detection system will be provided to initiate the fire protection and alarms. Manual "break glass" fire alarms shall also be situated at strategic locations around the site and inside the buildings.

A modern electronic fully addressable master fire alarm panel shall be located in the Central Control Room. All local fire panels shall be linked into the master fire alarm panel. This master panel should have a separate section for the gas detection system. A repeater panel should be provided in the site gatehouse to allow swift identification of the affected fire zone to incoming local fire-fighting appliances. This master fire panel shall be provided with its own dedicated battery system.

8.5 Emergency and Disaster Management of RPCL 360 MW CCPP.

The following team will work in RPCL 360 MW CCPP in the event of any emergency or disaster:

1. Plant Manager
2. Environmental Health & Safety Manager
3. Plant Engineer (Electrical)
4. Plant Engineer (Mechanical)

The Emergency team will sit in a regular interval to discuss about their responsibilities in case of any emergency. The team will also be responsible for taking care of disaster and emergency handling devices enable them available in good working condition in case of emergency. The following are the major responsibilities of the disaster management team of RPCL 360 MW CCPP:

1. Organize regular fire or emergency evacuation drill,
2. Check all emergency sign, emergency exit, alarm is in good working order.
3. Regular check of emergency evacuation alarm by blowing a test alarm for few seconds in a certain time of a day.
4. Sit with different emergency subcommittee to discuss various issues about the responsibilities of the subgroups in the event of emergency.

To prevent any unwanted Disaster or emergency, the following subcommittee will be in action during any emergency:

a. Fire prevention:

i) Fire Attacking team - to attack fire with prevention appliances within shortest possible time.

ii) Supporting team – This team will support the attacking team.

iii) Breathing apparatus team - will supply BA equipment.

iv) Containment team - for additional support.

v) First Aid support team: For providing first aid support to the victims, first aid boxes will be provided with sufficient first aid equipment.

vi) Emergency Casualties team: There will be plan to evacuate any injured or casualties to the hospital. These includes pick up, driver and stretcher.

b) Special event team: This team will be responsible for the following activities or other emergencies not mentioned in the list above:

1) Unrest management: Local police or law & force agencies will be contacted in case of any labor or political unrest will be beyond control.

2) Natural Calamity: The team will be trained to face any natural calamity like flood, earthquake, cyclone, tsunami, heavy rainfall etc.

3) Fear of unknown: Training will be given to the team to face any unwanted happening like aggrieved mob, sabotage etc.

CHAPTER -09
ALTERNATIVE ANALYSIS

9.1 The 'No Build' Scenario

From a purely physical environmental point of view, the 'do-nothing' is preferable to any project implementation, since it would avoid creation of any of the adverse impacts associated with the project. However, the potential socio-economic benefits to the nation would be foregone and industrial growth would be hampered.

It is concluded that the 'No build' alternative is unacceptable, and the potential socio-economic benefits of implementation of such project far outweigh the adverse impacts, all of which can be controlled and minimized to an allowable level.

9.2 Consideration of Alternatives

i. Hydroelectricity:

The country is flat having relatively limited potential for hydroelectricity.

ii. Geothermal Plant:

No active geothermal site has been found.

iii. Renewable Energy Plant:

Solar and wind energy can be considered as renewable energy but per KWh cost of renewable energy is not cost effective for the end users especially in the country like Bangladesh.

iv. Coal-Fired Plant:

The country has about 1700 million tons of bituminous coal, most of which lie buried at depth of over 400-900 meters thus making extraction relatively expensive. However, coal from low-lying structure (Barapukuria) is being dug out for power generation. Coal is less environment friendly as it gives high emission of dust sulfur dioxide and carbon dioxide which lead to the acid rain.

v. Resettlement:

Site selection is ideal as it involves no resettlement issues.

vi. Pollution Control:

As shown in subsequent sections, environmental pollution during the period of construction and also during the period of operation will be mostly insignificant.

vii. Connectivity with High transmission line:

In Mymensingh Power Grid Company Bangladesh (PGCB) have a big plan for high transmission line. There are two existing substations in Mymensingh, one in RPCL and other one in Mymensingh sadar. PGCB also planned to set up two substations in Shamvuganj and another one in Muktagaca. There is existing 132 kV line Mymensingh to RPCL, PGCB also planned to set up 230 kV line from Shamvuganj to Phulpur which is an ongoing project. They have also planned for 400 kV line in future from Kaliakoir to Shamvuganj. In **Figure 9.1 & 9.2** detail transmission line are represented.

9.3 Site Alternatives

The proposed project land was unutilized since long time and very near to the river old Brahmaputra. The site is well connected with the wide road which is also very suitable for transportation of project equipment and raw materials.

Mymensingh 360 MW Dual Fuel (Gas/HSD) CCPP is located at Shambhuganj, Mymensingh, Bangladesh. The plant's visual looks are modern and environmentally compatible, the site is environmentally acceptable, the plant construction has started and the IEE checklist has been submitted to DOE earlier for obtaining the Environmental Site Clearance Certificate. So, there is no logical need to look into alternative sites.

