রুরাল পাওয়ার কোম্পানী লিমিটেড
RURAL POWER COMPANY LIMITED

EIA of 2x660 MW Coal Based Thermal Power Plant to be Constructed at Kalapara, Patuakhali

Volume-I

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Submitted by

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Glossary

Aila:	Major Cyclone, which hit Bangladesh coast on May 25, 2009
Aman:	Group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, supplemental irrigation needed in places during dry spell.
Aus:	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed for HYV T. Aus.
B:	When preceding a crop means broadcast (B. Aus)
Bagda:	Shrimp (*Penaeus monodon),* brackish/slightly saline water species.
Bazar:	Market
Beel:	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
Boro:	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Golda	Prawn *(Macrobrachium rosenbergii*), non-saline/fresh water species
Gher	Farm lands converted into ponds with low dykes and used for cultivation of shrimp/prawn/fish.
Haat:	Market place where market exchanges are carried out either once, twice or thrice a week, however not every day.
Jaal:	Different types of fishing net to catch fish from the water bodies.
Kacha:	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal:	A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.
Kharif:	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Perennial Khal:	Water available in the khal all the year round.
Pacca:	Well-constructed building using modern masonry materials.
Rabi:	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
Seasonal Khal:	Water not available in the khal all the year round.
Sidr:	Major Cyclone, which hit Bangladesh coast on November 15, 2007.
T. *Aman*:	When preceding a crop means transplanted (T. Aman).
Upazila:	Upazila is an administrative subdivision of a District.

Abbreviations and Acronyms

AAEO	Assistant Agriculture Extension Officer
B	Boron
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
Ca	Calcium
Cd	Cadmium
Cu	Copper
DAE	Department of Agricultural Extension
DC	Deputy Commissioner
DLS	Department of Livestock
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FAO	Food and Agriculture Organization
Fe	Ferrum (Iron)
IEE	Initial Environmental Examination
IESCs	Important Environmental and Social Components
ICM	Integrated Pest Management
K	Potassium
Mg	Magnesium
MP	Muriate of Potash
Mn	Manganese
LLP	Low Lift Pump
LOQ	Limit of Quantitation
N	Nitrogen
Na	Sodium
NCA	Net Cultivable Area
OM	Organic Matter
P	Phosphorus
Pb	Lead
pH	Soil reaction
SAAO	Sub Assistant Agriculture Officer
S	Sulphur
SRDI	Soil Resource Development Institute
STWs	Shallow Tube Well
SOLARIS	Soil and Land Resources Information System
TSP	Triple Super Phosphate
TDS	Total Dissolved Solids
ToR	Terms of References
UAO	Upazila Agriculture Officer
ULO	Upazila Livestock Officer
VFA	Veterinary Field Assistant
Zn	Zinc

Unit Conversion Table

General Units

1 meter = 3.28 ft

1 kilometer = 0.621371192 mile

1 nautical mile = 1.852 kilometer

1 kilogram = 2.20 pound

1 metric ton = 1000 kg

1 barrel = 42 U.S. gallons = 159.0 liters

1 liter = 0.264172052 gallon (US)

1 square mile = 640 acres = 2.590 km^2

1 hectare = 10^{-2} km^2 = 2.471 acres

1 Pascal = 1 N/m^2= 0.01 millibar

1 liter = 0.001 cubic meter

1^0C = 274.15K=33.80F

1 mg/m^3 = 1 µg /L

1 mg/L ≈ 1 g/m^3 ≈ 1 ppm (w/w)

1 ≈ g/L ≈ 1 mg/ m^3 ≈ 1 ppb (w/w)

1 knot = 0.514444 m/s

1$µg/m^3$ = 1 ppb*(12.187)*(M) / (273.15 + °C)

Energy Units

1 Cal = 4.19 J

1 Btu = 1055.87J

1 Btu = 251.9958 cal

1 joule = 0.239 cal

1 kWh = 3412 Btu.

1MW=1000KW=10^6 W

1 kWh = 3.6 x 10^6 J

1 kWh = 859.85 kcal

1 horsepower = 746 W

1 GWyr = 8.76 x 10^9 kWh

Executive Summary

Background

The Power System Master Plan in 2010 hints to fuel diversification for electricity generation because of faster depleting the natural gas. In the meantime, the Government of Bangladesh has announced a new policy named 'Vision 2041' embarked on a mega plan to reach a supply capacity of around 57238 MW of electricity by 2041 and 20% of which will be generated from coal to reduce the dependency on natural gas and also to continue sustainable power supply for the socio-economic development of Bangladesh.

However, various assumptions related to the expected sources for base load energy have subsequently changed. Therefore, energy development is not on the same path as related to its PSMP 2010 plan. As a result a new Power System Master Plan 2016 has been finalized based on the future economic growth, fuel, demand and supply. This new plan aims at assisting the Bangladesh in formulating an extensive energy and power development plan up to the year 2041.To fulfil the target of PSMP 2016, Rural Power Company Limited (RPCL) intends to construct a 2x660 MW Coal Fired Thermal Power Plant at Kalapara, Patuakhali, Bangladesh.

The proposed Project falls under the 'Red' category of industry (Rule-7, Schedule-1).In compliance with the existing environmental legislation of Bangladesh for red category industries, the proponent has entrusted CEGIS with the responsibility of conducting IEE and EIA studies under a contract signed on 30 /6/2015.

Accordingly, CEGIS has prepared a detailed methodology for conducting the IEE and the EIA studies. For conducting this study, methodology has been prepared by the strong multidisciplinary team having expertise in EIA study. This EIA report has been prepared after a couple of field visits maintaining all statutory requirements.

Policy, Legal and Administrative Framework

A set of Policy, Acts, Administrative Framework and guidelines is required for the Environmental Assessment Study of a coal based thermal power plant. According to the ECR, 1997 this Power Plant Project falls under Red category where environmental Clearance/Approval Certificate from DoE is obligatory.

This study has detailed out of the relevant national and international acts and rules in different phases of the Power Plant Project. Chapter 2 of this report figures out the specific laws or legislatives works related to Power Plant construction and operation process. National and international acts have been identified for the coal-based Power Plant and for the transportation, handling process. In addition, latest national and international environmental standard limits have been specified which have to be strictly maintained at every phase of project development. This document focuses on the issues addressing the specific impacts which have been evaluated, mitigation measures suggested and monitoring plan prepared following the standard practices especially IFC project Performance Standard (2012).

Project Brief

The proposed project is a 2x660MW sub-bituminous coal based ultra-super critical thermal power Plant. Each 660 MW Plant will consist of one ultra-supercritical, balanced draft, pulverized coal fired Boiler with built in Dry Low NOx burners suitable for outdoor installation with a stack of 275 meter high and a tandem-compound, multi cylinder design condensing type steam turbine directly coupled with hydrogen cooled generator suitable for indoor installation.

The primary fuel will be sub-bituminous coal for continuous operation and liquid fuel (HFO, LDO) for Boiler start-up, flame stabilization and low load operation.

Using Payra Bandar port authority's Jetty the imported coal from source countries like Australia or Indonesia will be unloaded and finally stored in plant stockyard using conveyer belt. A detail discussion on fuel source, quality and requirement is made in article 5.8, under the title "Coal requirement and management.

Close cooling cycle with cooling tower has been envisaged for the project. Surface water from the RABNABAD CHANNEL shall be used for condenser cooling and all other purpose. In total 5117m3/h of surface water from "The Rabnabad Channel" will be withdraw for condenser and other auxiliary components cooling make up and for all other purpose. About 2573 m3/h of waste water after being treated will be used as sprinkling water, garden water/discharged in the outfall. The project adopts Reverse Osmosis Process of surface water for cycle makeup, HVAC makeup, etc.

The major project facilities comprises of water intake and discharge channels, Flue Gas Desulphurization units (FGD), Low-NOx burners, Conveyer belts, Coal storing facilities (Coal yard), ash pond for ash disposal, De-mineralization Plant, Water Treatment Plant, Effluent Treatment Plant, internal roads and buildings etc.

The proposed project site is located at Mauza Nishanbaria, Dhankhali and Londa, Kalapara Upazila, Patuakhali district and is on the western bank of River Rabnabad/Patuakhali, and adjacent to the proposed RPCL Power Plant in the south and APSCL's proposed Power Plant in the north.The site is selected on the basis of comparison matrix of four preselected sites. The total area of the project is around 916 acres of land.The proposed project site is accessible through the metal road from Londa Mauza to Dhankhali Union and Dhankhali Union to Patuakhali – Kuakata Highway. The project site can also be accessed through the river route using the Rabnabad and Andharmanik Rivers.

The generated power at 24KV of the proposed power plant after being stepped up to 400KV will be connected to the plant switch-yard and then to the PGCB's proposed 400 kV GIS substation at Kalapara Upazila. The power will then be evacuated through the national grid of Gopalganj-Dhaka. PGCB has already given a consent letter to RPCL for the power evacuation facilities on June-2019. RPCL will utilize this facility to evacuate their generated electricity from the proposed power plant.

The Project once completed, would add 2X 612 MW net power to the national power grid. Thereby improving the present power grid scenario significantly and triggering the national economic development through industrialization. Moreover, it will create employment opportunity for the local people and improve the transportation system in the Project area, which will ultimately play an important role in poverty reduction and develop social safety net condition. The Plant will be designed to meet the Best Available Control Technology (BACT) emission

Suitability Assessment

The selection of the best alternative site has been made through multi criteria analysis based on the criteria identified following the EIA Guideline of DoE (EIA Guideline for industries) and

IFC Environmental Assessment Guidance for Thermal Power Projects. This study evaluated a number of criteria in order to select the best alternative site. Selection from No action alternative, site alternatives, fuel alternatives, design alternatives etc have been considered to find out the optimal solution of adverse environmental and social impacts. A number of environmental, social, financial and technical criteria and indicators have been set up to finalize the specification of the project. These criteria have been developed through consultation and expert judgment by multidisciplinary team of EIA.

Description of Baseline Environment

The base situation of the study area in terms of physical resources, water resources, land and agricultural resources, fisheries resources, ecological and socio-economic resources have been identified for both project area and the study area as well.

The proposed 1320 MW Power Plant project is located at the Chittagong coastal area with an elevation of 1-2 m from MSL and itencircled by the coastal polder from the Rabnabad Channel, Andharmanik river, Tiakhali Khal etc. The seismic coefficient of the project area is 0.04g as it falls under zone-I under the classification of GSB.The tropical climate prevail in the study area with distinct monsoonal season which influences all other climatic parameters. Meteorological data of nearby station (BMD Stationa ID: 12103) was analyzed for the last 30 years to get the overall climatic conditions of the study area. The climate of study area experiences a hot, wet and humid tropical climate. Nearly 80% rainfall takes places in monsoon in the study area where annual average rainfall was recorded 2519 mm that particular areas. The monthly average relative humidity near the project area varies seasonally from 76.21% to 90.61%. Data for wind speed of Patuakhali BMD station and data for wind direction of Kuakata BMD station have also been illustrated through tables and diagrams.

Three major rivers and enormous canals are flowing in the study area. The name of rivers is Andharmanik, Rabnabad and Tiakhali. All the rivers and canals are tidal in nature. Specifically, water level of Andharmanik river during high tide ranges from +0.75 mPWD to +1.69 mPWD, whereas low tidal water level ranges from (-)1.12 mPWD to (-) 0.54 mPWD. Erosion was dominating in the Rabnabad channel during 1973 to 2015, although recently the erosion and accretion rates are about to be similar. During this period, a total of 844 ha of land have been eroded and 616 ha of land have been accreted.

The peripheral flood control embankment (interior dyke and sea dyke) effectively offers protection from the storm surge flooding in the area. Local people opined that there was no major storm surge flooding in the Polder area during AILA (2009) and SIDR (2007). Tidal flooding occurs inside the Amtali Union of the study area in almost every year and inundates about 7 to 8 % of the total area of the Union due to lower drainage capacity of Pujakhola regulator.

Present air quality, water quality and noise level have been investigated through standard practices. Four locations for air quality sampling, 8 locations for surface water and 2 locations for ground water quality, 20 location for noise level have been monitored depending on the location sensitivity and future impact potentiality. All the pollutants in the ambient air and water are within the limit of national and international standards. Present acoustic environment varies generally 43-65 dBA at different places during day time in the study area.

This study includes of the potential impacts on agricultural resources due to the construction of 2×660MW coal based power plant at Kalapara, Patuakhali. The acquired land for this project are mostly agricultural land (779 acre). A significant part of this land are used for multiple cropping system in different season. Besides this, 10km radius area is considered as study area of the project. This area faces potential risks if any accidental event takes place. The study area contains 40,706 acre agricultural land, which is normally double or single cropped.

The entire study area occupied with different ecosystems chiefly terrestrial and aquatic; and falls under two bio-ecological zones: a) Coastal Marine Water; and b) Ganges Floodplain. The project area shows it falls under agriculture and partially homesteads area where a large number of plant individuals have been recorded during the field investigation but no one was identified as threatened species. Among plants Gum Tree (n=117) is dominant species and followed by Hill Glory (n=112) where Lead Tree shows (n=32) a small number of individuals throughout the project area. The species diversity has been estimated and shown plant Species Diversity Index (SDI) 2.91. On the other hand, diversity and population of the fauna occur in the project area has been assessed and considered as moderate but only a species i.e. Bengal Fox has been categorized as vulnerable (VU) to the country by the IUCN Bangladesh (2015).

The ecosystems of the study area possess two major categories in accordance with vegetation patterns and landscapes- terrestrial and aquatic ecosystems. Moreover, mangrove and marine and coastal ecosystems also occur to the periphery of rivers and coast. The findings of the field investigation described under three categories are homestead, crop-field and roadside vegetation's. Of the homesteads, West Indies Mahogany and Acacia were noted as dominant in addition to common fruit bearing species. The crop-filed vegetation's are Spiny Amaranth, Mexican Tea, Glory bower, Burmuda Grass and Goose Grass. The road slopes are occupied with fast growing and exotic species of different timber and non-timber species like Acacia, *Rosewood,* Lead Tree, Date Palm, Neem, Palmyra Palm, Rain Tree and Gum Tree. The wildlife widely discussed in this report is amphibian, reptile, avifauna and mammal. The study area is a saline prone, so, the diversity and population of the amphibians has been considered as moderate. The latter two groups (reptiles and birds) are dominant and individuals like Common Garden Lizard, Little Skink, Asian Pied Starling, Black Drongo, Brahminy Kite, Red-vented Bulbul, Common Tailorbird, etc. were observed frequently. Of the mammals, small to medium-sized individuals found common i.e. Bandicoot Rat, Jungle Cat, Indian Flying Fox and Bengal Fox within the study area. Two mammalian species- Bengal Fox and Ganges River Dolphin categorized as threatened by the IUCN-Bangladesh (2015). The habitats are sporadic and not healthy to enhance diversity as well as population due to human disturbance.

Total fish habitat in the study area is about 28,548 acre, where the project area occupied by 522 acre. Among the fisheries habitats, riverine habitat shared by 22,866 acres in study area and 45 acre in project area. The estimated total annual fish production from all habitats is about 2,562MT in the study area and 49 MT in the project area. The project area is located adjoining the Rabnabad channel which is most important breeding ground for deshi pangus, black tiger shrimp and hilsa. This is also an important migration route for hilsa. Andharmanik River is one of the significant hilsa sanctuary declared by the government for conserving *Jatka* is also located in the study area.

The study area consists of 10 unions and 1 municipality either partially or fully having population of about 117,967 with the average household size of 4.1. The number of male (58,888) is slightly less than the number of female (59,080). The average population density is 422 which is little fewer than the national density of 1,015 persons per sq. km. At present around 121 numbers of households and around 560 number of people live inside the proposed project boundary. The inhabitants belong to two main religious groups; i.e. the Muslim and the Hindu. The distributions of employment of the area at reference period of census are as follows: about 81% are engaged in agricultural activities, about 2% in industrial and about 17%

in service sectors. Electricity facility is very poor (about 29.2%) in the area. The overall housing condition (84% households are kutcha) is not satisfactory. About 80% of the households use ground water as drinking water. According to the findings of RRA, there exists family graveyards, one mosque and one Madrasah falls under the proposed project area.

Impacts Assessment and Evaluation

The potential environmental and socioeconomic impacts have been identified considering the existing environmental and social aspects in the study area. Impacted components have been identified according to different stages of the project construction and operation stages. The impact extent of the impacts, duration and frequency of impacts, reversibility of the impacts are identified for assessing the magnitude of the impacts on the sensitive receptors in the study area. The receptor's sensitivities are also identified for assessing the significant of the impacts at different stages of eh project.

Major environmental impacts of the Project are registered under pre-construction, construction and operation phases may include; susceptibility of environmental pollution and social unconventional relations among different parties. Firstly, the landscape and scenic beauty might be aggravated temporarily during construction periods but recovered at time of operation of this project. The air quality will be deteriorated in the project area and its surrounds from the beginning of the construction such as land filling, construction materials processing, infrastructural development, vehicular transportation, machineries installation etc. It may generate fugitive dust particles and insignificant emission of CO_2, CO and NOx.

The proposed project will consume sub-bituminous type of coal at the rate of around 13,151 TPD corresponding to 4.8 million tons a year. The calculated byproducts like ash 62 Kg/hr, CO – 34.5 g/s, SO_2 – 122.8 g/s, NO_x-313.1 g/s, PM_{10} – 28.5 g/s and $PM_{2.5}$ – 2.4 g/s will release at 275m height and 7.2m width stack after taking inbuilt abotment measures like FGD, Low-NOx burner, ESP and provision for SCR etc by the power plant. To assess the dispersion of pollutants advanced sophisticated model CALPUFF is used for calculating 1-hr, 24-hr and annual maximum concentration in the study area. The model has been adopted by the USEPA for assessing long range transport of pollutants and their impacts on sensitive areas and on a case-by-case basis for certain near-field applications involving complex meteorological conditions. Flue gas will emit from the same stacks through two bifurcated line (using multiflue chimney). The measured pollutant concentration in four locations have been used for validation of the model in the study area. Three scenario has been developed to assess the pollution level of the criteria pollutants at different sensitive receptors. Around 120 numbers of discrete receptors have been selected around 25km from the project sites depending on the location or useable sensitivity or impact potentiality. Table –A shows the maximum ground level concentration of criteria pollutants during baseline, project and cumulative scenarios. For baseline modeling existing emission sources like vehicular emission, brick klins are accounted; to model the project case scenario, the baseline emission sources has been added with the emission of 1320 MW Power Plant of RPCL and for the cumulative case, the existing baseline sources, emission of proposed 1320 MW coal based power plant and emission from the other power plants been taken into account.

Table A: Maximum GLC of the criteria pollutants under different scenarios

Criteria Pollutants	Averaging Time	Location at Ground Level (UTM: 46)		Concentration ($\mu g/m^3$)	Standard Limit	
		East(km)	North (km)	Maximum Value	ECR 2005	IFC 2008
Baseline Case- SO_2	24 Hr - SO_2	217.436	2432.798	47.455E+001	365	125 (IT-1)
Project Case - SO_2		217.436	2432.798	4.8104E+001		
Cumulative Case - SO_2		217.436	2432.798	4.8104E+001		
Baseline Case - SO_2	Annual - SO_2	217.436	2432.798	6.5068E+000	80	-
Project Case- SO_2		217.436	2432.798	6.7193E+000		
Cumulative Case - SO_2		217.436	2432.798	7.3751E+000		
Baseline Case – NO_x	Annual	215.263	2439.294	1.1152E+001	100	
Project Case- NO_x		215.263	2439.294	1.1357E+001		
Cumulative Case - NO_x		215.263	2439.294	1.2425E+001		
Baseline Case - $PM_{2.5}$	24 Hr	217.436	2432.798	1.4076E+001	65	75 (IT-1)
Project Case - $PM_{2.5}$		217.436	2432.798	1.4397E+001		
Cumulative Case - $PM_{2.5}$		217.436	2432.798	1.4397E+001		
Baseline Case - $PM_{2.5}$	Annual	217.436	2432.798	1.9329E+000	15	35 (IT-1)
Project Case - $PM_{2.5}$		217.436	2432.798	2.0016E+000		
Cumulative Case - $PM_{2.5}$		217.436	2432.798	2.0050E+000		
Baseline Case – PM_{10}	24 Hr	217.436	2432.798	4.2784E+001	150	125 (IT-1)
Project Case – PM_{10}		217.436	2432.798	4.3782E+001		
Cumulative Case – PM_{10}		217.436	2432.798	4.3782E+001		
Baseline Case – PM_{10}	Annual	217.436	2432.798	5.8897E+000	50	70 (IT-1)
Project Case – PM_{10}		217.436	2432.798	6.0387E+000		
Cumulative Case – PM_{10}		217.436	2432.798	6.0830E+000		

The ambient concentration of PM_{10} and $PM_{2.5}$ is slightly higher than the national annual standard values. However, the contribution of pollutants by this proposed power plant in ambient environment is lesser. It maintains the national standard and interim target of IFC, 2008 well. This power plant will emit around 11.9 million Ton of GHG in every year for producing 1320MWhr electricity to the grid.

A number of mechanical instruments, truck, bulldozers, compaction roller, pneumatic hammers, gerators, mixers, unloaders will generate high noise that affect to the workers, their colony and nearest communities especially within the range of 500 m. Produced noise from the plant will be obstructed by acoustic hoods, green belt, and project boundary during the operation time. A simulation of noise propagation has been prepared by Sound Plan essential 3.0 for noise model approved by European Environment agency. The predicted noise level at different distances from the source has been identified through this model. Eventually, the resultant noise level has been estimated summing the predicted noise level with the measured noise level at certain distance for both day and night periods. The resultant noise level (*i.e*. Leq) will be lower to than the national standard (ECR, 2006) and international standard (IFC, 2008) for the recreational zone.

During construction phase, different kind of construction solid waste may have the chance to mingle with the surroundings environment. Coal dust, bottom ash, scraps materials, hazardous materials and domestic waste generated from the operation of the plant affect the neighboring environment without considering the mitigation measures. Since the project will use cooling tower for condenser cooling, there will be no possibilities of the effect of thermal plume discharge in any natural river system. During operation stage, the power plant will use CETP including oil separator, physico-chemical treatment plant, and biological treatment plant to clean the effluent. Moreover, as the project will be run through the concept of zero discharge law, the impact on the surface and ground water would be low. During transportation of coal wave action from the ships may affects the river bank, bilge and ballast water from the ships, emission from the ships may affects the ambient environment.

The proposed area is basically a cultivable land along with homesteads will incur vegetation loss due to site preparation, land development as well as construction activities. Similarly, pipeline installation for land development process would damage terrestrial vegetation including mangrove. The pipeline installation activities will do harm to shorebirds feeding habitat through labor movement by impeding their normal activities. Spectacularly, labor movement will disturb their normal activities and they can be migrated locally. Moreover, the marine habitat would receive oil spills during transportation of construction machineries to the project area. The construction activities will generate noise by high frequent sound machineries, blocking wildlife passage by stockpiling of construction materials and disturbance through vehicle and labor movements. During construction and operation the benthic community would receive major negative impacts by dredging works and oil spills from cargo/vessels. On the other way, the proposed greenbelt will provide positive impacts through create important habitat to different wildlife including local birds, and others. Coal dropping during transportation would lead deposit toxic elements in the bottom of waterways- ‘home to benthos’s. The benthos is sensitive to pollutants and pollutants may destroy the benthic community.

Ramnabad Channel is one the suitable spawning ground for Hilsa, Pangus and shrimp which might be affected because of dredging activities. Water intake from the Channel would also entrap fish, crustaceans and other aquatic organisms particularly the sluggish species. Fish species specially Hilsa, Pangus and Shrimp PL etc would be affected due to disposal of waste water like ballast and bilge water from the ship/cargo carrying machinery and ancillaries having oil and grease contaminants. Predator-prey relationship might be affected due to spread of invasive species through ballast water. Integrated impact to be caused for withdrawal of 3x1400 m^3/hour of water, daily for three power plants located at the Rabnabad channel may alter the fish diversity due to salinity intrusion.

As per the plan of GoB, a number of coal based power plants will be constructed at Patukhali District beside the Rabnabad channel for getting the coal carrying facilities. The proposition for this project is to reduce the settlement areas. Therefore, around 779 acres of agricultural land will be acquired for the power plant project in contrast of 9 acres of settlement areas. Most of these lands are used for agriculture in different seasons.

During pre-construction stage, there would be loss of properties of the households and landlords. An unrest situation among the local people may be raised if they are not rehabilitated or compensated properly. The people may lose their existing employment opportunities such as agriculture and livestock rearing. On the other hand, the employment opportunities would be created significantly for the labour class people during the pre - construction activities.

During construction stage labour in-migration may be increased. Contamination of water and sanitation system. Handling of heavy construction machineries may create health injury in the project sites. Unsafe and unhygienic labour shades may create a very hazardous health problem.

During operation stage, new employment opportunities and ensure employment opportunities will be created throughout the industrial development. Land price of the adjacent areas of the project will increase significantly. The sale value of land will be increased due to immigration of people as well as technical people in this area. On the other hand, environment especially water and sanitation may be disturbed by the labours. Health injury may be occurred in power plant for handling of heavy machineries.

Mitigation of the Impacts

The proposed 1320 MW coal base power plant has considered a number of environmentally friendly measures, such as combined cycle technology, close cooling system, central effluent treatment plant (CETP), etc. The mitigation measures for potential major impacts are discussed in detail in Chapter-IX. The minor and some moderate impacts will be managed and mitigated using environmental code of practices (presented in Appendix-VI) and Contractors' good practice. The mitigation for some of the potential major impacts may include the following:

Pre-construction

Resettlement and compensation plan should be governed by the Resettlement Action Plan (RAP) study and the construction activities should be initiated after completion of the total compensation process. Local labor both for technical and non-technical should be trained and engaged for the Project related activities thus they can be able to own the project. Moreover, the land compensation process should be efficient to the farmers in association support services.

The demarcation of project area and dykes must be created before going to land development process. In this aspect, pipeline installation for land development through sands, the implement agency should measure the damages and its proper management to minimize damages. Using low sound emission machineries would reduce both disturbance to wildlife and noise pollution. Dredging activities must be restricted during Hilsha (September - October) and Pangus (June - July) spawning period and peak shrimp PL (February – March) collection periods in the planning stage of this project.

Construction phase

Labor working condition must be guided with best practices maintaining the ECPs. The worker colonies must follow good housekeeping and appropriate PPEs at work station. All arc welding and cutting operations should be shielded by noncombustible or flameproof screens. Oils, lubricants and other hazardous materials should be bounded and stored separately so as to limit the spillage. The worker should be trained on safety precautions on identifying, using/handling such hazardous materials.

A pragmatic grievance redress mechanisms for both the community in the study area and labor in the project area must be regularized. Engaging the affected people in different Project activities with highest priority. Health and safety trainings should be provided regularly. An on-site medical team should be set up and emergency first-aid kit should be at hand in case of any accidental injuries (burns, cuts, broken bones etc.). Workers hygiene and health status should be ensured. Monthly health checkup should be conducted to monitor their health condition and appropriate treatment should be provided for any ailments.

They should be casing the pipe during buried pipes crosses the road. Watering or sprinking water over the area sources of dust generation. Dredging operation should be carried out in the route having minimum aquatic habitats. Appropriate benthic survey must be carried out prior to any dredging activities. The shipping company must ensure that the ship carrying construction materials and other raw materials, obey the national and International Maritime Laws. The vehicle speed should be limited to 15 kmph during the dry seasons and the truck must be covered when it hauling material. Contractor will compact the back-filling material to prevent any subsequent subsidence. Rubbles generated from the construction site should be stored in appropriate bins/skips, should be well-covered and later should be buried in an approved landfill site. All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal.

Establishment of greenbelt will be an option to create new habitats to wildlife and environmental protection to others. In this context, plantation of native species is suggested to improve the status of the habitat. To avoid disturbance to shorebirds and other wildlife install light downwardly and do not run construction works at night. The shippers should aware of consequence of toxicity to benthic community. The proposed project site is very close to feeding ground of wintering birds and it is suggested not to select winter season (October-February) as project implement period. The dredging work designated to channels is suggested to implement segment by segment to avoid total damage of the benthic communities. Fish breeding and fish spawning seasons should be avoided for transporting construction materials and machinery as well as ancillaries through waterways.

Operation phase

The dust particulates will be arrested from the sources through different equipment like ESP, sprinkler, DSS etc for different point and fugitive sources. Built-in Low-NOx burner and use of FGD will reduce the emission of SO2 and NOx from the 275m height stack. The ESP and FGD will be in operation stage and continuously monitored the environmentally susceptible pollutants to the stack.

The machines/equipment/vehicles should be turned off when not in use. Doors of the control room, windows and other doors should be fitted with proper sealing; the equipment like turbines, pumps, fans etc. should be covered with soundproof dampeners to limit the spread of noise. Workers should use appropriate PPEs (soundproof earpiece, earmuffs, etc.) while working close to the noise generating equipment. Local municipalities should have ordinances that regulate loud and objectionable noise; the authority should warn the local people about it.

Moreover, regular maintenance the greenbelts should around the power Plant area will limit the spread of noise to the nearby community.

Operation of CETP, STP and storm water drainage system separately will avoid the surface water pollution to the ambient river system. Construction of a leak-proof sump should be made to store sludge temporarily and to limit their spillage. They should then be transferred to sludge treatment plant for treatment. Use of concrete lining at the bottom and side of the ash pond, transformer, oil storage and treatment plant will protect ground water contamination in the project premises. The sump should be monitored and maintained by on board chemist and technicians and make sure everything (e.g. pollutant content, spill control etc.) goes smoothly.

Use of alternative oxygen scavenging chemical e.g. Helamin, Diethyl hydroxylamine, etc in feed water for corrosion protection in boiler instead of hydrazine as this chemical is banned worldwide. Introduction of Reverse Osmosis (RO) instead of using resin in demineralization plant.

Scattered throwing and burning of waste should be prohibited. There should be a designated site for kitchen waste disposal. A good practice of kitchen waste collection and disposal system should be adopted. The aim should be reduction of the waste generation. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Some temporary bins with different colors indicating disposal of degradable and non-degradable wastes might be installed at labor shed and work places to prevent scattered throwing of solid wastes.

The benthos are more sensitive to toxic elements especially the coal contamination. The shippers should well aware about the consequence of coal and develop management system to adhere properly. In this aspect, the loaded vessel should cover tightly to avoid coal dropping. The water intake velocity will not be more than 0.5ft/s at the screen of the intake channel. Ballast water and oil spillage must be controlled from the ships, vessels and construction site. Foreign ships must be checked for protecting the migration of invasive species.

Buried pipes and fittings should be protected against corrosion by means of external coating and wrapping. So, holiday detector shall be used to detect any holiday and should be repaired. Cathodic protection test points should be installed and connected to temporary cathodic protection facilities in accordance with the specification as the final operation of lowering or tie-in is in progress. Cleaning regime should include a combination of on-line cleaning and semi-annual off-line washing. Welded joint sections of the pipeline should be separated and tied into a continuous system in such a manner that no stress would be exerted into the pipe as a consequence of the tie-in operation.

Need to establish planned housing area and ensure all facilities like water, sanitation, electricity and road facilities for proper development of the area. Local resource based industries should be given the highest priority. Industrial development should be made under the guidance of regional development program. Facilitate to recruit local people according to their skill. In that case, training programs should be provided for assisting easy adoption of newly generated employment.

Environmental Management Plan

The Environmental Management Plan (EMP) includes several plans for implementing mitigation and enhancement measures, emergency response, occupational health and safety, and Environmental Code of Practices. Generally, the impacts, which are minor or moderate, are to be mitigated by adopting Environmental Code of Practices (ECP) and Contractor’s good practices during project implementation. On the other hand, impacts and risks which are critical or major will be mitigated or prevented by adopting mitigation measures. The contractor would prepare and implement the mitigation measures, which will be supervised by the proponent, PIU or a Health and Safety Officer as required. The total estimated cost of implementing the EMP would be around USD 13 million.

Risk and Hazard Assessment

Potential hazard during construction stage might include leakage of flammable gas, leading to explosion and fire hazards. Finally, during operation phase, potential hazard might also include accident, compound leak, leading to fire hazards, explosion and human toxicity. Mitigation measures include: use of personal protective equipment (PPE); fall protection devices; proper training on health and safety and safety equipment; proper training on how to use machineries and tools for construction; regular checkup of instruments and machineries; awareness on personal hygiene and road traffic rules and regulation; monthly health inspection of workers and staff etc. The contractor will also design an emergency response plan to better prepare in an event of emergency and how to recover after an emergency situation.

Emergency Response Plan

An Emergency Response Plan (ERP) has been prepared to provide a systematic approach for the protection of employees, assets and the environment from impact of serious incidents. Although a solar power plant project will pose minimum threat to the people working in the project site and its surrounding environment, the implementation of this plan will prevent any minor incidents from becoming a disaster, save lives, prevent injuries and minimize damage to property, workers and the surrounding environment. Possible emergency scenario includes, fire related disasters; immediate medical emergency due to injuries; leakage of hazardous materials; natural disasters (floods, cyclones etc.) and; civil disturbance/terrorist activities (bomb threats, kidnapping etc.) details of such emergencies and its preparedness and response plan is illustrated in **Volume III** as a separate report.

Environmental Monitoring Plan

Various monitoring programs have been proposed in the EIA, which include compliance monitoring, impact monitoring, and external or independent monitoring. The objective of this monitoring program is to ensure that the various tasks detailed in the environmental management plan, particularly the mitigation measures are implemented in an effective manner, and also to evaluate project's impacts on the key environmental and social parameters. The total estimated cost of monitoring would be around USD 1.8 million.

The proposed Project would be designed as environmentally sound procedure. Despite such design, the Project might have sensitivity to environment and thus measures to go beyond regulatory requirements would be introduced in the EIA and EMP. Aspects, such as corporate social and environmental responsibility (which included development of various socio-cultural facilities, toilets, hospitals and training of skilled/semi-skilled local youths for employment in project). For reducing the ground water pressure it is recommended to divert the treated waste water to use as irrigation water to the near crop field area.

Stakeholder Consultation

People are not disagreed to give their own land for this project in response to substantial compensation should be given to them in efficient manner. They have already experienced from the compensation process of the NWPGCL 1320 MW coal based power plant located at Dhankhali Upazila. That is why they expressed a negative attitude against the implementation of this project. They suggested to avoid this union for the implementation of this project. On the other hand, they also showed their eagerness for this project as Implementation of this project would also enhance the region's standard of living because of the increased generation of electricity, contributing to further industrial set up (which further leading to more employment opportunities), etc.

Conclusion

Under the Environment Conservation Act, 1995 the first set of rules promulgated is the Environment Conservation Rules, 1997. The Rules have provided categorization of industries where coal based thermal power plant falls into red category and Category –A as per IFC, 2008. The plant will use modern technologies with the sufficient environmental protection measures for abetting and mitigating the negative impacts. Numbers of measures and management plan have been distinctly instructed in this EIA study. However, the national demand on electricity generation has enormous positive feedback which will compensate the negative impacts after screening by the prescribed EMP. Although there will be some potential negative impacts, this coal-based thermal power plant will try to fulfill the regional electricity demand. The proposed project will create enormous potentiality of regional economic and social development. It will offer large number of job opportunity, infrastructural revolution, increasing social security, communication network development, cultural improvement and livelihood security in the south -east region of Bangladesh. At the end, it can be justified that the potential benefits may outweigh the negative impacts if the suggested EMP and recommendations are strictly followed. .

Finally, the following recommendations are made on the basis of EIA study that should be considered for achieving the goal of optimum minimum environmental impact and optimum benefits:

- Proper Resettlement and Rehabilitation plan is necessary for proper compensation to Project Affected People
- People (not owner) dependent on the land to be acquired should also be compensated and created scope for alternative livelihoods
- Findings and suggestion of EIA study in project planning, design and operation should be considered and implement with strong monitoring
- All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP
- Environmental Management Plan and, Hazard and Safety Management Plan should be implement at every suggested steps of plant construction and operation
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety in Project Management Unit during pre-construction, construction and operation phases of the project
- Strong environmental compliance monitoring activities to be ensured during pre-construction, construction and operation phases of the project
- The Plant should be operated ensuring all pollution abatement measures e.g. ESP, FGD, De-NOx burner, Effluent Treatment Plant, Provision of SCR etc all are in order.
- The project will follow the ISO-14001 and OHAS-18001 standers

The plant should be operated ensuring all pollution abatement measures e.g. ESP, FGD, SCR (if required), De-NOx burner, effluent treatment plant, etc are in order and regular monitoring has to be done to evaluate

1. Introduction

1.1 Project Background

Power is the main driving force of current progress and also the foundation of the growth rate. The vision of Bangladesh Government is to give access to moderate and reliable power to all by the year 2021 and in accordance with this present government's goal is to guarantee continuous and quality power supply for all by 2021 through change in generation, transmission and distribution methods. The Government of Bangladesh has announced the new policy, "Vision 2041" targeting Bangladesh to be a developed country by 2041. With the consistency of economic development, a secure power system would be necessary.

The government has further expanded its vision focusing on the coming years up to 2041 and arranged the Power System Master Plan 2016 (PSMP).This plan expresses that in 2020, 2030 and 2041, the power demand would be 12545MW, 27434 MW and 52034 MW where the power supply would be 12949 MW, 30178 MW and 57238 MW. To promote the fuel diversification for Power Generation and selecting coal as a primary option which will contribute around 20% in future.

To fulfill the future demand, GoB has already initiated international cooperation for Power Secotors. Based on the future economic growth, fuel, demand and supply, international cooperation, a new Power System Master Plan 2016 has been finalized Power System Master Plan (PSMP) 2016, aims at assisting the Bangladesh in formulating an extensive energy and power development plan up to the year 2041, covering energy balance, power balance, and tariff strategies. As per PSMP 2016, achieving middle to long term development issues and risks and to formulate a comprehensive and result-oriented aid strategy for the energy sector by examining effective approaches for each issue. The Rural Power Company Limited now intends to construct a coal fired Thermal Power Plant in Bangladesh to fulfill the target of PSMP.

RPCL is a Power Generation Company in Bangladesh under Power Division, Ministry of Power, Energy and Mineral Resources is hereinafter referred as the "proponent" of this project. The project proponent has taken the initiative to build up two coal based ultra-supercritical thermal power plants with fuel NO_x control technology on about 915.7 acres (371.5 Ha) of land to be acquired from Londa, Nishanbaria and Dhankhali Mauzas, of the Dhankhali and Lalua Unions, Kala Para Upazila in Patuakhali District.

As per the Environmental Conservation Rules, 1997 (amended in 2005) of Bangladesh, this project falls under the 'Red Category' project that requires approval from the Department of Environment (DoE) before starting the construction. The approval process requires carrying out Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA). However, RPCL has obtained redemption of carrying out IEE from the DoE with a condition of conducting a comprehensive EIA in line with a ToR approved by the DoE.

The Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources of the Government of Bangladesh and a pioneer scientific organization with vast experience in carrying out EIA studies of diversified fuel based power plants in Bangladesh, has been entrusted by RPCL for carrying out the EIA of a coal fired Thermal Power Plant in Patuakhali.

1.2 Objective of the Study

The ToR defines the objectives of this consultancy service to carry out the EIA study for the proposed 2x660 MW coal based thermal power plant project to be constructed at Kalapara Upazila in Patuakhali District (Appendix-I). The specific objectives are:

i. To identify environmental regulatory requirements for power plant designing, construction and operation;

ii. To assess the existing environmental and socio-economic baseline condition;

iii. To identify and assess all the potential environmental and socio-economic impact of the proposed plant during its construction and operation;

iv. To identify possible mitigation measures and propose an Environmental & Social Management Plan for ensuring environmental and social safeguard;

v. To prepare an Environmental Monitoring Plan including Environmental Compliance Monitoring during pre-construction, construction, and operation;

vi. To present the justification for the project, and to investigate alternatives to reduce potential environmental impacts and increase potential benefits;

vii. Documentation how stakeholders have been engaged during the EIA Process, and feedback incorporation in the EIA;

viii. To obtain an Environmental Clearance Certificate, issued by the DoE.

1.3 Need and Importance of the Project

At present aggregate introduced power generation limit is 11,532 MW, the present power interest is 10,283 MW and the supply is 8,763 MW (during fiscal year 2014-2015).[1] Around 60% of the number of population of the nation has the entrance to power while power demand growth is 12% for every annum. However, around 71% of the total population have grid or off-grid access to power according to BPDB (Energy and Power, April, 2017). To ensure the reliable electricity to the consumer, a rational demand scenario has been developed by the PSMP 2016 after a number of analysis. Figure-1.1 shows the daily load curve in 2014.

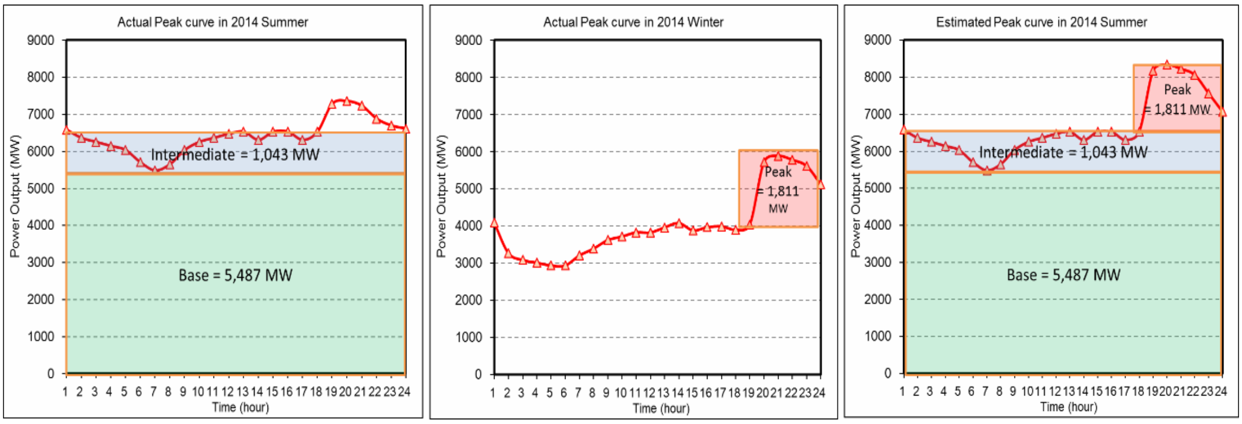


Figure 1.1: Estimated Composite Daily Load Curve in the Summer in Bangladesh (PSMP, 2016)

[1] Power Sector Emergency Information, System Planning Department, BPDB, February 16, 2015.

The performance records of the daily load curve in Bangladesh in 2015 are represented by a curve having a power demand peak in the evening, as illustrated below. In the meantime, by 2041, the economic growth rate in Bangladesh is estimated to reach the daily load curve of advanced countries, where the peak is found in the daytime and evening, if the growth of the electrification rate is taken into account.

As per the PSMP 2016, the forecasted power demand in response to the desired economic growth of the country, will reach around 14,000 MW in 2020 and around 26,000MW by 2030 (Figure 1.2).

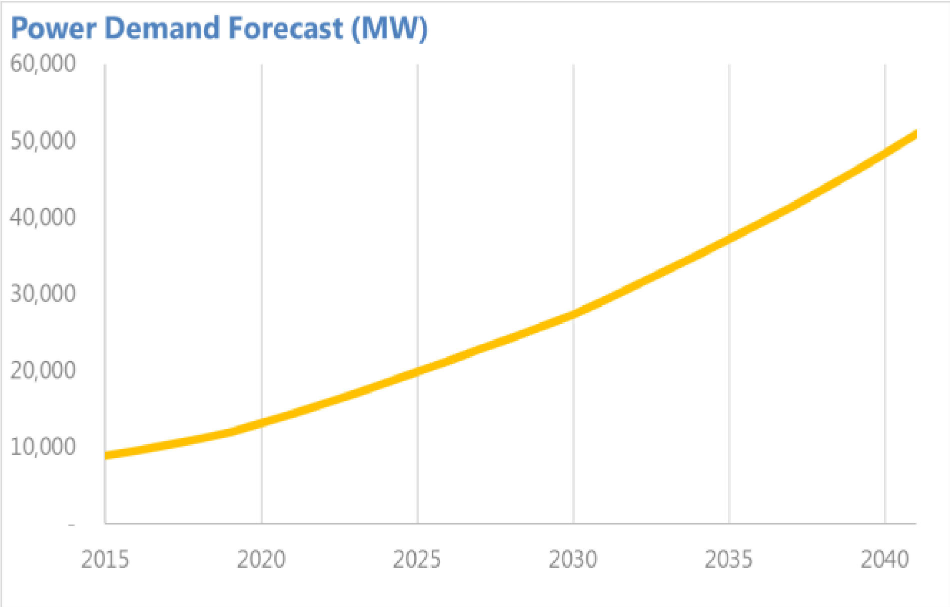


Figure 1.2: Daily load curve 2015-2041 (PSMP 2016)

The power supply plan has been formulated by adding the capacity of the existing plants retirement plan, existing capacity, the committed plant capacity constructed by 2025 etc. Figure 1.3 shows the annual power generation trend from different fuel sources. The plan includes different initiatives to generate additional electricity by diversifying fuel, rehabilitating age-old power plants, and importing electricity from the neighboring countries. The proposed 2x660 MW coal based thermal power plant project is one of such steps for contributing to meet the growing demand. Figure- 1.4 shows the amount of power generated from the coal based power plant up to 2041 where Figure 1.5 shows the sources of coal will be used for those power plant projects.

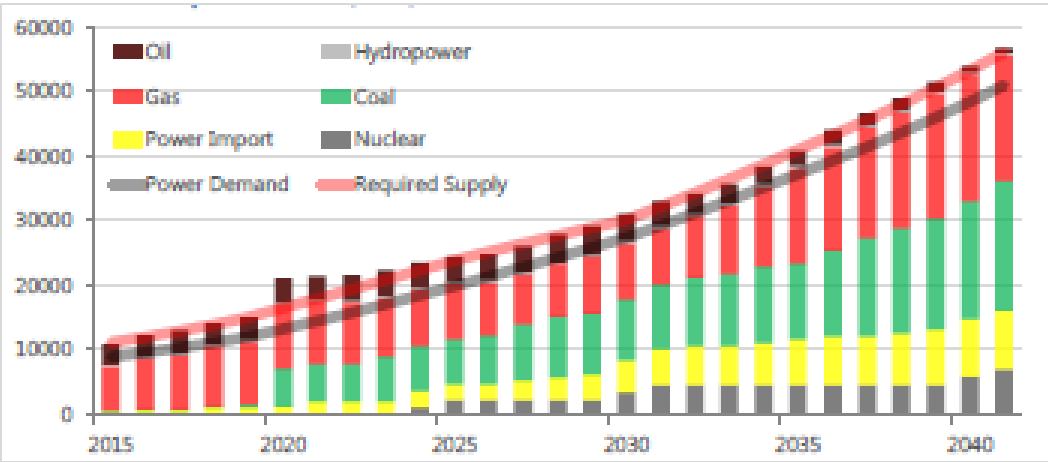


Figure 1.3: Annual Power Generation Trend from Fuel Sources (PSMP 2016)

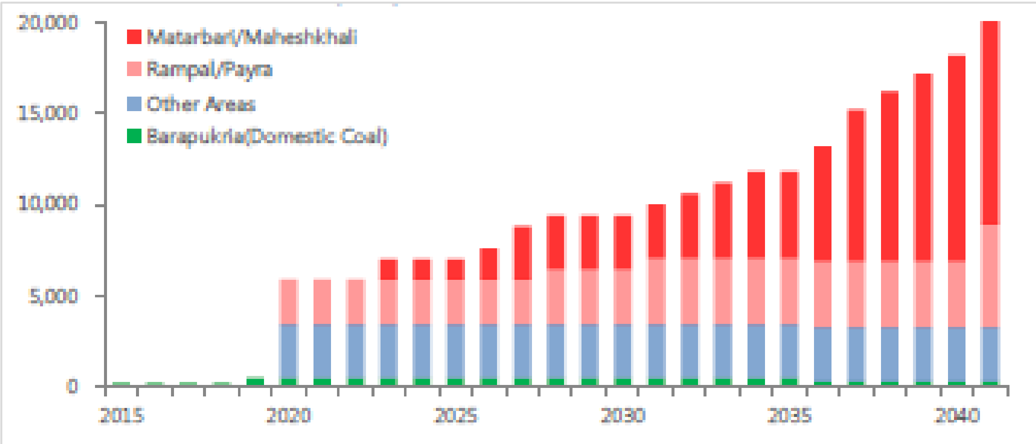


Figure 1.4: Power Generation Trend Coal Based Power Plant (PSMP 2016)

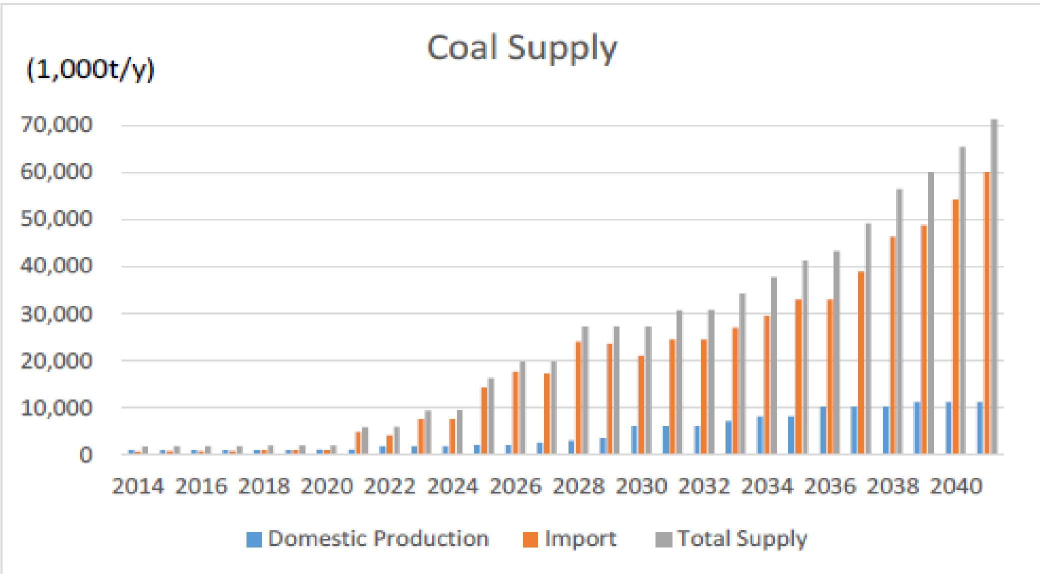


Figure 1.5: Souces of coal for running the Power Plants (PSMP 2016)

1.4 Scope of the EIA Study

The scope of the study is to carry out the EIA of the proposed 2x660 MW coal based thermal power plant project to be constructed at Kalapara Upazila in Patuakhali District, which would fulfil the applicable environmental requirements, including the laws, by laws and rules of Bangladesh and would also comply the World Bank (WB) Group's operational policies and guidelines including health and safety issues. The approved ToR from DoE has appended in Annex-I

- Description of the proposed project
- Description of the baseline condition of the environment of the study area *i.e.*
- Physical Environment
- Biological Environment
- Socio-Cultural Environment
- Legislative and regulatory considerations
- Determination of the potential impacts of the proposed project
- Analysis of the alternatives of the proposed project
- Cumulative impact assessment
- Development of the EMP which would also include emergency response requirement for accidental events and occupational safety followed by Monitoring Plan
- Consultation, disclosure and grievance redress.

1.5 Limitations of the Study

According to standard practice and instruction of DoE, all the seasonal viewpoints including a complete hydrological cycle ought to be considered amid the conduction of EIA study. However, due to time constraints, a complete hydrological cycle covering all the seasonal aspects could not be covered in this study. Secondary data was used in this study to overcome this issue.

As it was an extremely time-bound project, the chance of gathering water and air tests during dry season was exceptionally limited, which should ideally be done to understand the worst-case scenario. However, secondary information was utilized as a part of this respect to appreciate the year-wise situation.

1.6 EIA Study Team

A multidisciplinary team has been formed for conducting the EIA study. The team members with their positions are presented in **Table 1.1** below:

Table 1.1: Team composition for the EIA Study

Sl. No.	Name of Professional	Position Assigned
1.	Mr.A.T.M.ShamsulAlam	EnvironmentalExpert
2.	Engr.JalalAhmedChoudhury	ElectricalEngineer
3.	Mr.AshokeKumarDas	Ecologist
4.	Dr.DilrubaAhmed	Socio-economist

Sl. No.	Name of Professional	Position Assigned
5.	Mr.Mohammed Mukteruzzaman	FisheriesSpecialist(Biologist)
6.	Ms.TaslimaIslam	EnvironmentalLawSpecialist
7.	Dr. Anil Chandra Aich	SoilandAgriculturalSpecialist
Additional Team Members		
8.	Dr. K. M. Noor Newaz	Environmental Advisor
9	Md. Azizul Haque	Water Resources and Power Management Advisor
10	Pronab Kumar Halder	Environmental Expert
11	Md. Maqbul-E-Elahi	Primary Energy Expert- Oil, Gas and Coal
12.	Fatima Tuz Zohra	Junior Environmentalist
13.	Md. Mutasim Billah	Junior Environmentalist
14.	Deeba Farzana Moumita	Junior Electrical Engineer
15.	Redwan Hossain Jeshan	Health and Safety Specialist
16.	Farhad Ahmed	Junior Environmentalist
17.	Irin Afrin Lopa	Junior Environmentalist

1.7 Reporting Structure

The EIA report has been prepared in three volume which are Voume –I: Main EIA Report, Volume –II Appendix and Volume –III: Emergency Response Plan. This report (Volume-I) contains 15 chapters. These are:

Chapter 1 describes the introduction containing background, purposes, and limitations of EIA study, need and importance of the project and concludes by introducing the study team.

Chapter 2 is on legislative and regulatory aspect describing the relevant policies and legal frameworks for the EIA process of the power plant project.

Chapter 3 covers project data sheet of the proposed power plant comprising of project proponent, project location and area, nature and size of the project, project components, project activities and schedule, resources required and their quality, and utilities demand, required manpower and tentative organogram, tentative costing and funding etc.

Chapter 4 covers process description depicting project layout, technology selection and process description, waste management system, green initiatives etc. of the proposed power plant.

Chapter 5 presents an analysis of various alternatives options for project component such as fuel type, technology selection, water treatment system etc.

Chapter 6 describes the environmental and social baseline condition with detail physical environment, water resources, land use and land cover, land resources, agricultural resources, livestock and poultry, fisheries, ecological resources, transportation system, key point installations, socio-economic condition, community health and safety etc.

Chapter 7 presents the potential impacts of project during pre-construction, construction and post-construction/operation phases and evaluation of the impacts

Chapter 8 recommends mitigation measures for various identified impacts, enhancements, and compensation to restore including pollution control systems, waste treatment, engineering measures etc.

Chapter 9 outlines all possible hazards and risks associated with the decommissioning and proposed combined cycle dual fuel power plant, and management of the hazard and risks.

Chapter 10 describes the EMP with mitigation measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts during pre-construction, construction, and operation stages. The tentative budget for EMP is described in this chapter.

Chapter 11 describes the environmental monitoring plan, implementation of monitoring plan, performance indicators, and reporting and feedback mechanism.

Chapter 12 pointed out the project planning schedule as per the feasibility report

Chapter 13 Benefit –Cost Analysis describes the indirect project benefits and measure beyond compliance from the proposed project.

Chapter 14 presents the results of public consultation and information disclosure including consultation with expert and representatives of institutions and selected focus group discussions.

Chapter 15 is the concluding chapter of the EIA report with conclusion and recommendations.

2. Policy, Legal and Administrative Framework

2.1 Introduction

This section of the EIA describes the key regulatory framework relevant to the proposed 2x650 MW Coal based Power Plant Project at Pyra Port, Patuakhali which includes national regulations and also international treaties and conventions applicable for the Project. Therefore, for the purposes of this report, only those regulatory requirements that is directly relevant for the proposed project will be discussed.

This is to be noted that in Bangladesh, the environmental approval process is overseen by Department of Environment (DoE) under the Ministry of Environment and Forest (MOEF) and the key regulations which govern this process are: ECA, 1995 (including all amendments) and ECR, 1997 (including all amendments).

2.2 Legislative Framework

2.2.1 Overview of Approval Process

According to the national environmental legislation of Bangladesh (ECA, 1995) all development Projects are governed by some legal and institutional requirements. As such, assessment of relevant legal provisions, policies, strategies and institutional issues are very important for any Project proponent or developer before execution of a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. Before initiating any development Project, it is hence required to obtain Environmental Clearances or approval from the Department of Environment (DoE).

In accordance with the ECR, 1997, the proposed Coal Based Thermal Power Plant Project falls under the Red category and as such requires for submission of IEE report to obtain Site Clearance Certificate (SCC) and subsequently, the EIA report for Environmental Clearance Certificate (ECC).

An SCC will be issued by DOE upon approval of the IEE study. The submission of IEE shall include Project Authorization Letter, No Objection Certificate (NOC) from Local Authority/Deputy Commissioner (DC), Feasibility Report and SCC application form and also draft Terms of Reference (TOR) for EIA study. Environmental Clearance Certificate (ECC) will be issued upon approval of EIA study (including associated Environmental Management Plan). The whole process is shown as a flow chart in **Figure 2.1.**

2.2.2 Administrative Letter

The No Objection Certificate (NOC), which is a document of “proof of authorization”, is needed for initiating any Project. This NOC has to be taken for this study from the Local Government, the Civil Aviation Authority and the Department of Forest.

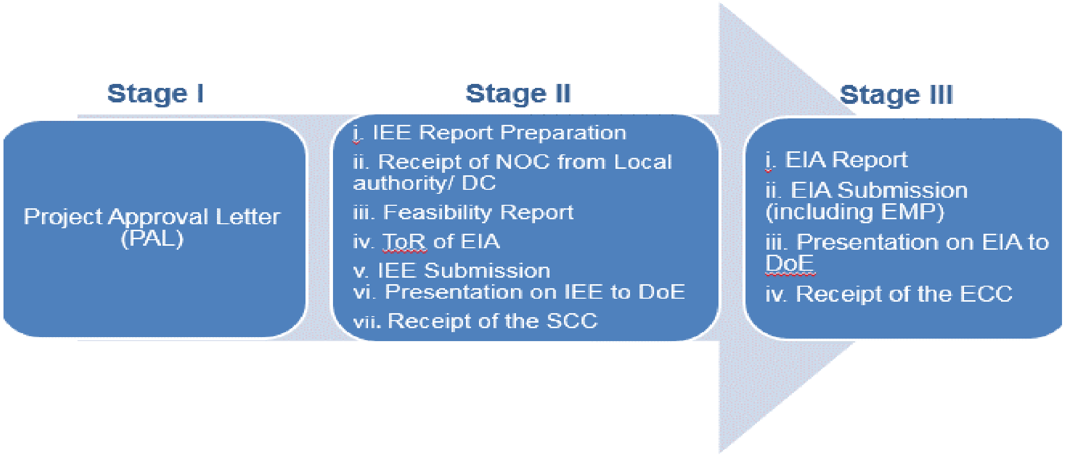


Figure 2.1: Process of Environmental Clearance Certificate obtaining

2.2.3 Key Legislative Approval

Certain permits and clearances are required to be obtained by the Project proponent from different Government and statutory agencies at various stages of development of the Project. A preliminary list of the required legislative approval (in relation to environment, social and safety issues) is provided in **Table 2.1** below:

Table 2.1: Required Permission for Project under Bangladesh Legislation

Legislation	Permission Required	Purpose	Permission Given by
• Environment Conservation Act, 1995 and all amendments. • Environment Conservation Rules, 1997 and all amendments	Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC)	DoE will issue SCC to allow for a detailed EIA as per Section 12 (ECA), Rule-7 and Form-3 of the ECR, 1997	Director General of DoE
• Explosives Act, 1884, • Explosive Substances Act, 1908, • Explosive Rules, 2003	Licence for explosive import, transport and possession	Licenses for explosive-related Activities will be required, including import, transport and possession.	Chief Controller of Imports and Exports. Chief Inspector of Department of Explosives.
Acquisition and Requisition of Immovable Property Act, 1982	Approval Required	To acquire and compensate for any private land	Ministry of Land and local Deputy Commissioner
Bangladesh Electricity Act (2010) and Regulations	Permission/Licence required	Laying down or placement of electricity supply lines	Ministry of Energy Power and Mineral Resources

2.3 Relevant Bangladesh Legislation

The Bangladesh Legislations relevant to this proposed Project are categorized by sectors and listed below in **Table 2.2**. In addition, some of the standards, under ECA, 1995 and ECR, 1997 are also outlined as a ready reference. This may be noted that where DOE standards are not present at the current stage, WB standards will be applicable as required. Detail applicable standards of GOB and IFC standards are shown in **Annex-II.**

Table 2.2: Sector wise relevant Bangladesh Legislations/ Policies

Sector	Legislation
Environment and Natural Resources	• Environment Conservation Act, 1995 and all amendments. • Environment Conservation Rules, 1997 and all amendments. • Environment Court Act, 2000 • Wildlife (Protection and Safety) Act, 2012 • Environmental Policy, 1992 • National Conservation Strategy, 1992NEMAP, 1995 • National Water Policy, 1999 • National Energy Policy (2008) • Bangladesh Water Act, 2013 • Noise Pollution Control Rules, 2006 • The Motor Vehicles Ordinance (1983) • Fish Act, 1950 • The Protection and Conservation of Fish Act, 1950 • The Protection and Conservation of Fish Rules, 1985 • The Forest Act, 1927 and all amendments
Industry	• Labor Law, 2006 (and all subsequent amendments). • Bangladesh Factory Rules, 1979 • National Industrial Policy, 1999 • Import and Export Control Act, 1950
Energy and Utilities	• Power System Master Plan, 2010 • Electricity Act 1990 and Regulation • Energy Regulatory Commission Act, 2003 • National Energy Policy, 1995 • Bangladesh Petroleum Act, 1974
Fisheries	• The Protection and Conservation of Fish Act, 1950 • The Protection and Conservation of Fish Rules, 1985
Land use	• The Acquisition and Requisition of Immovable Property Ordinance, 1982 • Non Agricultural Khas land Lease Rules (Circular no. VU. MO/ Sha-8/ Kha.Jo.bo/46/84/121) • Non Agricultural Khas land Lease Rules and Principles (VU.MO.Sha-8-Kha.Jo.bo/46/84/125)
Administrative and Antiquities	• Seventh Five Year Plan, 2016-2020 • The Antiquities Act (1968)
Transportation	• The Territorial Waters and Maritime Zones Act, 1974 • The Territorial Waters and Maritime Rules, 1977 • Bangladesh Merchant Shipping Ordinance, 1983 • Prevention of the Interference with Aids to Navigable Water Ways Ordinance, 1962 • Ports Act, 1908 • Chittagong Port Authority (CPA) Ordinance, 1976
Safety and Security	• Fire Services Ordinance, 1959 • Fatal Accident Act, 1855 • Dangerous Cargoes Act, 1953 • Dock Laborers Act, 1934 • Explosive Act, 1884 • The Penal Code, 1860

2.3.1 Brief outlines of some relevant regulations

National laws, by-laws and rules relevant to coal based Thermal Power Plant installation, operation and maintenance and associated activities have been identified under this study. Under the national legal framework, the proposed intervention needs to comply with the environmental legislations of the country and also fulfill the requirements to obtain required permissions to implement these Activities.

The Bangladesh Environment Conservation Act of 1995

(All amendments) is the key legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, standards, development, pollution control, and abatement. It has repealed the Environment Pollution Control Ordinance of 1977. The Act has been amended in different sections/sub-sections in 2000, 2002, 2007 and 2010.

The main objectives of the Act are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development Activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines.

Before any new Project/development interventions by the Government or by non-Government agencies can go ahead, as stipulated under the Environment Conservation Rules 1997, the Project promoter must obtain Environmental Clearance from the Director General of Department of Environment (DoE). An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this Act may result in punishment of imprisonment or fine or both. The DoE executes the Act under the leadership of the Director General.

The Bangladesh Environment Conservation Act (Amendment), 2000

Focuses on: (1) ascertaining responsibility for Compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

The Bangladesh Environment Conservation Act (Amendment), 2002

Elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like polythene bags, (3) assistance from law enforcement agencies for environmental Actions, (4) break up of punitive measures and (5) authority to try environmental cases.

The Bangladesh Environment Conservation Act (Amendment), 2010

Introduces new rules & restriction on: a) Ensure proper management of hazardous wastes to prevent environmental pollution and Health Risk, b) No remarked water body can be filled up/changed, in case of national interest; it can only be done after getting clearance from the respective department; and c) Emitter of any Activities/incident will be bound to control emission of environmental pollutants that exceeds the existing emission standards.

The Bangladesh Environment Conservation Rules, 1997(including all amendments)

The first set of rules, promulgated under the ECA 1995. The Environment Conservation Rules of 1997 has provided categorization of industries and Projects and identified types of environmental assessments needed against respective categories of industries or projects.

Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE and EIA's according to categories of industrial and other development interventions.

The proposed Project, according to the DoE, is considered under the Red category of the Environmental Conservation Rules, 1997 (Item 6: Power Plant). The detail guidelines are attached in **Appendix II.**

The Environment Court Act, 2000

It's provides for the establishment of environment courts and matters incidental there to. This Act also provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, authority of environment court to inspect, appeal procedure and formation of environment appeal court.

Noise pollution (control) Rules (2006)

This amendment gives the authority to all the Union Councils, Paurasabhas, City Corporations, City Development Authority (*i.e.* RAJUK, CDA, KDA, RDA etc.) to mark off the areas under their jurisdiction as silent, residential, mixed, commercial or industrial. They should also put signs to mark those areas. The Act also describes the approved standard limit of sound in the added **Schedule 1 and 2**. In the **Schedule 1,** silent area means area up-to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government. In the silent area it is prohibited to use any kind of horns of vehicles, audio signals and loudspeakers. According to this Act, daytime is counted from 6 am to 9 pm whereas nighttime is counted from 9 pm to 6 am. The details of the standards for sound in different types of areas are listed down in **Table-2.3** according to the **Schedule-1** of the Act. The standards for noise level are given in the following **Table 2.3**.

Table 2.3: Standards for sound level at day and night

SL. No.	Category of Areas	Standards (in dBA)	
		Day	Night
1	Silent Zone	50	40
2	Residential Area	55	45
3	Mixed Area	60	50
4	Commercial Area	70	60
5	Industrial Area	75	70

According to noise pollution (control) amendment 2006, use of pneumatic horn/hydraulic horn/multi-tuned horn in any kind of vehicle is banned. It is prohibited to use brick demolishing machine within 500 meters of residential area. Moreover, use of any kind of noise generating machine such as mixture machine is restricted to be used in residential area from 7 pm to 7 am.

During election period it is permissible to use loud speaker till 2 days before election from the period of announcing the schedule. However, this permission is not applicable for silent areas. Loud speaker can be used, only in residential and commercial areas.

This Act also requires the people exposed to high noise in industries to wear personal protective equipment (PPE) to reduce the impacts of noise pollution

The Motor Vehicle Ordinance, 1983

It stated to impose a penalty of maximum two hundred taka for those vehicles that are emitting smoke that poses health hazard in the public places. It also restricts the passenger from smoking in public service vehicles and in any other vehicles with notice of not smoking. This ordinance is enforced occasionally but a regular enforcement would be helpful to reduce air pollution in big cities including Dhaka. However, it is to be noted that amount of the penalty is very low which may be revised as well.

Bangladesh Sludge Management Plan 2015

To ensure human health and to protect the environment from any negative impacts, proper management of sludge is mandatory as per the Bangladesh Environment Conservation Act, 1995 (Amendment 2010). In relation to that installation of Effluent Plant (ETP) has been increasing and becoming advanced for environmentally sound operation and management. It is mandatory to apply pre-treatment before sludge disposal in order to implement the “National 3R Strategy” (reduce, reuse and recycle) which means that these measures shall be executed according to the state of technology and ecological feasibility before the waste has to be disposed in an end-of-pipe facility. Different sludge management options are permissible depending on the classification of the sludge (Category A, Category B and Category C). Various method of sludge treatment and disposal like mechanical treatment, chemical treatment, and biological treatment are available for sludge and industrial wastewater to protect the environment from the adverse and profound impacts.

The Protection and Conservation of Fish Act, 1950

This Act covers all types of aquatic species including fish, prawn, shrimp, amphibians, tortoises, turtles, crustaceans, mollusks, echinoderms and frogs at all stages in their life cycle and all types of water bodies. The Act specifies a number of useful fisheries management rules for sustainable fish culture and conservation in the country. These are: use of appropriate fishing gear (net, cage, trap, explosives) and building water management structures (dams, weirs, bunds and embankments). It also specifies the fishing and non-fishing seasons and the size of fish below which any prohibited species cannot be killed or sold. This Act is revised and included the banning of ‘jatka’ of hilsa and use of gill net (current jal) in 2011.

The Protection and Conservation of Fish Rules, 1985

Under the Rules, installation of fixed nets, cage, trap, etc. has been prohibited for controlling harmful and unlawful fishing Activities. Section 6 of the Rules states:-“No person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters”. Moreover, construction of bund, weir, embankment, etc. has been banned except for the purposes of irrigation, flood control and drainage. Use of explosives, poison and small meshes is banned. Also, catching certain fish during the breeding season from April 1 to August 31 has been banned. It has also been made illegal to dredge and extract sand and gravel, and discharge waste or any other polluting matter that disturb, alter or destroy natural habitats of fish in marine reserves. Therefore, the proposed intervention needs to be carried in such a manner that the activities do not cause damage to the inland waters or within coastal waters fisheries.

The Forest Act, 1927 (and all Amendments)

The Forest Act of 1927 provides for reserving forests over which the Government has an acquired property right. This Act has made many types of unauthorized uses or destruction of forest produce punishable. The Government may assign any village community its right to or over any land, which has constituted a reserved forest.

According to the Act the Government may prohibit certain Activities in the declared reserved forest area such as any intervention kindles, keeps or carries any fire arms; trespasses or pastures cattle, or permits cattle to trespass; causes any damage by negligence in felling any tree or cutting or dragging any timber etc.

Near the proposed location of the coal based Power Plant no mangrove forest exists at all. Therefore, the proposed Project complies with this requirement of legislation. During the study this law and rules and regulations under it has been reviewed to explore whether the proposed Activities of the Project violates any provisions of the Forest Act.

The Supplementary Rules of 1959 empowered the concerned Governmental bodies to restrict totally and for a specified period, the shooting, hunting or catching of various birds, animals and reptiles in the controlled and vested forests. The Private Forest Ordinance of 1959 provides for the conservation of private forests and for the forestation, in certain cases, of waste-land in Bangladesh.

Wildlife (Protection and Safety) Act 2012

The Wildlife (protection and safety) Act 2012, passed in Parliament on 8^{th} July, 2012. Under this Act, the hunting, trapping, killing of wildlife are strictly prohibited. After the establishment of this Act, a Board will be formed with the concerned members recommended by the Government. There are certain provisions kept in this Act, e.g. entrance, management, rules and regulation of the protected area etc. If any person without license performs any kind of trade, he will be jailed for at least a year.

The Bangladesh Water Act 2013

The Bangladesh Water Act 2013 was passed by the Government on 6 November 2013 to ensure “integrated development, management, abstraction, distribution, use, protection and conservation of water resources”. By virtue of this Act, all rights over surface water, ground water, sea water, rain water and water in the atmosphere is vested on the State. Notwithtanding the above, “rights over the surface water on any private land shall remain with the owners of such land”, and such right to use the water shall be subject to the provision of the Act. Furthermore, under the provisions of this Act, “right to potable water, and to water for hygiene and sanitation shall be treated as the highest priority right”.

The Act makes a provision for constituting a National Water Resources Council headed by the Hon’ble Prime Minister. The Council is the highest decision making body and is empowered to make policies, give instructions to develop National Water Resources Plan for integrated development and safe abstraction of water and its proper use to ensure protection and conservation of water resources. The Council is also mandated to approve the National Water

Resources Plan and ensure its implementation, as well as give advice to the Government to enter into agreement through signing memorandum of understanding and/or signing conventions and treaty with any Government and international or regional organization to undertake joint survey, exchange data/information with respect to common water resources and it's abstraction and development and undertaking joint measures to prevent pollution of common water resources.

The Act also makes a provision for approving National Water Resources Plan prepared in accordance with the Water Resources Planning Act, 1992 containing among others, the following matters namely:

- Analysis of economic , natural, social, political, environmental, and ecological and institutional elements, characteristics and impact of water resources;
- Integrated use of surface and ground water emphasizing the highest possible use of rain water;
- Determination of water quality standard;
- Fixation of priority of water use.

The Act also makes further provision for:

- Declaration of water stress area and management thereof;
- Preferential use of water in the water stress area and exemption thereof;
- Fixing the lowest safe yield level of aquifer and restrictions on abstracting groundwater; and
- Protection of flood control embankment which states "to ensure the sustainability of the flood control embankment, no person shall, without the permission of the appropriate authority, be allowed to construct any house, establishment or any other structure on, or on the slope of such embankment."

Finally, if anybody deliberately violates or ignores the responsibility or protection under this Act, in that case, under the provisions of Sub-section (2), she/he will get maximum of 5 years imprisonment or maximum Tk. 10,000 as financial punishment or both the punishments.

The Bangladesh Petroleum Act, 1974

The Bangladesh Petroleum Act is enabling legislation that allows the Government of Bangladesh to enter into all aspects of petroleum exploration, development, exploitation, production, processing, refining and marketing. In addition, the Government is authorized to enter into Petroleum Agreement(s) with any person(s) for the purpose of petroleum operations. The duties of such person(s) are:

- To ensure that petroleum operation is carried out in a proper and worker like manner and in accordance with good oil field practice.
- To carry out petroleum operation in any area in a manner that does not interfere with navigation, fishing and conservation of resources.
- To consider the factors connected with the ecology and environment.

Clause 6(2) of the Act sets out certain details related to environment and safety: "In particular, and without prejudice to the generality of the foregoing provision, a person engaged in any petroleum operations shall, in carrying out such operations in any area:

- Control the flow and prevent the waste or escape' in the area, of petroleum or water;
- Prevent the escape in that area of any mixture of water or drilling fluid with petroleum or any other matter;
- Prevent damage to petroleum-bearing strata in any area, whether adjacent to that area or not; and
- Keep separate any petroleum pool discovered in the area."

Apart from the above, the law provides the following obligations:

a) Prescribing places where petroleum may be imported and prohibiting its import elsewhere;

b) Regulating the import of petroleum;

c) Prescribing the periods within which licenses for the import of [Class i] petroleum shall be applied for, and providing for the disposal, by confiscation or otherwise, of any [Class i] petroleum in respect of which a license has not been applied for within the prescribed period or has been refused and which has not been exported;

d) Regulating the transport of petroleum;

e) Specifying the nature and condition of all receptacles and pipe-lines in which petroleum may be transported;

f) Regulating the places at which and prescribing the conditions subject to which, petroleum may be stored;

g) Specifying the nature, situation and condition of all receptacles in which petroleum may be stored;

h) Prescribing the form and conditions of licenses for the import of dangerous petroleum, and for the transport or storage of any petroleum, the manner in which applications for such licenses shall be made, the authorities which may grant such licenses and the fees which may be charged for such licenses; (i) determining in any class of cases whether a license for the transport of petroleum shall be obtained by the consignor. Consignee or carrier;

i) Providing for the granting of combined licenses for the import, transport 18 [storage and distribution] of petroleum, or for any two of such purposes;

    i. Prescribing the proportion in which any specified poisonous substance may be added to petroleum, and prohibiting the import, transport or storage of petroleum in which the proportion of any specified poisonous substance exceeds the prescribed proportion;

    ii. Regulating the distribution of petroleum;

    iii. Prescribing the conditions for the appointment of, and the granting of the licenses to, agents, dealers and stockiest;

    iv. Prescribing the form and conditions of agreement between and agent, dealer or stockiest and an oil marketing company;

    v. Providing for cancellation or restoration of licenses of an agent or a dealer and of agreement between an oil marketing company and an agent, dealer or stockiest; and

vi. Generally, providing for any matter which in its opinion, in expedient for proper control over the import, transport, storage and distribution of petroleum."

2.3.2 Administrative and land acquisition related relevant regulations

The Penal Code, 1860

The Penal Code of 1860 has some valid provisions related to pollution management, environment protection and protection of health and safety. Some of these are: Section 277: Falling Water or Public Spring or Reservoir; Section 278: Making Atmosphere Noxious to Health; Section 284: Negligent Conduct with Respect to Poisonous Substance; Section 285: Negligent Conduct with Respect to Fire or Combustible Matter; and Section 286: Negligent Conduct with Respect to Explosive Substance. (Chapter XIV of offences affective Public health, safety, convenience, decency and morals).

The Acquisition and Requisition of Immovable Property Ordinance, 1982

This Ordinance has replaced the Land Acquisition Act of 1894 and the East Bengal (Emergency) Requisition of Property Act of 1948. The Ordinance governs acquisition and requisition by the Government of immovable property for any public purpose or in the public interest. It may be noted that contrary to the previous Acts (i.e. Act XIII of 1948), this Ordinance deals only with immovable property.

The Ordinance has well-defined procedures regarding payment of compensation for an acquired piece of land. If, for example, the land is used for growing rice, then an amount equivalent to approximately 1.5 times the market value of a given variety of rice (e.g., paddy) that is currently being (or could be) produced annually is fixed as a yearly lease value. In case of outright purchase (carried out on a 99-year lease), the compensation-value of acquired land varies widely according to the locality, soil fertility, and access to transportation and related infrastructure factors. The current compensation and resettlement provisions are however inadequate both in terms of timing of payments and quantum. The procedures involved are cumbersome and time consuming and often causes hindrance to the smooth execution of the Project. Legal provisions covering adequate compensation to the Project affected persons, particularly disadvantaged groups such as women and squatters and such other vulnerable groups are yet to be framed.

Import and Export Control Act, 1950

The Government may prohibit, restrict or otherwise control the import or export of goods of any specified description, or regulate generally all practices (including trade practices) and procedures connected with the import or export of such goods. No goods of the specified description shall be imported or exported except in accordance with the condition of a license to be issued by the Chief Controller.

2.3.3 Relevant regulations related to Port and water ways

The Territorial Waters and Maritime Zones Act, 1974

The Territorial Waters and Maritime Zones Act, 1974 was adopted to declare the territorial waters, continental shelf and other maritime zones and to make rules related to these declared zones.

The law says that the Government may, by notification in the official Gazette, declare the limits of the sea beyond the land territory and internal waters of Bangladesh which shall be the territorial waters of Bangladesh specifying in the notification the baseline:

a) From which such limits shall be measured; and

b) The waters on the landward side of which shall form part of the internal waters of Bangladesh.

The law says that where a single island, rock or a composite group thereof constituting the part of the territory of Bangladesh is situated seawards from the main coast or baseline, territorial waters shall extend to the limits declared by notification under Section 3 sub-section (1) measured from the low waterline along the coast of such island, rock or composite group.

The Sovereignty of the Republic extends to the territorial waters as well as to the air space over and the bed and subsoil of, such waters. According to the law, no foreign ship shall, unless it enjoys the right of the innocent passage, pass through the territorial waters. Foreign ship having the right of innocent passage through the territorial waters shall, while exercising such right, observe the laws and rules in force in Bangladesh. The Government may, by notification in the official Gazette, suspend the innocent passage of any ship in the specified areas of the territorial waters, if it is of opinion that such suspension is necessary for the security of the Republic. No foreign warship shall pass through the territorial waters except with the prior permission of the Government.

This law is very important for the proposed intervention of coal based power plant to be constructed at Kalapara, Patuakhali as fuel (coal) for this would be imported from the source country to the Project site through the Bay of Bengal. During the study, this Act has been reviewed to explore whether there is any violation between the proposed Activities and the rules of law.

The Territorial Waters and Maritime Zones Rules, 1977

These Rules (implement Act No. XXVI of 1974) are bearing the declaration of the territorial waters and maritime zones. The 16 sections regulate the conduct of foreign ships in territorial waters, Activities in the economic zone and on the continental shelf, the application of custom and fiscal laws to the economic zone.

Hazardous Wastes and Ship Breaking Waste Management Rules, 2011

The main focus of this legislation describes, Premised on Basel; barred import if ships not certified by authorized agents of exporting countries as not containing hazardous wastes; provided regulations of safe disposal of hazardous waste; emergency response plan; Implementation rests with a National Technical Committee under MoEF.

This regulation is applicable for this project as the project activities involve in carrying coal from overseas and may encounter an accident which subsequently require ship braking within the territory of coal imported country and in case of this project is Bangladesh.

Bangladesh Merchant Shipping Ordinance 1983

Under the Bangladesh Merchant Shipping Ordinance 1983, it is prohibited for any foreign ship to load or unload cargo within the territorial waters of Bangladesh without written permission from the Shipping Authority. This Ordinance sets standards for the construction of vessels. If the vessel has not been surveyed within Bangladesh, the Ordinance will require the ship to hold evidence of equivalent inspection such as a valid Safety Convention Certificate. A valid

International Load Line Certificate (or proof of exemption) is also required under Sections .297 and 339 for Port clearance and to avoid undue delay in loading and unloading.

Prevention of the Interference with Aids to Navigable Water Ways Ordinance, 1962

Under the Prevention of the Interference with Aids to Navigable Water Ways Ordinance, 1962; whoever commits mischief by damaging, removing, tampering with or handling any of the aids to navigation, or by doing any act which renders any of the aids to navigation less useful as such, and whoever abets such mischief, shall be punished with imprisonment which may extend to three years, or with fine, or with both.

Ports Act, 1908

The Ports Act 1908 was adopted to consolidate the enactments relating to Ports and Port charges. The administering authority is the Ministry of Shipping. Subject to this Act, a Conservator is appointed for every Port. The Conservator of Chittagong Port administers the provisions of the Act for the Port.

Specific environmental management provisions of the Act are given under Section 21 (1) which prohibits the discharge of ballast, rubbish and oil into any Port or adjacent areas. Under Section 31 of the Act, the movement of vessels of 200 tons or more cannot enter, leave or be moved within any Port without having a pilot on board. In addition, no vessel of more than 100 tones is to enter, leave or be moved within any Port without having a pilot, unless authority to do so has been given in writing. The lawful use of infrastructure such as piers and moorings, and ensuring navigable waters are not obstructed is detailed under Section10, whereas Section 21 prohibits interference with buoys, beacons and moorings. Unless permission has been granted by the Conservator, any action that causes or may cause injury to the bank or shore is prohibited under Section 30 (1).

Chittagong Port Authority (CPA) Ordinance, 1976

It is mentioned in s.10 (1) Subject to the provisions of this Ordinance; the Authority may take such measures and exercise such powers as may be necessary for carrying out the purposes of this Ordinance. (2) Without prejudice to the generality of the powers conferred by sub-section (1), the Authority shall, in particular, have power-

- To construct, maintain and operate docks, moorings, piers and bridges within the Port, with all necessary and convenient drains, arches, culverts, roads, railways, fences and approaches;
- To undertake any work of or in connection with the loading, unloading and storing of goods in the port;
- To construct, maintain and operate ferry vessels to carry passengers, vehicles and goods within the port;
- To construct, maintain and operate railways, warehouses, sheds, engines, cranes, scales and other appliances for conveying, receiving, handling and storing goods to be landed or shipped or otherwise dealt with by the Authority;
- To reclaim, excavate, enclose or raise any part of the bank or bed of the river;
- To construct, maintain and operate dredgers and appliances for clearing, deepening and improving the bed of the river;

- To construct, maintain and operate all means and appliances for berthing, loading and discharging vessels;
- To construct, maintain and operate vessels, saving life and property or recovering any property lost, sunk or stranded;
- To supply fuel or water to vessels;
- To provide fire and security services within the port;
- To acquire, hire, procure, construct, erect, manufacture, provide, operate, maintain or repair anything whatsoever required by the Authority for the purposes of this Ordinance.

In s.42(1) in the –case of any damage or mischief is done to any dock, pier or work of the Authority by any vessel, through the negligence of the master thereof or of any of the mariners or persons employed therein, not being in the service of the Authority, any Magistrate of the first class having jurisdiction in the port area may, on the application of the Authority and on declaration by it that payment for such damage or mischief has been refused or has not been made on demand, issue a summons to the master or owner of such vessel, requiring him to attend on a day and at an hour named in the summons to answer touching such damage or mischief.

Payra Port Act, 2013

Payra Sea Port is the 3rd sea port of Bangladesh located in the bank of Rabnabad Channel under Kalapara, a sub district of Patuakali. In order to increase the economic activities in the central zone and meet the future demand, Payra Sea Port Act 2013 was passed in National Parliament on 10 November 2013. Government has taken Short, Mid & Long Term Plan to develop a state of art modern sea port.

- As Short Term Plan, Payra Port Authority is set to operate the port activities by off loading cargos from mother ships at outer/inner anchorage and transported to the hinterlands through river routes.
- Under Mid Term Plan, by 2018 Govt is going to operate the port with at least one multipurpose and one bull terminal where deep draught vessel with up to 12m can berth safely.
- Under Long Term Plan, by 2023 the port would be fully operational with a 16 m channel where minimum 10 km container & other terminals with all other associated facilities like establishing EEZ, Air port, Port city, Dockyard/Shipyard, Echo Tourism etc centering to the port.
- PPA'S objective focuses mainly on providing necessary services and facilities to the port users efficiently and effectively at competitive price.

2.3.4 Relevant regulations in relation to health, safety and labor

The Fire Services Ordinance 1959

The Fire Services Ordinance 1959 states that the owner needs to obtain a license under the Ordinance before using premises as a warehouse. In addition, under this Ordinance the Government by Order no. HSLG/SVII/1R-1/60/295 dated 3rd June 1960 declared that any stock of coal exceeding four tones shall be considered to be a fire risk.

The Fatal Accidents Act, 1855

An Act to provide compensation to families for loss occasioned by the death of a person caused by actionable wrong. It is mentioned in Section.1, whenever the death of a person shall be caused by wrongful act, neglect or default, and the act, neglect or default is such as would (if death had not ensued) have entitled the party injured to maintain an action and recover damages in respect thereof, the party who would have been liable if death had not ensued shall be liable to an action or suit for damages, notwithstanding the death of the person injured, and although the death shall have been caused under such circumstances as amount in law to felony or other crime.

The Dangerous Cargoes Act, 1953

The Dangerous Cargoes Act, 1953 was enacted to provide provisions related to the safety of ports in respect of the transit, working and storage of dangerous cargoes. Relevant provisions include Section.3 (which deals with explosives and fires on vessels), Section 6 (safety of vessels imports) and Section 9 (enforcement). The concerned authority is the Deputy Conservator of the Port, Board of Trade or the Ministry of Communication and the Chief of Naval Staff.

The Dock Laborers Act, 1934

An Act to give effect in Bangladesh to the Convention concerning the protection against accidents of workers employed in loading and unloading ships. It is stated in Section 5(1), the Government may make regulations providing for the safety of working places on shore and of any regular approaches over a dock, wharf, quay or similar premises which workers have to use for going to or from a working place at which the processes are carried on, and for the lighting and fencing of such places and approaches, prescribing the measures to be taken in order to prevent dangerous methods of working in the stacking, un-stacking, stowing and un-stowing of cargo, or handling in connection therewith, prescribing the precautions to be observed when the workers have to work where dangerous or noxious goods are, or have bee, stowed or have to deal with or work in proximity to such goods.

It is mentioned in Section 9, any person who unless duly authorized, or in case of necessity, removes any fencing, gangway, gear, ladder, life-saving means or appliance, light, mark, stage or other thing required to be provided by or under the regulations made under this Act; or having in case of necessity removed any such fencing, gangway, gear, ladder, life-saving means or appliance, light, mark, stage or other thing, omits to restore it at the end of the period for which its removal was necessary; shall be punishable with fine which may extend to five hundred taka.

Labor Law- 2006 and 2013

The Act provided guidelines for health, safety and wellbeing of work force during project life cycle. In addition, it also stipulated that children under 18 years are not allowed to be employed during project life cycle and therefore, this law requires to be complied.

The Explosives Act, 1884

The Government may for any part of Bangladesh, make rules consistent with this Act to regulate or prohibit, except under and in accordance with the conditions of a license granted as provided by those rules, the manufacture, possession, use, sale, transport and importation of explosives or any specified class of explosives.

Any person manufacturing, possessing, using, selling, transporting or importing an explosive in contravention of a notification issued, shall be punishable with imprisonment for a term which may extend to ten years and shall not be less than two years and also with a fine which may extend to fifty thousand Taka, in default of which with a further imprisonment for a term which may extend to one year, and in the case of importation by water or land, the owner and master of the vessel or carriage in which the explosive is imported shall, in the absence of reasonable excuse, each be punishable with imprisonment for a term which may extend to ten years and shall not be less than two years and also with a fine with a further imprisonment for a term which may extend to one year.

Boiler Act, 1923

The Act consolidates and amends the law relating to steam-boilers. The main objective of Boiler Act 1923 is to ensure safe operation and maintenance of boiler. Key issues of the Act are outlined below:

- Prohibition of use of unregistered or uncertificated boiler
- Renewal of boiler certificate upon the expiry, accidents, moved, structural alteration, or any dangerous condition
- Regulating the inspection and examination of boilers and steam-pipes,
- Prescribing the duties of owner at examination, and production and transfer of certificates
- Exclusion of any specified area from the boiler operation
- Impose local limits and power of authorized person to oversee the limit
- Prescribing the maximum pressure at which a boiler may be used and describing the method of determining the maximum pressure.
- Revocation of certificate or provisional order if the certificate is fraudulently obtained or boiler is not in good condition.
- Restriction on alterations and renewals of any registered boilers without written sanction of such alteration, addition, or renewal
- Reporting of accidents to boilers or steam-pipe must be made by owner within twenty-four hours of the accident in written form
- Registration number allotted to the boiler must be marked on the boiler otherwise penalties apply. Any kind of invisibility of register number by remove, alter or deface is also punishable.
- Prescribed penalties for illegal use of boiler or use the boiler at higher speed than the allowed limit.

2.4 Policy Guidance

Under this study, a number of sectorial national policies have been reviewed to identify the guiding principles which are relevant to the Coal based Thermal Power Plant installation, operation and maintenance activities. The sectors’ policies include energy, environment, water, forest, transport, import; fisheries, etc.

2.4.1 National Environment Policy, 1992

The National Environment Policy of 1992 sets out the basic framework for environmental action, together with a set of broad sectorial action guidelines. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment; (including setting up of an industrial establishment) must undertake an IEE and EIA before they initiate the Project.

The Policy delineates DoE, as the approving agency for all such IEE and EIA’s to be undertaken in the country. The policy guidelines of fifteen sectors are stated in the Policy.

Under the ‘energy and fuel sector’ (Section 3.4), the use of environmentally sound and less harmful fuel has been encouraged in Section 3.4.1. Section 3.4.5 provides, ‘Conservation of country’s fossil fuel reserve and renewable sources of energy’. Section 3.4.6 provides that EIA should be conducted before implementation of Projects for extraction of fuel and mineral resources.

Under the Environmental Action Plan Section of the Policy and sub-section ‘Fuel and Energy’ provides that:

- Section 4.2 “In the rural areas, the use of gas, coal, kerosene and petrol as fuel will be expanded, so that fuel wood, agricultural residues, and cow dung is conserved. This will help the use of agricultural residues, and cow dung etc. as manure” and
- Section 4.7 “Appropriate measures will be taken to ensure that extraction, distribution and use of natural resources such as oil, gas, coal, peat etc. do not adversely affect air, water, land, the hydrological balance and the ecosystem”.
- Section 3: ‘Forest, wildlife and biodiversity’ directs the followings:
    - Conserve wildlife and biodiversity, strengthen related research and help dissemination and exchange of knowledge in these areas; and
    - Conserve and develop wetlands and protection of migratory birds.

2.4.2 National Environmental Management Action Plan 1995

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

NEMAP has the following broad objectives:

- 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; and
- Improvement in the quality of life of the people.

One of the key issues in NEMAP regarding the energy sector is “energy conservation awareness is generally low throughout the country”. NEMAP did not recognize mineral resources as an important sector and there is no separate discussion on this.

2.4.3 Power System Master Plan, 2016

The Power System Master Plan (PSMP) 2016, aims at assisting the Bangladesh in formulating an extensive energy and power development plan up to the year 2041, covering energy balance, power balance, and tariff strategies.

PSMP 2016 addresses issues such as sustainable development harmonizing with economic optimization, improvement of power quality for the forthcoming high-tech industries, and the discipline of operation and maintenance (O&M) for power plants, energy subsidy etc.

Additionally, the Government of Bangladesh has indicated in its new policy “Vision 2041” that it targets to become one of the developed nations by 2041. To achieve VISION 2041, a road map for PSMP 2016 had been prepared as Bangladesh’s long term strategic power and energy development planning. The road map, classifying into three timeline; short, mid to long, and super long, states specific targets to be achieved, and also showed by when, what items that the government of the Bangladesh shall implement. The major contents of PSMP 2016 are economy, energy balance, power balance, energy cost and tariff balance which include economic development, primary energy demand, domestic gas supply, LNG supply, coal supply, oil supply, power development plan, hydropower, renewable energy, power import/ nuclear power, power transmission planning, distribution (rural electrification), improving power quality, Thermal O & M and Energy tariff policy.

2.4.4 Power System Master Plan, 2010

The main objective of the Master Plan is to formulate a Master Plan for the attainment of stable power supply in Bangladesh up to year 2030 in consideration of the diversification of fuel resources, including an optimum power development plan, power system plan, and identification of the potential power Plant sites based on the fuel diversification study. Therefore, the study includes a comprehensive power development master plan where the study of the fundamental conditions of the development (demand forecast, procurement of primary energy resources, optimum power development plan, future optimum power supply structure including the positioning of gas-fired power Plants, and so on) are added.

The power sector was heavily dependent on gas. Even two/three years back almost 90% of the electricity used to be generated from domestic natural gas and rest by hydro-electricity and coal. The Power System Master Plan 2010 has stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel etc. as well as non-renewable energy sources.

In this Master Plan, the target composition of power supply resources as of 2030 is set at 50% from domestic and imported coal, 25% from domestic and imported (in the form of LNG) natural gas, and 25% for other sources such as oil, nuclear power and renewable energy.

2.4.5 The National Forest Policy (1994)

The National Forestry Policy of 1994 is the revised version of the National Forest Policy of 1977 in the light of the National Forestry Master Plan. The major targets of the Policy are to conserve the existing forest areas; bring about 20% of the country’s land area under the afforestation program, and increase the reserve forest land by 10% by the year 2015 through coordinated efforts of GO-NGOs and active participation of the people.

The need of amendments of the existing forestry sector related laws and adopt new laws for sectoral activities, have been recognized as important conditions for achieving the policy goals and objectives. The Forest Policy also recognizes the importance of fulfilling the responsibilities and commitments under international multilateral environmental agreements.

2.4.6 The National Energy Policy (1995)

The National Energy Policy provides for utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy sources and environmentally sound, sustainable energy development programs. The Policy highlights the importance of protecting the environment by requiring an EIA for any new energy development Project, introduction of economically viable and environment friendly technology.

One (Section 2.2) of the seven objectives addresses the environment and states, “(vi) to ensure environmentally sound sustainable energy development programs causing minimum damage to the environment”.

The seven specific policy recommendations are listed under Chapter 1.9. Of those, the following three are relevant to the proposed Project:

- EIA should be made mandatory and should constitute an integral part of any new energy development Project;
- Use of economically viable environment friendly technology is to be promoted; and
- Public awareness is to be promoted regarding environmental conservation.

2.4.7 The National Water Policy (1999)

The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. It has also addressed issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation, and water needs for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc. It has also addressed issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation, and water needs for agriculture, industry, fisheries, wildlife, navigation, recreation, and environment and preservation of wetlands.

2.5 International Legal Obligation

Bangladesh is signatory to a number of Multilateral Environmental Agreements (MEAs) and also some bilateral instruments. Some of them are very important in context of environmental protection. The legal obligations and provisions of MEAs related to the proposed Project interventions has been reviewed; (Convention on Biological Diversity; Convention on Wetlands of International Importance Especially as Waterfowl Habitat; United Nations Convention on the Law of the Sea; Convention concerning the Protection of the World Cultural and Natural Heritage)

Bangladesh has already had accessed to, ratified or signed a number of important MEAs related to environment protection and conservation of natural resources which shall have to be complied with during implementation of the Project. The pertinent ones of these are highlighted below:

2.5.1 Rio Declaration

The 1992 United Nations Conference on Environment and Development (UNCED) adopted the global action program for sustainable development called ‘Rio Declaration’ and ‘Agenda 21’.

Principle 4 of the Rio Declaration, 1992, to which Bangladesh is a signatory along with a total of 178 countries, states, “In order to achieve sustainable development, environmental protection should constitute an integral part of the development process and cannot be considered in isolation from it”.

2.5.2 Convention on Biological Diversity (1992)

The Convention on Biological Diversity, Rio de Janeiro, 1992 was adopted on 5 June, 1992 and entered into force on 29 December, 1993. Bangladesh ratified the Convention on 20 March, 1994.

The Contracting Parties of the Convention have committed to:

- Introducing appropriate procedures requiring environmental impact assessments of its proposed Projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimizing such effects, and where appropriate allow for public participation in such procedures; and
- Introducing appropriate arrangements to ensure that environmental consequences of its programs and policies, that are likely to have significant adverse impacts on biodiversity, are duly taken into account.

Obligation has been placed on State parties to provide for environmental impact assessments of Projects that are likely to have significant adverse effects on biological diversity (Art. 4).

2.5.3 Convention on Wetlands of International Importance, Ramsar (1971)

This convention is also known as the Ramsar Convention. It was adopted on 2 February, 1971 and entered into force on 21 December, 1975. Bangladesh has ratified the Convention 20 April, 2002. This provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are 127 Parties with 1085 wetland sites designated as Wetlands of International Importance'.

This is an intergovernmental treaty, which provides the framework for international co-operation for the conservation of wetlands habitats. Obligations for Contracting Parties include the designation of wetlands to the "List of Wetlands of International Importance', the provision of wetland considerations within their national land use planning, and the creation of Natural Reserves. Parts of the Sundarbans Reserved Forest (Southwest of Bangladesh) are one of the Ramsar Sites.

2.5.4 United Nations Convention on the Law of the Sea, Montego Bay, (1982)

This Convention was adopted on 10 December 1982 at Montego Bay, Jamaica. Bangladesh has ratified this Convention.

Main objectives of the convention are:

- To set up a comprehensive new legal regime for the sea and oceans, as far as environmental provisions are concerned, to establish material rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment; and
- To establish basic environmental protection principals and rules on global and regional cooperation, technical assistance, monitoring, and environmental assessment, and adoption and enforcement of international rules and standards and national legislation with respect to alt sources of marine pollution.

2.5.5 UNESCO World Heritage Convention

Convention concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972: This convection has been ratified by 175 states. This defines and conserves the world's heritage by drawing up a list of natural and cultural sites whose outstanding values should be preserved for all humanity. Of the 730 total sites, there are currently 144 natural, 23 mixed and 563 cultural sites that have been inscribed on the World Heritage List (distributed in 125 State parties). These are the 'Jewels in the Crown' of conservation.

The proposed Project intervention should be carried out in such a manner that the above-mentioned provisions of the multilateral environmental agreements are not violated and many not cause adverse impact on the natural resources.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)

Entered into force on 1 July 1975, this frame work addresses the overharvesting and exploitation patterns that threatened species of flora and fauna. Bangladesh ratified on 20 November-1981. Under this Convention, the governments agree to restrict or regulate trade in species that are threatened by unsustainable patterns and to protect certain endangered species from overexploitation by means of a system of import/export permits.

Convention on the Conservation of Migratory Species of Wild Animals (Bonn 1979)

This convention sets the framework for agreements between countries that are important to the migration of threatened species. This Convention came into force on 23 June 1979. Bangladesh ratified on 1st December-2005.

Succeeding tranches will consult relevant Government authorities and/or experts to avoid areas known to be habitat of migratory species of wild animals in selecting sites of Project components.

Vienna Convention for the Protection of the Ozone Layer (1985)

A framework for efforts to protect the globe's ozone layer by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer. Bangladesh ratified on 2nd August-1990.

Project components will not use chemicals such as methyl chloroform, a solvent generally used for industrial processes that can affect the ozone layer.

Montreal Protocol on Substances that Deplete the Ozone Layer (1989)

This international treaty came into force on 1 January 1989 and is designed to protect the ozone layer by phasing out the production of numerous substances that are responsible for ozone depletion. This treaty also requires controlling emissions of substances that deplete ozone. Bangladesh ratified in 2nd August 1990.

Project components will not use chemicals that can cause harm to the ozone layer.

2.5.6 International Maritime Conventions, Protocols and Agreements

The International Maritime Organization (IMO) came into existence in 1958 but before that few important conventions came into existence. Bangladesh is signatory to the International Maritime Organization (IMO). Therefore, all activities relating to shipment of coal through the Port for consumption of proposed coal based power plant shall have to be done strictly in compliance with the standards set by the IMO. The Conventions/Protocols relevant for the proposed project and agreed by GOB are highlighted in **Table 2.4** below:

Table 2.4: Relevant Conventions/Protocols agreed by GoB

Issues	Conventions, protocols and agreements	Remarks
International Maritime Safety	International Convention for the Safety of life at Sea (SOLAS), 1960 and 1974 (including all amendments)	Applicable
	International convention on load lines, 1966 and all amendments	Applicable
	Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972 (including all amendments)	Applicable
Marine pollution	International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL), 1954 (including all amendments)	Applicable
	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972 (including all amendments)	Applicable
	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LDC), 1972 (including all amendments)	Applicable
	International Convention for the Prevention of Pollution from Ships (MARPOL), 1973 and all amendments	Applicable

2.6 Development Agency's Health and Safety Guidelines

There are numbers of international financing agencies such as IFC, WB and ADB. All these agencies have their own policies and guidelines for management of health and safety issues. In addition, new financial agencies such as Equator Principles Financial Institutions (EPFIs) also have developed their own policies, procedures and guidelines for management of environmental and social issues for financing development projects. If the proposed project has plan for receiving financial assistance from any of these financial institution, in that case, the proposed project shall have to follow environmental and social safety guidelines of that particular agency.

The Environmental and social guidelines of some of these financial agencies are described below:

2.6.1 Social Safeguard policies of ADB

ADB has had environment assessment requirements for more than 20 years and follow own safeguard policy framework, which is currently updated as Safeguard Policy Statement (SPS 2009). SPS 2009 comprises three key safeguard areas: i) environment; ii) involuntary resettlement and iii) indigenous peoples. All three-safeguard policies involve a structured process of impact assessment, planning and mitigation to address the adverse effects of projects and programs throughout the project cycle.It aims to avoid adverse Project impacts to both the environment and the affected people; minimize, mitigate and/or compensate for adverse Project impacts; and help Borrowers to strengthen their safeguard systems and to develop their capacity in managing the environmental and social risks.

ADB's Policy states that all investments are subject to categorization to determinine environmental assessment (EA) requirements. A project is therefore, categorized into one of the three environmentalcategories (A, B or C) todetermine the level of environmental assessment. As per ADB screening process, this proposed project is categorized (Coal transportation project due to its possible impacts may impact ECA area) as Category "A" and subsequently an EIA will be required.

Regarding the resettlement plan of a project ADB provides that 'A satisfactory resettlement plan must include all eleven essential elements'. The safeguard policies are at the front line of ADB's accountability mechanism and compliance review process, since these policies, if properly implemented, help ensure that third parties do not incur material damages, either directly or through environmental media, and thus have no basis for complaint.

2.6.2 Social safeguards policies of World Bank

In 1989, the World Bank adopted Operational Directive (OD) 4.00, "Appendix A: Environmental Assessment". EA became standard procedure for Bank financed investment Project. In 1991 the directive was as OD 4.01, which has subsequently been changed to operational policy OP 4.01 in January 1999 and the operational policy statement has been updated in March, 2007. EA is designed to be a flexible process that part of Project preparation allows environmental issues to be addressed in a timely and cost-effective way during Project preparation and implementation.

In addition to efforts identified in the 2001 Strategy, the Bank has adopted a set of operational policies and procedures that deal with the Bank's core development objectives and goals, the instruments for pursuing them, and specific requirements for Bank financed operations.

World Bank seeks to ensure that –supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water areas where most of the native plant and animal species are still present).

Specifically, the policy prohibits Bank support for projects which would lead to the significant loss or degradation of any Critical Natural Habitats, whose definition includes those natural habitats which are either:

- legally protected,
- officially proposed for protection, or
- Unprotected but of known high conservation value.

In other (non-critical) natural habitats, Bank supported projects can cause significant loss or degradation only when

i. there are no feasible alternatives to achieve the project's substantial overall net benefits; and
ii. Acceptable mitigation measures, such as compensatory protected areas, are included within the project. *(Operational Policy 4.04)*

According to the procedure followed by the international financial organizations they are apprised about the projects for environmental and social risks at an early stage. In the first appraisal, the so-called screening, the risk of the project is categorized in accordance with internal guidelines based upon the environmental and social screening criteria of the IFC. Projects are classified, relating to social or environmental impacts, in Category A (significant impacts), Category B (limited impacts), and Category C (minimal or no impacts). In regard to these categorization, the proposed RPCL Coal based Thermal Power Plant Project at Pyra, Patuakhali falls under Category –A. This is to be noted that, if the project planned to access fund from WB, in that case all applicable operational policies will be adopted which include

OP-4.01 for environmental. In addition, OP-4.10 on Indigenous Peoples (ethnic minorities) may be applied to the project because there are settlements of ethnic group within the project study area and site-specific project activities will be implemented in areas where ethnic minorities that meet the eligibility criteria of OP 4.10 are present.

2.6.3 Environmental and social guidelines for Equator principles

The Equator Principles (EPs) are a voluntary set of standards for determining, assessing, and managing social and environmental risk in project finance, in which the lender looks primarily to the revenues generated by a single project both as the source of repayment and as security for the exposure. Project financiers may encounter social and environmental issues that are both complex and challenging, particularly with respect to projects in the emerging markets.

Equator Principles Financial Institutions (EPFIs) will only provide loans to projects that conform to the Equator Principles listed below:

Principle 1: Review and Categorization

The risk of the Project is categorized in accordance with internal guidelines based upon the environmental and social screening criteria of the IFC. Projects are classified, relating to social or environmental impacts, in Category A (significant impacts), Category B (limited impacts), and Category C (minimal or no impacts).

Principle 2: Social and Environmental Assessment

For all medium- or high-risk Projects (Category A and B Projects), sponsors complete an Environmental Assessment, the preparation of which must meet certain requirements and satisfactorily address key environmental and social issues.

Principle 3: Applicable Social and Environmental Standards

The environmental assessment report addresses baseline environmental and social conditions, requirements under host country laws and regulations, applicable international treaties and agreements, sustainable development and use of renewable natural resources, protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems, use of dangerous substances, major hazards, occupational health and safety, fire prevention and life safety, socioeconomic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities, cumulative impacts of existing Projects, the proposed Project, and anticipated future Projects, participation of affected parties in the design, review and implementation of the Project, consideration of feasible environmentally and socially preferable alternatives, efficient production, delivery and use of energy, pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions), and solid and chemical waste management.

Principle 4: Action Plan and Management System

Based on the Environmental Assessment, Equator Banks then make agreements with their clients on how they mitigate, monitor and manage those risks through a “Social Environmental Management Plan”.

Principle 5: Consultation and Disclosure

For risky Projects, the borrower consults with stakeholders such as NGOs and affected groups and provides them with information on the risks of the Project. The borrower has to consult the Project affected communities in a structured and culturally appropriate manner. The process will ensure free, prior, and informed consultation for affected communities.

Principle 6: Grievance Mechanism

The borrower will establish a grievance mechanism as part of the management system.

Principle 7: Independent Review

For all Projects, an independent social or environmental expert not directly associated with the borrower, will review the Assessment, Action Plan and consultation process documentation in order to assist EPFI's due diligence, and assess Equator Principles compliance.

Principle 8: Covenants

Incorporation of covenants linked to compliance. Compliance with the plan is required in the covenant. If the borrower does not comply with the agreed terms, the Bank will take corrective action, which if successful, could ultimately result in the Bank cancelling the loan and demanding immediate repayment.

Principle 9: Independent Monitoring and Reporting

Over the life of the loan, in Category A and, if necessary in Category B, an independent expert is consulted.

Principle 10: EPFI Reporting

Each EPFI adopting the Equator Principles commits to report publicly, at least annually, about its Equator Principles implementation processes and experience, taking into account appropriate confidentiality considerations.

2.7 Environmental Standards

The appropriate national environmental standards are applied under the Environmental Conservation Rules 1997 and subsequent amendments made in 2005 and 2006. Moreover, the World Bank has established standard for "Environmental, Health and Safety Guidelines-Thermal Power Plants" dated December, 2012. The relevant standard has been pointed out bellow.

2.7.1 Emission and Ambient Pollution Standards

The environmental emission standards in Bangladesh are promulgated under the Environment Conservation Rules of 1997 in Schedule-11. There are standards prescribed for varying with sources of industries. The relevant Gaseous Discharge Quality Standards for Industrial Units [vide Rule 13] of ECR 1997 are presented in **Table- 2.5**.

Table 2.5: Gaseous discharge quality standard for industrial units (ECR, 1997 and Draft ECR 2017)

Sl No.	Parameters	Capacity of the Power Plant	ECR, 1997	Draft ECR, 2017
1	Particulate Matters	Power station of capacity of 200 MW or more	150 mg/Nm^3	50 mg/Nm^3 for Coal Power Plant
2	Lowest height of stack height	500 MW and above	275 m	275 m for Coal Power Plant
3	Oxides of nitrogen	500 MW and above	50 ppm	350 ppm for Coal Power Plant
4	Chlorine (Cl_2)		150 mg/Nm^3	15 mg/Nm3

Sl No.	Parameters	Capacity of the Power Plant	ECR, 1997	Draft ECR, 2017
5	Hydrochloric acid vapor and mist		350 mg/Nm^3	35 mg/Nm3
6	Total fluoride (as F)		25 mg/Nm^3	35 mg/Nm3
7	Sulfuric acid mist		50 mg/Nm^3	25 mg/Nm3
8	Lead particulates (Pb)		10 mg/Nm^3	5 mg/Nm3
9	Mercury particulates (Hg)		0.2 mg/Nm^3	0.2 mg/Nm^3

The World Bank have also emission standard for different types of power plant. The emission standard has the limit depending on the types of fuel use and process of fuel combustion. The International Finance Corporation (IFC) emission guidelines are produced both for degraded airshed (DA) and Non-degraded airshed (NDA). However, the IFC emission standard guideline for thermal power plant are presented in **Table-2.6.**

Table 2.6: Emission standard guideline for coal fired boiler (IFC 2008)

Pollutants	Non Degraded Airshed (NDA)	Degraded Airshed (DA)
Unit	**mg/Nm^3**	**mg/Nm^3**
SO_2	200-850	200
NOx	510	200
PM	50	30

2.7.2 Ambient Air Quality Requirements

The emitted polluted air from different sources make load to the ambient environment. To maintain the quality of ambient environment the Department of Environment, Bangladesh has standardized the ambient air quality standard in ECR, 1997 in Schedue-2. The standard values are precisely changed in the subsequent amendment of ECR in 2005. The air quality standard is presented in **Table- 2.7**

Table 2.7: Air quality Standard (ECR 2005)

Air Pollutants	Concentration ECR, 2005	Concentration Draft ECR, 2017	Average Time
CO	10 mg/m^3	10 mg/m^3	3 hr
	40 mg/m^3	40 mg/m^3	1 hr
Pb	0.5 µg/m^3	0.15 µg/m^3	Annual
NOx	100 µg/m^3	100 µg/m^3	Annual
		200 µg/m^3	24 hr
SPM	200 µg/m^3	-	8 hr
PM10	50 µg/m^3	50 µg/m^3	Annual
	150 µg/m^3	150 µg/m^3	24 hr
PM2.5	15 µg/m^3	15 µg/m^3	Annual
	65 µg/m^3	35 µg/m^3	24 hr
O_3	235 µg/m^3	235 µg/m^3	1 hr
	157 µg/m^3	157 µg/m^3	8 hr
SO_2	80 µg/m^3	80 µg/m^3	Annual
	365 µg/m^3	85 µg/m^3	24 hr

The World Bank has established in their standard following emission values from the WHO (World Health Organization), "WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide, global updated 2005". In the IFC EHS guideline for thermal power plant in 2008 stated that emission from a single project should not contribute more than 25% of the applicable ambient air quality standard to allow additional, future sustainable development in the same airshed. The approach, termed the Prevention of Significant Deterioration (PSD) Increment approach is based on allowing a specific incremental release (termed PSD increment) from each installation. The PSD increment can be viewed as the maximum relative increase in concentration (as a percentage of the ambient air quality standard) that is allowed to occur for each pollutant from each installation. The IFC standard for ambient air quality and PSD value for national ambient quality are presented bellow **Table-2.8** for SO_2 and NO_2.

Table 2.8: Ambient air quality standard

Air Pollutant	Average Period	IFC, 2008 (µg/m^3)	PSD value for National Standard (25%) (µg/m^3)
SO_2	10 min	500	
	24 hr	125 (IT-1)	91.25
		50 (IT-2)	
		20	
	Annual		20
NO_2	1-hr	200	
	1-Year	40	
NOx	Annual		25

Note: IT-Interim Target

In order to determine compliance, the predicted ground level concentration (based on the full cumulative analysis and existing background data) at each model receptor is compared to the applicable ambient air quality limit value or PSD increment in the region of overlap between the impact area of the proposed installation and the existing installation. If the predicted pollutant concentration increase over the baseline concentration is below the applicable increment (i.e. 25% of the AQS), and the predicted total ground level concentrations are below the ambient air quality standards, then the applicant has successfully demonstrated compliance IFC, 2007 standard for Particulate Matters (PM):

Particulate matter PM10 - 1 year averaging period:	70 µg/m3	interim target 1
	50 µg/m3	interim target 2
	30 µg/m3	interim target 3
	20 µg/m3	guideline
Particulate matter PM10 - 24 hr averaging period:	150 µg/m3	interim target 1
	100 µg/m3	interim target 2
	75 µg/m3	interim target 3
	50 µg/m3	guideline
Particulate matter PM2.5 - 1 year averaging period:	35 µg/m3	interim target 1
	25 µg/m3	interim target 2
	15 µg/m3	interim target 3
	10 µg/m3	guideline
Particulate matter PM2.5 - 24 hr averaging period:	75 µg/m3	interim target 1
	50 µg/m3	interim target 2
	37.5 µg/m3	interim target 3
	25 µg/m3	guideline

The WHO recommends the guideline values, but accepts that for countries where pollution is already high the interim targets may be used.

2.7.3 Ambient Noise Level

The ambient noise level standard has been modified in the amendment of ECR 2006. The level of noise from multiple sources will be limited to the following (**Table-2.9**) standard depending on the temporal and spatial sensitivity. The noise level standard of IFC guideline is shown in **Table-2.10.**

Table 2.9: Noise level standard (ECR, 2006)

Sl. No.	Zone Categorization	Standard dB(A) Leq	
		Day (6:00 am – 9:00 pm)	Night (9:00 pm – 6:00 am)
1	Silent Zone	50	40
2	Residential Zone	55	45
3	Mixed Zone	60	50
4	Commercial Zone	70	60
5	Industrial Zone	75	70

Table 2.10: Noise level guideline (IFC, 2008)

Receptor	One Hour L_{eq} (dBA)	
	Daytime (7:00-22:00)	Nighttime (22:00-7:00)
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

2.7.4 Effluent Standard

Table-2.11 presents the standards for industrial project effluent and sewerage disposal quality as per guideline of ECR 1997. **Table – 2.12** shows water quality standard as per the Draft ECR 2017. **Table- 2.13** and **Table – 2.14** shows the IFC standard guideline used for effluent and sewerage disposal.