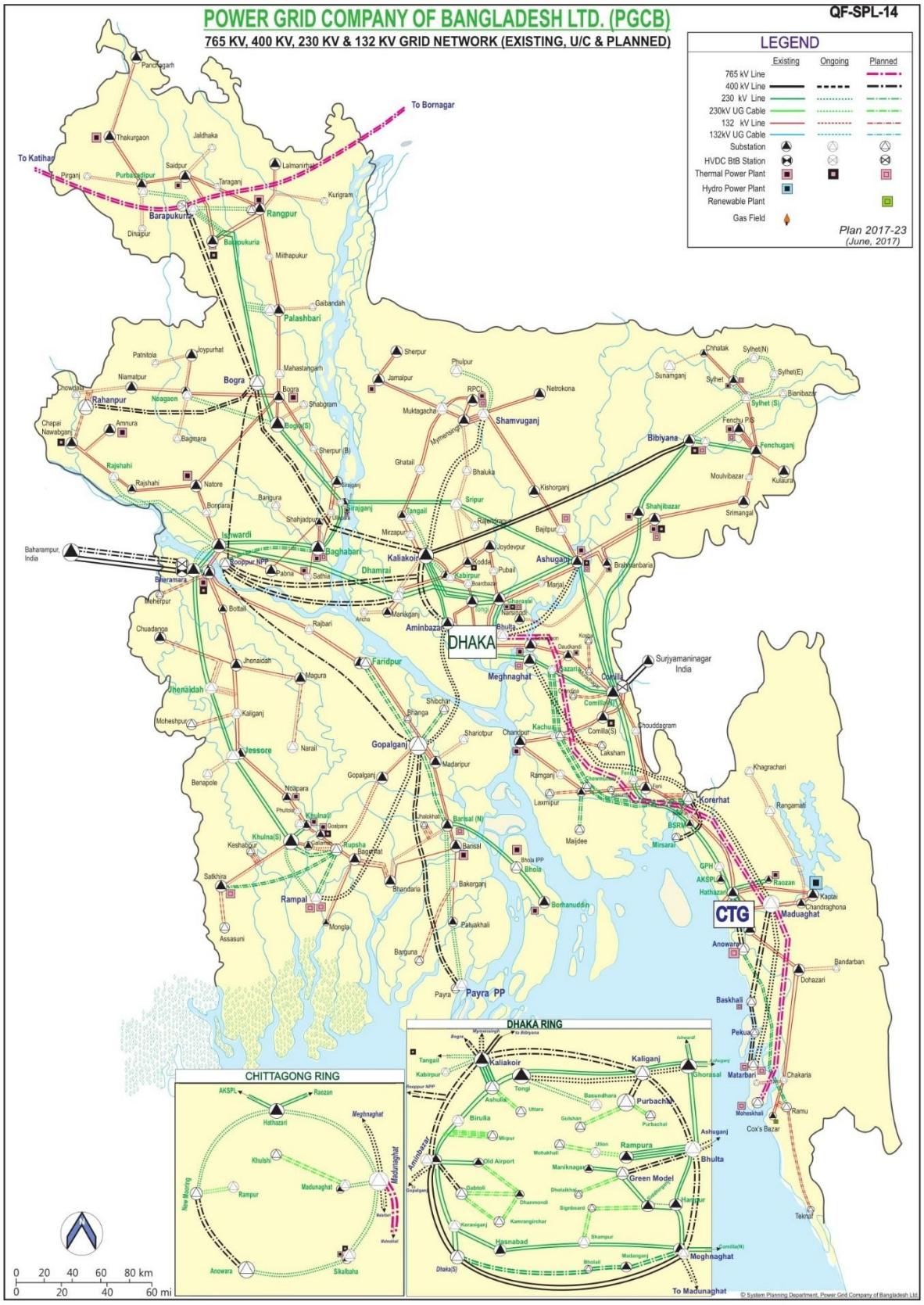


Figure 9.1 Transmission line in Bangladesh (source PGCB)