Table 2.11: Bangladesh Standards for Industrial Project Effluent (ECR, 1997)

Sl. No	Parameter	Unit	Discharge To		
			Inland Surface Water	Public Sewer to Secondary Treatment Plant	Irrigable Land
1	Ammonicalnitrogen (aselementary N)	mg/l	50	75	75
2	Ammonia(asfreeammonia)	mg/l	5	5	15
3	Arsenic(asAs)	mg/l	0.2	0.05	0.2
4	BOD5at 20^{o}C	mg/l	50	250	100
5	Boron	mg/l	2	2	2
6	Cadmium(asCd)	mg/l	0.05	0.5	0.5
7	Chloride	mg/l	600	600	600
8	Chromium(astotalCr)	mg/l	0.5	1.0	1.0
9	COD	mg/l	200	400	400
10	Chromium(ashexavalentCr)	mg/l	0.1	1.0	1.0
11	Copper(asCu)	mg/l	0.5	3.0	3.0
12	Dissolved oxygen(DO)	mg/l	4.5-8	4.5-8	4.5-8
13	Electro-conductivity(EC)	µs/cm	1200	1200	1200
14	Total dissolvedsolids	mg/l	2100	2100	2100
15	Flouride(asF)	mg/l	2	15	10
16	Sulfide(asS)	mg/l	1	2	2

Sl. No	Parameter	Unit	Discharge To		
			Inland Surface Water	Public Sewer to Secondary Treatment Plant	Irrigable Land
17	Iron(asFe)	mg/l	2	2	2
18	Total kjeldahlnitrogen(asN)	mg/l	100	100	100
19	Lead(asPb)	mg/l	0.1	1	0.1
20	Manganese(asMn)	mg/l	5	5	5
21	Mercury(asHg)	mg/l	0.01	0.01	0.01
22	Nickel(asNi)	mg/l	1.0	2.0	1.0
23	Nitrate(aselementaryN)	mg/l	10.0	Notyet set	10
24	Oil andgrease	mg/l	10	20	10
25	Phenoliccompounds(asC_6H_5OH)	mg/l	1.0	5	1
26	Dissolvedphosphorus(asP)	mg/l	8	8	15
27	Radioactivesubstance	(to bespecifiedbyBangladeshAtomicEnergyCommission)			
28	PH		6-9	6-9	6-9
29	Selenium(asSe)	mg/l	0.05	0.05	0.05
30	Zinc(asZn)	mg/l	5	10	10
31	Total dissolvedsolids	mg/l	2100	2100	2100
32	Temperature	^{o}C (summer)	40	40	40
		^{o}C (winter)	45	45	45
33	Suspendedsolids	mg/l	150	500	200
34	Cyanide	mg/l	0.1	2.0	0.2

Table 2.12: Surface water quality Standard (Draft ECR 2017)

Usage type	pH	DO (mg/l)	BOD (mg/l)	NO^{3-} (mg/l)	N (mg/l)	PO^{4-}-P (mg/l)	Cr (mg/l)	Pb (mg/l)	Hg (mg/l)	Total Coliform No/100 (mg/l)	TDS (mg/l)	COD (mg/l)
Source of drinking water for supply only after disinfecting:	6.5-8.5	≥5	≤2	10.0	1.5	0.5	0.02	0.03	0.03	≤2000	1000	25
Water usable for recreational activity	6.5-8.5	≥5	≤3	10.0	1.5	0.5	0.1	0.1	0.05	≤500	1000	25
Source of drinking water for supply after conventional treatment	6.5-8.5	≥5	≤3	10.0	1.5	0.5	0.02	0.03	0.03	≤5000	1000	10
Water usable by fisheries	6.5-8.5	≥5	≤10	5.0	1.5	0.5	0.1	0.1	0.05	≤5000	1000	25
Water usable by various process and cooling industries	6.5-8.5	≥5	≤10	5.0	1.5	0.5	0.1	0.1	0.05	-	1000	25
Water usable for irrigation*	6.5-8.5	≥5	≤10	5.0	1.5	0.5	0.1	0.1	0.5	≤1000	1000	25

*Note:*Electrical conductivity for irrigation water – 2250 μs/cm (at a temperature of 25° Sodium less than 26% ; boron less than 0.2%.*

Table 2.13: Bangladesh Standards for Sewage Discharge (ECR, 1997)

Parameters	Unit	Values
BOD	mg/l	40
Nitrate	mg/l	250
Phosphate	mg/l	35
SuspendedSolids(SS)	mg/l	100
Temperature	^oC	30
Coliforms	number/100ml	1000

Table 2.14: Effluent guideline (IFC, 2008)

Parameter	mg/L, (exceptpHandtemp)
pH	6–9
TSS	50
Oil and grease	10
Total residual chlorine	0.2
Chromium -Total (Cr)	0.5
Copper (Cu)	0.5
Iron(Fe)	1.0
Zinc (Zn)	1.0
Lead(Pb)	0.5
Cadmium(Cd)	0.1
Mercury (Hg)	0.005
Arsenic(As)	0.5
Temperatureincrease by thermal discharge fromcoolingsystem.	Elevated temperature areas duetodischarge ofonce-through coolingwater (i.e. maximum 3^0C above ambientwatertemperature)shouldbe minimized in mixing zone (i.e. 100m) by adjusting outfalldesignor bythe project specific EA dependingonthesensitive aquatic ecosystems aroundthe discharge point.

Table 2.15: Standard after treated sanitary sewage discharge (IFC, 2008)

Pollutants	Units	GuidelineValue
pH	pH	6–9
BOD_5	mg/l	30
COD	mg/l	125
Totalnitrogen	mg/l	10
Totalphosphorus	mg/l	2
Oil andgrease	mg/l	10
Totalsuspendedsolids	mg/l	50
Totalcoliformbacteria	MPN/ 100ml	400*

*Note: *Notapplicableto centralized, municipal, waste water treatment systems which are included in EHS Guidelines for Water and Sanitation.*

bMPN=MostProbableNumber

3. Project Data Sheet

3.1 Background and Justification

Electricity is one of the most usable forms of energy and its sustainable availability is one of themajor preconditions for socio economic development of a country. Bangladesh is one of the countries where electricity demand is much more than its availability. This short fall becomes acquit during irrigation period. Recent rapid industrialization and urbanization has increased the power demand to many fold. Moreover, the government of Bangladesh has targeted to provide electricity to all by 2021. The Government expects a power demand of 40,000 MW by 2030. Considering the present power scenario of the country the government has prioritized the Power sector and has formulated Power System Master Plan (PSMP) 2010. Based on the recommendations of the PSMP 2010 for coal as diversified fuel, "The Rural Power Company Limited", an enterprise under the Ministry of Power, Energy and Mineral Resources, has planned to enhance country's power generation by constructing 2x660 MW coal based power plant at- Mauza Nishanbari, Dhankhali and Londa, Kalapara Upazila, Patuakhali district. The project once completed will add about 1320MW power to the national grid.

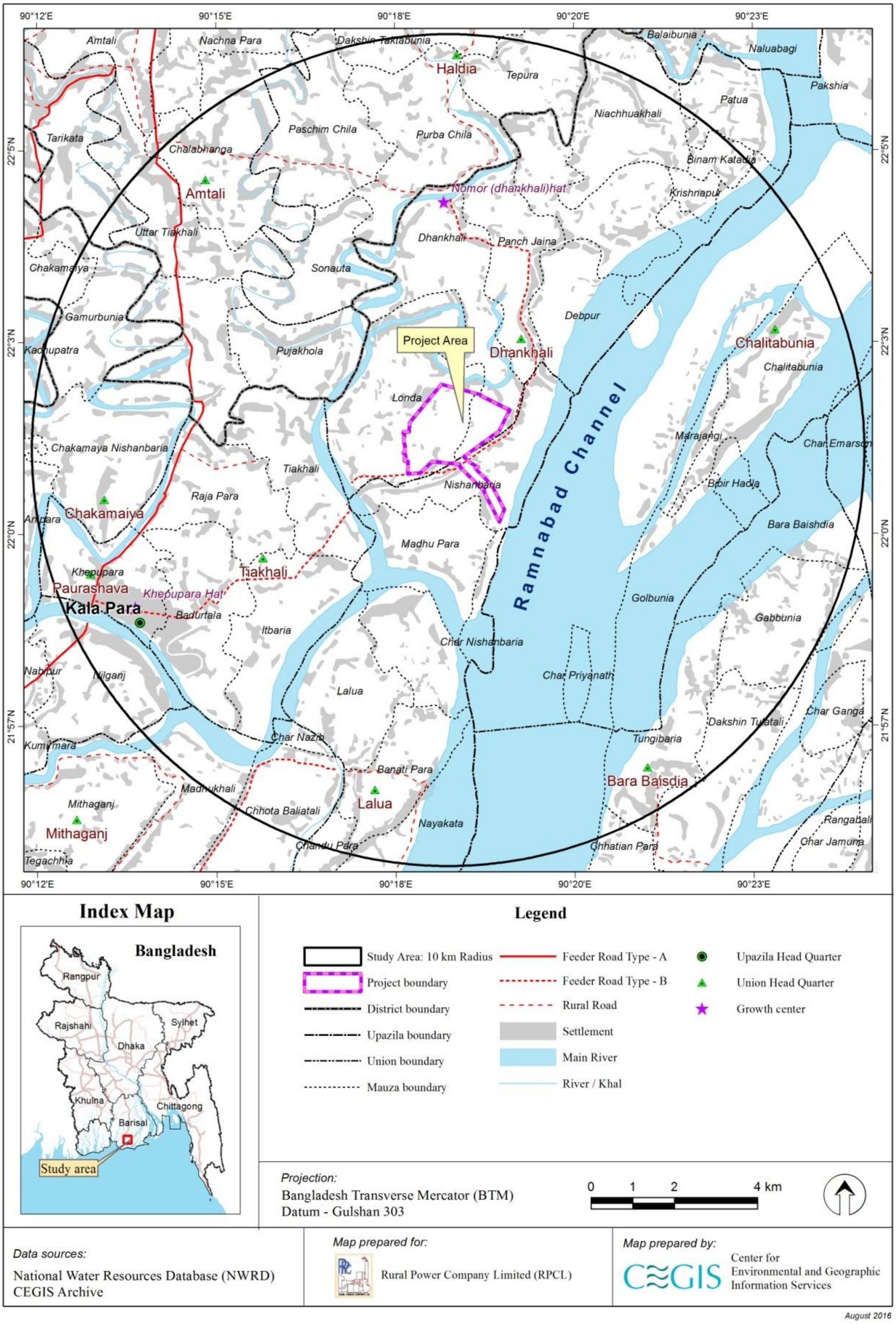
3.2 Project Proponent

The Rural Power Company Limited (RPCL), an enterprise under the Power division of the Ministry of Power, Energy and Mineral Resources, is the proponent of this proposed 1320 (2x660) MW Coal Fired Thermal Power Plant project.

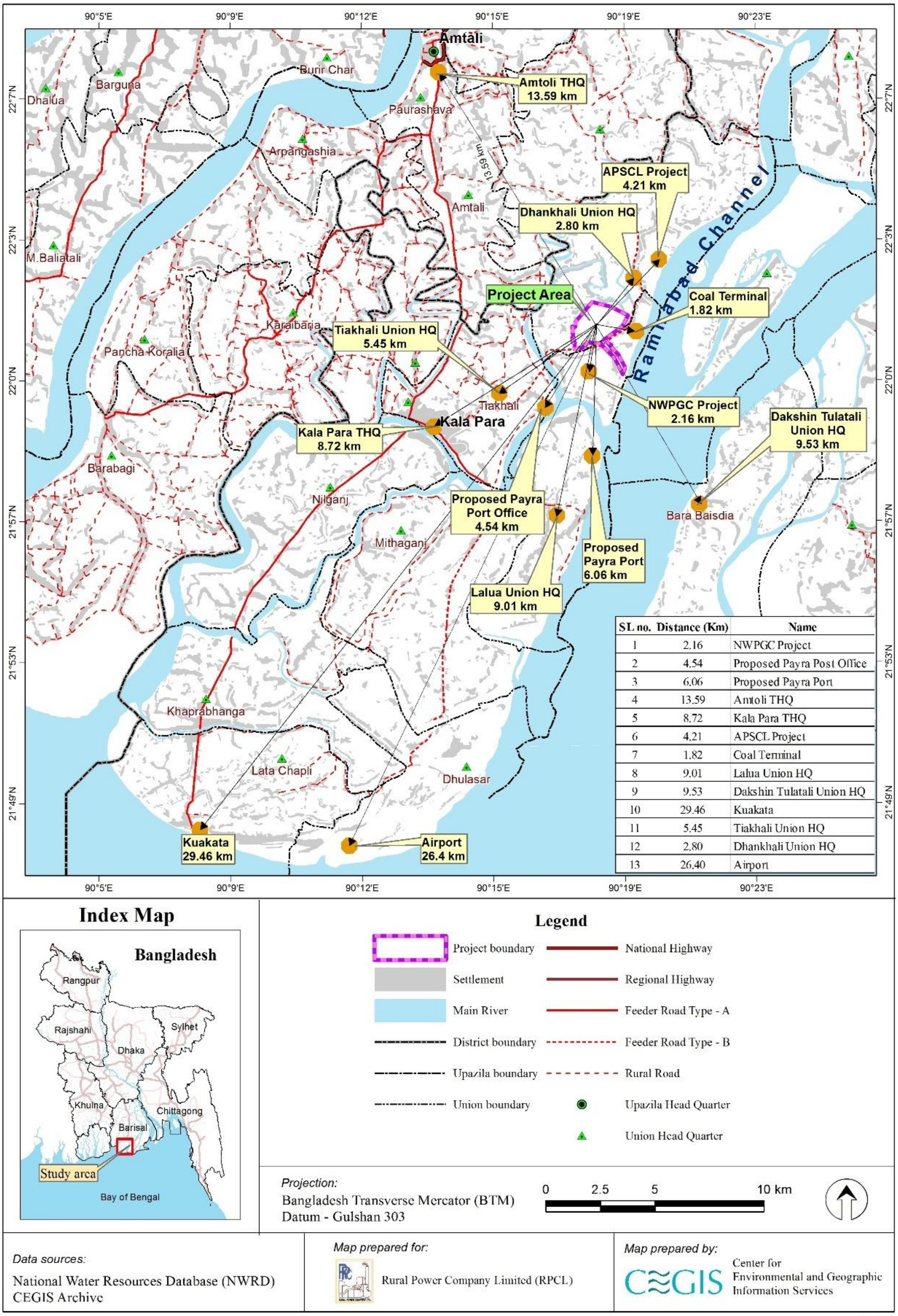
3.3 Project Loacation

The proposed power plant project will be located at Mauza Nishanbari, Dhankhali and Londa, Kalapara Upazila, Patuakhali district.The site is located on the western bank of River Rabnabad and adjacent to the proposed RPCL Power Plant in the south and APSCL's proposed Power Plant in the north. Considering a number of social and environmental criterion including availability of uninhabited land, proximity to water and fuel source and evacuation of power facility, the site has been selected from four preselected sites through a compression matrix.

The proposed project site is accessible through the metal road from Londa Mauza to Dhankhali Union and Dhankhali Union to Patuakhali – Kuakata Highway. The project site can also be accessed through the river route using the Rabnabad and Andharmanik Rivers. The access way to the project site is presented in **Map 3.1** and the location of the project site is shown in **Map 3.2.** Location of the other KPIs, adminstrative units, proposed airports have been sketched in Map 3.2. At present, Atomoic Energy Commission of Bangladesh is searching for the safe site of second Nuclear Power Plant Project in the Barishal Division. They are initially selected two upazilas: a) Kalapara Upazila in Patuakhali District and b) Motbaria Upazila in Pirojpur District for geological study. They are trying to select the initial project area on the basis of a number of set criteria like gelogically stable, isolated area, less vulnerable to disaster etc.



Map 3.1: Accessibility map of the project site



SL no.	Distance (Km)	Name
1	2.16	NWPGC Project
2	4.54	Proposed Payra Post Office
3	6.06	Proposed Payra Port
4	13.59	Amtoli THQ
5	8.72	Kala Para THQ
6	4.21	APSCL Project
7	1.82	Coal Terminal
8	9.01	Lalua Union HQ
9	9.53	Dakshin Tulatali Union HQ
10	29.46	Kuakata
11	5.45	Tiakhali Union HQ
12	2.80	Dhankhali Union HQ
13	26.40	Airport

Map 3.2: Project Location and Distance Map of the proposed project

3.4 Nature and Size of the Project

The Size of the Project is1320 (2x660) MW andthe nature of the proposed project is a Ultra-supercritical Bituminous or Sub-bituminous coal based thermal power Plant. Each 660 MW Plant will consist of one ultra-supercritical balanced draft pulverized coal fired Boiler with built in Dry Low NOx burners suitable for outdoor installation with a stack of 275 meter high and a tandem-compound, multi cylinder design condensing type steam turbine directly coupled with hydrogen cooled generator suitable for indoor installation.

3.5 Project components

The proposed project is a green field project which will require a total of about 915.7 acres of land for construction/installation of Boiler structure, Turbine, Generator, Control room building, Transformer yard, switch yard, coal stock yard for 60 days' reserve, ash pond and ash dyke, conveyor belt, greenbelts, roads, security post, FGD and ESP system, ETP and WTP, water intake and out fall, compressor house, fire station, laboratories, workshops, security office, Admin building, canteen, boundary wall, townships, School, Mosque, other community facilities, etc.

3.6 Project Activities and Schedule

The project schedule received from the proponent are as below.

1. Expected date of starting construction	2. August-2017
3. Expected date of completion of construction	4. December-2021
5. Expected date of trial production	6. June-2021

Activities of the project are classified as Pre-construction, Construction and post construction or operation phase activities and are detailed as below.

A) Pre-construction phase:

- a) Selection of alternative sites (Done)
- b) Selection of project site (Done)
- c) Land acquisition & site establishment (In progress)

B) Construction phase

- a) Civil construction and technological installation work
- b) Post erection check & pre commissioning test
- c) Monitoring of mitigation measures for Environmental impact of the plant
- d) Commissioning test
- e) Reliability test run
- f) Commercial operation of the plant
- g) Overall project management
- h) Post construction
- i) Commercial operation of the plant
- j) Monitoring of EMP
- k) Proper O & M of the plant for efficient running

3.7 Required Resource and utility demand

Resources required to develop the project include soil, construction material, manpower etc. The site is a low lying agricultural land. The site needs earth filling considering the nearest bench mark of survey of Bangladesh and historical maximum Cyclonic surge height. The filling earth could be dragged spoil of nearest river (Rabnabad River, Andharmanik River) or could be brought from other places. Construction materials like cement, MS rod, brick etc. should be used from the local or regional market of Patuakhali or Barisal.

Electricity demand during pre-construction and construction phases shall be met up from the nearest sub-station of BPDB if available. Otherwise, a sub-station is to be constructed at project site and a transmission line with necessary ancillaries. The proponent/PGCB is to draw the necessary power line with other ancillary components from the nearest sub-station to the project site. Construction water can be fetched from the nearby "Rabnabad" River. Drinking water can be drawn from the ground water sources using Deep Tube wells.

The project shall provide employment opportunity for unskilled, semi-skilled, and skilled categories man power. Employment potential shall increase with the start of construction activities. During operation phase there will also be employment opportunities, mainly in Plant operation and maintenance.

3.8 Source and Transportation of Construction Material

Construction materials generally include land filling material (sand, earth), sand, cement, brick, MS road, shuttering material etc. Most of these construction materials will be available in the local markets of Patuakhal and Barisal and can be brought to the site by road or river transport. Land filling material (Sand/Earth/ dredged spoil) is to be collected either by dredging the nearby river as is the case of RPCL site or by importing soil from other areas. Construction water can be fetched from the nearby "Rabnabad" River.

3.9 Transportation of Equipment, Machinery, etc

Heavy machineries and Equipment like Boiler structure, Turbo- GeneratorRotor, Transformer , switch yard etc needs to be transported from abroad.Using Mongla port authority these machineries and Equipments are to be tranported to the project site by Lighter vessel and other machineries and equipments like Pump,Fans,firing equipments are to be transported through road net work.

3.10 Requirement, Source and Composition of Fuel for Plant operation

The main fuel to be used in the proposed project will be sub-bituminous coal. Based on the chemical configuration of the coal shown in the matrix below (**Table 3.1**) the feasibility consultant has recommended for "Designed Blended Coal" of 4,644,692 Tons per annum for generation of 1320 MW power by operating two units of 660 MW each, which is shown in **Table 3.2**. Besides, light diesel fuel oil (LDO) and Heavy fuel oil (HFO) will also be used for boiler start up, flame stabilization and low-load operation. Annual LDO and HFO consumption is estimated to be 20,000 m3 (**Table 3.3**). Required amount of coal can be procured from the coal yard of 'Payra Bondor' coal authority adjacent to the Power Plant and can be transported to Plant coal stock yard by conveyer belts. From environmental consideration and hazard point of view, the conveyer belt and the plant's coal stock yard should be covered with coal gas venting / flaring provision. (Ref. Feasiblity Report)

Table 3.1: Chemical composition of the imported coal

No	Item	Unit	Blended Coal (Australian - A, Indonesian - I)			
			Super	Best	Design	Worst
			A:I	A:I	A:I	A:I
	Proximate Analysis		2:01	3:02	1:01	2:03
1	Total moisture(arb)	%	18.33	20	22.5	25
2	Inner Moisture(adb)	%	9.56	10.78	12.6	14.41
3	Ash(arb)	%	13.76	12.77	11.29	9.8
4	Volatile Matter(arb)	%	29.47	29.72	30.1	30.48
5	Volatile Matter(daf)	%	26.33	23.7	19.75	15.8
6	Fix carbon(arb)	%	38.47	37.52	36.1	34.68
7	FC/VM		1.31	1.26	1.2	1.14
	Ultimate Analysis					
1	Carbon(arb)	%	53.73	52.78	51.35	49.92
2	Hydrogen(arb)	%	3.69	3.66	3.61	3.56
3	Oxygen(arb)	%	8.5	8.82	9.3	9.78
4	Nitrogen(arb)	%	1.27	1.24	1.2	1.15
5	Sulphur(arb)	%	0.52	0.48	0.43	0.38
6	Qgr(adb)	kcal/kg	5,226.67	5,124.00	4,970.00	4,816.00
7	Qnet(arb)	kcal/kg	4,950.00	4,840.00	4,675.00	4,510.00
8	HGI		55	55	55	55
	Ash Analysis					
1	SiO_2	%	50.87	48.48	44.9	41.32
2	Al_2O_3	%	20.07	19.26	18.05	16.84
3	Fe_2O_3	%	9.73	10.36	11.3	12.24
4	CaO	%	10.67	12.6	15.5	18.4
5	MgO	%	2.6	2.94	3.45	3.96
6	TiO_2	%	1	0.96	0.9	0.84
7	Na_2O	%	0.63	0.7	0.8	0.9
8	K_2O	%	1.13	1.06	0.95	0.84
9	P_2O_5	%	0.27	0.26	0.25	0.24
10	SO	%	2.33	2.7	3.25	3.8

Table 3.2: Coal Requirement for Plant

Unit	Best Blended Coal (Super NotConsidered)	Design Blended Coal	Worst Blended Coal
Tonnes per annum	4,505,098	4,644,692	4,793,214

Table 3.3: Diesel oil requirement

Type of Oil	No of tanks	Capacity of each tank(in kl)	
		Super Critical Cycle	Ultra Super Critical Cycle
HFO	2	2300	2000
LDO	2	500	450

3.11 Transportation of Fuel for plant operation

Required coal can be procured from the coal yard of 'Payra Bondor' coal authority adjacent to the Power Plant and can be transported to Plant coal stock yard by covered conveyer belts. The coal will then be transported to crusher and finally to miller for blowing into the furnace for firing.

3.12 Ash Production

The imported coal will contain on an average 12.77% of ash. Based on the specified coal quality, it is estimated that around 984.48ton of ash per day will be generated as bi-product from the plant to generate 612MW electricity. A single plant will produce around 836.64ton of fly ash (85%) and 147.84 ton of bottom ash (15%) every day. Project has developed 147 acres of ash impondments to store the unsold/remainings ash through HCSD sytem.

3.12.1 Ash utilization

The dry ash is taken to buffer hoppers for its onward transportation in dry form to storage silo near plant boundary for utilization. The residual ash can be used in Brick manufacturing, clinker industries, cement industries, feelings the low lands, compaction purposes etc. There will be also scope for ash export. At initial stage, the generated ash will be used in and for development of the project area.

Many Cement plants exist in the vicinity, hence, 100% fly ash utilization might be considered. Hundred percent bottom ash utilization might also been considered. Ash may be utilized for the following purposes:

- Concrete production, as a substitute ingredient for Portland cement and sand
- Embankments and other structural fills (usually for road construction)
- Grout and Flowable fill production
- Waste stabilization and solidification
- Cement clinkers production - (as a substitute ingredient for clay)
- Mine reclamation
- Stabilization of soft soils
- Road sub-base construction
- As aggregate substitute material (e.g. for brick production)
- Mineral filler in asphaltic concrete
- Agricultural uses: soil amendment, fertilizer, cattle feeders, soil stabilization in stock feed yards, and agricultural stakes
- Loose application on rivers to melt ice
- Loose application on roads and parking lots for ice control
- The following sections discuses potential sectors of ash utilization in case of Banshkhali Thermal Power Plant.

3.12.2 Ash Demand in Cement production

Fly ash is used as a partial replacement for Portland cement. It can replace up to 30% by mass of Portland cement, and can be added to the concrete's final strength and increase its chemical resistance and durability. Recently concrete mix design for partial cement replacement with High Volume Fly Ash (50 % cement replacement) has been developed. For Roller Compacted Concrete (RCC) [used in dam construction] replacement values of 70% have been achieved with processed ash. Due to the spherical shape of fly ash particles, it can also increase workability of cement while reducing water demand. The replacement of Portland cement with fly ash is considered by its promoters to reduce the greenhouse gas "footprint" of concrete, as the production of one ton of Portland cement produces approximately one ton as compared to zero CO_2 being produced using existing fly ash. New fly ash production, i.e., the burning of coal, produces approximately twenty to thirty tons of CO_2 per ton of fly ash. Since the worldwide production of Portland cement is expected to reach nearly 2 billion tons by 2010, replacement of any large portion of this cement by fly ash could significantly reduce carbon emissions associated with construction. A scientific study on use of fly ash in cement carried out by NTPC India, concludes that use of fly ash in cement have the following advantages (NTPC, undated):

- Reduction in heat of hydration and thus reduction of thermal cracks
- Improves soundness of concrete mass.
- Improved workability / pump ability of concrete
- Converting released lime from hydration of OPC into additional binding
- Material – contributing additional strength to concrete mass.
- Pore refinement and grain refinement due to reaction between fly ash and liberated lime improves impermeability.
- Improved impermeability of concrete mass increases resistance against ingress of moisture and harmful gases resulting in increased durability
- Reduce requirement of cement for same strength and reducing cost of concrete.
- Environmental benefits:
- Reduce cement requirement
- Less emission of carbon

There is a huge demand of ash in Bangladesh. At present there are 81 cement industries. Among these around 37 - 40 cement industries are always in production. Grossly, country's annual cement production is around 14 – 15 million ton. **Table 3.4** gives present and forecasted cement production as well as possible ash demands.

Table 3.4: Present and forecasted cement production and ash demand

Year	Cement Production and future projection (million Ton)	Required amount of Ash (million Ton)
2011	14	2.1
2015	18	2.7
2020	25	3.75

Source: Estimated from data of Bangladesh Cement Manufacturer Association (BCMA, 2011)

Moreover, one of the power company in Bangladesh named BIFPCL, for receiving the EOI from the local local/nationa companies especially from the cement factories. EOI for 100% lifting of ash published in news paper in May, 2015. The results shown optimistic that using the ash in future which is as follows.

- 7 parties have shown interest.
- In case of Fly Ash the requirements is approx. 4 times of annual production & in case of Dry Bottom Ash it is almost double.
- 100% ash generated from the project can be utilized.

Embankment construction

Fly ash might be used in embankment construction of which properties are somewhat unique as an engineering material. Unlike typical soils used for embankment construction, fly ash has a large uniformity coefficient consisting of clay-sized particles. Engineering properties that will affect fly ash's use in embankments include grain size distribution, compaction characteristics, shear strength, compressibility, permeability, and frost susceptibility. In coastal region, BWDB constructs thousands of kilometers of coastal embankment. Bangladesh Water Development Board might be an important client having scope of using large volume of the generated ash.


BANGLADESH-INDIA FRIENDSHIP POWER COMPANY (Pvt.) LIMITED
(A Joint Venture Company of BPDB & NTPC Ltd.)

Memo no.: BIFPCL/Coal/Ash/2015/065 Date: 20/05/2015

EXPRESSION OF INTEREST (EOI)
FOR LIFTING DRY FLY ASH & DRY BOTTOM ASH

Bangladesh India Friendship Power Company (Pvt.) Ltd. (BIFPCL) is executing a 2x660 MW, Coal based Power Project at Rampal, Distt Bagerhat. Dry bottom ash of approx.150000 MT/ year and Dry Fly Ash of approx. 600000 MT/year shall be generated and likely to be available from 2018-19. The same may be used in cement industry, manufacturing of bricks, tiles and in land filling. BIFPCL intends to conduct a market survey to assess ash utilisation potential through this EOI.

Interested parties may submit EOI before 23.06.2015 in the prescribed format available at www.bifpcl.com for lifting of ash from Ash Silos inside plant and near dedicated project jetty on chargeable basis at the address mentioned below. Parties have to arrange for transportation of ash in an environment friendly manner from the project.

Address for communication:
CPO, BIFPCL
Unique Heights (Borak),16th Floor
117, Kazi Nazrul Islam Avenue, Eskaton; Dhaka-1217
+880-1678582805
Or email at: maitreestpp@bifpcl.com

Pre-stressed Railway Concrete Sleepers

Fly Ash might be used in manufacturing the pre-stressed Concrete Sleepers. Over the years Bangladesh Railway Authority manufactures Concrete Sleepers. BPDB may negotiate with Bangladesh Railway and demonstrate scope of ash utilization in concrete sleeper manufacturing.

Utilization in agricultural field

Ash might be used as fertilizer in agricultural field; blending with organic matter and taking some measures; the fly-ash might be used as safe and effective fertilizer (Swamy, T. N., *et al.*, 2012; Gupta, D. K. et. al., 2002). Ash acts as soil modifier and source of micro and macro nutrients. There are different studies around the world especially in India shows that, use of ash in agricultural field might result better crop yields (NTPC, undated). Another research jointly carried out by World Bank and NTPC-India (World Bank-NTPC, 2007) finds Fly Ash doses of 50 to 200 ton per Hectare in every five years helps to improve soil nutrient status, textures, permeability etc. The following advantages of fly ash use in agricultural field are scientifically accepted (Vitekari, H. N., *et al.,* 2012 and Gupta, D. K. *et al.*, 2002) and practically established in field (World Bank-NTPC, 2007):

- Reduces bulk density of soil–Improves water holding capacity and porosity
- Improve Soil Texture

- Improve permeability status of soil
- Optimizes pH value
- Improves soil aeration
- Reduces crust formation
- Provides micro nutrients like Fe, Zn, Cu, Mo, B etc.
- Provides macro nutrients like K, P, and Ca etc.
- Works as a part substitute of gypsum for reclamation of saline alkali soil and lime for reclamation of acidic soils
- Surface cover of bio reclaimed vegetated ash pond get stabilized and can be used as recreational park
- Ash ponds provides suitable conditions and essential nutrients for plant growth, helps improve the economic condition of local inhabitants
- Works as a liming agent
- Helps in early maturity of crop
- Improves the nutritional quality of food crop
- Reduces pest incidence
- Conserves plant nutrients / water
- Improves the yield by 10% to 40%

Brick manufacturing by using coal Ash

Most modern manufacturing processes use a greater proportion of fly ash, and a high pressure manufacturing technique, which produce high strength brick with environmental benefits. They are widely used for the inner skin of cavity walls. They are naturally more thermally insulating than normal bricks made with other aggregates. Recently in Bangladesh private brick manufacturing organizations are using these kinds of bricks products because it is more cost effective and good quality of brick. This makes ash utilization in this sector more essential.

Road sub-base construction

In many ways the geo-technical and pozzolanic properties of ash enables its use in road pavement construction. Compacted pond ash and bottom ash possess adequate bearing strength and also meet gradation requirements and can be used as a granular sub-base material. Fly ash can be utilized for construction of semi-rigid pavement using lime fly ash concrete and lean cement fly ash concrete. These compositions possess more flexural strength than flexible pavements and can be adopted for high traffic density roads. In the concrete roads and runways, fly ash can be utilized as a partial replacement of ordinary Portland cement (up to 35%) and sand (5-15%). This would result in lowering the cost of concrete without affecting strength and which will also increase the durability.

3.13 Manpower and Tentative Organogram (RPCL)

3.13.1 Rural Power Company Ltd. (RPCL)

RPCL is a wholly owned subsidiary of the Bangladesh Power Development Board (BPDB) a state-operated entity executing power generation in different districts of Bangladesh. The company was established as a Pilot Project of Private Power Generation as per ECNEC decision on 23rd November, 1994 to enhance the privatization in the Power sector of Bangladesh. It started generating electricity from 2005, with a present generation capacity of 210 MW.

This company was created in order to meet the prevailing demand of electricity, to solve the load shading problem in the rural section of the country and to commit to the generation of reliable power for Rural Development as well as taking part in social & economical development for rural people of the country. The organogram of the RPCL is presented in **Figure 3.1**.

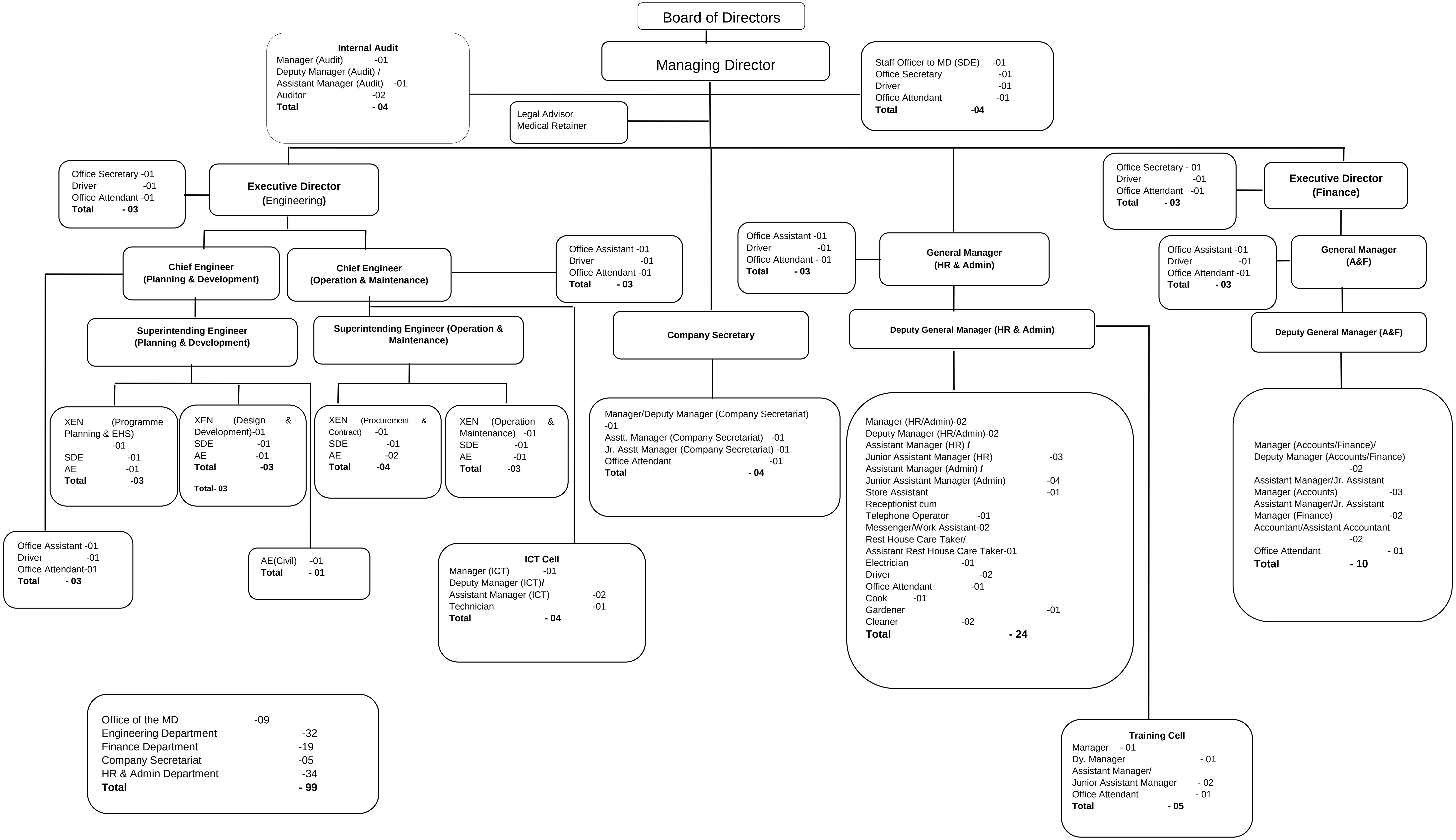


Figure 3.1: Organogram of RPCL

4. Process Description and Technology

4.1 Process of Site Development

The area will require substantial amount of back filling to achieve the final grade level which will be minimum 1.5 m higher than the highest flood level (Highest flood level 4.86m MSL) at the proposed location. The topographical survey report and soil investigation report for this project are available separately. Contractor is required to carry out the detail soil investigation and topographic survey and work out the actual earthwork volume during detailed engineering stage. Fine adjustment in the suggested plant grade levels may be done during that stage

4.2 Project Layout

Project layout plan received from the feasibility consultant is shown in the **Figure 4.1.** The project layout include al of the major components like boiler, turbine hall, HCSD places, ETP, FGD, residential buildings etc.

4.3 Technology and Process Description of Individual Plant Components

4.3.1 Power Generation

The proposed 1320 MW power plant will have a pulverized coal fired ultra-super critical boiler with auxiliaries and ancillaries like feed water pump, FD Fans, coal crasher etc., a steam turbines coupled with hydrogen cool generators suitable for indoor installation. There will be 400 KV GIS sub-station for power evacuation. In addition to coal, light diesel fuel oil will be used to start-up as well as flame stabilization and during low-load operation. The main Plant consists of three interconnected structures: (i) boiler structures, (ii) turbine building, and (iii) an integrated control and electrical building as shown in the **Figure 4.2**.

4.3.2 Turbine and its Auxiliaries

The steam turbine-generator converts the heat energy of steam into electrical energy. The steam after releasing most of its energy is discharged to the condenser to condense. The steam turbine is a tandem-compound, condensing, multi cylinder design, directly coupled with the generator suitable for indoor installation. It has its integral systems and auxiliaries like HP/MP/LP parts, Hydrogen cooled Generator, lube oil system, control-fluid system, condensers, condenser air evacuation system, HP&LP Bypass system, condensate polishing system, condensate pumps along with their drives, automatic turbine run-up system, instruments, turbine protection and interlock system, automatic turbine testing system and turbine hall EOT cranes.

4.3.3 Steam Generator and Auxiliaries

The steam generators shall be a once through, water tube, direct pulverized coal fired, top supported, balanced draft furnace, single reheat, dry bottom type, suitable for generation of steam at ultra-supercritical pressure and temperature with built in dry low NOx burner for NOx reduction. Boiler will be designed in such a way that oil firing for flame stabilization will not be required beyond low load. For coal firing the entire operation of purging, insertion, air and fuel sequencing, removal and blow off shall be automatic. The furnace should be suitable for out door installation.

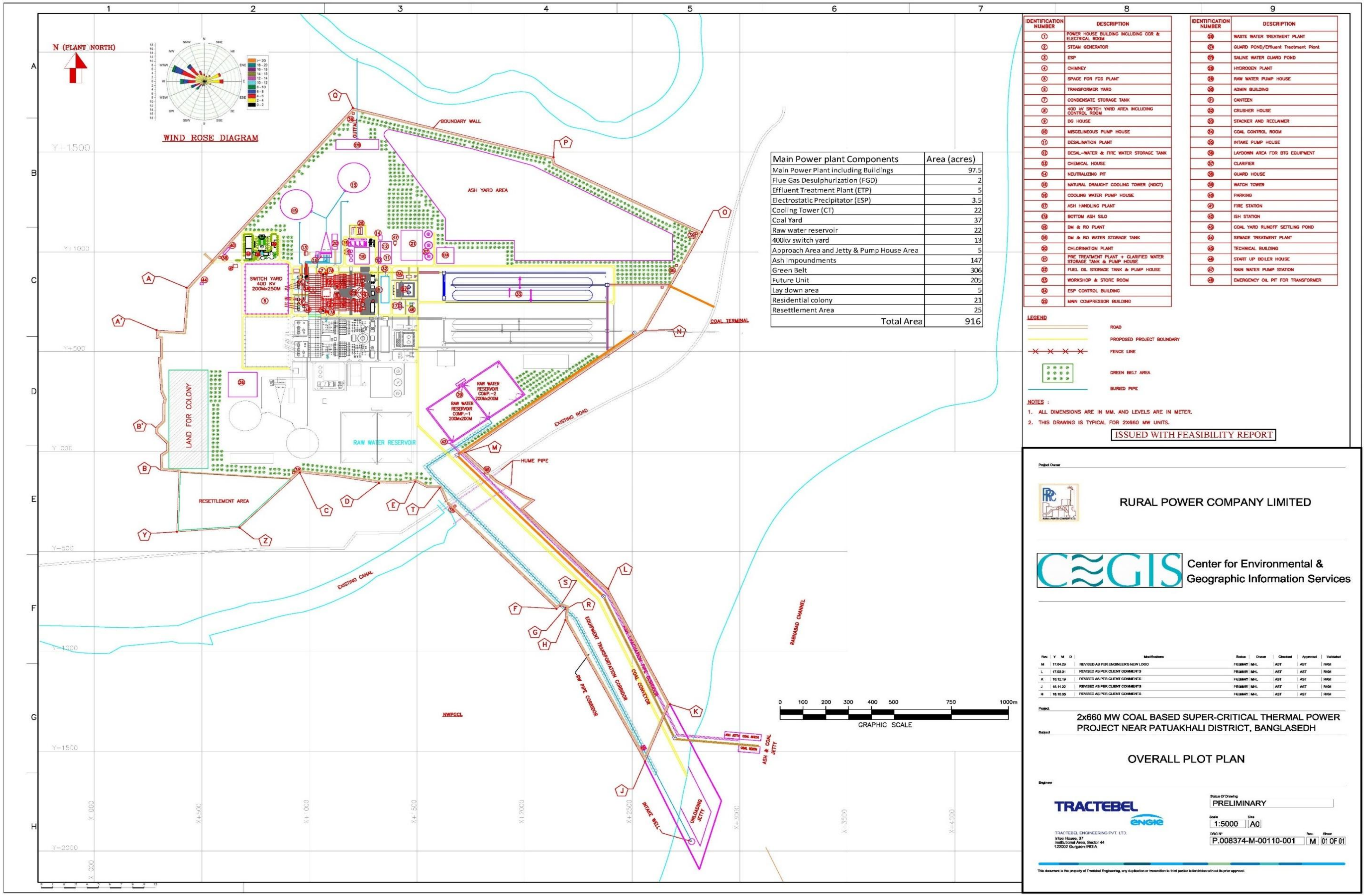


Figure 4.1: Project Layout Plan

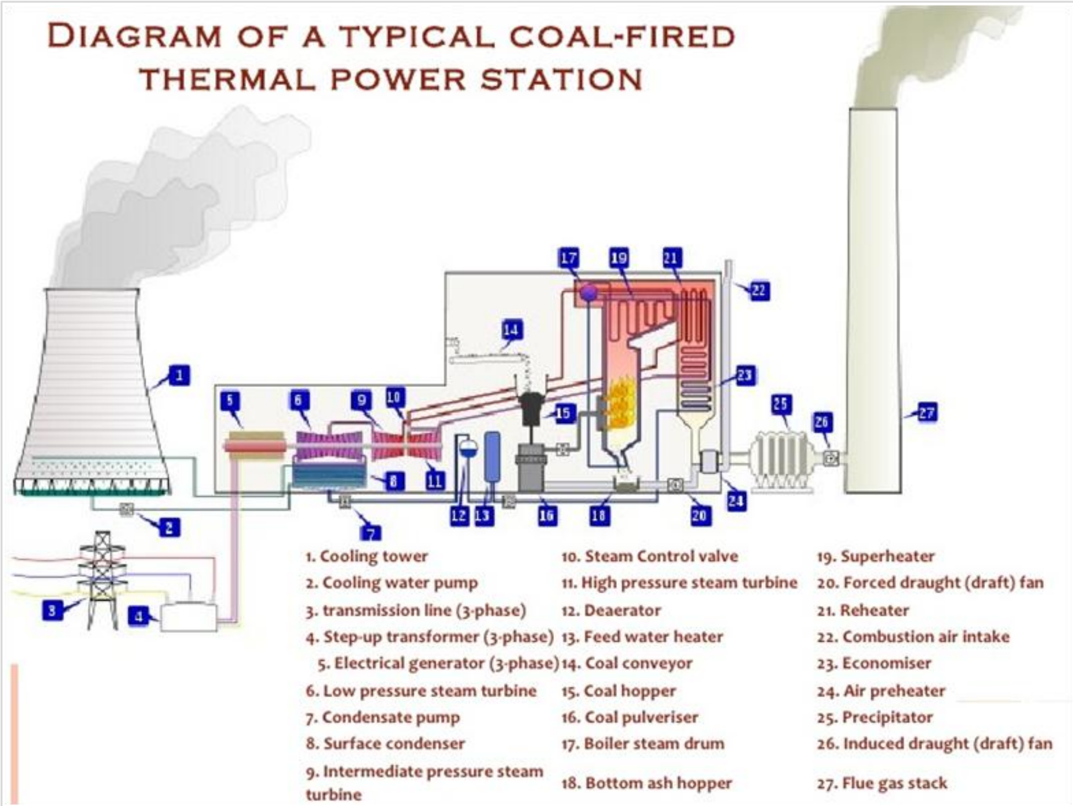


Figure 4.2: Process flow diagram of the coal based thermal power plant

4.3.4 Fuel Oil Burning System/Firing system

Heavy Fuel Oil (HFO) would be used for start-up and low load operation and Light Diesel Oil (LDO) will be used for light up and warm up of unit.

Boiler will be designed in such a way that oil firing for flame stabilization will not be required beyond low load. For coal firing the entire operation of purging, insertion, air and fuel sequencing, removal and blow off shall be automatic.

4.3.5 Soot Blowing System

Soot blowers are designed to clean soot and slag from the heat transfer surfaces of the boiler and air pre-heater. A fully automatic, sequentially controlled, microprocessor based steam soot blowing system, complete with provision for individual or pair operation with facility to bypass any soot blower shall be provided. Steam will be supplied at a constant pressure from the cold reheat system. The system shall have short retractable rotary wall blowers for the furnace and long retractable rotary blowers for the super heater, re-heater and economizer. The number and location of the soot blowers shall be determined by the boiler supplier.

4.3.6 Electrostatic Precipitator (ESP)

An electrostatic precipitator consists of a box with metal plates and hanging electrodes parallel to flow. The electronic components set the power to high voltage and apply between the plates and the electrodes, such that the electrodes charge the particles, then the particles are attracted to the oppositely-charged plates.

A high efficient electrostatic precipitator (ESP) having efficiency to limit outlet particulate emission will be installed. The ESP will collect fly ash and other air borne particulate matters from flue gas. The electrostatic precipitator (ESP) will have a dust collection efficiency of not less than 99.9% while firing coal. The ESP will be provided with gas tight dampers at inlets and outlets so as to allow safe maintenance during operation. The ESP will be provided with programmable wrapper control system and management system to ensure safe and optimum operation of ESP. Periodically, the plates are wrapped with automatic hammer assemblies, which causes the ash to fall into hoppers below the plates.

4.3.7 Flue Gas Desulfurization System

Lime operated Flue Gas Desulfurization (FGD) system will be installed in the flue gas path before Chimney. This system should have the facility to operate as and when required based on Sulfur content in the coal to meet the ground level SO_2 concentration within the standard of MoEF.

4.4 Project Overview

The proposed project is a 2x660MW sub-bituminous coal based thermal power Plant. Each 660 MW Plant will consist of one ultra-supercritical balanced draft pulverized coal fired Boiler with built in Dry Low NOx burners suitable for outdoor installation with a stack of 275-meter-high and a tandem-compound, multi cylinder design condensing type steam turbine directly coupled with hydrogen cooled generator suitable for indoor installation.

The primary fuel will be sub-bituminous coal for continuous operation and liquid fuel (HFO, LDO) for Boiler start-up, flame stabilization and low load operation. A detail discussion on fuel source, quality and requirement is made in article 3.9, under the title "Requirement, Source and Composition of Fuel for Plant operation:

Close cooling cycle with cooling tower has been envisaged for the project. Surface water from the Rabnabad channel shall be used for condenser cooling and all other purpose.

The generated power of the proposed power plant after being stepped up needs to be connected to the plant switch-yard and then to the PGCB's proposed 400 kV GIS substations at in Kalapara Upazila. The power generated will then be evacuated through the national grid of Gopalganj-Dhaka. PGCB has already given a consent letter to RPCL for the power evacuation facilities on June-2019. RPCL will utilize this facility to evacuate their generated electricity from the proposed power plant.

Generated power at 24 KV of the proposed power plant will be stepped up to 400KV and will be connected to the plant switch-yard and then to the national grid through a 400KV transmission line and the proposed Gopalgang sub-station. In this connection, it can be mentioned that for evacuating the generated power of the identical adjacent coal based power plant of RPCL, a 400 KV transmission line and a 400/230KV sub-station at Gopalganj are under construction by PGCB. In this case RPCL may discuss the issue with RPCL to develop a common transmission facility for evacuation of power of both plants. The same facility can also be extended for power evacuation of the other upcoming power plant like "Ashuganj Power Company" and others. This may reduce the project cost and environmental impacts. Otherwise RPCL has to take up the issue with PGCB for construction of transmission line.

The plant will be designed to meet Best Available Control Technology (BACT) emission limits.

4.5 Land requirement and Acquisition

It has been estimated that the proposed 1320 MW Power Plant will require approximately an area of 915.7 acres of land for construction of power plant and its other ancillaries and auxiliaries. This land will be acquired from public under the provision of the Acquisition and Requisition of Immovable Property Ordinance, 1982 (Ordinance II of 1982). RPCL is to submit the land acquisition proposal/ request to the concerned Deputy Commissioner (DC) for further necessary action.

4.6 Stack height

On the basis of DoE regulation (ECR, 1997), a coal based Power Plant of capacity 500MW or above should have a stack of 275 meter high which is also retain in the Draft ECR 2017.

4.7 Ash handling

Ash is the solid wastes resulting from the combustion of coal in the boiler. It will be managed through collecting, conveying and interim storing. Ash is of two types (i) Bottom ash and (ii) Fly ash. The heavier one known as Bottom ash is collected from boiler furnace and the lighter one called Fly ash is collected at ESP ash hoppers and Economizer hoppers. The total handling process will employ pneumatic or mechanical conveyors. A cyclonic separator will separate the bottom ash of each unit in dry form which ash will be collected by ash collection hopper and will be transported by the pneumatic/mechanical ash conveying system to the ash silo. The Fly ash will be separated by electrostatic precipitator (ESP) and transported through the same pneumatic/mechanical conveying system. This dry ash will be collected and transported in dry form to storage silo for utilization in land development, brick manufacturing, clinker industries, cement industries, compaction purposes, etc. In case of non-utilization, this dry ash will be converted to high concentration slurry and will be disposed off to ash disposal pond.

4.8 Cooling system

Water will be required for steam generation, condensers and other equipment cooling, coal and ash management, Boiler makeup and domestic purposes etc. Major part of water is required for condenser cooling. Condenser cooling system of a thermal power plant is either of closed cooling cycle using cooling tower technology or of once through open cooling cycle system.

Feasibility consultant has proposed for close cooling system with water requirement as presented in the table below. Water for cooling tower, Demineralization plant and all other purpose can be withdrawn from the nearby Ramnabad channel. Sufficient screening including drum screens to filter out larger aquatic organisms like fishes, frogs shall be adopted. A schematic water management diagram is presented below in **Figure 4.3**.

Table 4.1 below shows the comparison in requirements between the super critical and ultra super critical power plant.

Table 4.1: Comparison between the super and ultra super critical power plant

Sl. No.	Item Description	Super critical PP	Ultra Super critical PP
1	Cooling water required	1,43,582 m3/h	1,27,270 m3/h
2	Auxiliary cooling water	8,615 m3/h	7,636 m3/h
3	Plant water requirement	5,617 m3/h	5,258 m3/h
4	DM water requirement	41 m3/h	40 m3/h
5	Cooling Tower Makeup	3,147 m3/h	2,795 m3/h

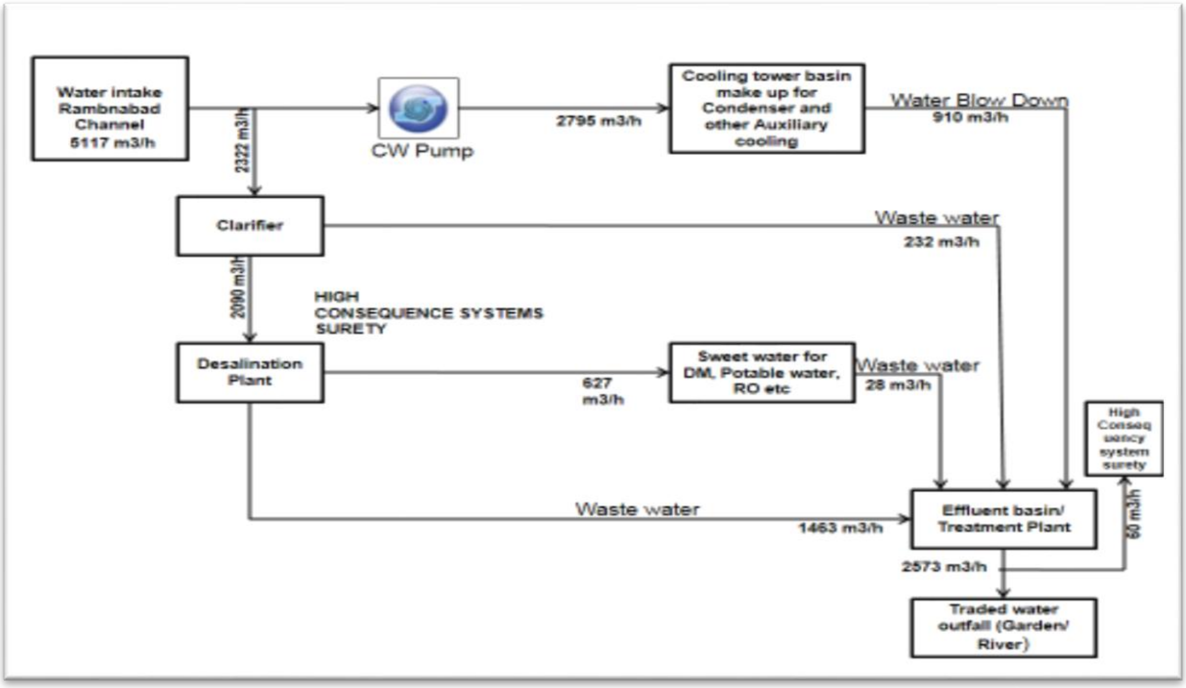


Figure 4.3: Schematic Water Management Diagram

4.9 Waste Management

In a power plant the wastes are of two types. Solid waste and liquid wastes. During construction phase the solid wastes are mainly the construction wastes like concrete pieces, small cut pieces of MS bars/rods, empty cement bags, empty cartons, garbage etc and waste from worker's colony, human wastes, kitchen wastes etc. Human wastes will be managed by constructing sanitary latrines which will be finally demolished and refilled. Construction wastes and kitchen wastes will be disposed off in covered Plastic containers kept at designated place which will be periodically collected by local authority for final disposal. Metal pieces, empty cartons and paper bags will be initially kept at some designated place and finally sold to the re-cycling companies. In short all kind of solid wastes to be generated will be disposed off on site maintaining DoE's standard. The liquid waste generated in the same period is mainly water from bore holes, non- consumptive construction water, and waste water from worker's colony. Construction site waste water will be collected in a pool and will be reused in construction activities. Liquid waste from worker's colony will be drained to a soak pond/ soak pits.

During operation phase ash particle will be the major solid waste to be generated from the power plant. The dry ash is taken to buffer hoppers for its onward transportation in dry form to storage silo. The ash can be used in Brick manufacturing, clinker industries, cement industries, compaction purposes, etc. There will be also scope for ash export.

A blanket of water over the ash pond and water spraying system will prevent dust emission from ash pond, coal storage yard and belt conveyor facilities.

All liquid waste generated from boiler blow down, cooling tower blow down, water from leaks and vents, oily water from turbine floor and transformer areas, waste water from workers' colony and offices etc. will be drained to and treated as per DOE and other international standard in sewage treatment plant and oil water separator. After treatment the liquid will be mostly used as gardening water for green belt and other area.

4.10 Civil Structure and Urban Facilities

A good numbers of civil structures and facilities are to be constructed at site under this project such as Boiler structure with stake of 275 m high, Turbine house with turbine hall and Control room, Electrical control room, work shop and warehouse, Office building, Coal handling, storage and transportation facilities, ash pond, Security fencing, internal roads, Plant Jetty, Coal storage yard, Rest house, staffs quarter, Guard shed, community facilities like School, Mosque, Playground etc, Water treatment plant, Central effluent monitoring basin etc.