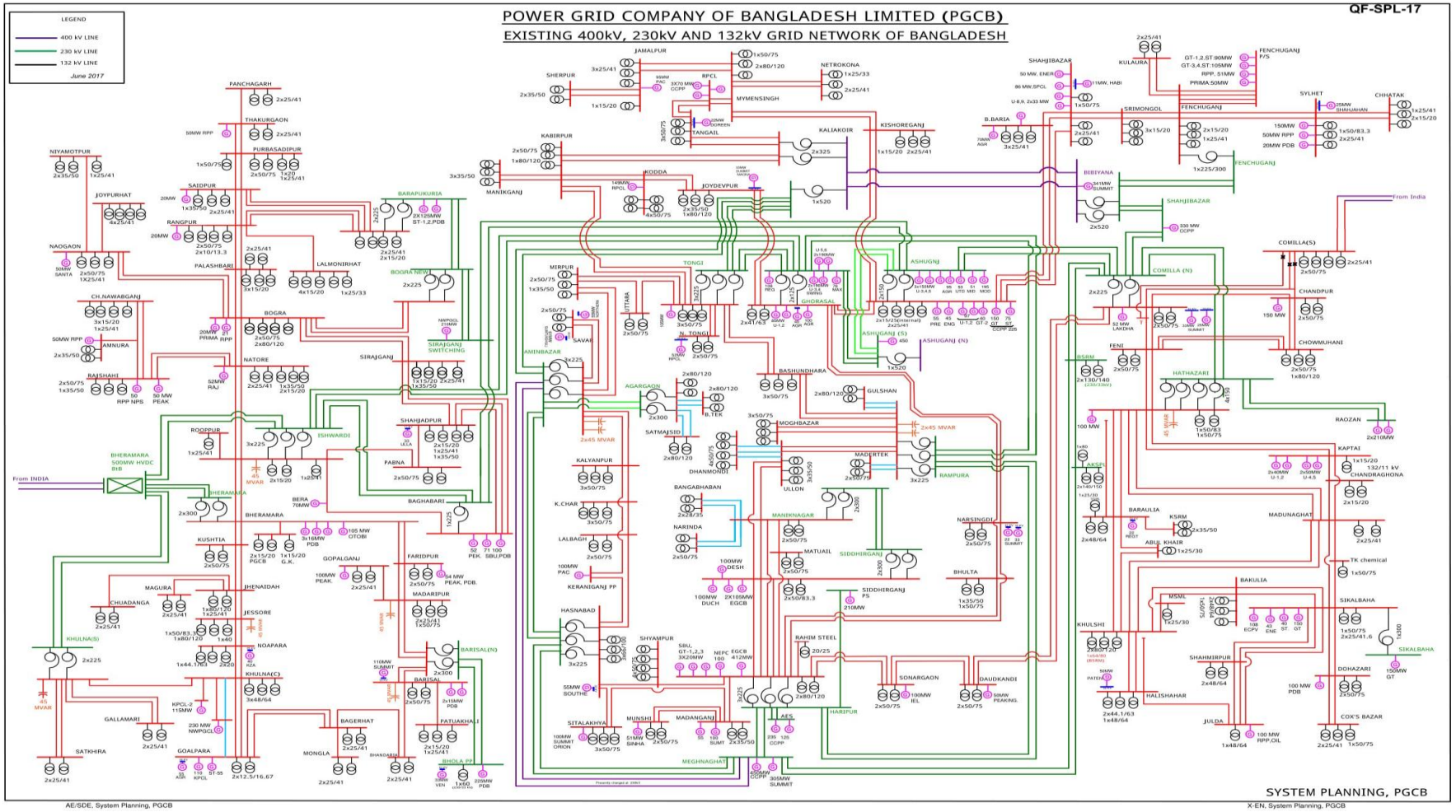


Figure 9.2 Existing 400 kV, 230kV & 132kV Grid Network of -Bangladesh (source PGCB)

CHAPTER -10

STAKEHOLDER CONSULTATION

10.0 Stakeholder Consultation

Stakeholder consultation is a means of involving all primary and secondary stakeholders in the project's decision-making process in order to address their concerns, improve project design, and give the project legitimacy. Stakeholder consultation, if conducted in a participatory and objective manner, is a means of enhancing project sustainability.

Community input (both of knowledge and values) on socioeconomic and environmental issues can greatly enhance the quality of decision-making. Stakeholder consultation was therefore conducted in the project area not only to satisfy the legal requirements of the EIA process in Bangladesh but also to improve and enhance the social and environmental design of the project.

10.1 Objectives of Stakeholders Consultation

The process of public participation and consultation was endorsed in the United Nations Conference on the Environment and Development (UNCED) in 1992 through one of the key documents of the conference Agenda 21. Agenda 21 is a comprehensive strategy for global action on sustainable development and deals with issues regarding human interaction with the environment. It emphasizes the role of public participation in environmental decision-making for the achievement of sustainable development.

For projects that have environmental and social impacts, consultation is not a single conversation but a series of opportunities to create understanding about the project among those it will likely affect or interest, and to learn how these external parties view the project and its attendant risks, impacts, opportunities, and mitigation measures. Listening to stakeholder concerns and feedback can be a valuable source of information that can improve project design and outcomes and help a company to identify and control external risks. It can also form the basis for future collaboration and partnerships. For stakeholders, a company's consultation process is an opportunity to get information, as well as to educate company staff about the local context in which a project will take place, to raise issues and concerns, ask questions, and potentially help shape the project by making suggestions for the company to consider and respond to.

Through the public consultation process, **RPCL** hopes to:

- Promote better understanding of the project, its objective, and its likely impact;
- Identify and address concerns of all interested and affected parties of project area;

- Provide a means to identify and resolve issues before plans are finalized and development commences, thus avoiding public anger and resentment and potentially costly delays;
- Encourage transparency and inculcate trust among various stakeholders to promote cooperation and partnership with the communities and local leadership;

10.2 Consultation Process

Primary stakeholders were consulted during informal and formal meetings held in the project area. The consultation process was carried out in the Bangla language. During these meetings a simple, non-technical, description of the project was given, with an overview of the project's likely human and environmental impact. This was followed by an open discussion allowing participants to voice their concerns and opinions. In addition to providing communities with information on the proposed project, their feedback was documented during the primary stakeholder consultation. The issues and suggestions raised were recorded in field notes for analysis, and interpretation.

By reaching out to a wider segment of the population and using various communication tools—such as participatory needs assessment, community consultation meetings, focused group discussions, in-depth interviews, and participatory rural appraisal—EIA involved the community in active decision-making. This process will continue even during construction and operation phase of the project to create consensus among stakeholders on specific environmental and social issues raised in the context of proposed project.