4.11 High Voltage Switchyard and power evacuation

Based on the plant's generation capacity, a 400 KV GIS switch yard shall be constructed over 13 acre of land within the project area with required number of circuit breakers, isolators, incoming outgoing feeders etc. Other major components of the switch yard are the two numbers of properly rated unit transformers, Current Transformer (CT), Potential Transformer (PT), Lighting Arrestor (LA), Communication equipment, etc. The generated power of each 660 MW generator will be stepped up to evacuation voltage level through suitably rated Generator Transformer and will be sent to the proposed Gopalganj 400KV/230KV/132KV sub-station through 158 Km long proposed 400KV Patuakhali- Gopalganj transmission line. The proposed sub-station and the proposed transmission line will be constructed by PGCB.

4.12 Central control and Monitoring

A central control room for controlling and monitoring of plant process using SCADA system at operating floor will be installed. The boiler, turbine and generator along with their associated auxiliaries would be controlled and monitored from the common control room. All effluents and pollutants (SOx, NOx, O_2, CO_2, CO) generated from the plant will be monitored using on line electronic monitors and will be controlled by the built in DCS controllers.

4.13 Design and construction

The project shall be designed in accordance with the international standards for pulverized coal based ultra-supercritical steam Power Plant. The design of support facilities and associated works shall be in accordance with appropriate national and international standards. The Plant design will cope with local seismic conditions.

The design life of the Plant will be at least 30 years. Civil works, such as, structures and foundations of Boiler, Turbine hall including central control room, administration building, and other facilities will be designed for a life exceeding 45 years. For proper operation and maintenance of the Plant, about 300 persons excluding contractor laborers will be required.

4.14 Material Balance

Coal is the major operating fuel of this proposed power plant. The coal will be imported from sourced countries like South Africa, Indonesia, and Australia etc. Coal will be reserved to the coal terminal and transferred to the plant site thought closed conveyer system. However, this power plant will add 1320 MW electricity to the national grid and will generate ash and gases as byproducts during operation period. The material balance of this power plant is expressed in Table 4.2.

Table 4.2: Material Balance of the power plant project

Input	Quantity	Output	Quantity
Coal after Pulverization (Average S-0.43 %)	548 ton/hr	Electricity	Gross 2X660MW
		Ash (11.29%)	61.86 kg/hr
Air	O_2 (6%)	CO_2	1,029 kg/MWh
		CO	34.5 gm/s
		SO_2	122.8 gm/s
		NOx	313.1gm/s
		PM_{10}	28.5 gm/s
		$PM_{2.5}$	2.1gm/s

4.15 Pollution Mitigation Measures

4.15.1 Air pollution mitigation

The major air pollutants which are released to atmosphere from a coal based power plant are SOx (SO_2), NOx, Particulate matter (PM), Mercurry, Hg etc.

Burning of low sulfur content coal as fuel, installation of high efficiency Electrostatic Precipitators (ESPs) and Flue gas Desulphurization (FGD) units will reduce these unwanted pollutants up to the standard limit. Moreover, to facilitate wider dispersion of remaining particulates and gaseous pollutants (SPM, SO_2, and NOx) a chimney of 275 m height with online monitoring facilities shall be provided. To control emission of fugitive dust within and around the coal handling Plant and coal stockyard, automatic sprinkler systems shall be installed.

A. Particulate matter abatement measures

Airborne particulate matter (PM) emissions can be minimized by pollution prevention and emission control measures. Measures such as improved process design, operation, maintenance, housekeeping, and other management practices can reduce emissions. By improving combustion efficiency, the amount of products of incomplete combustion (PICs) can be significantly reduced. Proper fuel-firing practices and combustion zone configuration, along with an adequate amount of excess air, can achieve lower PICs. Atmospheric particulate emissions can be reduced by choosing cleaner fuels. Natural gas used as fuel emits negligible amounts of particulate matter. Oil-based processes also emit significantly fewer particulates than coal-fired combustion process. Lighter distillate oil–based combustion results in lower levels of particulate emissions than heavier residual oils.

A variety of particulate removal technologies, with different physical and economic characteristics, are available. For effective PM control in industrial application, the use of ESPs or bag houses is recommended.

Electrostatic precipitators (ESPs) remove particles by using an electrostatic field to attract the particles onto the electrodes. ESPs are especially efficient in collecting fine particulates and can also capture trace emissions of some toxic metals with an efficiency of 99.9%.

Filters and dust collectors (bag houses) collect dust by passing flue gases through a fabric that acts as a filter. The most commonly used is the bag filter, or bag house. Accumulated particles are removed by mechanical shaking, reversal of the gas flow, or a stream of high-pressure air. Fabric filters are efficient (99.92% removal) for both high and low concentrations of particles.

Wet scrubbers rely on a liquid spray to remove dust particles from a gas stream. They are primarily used to remove gaseous emissions. Wet-scrubbing technology is used where the contaminant cannot be removed easily in a dry form, soluble gases and wet able particles are present.

B. SO2 emissio abatement measures

Sulphur dioxide (SO2) is one of the highly reactive gases .SO2 is linked with a number of adverse effects on the respiratory system and other environmental issues. It is an important industrial emission gas which causes several difficulties in the environment like acid rain. Several approaches have been adopted to reduce SO2 content in the environment. One of the most difficult environmental problems is how to control SO2 emissions economically and efficiently.

Limestone/gypsum system: Globally the most commonly used flue gas desulphurization system is based on limestone/gypsum system. It involves mixing of crushed limestone/lime with water to form a slurry and spraying it into the sulphur containing flue gases. The sorbent reacts with SO2 and forms an aqueous slurry of calcium sulphite. About 90% SO2 removal can be achieved. Limestone-gypsum wet flue gas desulphurization method is most widely accepted due to its efficiency and reliability.

C. NOx emission abatement measures

I. Combustion Control

Combustion control methods are applied to reduce the formation of NOx. The combustion control processes that reduce the formation of NOx are reduced oxygen concentration, reduced combustion temperature, and reduced reaction time at oxygen rich, high-temperature conditions. The principal NOx reduction combustion control methods for new equipment and retrofit applications include low-NOx burners, air staging, fuel staging, and operational and design modifications.

II. Low-NOx Burners:

Low-NOx burners are available for new and retrofit applications on boilers and combustion turbines burning nearly any fuel. Low-NOx burner systems on PC boilers are readily divided into wall-fired and corner-fired systems.

The basic NOx reduction principles for wall-mounted burners are to control and balance the fuel and air flow to each burner, and to control the amount and position of secondary air in the burner zone so that fuel devolatilization and high-temperature zones are not oxygen rich.

Corner-fired low NOx burner systems further divide into two types. The Low NOx Concentric Firing system (LNCFS) is principally used on retrofit situations, while the Pollution Minimum (PM) System is typically used on new construction. In field retrofit demonstrations, LNCFSR has been shown to provide a proximately 20% to 50% NOx reduction compared to conventional tangential firing systems.

III. Air Staging:

Air staging external to the burner consists of OFA ports. OFA may or may not be used in conjunction with low-NOx burners, depending on the fuel and the NOx emission requirement. The typical effect of OFA addition to a new or retrofit low-NOx burner system is a further 10% to 20% reduction of NOx emissions. However, unburned carbon and combustible materials may increase as a result of the addition of OFA.

IV. Fuel Staging.

Staging fuel introduction into the furnace is a method to control NOx formation. Reburning technology is the most common form of fuel staging. The reburn process employs three separate

combustion zones to reduce NOx emission, viz. i) Main Combustion Zone (with 70 to 80% heat input), ii) Reburn Zone (with 20 to 30% heat input) and iii) Over-fire Air Port (Burnout) Zone. The first zone burners are operated with 10% excess air. A second combustion zone (the reburn zone) is created above the lower furnace by operating a row of conventional burners at a stochiometric ratio much less than 1.0. The reburn zone stochiometric ratio (mixing of reburn fuel and lower furnace combustion products) is between 0.8 to 0.95. This reducing environment causes reduction of NO (produced in the lower zone) to molecular Nitrogen and Oxygen, because more active carbon monoxide molecules produced from incomplete combustion in this reburn zone strips off the oxygen to form carbon dioxide. Fuel burnout is competed in the burnout zone by sufficient OFA introduction with an overall excess air for the boiler of 15% to 20%.

Reburn technology has demonstrated NOx removal efficiencies of 40% to 65%. However, successful retrofit of this technology requires space within boiler to allow adequate residence time for both the additional burning zone and the associated OFA burnout zone. Hence, this technology adoption does require a closer consultation with Boiler OEM on retrofit feasibility of this technology for existing boilers.

V. Operational Modifications:

Operational modifications have been implemented on existing boilers to achieve NOx reductions of 5% to 15%. Operational modifications typically have been applied in situations where only marginal NOx reductions are required. Operational modifications are attractive because capital investment is either minimal or not required, although operating costs may increase. Operational modifications include flue gas recirculation, reduced air preheat, water injection, reduced excess air, biased firing, burners out of service, and fuel switching or dual fuel firing.

VI. Post-combustion Control—Selective Catalytic Reduction Systems

Selective catalytic reduction (SCR) is a post-combustion NOx emission reduction system. In SCR systems, vaporized ammonia injected into the flue gas stream acts as a reducing agent in the presence of a catalyst, achieving NOx emission reductions as high as 95%. The NOx and ammonia (NH3) reagent react to form nitrogen and water. The reaction mechanisms are very efficient, and with very low ammonia slip (un-reacted ammonia emissions).

Design ammonia slip values range from 2 to 10 ppm. With adequate design, SCR systems can be installed on new plants or retrofitted onto PC, CFB, or combustion turbine units fueled by coal, oil, or natural gas with very little effect on balance-of-plant equipment or unit availability. The following describes the basic process reactions, alternative SCR systems available, system configuration, catalyst considerations, and developmental status of SCR systems.

Retrofit of either low- or high-dust SCR systems requires adequate space proximate to the boiler area.

VII. Post-combustion Control—Selective Non-catalytic Reduction Systems

Selective non-catalytic reduction is another commercially available technology to control NOx emissions from fossil fueled boilers. SNCR systems rely on an appropriate reagent injection temperature, good reagent-gas mixing, and adequate reaction time rather than a catalyst to achieve NOx reductions. SNCR systems can use either ammonia or urea as reagents. Ammonia or urea is injected into areas of the steam generator where the flue gas temperature ranges from 1,500 to 2,200°F (~815 to 1095°C). SNCR systems are capable of achieving NOx reduction efficiencies as high as 70% to 80% in optimum situations (adequate reaction time, temperature, and reagent-flue gas mixing) with ammonia slips of 10 to 50 ppm.

SNCR systems reduce NOx emissions based on a thermally based exothermic reaction between reagent and NOx.

D. <u>Mercury emission abatement measures</u>

Coal contain heavy metals as trace elements (less than 100 micrograms per gram). Most of these elements will be retained in the bottom Ash except mercury. During combustion, the mercury (Hg) in coal is volatilized and converted to elemental mercury (Hg_0) vapor in the high temperature regions of coal-fired boilers. In general, the majority of gaseous mercury in bituminous coal-fired boilers is Hg^{2+}. On the other hand, the majority of gaseous mercury in subbituminous- and lignite-fired boilers is Hg_0 .As the flue gas is cooled, a series of complex reactions begin to convert Hg_0 to ionic mercury (Hg^{2+}) compounds and/or Hg compounds (Hg_p) that are in a solid-phase.

Control of mercury emissions from coal-fired boilers is currently achieved via existing controls uint which are used to remove particulate matter (PM), sulfur dioxide (SO_2), and nitrogen oxides (NO_x). This includes capture of Hg_p in PM control equipment and soluble Hg^{2+} compounds in wet flue gas desulfurization (FGD) systems. Available data also reflect that use of selective catalytic reduction (SCR) NO_x control enhances oxidation of Hg_0 in flue gas and results in increased mercury removal in wet FGD.

4.15.2 Water pollution mitigation measures

A. <u>Thermal pollution control process</u>

In a thermal power plant thermal plume (impact due to high temperature) can be caused from two sources like heat from flue gas and heat from discharge of hot water. The proposed power plant is a combined cycle power plant. Its flue gas temperature at the emission point of chimney will be about 110-115^0 C at full load. A closed cooling system with cooling towers using surface water has been envisage for the project. So there is no scope of any hot "Cooling water" discharge to the River. The capacity of both the cooling tower. The cooling water blow down will be rejected to the saline water guard pond where the continuous monitoring devices will be installed. Before, discharge the blow down water into the river the prime parameter like Temperature, pH, EC, TDS will be monitored as per ECR, 1997 and IFC 2008 standard.

B. Effluent Treatment Process

The effluent from the water treatment plant and other systems, like the clarifier will be collected in the neutralizing tank and the sludge gradually will settle at the bottom of the tank. After a couple of years, the sludge will be collected and buried in the waste disposal pit. Effluent Treatment Plant/system (over 5 acre in the project area) will be provided to maintain the standards of Industrial Waste as mentioned in the ECR, 1997. As per the feasibility report, around 34 m^3 quantity of liquid waste will treated per hour from this power plant. The treated water will maintain the ECR, 1997 and IFC 2008 for thermal power plant. After treatment from the guard pond / effluent treatment plant, the treated water will be used for gardening or dust suppression system.

C. Sewerage Treatment Process

The generated sludge will be treated and discharged into the underground pit with concrete revetment or encircled with durable polythene sheet. For monitoring the effluent quality, a continuous monitoring system has been considered in the design. A typical capacity of the STP will be 2x8m^3/hr. The following measures are included in the project design

- EPC Contractor will provide septic tank for a building or cluster of buildings or connect to proposed septic tank depending upon the layout to be decided during detailed engineering for the buildings. The maximum size of septic tank will be as per local need.
- The sludge removal from the septic tanks is expected to be done once a year or as per the requirement of local laws and regulations by the Project Proponent.

4.15.3 Noise Control

All rotating machineries are the major noise generating source like, turbo-generators, compressors, pumps, fans, coal handling Plant and other rotating equipment from where noise is continuously generated. Modern low noise producing equipment with silencer will be selected to keep the noise level below 90 dB (A) within one meter distance. Moreover, all noise producing machineries will be under noise proof hoods and the workers will be provided with personal protective equipment (PPE) like ear plug, ear muffler etc. to use at work site. The buffer area around the Plant, development of green belt, boundary wall etc. around the project shall dampen the noise level so that nearby community do not feel any noise.

4.15.4 Intent of Water Reuse

The entire water consumption and management system shall be designed with provision of water re-use facilities. A Close cycle with cooling tower with surface water is planned for condenser and other auxiliary equipment cooling and FGD operation of the Plant and reverse osmosis plant with demineralization Plant is proposed for, power cycle and other makeup, ash disposal and handling system.

4.15.5 Afforestation and Greenbelt Development

At the end of the construction a large scale green belt development has been planned over 306 acre all around the main Plant area and within the colony except the switch yard side. The treated effluent will be used for watering the green belt.

4.16 Operation and Monitoring Program

A daily monitoring of pollutants in different environmental disciplines like air, stack emission, waste water, etc. shall be conducted and the data shall be recorded in a proper resister and the same should be submitted to DoE on quarterly or monthly basis. The proponent shall finalize the monitoring locations in consultation with the monitoring consultant and DoE if required. Power Station management shall have all necessary equipment and manpower for ensuring effective monitoring. The management shall submit a quarterly and yearly monitoring reports to the DoE for renewing the Environmental Clearance Certificate. Some monitoring instruments of the gas emissions and particulate matter dispersion etc. are mentioned below.

Electronic Transmitter from internationally famous manufacturer like SIEMENS, GE, ABB, Durag etc. can be installed for on line continuous measuring and recording of CO, CO_2, SO_2, NO_2, pH, Conductivity meter, Turbid meter etc.

5. Suitability Assessment

5.1 Introduction

Alternative evaluation is the process of comparing and contrasting different solutions in order to select the optimal alternative which is important for maximizing the output and profit, minimizing the environmental and social consequences and assuring the project security. Therefore, high investment based industrial development projects should consider a number of alternatives on the basis of technical suitability, financial viability and environmental friendly for making the investment a sustainable one with sustainable return.

IFC 2012 guidelines of WB state that “The environmental assessment process may recommend alternative (higher or lower) levels or measures, which, if acceptable to IFC, become Project- or site-specific requirements.” In pursuance of that, the alternative scenarios have been contemplated to review the status of the concepts for the proposed project.

5.2 The “No Action” Alternative

This indicates that the proposed Project will not be executed. The ‘no action’ alternative is required to ensure the consideration of the original environment without any development. This negates the need to meet the electricity demand in future of Bangladesh. The Power System Master Plan (PSMP, 2016) forecast the daily load curve in future as shown in **Figure 5.1**.

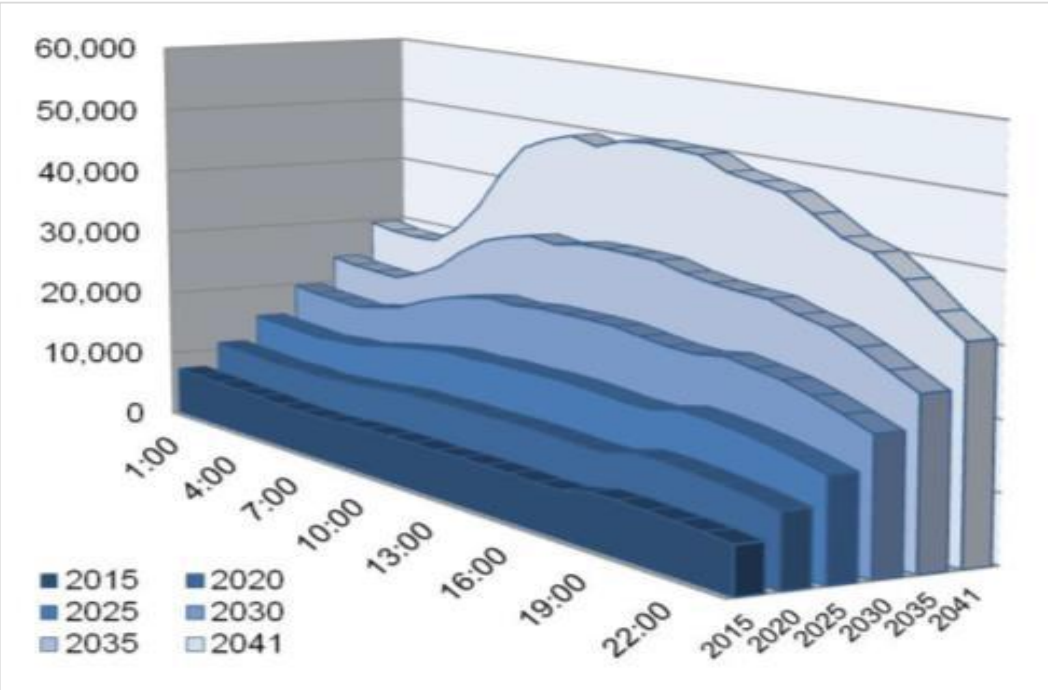


Figure 5.1: Daily Load Curve 2015-2016 (PSMP 2016)

This demand has been forecasted depending on the GDP growth rate of the country between 6%-7%. In order to meet up this demand, electricity will have to be produced in the public sectors, private sectors and imported from neighboring countries respectively including considering the possible impact of demand-side management (DSM) programs. DSM programs involve use of energy-saving equipment and machinery, holiday staggering programs in the industrial segment, and avoiding wastage of electricity.

The peak demand (9,268 MW for 2014) of electricity could not be fulfilled as the highest capacity has been recorded as 7418 MW in FY 2013-2014. The installed generation capacity (December' 2015: http://www.bpdb.gov.bd/bpdb/) has increased to **12,071 MW**. Moreover, the demand of electricity is not equal throughout the country. For power system development analysis, Bangladesh is divided into five geographical regions: the Central, Northern, Southern, Western and greater Dhaka regions where the load distribution factor for a region is it’s percentage of total national demand. **Table 5.1**presents estimated electricity demand for each area for the Base Case of the Power Sector Master Plan 2006.

Table 5.1: Load center demand for electricity by region

Regional Peak Load Year	Central (MW)	Northern (MW)	Southern (MW)	Western (MW)	Dhaka (MW)
2005	369	519	880	516	2,024
2006	402	566	958	562	2,204
2007	438	616	1,044	612	2,401
2008	478	671	1,137	667	2,616
2009	520	731	1,239	726	2,849
2010	567	797	1,349	791	3,104
2011	613	862	1,460	856	3,357
2012	663	932	1,579	926	3,632
2013	717	1,009	1,708	1,001	3,929
2014	776	1,091	1,847	1,083	4,250
2015	839	1,180	1,998	1,172	4,597
2016	902	1,268	2,147	1,259	4,938
2017	968	1,362	2,306	1,352	5,304
2018	1,040	1,462	2,477	1,452	5,697
2019	1,117	1,571	2,660	1,560	6,119
2020	1,200	1,687	2,857	1,675	6,573

Source: Power System Master Plan 2006

The proposed coal based power plant by *RPCL* is located in the Southern region of the country which is conceptualized as one of the emerging electricity demanding area of the country in near future. The plant will play a crucial role in supplementing the future power demand of this part of the country. Moreover, development of transmission facilities from the Kala Para, Patuakhali to Barisal – Gopalganj 400 KV national grid line will highly strengthen the decision of constructing the project.

It will facilitate the local and regional development by supplying electricity. It will coherence with the national goal through assisting electricity to residence of southern zone, increasing job opportunity, enhancing industrial and port facilities, sustaining irrigation system etc. However, the facilities of this added amount of electricity would not be acquired if the “No Action” alternative is chosen.

5.3 Site Alternative

Lots of factor comes into play during selecting a proper site for a Thermal Power Plant Project. A suitable position highly depends on the technically feasible, socially acceptable and environmentally friendly. However, an optimum criterion has been set to figure out the best location among the alternate sites proposed by the proponent.The following key factors were considered and evaluated before proposing the potential area at those given locations:

- Availability of land for the ultimate capacity
- Connectivity to coal sources for the ultimate capacity
- Coal Transportation Logistics and constraints thereof
- Power evacuation facilities and its proximity
- Accessibility by Road and Waterways
- Availability of Water for the ultimate capacity
- Availability of material, power and water for construction purposes
- Environmental and Social scenarios and sensitivities
- Existence of forest or prime agricultural land
- Distance from the outer peripheries of major rehabilitation and cities
- Distance from the flood plain of the riverine system
- Distance from national park, wildlife sanctuaries, ecological sensitive area, tropical forest etc.
- Distance from place of archaeological, historical, religious or tourist importance
- Proximity to the approach funnel of the runway of the nearest airport

This EIA study has emphasized on the comprehensive comparison of all major potential impacts associated with social and environmental issues for selecting the site of the power plant. The proposed Power Plant will consume huge quantities of coal depending on the load factor of the Plant and coal quality including large quantities of fuel. By product from the plant will be needed to store for reasonable period and generated power to be transmitted from project site. In addition to that, a number of machineries, systems, greenbelt, townships and roads will occupy the project area. Boiler and Transformer yard, switchyard, transmission bay, coal stockyard, FGD and ESP system, ETP and WTP, ash silo and ash dyke, townships, green belts are the necessary components which have to be considered during the project site area allocation. Moreover, a number of miscellaneous station facilities like compressor house, fire station, laboratories, auxiliary boiler building, workshops, security officer's room, canteen etc. must be included commonly in the Power Plant complex. However, efficient use of land will ensure to reduce the land requirement for the proposed Project site. The Project client has selected four sites for the proposed Power Project **Map 5.1** shows the potential sites for selecting the proposed power plant.

Site- 1: In Banskhali Upazila, District - Chittagong

Site- 2: In Magnama, Upazila –Pekua, District – Cox's Bazar

Site- 3: In Upazila Zajira, District - Shariatpur

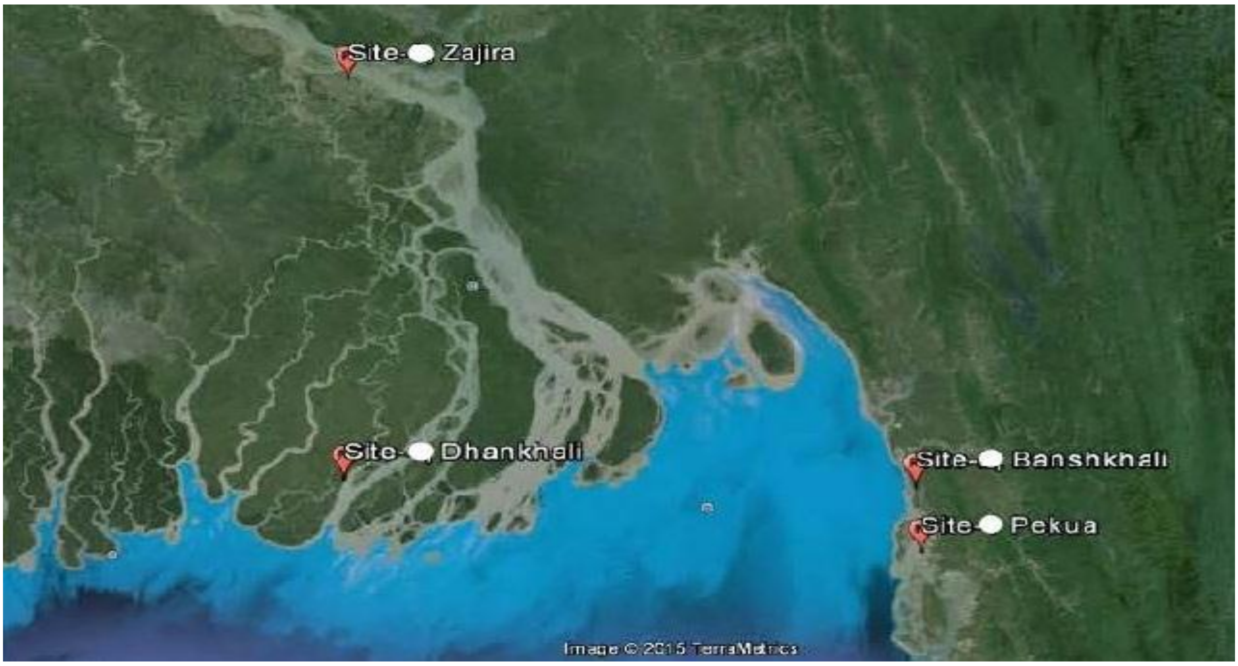
Site- 4: In Kalapara Upazila, District - Patuakhali

A number of social and environmental criterions have been considered based on the DoE and World Bank accepted guideline to examine the alternative sites for the proposed Power Plant. During the process of evaluation for each site, the different criteria considered and their respective indicators are given in the **Table 5.2.**

Table 5.2: Selected indicators and criteria for alternative site analysis

Factors	Indicators
Administrative Location and Relative GPS Position	Mouza, Union, Upozilla and District,North and East Coordinates
Land status	Availability, Elevation, Availability & Use of Khas land
Land Classification	Cropped area, Fisheries and Salt Production area
Settlement Area	Number households to be rehabilitated, Population density of the union
Accessibility & Logistics	Waterways, Roadways, Railways, Average Draft in waterways
Vulnerability to Natural Hazards	Flood, Cyclone and Storm surge
Water Resources	Draw down ratio of Water, Possibility of Once through Cooling System
Air pollution Coverage	Local and Regional Air-shed covering
Environmental Sensitivity & Ecosystem	Sensitive Ecosystem, Tourism Places, Archeological & Cultural Heritage Sites
Ethnic community or Minority Groups etc.	Presence of Ethnic Communities

To select the best place for generating such a high quantity of electricity form from coal, a separate study was conducted which is appended in **Appendix- III.** A number of social and environmental indicators are justified and checked for each of the places and finally one place has been selected for this power plant.



Map 5.1: Potential sites for the proposed power project

From the above comparative study, site – 4, i.e. Kala Para Upazila has been selected for the proposed Power plant depending on lower settlement area, stable soil and transportation and evacuation facilities, availability of land, presences of sensitive receptors etc. 915.7 acres of land will be acquired for the entire Power Plant where the plant area will be 890.7 acres. The remaining 25 acres will be acquired for development of resettlement villages for the resettles. However, the Project will consume maximum 0.7 acre of land to produce 1MW electricity. In

India, about 1.0 acre/MW land is required to produce electricity from imported coal in the coastal areas with inclusion of cooling tower and MGR whereas only 0.4 acre/MW is required without cooling tower and MGR (MOP 2007). Therefore, the land that has planned to be acquired (915.7 acres) for the proposed project is found rational based on the calculation from secondary sources shown above.

5.4 Fuel Alternatives

At present, Bangladesh highly depends on natural gas for energy production whereas the PSMP 2010 certainly suggested for reducing the dependency on gas. Under the given scenario of gradual price hike of LNG in the Asian market and no significant discovery of new natural gas reserve; coal is likely to dominate the fuel-mix of power generation of Bangladesh. The draft coal policy of Bangladesh states that coal will be used for power generation instead of gas which is an alternative fuel to maintain national energy stability. Three alternatives are considered from the view point of environmental and socio-economic consideration and with respect to different fuel use namely, gas, oil and coal. Comparative analysis of the proposed alternatives is presented in **Table 5.3**.

Table 5.3: Comparative statement of fuel use for power generation

Sl. No.	Subject	Coal	Gas	Oil
1	Reserve in world respect	H	L	L
2	Global Electricity Generation	H	M	L
3	Supply chain	H	M	M
4	Fuel Price in international market	L	M	H
5	Air Pollution in air shed	M	L	M
6	Noise Pollution	L	M	H
7	Water Use	H	L	M
8	Impact on aquatic life	M	L	L
9	Impact on terrestrial bio-diversity	M	L	M
10	Investment for power generation	H	M	M
11	Pollution abatement measures	H	L	M

Note: L-Low, M-Moderate, H-High

From the above comparative statement, it can be concluded that coal, as a fuel has relatively higher environmental impacts than gas. Again, the availability of coal is significantly higher whereas the price is considerably lower than gas. Moreover, at present the best available technologies i.e. state of art stand highly effective to control the pollution produced by coal fired power plant.

5.5 Alternative Technologies

Based on pressure and temperature of operating fluid (Steam), coal based power Pants are classified as Subcritical, Super Critical (SC), Current Ultra Super Critical (USC) technologies and Advanced Ultra Supercritical Technologies (A-USC) available in the world for producing electricity from coal. A-USC is in developing stages of the developed world particularly in USA. However, the boiler technology will be selected for the proposed RPCL coal based power plant on the basis of improved efficiency and reduced rate of emission of CO_2 and other pollutant gases from per MW electricity generation.

a) Selection of Boiler Type

The technologies are changing over the years. The efficiency of the boiler is improving and which ultimately reducing the cost of electricity production. A detail comparison has been conducted by Electric Power Research Institute (EPRI) in 2011 (**Table-5.4**). For constant electricity production, the coal consumption decreases by over 15% between the sub-critical to A-USC. In the same away, the rate of CO_2 will be reduced on a kg/MWh basis. It should also be noted that the amount of flue gas to be processed by the air quality control equipment also decreases as the thermal efficiency increases. However, this allows for capital cost savings in the emission control equipment.

Table 5.4: Comparisons among the Key Performance of different boilers

Indicators	Sub-critical	Supercritical	Current USC	A-USC
Thermal efficiency, %(HHV)	36.2	38.5	39.2	42.7
Net heat rate, Btu/kWh (HHV)	9,430	8,860	8,700	7,990
Net heat rate, kCal/kWh (HHV)	2376.3	2232.7	2192.4	2013.4
Coal feed rate, kg/hr	384,000	361,000	355,000	326,000
Flue gas mass flow, kg/hr	3,420,000	3,151,000	3,098,000	2,827,000
Volume at boiler outlet, actual m3/min	66,700	61,400	60,400	55,100
NOX and SO2, kg/MWh	0.127	0.121	0.118	0.109
PM10, kg//MWh	0.0422	0.0399	0.0395	0.0363
PM2.5, kg/MWh	0.0535	0.0508	0.0499	0.0458
CO2, kg/MWh	900	851	836	763
Capital cost, $/kW	1780	1800	1840	1990
Coal cost, $/GJ (Constant)	1.71	1.71	1.71	1.71
Cost of Electricity	Assume Without any penalty for CO2 emission			
Capital, $/MWh	28.9	29.3	29.9	32.3
O&M, $/MWh	8.1	8.1	8.2	8.6
Fuel, $/MWh	17.0	15.9	15.7	14.4
Total, $/MWh	54.0	53.3	53.7	55.3
Dispatch cost, $/MWh*	18.6	17.4	17.1	15.7

*Note: *Fuel cost plus variable O&M Source: Philips J. N. & Wheldon, 2011, EPRI*

After the comparison, Ultra Super Critical power plants is being suggested to adopt for the project in order to meet up other design criteria, geotechnical supports and other facilities. It is also operated at a higher pressure and temperature than the critical point of water. However, it is more efficient than the Super Critical option. The efficiency of this technological option is considered to be 42.7%. Though the unit construction cost and operation and maintenance cost of this option 1495 USD/kW are slightly higher than the super critical option, the fuel cost for generation is 4.82 USC/kWh, which is 0.19 USC/kWh lower than the previous option. The emission rate of CO_2 (743 g/kWh) is also considerably lower in this option. However, after detail feasibility and EIA study, this key boiler technologies will be finalized which will be cost-effective as well as environmentally sustainable.

b) Selection of Cooling System

Water will be required for steam generation, condensers and other equipment cooling, coal and ash management, Boiler makeup and domestic purposes etc. Major part of water is required for condenser cooling. Condenser cooling system of a thermal power plant is either of closed cycle cooling technology or once through cooling system. In case of once-through cooling – Water is withdrawn directly from the river and then diverted through condenser tubes to absorbs heat from the turbine exhaust and eventually discharged back to the river at an elevated temperatures. The construction, operation and maintenance cost of once through cooling system is low. However, it is not environment friendly due to the direct discharge of thermal plume into the riverine ecosystem.

On the other hand, closed cycle cooling system with cooling tower, the hot Cooling water from the condenser end is pumped to cooling tower where the cooling water dissipates heat through evaporation and convection. Water from the tower basin is re-circulated through the condensers tubes continuously to dissipate heat. Compared to once-through cooling systems, re-circulating cooling system drastically reduces water withdrawal from water body. The system is more environment friendly, but its construction, operation and maintenance cost is higher than the other systems.

In this project once-through cooling system is not recommendable due to high sediments present in the neighboring water body (Table 5.5). These sediments will get stuck and finally will damage the condenser tubes. It has therefore been proposed to have two raw water reservoirs from where cleaner water will be taken to the cooling system.

Table 5.5: Comparative Analysis of Alternative Cooling System

Sl. No	Issue	Open Cycle	Closed Cycle
01	Water Requirement	High	Minimum
02	Discharge of Heated water	High	Minimum
03	Intake velocity at strainer	High	Low
04	Discharge Velocity	High	Low
05	Environmental Protection	Low	High
06	Capital and Operation Cost	High	Low

Considering the above-mentioned advantages Closed cooling system with natural draft cooling tower has been envisaged for the project.

6. Description of Baseline Environment

6.1 Introduction

Baseline situation study refers the proper documentation before implementation of any project. Records of environmental and social existing situation greatly support the EIA study. This chapter represents the existing situation of environment and social context before implementation of the 2x660 MW coal based thermal power projects at Kalapara in Patuakhali District. In broad sense environmental and social condition for baseline study comprises outlining the physical environment (e.g. including meteorological, hydrological, geological components and processes), biological environment (e.g. including flora, fauna, and ecosystems), land use pattern, agricultural practices, cultural activities, socio-economic status, livelihoods and hazard of the study area. Primary and secondary data have been used to document the baseline condition of this study.

6.2 Physical Environment

This chapter on environmental and social baseline has been prepared using both primary and secondary data collected for the proposed Project site and defined study area. The baseline condition has been defined in respect of physical environment (e.g., including meteorological, hydrological, geological components and processes), biological environment (e.g., including flora, fauna, and ecosystems), land use pattern, agriculture practices, cultural activities, economic status, and hazards of the study area.

6.2.1 Land cover and Land use

The total study area has been considered as 10 km radius from the stack point. Land use of the study area has been identified using satellite image and classified as agriculture land, sand bar/char land, forest, industrial area, road, settlement with homestead vegetation, power plant, and urban built-up area and water bodies. The maps are shown in the relavent sections of this baseline study.

6.2.2 Description of Satellite Image

Basic information

RapidEye satellite image was used for the land use mapping. Images that have been used in land use classification were acquired on 22 February 2015 and 21 March 2015. Spatial resolution and color composition of the images are presented as follows in **Table 6.1a**.

Table 6.1a: Details of satellite images used for land use mapping

Area	Spatial Resolution	Spectral Resolution	Acquisition Dates
Kala Para Power Plant Study Area	5 meter	5 Bands (B, G, R, RE and NIR)	22 February 2015 and 32 March, 2015

The spectral bands of RapidEye Satellite images has a multi-spectral color composition for various wave lengths. The following **Table 6.1b** shows the band names of the respective wavelengths.

Table 6.1b: Spectral bands and wavelengths

Band ID	Band Name	Wave length (nm)
1	Blue (B)	440-510
2	Green (G)	520-590
3	Red (R)	630-685
4	Red Edge (RE)	690-730
5	Near Infra-Red (NIR)	760-850

The above basic elements are required for analyzing the satellite images and obtaining the land uses for EIA.

6.2.3 Process of Analysis

Land use analysis was carried out using ERADAS IMAGINE and ArcGIS 10.1 software. A multi-step task has been followed in analyzing the images. A series of tasks were followed for analyzing after receiving the images from image provider, each of the images was processed using ERADAS IMAGINE software. Geo-referencing was done to make corrections of geometric distortions. CEGIS has a national archive of Ground Control Point (GCP) coordinates, which were collected by Differential Global Positioning System (DGPS) survey. These GCPs were used as reference coordinates for rectifying the images.

On screen digitization techniques were used to extract required land use and land cover data from the satellite images. Using this technique, major classes such as agriculture land, sand bar/char land, forestland, water bodies (baor, beel, rivers, canal, pond, ditch), rural settlement with homestead vegetation, urban built-up area, industrial area, road etc. were derived from the images.

Settlement with homestead vegetation

Settlement area contains homesteads, house structures and yards and sometimes attached small farmlands surrounded by different types of homestead vegetations.

Agricultural Land

Agricultural land is flat/plain lands comprising of many continuous plots, which may have crop or fallow. They were identified by their finer texture and specific shape (mostly rectangular form) from the satellite images.

The seasonal *Boro* rice area were prepared from latest available Landsat 5 and Landsat 8 satellite images and the monsoon seasonal *Aman* rice area were prepared from available Radarsat satellite images. Available published statistical data of seasonal *Boro* and *Aman* rice area were compared with the seasonal *Boro* and *Aman* rice area derived from the satellite images in order to be confident about the accuracy of the output.

Road

Road class includes all types of metal and non-metal roads of the study area those are visible in the satellite images. This class was identified from satellite images by its linear nature and connectivity with one another, sometimes exposed and in some places covered with trees. However, assistance from existing available road network was also used during identification, interpretation and digitization of the roads from satellite images.

Brick field

This class was interpreted from images by using bright tone, regular shape pattern of piles of bricks, at least one vertical chimney and its shadow.

Sand Bar/Char Land

This class includes dry sands near or besides rivers. It was identified in the false colour composite of the images by bright white to light cyan colour, finer texture, without vegetation.

Urban built-up area

An urban area is characterized by higher population density and vast human features in comparison to the areas surrounding it. Urban areas may be cities, towns or conurbations, but the term is not commonly extended to rural settlements such as villages and hamlets. Urban areas are created and further developed by the process of urbanization.

River & Canal

River is considered as a land use section if the actual riverbed is linear and wide, naturally flowing water bodies and never without water during any period of the year. Branches of the rivers are considered as canal.

This class includes rivers, canals and other linear water bodies those are visible in the satellite images.

Pond and ditch

Ponds are artificial storage of water. Basically ponds have rectangular or square shape. Ditches are the water bodies like ponds that are situated beside the river side or road side. They do not have any regular shape like pond.

6.2.4 Physiography

Physiographical the Kalapara coal fired thermal power plant project area is within the Ganges Tidal Flood Plain Physiographic unit of Bangladesh (**Map 6.1**).The boundary between this unit and the Ganges river floodplain is traditional. Soils in the area have some localized variation, areally but consist primarily of fine sands, silts, silty sands, sand silts and clayey silts. To the south, it is very close to the Bay of Bengal. The ground elevation of the area compared to sea level is very low; about two (02) meters only.

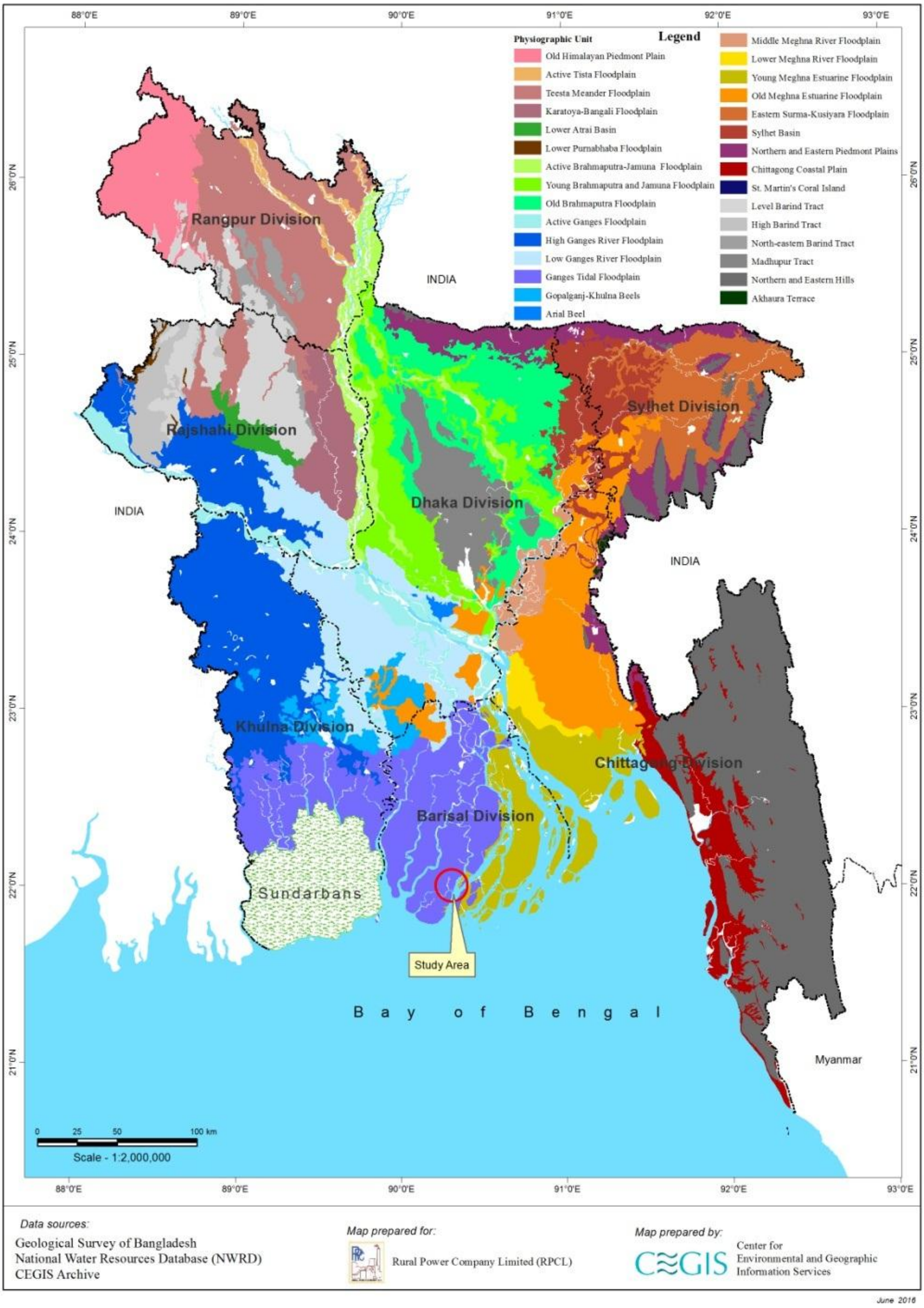
6.2.5 Topography

The proposed RPCL 1320 MW kalapara power plant project is located near the Kuakata coastal area where the land is gently sloped towards the sea. This site is about 30 km northward from the Kuakata coast, around 7 km eastward distance from the Patuakhali – Kuakata highway and near to the Rabnabad Channel. From digital elevation model (DEM) analysis it is found that the study area of the proposed power plant has an elevation of 1 m ~ 2 m above MSL and the project area is located over a land which is only 1 m ~ 1 m above the MSL (**Map 6.2).**In some places inside the project boundary, the elevation level of the land is found less than 1m from the MSL. The proposed project area is occupied by crop cultivable land and fish culture in the lower khal areas.

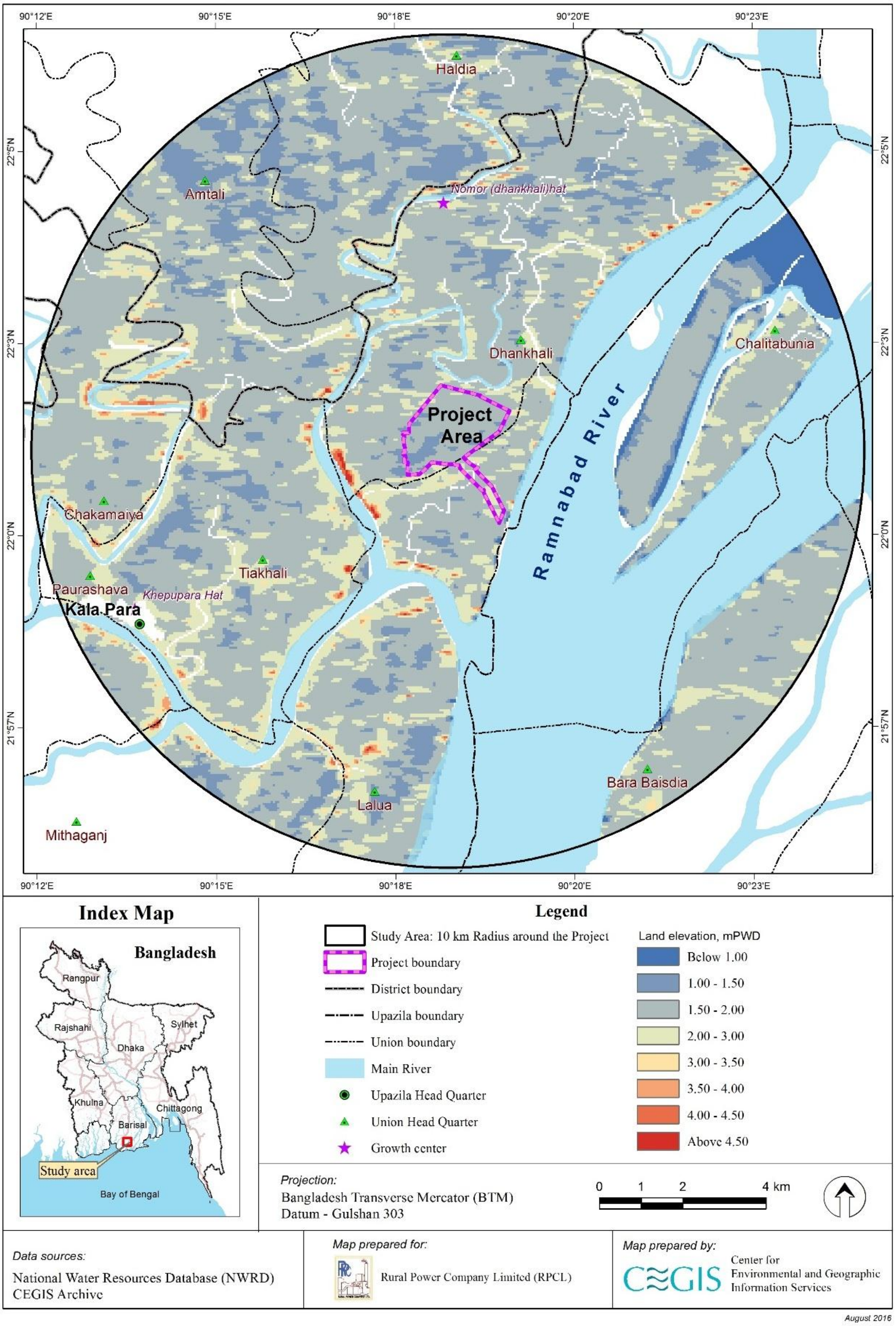
6.2.6 Tectonic Setting

Bangladesh consists of six tectonic (**Map 6.3**) elements. These are as follows:

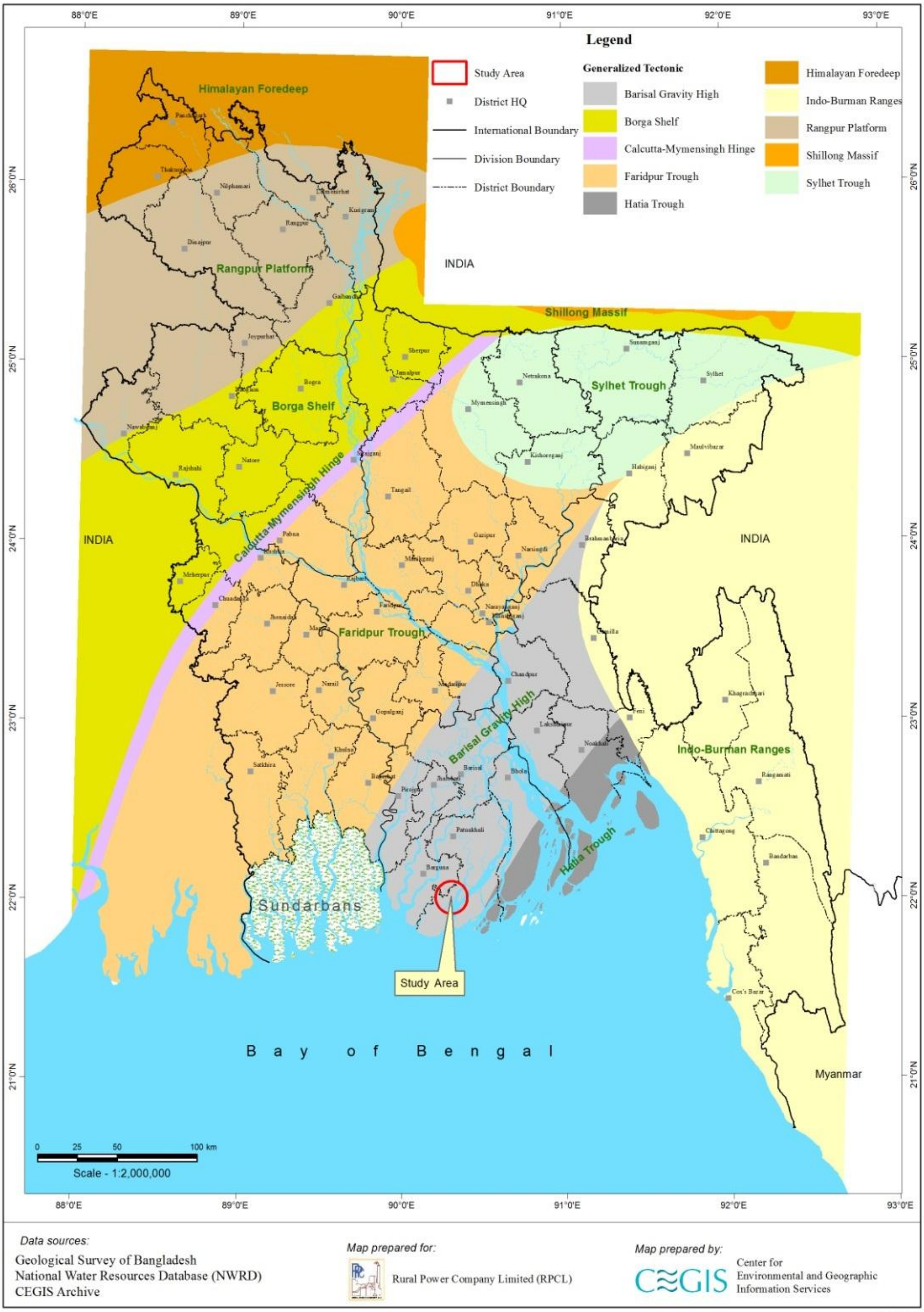
- Himalayan Fore Deep
- Bogra Shelf
- Faridpur-Sylhet Trough (Separated by Tripura- Madhupur thrash hold)
- Barisal –Chandpur Gravity High
- Hatia Trough



Map 6.1: Physiographic Map showing the Kalapara project area



Map 6.2: Land Elevation of the Project area from DEM analysis



Map 6.3: Tectonic map of Bangladesh showing the Kalapara project area

The Proposed Kalapara Coal Fired Thermal Power Project lies in the South western part of the Barisal- Chandpur Gravity high. It is also situated in the close proximity (North-west) of Hatia Trough/Patuakhali depression. Thickness of the sediments is estimated to be about 15km and this thickness correspond the Carboniferous to Recent geological age. This is geologically one of the least explored areas in Bangladesh.

6.2.7 Stratigraphy

Due to unavailability of bore log data in the project and neighboring area details stratigraphy study on the project area could be carried out. It is expected that before preparation of design of the structure of the project at least couples of bore holes to be drilled up to a depth of about 150m to collect the Geological, Hydrological and engineering data of the area.

From the literature review it reveals the thickness of the Holocene sediment of the area ranges from. 30-70 m. It also revealed the Sedimentary thickness of the area from cretaceous to recent is about 15,000m. A generalized stratigraphic section of the area is given below (**Table 6.2a and Table 6.2b**).

Table 6.2a: Stratigraphic units of the Cenozoic and Quaternary sediments

Stage	Group	Formation	Lithology
Holocene		Alluvium	Silt, sand, gravel and clay
Pleistocenw/Pliocene(upto 6375 m)	Madhupur	Hihing Formation/ Madhupur Clay	Yellow to yellowish grey, massive, fine to medium sandstone and clay stone/sticky clay
		Dupi Tila Formation	Yellow to ochre, pink, light brown, light grey to greyish-white sandstone, siltstone and conglomerate. Several oxidized, iron-rich, clayeypalaeosols. Petrified woodGrey to greenish grey, red mottled, silty shale, shale and claystone
Pleistocene/Neogene	TipamGroupGirujan Clay (U. Jamalganj in NW	Girujan Clay	Grey to greenish grey, red mottled, silty shale, shale and claystone
Neogene		Tipam Sandstone	Light yellow to yellowish grey, grey, brownish grey and orange fineto medium grained pebbly sandstone, siltstone and shale
	Surma Group (L. Jamalganj in NW)	Boka Bil formation	Greenish to bluish grey and yellowish grey marine pyritic shale, silt-stone and very fine to medium grained sandstone, marine fossils
Miocene(3100 m)		Bhuban Formation	Grey to bluish grey fine to medium sandstone, siltstone, claystone
Oligocene (800-1000 m)		Barail Formation Bogra Formation in the NW	Brown, yellow-brown, pink and grey sandstone, siltstone and car-bonaceous shale
Late Eocene (Eocene 600-800 m) Middle to Early Eocene	Jaintia Group	Kopili Formation	Grey, greenish grey to black silty claystone, fossiliferous shale, thinbeds of glauconitic sandstone and limestone
		Sylhet Limestone	Grey to greyish brown massive nummulitic limestone

Stage	Group	Formation	Lithology
Eocene and Paleocene		Tura Formation	Grey, brown, pink and greyish-white ferruginous sandstone, coal and shale
Late-Middle Cretaceous	Upper Gondwana	Sibganj Trapwash	Coarse yellow brown sandstone; white clay; volcanic ash
Early Cretaceous - Jurassic		Rajmahal Traps	Amygdaloidal basalt; serpentinised andesite; shale; agglomerate
Late Permian	Lower Gondwana	Paharpur Formation	Sandstone; feldspathic greywacke; coal, shale; coarse sandstone
Early Permian	Lower Gondwana	Kuchma Formation	Coarse grained sandstone, shale; thick coal seams
Precambrian		Basement Complex	Gneiss and schist

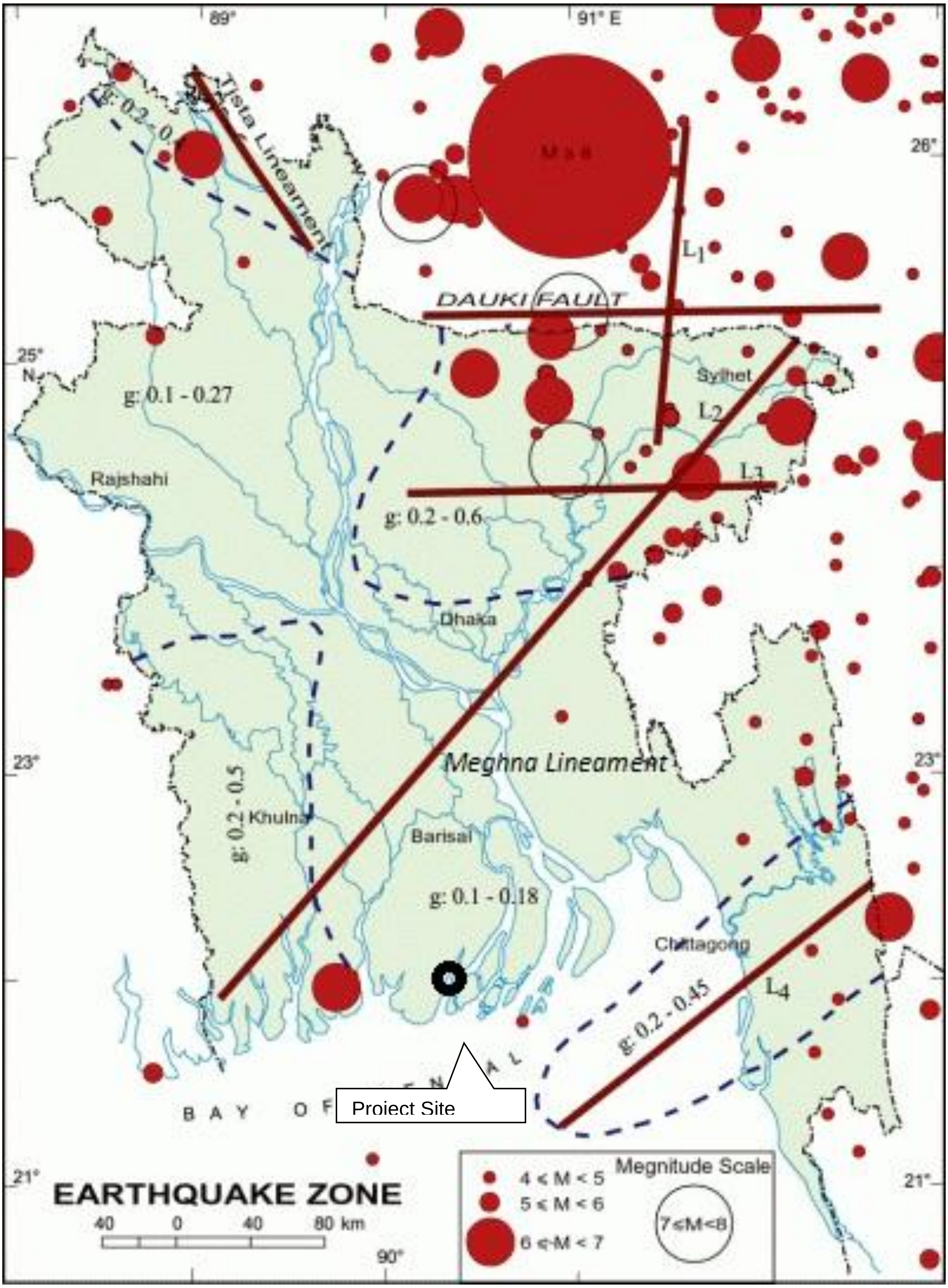
Source: Alam et.al. 1990

As the civil construction works would be limited to Holocene deposits, generalized description of the area is described below:

Table 6.2b: Pattern of sediment deposition within Bengal deltaic environments

Period/event	Major channels	Minor channels
128–28 ka BP Steady decline in sea level indelta plain to –40 to –65 m.	• Slow inland erosion along major channels • Planation of highstand deposits • Slumping of valley sides	• Slow inland erosion of high stand deposits along dendritic drainage • Slumping of valley sides
28–21 ka BP Rapid fall in base level	• Rapid headward and downward valley incision • Erosion and retreat of valley sides	• Incision of dendritic drainage
21–18 ka BPLowstand sea level hiatus at glacial maximum	• Delta deposition of coarsening-upward sequences along incised channels • Headword erosion and valley side retreat	• Stream captures • Valley deepening
18–5 ka BP Rapid base level rise	• Deposition of fining upward, braided coarse sediments aggrading as delta lobes back-stepping up valley from delta front • Filling of main valley to former high stand level • Deposition of medium sands in meandering channels; deposition of fine sands, silts and peats in inter channel areas • Crevasse-splay sands during flood events • Laminated fine sediments deposited during cyclones	• Laminated fine sediments deposited during cyclones • Main channels in filled to former high stand level • Medium to fine sands deposited by meandering distributaries • Minor crevasse-splay sands deposited during floods • Laminated fine sediments deposited during cyclones

Map 6.4a: Earthquake zoning map of Bangladesh



Map 6.4b: Earthquake location map of Bangladesh and surrounding area

6.2.8 Seismicity

Bangladesh Geological Survey has published an Earthquake Zoning Map of Bangladesh based on Seismic intensity. They have divided the country into three depending on the seismic intensity namely Zone-I, Zone- II and Zone III (**Map 6.4a**).