Secondary stakeholder consultations were more formal as they involved government representatives and local welfare organizations consulted during face-to-face meetings and through telephonic conversations. They were briefed on the EIA process, the project design, and the potential negative and positive impact of the project on the area's environment and communities.

It was important not to raise community expectations unnecessarily or unrealistically during the stakeholder consultation meetings in order to avoid undue conflict with local leaders or local administrators. The issues recorded in the consultation process were examined, validated, and addressed in the EIA report.

10.3 Stakeholder Consultation Technique

In recognition of the diversity of views within any community, it is very important to obtain a clear understanding of the different stakeholders and to analyze their capacity and willingness to be involved in some or all of the project and its planning process. It is important to be aware of how different power relations can distort participation. It is also important to examine how community skills, resources, and 'local knowledge' can be applied to improve project design and implementation. All of this can be achieved by careful use of the various tools of

Stakeholder Consultation. Therefore, the following participatory technique was employed during stakeholder consultation:

- Informal meetings with communities in surrounding areas. Men and local elders attended these meeting.

10.4 Stakeholders Consulted

In the consultation process for EIA, following key stakeholders were consulted:

- ❖ Local communities, Men, women and local elders attended meetings.
- ❖ Local Government & NGO representatives.

Meetings with stakeholders consisted of community consultation meetings, focus group discussions, and in-depth interviews with men and limited focus-group discussions with women. The stakeholder meeting was organized at Mymensingh DC Office Conference Room on **06.11.2017** by verbal and official notice. The location of the meetings, the process followed, and the outcomes are discussed in this section.

10.5 Stakeholder Concerns and Recommendations

The findings of the Community consultations are given in ***Table 10.2.*** All these have been addressed in various sections of the EIA, and the mitigation plans have been incorporated into the EMP. The summary of the various stakeholder consultations is given below.

10.5.1 Community Concerns

Project Approval

The community consultations demonstrated that goodwill towards the project proponents indeed exists; approval for project activities by the communities was evident. The consultations were considered a good gesture and appreciated, especially by the men and women. The poverty level is such that communities are looking to any project proponent to improve their financial well-being to a great extent. RPCL recognizes that benefits from the project should be distributed judiciously and equitably especially among primary stakeholders in the project area, and will continue to ensure that this principle is followed in its projects and community development program.

Resettlement/ Relocation

The proposed site of 360 MW Dual Fuel (Gas/HSD) Combined Cycle Power Plant, Mymensingh, Bangladesh. The proposed power plant site is situated in the vacant land of

RPCL. Most of the part of the land is vacant low land and the rest of the part is fallow and watery low land. There was no household inside the land. Therefore, physical relocation/resettlement issue is not applicable for the proposed project.

Local Employment

Communities in the project area emphasized that local people should be given priority when employing people for various project-related works and activities according to their skills.

Compensation

As the proposed power plant site is situated in the vacant land of own purchased of the RPCL Group, there is no private land owners fall in the project site.

Interaction with Local Community

Non-Local work force to be engaged in the project may not be aware of the local customs and norms, it may result conflicts with the local community, particularly in some benefit sharing issues. Keeping in mind of the sensitive issues and culture of the area law and order situation will be kept quiet by taking help of the local administration and LGED.

Impact on Livelihood

The communities also expressed some fear that construction process would disturb their cattle and that their livestock might get hurt or run away or die accidental death due to construction process. Scope of livelihood of the local people will be increased due to job and business/sub-contract opportunities to be created in the project.

10.5.2 Local Government Representatives

The consultations were considered a good gesture and appreciated. They also expressed the jobs and business opportunities for the local community will be increased due to project activities. They also expressed the concern that most of the unskilled and skill jobs should be reserved for the local communities.

10.6 Stakeholder consultation participants and Recommendations

The findings of the Community consultations are given in ***Table 10.1***. All these have been addressed in various sections of the EIA, and the mitigation plans have been incorporated into the EMP. The summary of the various stakeholder consultations is given below.

Table 10.1: Participants in the Stakeholder Consultation meeting

a) Local Community:

Date	Name	Location	Age	Occupation	Contact No
	Md. Osman	Char Issordia	72	Businessman	01712991054

05/11/2017 to 06/11/2017	Md. Anoarul KAdir	Char Kali Bari	37	Businessman	01712021455
	Md. Mosarof Hossain	Char Kali Bari	63	Businessman	01712492901
	Md. Altaf Hossain	Char Kali Bari	59	Service holder	01716553769
	Md. Ariful Islam	Char Kali Bari	27	Student	01717070292
	A.H.M. Rased	Char Kali Bari	47	Service holder	01711178895
	Md. Ajrail Islam	Char Kali Bari	36	Service holder	01718817663
	Rajib Dotto	Char Kali Bari	31	Service holder	01817711882
	Md. Zahedur Islam	Boro Bazar	35	Service holder	01714877366
	Rifat Rayhan	Pion Para	37	Service holder	01700635854
	Mizanur Rahman	Char Kali Bari	42	Businessman	01918256840
	Delwer Hossain	Char Kali Bari	40	Businessman	01717715545
	Md. Samim	Char Kali Bari	35	Farmer	01928059275
	S.M. Mohammod Hossen	Choto Bazar	24	Student	01721367965
	Barek	Char Issordia	28	Shop Keeper	
	Yasin	Char Issordia	12	Shop Keeper	
	Md. Amjot	Char Issordia	35	Shop Keeper	
	Md. Mahfujul	Char Issordia	32	Shop Keeper	
	Amrita Kumar Ghose	2 no Amlapara	44	Service holder	01711232008
	Md. Ahsanul Habib	2 no Amlapara	29	Service holder	01727988583
	Malek Masud	2 no Amlapara	40	Service holder	01717346823
	Md. Faruqul Islam	Natun Bazar	49	Service holder	01712343868
	Md. Shamsul Haque	Sanki Para	45	Service holder	01711287794
	Biprpjeet	Alia Madrasa	35	Service holder	01718768468
	N.M. Sayedul Hasan	Chor Kalibari	54	Service holder	01711489888
	S.H. Khan	K.B. Ismail Road	45	Service holder	01711489888
	Emdadul Hoq	Char Issordia	68	Service holder	01712287933

b) Different Officials:

Date	Name	Location	Age	Occupation	Contact No
06/11/2017	Khalilur Rahman	Deputy Commissioner, Mymensingh	45	Service holder	01733373300
	Mohammad Mohoshin Uddin	ADC (General) Mymensingh	35	Service holder	01733373301
	Zahid Uddin Ahmed	OMS solution	63	COO of OMS	01714073795
	Zahedur Rahman	AECL	62	COO of AECL	01711565728
	Md. Johirul Amin	AECL	24	Senior Environment Eng.	01671865121
	Md. Anwarul Kabir	OMS solution	25	Service holder	01833101252
	Morshadul Alom	Chairmen Char Issordia	54	Chairmen	01711069464
	Md. Bellal Hossain	Char Issordia	47	UP Member	01718044965

Table 10.2: Concerns Raised by the Communities during Stakeholder Consultations

Issues	Concern Raised by the Community	Communities' Remarks
Employment	Provision of semi-skilled and unskilled jobs for the local labor	Maximum unskilled jobs should be allocated to the locals.
Livelihood	Restriction of livestock grazing and accidental killings of livestock	Grazing and vegetation areas should be protected and speed of vehicles should be limited to avoid accidents
Environment	Possibilities of air & noise pollution	RPCL assures the local community that the project will have modern facilities to control possible negative environmental impacts.
Project Construction	May obstruct natural drainage or disturb local business	RPCL assures the local community that the project will neither hamper any natural drainage system nor disturb the local business.
Development of communication system	Local bridges and roads should be repaired or newly constructed	RPCL expresses their interest to develop the local communication system.
Fishing	Thermal pollution of river may hamper aquatic growth	RPCL ensures that the thermal increase of Brahmaputra river will be within acceptable limit. Lack of electricity obstructs the fishermen engaging in many incomes generating activities, hence it will be a great boom for the economy and power generation will help the local fishermen to carry out their business and daily lives in a better way.
Repair of local roads	Existing road may be damaged by construction activity	Project authority should repair the local roads in a regular basis
Health check up	Provision of health check-up of school student	RPCL should arrange health checkup for school students in a regular basis

Table 10.3 Meeting Minutes of the Public Consultation

Name	Designation	Opinion
Md. Khalilur Rahman	Deputy Commissioner Mymensingh	He delivered the speech regarding the government point of view about the project.
Mohammad Mohoshin Uddin	ADC General Mymensingh	He described the importance of electricity in our country and Consensus with RPCL about the project.
Rezaul Kabir	Project Director (PD) RPCL	He delivered the introductory speech regarding the project and described the different components of the project.
Emdadul Haque Mondol	Former Chairmen Chor Issordia.	He expressed his gratitude towards RPCL and supported the issues raised by the participants of the consultation. He expressed his concerns that the local people need some job according to their Qualifications.
Morsedul Alam Jahangir	Present Chairmen Chor Issordia.	He thanked to the authority for their progress towards power generation of Bangladesh and expressed his concerns about the heat and noise pollution. He also demanded for more jobs for local people in the project.
Md. Zahedur Rahman	Chief Operating Officer, AECL (Project Environment Consultant)	He welcomed the project and express his voice about the relation between the power plant and environment.
Zahid Uddin Ahmed	COO, OMS (Project Consultant)	He expressed his gratitude towards RPCL and told detail about the project and about the environment friendly machinery which will be used in the power plant.
Md. Anowarul Hossain	Service Holder	He thanked to the authority for their progress towards power generation of Bangladesh and expressed his concerns about the heat and noise pollution. He also demanded for more jobs for local people in the project.
Md. Bellal Hossain Bakul	Local Businessman	He raised his concerns regarding the heat and noise pollution due to power plant operation.

Figure 10.1: Photographs of Public Consultations at Mymensingh DC Office (06/11/2017).