The proposed Kalapara coal fired thermal power plant area is located within Zone -I of the earthquake zoning map of Bangladesh (GSB, 1979). The seismic coefficient of this zone is 0.04 g. The project has least venerability in terms of earth quake compared to the other part of Bangladesh. However during designing of the civil structure for the proposed power plant, Bangladesh building code should be strictly followed.

Details of seismic intensity and the historical records of earthquake in and around Bangladesh that occurred during last about 450 years are presented in the in **Table 6.3** and **Map 6.4b.**

Table 6.3: List of Major Earthquakes in Last 450 Years

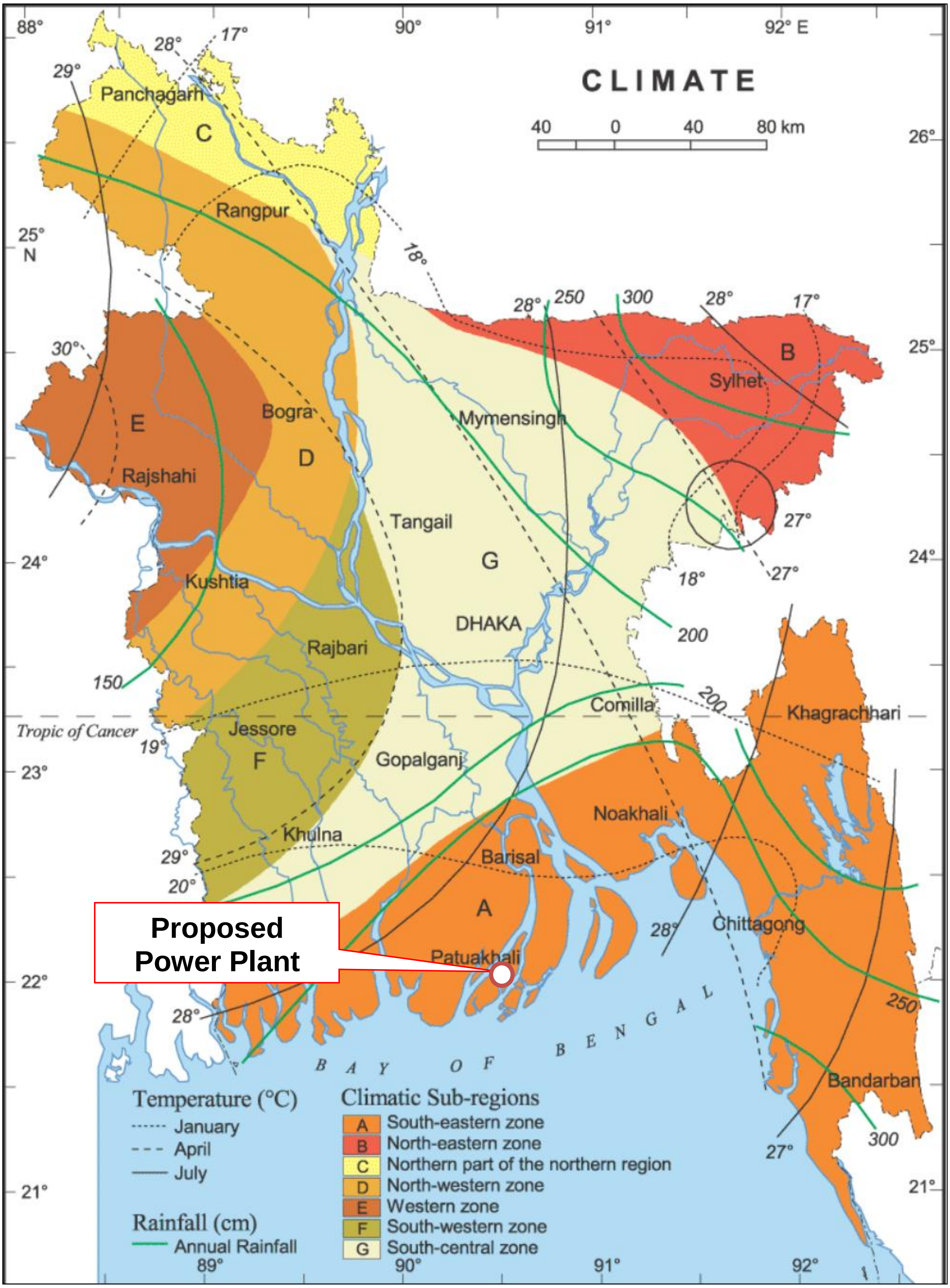
SL	Year	Source Area	Magnitude (Richter Scale)	Depth (Km)
1	1548	Sylhet	-	-
2	1664	Shillong-Plateau	-	-
3	1762	Chittagong-Arakan	-	-
4	1858	Sandway, Myanmar	6.5	-
5	1869	Cachar, India	7.5	48
6	1885	Sirajganj, Bangladesh	7	72
7	1897	Assam, India	8.1	60
8	1906	Calcutta, India	5.5	-
9	1912	Mandalay, Myanmar	7.9	25
10	1918	Srimangal, Bangladesh	7.6	14
11	1930	Dhubri, India	7.1	60
12	1934	Bihar, India-Nepal	8.3	33
13	1938	Mawlaik, Myanmar	7.2	60
14	1950	Assam, Himalaya	8.6	25
15	1954	Manipur, India	7.4	180
16	1975	Assam, India	6.7	112
17	1984	Cachar, India	5.7	4
18	1988	Bihar, India-Nepal	6.6	65
19	1997	Sylhet, Bangladesh	5.6	35
20	1997	Bangladesh-Myanmar	5.3	56
21	1999	Maheshkhali, Bangladesh	4.2	10
22	2003	Rangamati, Bangladesh	5.6	-
23	2011	Sikim, India	6.9	-

6.3 Climate and Meteorology

In order to investigate the climatic condition of the study area different meteorological parameters have been collected from multiple secondary sources. The proposed power plant area falls under tropical climate. Basically this region has a distinct monsoonal season which influences all other climatic parameters. **Map 6.5** shows the location of the study area in the climatic sub-regions of Bangladesh. The study area falls in the South-eastern climatic zone of Bangladesh.

The ambient mean temperature of the study area is found as 20°C in winter and 28°C-29°C in summer. On the other hand, the annual average rainfall in this region varies from 2500mm – 3000mm, which is relatively higher than the western areas of the county. Southwest monsoon occurs in this region from June till September; during this period heavy rainfall takes place for which the project area experiences tidal and coastal flooding.

Besides, tropical storms i.e. Kalbaishakhi and cyclones occur during summer i.e. April to June and then from September to December. Cyclones occur almost every year in the Patuakhali coastal areas with varied intensity and magnitude. Meteorological data for the last 30 years was collected from the nearest BMD stations in Patuakhali (BMD Station ID: 12103) which is analyzed to get the overall micro-climatic conditions of the study area. Summary of the analysis of climatic parameters are given in the following sections:

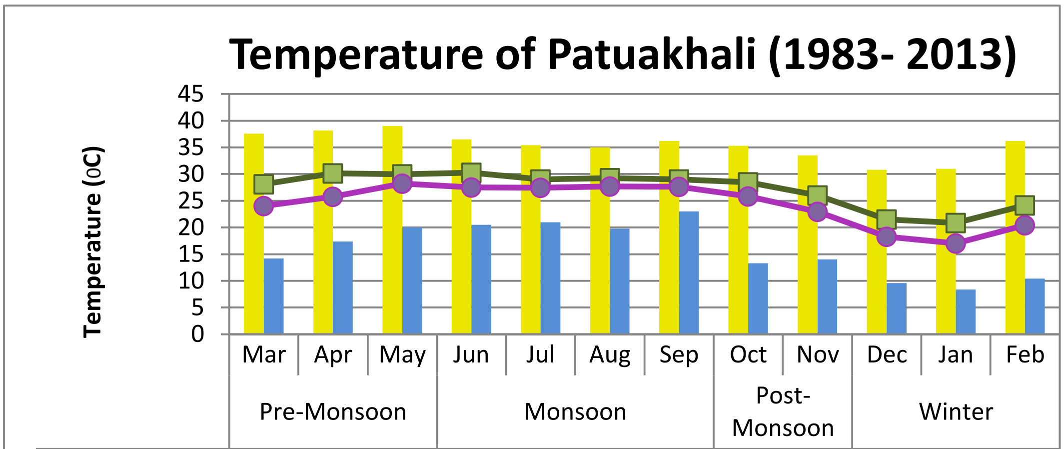


Source: ASB, 2006

Map 6.5: Climatic Sub-regions of Bangladesh

Temperature

Temperature of Patuakhali Station does not show remarkable fluctuation (**Figure 6.1**). Data of last 30 years (1983-2013) shows that monthly maximum temperature varies from 30.8°C to 39°C, and May is the warmest month in pre-monsoon period. The monthly minimum temperature varies within a range of 8.4°C to 23.0°C, and January is the coldest month. The highest recorded maximum temperature during the last 30 years is 39°C occurred in May, 1990 and the lowest ever recorded minimum temperature is 8.4°C first occurred in January, 2013. The monthly maximum, minimum and average temperature of the last 30 years (1983-2013) are given in **Figure 6.1**. **Figure 6.2** shows the trend of annual maximum and minimum temperature of Patuakhali, which reveals that the winter season is getting colder and the summer, in contrast, is becoming hotter over time.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Maximum	37.6	38.2	39	36.5	35.4	35	36.2	35.3	33.5	30.8	31	36.2
Minimum	14.2	17.4	20	20.5	21	19.8	23	13.3	14	9.6	8.4	10.4
Max of Avg	28.13	30.17	29.97	30.26	28.98	29.23	29.01	28.44	26	21.49	20.84	24.13
Min of Avg	24.06	25.79	28.2	27.51	27.47	27.66	27.6	25.83	22.95	18.27	17.04	20.46

Figure 6.1: Monthly maximum, minimum and average temperatures (1983-2013)

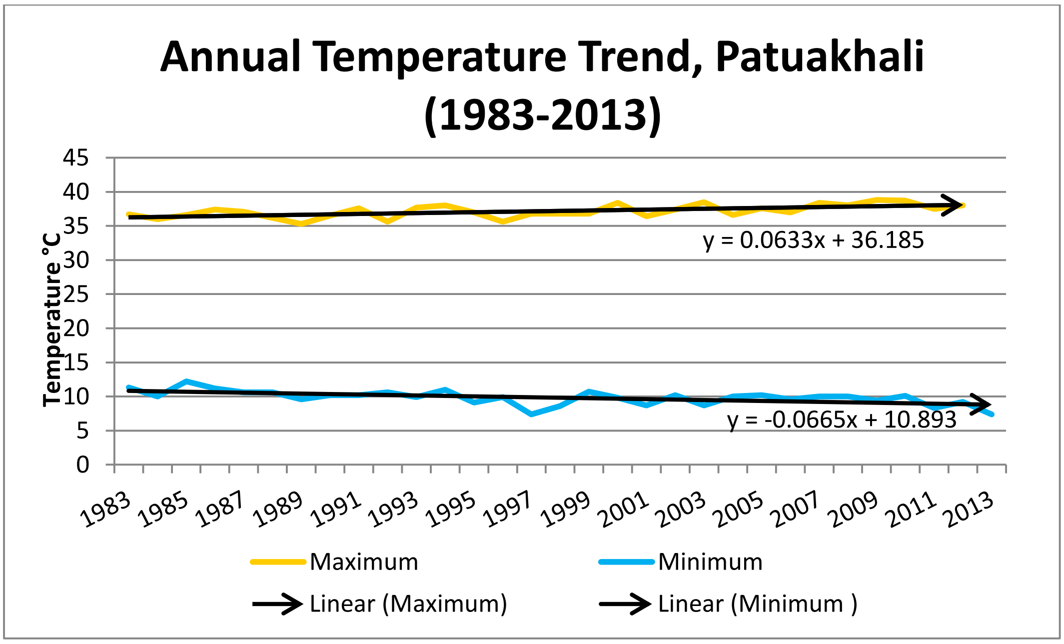
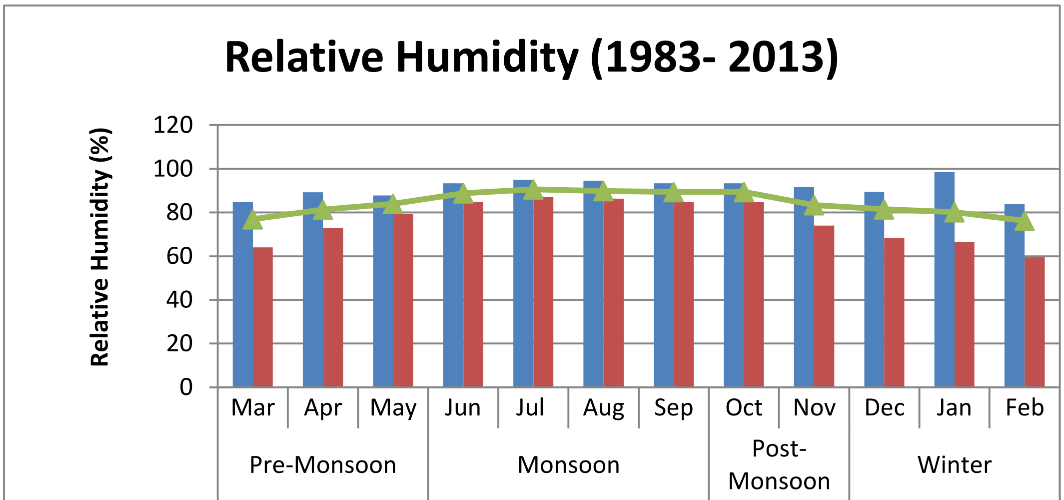


Figure 6.2: Trend of annual maximum and minimum temperatures (1983-2013)

Humidity

Humidity is directly related with temperature fluctuation of a region. The atmosphere of coastal zone is always enriched with humidity because of high evaporation over the sea surface. Patuakhali BMD Station (station ID: 12103) has been selected in order to delineate the situation of humidity of the study area. The monthly average relative humidity near the project area varies seasonally from 76.21% to 90.61%. Monsoon (June to September) is the most humid period, whereas from late post-monsoon to the winter season i.e. November to February, the weather remains relatively dry. **Figure 6.3** shows the data for monthly maximum, minimum and average humidity of the last thirty (30) years (1983 to 2013) for Patuakhali station.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Maximum	84.67	89.28	87.76	93.4	94.94	94.5	93.4	93.4	91.55	89.34	98.5	83.9
Minimum	63.97	72.78	79.32	84.91	87.13	86.27	84.77	84.77	73.99	68.23	66.41	59.52
Average	76.87	81.39	84.04	88.84	90.61	89.79	89.42	89.42	83.41	81.46	80.16	76.21

Figure 6.3: Monthly maximum, minimum and average humidity (1983-2013)

Rainfall

The last 30 years data of Patuakhali BMD station shows that the annual average rainfall is recorded as 2519 mm/yr. According to the analysis of this data (**Figure 6.4**), monthly average maximum rainfall occurred in June (1084 mm/month) and monthly average minimum rainfall recorded during winter season. This indicates that the rainy season is very prominent in this region. The ever maximum annual rainfall was recorded as 4320 mm in the year of 1983, as found in the BMD data for this station. It is also observed that, the annual rainfall in this area is gradually decreasing at a rate of 17.6 mm/year. Average monthly rainfall of thirty (30) years is presented by graphs in **Figure 6.4** and **Figure 6.5**, both showing that the Monsoon period (June to September) having the maximum rainfall record of a year. On the contrary, December to February shows negligible amount of rainfall. For this analysis, time series rainfall data of Patuakhali station (BMD station ID: 12103) has been used.

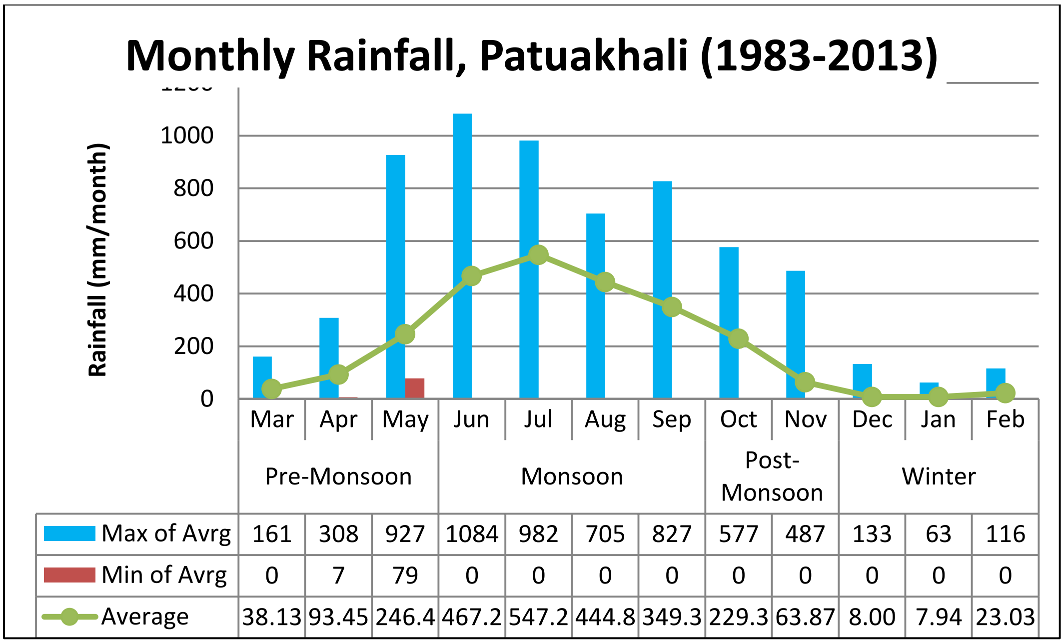


Figure 6.4: Monthly maximum and minimum of average rainfall (1983-2013)

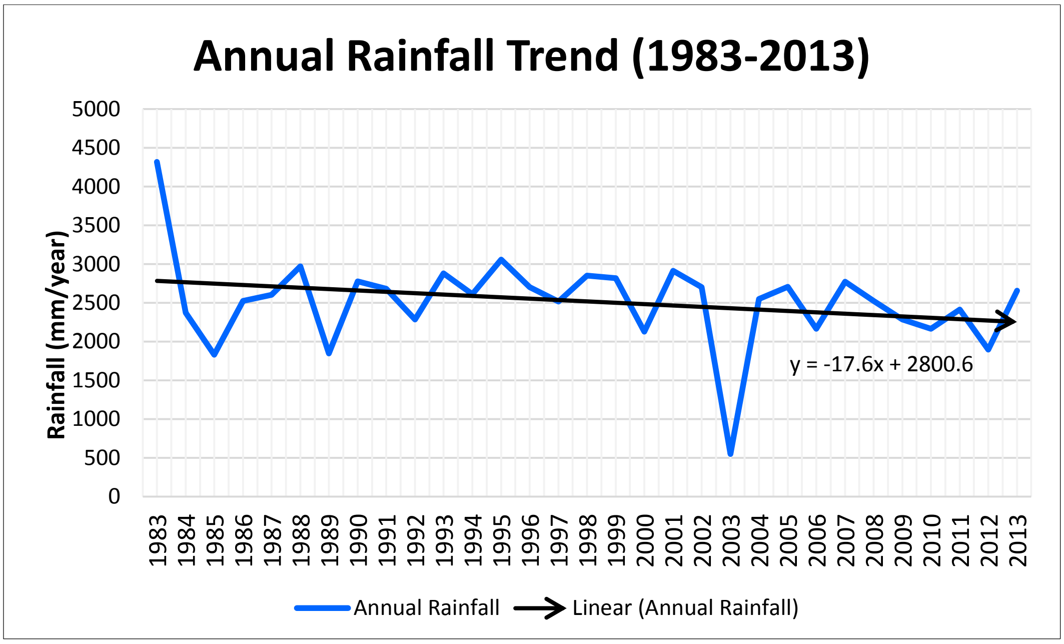
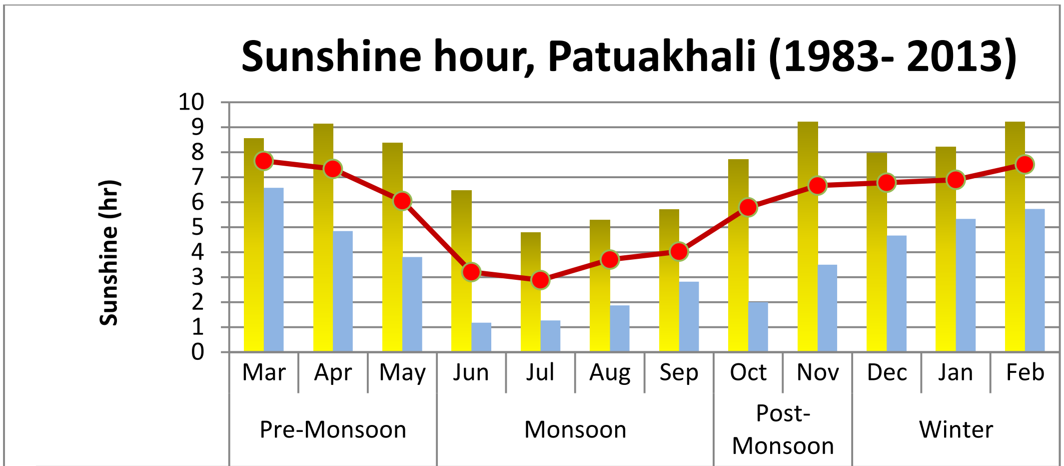


Figure 6.5: Trend of annual rainfall (1983-2013)

Sunshine Hours

Sunshine hour is a climatological indicator, measuring the duration of sunshine for a given location and period which indicates the total energy delivered by sunlight. In order to investigate the sunshine hour over the study area, sunshine hour records (1983-2013) of Patuakhali BMD station has been analyzed. The monthly average sun-shine hour in Patuakhali varies from 2:88 to 7:65 hour/day in a year. The monthly highest sunshine hour occurred in November i.e. 9:22 hour/day. Length of the sunshine hour reduces during monsoon season. **Figure 6.6** shows the daily sunshine hour condition of the study area in different months.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Max of Avg	8.55	9.13	8.37	6.47	4.78	5.28	5.72	7.71	9.22	7.97	8.22	9.2
Min of Avg	6.57	4.84	3.81	1.18	1.27	1.87	2.82	1.99	3.5	4.67	5.33	5.73
Average	7.65	7.33	6.04	3.20	2.88	3.71	4.03	5.79	6.67	6.78	6.89	7.51

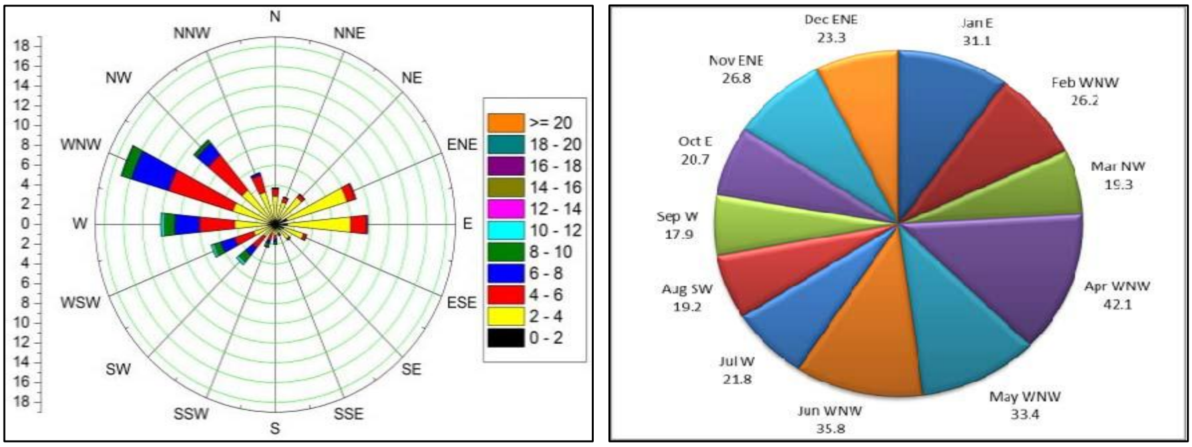
Figure 6.6: Monthly maximum, minimum and average sunshine hour (1983-2013)

Wind speed and direction

Since tropic of cancer passes through the central part of Bangladesh therefore, the south-eastern zone of Bangladesh lies in the tropical atmosphere. The climate of Bangladesh is administered by monsoon wind which possesses reverse direction in specific seasons.

The study area is prejudiced by the interaction of sea breeze; it has low topography similar to the sea level. Wind flow and direction are very important for the oceanic tides, waves, currents and atmospheric status.

Figure 6.7 and **Figure 6.8**showthe wind speed and direction of wind blowing in Kuakata which is 20 km away from the study area. **Figure 6.7** is collected from the study conducted by Alam and Azad (2014) on wind energy analysis for three coastal sites of Bangladesh. The wind rose diagram in **Figure 6.7** (a) shows that in Kuakata, most of the time of year wind comes from the direction between South-West and North-West with a significant amount from direction East and Eastern-North-East. This is well-expected outcome since this particular region is influenced by the wind blowing from south-west and north-east. The long converging south–west coastal line of Bangladesh has its influence which changes the general direction slightly. **Figure 6.7** (b) shows the prevailing wind direction of each month throughout the year and also indicates that the characteristic of country’s climate reversal wind circulation is present. The reversal wind starts blowing in February and remains till September with a general trend for stabilizing one wind direction. This is true for the months of October to January. (Alam & Azad, 2014).



(a) **(b)**

(Source: Alam & Azad, 2014)

Figure 6.7: (a) Wind Rose and (b) Monthly prevailing wind for Kuakata

It is observed that the proposed project site is highly windy. Wind data of PatuakhaliBMD station has been sorted out to represent the maximum and average wind speed of wind flow over this area (**Figure 6.8**). Overall, it is observed that the average wind speed over this area is slightly decreasing.

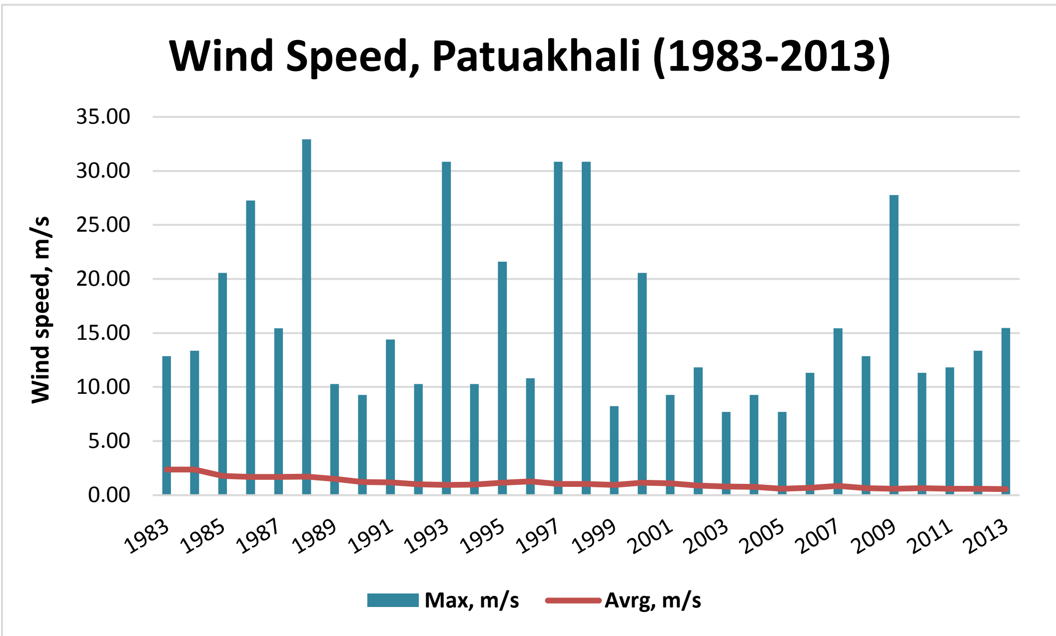


Figure 6.8: Annual wind speed (1983-2013)

6.4 Ambient Air Quality

The air quality of the study area are investigated through standard sampling process and laboratory analysis. Some of the brickfields were found in the Itabaria Villages. RPCL is developing the land through dredged spoil from the Andharmanik River. Emission from the brickfields, small automobiles, engine van, heavy vehicles on the Barisal- Kuakata highway, vessels in the Rabnabad, Andharmanik River and RPCL power plant development activities are the major sources of pollution of the air in the study area. Moreover, frequent rainfall clears the air regularly. Four sites within the study area have been selected (**Map 6.6)** in order to investigate the ambient air quality. The location has been selected depending on the wind direction, location, and sensitivity and pollution potentiality for future monitoring. All the samples were collected for 8 hrs. **Table 6.4** shows the ambient air quality like SOx, NOx, $PM_{2.5}$, PM_{10}, CO, O_3 and CO_2 etc. at the selected points of the study area. The sampling locations are shown in **Map 6.6**. The day on which the samples were collected, it was a clear sunny day and the wind direction was relatively calm.

Table 6.4: Ambient air at different locations around the project site

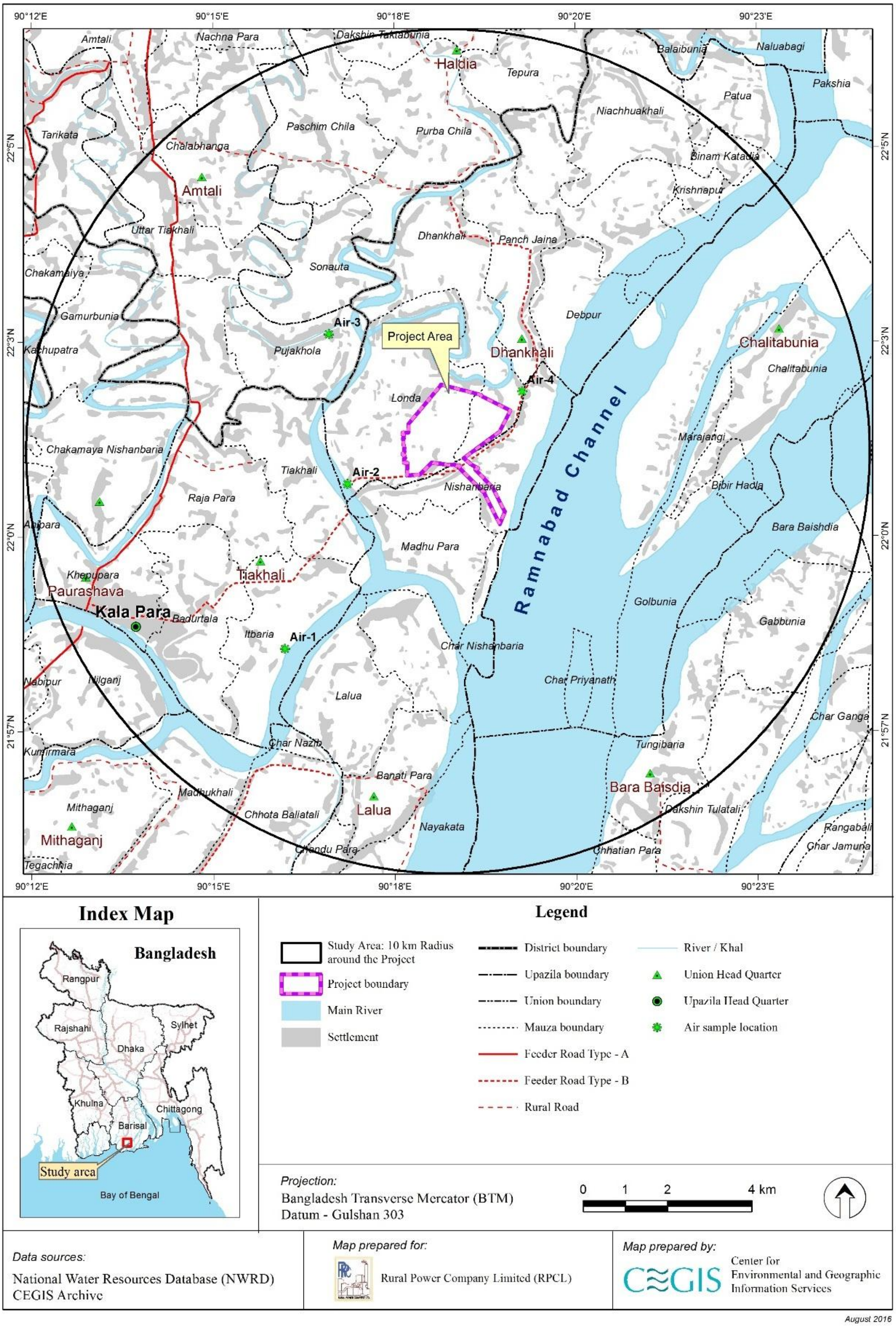
SI	Sample Location	Coordinates		Concentration present of different parameter in ambient air (µg/m^3)						
				$PM_{2.5}$ (µg/m^3)	PM_{10} (µg/m^3)	SO_2 (µg/m^3)	NO_x (µg/m^3)	CO (µg/m^3)	O_3 (ppm)	CO_2 (ppm)
1	Itbaria village	21°58'36.9" N; 90°15'49.4"E	Dry	62	182	23	18	54	0.004	683
			Wet	5	10	10	6	51	0	554
2	Londakheyaghat, Dhankhali	22°00'43.7" N; 90°16'41.3"E	Dry	48	149	24	20	63	0.004	648
			Wet	11	23	8	9	49	0	612
3	Islampur, Pujakhola	22°02'39.3" N; 90°16'26.3"E	Dry	65	172	27	24	61	0	685
			Wet	6	25	7	6	55	0	633
4	Dhankhali Ashraf Academy	22°01'54.8" N; 90°19'5.9"E	Dry	48	106	24.5	22	70	0.001	664
			Wet	7	17	9	9	54	0.002	607
	Method of Analysis			Gravimetric	Gravimetric	West-Gaeke	Jacob & Hochheiser	CO Meter	O_3 Meter	CO_2 Meter
	Test Duration (minutes)			480	480	480	480	480	480	480
	DoE Standard for ambient Air quality			65 (24hr)	150 (24hr)	365 (24hr)	100 (Annual)	10,000 (8 hrs)	157 (8 hrs)	NF
	IFC/WB Standard			75 (24hr)	150 (24hr)	125 (24hr)	40 (Annual)	NF	160 (8 hrs)	NF

Source: CEGIS, 2015

Source: CEGIS, 2015

Photo 6.1: Sampling of Air quality around project site

Photo 6.2: Monitoring of Noise level around project site



Map 6.6: Air sampling location map

6.5 Acoustic Environment

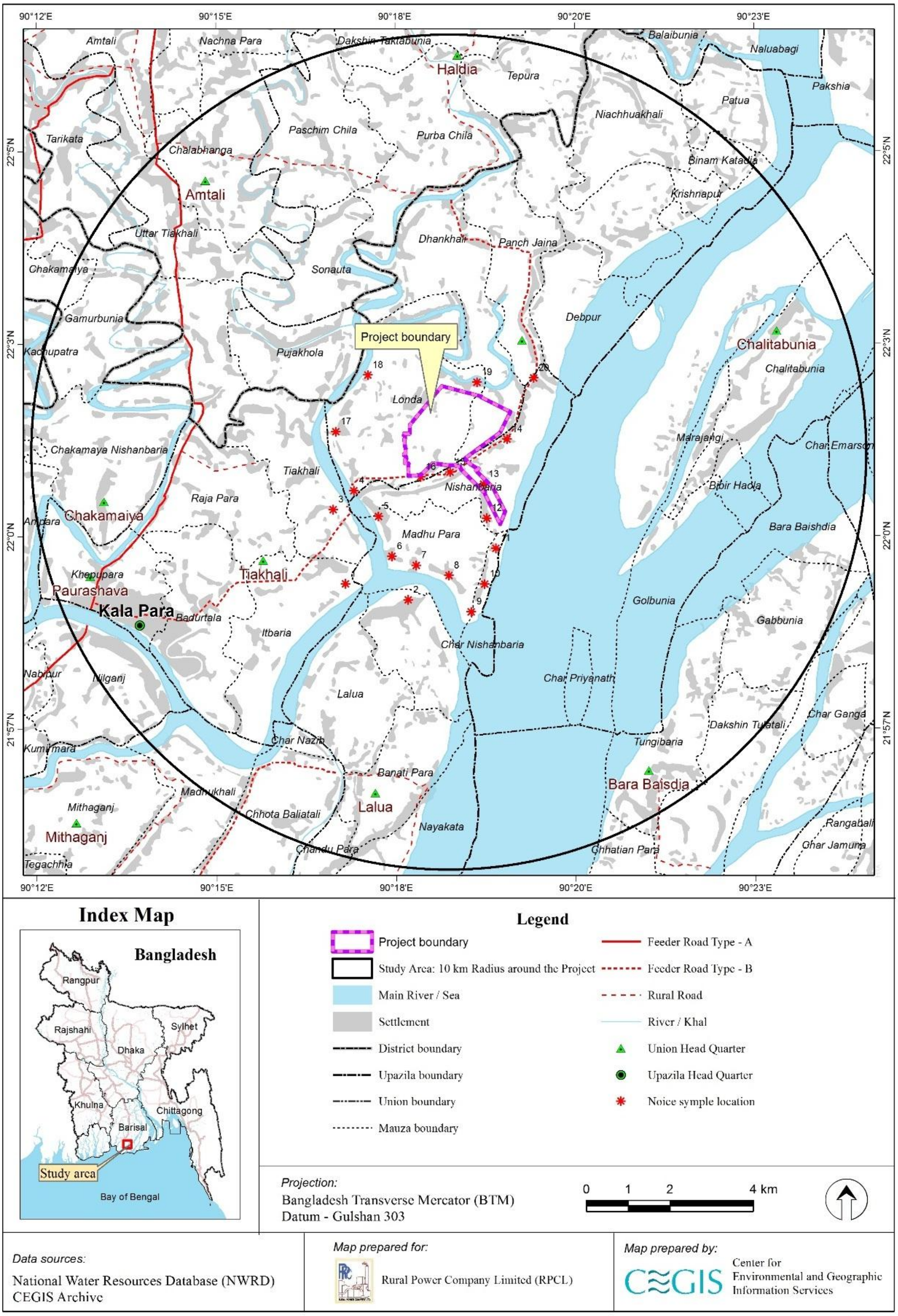
The proposed project area is located in rural settings at present. It is situated on the northern side of the RPCL 1320 MW coal based power plant. Around 250 m is the lowest distance between RPCL power plant and RPCL proposed power project. Therefore, this area is transforming from rural settings to semi-urban settings as the major infrastructure in association with other development activities are progressing. As per DoE and World Bank guideline, the standard level of noise are shown in **Table 6.5.**

Table 6.5: Noise Level Standard

Guideline	Location/ Receptors	ECR, 2006 (L_{eq}, dBA)	
		Day 6:00 Hr-21:00 Hr	Night 21:0 Hr – 6:00 Hr
ECR, 2006	Silent Area	50	40
	Residential Area	55	45
	Mixed Area	60	50
	Commercial Area	70	60
	Industrial Area	75	70
		Day 7:00 Hr-22:00 Hr	Night 22:00 Hr – 7:00 Hr
IFC, 2008	Residential, Institutional, Educational	55	45
	Industrial, Commercial	70	70

At present, the land development activities of RPCL is progressing along with the bank protective works. Numbers of dredgers have been installed sequentially on the Andharmanik River and Tiakhali Khal for withdrawal of filling materials. Therefore, the villagers especially near the river bank are found to be annoyed for the noise generating from the dredger. The dredgers start operation early in the morning and continues up to 8:00 pm. Moreover, frequent movement of diesel engine operated vehicles e.g. engine vans produce high noise near the road side residence. River side residence and the fishers are also susceptible to high noise from the vessels (e.g. engine boat, cargo, launch etc.) moving through the Tiakhali Khal, Andharmanik River, and Rabnabad River.

The proposed project area is presently occupied with agricultural crops and settlements. The acoustic environment in the project area are normal. Numbers of diesel machines and Power tillers are operated for field preparation purposes. However, noise of birds cheering, local loud speakers and sea shore sound are creating localized noise in the study area. **Map 6.7** shows the susceptible places which can be potentially affected for noise generation during construction and operation of the power plant project. The noise level, measured in fifteen locations during daytime around the project area is represented in **Table 6.6.**



Map 6.7: Noise sampling location map

Table 6.6: Noise level at different locations around the project area

Sl. No.	Measuring Location	Coordinates	Noise Level (dB)	
			Day	Night
1	Payra Port Administrative office	21°59'26.34"N 90°16'38.13"E	63	42
2	Lalua	21°59'13.70"N 90°17'30.43"E	52	35
3	Londaghat	22° 0'24.16"N 90°16'27.18"E	60	45
4	Londa Bazar	22° 0'38.93"N 90°16'45.20"E	63	46
5	Londa (East of RPCL)	22° 0'18.84"N 90°17'5.67"E	58	48
6	Madhu Para (S-W of RPCL Project)	21°59'47.66"N 90°17'16.82"E	57	41
7	Madhu Para (South of RPCL Project)	21°59'40.63"N 90°17'37.06"E	61	40
8	Madhu Para (South of RPCL Project)	21°59'32.60"N 90°18'4.37"E	54	44
9	Char Nishanbaria	21°59'4.41"N 90°18'23.11"E	65	50
10	Char Nishanbaria (S-E of RPCL Project)	21°59'26.05"N 90°18'34.43"E	51	46
11	Char Nishanbaria (E of RPCL Project)	21°59'53.86"N 90°18'43.75"E	43	35
12	Gondamari	22° 0'17.36"N 90°18'36.16"E	54	45
13	Gondamari (Proposed Approach Jetty Road)	22° 0'43.74"N 90°18'33.65"E	49	38
14	Debpur (E-of the Proposed power plant)	22° 1'18.76"N 90°18'53.24"E	47	35
15	Dhankhali (South of the proposed Project)	22° 0'53.21"N 90°18'5.61"E	45	40
16	Londa (Proposed resettlement village)	22° 0'49.51"N 90°17'40.93"E	43	35
17	Londa (East side community near the Tiakhali Khal)	22° 1'24.98"N 90°16'30.21"E	48	42
18	Londa (Opposite site of Pujakhola)	22° 2'8.96"N 90°16'57.00"E	50	33
19	Dhankhali (East side of the proposed project)	22° 2'3.18"N 90°18'28.13"E	46	30
20	Dhankhali Bazar	22° 2'6.52"N 90°19'15.69"E	56	50

Source: CEGIS Field survey, February, 2016

6.6 Water Resources System

The existing water resources system of the study area is plays indispensable role in attenuating and regulating drainage in controlled way, recharging the aquifer, and maintaining the environment for aquatic habitats.

6.6.1 Major Rivers

Three major rivers and enormous canals are flowing in the study area. The names of rivers are *Andharmanik*, *Rabnabad* and *Tiakhali*. All the rivers and canals are tidal in nature. The Project area is bounded by *Andharmanik* River **(Photo 6.4**) to the south, *Rabnabad* River (**Photo 6.3**) to the East, and *Tiakhali* River (**Photo 6.5**) to the West.

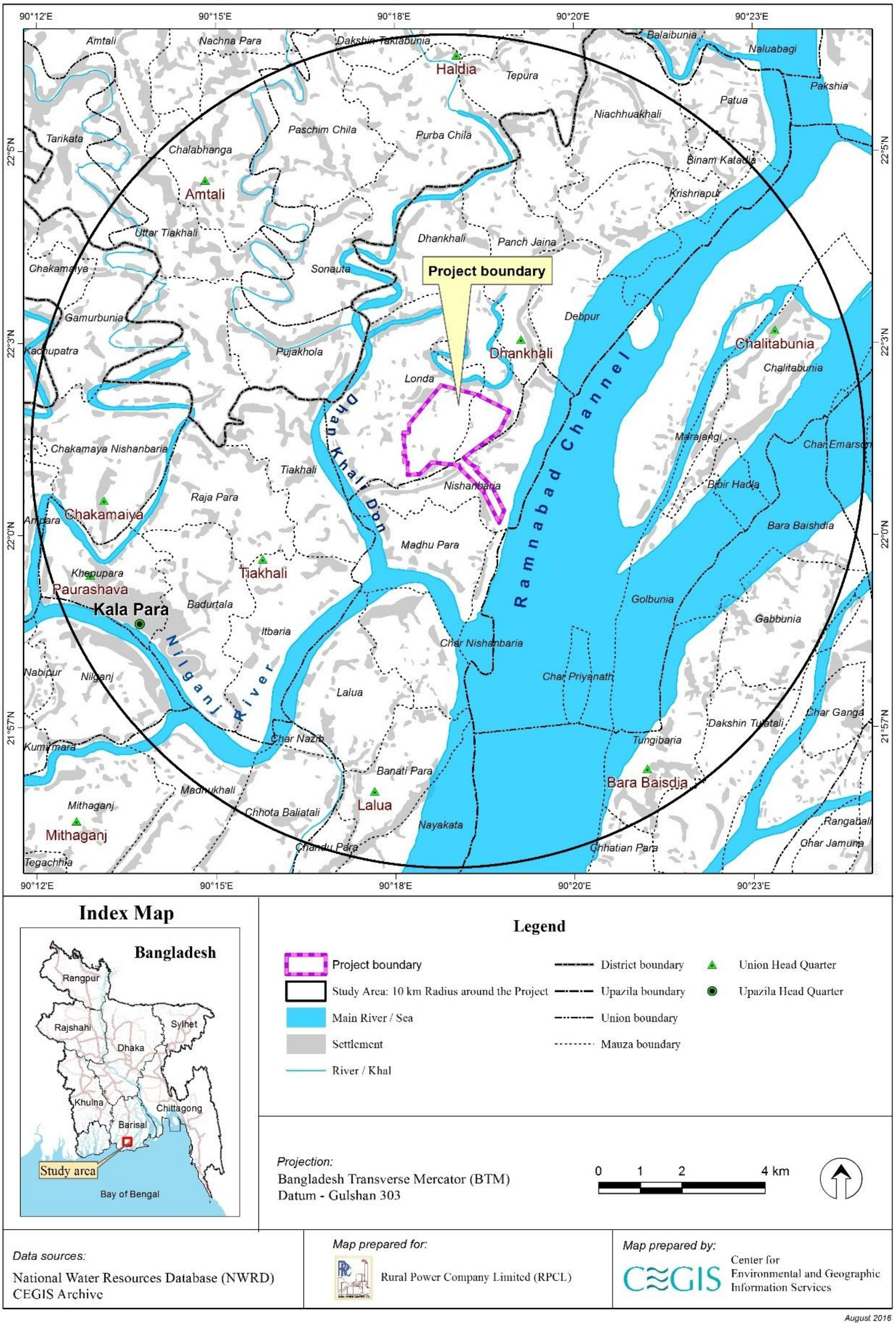
The *Andharmanik* River has originated from the *Rabnabad* Channel at Char Nishabaria in Dhankhali Union of Kalapara Upazila and discharges into the Bay of Bengal at Amtali Upazila. The length of the *Andharmanik* River is about 40 km having maximum width of 1,363 m, minimum 250 m and average 500 m. It is a tidal dominated river as such water is available throughout the year. During monsoon, flow from the upstream is dominating but in the dry period tidal water flow is also dominating. The average variation of water level is 3.0 m between high tide and low tide. The width of the river is wider in the downstream than the upstream portion. (Bangladesh Rivers, August 2011, BWDB)

The *Tetulia* River is named as *Rabnabad* River at *Chalitabunia* Union of Galachipa Upazila. The length of the river *Rabnabad* is approximately 20.0 km, having maximum width of 4,408m, minimum 1,190 m and average 1,840m (Bangladesh Rivers, August 2011, BWDB). It is tidal river and flow is available throughout the year. The river falls into the Bay of Bengal. The river system of the area is shown in **Map 6.8**.

6.6.2 Water Connectivity

The water resources system of the study area is mainly governed by the *Andharmanik*River and *Rabnabad* River which are fedby water from the upstream and downstream (during *high tide*). There are numerous *khals* in the polder namely *Nanda Khal, Mach Khali* River, *Modhupara Khal,* and other branch khals which facilitate the flow circulation inside the proposed Project area. The area of the *khals* in the project area is 18.62 ha (46 acre). The outfalls of all these internal *khals* are connected with *Tiakhali* River which controls the main drainage system of the Project area. These khals have tidal effects and the flow direction is from east to west. During high tide the flow direction of the *khals* is from **Tiakhali** River to the inner side.

During rainy season, these *khals* drain the surplus water out of the polder 54 A through Hafez Podder sluice (**Photo 6.6**). However, in recent years, most of the *khals* have been silted up due to increased siltation. This also hampers the flow circulation inside the polder area.



Map 6.8: River system of the study area

Photo 6.3: Rabnabad Channel at Char Nishanbaria

Photo 6.4: Andharmanik River at Lalua Kheya Ghat

Photo 6.5: Tiakhali River at Dhankhali Bridge

Photo 6.6: Main Drainage Channel of Polder 54 A& B at Londa Village

6.6.3 Hydrological Setting

Water Levels

The water level is an important issue of water resources. The available water level data of at Khepupara (BIWTAtidal water level Station ID-610: *Andarmanik* River,) was collected for the period of 1977 to 2007.**Figure 6.9** shows that water level during high tide ranges from +3.65 mPWD to +4.95 mPWD, whereas low tidal water level ranges from (-)0.03 mPWD to (+) 0.69mPWD.

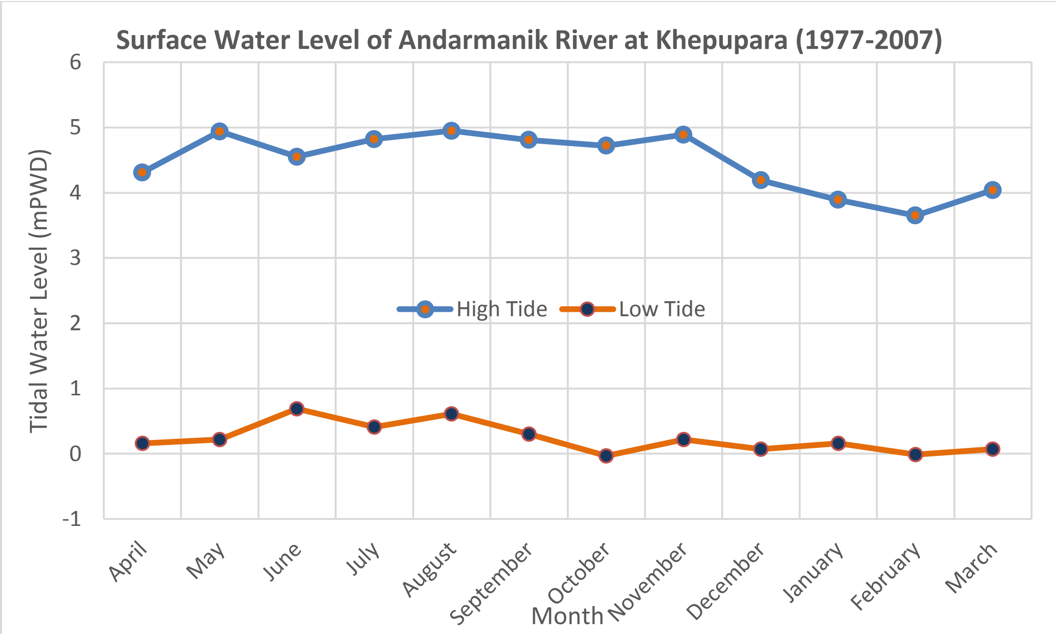


Figure 6.9: Surface water level of Andarmanck River at Khepupara

Groundwater Table

The study area like other parts of the country, receives sufficient amount of rainfall and groundwater is available there which are used by hand pumps for drinking and domestic purposes. Monthly variation in ground water level from the year 1977 to 2013 has been analyzed from the nearest BWDB ground water observation well PAT002 (Well ID: 17857001) at Amtali Upazila. The variation pattern for PAT002 station shows that the GWT values are fairly low, with lowest and highest values in September and March respectively. The monthly variation of average ground water level at Amtali Upazila is shown in **Figure 6.10**.

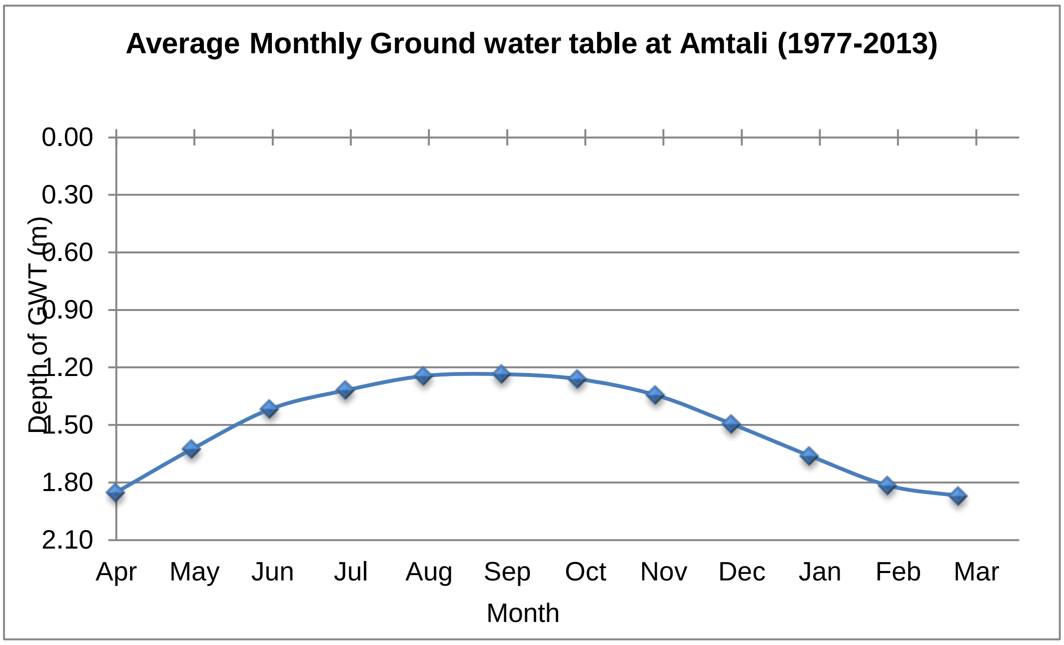


Figure 6.10: Average monthly variations of GWT

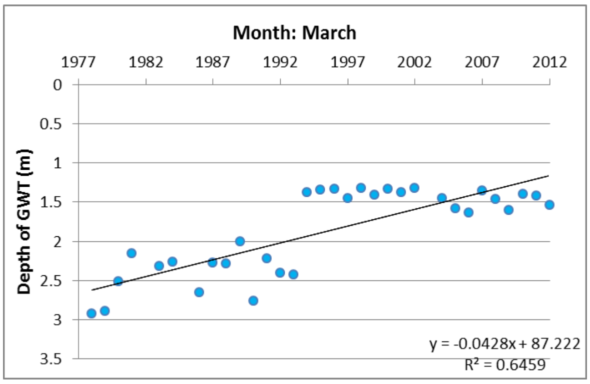
The Ground Water Table (GWT) measured in the aforementioned location at ten year intervals are shown in **Table 6.7.** Values are analyzed for the months of March (Considered as dry period) and September (considered as wet period). In dry season, increased dependency of the local people on ground water lowers the GWT. During monsoon, the higher availability of surface water leads to higher recharge of ground water sources.

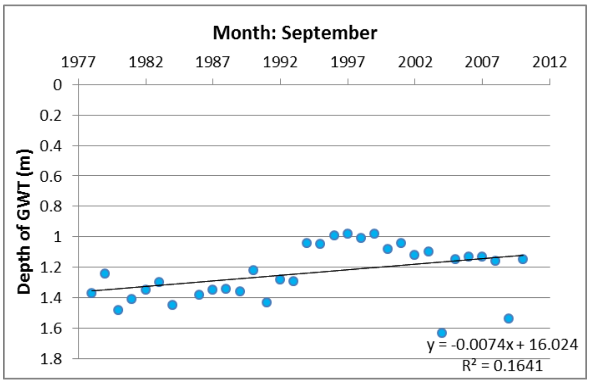
Table 6.7: Ground Water Tables (GWT) shown at ten-year intervals

New ID	Location	1980		1990		2000		2010	
		Mar	Sep	Mar	Sep	Mar	Sep	Mar	Sep
		Depth in Meter							
PAT002	Amtali	2.51	1.48	2.00	1.36	1.41	0.98	1.61	1.54

Source: NWRD, 2010

Analyses have also been made to understand the long-term annual variations of GWT from 1977 to 2013 at PAT002 station, for the month of March (driest period) and September (wettest period). The values are presented in **Figures 6.11 and 6.12.** A mild increasing trend of annual GWT variation is observed in both cases. **Figure 6.11 and 6.12** shows that the ground water table is gradually increasing both in the month of March and September





Source: BWDB, 2014

Figure 6.11: Variation of GWT at PAT002 in March (1977-2013)

Figure 6.12: Variation of GWT at PAT002 in September (1977-2013)

Aquifer System

The aquifer system in Bangladesh is categorized mainly in three groups which are; a) the upper aquifer or composite aquifer, b) the main aquifer and c) deeper aquifer. However, the study area has fallen under coastal area, which belongs to the deeper aquifer of the country. The brief characteristic of this aquifer system is described below:

The deeper aquifer: The deeper unit is separated from the overlying main aquifer by one or more clay layers of varied thickness and extent. Deep aquifers are generally based on depth and in some areas the aquifers water have no flow either vertically upward or downward but flows very slowly along the dips and slopes of the aquifers (**Figure 6.13).** This water bearing zone comprises of medium to coarse sand in places inter bedded with fine sand, silt and clay. At present, water of coastal zone are being exploited in limited quantity from the water bearing formations deeper than 150-200 m. Large scale extraction is not encouraged in the coastal areas due to the every possibility of sea-water intrusion or leakage from the upper aquifer (Sattar, M.A. 1993). The characteristics of the main aquifers of the country including the coastal zone where the study area is situated are presented in Table -1 of **Appendix –XII.** From the Table, it has been observed that the lithology of the coastal aquifer is grey medium to coarse sands with mostly confined to semi-confined in nature with transmissivity rate of 1,000-3,000 m2/day (EIA Report of Polder 48, CEIP).

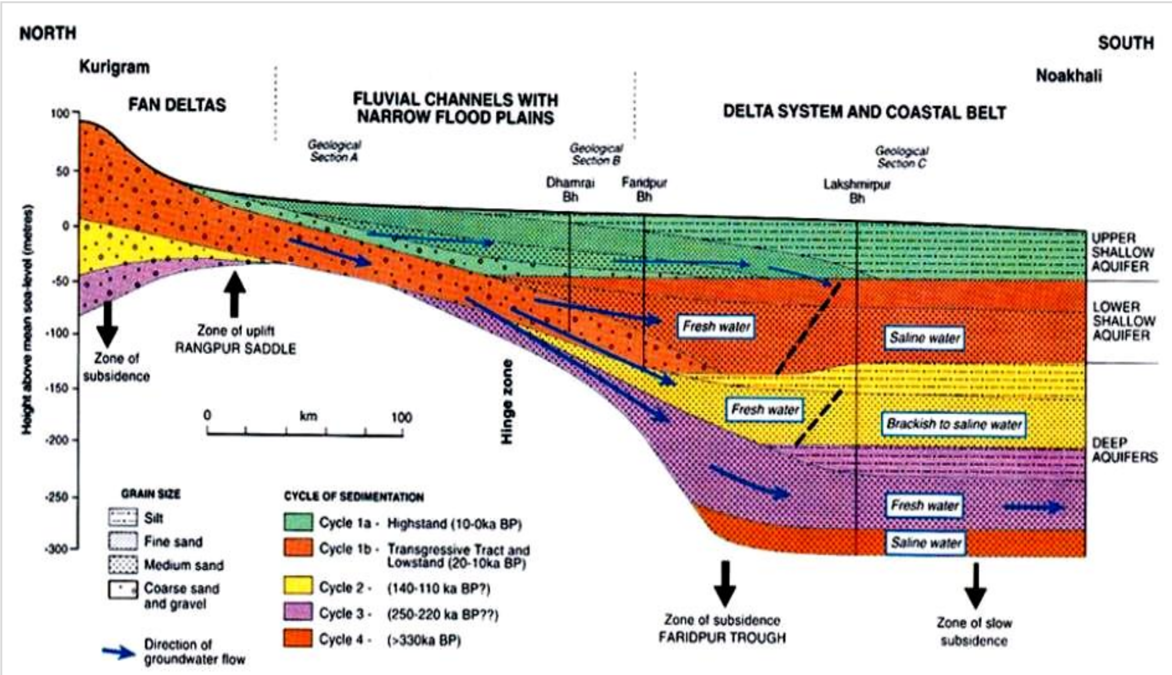


Figure 6.13: Hydro geological Cross Section from North to South across Bangladesh

The lithology of coastal aquifer is presented in **Figure 6.14** below.

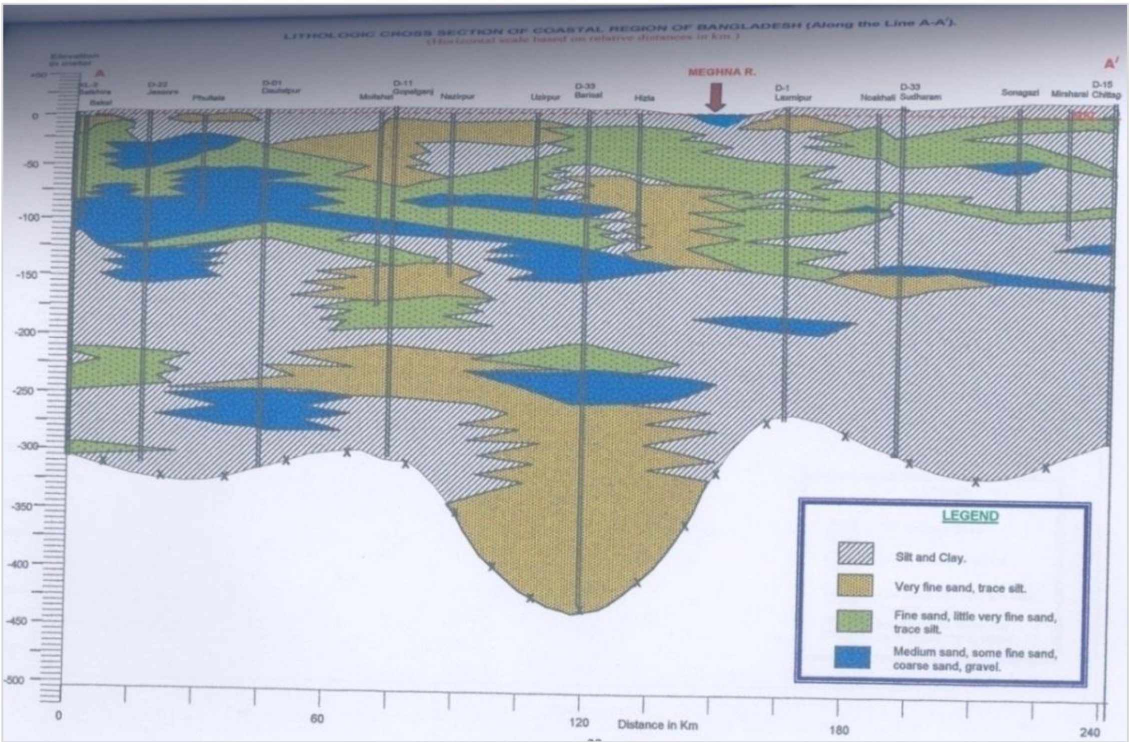
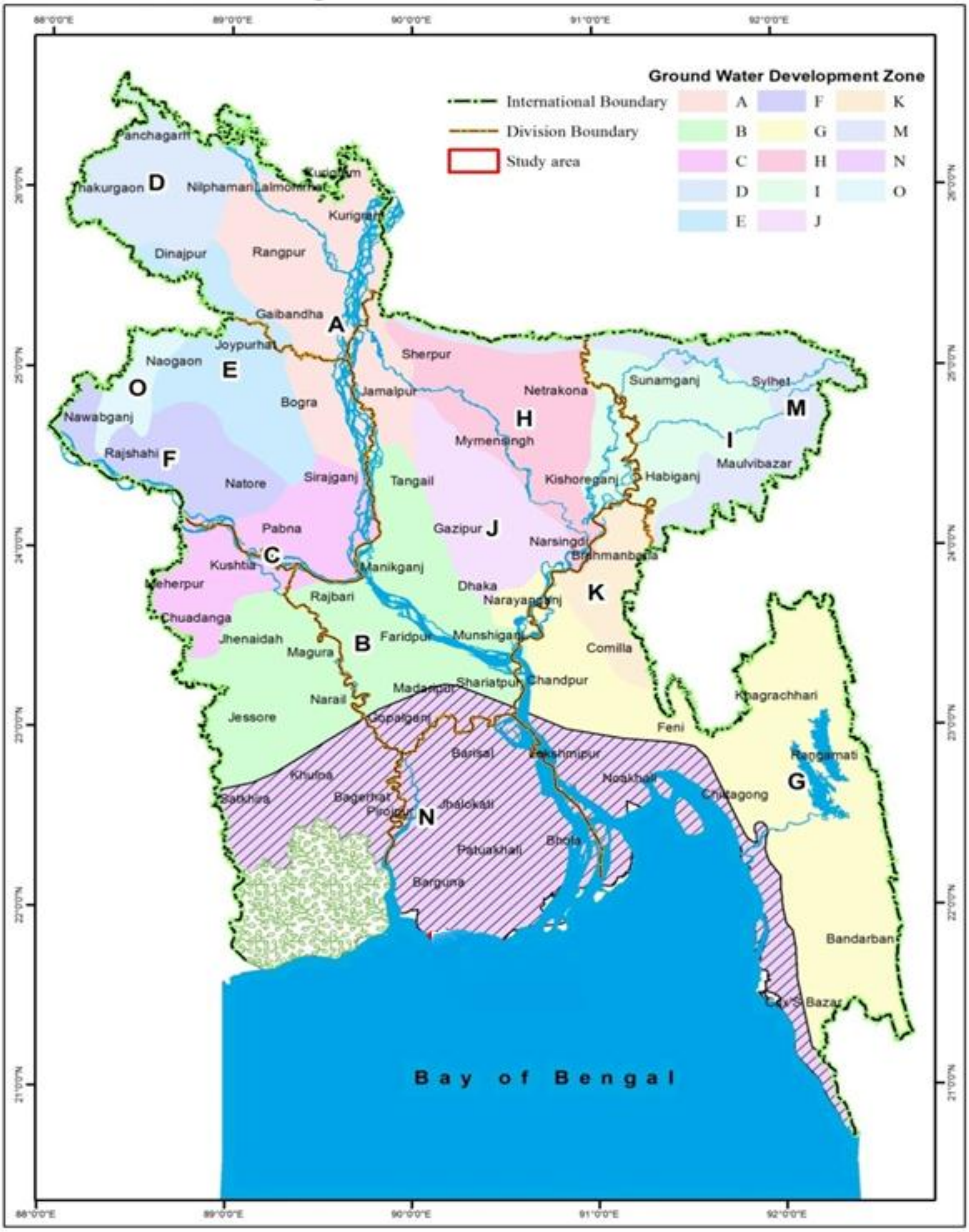


Figure 6.14: Lithological Cross-section of the Coastal Aquifer

Furthermore, based on the lithology and other characteristics of the aquifer the entire country has been divided into 15 potential groundwater development zones (**Map 6.9**). The study area has fallen under zone N (Annex, **Table -II**) which has been characterized as Floodplains of GBM with brackish and saline water problems.



Map 6.9: Potential groundwater development zones

6.6.4 Water Resources Issues and Functions

Tidal and Storm Surge Flooding

Tidal flooding is very common in the coastal area. The main reasons for flooding are heavy rainfall, tidal water intrusion throughsluice gates and sea water level rising etc. At present, no tidal flooding is observed in the study area except in the *Amtali* Union. Tidal flooding occurs inside the *Amtali* Union in almost every year and inundates about 7 to 8 % of total area of the Union due to lower drainage capacity of *Pujakhola* regulator (**Photo 6.7**).

The peripheral flood control embankment effectively offers protection to the area from the storm surge flooding. The existing crest level of embankment is 4.40-5.80 mPWD (Source: CEIP report). Local people opined that there was no major storm surge flooding in the Polder area during AILA, 2009 and SIDR, 2007. However, this problem will aggravate in future particularly at *Debpur* in the south-eastern part of the polder area (GPS: 0224062, 2439360) as is under threat for severe bank erosion (**Photo 6.8**) from the tidal wave action and storm surge of the Bay of Bengal.

Photo 6.7: One vent Pujakhola Regulator at Pujakhola village, Amtali Union

Photo 6.8: 700 meter Erosion at Debur in Rabnabad Channel, Champapur Union

Drainage Congestion and Water Logging

Drainage congestion has been identified as a common problem inside the *Amtali* Union and its intensity varies from place to place. *Pujakhola*Khal (**Photo 6.9** and 6.**10**) suffers from moderate drainage congestion problems. The drainage direction of this *khal* is from north to south and interconnected by a channel naming *Tiakhali* River. A total of about 84% (2,354 mm) of total annual rainfall occurs during monsoon and post-monsoon periods. As a result, the internal *khals* and *Pujakholakhal* cannot cope with the increased rainfall occurrences due to high siltation through rotten leavesand leading to moderate congestion. Local people reported that, about 10% of the *Amtali* Union of the study area suffers from moderate drainage congestions during the field investigation from 4th to 9th February 2016.

Photo 6.9: PujakholaKhal at Paschim

Photo 6.10: Pujakhola Khal at Sonauta

Such drainage congestions, mostly affect the agriculture and its production. Due to reduced drainage capacity of the khals, rainwater inundates agricultural fields for a period of 10 to 15 days, and delays the plantation of Aman crops. The main reason for drainage congestion is of two-fold; decreasing of the conveyance capacity of the internal and lateral khals due to sedimentation and occurrence of heavy rainfall during monsoon. Local people opined that, no prolonged water logging situation exists inside the study area, however, rain fed inundation exists in some areas as already discussed above.

Salinity

Salinity intrusion is one of the major problems in the study area. During monsoon moderate salinity is found inside the study area. It increases during dry season (November to May).

Tidal water intrudes during high tide through the unprotected area and deteriorates water control structures to some extent. However, the surface water as well as the groundwater are recorded to be saline (**Table 6.9)** causing crisis of fresh water in the study area for short period of time.

Navigation

Waterway is the most important means of communication of this area, which is cheaper compared to the road transportations. The peripheral *Andharmanik* River and *Tiakhali* River are used as waterway communication. Local people use small and medium trawlers for carrying passengers and goods from one place to other throughout the study area.

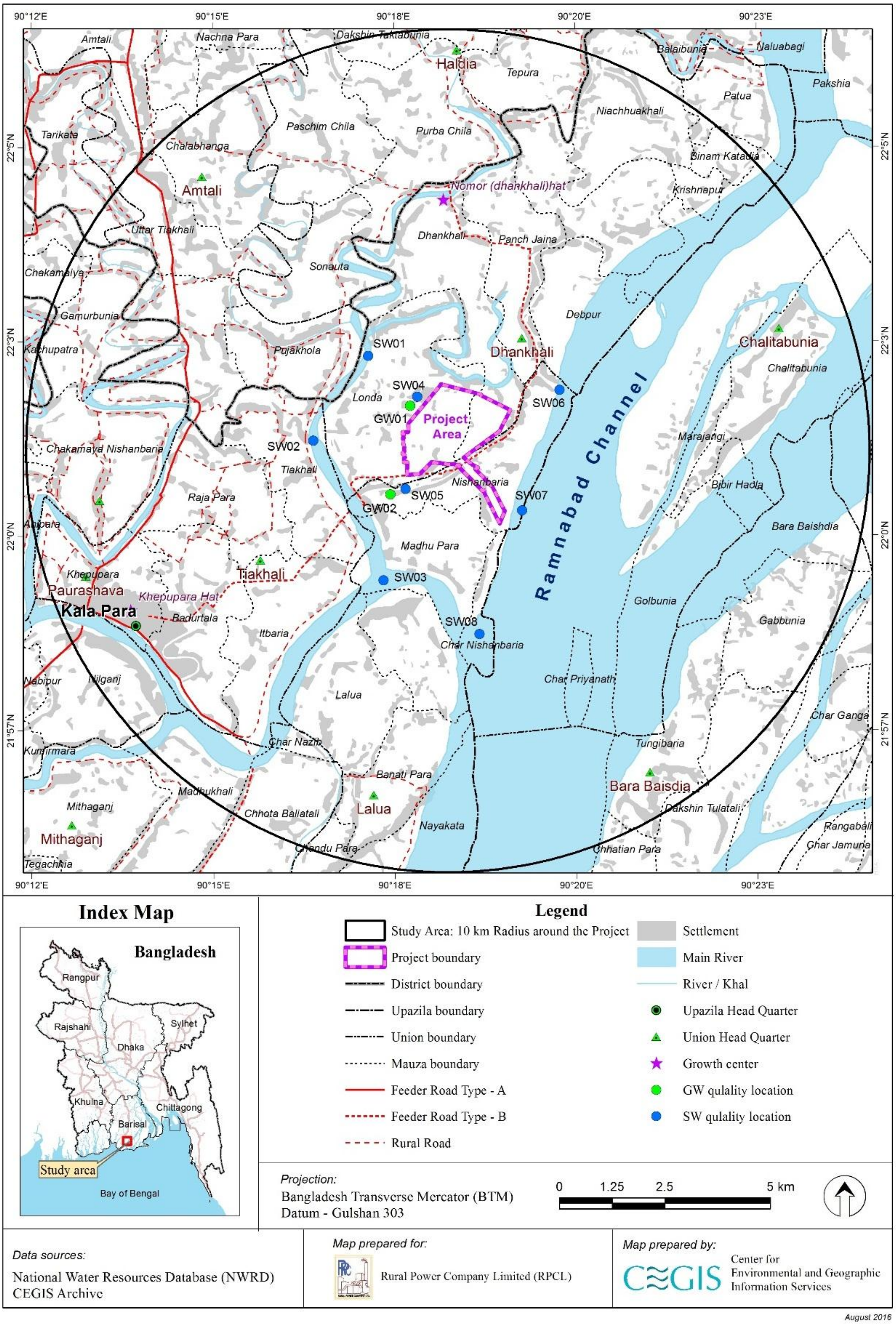
The important inland navigation facilities are Kalapara Ferry Ghat and Londa Kheya Ghat. The latter is the most prominent *kheyaghat* for Dhankhali and Champaur Union through which a large number of passengers (about 300-500 passengers/hr), small and medium trawlers (50-60 nos/day), fishing boat (100-120 nos/day) move round the year. One small ferry, with carrying capacity of 3-4 buses was found at Baliatoli Ferry Ghatduring field visit. But, at present, this Ferry Ghat is inactive due to mechanical problem of the Ferry. People of Baliatoli and Lalua Unions (500-600) moves through the *Andharmanik* River by mechanized boats.

Photo 6.11: Navigation at Londa Kheya Ghat

Photo 6.12: Navigation point at Debpur

6.6.5 Water Quality

Water quality test has been performed in and around the project area for both surface and ground water. The locations of sampling have been selected such a way that it would represent entire study area (**Map-6.10**). In-situ tests have been conducted maintaining the standard practice during field visit in June, 2016.The measured values (pH, DO, EC, TDS and Salinity) are presented in **Table 6.8a** where the lab analysis report.



Map 6.10: Baseline water quality monitoring location

Table 6.8a: Result of the Water quality in the study area (In-situ)

Sample Source	Location of Sampling	Season	pH	DO ppm	EC ppm	TDS ppm	BOD5 (ppm)	Salinity (ppt)
GW-1	Near to the Outlet of Majher Khal (from 80 feet depth)	Dry	7.77	1.4	1140	570	-	0
		Wet	6.91	0.9	0.05	87	-	0
GW-2	Near the to the mosque outside the project area (from 110 feet depth)	Dry	8.17	2.7	1110	550	-	0
		Wet	7.3	0.8	0.05	88	-	0
SW-1	Payra Port Authority	Dry	7.75	6.3	-	-	2.5	2.2
		Wet	7.58	7.1	0.28	165	1.4	0
SW-2	Tiakhali Khal	Dry	7.9	5.6	-	-	2.0	0.5
		Wet	7.24	5.5	0.38	276	2.1	0
SW-3	Tiakhali Khal	Dry	7.9	5.4	-	-	2.2	2.0
		Wet	7.74	6.2	0.23	173	2.0	0
SW-4	Shonirvar Khal	Dry	7.74	1.4	300	140	2.4	0
		Wet	7.60	9.3	0.15	111	2.5	1.0
SW-5	Rabnabad Channel (Intake Upstream)	Dry	7.11	5.3	-	1860	1.5	2.1
		Wet	7.75	7.3	0.12	94	1.7	2.0
SW-6	Rabnabad Channel (Intake Point)	Dry	7.8	4.2	1750	870	1.8	2.3
		Wet	7.67	6.9	0.12	94	1.7	2.0
SW-7	Rabnabad Channel (Intake Downstream)	Dry	8.27	5.8	-	-	1.9	2.4
		Wet	7.75	7.9	0.12	94	1.5	2.0
SW-8	Majher Khal (Inside the project)	Dry	8.01	5.6	-	1910	2.9	0
		Wet	7.69	6.0	0.08	62	2.0	1.0

Source: CEGIS, January and June 2016 (primary water quality in-Situ test results)

Table 6.8b: Result from the Water quality in the study area

S.L	Water Quality Parameters	Season	SW1 (mg/l)	SW2 (mg/l)	SW3 (mg/l)	SW4 (mg/l)	SW5 (mg/l)	SW6 (mg/l)	SW7 (mg/l)	SW8 (mg/l)
1	Alkanity	Dry	108	107	108	80	115	90	143	128
		Wet	88	80	78	73	63	65	68	45
2	Arsenic (As)	Dry	0.002	0.001	0.003	0.003	0.002	0.002	0.001	0.002
		Wet	0.002	0.003	0.003	0.001	0.002	0.001	0.001	0.001
3	Calcium (Ca)	Dry	77	79	75	18	61	59	45	60
		Wet	28	15	19	20	10	17	18	10
4	COD	Dry	40	32	40	36	28	16	32	24
		Wet	28	4	8	8	4	4	12	8
5	Chloride	Dry	1588	2280	3276	40	1240	1142	560	1710
		Wet	20	24	17	13	12	11	12	25
6	EC	Dry	4980	7010	10540	229	4090	3800	1854	5700
		Wet	369	383	274	154	148	141	144	443
7	Hardness	Dry	735	980	1470	325	755	745	510	905

S.L	Water Quality Parameters	Season	SW1 (mg/l)	SW2 (mg/l)	SW3 (mg/l)	SW4 (mg/l)	SW5 (mg/l)	SW6 (mg/l)	SW7 (mg/l)	SW8 (mg/l)
		Wet	188	160	155	138	140	123	142	160
8	Iron(Fe)	Dry	3.21	0.78	1.17	1.97	1.16	1.15	1.82	3.2
		Wet	7.48	4.88	6.31	2.37	7.83	6.13	5.92	2.42
9	Lead(Pb)	Dry	0.026	0.052	0.182	<LOQ	0.02	0.047	0.015	0.042
		Wet	0.007	0.005	0.010	0.001	0.006	0.006	0.005	0.001
10	Magnesium (Mg)	Dry	61	63	64	19	53	55	38	48
		Wet	13	11	11	5	8	4	4	7
11	Mercury (Hg)	Dry	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
		Wet	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
12	Nitrogen (NO3)	Dry	0.5	1	0.4	0.7	0.3	0.9	0.4	0.8
		Wet	7.31	9.81	11.07	10.33	13.16	17.10	18.01	20.36
13	Phospate	Dry	1.39	0.32	1.52	1.54	0.27	0.99	0.55	0.85
		Wet	4.47	2.89	6.68	3.15	3.41	7.02	6.72	2.09
14	Potassium(K)	Dry	21	21	23	6	61	15	9	10
		Wet	6	5	5	3	4	4	3	3
15	Sodium (Na)	Dry	839	1235	2072	43	605	680	280	1191
		Wet	58	71	48	41	36	21	24	72
16	Sulphate	Dry	300	390	630	<LOQ	320	280	120	410
		Wet	22	7	12	5	7	8	10	14
17	Total Dissolved Solid (TDS)	Dry	2610	3740	5547	109	2125	2010	972	2987
		Wet	177	184	132	74	71	68	69	213
18	Turbidity	Dry	54	15	21	5	10	15	14	1
		Wet	197	86	215	77	200	170	181	26
19	Total Organic Carbon	Dry	7.62	6.05	5.56	6.12	4.4	4.31	4.21	4.75
		Wet	3.21					1.72	1.31	
20	Silica	Dry								
		Wet	121	78	116	72	122	98	110	29

Source: CEGIS January, June 2016 (primary water quality in-Situ test results)

Table 6.8c: Result of the Water quality (Lab test) in the study area

Sample	*Season*	*As*	*Ca*	*COD*	*Chloride*	*Silica*	*Hardness*	*Fe*	*Pb*	*NO_3*	*Phospate*	*K*	*Hg*	*SO_4*
GW1 (mg/l)	*Dry*	*0.001*	*12*	*4*	*46*	*-*	*270*	*0.87*	*0.062*	*3.8*	*7.29*		*<LOQ*	*5.0*
	Wet	*0.001*	*7*	*4*	*264*	*9.2*	*103*	*2.1*	*0.001*	*10.56*	*4.63*	*<LOQ*	*-*	*<LOQ*
GW2 (mg/l)	*Dry*	*0.001*	*15*	*4*	*40*		*230*	*0.74*	*0.057*	*2.3*	*7.65*	*-*	*<LOQ*	*3.0*
	Wet	*0.007*	*7*	*4*	*277*	*12*	*113*	*1.03*	*0.002*	*27.82*	*3.95*	*<LOQ*	*-*	*<LOQ*

Source: CEGIS January, June 2016 (primary water quality in-Situ test results)

6.6.6 Water Use

The standard value of average daily demand of water for domestic and drinking purposes in rural areas is considered as 50 lpc (Ahmed and Rahman, 2010). However, the actual status of drinking water in some of the coastal polders is very poor. During field survey in the study area, it was found that the average daily domestic use of water was around 40 lpc.The study found that around 27,200 m3 of water is consumed daily by a total number of 680 people living in the Project area.Local people opined that they prefer Deep Tube Wells (DTWs) for drinking water source to meet up their daily requirements. For other domestic uses, Shallow Tube well and surface water sources are used. Overall, water availability in the study area is not a major concern as local people claimed that they have sufficient surface and groundwater sources to meet up their daily need for drinking and domestic purposes. In the study area, use of pond during dry season is very essential due to increasing surface water salinity. About 3.64 ha (9 acre) of pond area is being used as fishing and kitchen water purpose.

6.6.7 River morphology and dynamics

Three rivers have been found within the study area, the *Rabnabad*, the *Tiakhali* and the *Andermanik*. The latter two are the linking channels of the *Rabnabad* and the Bay of Bengal. In the *Tiakhali*, there is one north-south flowing dead-end portion, which is also names as *Tiakhali*. Tide is very strong in these rivers due to proximity to the sea.

There is no along shore sediment transport along the southern coast of Bangladesh, as many estuaries have interrupted the transport along with fluvial input from the river. Hence, during tides from the sea, it erodes huge land mass and carry the sediment to the upstream and on its way back it deposited them in the rivers and estuaries.

This phenomenon, of course, is related with the stage of delta building process, along with changes of fluvial/tidal flow and sediment, tidal amplification/dampening and many more. For morphological analysis of the study area, satellite images of 1973, 2008 and 2015 have been used. GIS and RS tools and technologies have been used for this assignment. Backlines of those three years have been delineated following the CEGIS defined methodologies. Then the bank lines have been used for analyzing the erosion accretion pattern of the study area.

a. Erosion-accretion during 1973 to 2008

Huge erosion has occurred during this period, especially in the *Rabnabad* Channel, in comparison to the accretion. At the downstream part of the island, namely *Bibir Haola* (polder 49), adjacent to the *Tetulia* Channel, big land mass was found to be eroded. About 824 ha land has been eroded in the *Rabnabad* channel within the study area (circle), as shown in **Figure 6.15**; whereas 566 ha land was accreted. Erosion is observed along both banks of the channel. In the downstream the erosion rate was more than that of the upstream. Accretion is mainly observed in the western side of the *Chatalbunia*Island.

On the other hand, there was some erosion (104 ha) in the *Tiakhali* main channel that connects with the Andermanik Channel, but complete accretion (303 ha) was observed in the dead-end part of *Tiakhali*, that following north-southward from the Tiakhali main channel (**Figure 6.16**). Negligible erosion accretion was found in the *Andermanik* Channel in comparison with those of the *Rabnabad* and *Tiakhali* channels.

The overall erosion rate in the *Rabnabad* channel with the study boundary area was 24 ha/yr, whereas the accretion rate was 16 ha/yr. As a result, net erosion was observed during this period. On the other hand, the erosion rate in the *Tiakhali* was 3 ha/yr and the accretion rate were three times more than the erosion rate. Hence, net accretion was prevailing in the

Tiakhali channel. The rate of erosion and accretion in the *Andermanik* was negligible within the study reach.

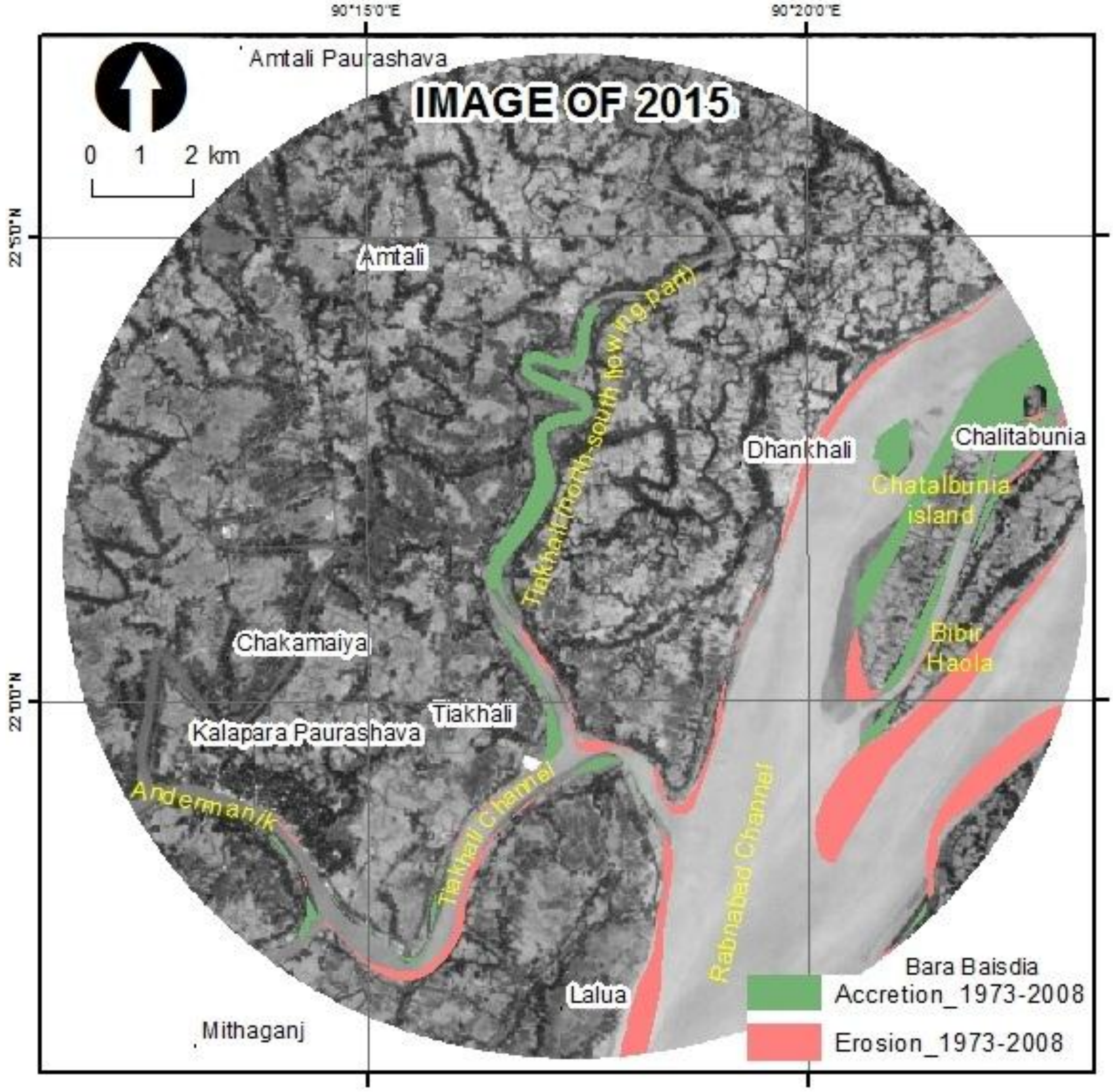


Figure 6.15: Erosion-accretion during 1973 to 2008

b. Erosion-accretion during 2008 to 2015

The erosion- accretion was different during 2008 to 2015 in comparison to that of 1973 to 2008 (**Figure 7**). The erosion rate in the Rabnabad has reduced to 15 ha/yr from 24 ha/yr of 1973-2008. Accretion rate in this channel within the study reach remained same, i.e. 16 ha/yr. In the *Tiakhali* channel, the erosion rate has reduced to 2 ha/yr from 3 ha/yr comparing those took place earlier.Again, the accretion rate has increased to 17 ha/yr, which is almost double from that of 1973-2008. Even, substantial accretion rate in the *Andarmanik* Channel has been observed found. In every channel, accretion was prevailing in the process during 2008-2015.

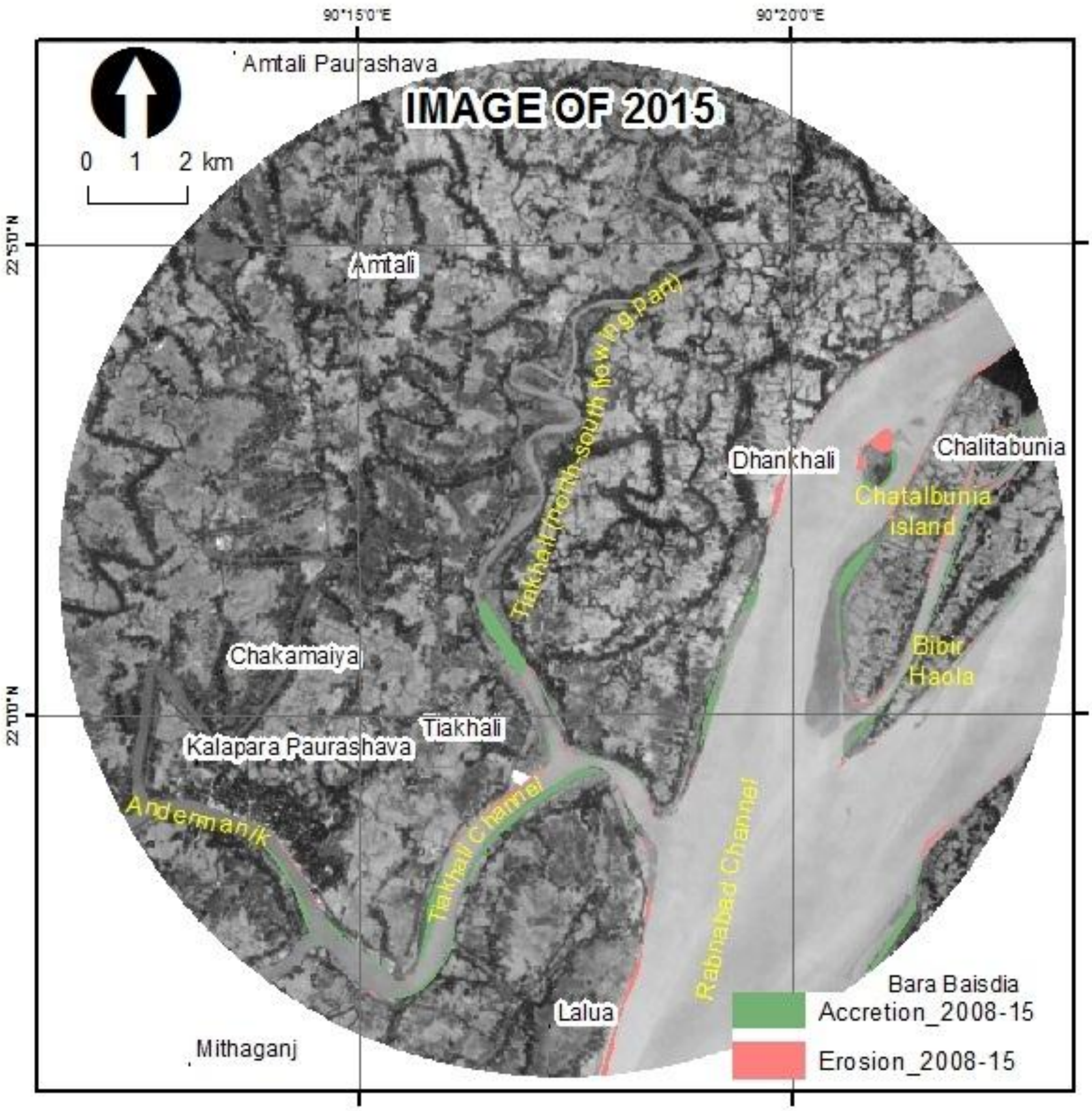


Figure 6.16: Erosion-accretion during 2008 to 2015

c. Overall erosion-accretion during 1973 to 2015

Erosion was the dominating process in the *Rabnabad* channel during 1973 to 2015 (**Figure 6.17**), although recently the erosion and accretion rates are nearly similar. During this period, a total of 844 ha of land has been eroded and 616 ha of land has been accreted. In the *Tiakhali* River, the north-south section, that has a dead-end, is dying and has been accreted. A total of 101 ha of land has been eroded, whereas 386 ha of land has been accreted. Few lands in the connecting channel of *Rabnabad* and *Andermanik* are eroding, especially in the outer bank of the channel. A summary of erosion and accretion is given in **Table 6.9**.

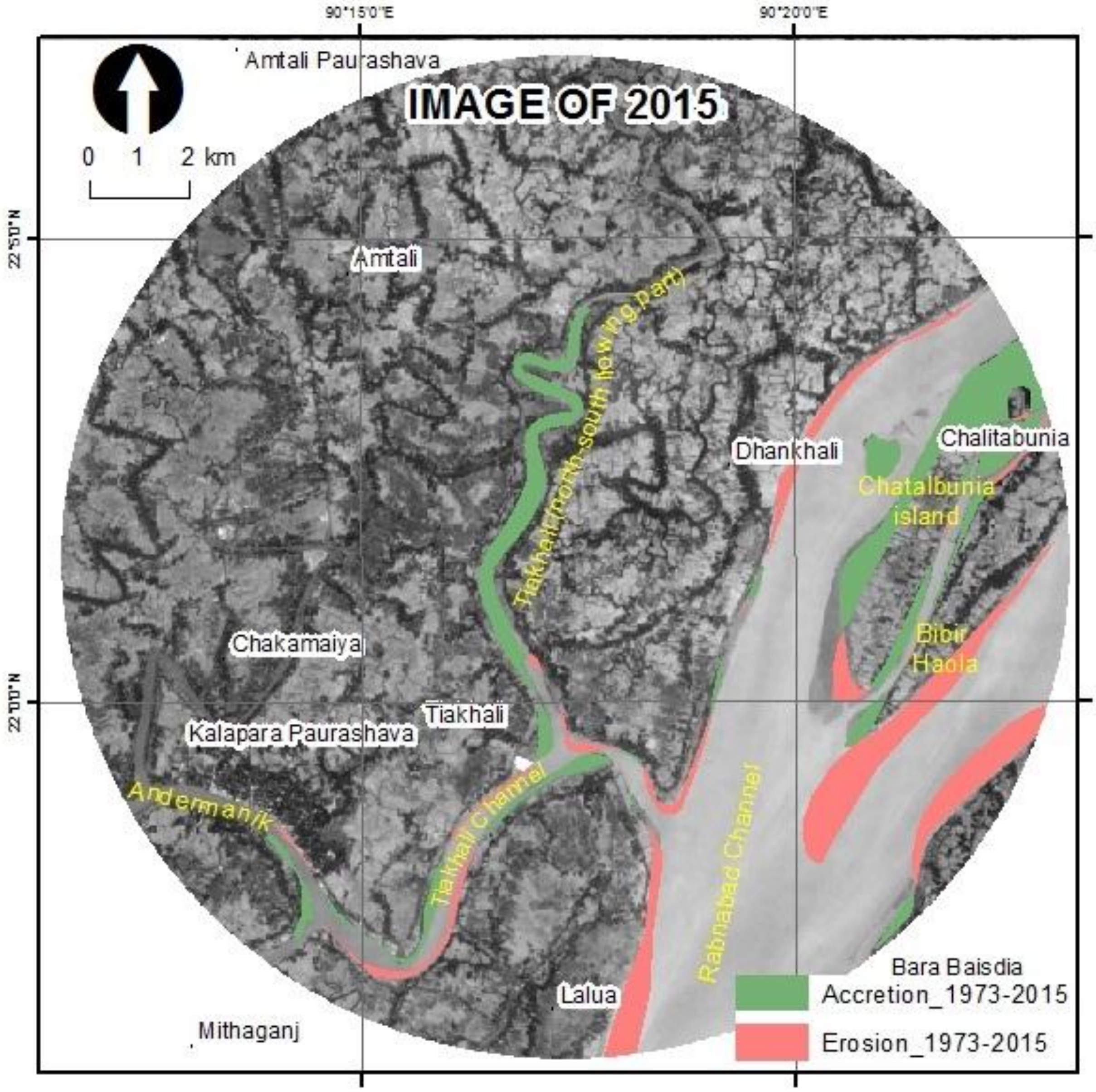


Figure 6.17: Erosion-accretion during 1973 to 2015

Table 6.9: Summary of erosion accretion

Duration	River	Rabnabad	Tiakhali	Andarmanik
1973-2008	Erosion (ha)	824	104	6
	Accretion (ha)	566	303	15
	Net accretion (ha)	(258)	199	9
	erosion (ha/yr)	24	3	0
	accretion (ha/yr)	16	9	0
2008-2015	Erosion (ha)	104	17	2
	Accretion (ha)	115	119	20
	Net accretion (ha)	11	102	18
	erosion (ha/yr)	15	2	0
	accretion (ha/yr)	16	17	3

Duration	River	Rabnabad	Tiakhali	Andarmanik
1973-2015	Erosion (ha)	844	101	6
	Accretion (ha)	616	386	32
	Net accretion (ha)	(228)	285	26
	erosion (ha/yr)	20	2	0
	accretion (ha/yr)	15	9	1

6.6.8 Water Availability

Waters are the essential living elements in any industrial development. The present power plant is located in the coastal region of Bangladesh. This area is a tidal dominating area, where sea water enters into the coastal zone twice daily in an interval of 12.43 hours. In the plant site, the available water source is the Rabnabad channel.

The tidal extent (521 sq. km) of two channels named Rabnabad and Golachipa have been considered for calculation of the tidal prism. Tidal range near the plant area varies from 3.66 m to 4.75 m round the year (**Table 6.10**). Minimum tidal range has been considered during estimation of tidal prism.

Table 6.10: Tidal range of the Rabnabad Channel

Month	Average High Tide (mPWD)	Average Low Tide (mPWD)	Tidal Range (m)
April	4.31	0.16	4.15
May	4.94	0.22	4.72
June	4.55	0.69	3.86
July	4.82	0.41	4.41
August	4.95	0.61	4.34
September	4.81	0.3	4.51
October	4.72	-0.03	4.75
November	4.89	0.22	4.67
December	4.19	0.07	4.12
January	3.89	0.16	3.73
February	3.65	-0.01	3.66
March	4.04	0.07	3.97

Source: BIWTA; 1977-2007 (Station ID: 610 , Khepupara)

The estimated tidal prism of the channel adjacent to plant site is 595 Million m^3per cycle. The present water requirement of the power plant is 5,117 m^3/hr while the net requirement is 2,544 m^3/hr. So, 0.031623 million m^3 water per cycle is required during the operation period of the plant. The required amount of water is very negligible compare to the water available in the Rabnabad channel.

6.7 Land Resources

Baseline report of land resource is prepared on the basis of primary and secondary information. Primary data was collected through field visit by a multidisciplinary team. Soil samples were collected in the primary stage. Secondary sources of data were from BARC, SRDI publication, local DAE and DL

6.7.1 Agro-Ecological Zones (AEZs)

The study area is under two different AEZs, while the project area is under one AEZ which are situated in Barisal Division of Patuakhali district. The entire project area is under Ganges Tidal Floodplain.. Details of AEZs are presented in **Table 6.11** and **Map 6.10**.

Table 6.11: Information of area coverage by AEZ

Name of AEZ	Project area (acre)	% of gross area	Study area (acre)	% of gross area
Ganges Tidal Floodplain	915.65	100	69,061	89
Young Meghna Estuarine Floodplain	0	0	8,536	11
Total	**915.65**	**100**	**77,597**	**100**

Sources: SOLARIS-SRDI-2006.

6.7.2 Land Type

Land type classifications are based on depth of inundation during monsoon season due to normal flooding on agriculture land. According to MPO, there are five land type classes: F_0, F_1, F_2, F_3 and F_4 of which there are one land type in the project area and two land types in the study areas. Details are presented in Table 6.12 and Map 6.11.

Table 6.12: Detailed land type of project and study area

Land Type	Flooding depth and characteristics	Project area		Study area	
		Area (Acre)	% of NCA	Area (Acre)	% of NCA
F_1	Land which is normally flooded between 30- 90 cm deep continuously more than two weeks to few months during the flood season.	779.18	100	38,671	95
F_3	Land which is normally flooded between 180 and 360 cm deep of inundation continuously for few months in flood season	0	0	2,035	5
	Total:	**779.18**	**100**	**40,706**	**100**

Source: Master Plan Organization, Technical Report No-1, 1987 and field observation June, 2016

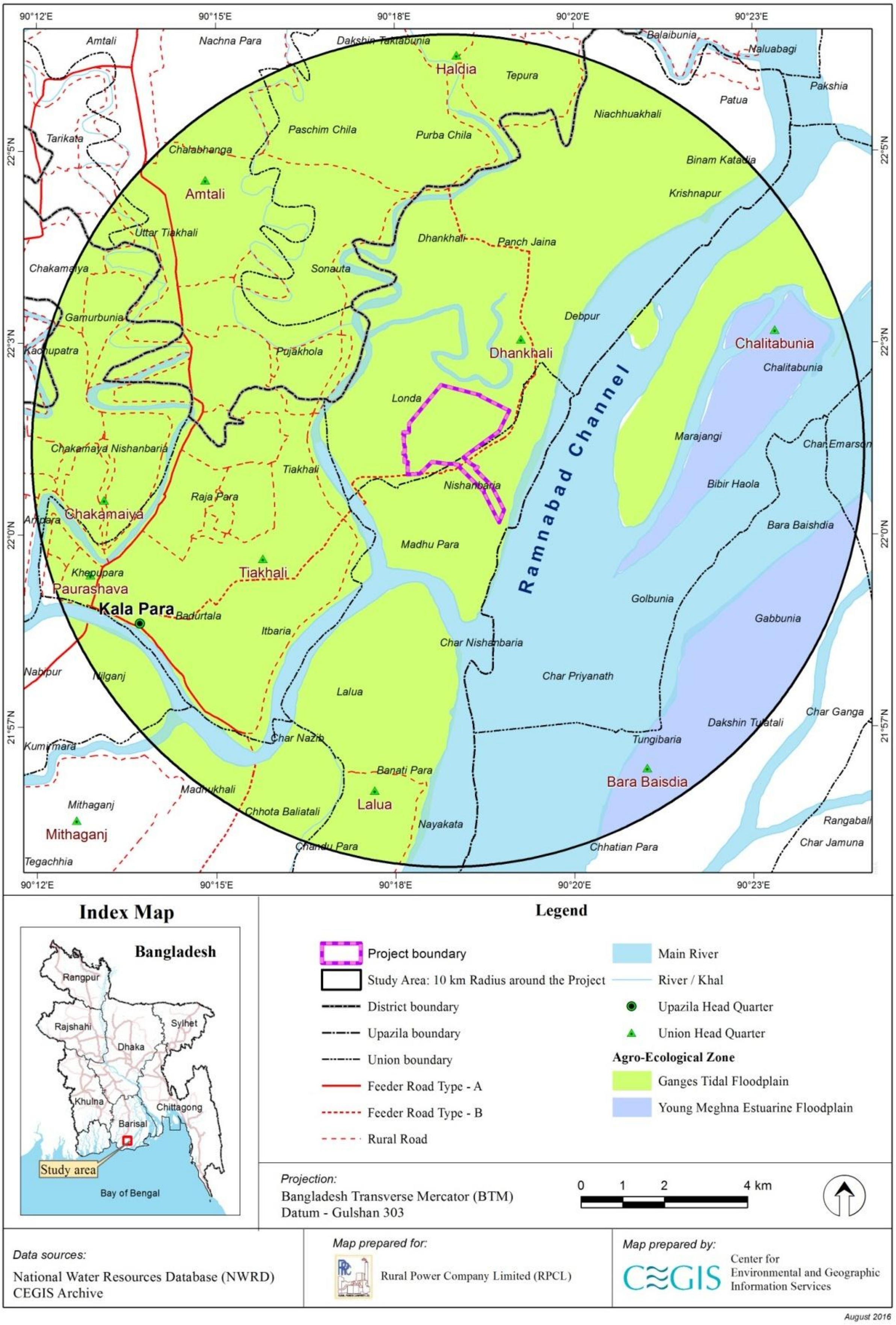
6.7.3 Soil texture

Soil texture is the relative proportions of sand, silt and clay. Soil texture is an important soil characteristic that guides crop selection, crop production and also field management. According toSOLARIS-SRDI-2006, there are four major textural classes: .a) sands b) silts c) loams and d) clays. Soil texture of the project area is clay loam. While in study area, three types of soil texture were found. Soil texture of both the study and project area is presented in Table 6.13 and Map 6.11.

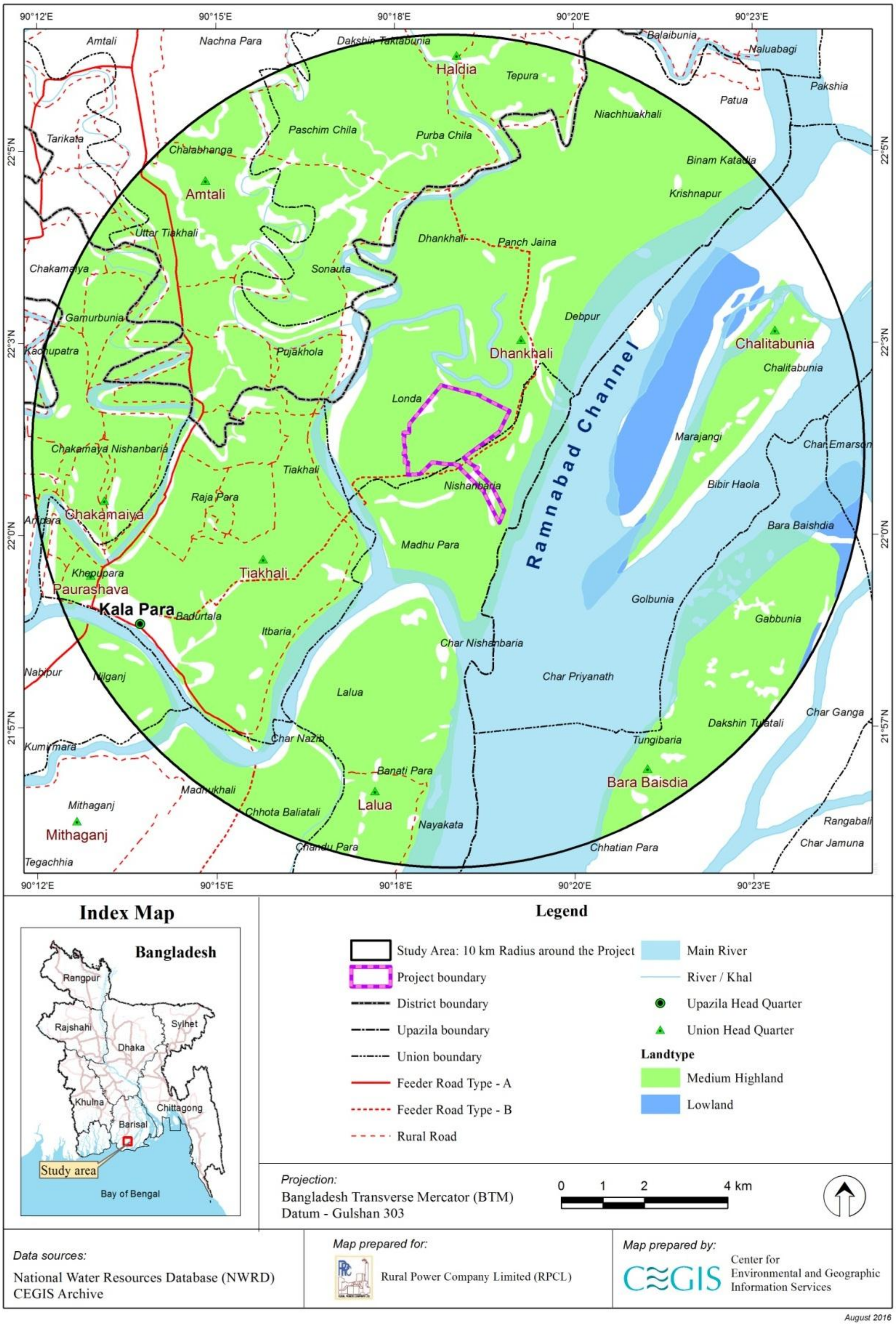
Table 6.13: Information on soil texture of the project and the Study area

Sl. No	Soil Texture	Project area		Study area	
		Area (Acre)	% of NCA	Area (Acre)	% of NCA
1	Clay	-	-	4,592	11
2	Clay Loam	779.18	100	28,871	71
3	Loam	-	-	7,243	18
Total		779.18	100	40706	100

Sources: SOLARIS-SRDI-2006.



Map 6.11: Agro-ecological zones of the Project and the Study area



Map 6.12: Land Type of the Project and the Study area

6.7.4 Soil Salinity

Salinity data of the study area was collected from the report of SRDI, SFSDP program. Soil salinity of the entire project area is slightly saline with some moderate ones. Almost half of the NCA in the study area has fallen under slightly saline with some moderately saline (S3) zone. From Mr. Musiur Rahman, Upazila Agriculture Officer (UAO) of DAE (Department of Agricultural Extension) and local farmers it is learnt that the soil and water salinity gradually increases with dryness from January and reach the maximum level in the month of March and April and then decreases due to onset of monsoon rainfall. Detailed soil salinity of both the project and the study area is presented in Table 6.14 and Map 6.14.