Figure 10.2: Getting local public opinion about the project

(05/11/2017 to 06/11/2017)

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সিনিয়র করেসপন্ডেন্ট | বাংলানিউজটোয়েন্টিফোর.কম | আপডেট: ২০১৭-১১-০৬ ৫:১১:২০ পিএম

জেলা প্রশাসকের সম্মেলন কক্ষে বিদ্যুৎকেন্দ্র স্থাপন বিষয়ক মতবিনিময় সভা

ময়মনসিংহ: ৩৬০ মেগাওয়াট বিদ্যুৎকেন্দ্র স্থাপিত হচ্ছে ময়মনসিংহ সদর উপজেলার চর ঈশ্বরিদয়া এলাকায় । দ্বৈত জ্বালানি ভিত্তিক এ বিদ্যুৎকেন্দ্র নির্মাণ করছে রুরাল পাওয়ার কোম্পানি লিমিটেড (আরপিসিএল)।

বছর দুয়েক আগে এ বিদ্যুৎ কেন্দ্রের জন্য জেলা প্রশাসনের মাধ্যমে সেখানে ১৬.২ একর জমি অধিগ্রহণ করেছে কোম্পানিটি। মাটি ভরাট কাজও শেষ হয়েছে। চলতি বছরের ডিসেম্বরের শেষের দিকে আন্তর্জাতিক দরপত্র আহ্বান করা হবে।

সোমবার (০৬ নভেম্বর) দুপুরে জেলা প্রশাসকের সম্মেলন কক্ষে এ বিদ্যুৎ কেন্দ্র স্থাপনের লক্ষে স্থানীয় সাবেক ও বর্তমান জনপ্রতিনিধিদের সঙ্গে মতবিনিময় সভায় এমন তথ্য জানান প্রকল্প বাস্তবায়নকারী প্রতিষ্ঠান রুরাল পাওয়ার কোম্পানি লিমিটেডের (আরপিসিএল) প্রকল্প পরিচালক (পিডি) রেজাউল কবির।

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এ সময় জেলা প্রশাসক (ডিসি) খলিলুর রহমান, অতিরিক্ত জেলা প্রশাসক (সার্বিক) মহসিন উদ্দিন, চর ঈশ্বরদিয়া ইউনিয়ন পরিষদের সাবেক চেয়ারম্যান এমদাদুল হক মন্ডল, বর্তমান চেয়ারম্যান মোর্শেদুল আলম জাহাঙ্গীর প্রমুখ উপস্থিত ছিলেন।

রুরাল পাওয়ার কোম্পানি লিমিটেডের (আরপিসিএল) প্রকল্প পরিচালক (পিডি) রেজাউল কবির জানান, বিদ্যুৎ কেন্দ্র স্থাপিত হলে ময়মনসিংহে বিদ্যুতের চলমান সঙ্কট পুরোপুরি কেটে যাবে। স্থানীয় জনসাধারণ স্বতঃস্ফূর্তভাবে এ বিদ্যুৎ কেন্দ্র স্থাপনে সহযোগিতা করছে। প্রধানমন্ত্রীর অগ্রাধিকার এ প্রকল্প বাস্তবায়নে তারা স্বাগত জানিয়েছেন।

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Figure 10.3: Circular in the Newspaper

CHAPTER -11
A GRIEVANCE REDRESS MECHANISM AND DISCLOSURE

11.1 Grievance Redress Mechanism

Public participation, consultation and information disclosure undertaken as part of the local EIA process have discussed and addressed major community environmental concerns. Continued public participation and consultation has been emphasized as a key component of successful project implementation. As a result of this public participation during the initial stages of the project, major issues of grievance are not expected. During the operational phase of the project, the complaints that may be anticipated are mostly related to dust, noise & vibration of the turbine and some other social and environmental issues. However, unforeseen issues may occur. To settle such issues effectively, an effective and transparent channel for lodging complaints and grievances will be established. The grievance redress mechanism should be scaled to the risks and adverse impacts of the project. It should address affected people's concerns and complaints promptly, using an understandable and transparent process. It should also be readily accessible to all sections of the community at no cost and without retribution.

The Grievance Mechanism will be implemented during both the construction and operational period of the project to ensure that all complaints from local communities are dealt with appropriately, with corrective actions being implemented, and the complainant being informed of the outcome. It will be applied to all complaints from affected parties.

The mechanism will be accessible to diverse members of the community, including more vulnerable groups such as women and youth. Multiple means of using this mechanism, including face-to-face meetings, written complaints, telephone conversations should be available. Confidentiality and privacy for complainants should be honored where this is seen as necessary or important.

A grievance redress mechanism and procedures are setup to provide opportunity for project affected persons to settle their complaints and grievances amicably. The established grievances redress procedures and mechanism ensures that project affected persons are provided with the appropriate compensations and that all administrative measures are in line with the law. It also allows project affected persons not to lose time and resources from going through lengthy administrative and legal procedures. Grievances are first preferred to be settled amicably.

RPCL shall set-up a grievance redress committee that will address any complaints during both the construction and operational period of the project.

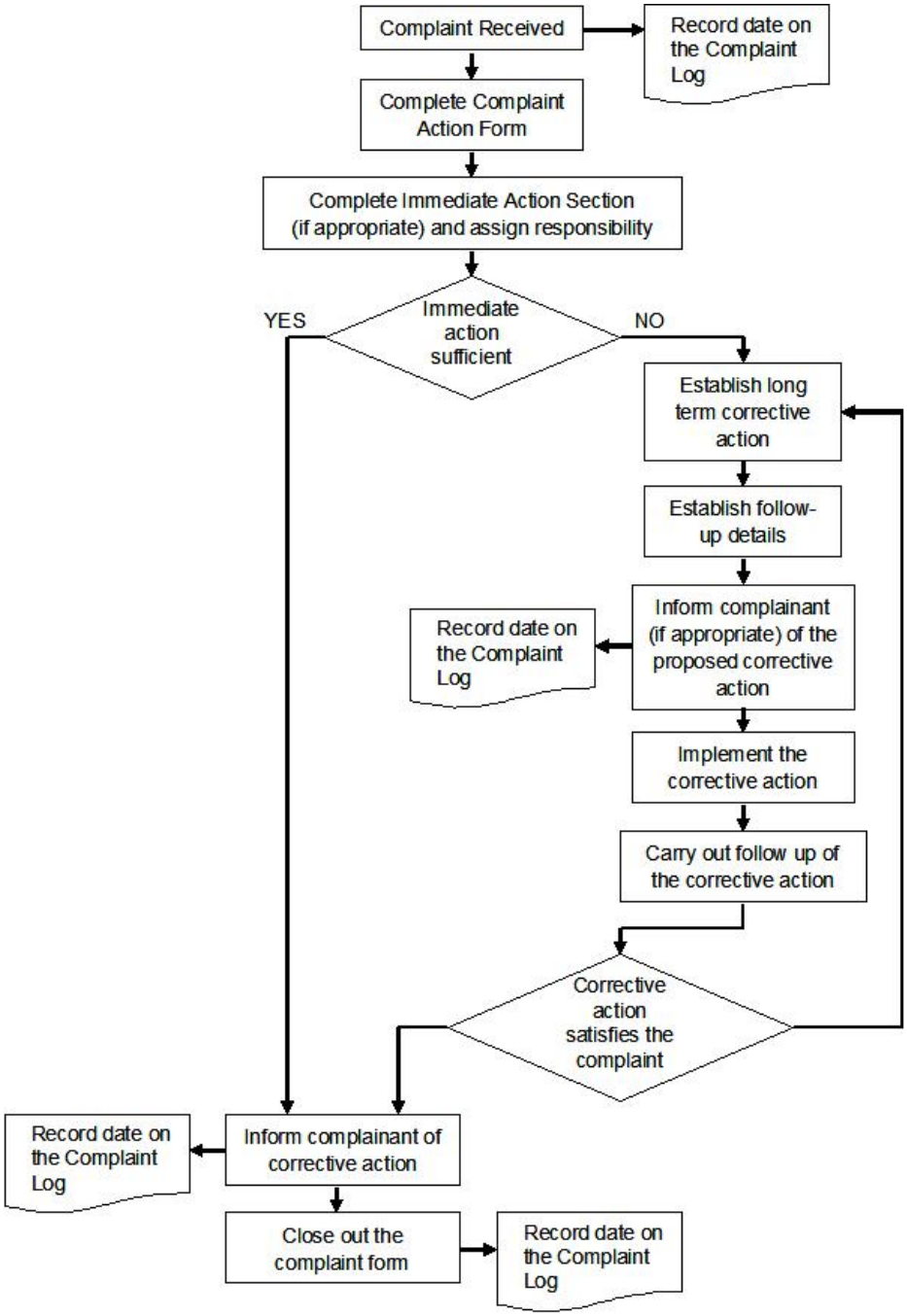

Figure 11.1: Flowchart of Complaints/Grievance Procedure:

The representation in the committee makes project affected persons to have trust and build confidence in the system. The grievance redress committee reports its plan and activities to the Implementation committee.

GRC will maintain a Complaints Database, which will contain all the information on complaints or grievances received from the communities or other stakeholders. This would include: the type of complaint, location, time, actions to address these complaints, and final outcome.
The procedures to be followed and adopted by the grievance redress should be transparent and simple to understand or uniform process for registering complaints provide project affected persons with free access to the procedures. The response time between activating the procedure and reaching a resolution should be as short as possible. An effective monitoring system will inform project management about the frequency and nature of grievances. GRC will arrange half yearly meetings where the activities and the outcomes/measures taken according to the Complaints Database are to be monitored and reviewed by third party consultant to ensure the required transparency. In addition to the above, if there are any grievances related to social or environmental management issues in the project area, the GRC will record these grievances and suggestions and pass it on to the relevant consultant for necessary action and follow-up.

In case a dispute is not resolved by arbitrational tribunal, then if any of the Party disagrees, the aggrieved party has the right to appeal to the ordinary courts of law. However, the preferred option of dispute settlement ought to be the option of settling the dispute amicably because recourse to courts may take a very long time even years before a final decision is made and therefore, should not be the preferred option for both parties concerned.

A grievance form is presented below and hard copies of both English and Bangla will be made available at the RPCL project office.

Table 11.1: Sample Grievance Reporting Form

Contact Details	Name:		
	Address:		
	Telephone Number/ Cell Phone Number:		
	Email:		
How would you prefer to be contacted? (please tick box)	By Phone By Email		
Details of your Grievance (Please describe the problems, how it happened, when, where, and how many times, as relevant)			
What is your suggested resolution for the grievance?			
Signature:		Date:	

11.2 Disclosure

The draft EIA report will be available for the public review. Once the final version is ready, it will replace the draft version on the website. The executive summary will be translated into Bangla and will be made available to the public.