Table 6.14: Historical Information on soil salinity

Sl. No	Soil Salinity Characteristics	Soil salinity class	Project area		Study area	
			Area (Acre)	% of NCA	Area (Acre)	% of NCA
1	Slightly saline with some moderately saline	S_3 (8.1-12.0 dSm^{-1})	779.18	100	19,946	49
2	Moderately saline with some strongly saline	S_4 (12.1-16 dSm^{-1})	-	-	12,212	30
3	Strongly saline with some very strongly saline	S_5 (>16 dSm^{-1})	-	-	8,548	21
Total			**779.18**	**100**	**40,706**	**100**

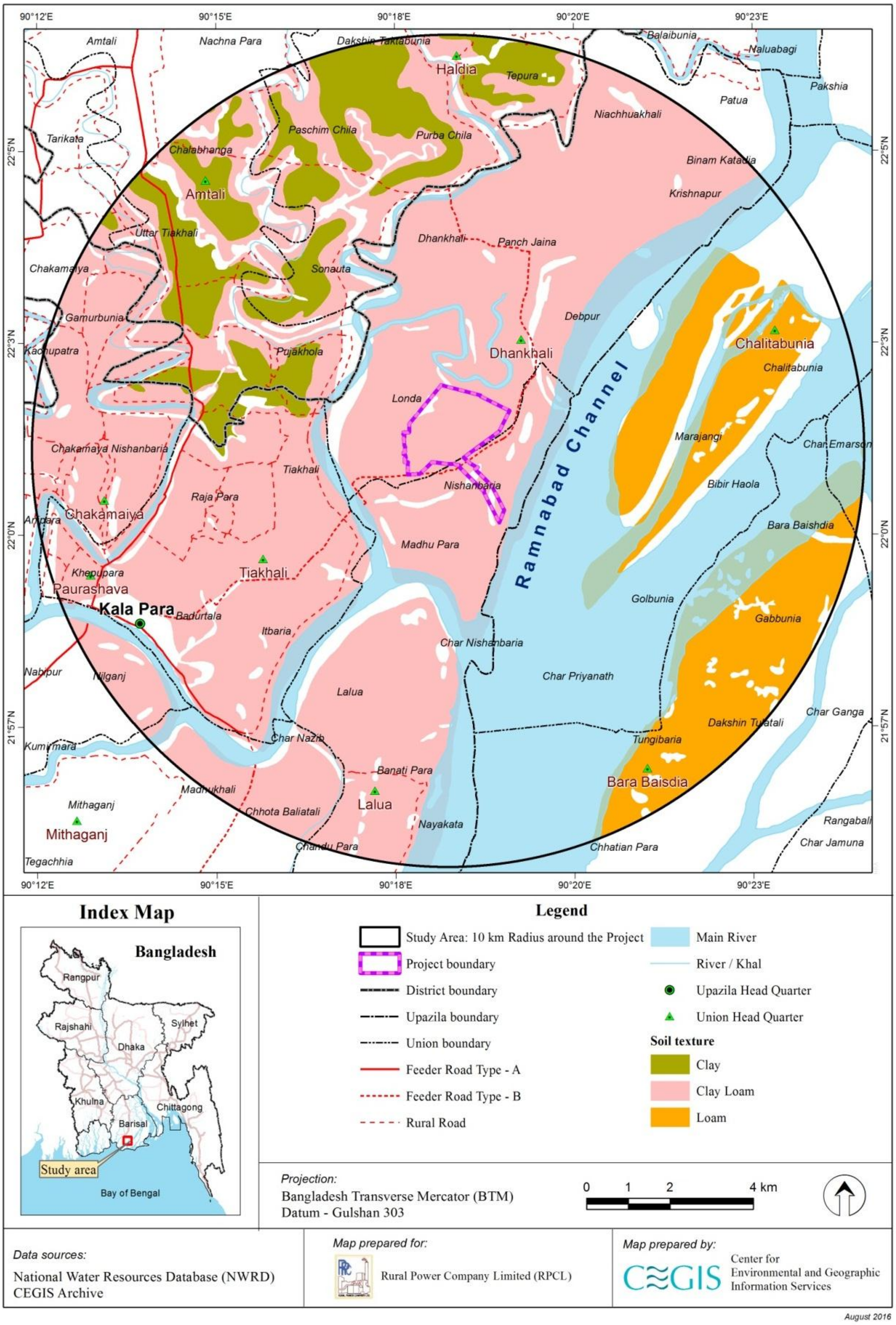
Source: SRDI; 2012

CEGIS team has collected three soil samples. One from project area (Gondabari) and the other two from study area. (Uttor Nishanbaria and Londa). These soil samples were analyzed by SRDI (Soil Resources Development Institute), Dhaka.

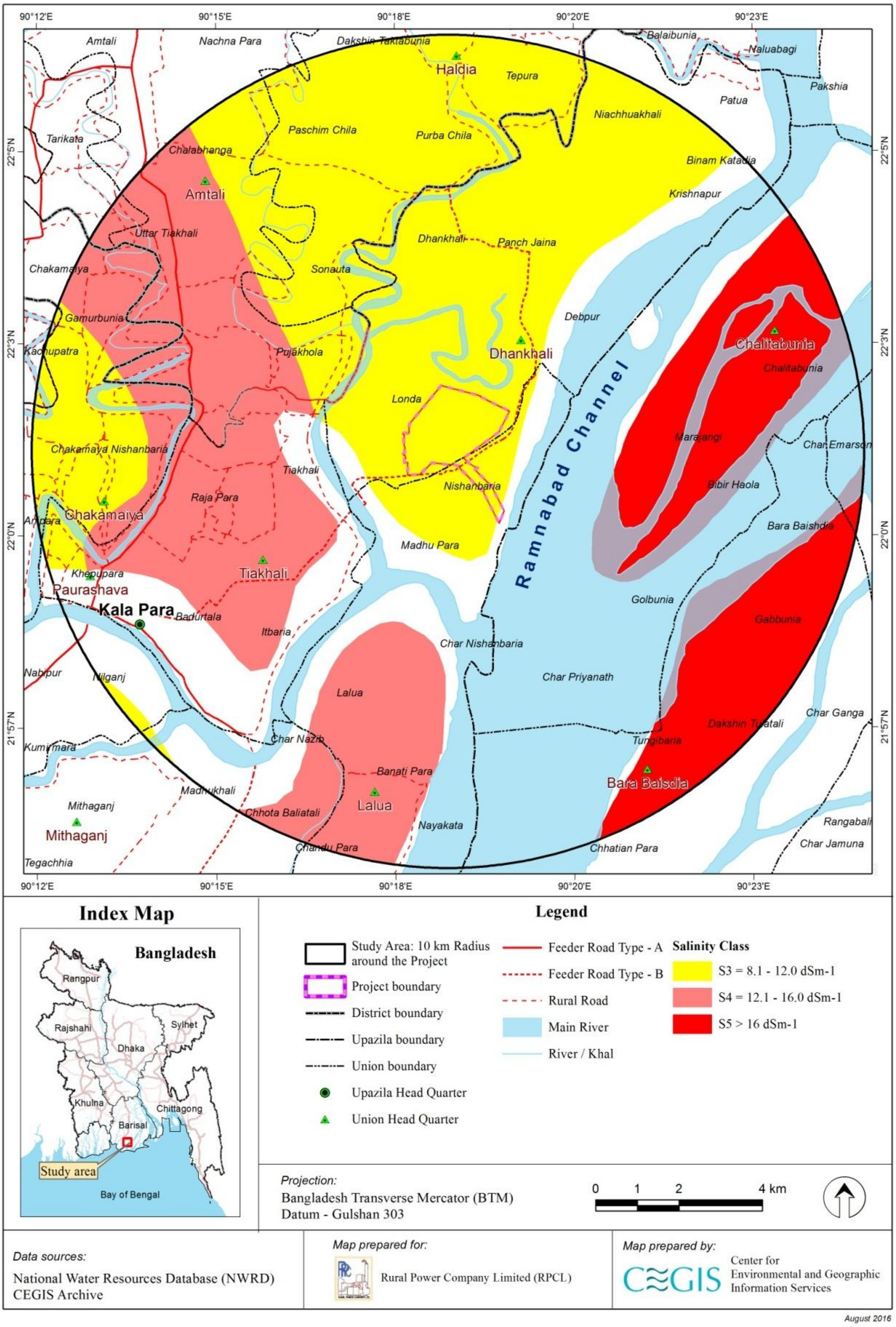
The analyzed data for soil salinaty has been shown as S1 for project area and S2 and S3 for study area in the table 6.15 belowIt might be due to the impact of poldarization of the area. Polders protect soil from regular inundation of tidal effect during dry seasons, when water salinity is very high. Details soil analysis data is presented in Table 6.16.

Table 6.15: Information on soil salinity

Area	Location	Depth of soil (cm)	Analyzed data result (ds/m)	Standard
Project area	Gondabari	0-15	2.46	**S1(2.0-4.0): -**Non-Saline with some very slightly Saline
	Gondabari	15-30	0.70	**S1(2.0-4.0):-** Non Saline with some very slightly Saline
	Gondabari	30-45	1.27	**S1(2.0-4.0): -**Non-Saline with some very slightly Saline
Study area	Uttor Nishanbaria	0-15	8.60	**S3(8.1-12.0): -**Slightly saline with some moderately saline
	Uttor Nishanbaria	15-30	7.25	**S2(-8.0): -** Very Slightly Saline with some slightly Saline
	Uttor Nishanbaria	30-45	6.26	**S2(4.1-8.0): -** Very Slightly Saline with some slightly Saline
	Londa	0-15	5.37	**S2(4.1-8.0): -** Very Slightly Saline with some slightly Saline
	Londa	15-30	2.68	**S1(2.0-4.0): -**Non-Saline with some very slightly Saline
	Londa	30-45	10.05	**S3(8.1-12.0): -**Slightly saline with some moderately saline



Map 6.13: Soil Texture of the Project and the Study area



Map 6.14: Soil salinity of the Project and the Study area

6.7.5 Soil Quality

Soil sample were collected from three locations in three depths (0-15 cm, 15-30 cm and 30-45 cm) inside the project and the study areas on 7th February, 2016. Collected soil samples were analyzed by Soil Resource Development Institute (SRDI), Dhaka. It has been found that top soil organic matter concentration is high. This condition is good for supporting plant growth. Macro and micro nutrient concentration of the soils are also sufficient, while heavy metal concentration is within the permissible limit for plant growth. Detail soil analysis result is presented in **Table 6.16.**

Table 6.16: Information on soil quality

Area	Location	Depth of soil (cm)	pH	OM	N	K	Ca	Mg	Na	P	S	B	Fe	Mn	Zn	Pb	Cd
				%		Meq/100g				µg/g							
Project area	Gondabari	0-15	8.6	1.33	0.07	0.35	22.72	4.44	2.38	17.19	55.20	16.1	26.10	29.35	0.60	0.005	0.001
	Gondabari	15-30	7.4	1.24	0.07	0.34	10.50	6.08	0.29	11.32	16.20	2.50	104.06	26.74	0.51	0.003	0.000
	Gondabari	30-45	7.9	0.97	0.05	0.40	12.01	7.87	1.11	7.95	29.28	1.89	17.75	21.86	0.50	0.007	0.001
Study area	Uttor Nishanbaria	0-15	8.5	3.10	0.18	1.09	25.84	12.19	11.26	20.95	377.20	2.18	179.72	49.98	2.27	0.004	0.004
	Uttor Nishanbaria	15-30	8.2	0.92	0.05	0.68	9.83	9.75	7.21	8.66	143.10	2.00	20.44	14.55	0.67	8.72	0.001
	Uttor Nishanbaria	30-45	8.2	0.69	0.04	0.55	7.72	8.03	6.58	11.57	77.64	1.64	9.31	6.65	0.39	0.002	0.000
	Londa	0-15	5.2	2.28	0.13	0.33	12.11	8.42	3.97	1.01	295.60	1.97	162.18	24.32	1.22	0.004	0.002
	Londa	15-30	7.6	1.69	0.09	0.32	12.84	7.56	2.76	11.51	80.00	2.40	52.12	23.23	0.50	0.003	0.001
	Londa	30-45	7.8	1.60	0.09	0.50	16.56	11.29	8.83	10.26	335.60	2.12	41.57	19.84	1.17	0.003	0.002

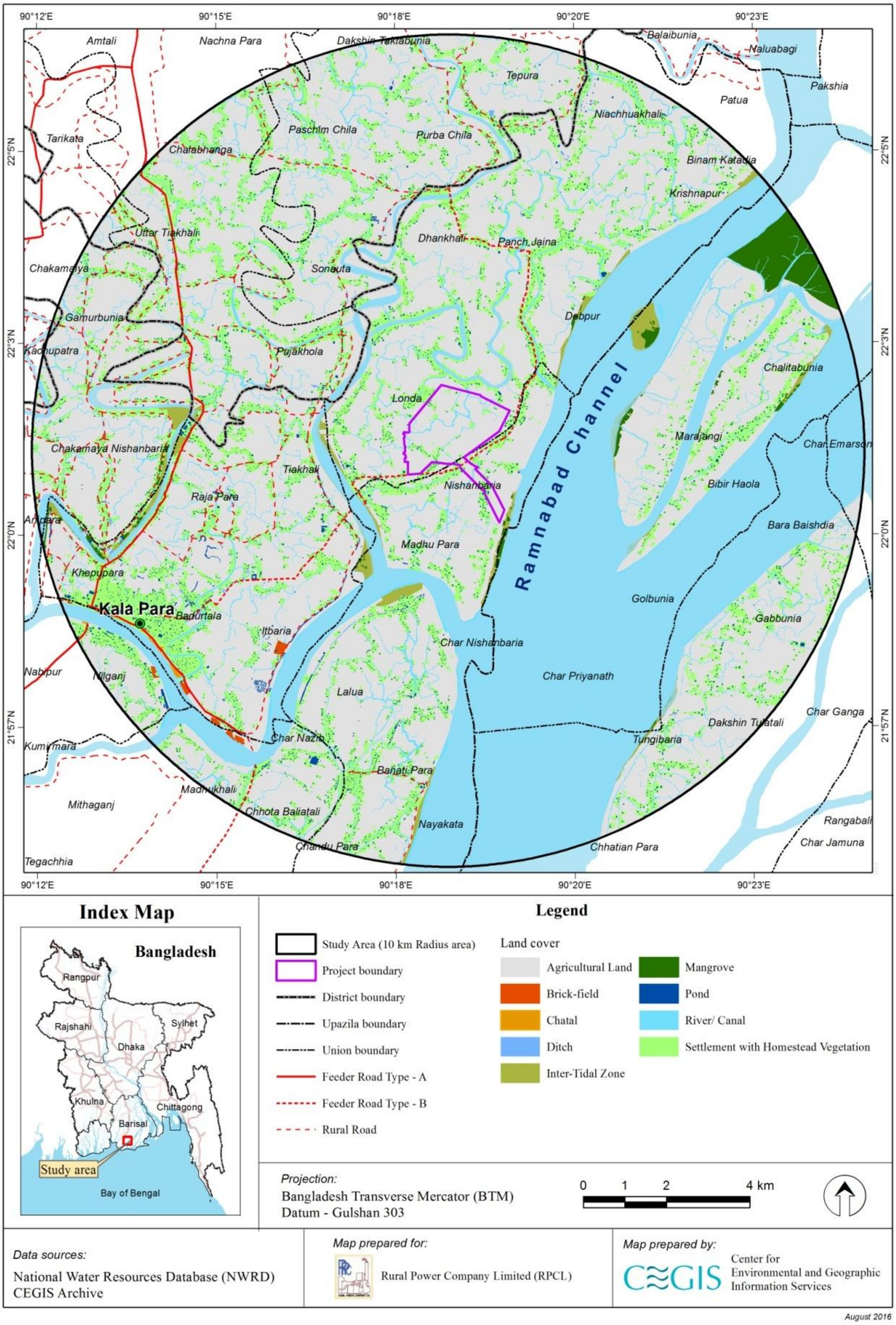
6.7.6 Land Use

The gross area of the project is 915.65 acres, where 779.18 acres is under cultivation, which is 85.10% of the gross area. In the study area of 77,597 acres, around 40,706 acres is under cultivation, which is 52.5% of gross area. Detailed land use of the study and project area is presented in Table 6.17 and Map 6.15.

Table 6.17: Information on land use of the project and study area

Land Use	Project Area		Study area	
	Area (Acre)	% of Gross area	Area (Acre)	% of Gross area
Agricultural Land	779.18	85.10	40,706	52.5
Brick-field	0	0	53	0.1
Chatal	0	0	33	0.0
Ditch	0.69	0.08	73	0.1
Inter-Tidal Zone	0	0	807	1.0
Mangrove (River bankside forest)	0	0	814	1.0
Pond	8.94	0.98	1,131	1.5
River/ Canal	45.03	4.92	22,866	29.5
Settlement with Homestead Vegetation	81.82	8.94	11,114	14.3
Total	**915.65**	**100.0**	**77,597**	**100.0**

Source: CEGIS 2015 (Rapid eye image analysis in March; 2015) and field visit at June, 2016.



Map 6.15: Land use map of the Project and the Study area

6.8 Agricultural Resources

Baseline of agriculture resources was prepared based on primary and secondary information. The secondary data were collected from DAE office in consultation with DAE personnel's. During field visit, four (4) questionnaires were filled up in four locations namely Itbaria, Chakamaya Nishanbaria, Ghenda and Dhankhali under Dhankhali, Lalua and Chakamaiya Upazilas of Patuakhali district for the interest of the study.

6.8.1 Farming practices

Farming practices largely depend on the cropping seasons. In Bangladesh, mainly three cropping seasons prevails in a year. They are Kharif-I, Kharif-II and Rabi seasons. The Kharif-I season, start from March and ends in June. This season is characterized by the uncertainty of weather of alternating dry and wet spells. The Kharif-II season comprises of wet and cloudy environment and heavy rainfall but uneven distribution, low solar radiation, high temperature and humidity. The Kharif–II season starts from July and ends in October. The Rabi season starts from November and ends in February. During this season, crops are favored with high solar radiation, low humidity and temperature, but lack of adequate soil moisture depresses the crop yield.

In the Project area, HYV Aus dominates over Jute in Kharif-I. HYV Aman is the major crop in kharif-II, while watermelon dominates in the Rabi season. Moreover, HYV Boro, Sunflower, Chilli and pulses are also grown under irrigated condition. The soils of Dhankhali (project area) are fertile and salinity level is also under tolerable limit for crop production. As a result, most of this land is cultivated throughout the cropping season.

In the study area, HYV Aus and HYV Aman dominate in Kharif-I and Kharif-II respectively, while water melon is the major crop in Rabi season.

6.8.2 Cropping pattern and cropping intensity

The dominant cropping pattern in the project area is Fallow-HYV Aman-Watermelon which occupies about 28% of the NCA. In the Kharif-I season, Local Ausand HYV Aus are grown in about 3% and 15% of the NCA and the rest of NCA remains fallow. In the Kharif-II season, HYV Aman occupies about 82% of the NCA, while the rest is covered by Lt. Aman. About 31%, 25%, 6%, 10%, 15% and 5% of the NCA is covered with Watermelon, Pulses, Chilli, Boro, vegetable and Sun flower respectively in Rabi season.

Fallow-HYV Aman-Fallow dominates (55% of NCA) the cropping pattern of the study area. Only 30% of land goes under cultivation in Kharif-I (HYV Aus-18% and Lt. Aus-12%). But in Kharif-II, almost all the area goes under cultivation, where HYV Aman (85% of NCA) is the major crop. In Rabi season, only 45% land of the NCA is being covered under cultivation and rest remains fallow due to non-availability of fresh water (**Photo 6.13** and **Photo 6.14**).

The cropping intensity of the Project area is 210%, where double and triple cropped areas are 70% and 26% respectively. Cropping intensity in the study area is 175%, where single, double and triple cropped areas are 55%, 15% and 30% of NCA respectively. A detailed cropping pattern of the project and the study and areas is presented in **Table 6.18**.

Table 6.18: Cropping pattern of both the Project and the study area

Project Area				
Kharif-I (March-June)	**Kharif-II (July-October)**	**Rabi (November-February)**	**Area(acre)**	**% of NCA**
Fallow	HYV Aman	Water Melon	218	28
HYV Aus	HYV Aman	Vegetables	117	15
Lt. AUS	HYV Aman	Water Melon	23	3
Fallow	HYV Aman	Pulses	195	25
Fallow	HYV Aman	Chilli	47	6
Fallow	Lt Aman	HYV Boro	78	10
Fallow	HYV Aman	Sunflower	39	5
Fallow	Lt Aman	Fallow	62	8
Total			779.18	100
Study Area				
Kharif-I (March-June)	**Kharif-II (July-October)**	**Rabi (November-February)**	**Area(acre)**	**% of NCA**
HYV Aus	HYV Aman	Water Melon	7327	18
Lt. Aus	HYV Aman	Pulses	4885	12
Fallow	Lt Aman	Chilli	4071	10
Fallow	Lt Aman	Boro	2035	5
Fallow	HYV Aman	Fallow	22388	55
		Total	40706	100

Source: CEGIS field visit; June, 2016

Photo 6.13: Field preparation for cultivation by using tractor (Ghenda, Dhankhali, Kalapara)

Photo 6.14: view of agricultural land in the study area, (Tiakhali, Dhankhali, Kalapara)

6.8.3 Area, yield and production

The crop area, yield and production of both the project and study area were estimated by using primary and secondary data of Kalapara Upazila under Patuakhali district. The secondary data were collected from DAE office in consultation with DAE personnel's and primary data were collected through questionnaire survey in June, 2016. Total cropped area in the proposed project is 1636 acres, of which area of rice is 997acre (61% of cropped area) acres and non-rice crop area is 639 acre (39% of cropped area). Total cropped area in the study is about 71,236 acres of which 54,953 acres (77% of cropped area) are covered with rice while the rest 16,282 acres (23% of cropped area) are occupied by non-rice.

In project area, the production contribution of HYV Aus, Lt Aus, HYV Aman, Lt Aman and HYV Boro are about 12%, 2%, 14%, 64% and 8% respectively over total rice production, while vegetables, pulse, water melon, sunflower, chilli 18%, 30%, 38%, 6% and 7% of non-rice production respectively. Total annual crop production in study area is about 229,419 tons of which rice production is about 63,257 tons (28% of total production) and non-rice crops is about 166,162 tons (72% of total production). The contribution of HYV Aus, Lt Aus, HYV Aman, Lt Aman and HYV Boro are about 15%, 8%, 7%, 66% and 5% respectively over total rice production, while production of pulse, watermelon and chilli production are 1%, 86% and 13% of non-rice production.

Detailed cropped area and crop production is presented in **Table 6.19**.

Table 6.19: Crops area, yield and production

Project Area				
Crop name	**Crop Area (Acre)**	**Yield (ton/Acre)**	**Production (ton)**	**Production Contribution (%)**
HYV Aus	117	1.3	152	13
Lt Aus	23	0.6	14	1
Lt. Aman	140	0.7	98	9
HYV Aman	639	1.2	767	67
HYV Boro	78	1.5	117	10
Total Rice	997		1148	100
Vegetables	117	0.9	105	2
Pulses	195	0.5	97	2
Water Melon	242	19.4	4686	90
Sunflower	39	2	78	1
Chilli	47	5.3	248	5
Total Non-Rice	639		5214	100
G.T.	1636		6362	122
Study Area				
Crop name	**Crop Area (Acre)**	**Yield (ton/Acre)**	**Production (ton)**	**Production Contribution (%)**
HYV Aus	7,327	1.3*	9,525	15
Lt. Aus	4,885	1*	4,885	8
Lt. Aman	6,106	0.7*	4,274	7
HYV Aman	34,600	1.2*	41,520	66
HYV Boro	2,035	1.5*	3,053	5
Total Rice	54,953		63,257	100
Pulses	4,885	0.5	2,442	1
Water Melon	7,327	19.4	142,145	86
Chilli	4,071	5.3	21,574	13
Total Non-Rice	16,282		166,162	100
G.T.	71,236		229,419	

*Source: CEGIS field visit and DAE; June, 2016 *Indicates cleaned rice*

6.8.4 Agricultural input use

Seed, labor, fertilizer and pesticides are the major inputs for crop production.

a. Seeds and labor

The role of seed is very important for growing crops. Selection of seeds should be considered on the basis of more than 85% germination rate, free from disease infestation, good in shape and size and high yield potential need to be considered. Farmers are using more seeds than the recommended dose. Almost 50% of the cultural practice for crop production is being done manually. Agricultural labor is considered as one of the essential inputs for crop production. The labor requirement is not uniform throughout the year. The number of labor requirement varies from crop to crop. The rate of labor wages varies from male and female. Average number of labor used per hectare and the seeds/ha used by farmers is shown in **Table 6.21.**

Table 6.20: Seed and labor used in the study area and project area

Crop Name	Use of seeds by the Farmers (Kg/Acre)	Labor(no/Acre)
HYV Aus	18-20	70-75
Lt. Aus	22-25	60-65
HYV Aman	18-20	60-65
Lt. Aman	22-25	65-70
Boro	25-30	80-85
Vegetable	3-4	50-65
Water melon	0.75-1	50-55
Chilli	0.75-1	55-60
Pulses	20-25	55-60
Sunflower	4-5	55-60

Source: CEGIS field visit; June, 2016

b. Fertilizer and Pesticides

The rate of fertilizers used per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Urea, TSP and MP. Most of the farmers apply fertilizers in an unbalanced way compared to recommended doses of fertilizers.

The use of pesticides depends on the degree of pest infestation. The major insects as reported by the farmers are Stem borer, Green leaf hopper, Ear cutting caterpillar, Brown plant hopper, Cut worm and Aphid of mustard. Local farmer reported that they are using different types of pesticides such as Virtako, Basudin and Ripcord etc. to prevent pest infestation both in rice and non-rice cultivation. The fertilizer and pesticides using in the field are presented in Table 6.21.

Table 6.21: Fertilizer and pesticides application in the study area

Crop Name	Farmers use fertilizer (Kg/acre)				Farmers use pesticides		
	Urea	TSP	MP	Gypsum	No of Application	Liq. (ml/acre)	Gran. (Kg/acre)
HYV Aus	45	32	20	0	1-2	283	3
Lt. Aus	32	0	0	0	0	0	0

Crop Name	Farmers use fertilizer (Kg/acre)				Farmers use pesticides		
	Urea	TSP	MP	Gypsum	No of Application	Liq. (ml/acre)	Gran. (Kg/acre)
HYV Aman	45	32	20	0	1-2	283	3
Lt. Aman	36	28	16	0	1-2	202	0
HYV Boro	85	65	32	6	2-3	364	3
Pulses	32	-	-	0	0	0	0
Vegetable	126	69	69	0	3-4	600	3
Water melon	113	227	38	-	4-5	364	3
Chili	89	49	36	49	1	-	0
Sunflower	55	45	45	-	2-3	360	2

Source: CEGIS field visit; June, 2016

6.8.5 Irrigation

Irrigation coverage of project area is 73% and in the study area is 33% of total NCA during the Rabi/dry season. At present BADC initiated DTW project in Dhankhali and surrounding Upazillas. Moreover, farmers used to irrigate their field from Tiakhali, Andarmanik, Ramnabaad channel and their tributaries and khals. Irrigation is provided by using Shallow Tube wells (STWs) and Deep tube wells (DTWs) in some places. HYV Boro, Chilli, Watermelon and Sunflower are irrigated with these pumps. Details are presented in Table 6.22.

Table 6.22: Irrigated area by crop in both project and study area

Crop name	Irrigation					
	Surface water (LLP)			Ground water (DTW)		
	Area (acre)	% of NCA	Charge (Tk./Acre)	Area (acre)	% of NCA	Charge (Tk./Acre)
Project Area						
HYV Boro	23	3	2500-2800	55	7	4000-4500
Water melon	86	11	2500-2800	156	20	4000-4500
Chili	23	3	2500-2800	23	3	4000-4500
Vegetables	62	8		55	7	
Sunflower	23	3	2500-2800	16	2	4000-4500
Study Area						
HYV Boro	611	2	2500-2800	1424	3	4000-4500
Water melon	2931	7	2500-2800	4396	11	4000-4500
Chili	3257	8	2500-2800	814	2	4000-4500

Source: CEGIS field visit; June, 2016

6.8.6 Crop production constraints

According to local farmers the constraints of crop production are:

- Salinity in khals and soils during Rabi/dry seasons.
- Scarcity of irrigation water in Rabi/dry seasons.
- Siltation of the rivers and khals (February-March).
- Water logging in rainy season (March-June; Kharif-I).

6.9 Livestock Resources

Baseline of livestock resources is prepared based on primary and secondary information. The secondary data were collected from DLS office in consultation with DLS personnel's. During field visit, four (4) questionnaires were filled up in four locations namely Itbaria, Chakamaya Nishanbaria, Ghenda and Dhankhali under Dhankhali, Lalua and Chakamaiya upazilas of Patuakhali district for the interest of the study.

6.9.1 Status of livestock and poultry

Livestock and poultry is an essential element of integrated farming system. This plays an important role in the economy of both project and study area (**Photo 6.15**). Most of the households have poultry and livestock, which significantly reduce poverty through generating income. Detail information on livestock and poultry is presented in **Table 6.24**.

Table 6.23: Present livestock and poultry in both project and study area

Name of livestock/poultry	% of H/H having livestock/poultry	Average number of Livestock and Poultry in each household	Number of Livestock and Poultry of the Project Area	Number of Livestock and Poultry of the Study Area
Cow/Bullock	30	3-Jan	108.9	25,559
Buffalo	5	2	12.1	2,840
Goat	40	4	193.6	45,438
Sheep	5	3	18.15	4,260
Duck	50	5	302.5	70,998
Chicken	70	6	508.2	119,276

Source: CEGIS field visit; June, 2016

Photo 6.15: View of cattle in the Project area (Ghenda, Dhankhali, Kalapara, Patuakhali)

6.9.2 Feed and fodder

The owners of the livestock population in the study area face problems in respect of non-availability of fodder and feeds during the months of July to November due to grazing land. Rice straw is used as the main source of fodder, because grazing land is decreasing day by day. Besides, oil cakes, rice husks are also used as fodder. The poultry population at family level survives by scavenging and generally no feed supplements are provided. However, sometimes kitchen waste becomes poultry feed.

6.9.3 Livestock and poultry diseases

Production of livestock and poultry of the study area are mainly constrained due to diseases and death of the population. Outbreak of diseases causes considerable economic loss in livestock farming. Every year, livestock population is affected by different diseases like Foot and Mouth Disease (FMD), Anthrax (Torka), Black leg (Badla), Gola fula (Hemorrhagic Septicemia), Pet fula (Enterotoxaemia), Diarrhea, Mastitis (Olan fula), Peste Des Petits Ruminants (PPR) etc. The goat cyst in head is a common disease of goat. Major poultry diseases are New Castle (Ranikhet), Fowl pox, Duck plague, Chronic Respiratory Disease (CRD) and Dysentery, etc.

6.10 Fisheries Resources

Fish is the second most valuable agricultural crop in Bangladesh and its production contributes to the livelihoods and employment of millions of people. Fish is one of the main sources of animal protein in our country that meets 60% of our daily animal protein. Fisheries sector contributes 3.69 percent of national GDP (Gross Domestic Product), which is almost one-fourth (22.60 %) of country’s agricultural GDP, 2014. Annual production of Hilsa fish is about 3.85 lakh metric ton which contributes 11% of total fish production and its market value is about 17,000 crore tk and only Hilsa contributes 1% of national GDP (National Fish Week, 2015). Bangladesh presently stands fourth in producing freshwater fish production (FAO, 2014-15). So now becoming self-reliant through fish cultivation is no longer a dream. In 2013-2014, total fish production was about 3.55 million metric ton (FRSS, 2013 - 14).

6.10.1 Fish Habitat Characteristics

Fish habitats of the study area are classified into two broad categories such as capture fisheries and culture fisheries. The capture fisheries comprises the following habitats such as the Andharmanik and the Tiakhali River, the Rabnabad channel and *khal* etcwith have tidal influence and serve as breeding and feeding grounds for brackish and some fresh water fishes. These habitats also act as important migration route like Ilish, Koral, Poa, Deshi Pangus, Bagda Chingri, Golda Chingri etc in the study area. The fresh water aquaculture is practiced in larger and homestead pond by semi intensive and extensive cultured method. Most of the homestead ponds are smaller in size and single cycle of fish culture is practiced during wet season. The larger ponds are practiced with two cycle of fish culture as the ponds contain water round the year. The Andharmanik and the Rabnabad channel are nationally important for the following reasons are shown in **Table 6.24**.

Table 6.24: Significant fish habitat in the study area

Capture Habitat	Significant reasons
Andharmanik River	**A.** Whole 40km stretch of the Andharmanik River at Kalapara Upazila has been declared as Hilsa sanctuary because of abundance of Jatka and more than 10% of the Hilsa sanctuary has been fall inside the study area.
Rabnabad Channel	**B.** Rich in Deshi Pangus fry, Prawn and Shrimp PL **C.** Important migration route and suitable spawning ground for Hilsa fish. **D.** Important source of brackish water fishes.

Ramnabad Channel

Andharmanik River

Photo 6.16: Capturefish habitat

6.10.2 *Fish Habitat Assessment*

The estimated total fish habitat of the study area is about 28,548 acre, where the sharing of the project area is about 522 acre. Fish habitat distribution is shown in **Table 6.25**.

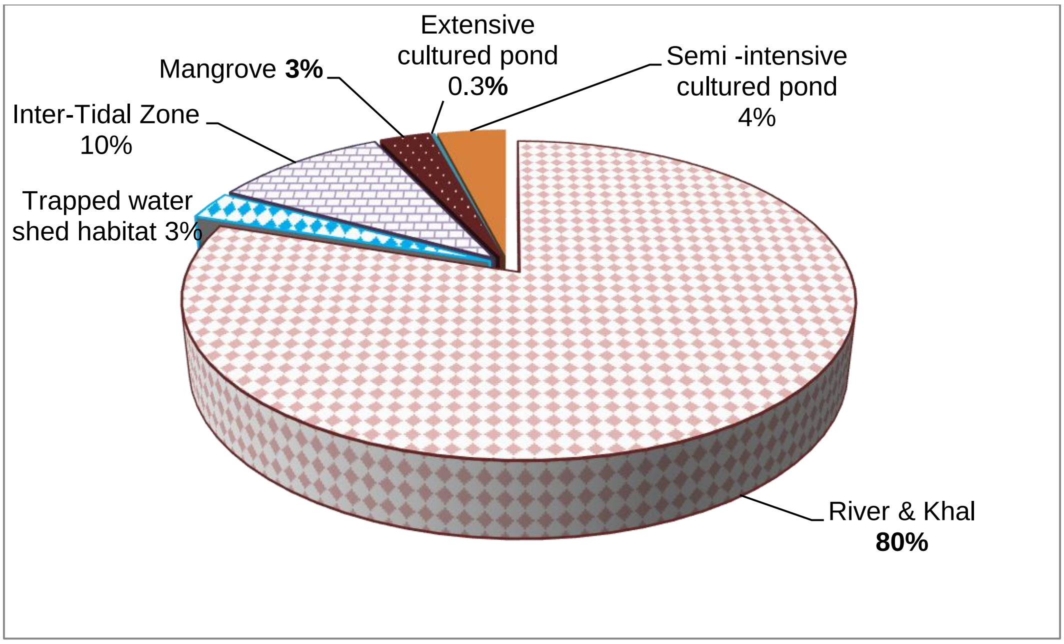
Table 6.25: Analysis of fish habitat in the study area

Sl. No.	Fisheries Habitat	Habitat Types	Study Area (acre)	Project Area (acre)
1	Capture	River/Channel/Estuary/Khal	22,866	45
2		**Trapped water shed habitat	2857	467
3		Inter tidal area	807	-
4		Mangrove	814	-
		Sub-Total=	***27,344***	***512***
5	Culture	Extensive cultured pond	73	***1***
6		Semi -intensive cultured pond	1,131	***9***
		Sub-Total=	***1,203***	***10***
		Grand Total=	**28,548**	**522**

Source: CEGIS estimation using field data, land use data prepared using RapidEye image, February 2016

**Trapped water shed habitat is not a conventional fish habitat. Rain water are trapped for one or two month for cultivating of transplanted *Amon*inside the polder which serves as temporary grazing and feeding ground for some fresh water fishes during rainy season.

Amongst the fish habitats, the capture fisheries contribute the most (about 96%) and the rest is shared by culture fisheries. River/channel/*Khal* contributes about 80% followed by tapped water shed habitats, intertidal zone, mangrove, extensive and semi intensive cultured pond as shown in **Figure 6.18**.



Source: Land use data extracted from RapidEye image in February 2016 and also validated at field level

Figure 6.18: Percentage of fish habitat area in the study area

6.10.3 Fish Production Assessment

The estimated total fish production of the study and project area is about 2,483 MT and 49 MT respectively. In case of study area, capture fisheries contributes bulk of the total production which accounts for about 2,086 MT and the rest is contributed by the culture fisheries.Aquaculture in the larger ponds are done applying semi-intensive culture technology with different species compositions such as poly- and mix culture with Indian major carps (Rui, Catla, Mrigel), Chinese carps (Grass carp, Silver carp, Bighead carp) and mono culture with mono sex tilapia culture etc. Aquaculture in the smaller ponds is generally done by applying the extensive technology. Fish productivity has been collected from the FRSS, 2015 for district level fish habitats. Fish productions from different habitats are shown in **Table 6.26.**

Table 6.26: Fish productions from different habitats

Sl. No.	Fisheries Habitat	Habitat Types	Fish Production (MT)	
			Study Area	Project Area
1	Capture	River/Channel/Estuary/Khal	1815	4
2		*Traped water shed habitat	204	42
3		Inter tidal area	34	
4		Mangrove	34	
	Sub-Total=		***2086***	***46***
5	Culture	Extensive cultured pond	386	0.1
		Semi -intensive cultured pond	10	2.9
Sub-Total=			***396***	***3***
Grand Total=			**2483**	**49**

6.10.4 ***Fishermen Status and Effort***

Mainly two types of fishermen i.e. professional and part-time carry their life and livelihoods by catching fish from different habitats of the study area. Among the fisher households of Londa village, about 40% and 60% are involved in commercial and part time fishing respectively. The professional fishermen mostly have own boat catching fish in the remote & peripheral channel, river, Khal and part time fishermen catch fish in nearby rivers, Khals etc. Around 40 boat dwelling fishermen family are dwelled in the study area and their livelihood fully depends on catching fish and most of them migrated from Barishal district. The woman of these family helps to catch fish and sometimes they catch fish herself. The professional and part-time fishermen spend time in fishing activities for 6-10 hrs/day and 4-6 hrs/day respectively. Boat dwelling fishermen are shown in **Photo 6.17.**


Photo 6.17: Boat dwelling fishermen

6.10.5 Fishing Gears

The study area has the characteristics of a mixture of estuary and inland fishing. Fishing in such habitats is carried out using diversified gears and appliances for catching different fish species. Gears used in this area and gear specific fish species are: (i) Current jal, used to catch Ilish, (ii) Tonajal, used to catch Bata, Koral, Khalla etc., (iii) Poajal, used to catch Bata, Poa, Ramsoch etc., (iv) Behundijal, used to catch Ilish., (vi) Thelajal, used to catch chingri., (vi) Net jal, used to catch PL of shrimp, (vi) Jhakijal used to catch fresh water fish,(vii) Borjal, used to catch all types of brackish water fish etc.

Current Jal

Poa Jal


Non Mechanized Craft (*Dinghi* Boat)　　　　Mechanized Craft (Trawler)

Photo 6.18: Fishing Gears

6.10.6 Collection of shrimp and prawn PL

Rabnabad channel is one of the important sources of prawn and shrimp PL. Shrimp PL are collected from mid February to mid May (Falgun - Boishak) when water salinity is relatively high and prawn PL are collected from mid May to mid August (Joistho - Srabon) when water salinity is very low.There are around two thousands prawn and shrimp PL collectors in the study area and their average income BDT 40,000-50,000 per year.


Photo 6.19: Prawn PL collected from Rabnanabad Channel

6.10.7 Fish Migration

The Rabnabad Channel, the Andharmanik and the Tiakhali River serve as a major corridor for Hilsa migration of the study area. These rivers play an important role in fish migration from sea shore to inland water bodies. Both anadromous and catadromous fishes migrate through these rivers for meeting different biological requirements throughout the year at each stage of their lifecycle. Hilsa uses the Rabnabad Channel and the Tiakhali River as diadromous migration route both from sea to upstream river migration and vice versa.Besides, the major migratory fish species of the study area are Koral, Pangus, Poa, Bata, Bagda etc. The life cycle of Hilsa is shown in **Figure 6.19**.

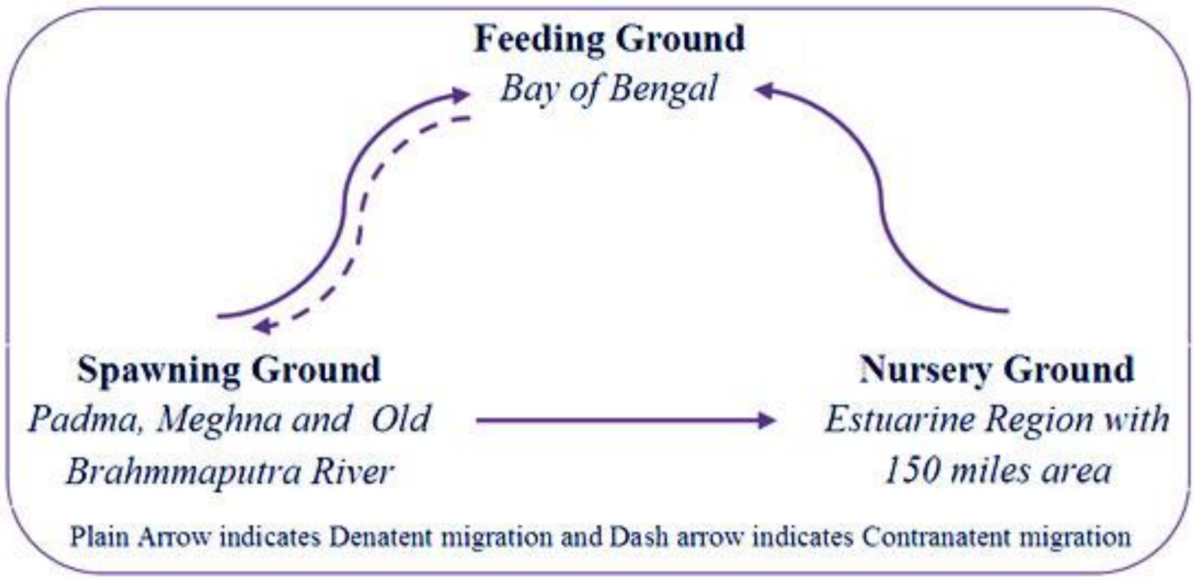
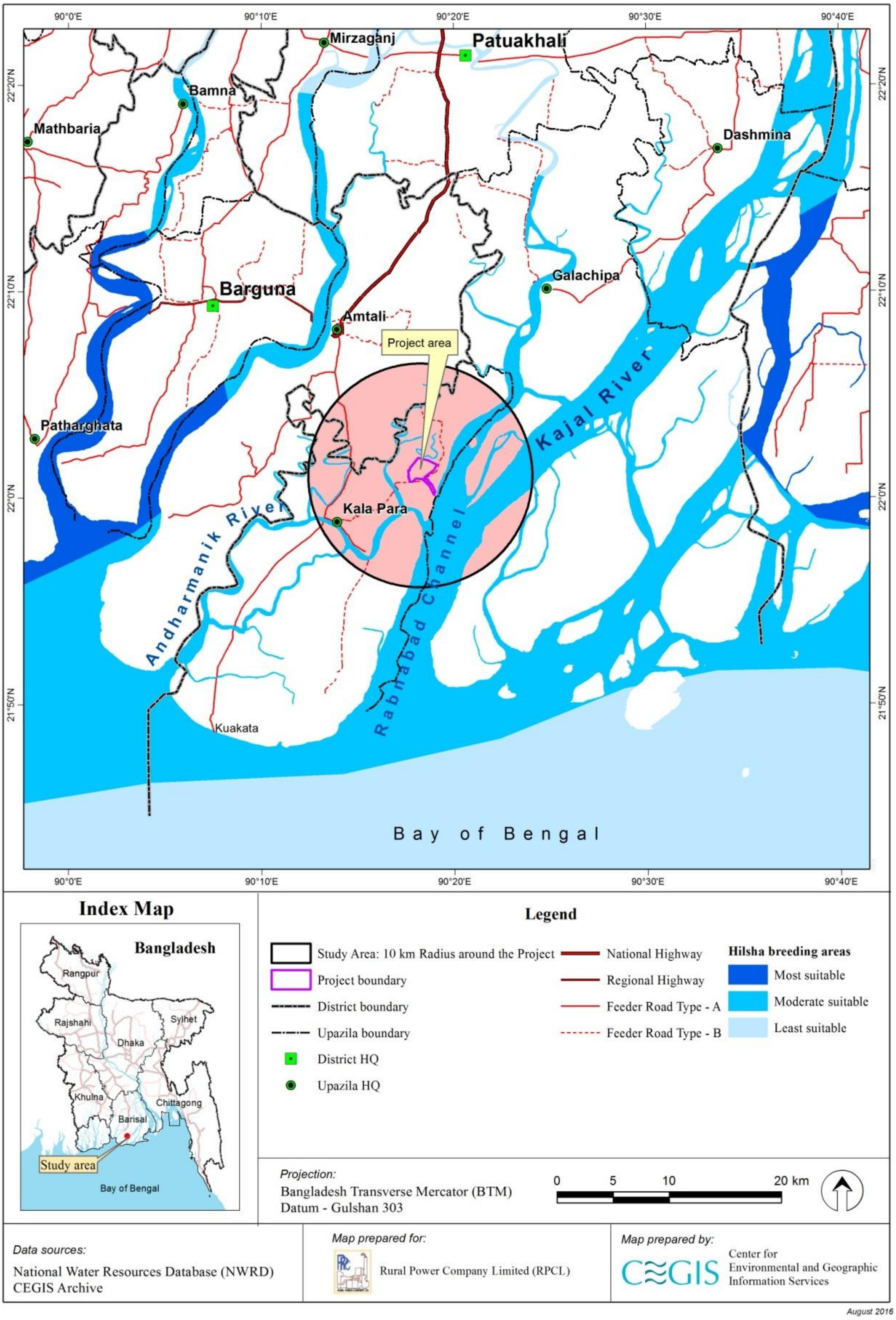


Figure 6.19: Life cycle of Hilsa fish

6.10.8 Fish spawning grounds and seasonality

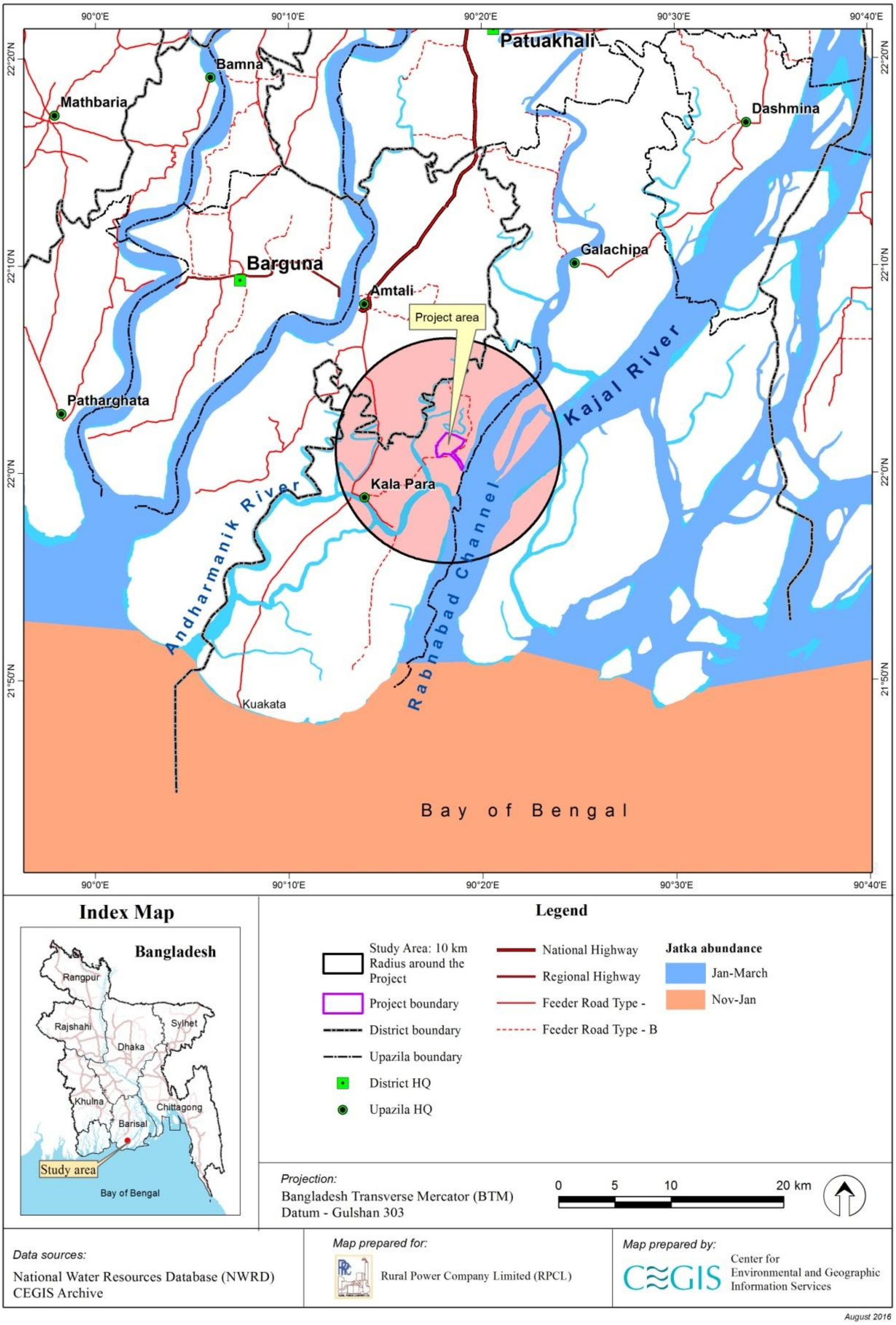
Hilsa spawns throughout the year but the peak season is September and October. Rabnaabd channel is moderate suitable spawning ground for Hilsa but suitable for other brackish water fishes. The spawning ground of Hilsa fish is shown in **Map 6.16**.

From January to March, the abundance of Jatka in the Andharmanik River and Rabnabad channel are very high and these habitats are used as nursery grounds for Hilsa. After that, adult Hilsa are migrated to the Bay of Bengal and again comes to the estuarine river for spawning. The abundance of Jtaka is shown in **Map 6.17**. Due to the high abundance of Jatka in the Andharmanik River, Government has declared it Hilsa sanctuary and shown in **Map 6.18**.



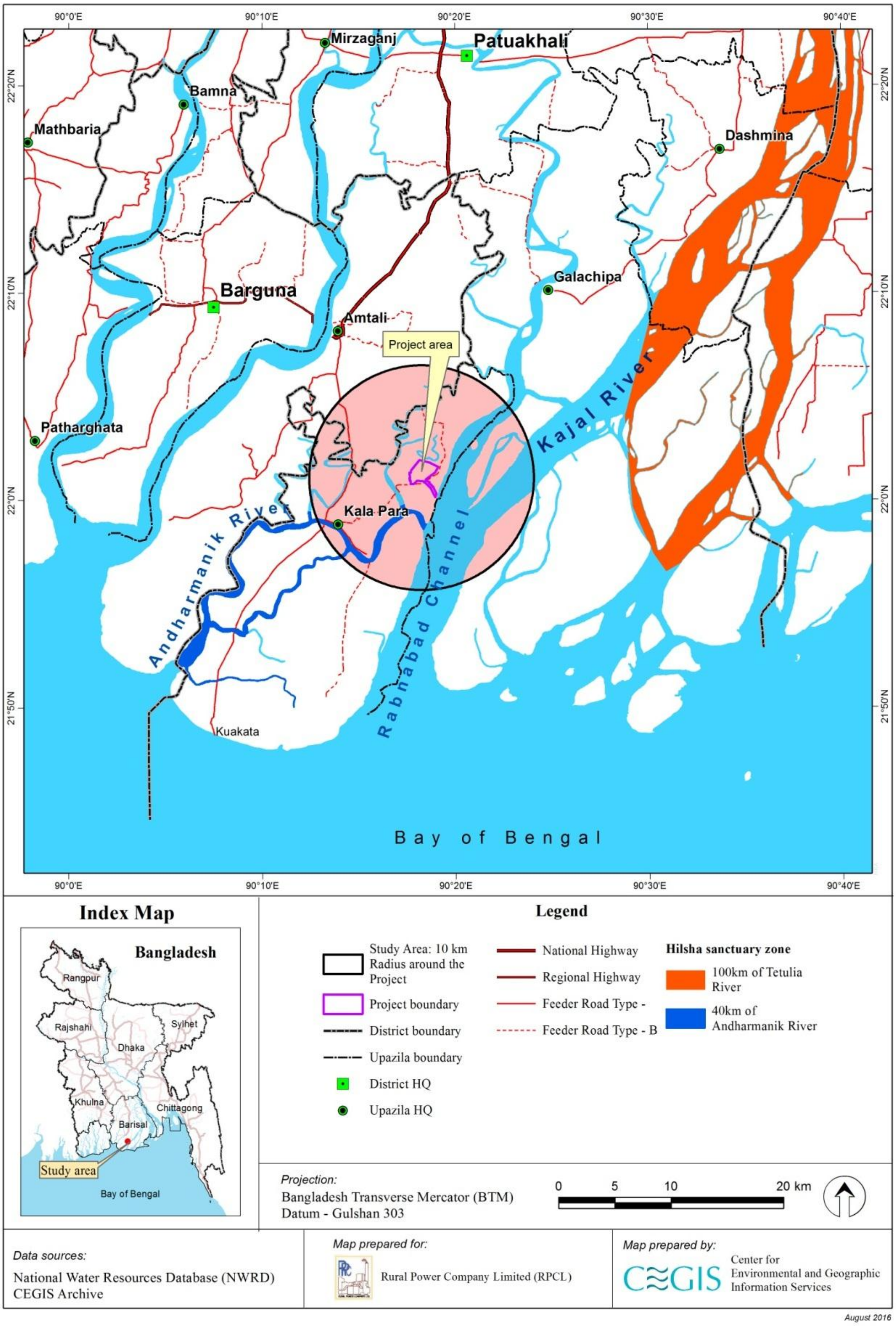
Source: DoF

Map 6.16: Hilsa Spawning Ground



Source: Dof

Map 6.17: Jatka Abundance



Source: DoF

Map 6.18: Hilsa Sanctuary at Andharmanik River

6.10.9 Fish Diversity and Composition

During consultation at Londa Kheya Ghat, local fishers and elderly people reported that the fish biodiversity is declining over the years. It is reported that the Andermanik River and the Ramnabad Channel once were available with large fish species like Ilish, Koral, Boal, Pangus, etc but the catch is now rather meager. Major factors responsible fordeclining fish diversity and fish abundance are: (i) fishing by destructive gear; (ii) increasing fishing pressure; (iii) collection of shrimp PL which cause the mortality of other fish fauna, (iv) obstruction in fish migration routes; (v) over harvesting of the natural resources (vi) shrinkage of spawning and feeding ground, etc.

The study area comprises both brackish, marine water and fresh water fish species as shown in **Photo 6.20**. The indicative fish species from different habitats of the study area are presented in **Table 6.28.**

Assemblage of Hilsha (*Tenualosa ilisha*)

Assemblage of Horina Chingri (*Metapenaeus ensis*)

Assemblage of Phasa (*Setipinna phasa*)

Assemblage of Poa (*Otolithoides pama)*

Photo 6.20: Indicative riverine fish species of the study area

Checklist of the fishes of different habitats reported by local fishers is analyzed to draw a tentative scenario of the local fish diversity of the study area.

Table 6.27: Indicative fish species diversity by habitats with IUCN status

Scientific Name	Local Name	IUCN Status	Habitat Type		
			Capture		Culture
			River/Channel/ Estuary	*Khal*	Fish Pond
Brackish water fish species					
Tenualosa ilisha	Ilish	LC	P	A	A
Otolithoides pama	Poa	LC	P	A	A
Lates calcarifer	Koral	-	P	A	A
Setipinna phasa	Phasa	LC	P	A	A
Rita rita	Rita	EN	P	P	A
Sperata aor	Aor	VU	P	P	A
Wallago Attu	Boal	VU	P	P	A
Pangasius pangasius	Pangus	EN	P	P	A
Rhinomugil corsula	Khalla	LC	P	P	A
Polynemus paradiseus	Ramsoch	LC	P	P	A
Plotosuscanius	Gang Magur	NT	P	A	A
Harpadon nehereus	Loitya	-	P	A	A
Apocryptes bato	Chiring	-	P	P	A
Penaeus monodon	Bagda Chingri	LC	P	A	A
Metapenaeus ensis	Horina Chingri	DD	P	P	A
Metapenaeus monoceros	Horina Chingri	LC	P	P	A
Macrobrachium rosenbergii	Golda Chingri	LC	P	P	A
Channa punctatus	Taki	LC	P	P	A
Heteropneustes fossilis	Shing	LC	P	P	A
Clarias batrachus	Magur	LC	P	P	A
Anabas testudineus	Koi	LC	P	P	A
Puntius spp	Puti	-	P	P	A
Labeo rohita	Rui	LC	A	P	P
Catla catla	Katol	LC	A	A	P
Cirrhinus cirrhosus	Mrigel	LC	A	A	P
Exotic species					
Oreochromis niloticus	Nilotica	-	A	A	P
Hypophthalmichthyes molitrix	Silver carp	-	A	A	P
Pangasius sutchi	Thai pangus	-	A	A	P

Note: Habitat preference (A= Absent and P=Present). Threatened category (CR – Critically endangered, EN – Endangered, VU – Vulnerable, NT - Near threatened, LC – Least Concern, DD - Data deficient)

6.11 Ecological Resources

The proposed study area (10 km radius from zero point of the project site) covers various landscapes and ecosystems. Primarily, terrestrial and aquatic ecosystems can be considered as major to the designated study area. The dominant ecosystem within the terrestrial is homestead. The other group called mangrove ecosystem exhibits amphibian characteristics is also dominant to shorelines of channels, rivers, canals and ditches. In addition, marine and coastal ecosystem has been considered to be described under ecological resources of the study area.

6.11.1 Bio-ecological Region

The International Union for Conservation of Nature (IUCN), Bangladesh has divided the whole country into 25 Bio-ecological Zones in context of biological diversity. The study area (77,629 acre include project area) passestwo Bio-ecological Zones: a) Coastal Marine Water; and b) Ganges Floodplain. The project site, direct impact area, possesses only terrestrial ecosystem. **Map 6.19** shows the bio-ecological zones of the study area (IUCN 2002).