CHAPTER -12

CONCLUSION

12.0 Conclusion

Rural Power Company Limited (RPCL) 360 MW Combined Cycle Power Plant, an upcoming project of Rural Power Company Limited (RPCL), intends to build and operate a 360 MW dual fuel (Gas/HSD) CCPP at Shambhuganj, Mymensingh beside existing RPCL Power Plant Complex**.** An EIA has been prepared for the project according to the requirement of DoE for necessary environmental clearances as it is made mandatory in ECA'95 for any new industrial set up. The EIA has been prepared through identifying the potential impacts, assessing them and recommendation possible mitigating and enhancing measures for negative and positive impacts, respectively.

The environmental analysis has revealed that the project can be set-up according to the proposed design and configuration in the proposed site and location. The environmental impacts are of limited nature, whereas the benefits of the project are many.

The primary reason why the environmental impact from the plant is minimal is that the project proponent is abide by Bangladesh, ADB & World Bank Standards and build a plant, which will meet the emission standards of Bangladesh, ADB & World Bank. The excellent characteristics of the fuel (Gas/HSD) used, equipment and machinery, which conform to international standard and good operation practices all combine to make the proposed power plant project acceptable one.

The main potential environmental problems, which may arise as a result of construction of power plant, can be grouped as follows-

- Atmospheric emissions and Air quality
- Water pollution and waste water disposal
- Noise

All these aspects have been examined and the findings are as follows:

Atmospheric Emission and Air Quality: The proposed power station will be fired on natural gas or HSD. Emission of NO_x will be very low as electricity will be produced using lean burn mixture of air and gas in the cylinder i.e. more air will be present in the cylinder than required for complete combustion. Based on the appropriate design of burner, dry low NOx (DLN), water injection or Selective Catalytic Reduction (SCR) and the stack of Gas Turbine: 40 m, HRSG: 50 m height, as per the emission dispersion modeling, the NOx emission from all the stacks would be within the Bangladesh and WB/IFC standard.

The proposed power plant will be operated 30% of operation hour by HSD and use HSD of lower than 0.50% sulfur content which is lower than the IFC/WB standard of thermal power plant emission guideline.

Liquid Discharge: The proposed power plant will not create any process liquid from the production process. The total water requirement of the project will be (125-150) m^3/hr. which will be abstracted from the Brahmaputra river and deep tube well. The power plant will have closed loop water cooling system for the main steam condensation unit of HRSG system in which 548 m^3/hr. of water will be required as makeup water in the circulating cooling system where the 22500 m^3/hr. water flow will be maintained in the close circuit cooling loop. In addition, 24 m^3/hr. waters will be needed for service water, HRSG blow down and other different uses and 101 m^3/hr. waters will be required for DM water system. The DM water after treatment will be fed to different cooling system and steam boiler in the plant as makeup water. There will be around 20 m^3/hr. wastewaters will be generated from the different section of the plant as blow down and from domestic sources. This wastewater will contain significant amount of pollution, which may impact the surface water quality.

The cooling water will be used in a close loop system having no discharge. As mentioned earlier, around 20 m^3/hr. wastewaters will be generated from the different section of the project which will be treated in the Effluent Treatment Plant (ETP). The plant will use (125-150) m^3/hr. groundwater and river water which will be treated in WTP prior to use in the plant. The wastewater will be stored in a collection tank and after controlling pH, TDS and suspended solids the water will be discharged into the river. The domestic liquid waste will be disposed through a septic tank with a soak pit. The project will have planned drainage system to discharge the surface runoff. The surface drainage network would be connected with an interceptor prior to discharge through natural water. The interceptor will trap all oily matter present in the water.

Noise: The noise impact generated by operation of the plant has been predicted by means of noise impact modeling. The results will be used to specify noise abatement measurers. Appropriate noise controls will be installed to keep the neighborhood impact due to noise emissions within the limit of DoE and international standards.

Having reviewed all the potential environmental impacts, and following our proposed mitigation measures the project is expected to proceed without having unacceptable environment. Electricity supplies could be provided to the area without much of load shedding and it will also add a significant amount of electricity to the national grid. In this context, the proposed power station, RPCL 360 MW Combined Cycle Power Plant, would be a welcome relief for the people in that area as well as for the people of Bangladesh.

However, no development can be expected without any adverse impact on the environment. The beneficial impacts on the nation as well as human beings would only be meaningful and sustainable development would only be possible if adverse impacts are minimized through strict maintenance and control measures as mentioned for this project. All this would need vigilant care and cost money, and the project authority should take these into consideration.

12.1 Recommendations

In order to manage the potential adverse environmental impacts, especially in the operational phase of the plant, the recommendations provided in the EMP should be followed with due diligence. Some of important actions required are:

1. Activation of Environmental Monitoring Committee, holding of its regular meeting and preparation of the monitoring report.
2. Activation of Emergency Management and Safety Committee and holding of its regular meeting.
3. Training of staff on EMP related issues.
4. Activation of the Grievance Redress Committee and prompt response to public complaints.
5. Development of an Environment Management System (EMS) for the plant and preparation of SOPs on specific issues.
6. Allocation of adequate resources in the yearly budget for implementation of EMP.
7. Conducting a post construction environmental study to evaluate the environmental impacts from the project and compare those with the EIA.

However, most important issue is the commitment for the implementation of the actions required under the EMP by the management.

CHAPTER 13: REFERENCE

13.0 Reference

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