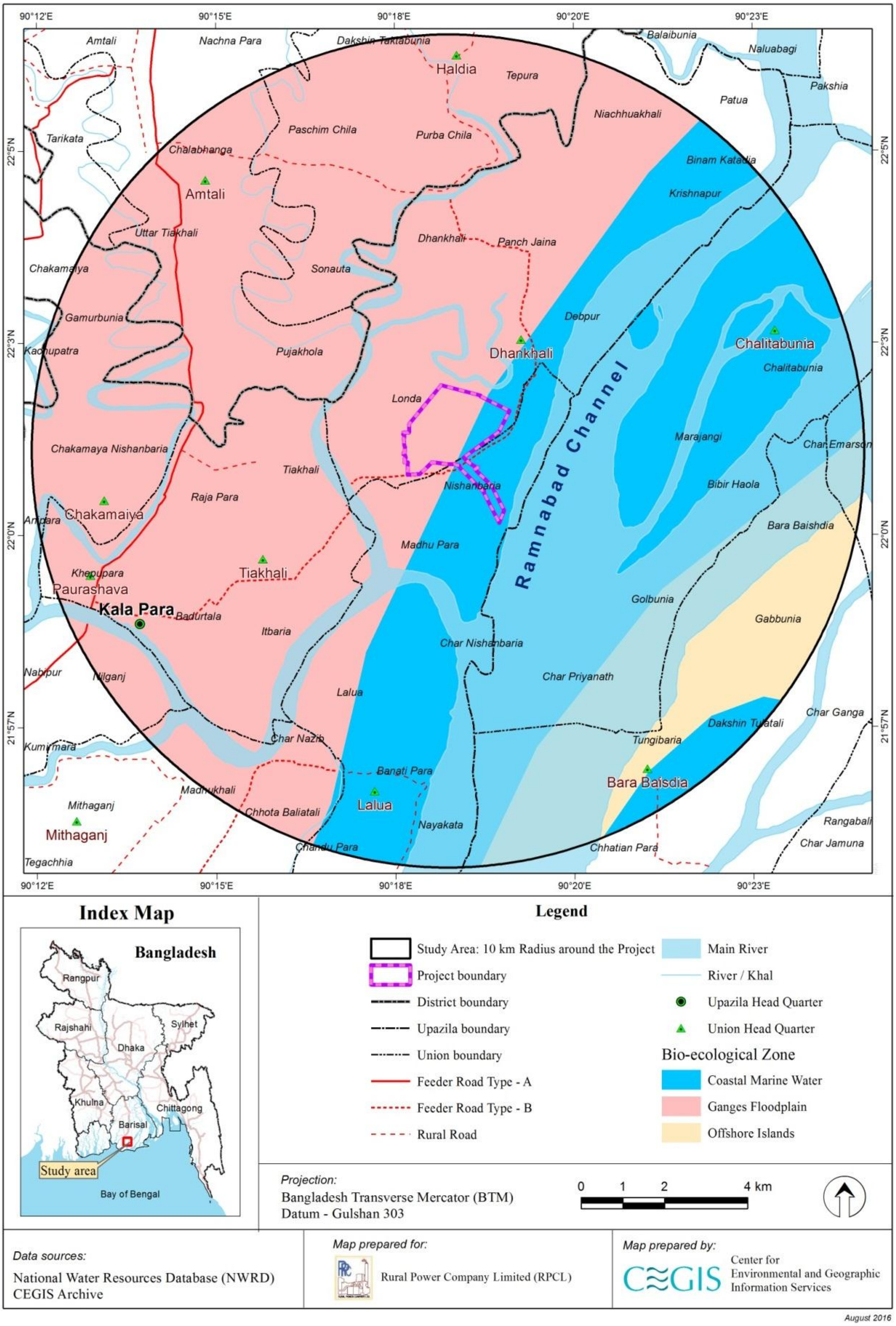
6.11.2 Ecosystem and Biodiversity

A. Proposed Area

The proposed site (915.7 acre) is mostly an agricultural land include settlements which belongs to different terrestrial ecosystems i.e. homestead, cropland, etc. The dominant plant species in this area has been noted as Coconut (47), Betel-nut (12), Indian Plum (32), Lead Tree (24), Date Palm (74), Palmyra Palm (10), Gum Tree (117), Tamarind (12), Acacia (72), Mango (114), Guava (50) and Hill Glory (112). A wide variety of plant species provides support to wildlife e.g. small to medium sized mammals, different birds, reptiles, amphibians and numerous invertebrates. Some locally dominant species have noticed during the field investigation and they are Bengal Fox, Common Mongoose, Jungle Cat, Asiatic Pied Starling, House Sparrow, Common Tailorbird, Purple Sunbird, Indian Rufous Treepie, Oriental Magpie Robin, Checkered Keelback, Bengal Lizard, Indian Bullfrog, and Common Toad. A detail list on both flora and fauna along with their conservation status is given in the A**ppendix –VII.**

Status of Biodiversity

A total of 25 species of plants from different families have been recorded from the proposed site. Of them Albizia, Coconut, Gagan Shirish and West Indies Mahogany are major species. Floral composition and species diversity of the project site has been given in the **Table 6.29**.



Map 6.19: Bio-ecological Zone of the study area

Table 6.28: Floral species composition of the proposed site

Sl. No.	Common Name	Scientific Tame	Species Diversity Index (SDI)	Density	Frequency	Abundance
1	Albizia	*Albizia lebbeck*	2.19	6.25	66.67	417
2	Bamboo	*Bambusa tulda*		2.33	50.00	117
3	Barmuda grass	*Dactylon cynodon*		15.25	66.67	1,017
4	Banana	*Musa paradisiaca*		24.25	66.67	1,617
5	Betel-nut	*Areca catechu*		0.25	83.33	17
6	Blackberry	*Sygizium cumuni*		0.33	50.00	17
7	Chhatim			0.50	33.33	17
8	Coconut	*Cocos nucifera*		3.67	66.67	183
9	Date Palm	*Phoenix sylvestris*		2.50	33.33	83
10	Dewa			1.00	33.33	17
11	Fig	*Ficus hispida*		3.00	16.67	50
12	Gagan Shirish	*Albizia richardiana*		8.50	50.00	283
13	Guab			0.50	33.33	17
14	Guava	*Psidium guajava*		7.00	16.67	117
15	Indian Plum	*Zizyphus mauritiana*		1.50	33.33	50
16	Ipil-ipil	*Laucenea leucephala*		7.00	16.67	117
17	Jackfruit	*Artocarpus heterophyllus*		2.00	16.67	33
18	Mango	*Mangifera indica*		1.00	16.67	17
19	Mehedi	*Lawsonia inermis*		1.00	16.67	17
20	Neem	*Azadirachta indica*		1.00	16.67	17
21	Palmyra Palm	*Borassus flabilifer*		1.00	16.67	17
22	Papaya	*Carica papaya*		1.00	33.33	33
23	Pink Morning Glory	*Ipomoea carnea*		5.00	50.00	83
24	Pitali	*Trewia nudiflora*		2.00	33.33	17
25	West Indies Mahogany	*Swietenia mahogani*		18.00	50.00	600

Source: CEGIS Field Survey, June 2016

The proposed project site falls partially on settlemement and it possess different fruit and timber trees of different size and ages. A total of 55 individuals including saplings were measured during the field visit. The following **Table 6.29** represents the actual scenerio of exisitng trees of the proposed site.

Table 6.29: Existing trees of the project area.

Sl.	Species	DBH (inch)	Average Height (feet)	Sample Size
1	Albizia	10	20	10
2	West Indies Mahogany	8	20	5
3	Date Palm	12	7	10
4	Palmyra Palm	16	22	5

Sl.	Species	DBH (inch)	Average Height (feet)	Sample Size
5	Acacia	10	20	10
6	Mango	12	16	10
7	Coconut	14	20	5
			Total	**55**

Source: CEGIS Field Survey, June 2016

B. Study Area

The status of biodiversity of this investigated area varies slightly by locations because the landscape patterns throughout the study area more or less are same. A small island called Chalitabunia across the Rabnabad Channel supports asmall stand of trees important for birds because of its isolation from the terrestrial predators.

The study area supportsmany habitats with different species of flora and fauna. Ecosystems of the study area can be divided into two major categories in accordance with their vegetation patterns and landscapes: i) Terrestrial ecosystem, and ii) Aquatic ecosystem. Other two ecosystems namely mangrove as well as marine and coastal ecosystems also exist in this study area.A habitat map is presented in the **Map 6.20**.

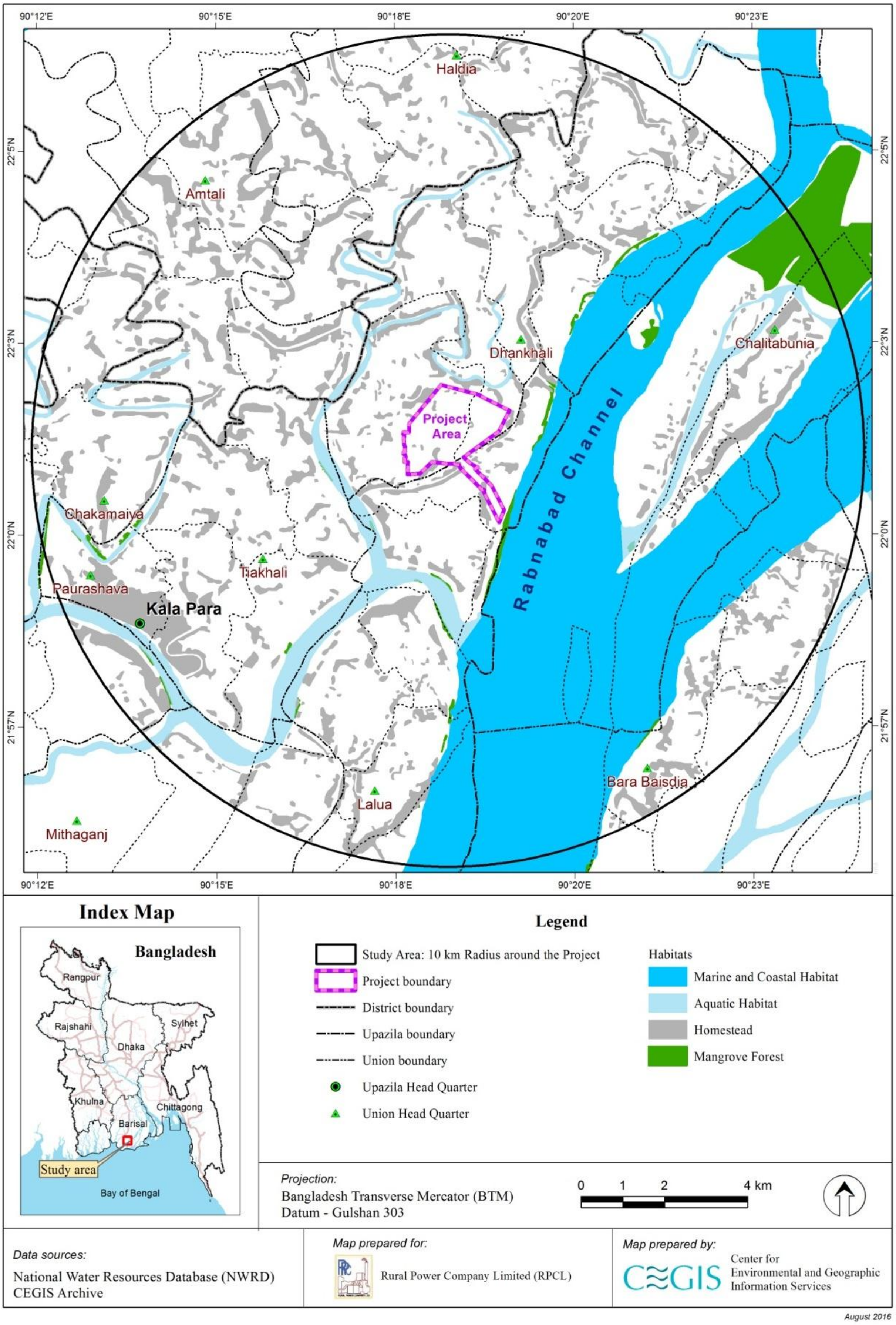
Terrestrial Ecosystems

The terrestrial ecosystem is the composition of flora and fauna of any given area. This ecosystem is vast and most dominant compared to others. The diversity of species both flora and fauna in terrestrial ecosystem is high compared to other ecosystems in any location of the country. The following vegetations were noticed in this study area.

- **Homestead vegetation**: This type of vegetation occurs within the home territory and/yard having diversity of trees including fruits, timbers, fuel and medicinal plants as Mango (*Aam*), Coconut (*Narikel*), Banana (*Kola*), Acacia (*Akashmoni*), West Indies Mahogany (*Mehogani*), Neem (*Nim Gachh*), etc.
- **Crop-field vegetation**: This vegetation type of vegetation occurs within the crop varieties, peripheries and isles of the cropland people widely called weeds. The crop field vegetation in this study area is less diversified in comparison with crop varieties. The noticeable species are SpinyAmaranth (*Katanotey*), Mexican Tea (*Chapali Ghash*), Glorybower (*Bhat*), Burmuda Grass (*Durba Ghash*), and Goose Grass (*Chapra Ghash*).
- **Roadside vegetation**: This type of vegetation is very dominant in this study area but less diversified throughout the study area include project area. The road slopes are usually planted with fast growing and exotic species. Few species also observed throughout the study, those are not dominant but have great contribution to ecosystem functions on the way of survive. The roadside vegetation recorded as Acacia (*Akashmoni*), Rosewood *(Sisu*), Lead Tree (*Ipil-ipil*), Date Palm (*Khejur*), Fig (*Dumur*), etc.

Aquatic Ecosystem

- Aquatic ecosystem belongs to many rivers and their tributaries, channels, khals, homestead ponds, floodplains and ditches. The main water ways connected to the proposed project area including Tiakhali, Agunmukho and Andaman rivers, and Morichbunia as well as Madhupara khals. Moreover, the Rabnabad channel of the Bay of Bengal is very close (<1km) to project area. It has valuable biological resources include the benthic community and planktons. Information on benthos and planktons on Tiakhali River system and Rabnabad channelboth dry and wet seasons are presented in the T**able 6.30-6.31**



Map 6.20: Habitat map of the study area

Table 6.30: Dominent benthos and planktons in dry season

Water system	Benthos (Unit/M)	Plankton		Total (no/L)
		Phytoplankton (unit/L)	Zooplankton (unit/L)	
Tiakhali River	0	Diatom 453	*Arcelia vulgaris* 861 *Nauplius* and *Metanauplius* 2102 Cyclops 68	3032
Rabnabad Channel	-	Diatom 48	*Arcelia vulgaris* 60 *Keratella cochlearis* 6 *Nauplius* and *metanauplius*132 *Cyclops*18	216
Gondabaria intake	Policheat (Annedia) 1 Lucifer (Crustacea) 6 Unidentified mites (Arachnida) 1	-	-	08
Total	**08**	**501**	**3247**	**3256**

Table 6.31: Dominent benthos and planktons in wet season

Water system	Benthos (unit/M)	Plankton		Total (no/L)
		Phytoplankton (unit/L)	Zooplankton (unit/L)	
Tiakhali River (Sample 1)	Polychaetes,Annelid -1	0	Arcella- 1 Cyclops-3 Daphnia- 3 Moina – 2	1200
Tiakhali River (Sample 2)	Gastropods-Mollusca- 7 Polychaetes- Annelida- 4	0	0	0
Rabnabad Channel (Sample 1)	Polychate-Brachiura-1 Small Mollusca- Gastrpods - 3	Diatom (*Stephanodiscus*) -1	Crustacean Nauplius- 1	213
Rabnabad Channel (Sample 2)	Polychaetes,Annelid -2 Gastropods-Planorbis - 3	Spirogyra- 2	*Diaptomus- 1* Anuraea (Rotifera)-1	440

Note: Samples of dry (February 2016) and wet seasons (June 2016) were analyzed in the laboratory of Zoology, University of Dhaka

Aquatic Flora

The existence of aquatic flora relies upon the nature of wetlands i.e. free flowing or stagnant water, water quality, etc. The entire water ways are tidal influenced except the homestead ponds and ditches. The latter two stagnant water bodies keep different free-floating species. In a few locations, small numbers of Water Lily were sighted very occasionally. The mangrove and marine ecosystem has been described separately in the following sections.

Mangrove Ecosystem

This is an ecosystem of incredible biological diversity of hundreds of aquatic life-forms like algae, numerous invertebrates and vertebrates. The trees intricate network of roots provides a shelter to many oceanic species. The mangrove forest provides nourishes to many more organisms while certain species spend their entire lifespan in this ecosystem. As a consequence, the mangroves' well being is central to health of many ecosystems. The proposed study area is the delta of the Bay of Bengal which belongs to mangrove ecosystems in some certain locations. The biodiversity of this ecosystem has been considered as moderate on the basis of major field investigation.

Marine and Coastal Ecosystem

The coastal area within the study area offers different marine habitats like sandy and muddy intertidal zone and mangroves for a variety of resident and migratory birds. The birds use these habitats as their active feeding ground especially during low tide. A large numbers of migratory species pass this area and a small population of them in the form of juveniles and non-breeding adults take shelter in coastal areas. The intertidal area also supports significant populations of migratory shorebirds, gulls and terns together with large feeding flocks.

Marine turtles are commonly represented by Loggerhead Turtle and followed by Olive Ridley and Hawksbill. However, marine turtles have not been sighted at coasts during the major field investigation. Information on marine turtle's was received from locals through people interviews. The marine mammals are represented by Ganges River Dolphin and Porpoise in the coastal waters. As per consultation with the experts, the down stream of Rabnabad channel especially at the estuary reagion are suitable for Irrawady Dolphins. However, Gangetic dolphins are presented at the Rabnabad and Andharmanik river according to the consultation with the fisher but not sited during the field investigation. Actually, Dolphins communities are relativelely lower than the rivers of Sundarbans area.

6.11.3 Status of Biodiversity

A. Floral Abundance

The settlement and homestead pattern of the area is almost identical to each other. The study mostly considers the settlement and homestead ecosystem of the villages closer to the site for biodiversity analysis. The villagesvisited during the major field investigation are Char Nishanbaria, Morichbunia, Gondabaria, Lunda and Dhankhali. The ecosystem possesses 15 tree species which are dominated by Acacia, West Indies Mahogany, Banana and Guava. A list of tree species of the homestead is presented in **Table 6.32**.

Table 6.32: Indicative tree species in the settlement/homestead

Common Name	Species Name	Density/Acre	Using Parts	Usage
Jackfruit	Artocarpus heterophylla	7	Fruit and trunk	Food, Timber
Mango	Mangifera indica	20	Fruit and trunk	Food, Timber
Bansh	Bambusa Spp.	25	Trunk	Thatch
Acacia	Acacia auriculiformis	120	Whole plant	Timber, Fuel
Charcoal	Trema orientalis	2	Whole plant	Fuel
Banana	Musa Spp.	85	Fruit	Food
West Indies Mahogany	Swietenia mahagoni	64	Trunk and fruit	Timber and medicine
Neem	Azadirachta indica	4	Trunk and fruit	Timber and medicine
Guava	Psidium guajava	20	Fruit	Food
Betel-nut	Areca catechu	5	Fruit and trunk	Food and Thatch
Wood Apple	Aegle marmelos	1	Fruit	Food and medicine
Litchi	Litchi chinensis	1	Fruit	Food
Lemon	Citrus indica	1	Fruit	Food
Mehedi	Lawsonia inermis	1	Leaf	Aesthetic
Coconut	Cocos nucifera	15	Fruit, leaf and trunk	Food and thatch

Source: CEGIS Field visit, June 2016

B. Fauna

In this study only the higher vertebrate group has been considered to conduct. Of the higher vertebrates, the wildlife species are described below in accordance with their hierarchy.

The amphibians possess diversified life. At an early stage they pass life in an aquatic environment and later in lands in accordance with their instinct characteristics. Some species remain in the water throughout the lifespan are called aquatic amphibians. The amphibians considered very sensitive to environmental changes. The study area is a saline prone area, so, the diversity and population of the amphibians is moderate. Dominant amphibians recorded as Common Toad (*Kuno Beng*), Indian Bullfrog (*Sona Beng*), Cricket Frog (*Jhi-Jhi Beng*), Common Tree Frog (*Pati Gecho Beng*) and Ornate Microhyla (*Choto Laubichi Beng*) within the study area boundary.

The reptiles are more or less diversified in comparison with amphibians. The reptiles in this study area were found in different habitats i.e. homestead, cropland, roads and embankments and settlement vicinity. Of the reptiles, turtles and tortoise are quite occasional and there is no recent record of their existence. The lizards, skinks and snakes are frequent species like Common Garden Lizard (*Girigiti*), Northern House Gecko (*Tiktiki*), Little Skink (*Anjan*), Brahminy Skink (*Anjan*), Bengal Lizard (*Gui Shap*), Banded Krait (*Shankhini Shap*), Monocellate Cobra (*Gokhra Shap*), and Vine Snake (*Laudoga Shap*).

The availability of birds depends on the source of food and nesting facilities. Homestead and roadside habitat support most of the avifauna survival and parental care to their offspring. Besides, the corn fields offer insectivores to get nourishes through taking insects from corn fields. During the major field investigation avifauna were recorded through direct observation and dominant species noted as Asian Pied Starling (*Pakra Shalik*), Common Myna (*Bhat Shalik*), Jungle Myna (*Jhunti Shalik*), Black Drongo (*Kalo Fingey*), Oriental Magpie Robin (*Doel*), House Crow (*Pati Kak*), Brahminy Kite (*Shankho Cheel*), Blue-eared Kingfisher (*Dholachokh Machhranga*), Red-vented Bulbul (*Bangla Bulbuli*), Blue-tailed Beeeater (*Suichora*), Baya Weaver (*Charui*), Indian Rufous Treepie (*Harichacha*), and Common Tailorbird (*Suta Tuntuni*) within the study area. Those are recored at the river bank, mangrove vegetation, and homestead trees.

The mammals are very magnificent animals but they are now in peril due to habitat destruction, scanty of food resources and human induced pressures. Diversity and density of vegetation in the coast is not dominant in comparison with tropical areas. Thus, habitat structures and their quality are not suitable for such magnificent animals. Out of the mangrove forest, the village' groves are only habitats for mammals and enhance their population but existing habitats are insufficient to support viability of population. No large mammals have seen during the major field study. Currently, small to medium-sized mammals found in various ecosystems like homestead, agricultural land, fallow land, roads, etc. Jungle Cat (*Bonbiral*), Common Mongoose(*Boro Beji*), Northern Palm Squirrel(*Dora Katbirali*), Bandicoot Rat(*Metho Indur*), Indian Flying Fox (*Kola Badur*), Indian Hare(*Khorghosh*), Greater Short-nosed Fruit Bat(*Bocha-nak Kola Badur*) and Bengal Fox (*Khek Shial*) were noted as available through peoples' interviews. A list of wildlife species is provided in the **Appendix-VII.**

6.11.4 Existence of important habitat near the proposed site

The project site is very close to Rabnabad channel having connectivity to the Bay of Bengal is home to many aquatic mammals and waders as well. Specifically, no important bird area (IBA) declared by the Birdlife. But marsh, ditches, and wetlands are very important to waders including the wintering birds as their feeding ground and stopovers exist with a limited numbers. The mangrove ecosystem occurs within the study area can be mentioned as Rabnabad Channel and Payra River system. The PayraRiver systemis aplace for roaming, surfing, and diving of Ganges River Dolphin. It has been classified as vulnerable (VU) speciesby the IUCN-Bangladesh (2015).

6.11.5 Existence of flyway in the study area

Two international wintering birds' flyways namely the East Asian and Australasian crisscrossed the country for searching their destination as feeding ground during the winter season. The study area does not possess many stopovers due to its insufficient safe wetlands. Two major wetlands in this study area namely the Payra and Tiakhali River systems have been considered as disturbed to waders due to human pressure.

6.12 Socio-economic Condition

The data on the socio-economic condition of the inhabitants of the study area were collected from both primary and secondary sources. The primary data were collected using a range of Rapid Rural Appraisal (RRA) tools and techniques including Key Informant's Interviews (KIIs), Focus Group Discussions (FGDs), observation and informal public consultations. On the contrary, relevant secondary information was compiled from the community series of the Population Census, 2011 published by Bangladesh Bureau of Statistics (BBS)

6.12.1 Area and Location

Administratively, the study area consists of 10 unions and 1 municipality either partially or fully. The municipality falls in the KalaparaUpazila while unions are dispersed as follows: Six (6) unions in Kalapara upazila, two (2) unions in Galachipa upazila, and two unions in Amtali Upazilaunder Barguna district. Percentages of unions in the study area are shown in the following **Table 6.33**

Table 6.33: Unions and upazilas in the study area

Name of district	Name of upazila	Name of unions	Percentage of union within study area
Barguna	Amtali	Amtali	62.98
	Amtali	Haldia	43.62
Patuakhali	Galachipa	Bara Baisdia	18.21
	Galachipa	Chalitabunia	68.08
	Kala Para	Chakamaiya	49.40
	Kala Para	Lalua	68.32
	Kala Para	Dhankhali	88.90
	Kala Para	Mithaganj	9.99
	Kala Para	Nilganj	5.72
	Kala Para	Tiakhali	100.00
	Kala Para	Kalapara Paurashava	96.48

Source: Spatial GIS Analysis, CEGIS, 2016

The land of the project area are also classified as per the Govt. Land Classification process surveyed by the govt. land department on the time span of 1970-1980. The Mouza wise detail land classification are shown in **Appendix XIV**. Types of land like Jangale, Kati, Nal, Doba, Pukur, Khal Bari, Bhiti etc as per DC office and their acquisition part are detailing in the

Appendix XIV with Map. Moreover, the non acquisitional properties i.e. (mosque or jalabhume) as per law of the land are pointed in that section.

6.12.2 Demographic Profile

According to the BBS 2011, the area has 28,399 number of households, having a total population of 117,967 of which 58,888 (49.9%) are male marginally dominant over female 59,080 (50.1%). The present population (year 2016) of the study area is 126,272[2]. The average male-female sex ratio3 is 100, which is slightly lower than the national figure of 100.3 (HIES) 2010]. The average population density is 422 in compared to the national density of 1,015 persons per sq. km. (excluding the population density of kalaparapaurashava). The inhabitants belong to two main religious groups; i.e. the Muslim and the Hindu. Indigenous people have not been found in the project area. Near about 150-200 of Rakhainhouseholds are residing in the Modhupara, char Nishanbaria and Boratpur village under Dhankhali union. The demographic data of the study and project area are presented in **Table 6.34a** and **Table 6.34b.**

Table 6.34a: Demographic data of the study area

Households	Population			Sex ratio	Population density
	Total	Male	Female		
28,399	117,967	58,888	59,080	100	422
	100 (%)	49.9 (%)	50.1 (%)		

Source: Population Census 2011, BBS

Table 6.34b: Demographic scenario of Project area

Name of Mauza	Key Features	Numbers	Description
Dhankhali, Londa and Nishanbaria	Number of population	560	Male, Female, Children
	Number of Households	121	No indigenous and Minority community
	Number of Houses	230	Semi pucka and kutcha
	School	2	A girls school and a primary school
	Graveyard	8/10	Family graveyard

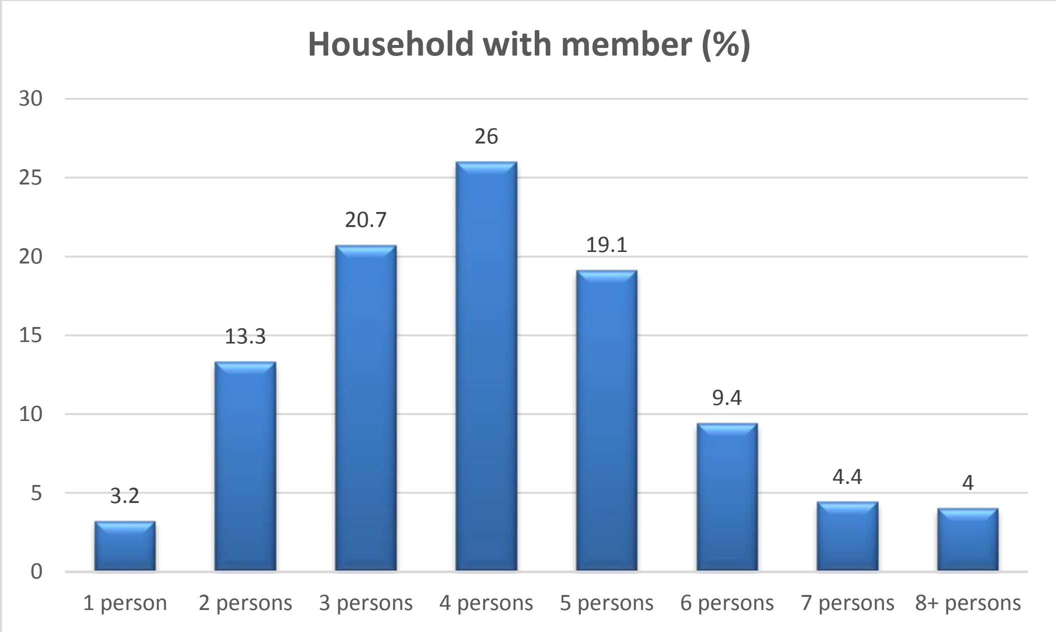
Source: CEGIS field visit June (FGD and KII), 2016

6.12.3 Household size

The average household (HH) size of the study area is 4.1 while it is 4.48 nationally. The size of highest percentage (about 26%) of HHs is 4 and the lowest percentage (about 3.2%) of HHs is 1 as shown in the following **Figure 6.20**.

[2]This estimation is based on BBS, 2011 Census data and 1.37 linear national growth rate; $Pop_{Future} = Pop_{Present}(1+r)^n$
[Where: Pop Future = Future Population, Pop Present = Present Population, r = Growth Rate and n = Number of Years]

[3]Number of males per 100 females in a population, using the formula: Sex Ratio SR = M x 100 / F

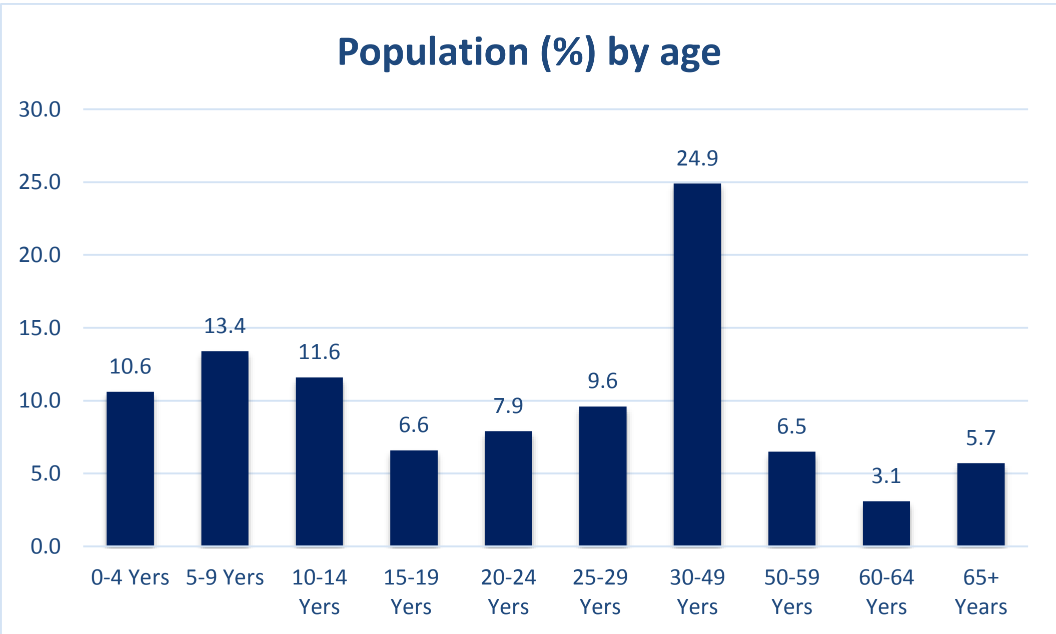


Source: Housing and Population Census, BBS, 2011

Figure 6.20: The household sizes of the study area

6.12.4 Age structure

In the study area, the highest number of population (about 24.9%) belongs to age group of 30 to 49 years while the lowest number (about 3.1%) belongs to 60 to 64 years age group as shown in **Figure 6.21**. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-59 years as prime working age, above 60 and over as elderly people. This classification is important as the size of young population (under age 15) would need more investment in education, while size of older populations (ages 65 and over) would need for more invest in health sector.



Source: Housing and Population Census, BBS, 2011

Figure 6.21: Age structure of the studied population

6.12.5 Education

Literacy rate of the area is 49.4% (nationally 52.7%), where for male it accounts to 51% (nationally 54.6%) and female 48.9% (nationally 50.8%). Field survey showed that there are Field survey showed that there is a school in the project area named DhankhaliGazi A Mannan Girls High school and a primary school namely DhankhaliGaziShofiur Rahman primary school.

Photo 6.21: Educational institute in the project area

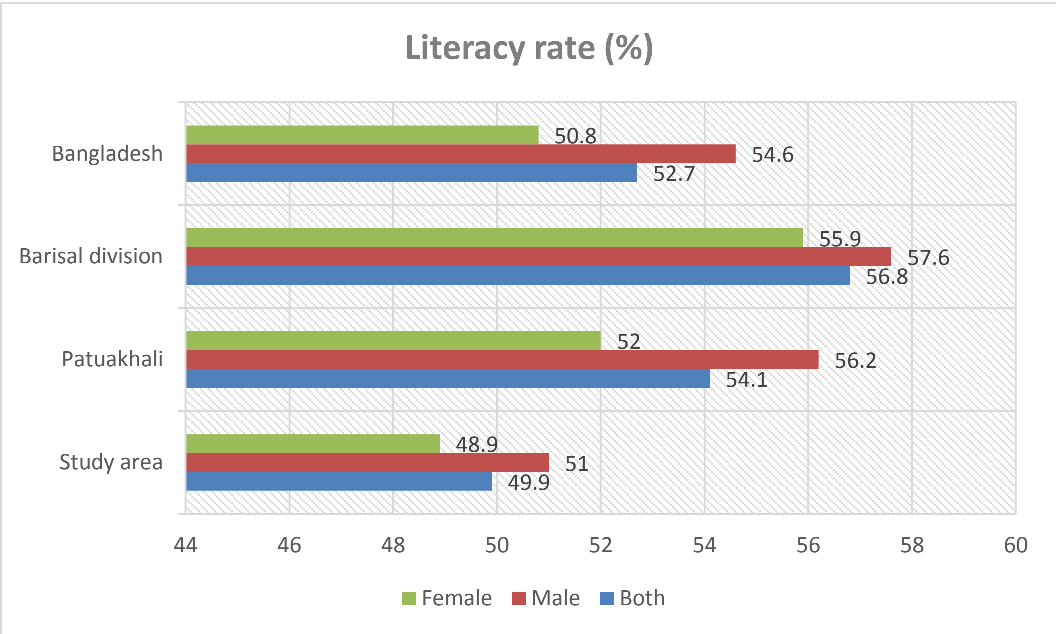
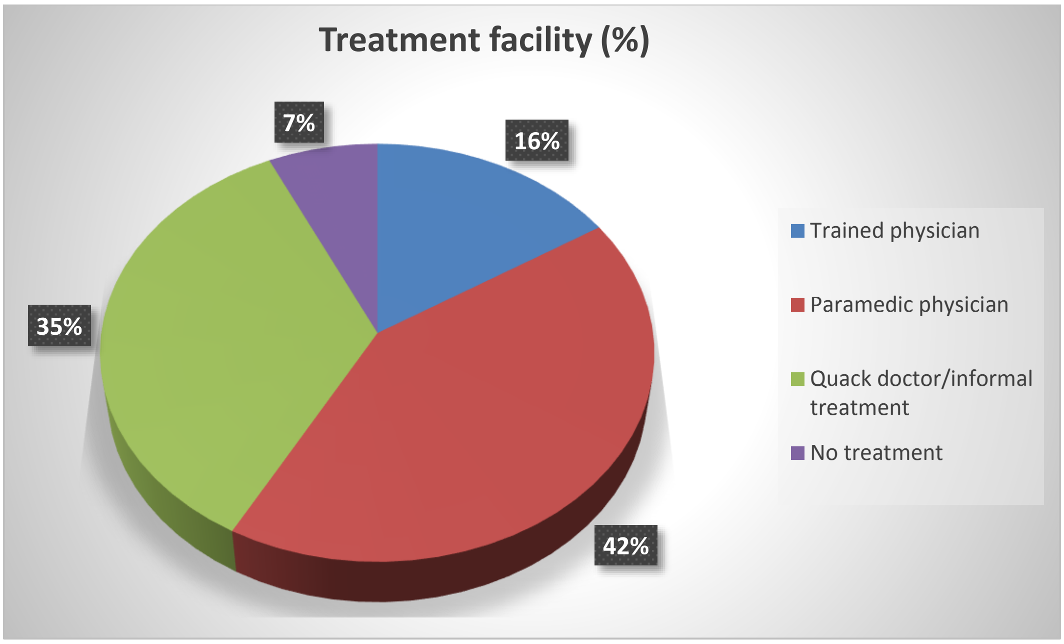


Figure 6.22: Literacy rate of the study area

6.12.6 Public Health

According to local inhabitants, the existing services are almost inaccessible to rural poor people. Therefore, local people have been receiving services from local chemist, paramedic or village trained physicians. Only a few number of local people (16%) receives treatment from the trained physician. **Figure 6.23**shows the status of receiving treatment facilities by households



Source: Field Survey, 2016

Figure 6.23: Status of receiving treatment facilities by household

Community health condition and common diseases

The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the respective area. It is found that the study area comprises 1.5% of all types of disabilities and 0.7% people reported that they are physically challenged. 0.1% mentioned speech and 0.2% mental disorder. Local people claimed that diseases like dysentery, skin diseases, diabetes and common fevers are commonly found in the area.

6.12.7 Ownership and Utilization of Land

Out of total land holdings, about 74.02% are farm-holdings and the remainders are non-farm holdings. Land holding patterns of the area are as follows: about 46.0% households are in small farm holdings category, about 23.1% households belongs to medium land holdings category and other land holdings are shown in the **Figure 6.24** and land tenure arrangement of the area are presented in **Table 6.35**.

Source: The Census of Agriculture, 2008, BBS

Figure 6.24: Households by land holdings

Table 6.35: Land tenure arrangement in the study area

Tenancy type	Farmers by holding category (%)			
	Marginal	Small	Medium	Large
Owner	31.8	34.4	26.5	7.3
Owner-cum-tenant	3.2	34.6	47.4	14.8
Tenant	50.0	28.6	18.9	2.6

Source: The Census of Agriculture, 2008, BBS

6.12.8 Land Price

Price of the land of this area has been raised after the establishment of Payra port and other development activities. The communication and transportation facilities have also developed in this area. The current market price of the project area is 12000 tk. per decimal for agricultural land and 20000 tk. per decimal for homestead land.

6.12.9 Occupation and Livelihood

According to the BBS 2011, about 40.16% (male- 37.74% & female- 2.43%) of local people are employed, about 42.69% (male- 1.26 %, female- 41.43 %) are occupied in the household activities and about 16.47% (male- 7.05% & female- 9.42%) people do not work in the study area (**Figure 6.25**). Here, household work particularly for women participation is accounted in terms of household activities as well as alternative income generation such as livestock rearing, poultry farming, small cottage industry, local cigarette (biri), etc.

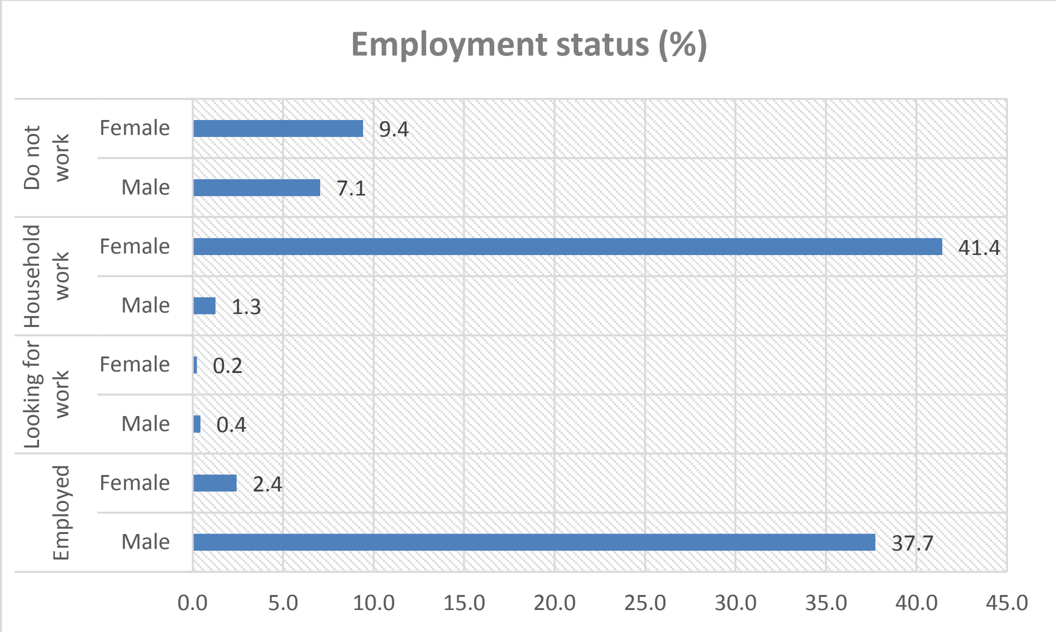


Figure 6.25: Employment Status

The distributions of employment of the area at reference period of census are as follows: about 81% are engaged in agricultural activities, about 2% in industrial and about 17% in service sectors. Agricultural activities includes broadly crop farming, fishery and livestock and poultry farming, business (fishery business, rice and dal business, tree business etc). Presently, industrial activities are seen in the study area as the entire area is being developed as business and industrial area.

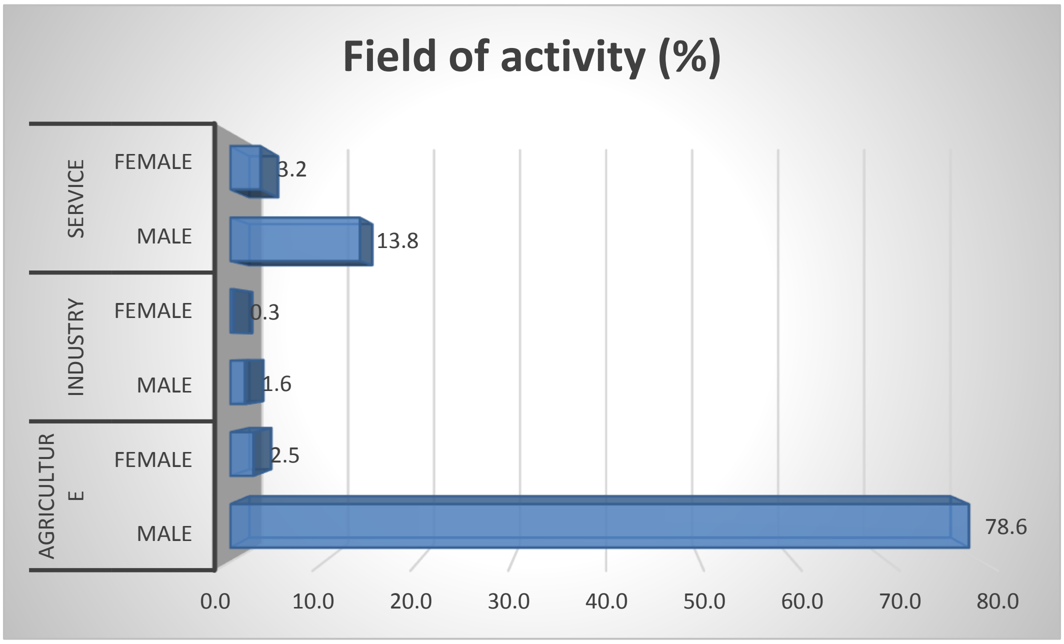


Figure 6.26: Field of Activity (%)

The present wage rate varies between BDT 300 to BDT 400 per day for male agriculture laborer.

During field visit, people stated that out-migration of laborers is commonly found around 25% while in-migration is 12%. The out-migrants usually go to Chittagong, Dhaka, Barisal and

Khulna for diversified jobs predominantly in the garments and business sectors. Besides, a remarkable number of out migrants are engaged in the existing other Power Plants. Moreover, there are trivial international out-migrants (about 2%) who tend to go to Middle East for searching of better livelihood options.

6.12.10 Standard of Living

Standard of living indicates the level of wealth, comfort; material goods and necessities available to the study are population.

Electricity facility is very poor (about 29.2%) in the area. BBS data shows that Kalapara Paurashava comprises the highest (87.1%) electricity coverage whereas Haldia union has the lowest (14.4%) coverage. The people of the char areas are yet not receiving electricity connection.

The overall housing conditions is not satisfactory. The housing pattern of the area is as follows: Kutcha houses (about 84%) followed by Semi-pucca houses about 4%, Pucca houses about 1% and Jhupri houses about 11%.

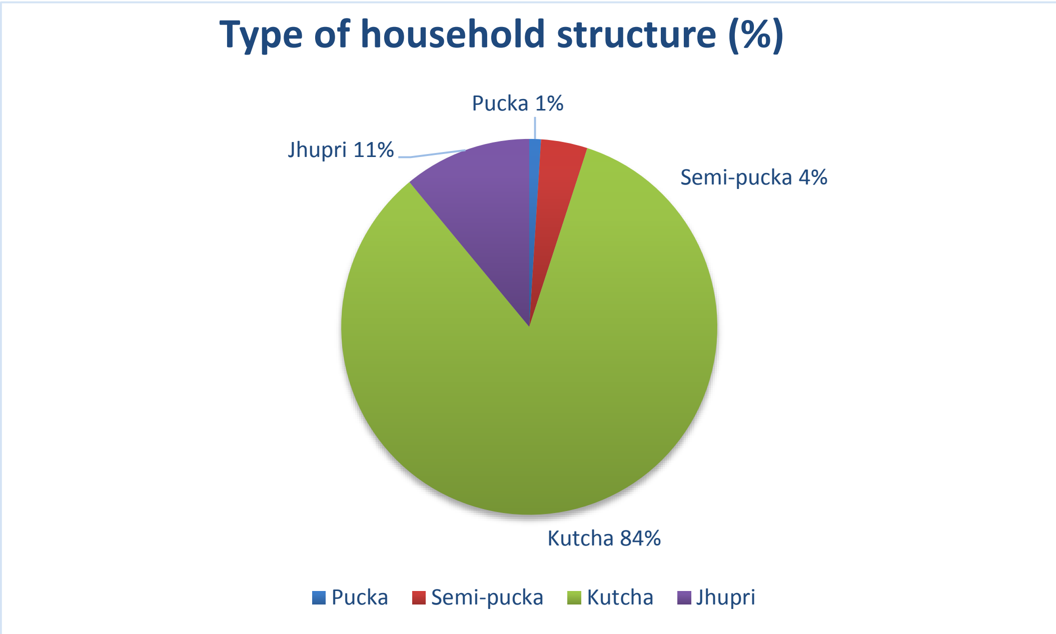


Figure 6.27: Household structure of the study area

Sanitation4 facilities of the area are is non-sanitary latrine households about 26%.Non-water sealed sanitary latrine households about 41%, water sealed sanitary latrine households about 27% and the rests have no latrine households.

[4]BBS defined four types sanitation in Bangladesh such as (i) Sanitary (water-sealed): A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. (ii) Sanitary (not water-sealed/ring slab), latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing in-sects from flying into or coming out of the pit; and (iii) Non-sanitary (Kucha): latrine is a frame or platform extending over earth or water; an “open pit latrine” does not have a squat platform or slab on the pit and (iv) No facilities: Defecation in bushes or fields or other outdoor locations.

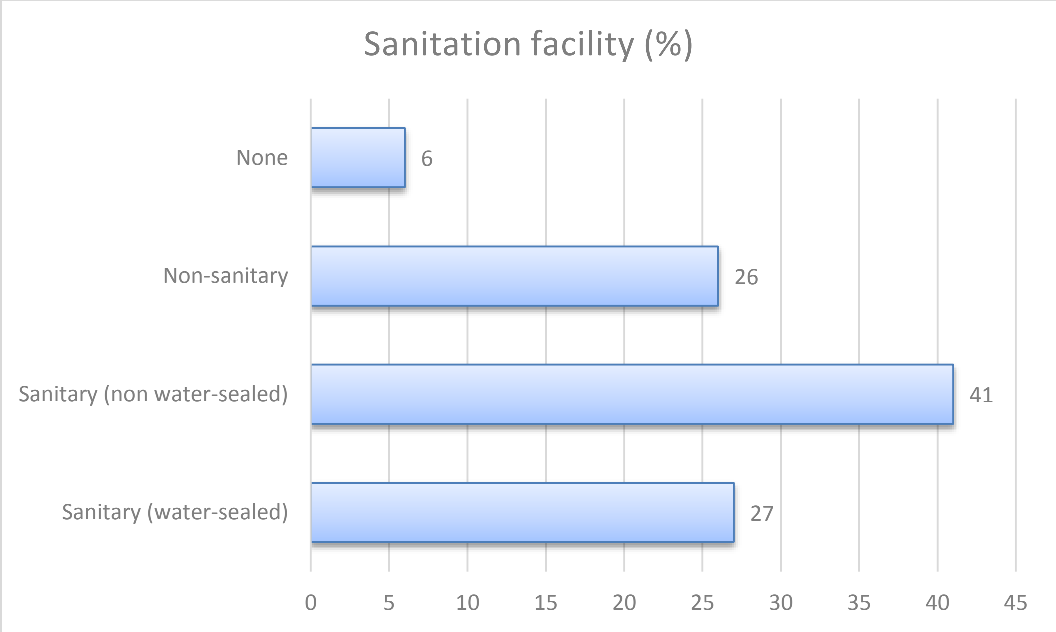


Figure 6.28: Percentage of sanitation facilities

Drinking water source of the area is ground water and is generally abstracted using tube-well. About 80% of the households use ground water as drinking water through tube-well. 18% of households collect drinking water from tap. And 2% of households collect drinking water from other (pond, river, etc) sources.

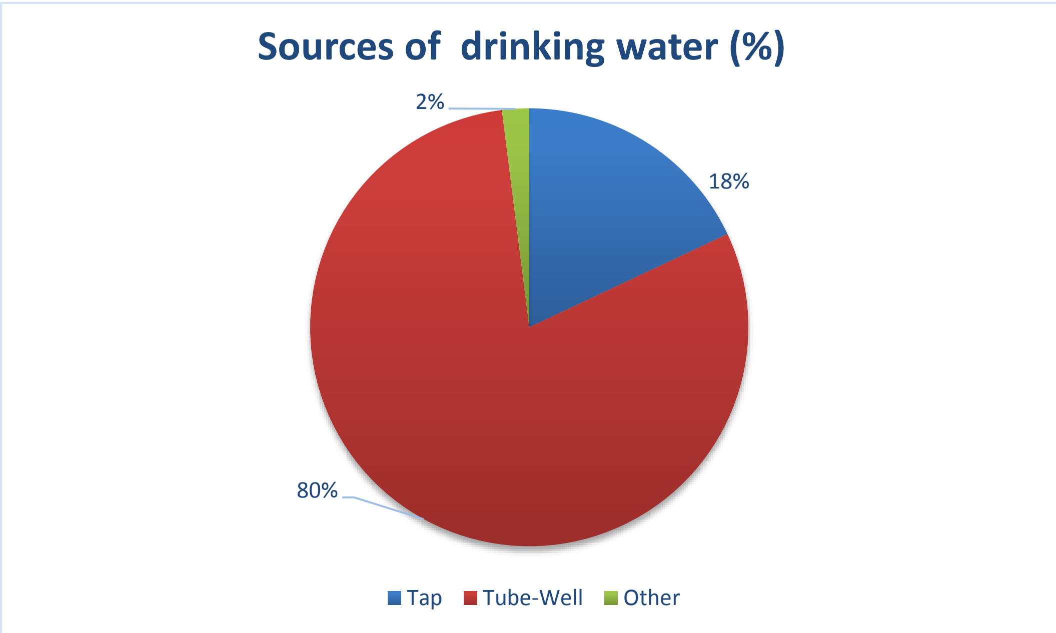


Figure 6.29: Sources of drinking water in the study area

Household income and expenditure is an important indicator to assess the socio-economic condition of the people. The following Table 6.36 describes the income and expenditure level of the people of the area.

Table 6.36: Distribution of income and expenditure

Range (Tk./month)	Percentage of Households	
	Income	Expenditure
< 1,000	-	-
1,000 - 2,000	-	-
2,000 – 5,000	10	13
5,000 - 9,000	40	65
9,000 - 20,000	42	20
> 20,000	8	2

Source: RRA, 2016

6.12.11 Roads/ Railway/Waterway

It is found that the main mode of communication in this area is roadway and waterway. The main roadway of the project area is from Khuriarkheyaghat to Londakheyaghat road. Tentatively the length of this road is 15 km. On the other hand, the waterway communication is mainly maintained by the river Andharmanik and Rabnabad channel in this area. This area is very much supportive for the business and industrial sector due to having a sound waterway network facility.

6.12.12 Poverty Situation

Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories. It is observed that about 45% percent of the households in average are in the 'balance' category followed by deficit category (about 40%) and surplus category (about 15%).

6.12.13 Safety nets

The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social safety nets among the targeted poor households and vulnerable communities to some extent. **Table 6.37** shows the current social services and facilities for alleviating poverty in the study area.

Table 6.37: Households served by different social safety nets programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	6
Food/Taka For Work (F/TFW) of PIO	4
Food for Education/Cash for Education	10
Rural Maintenance Program (RMP)	6
Old Age Allowance	5
Freedom Fighter Allowance	3
Integrated Poverty Reduction Program of BRDB	6

Source: CEGIS Fieldwork, 2015

A number of local, national and international NGOs are working in the study area. The main activities of these NGOs are operating micro credit programs among the rural poor and landless women/men.

6.12.14 Market/growth center

Three markets have been found which are very adjacent to the project area. These are Shombaria bazar, Gilatola bazar, Dhankhali bazar, Lalua bazar etc.

6.12.15 Vulnerability to natural disaster

Geographically Patuakhali is situated in the natural disaster prone area. Local people opined that, flood is the main natural disaster of the study area. It occurs almost every year in this area. But historically the flood of 1998 was destructive and long lasting. The cyclone, SIdr, Aila, Mohasen, Roanu has created destructions in this area. Moreover, riverbank erosion, storm, tidal surge are the other notable natural disasters occuring in the area.

6.12.16 Key Point Installation

Key Point Installation (KPI) is a sensitive establishment of Government guarded on the spot by one security guard and one security supervisor/security head guard in each eight-hour shift, for three shifts a day. The KPIs in the adjacent areas of the RPCL and the Payra port.

6.12.17 Common Property Resources

The common property resources and/or community facilities in the area are different social amenities e.g. mosques, graveyards, temples, cremation grounds, playgrounds, open water bodies and Eidgahs (place for offering Eid prayers). These are used by the local people for the purposes of religious, social and cultural gathering. There is no mosque, temple, cremation ground and Eidgah in the project area. But graveyards has been found in the project area. It is family graveyard.

7. Environmental Impacts Assessment and Evaluation

7.1 General

At present, a 1320MW coal based thermal power plant is being constructed by RPCL adjacent to the Power Posed Power Plant. Another two coal based power plant will come in this area in future. Therefore, this plant will use the natural resources like water, air, and ambient amenities in association with other power plants. Hence, the power plant projects will create significant impact to the same airshed, watershed etc. Land acquisition is one of the important issues implementing this project. Initially, the success of the projects depends how well the project affected people are resettled and rehabilitated.

The proposed major activities will involve construction of labor camp, site preparation, transportation of machinery and ancillaries, storage of equipment and materials for construction, erection of all equipment and machineries, construction of temporary jetty. These activities will have diversified impacts on the environment and the socio-economic conditions of the local people with various natures and magnitudes. Among the impacts from the proposed activities, some are temporary in nature and limited to pre-construction and construction period, and others are permanent in nature during the operation period. Based on the experience of other similar power generation projects, many of the environmental issues are mainstreamed in the project design. Clearing of bushes and felling of trees during site preparation and labor camp induced sanitation and social stress are the most significant impacts of the construction works. Emission of pollutants from flue gas, thermal plume, coal transportation and accidental events are the key concerning issues during operation of the Power Plant. The overall positive impacts of the project are as follow: - the enhancement of the generation capacity of the electricity and improving the socio-economic conditions and lifestyle of the local as well as of country people.

7.2 Impact Assessment and Evaluation Methodology

Potential environmental and social impacts were identified on the basis of the review of Feasibility Report, field visits, and stakeholder consultations. The significance of potential impacts was assessed using the criteria and methodology given step by step.

7.2.1 Impact Magnitude

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

The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in **Table 7.1**.

Table 7.1: Parameters for Determining Magnitude

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

7.2.2 Sensitivity of Receptor

The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of the features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in **Table 7.2**.

Table 7.2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.

Sensitivity Determination	Definition
Medium	Vulnerable receptor with some capacity to absorb proposed changes or moderate opportunities for mitigation
Low	Vulnerable receptor with good capacity to absorb proposed changes and/or good opportunities for mitigation

7.2.3 Assigning Significance

Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in **Table 7.3**.

Table 7.3: Significance of Impact Criteria

Magnitude of Impact	Sensitivity of Receptors			
	Very High	High	Medium	Low
Major	Critical	Major	Moderate	Minimal
Moderate	Major	Major	Moderate	Minimal
Minor	Moderate	Moderate	Minor	Minimal
Minimal	Minimal	Minimal	Minimal	Minimal

7.3 Summary of Assessed Impacts

The project's potential impacts and their significance have been assessed using the methodology described above. A summary of these impacts and their significance is presented in **Table 8.4**.

Table 7.4: Potential impacts and their significance

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
Environmental impacts during pre-construction stage					
A. Ambient Air					
A1 Dust Emission	Land filling activities will generate local dust to the ambient environment	Medium	Minor	Minor adverse	ECP 10
	Nuisance and health hazard for local people and workers reduce visual quality of sites.	Medium	Minor	Minor adverse	ECP 10
B. Ambient Noise					
B1. Noise pollution	Little increase in the ambient noise level during construction of labor shed, felling timber trees and leveling up the land.	Low	Minor	Minimal adverse	Noise Pollution Control Act, 2006 of Bangladesh
	Increases of associated heavy traffic affect residential and commercial area and unacceptable disturbance at the site.	Low	Minor	Minimal adverse	Noise Pollution Control Act, 2006 of Bangladesh
C. Water Resources					
C1. Surface Water Quality	Direct disposal of debris or waste materials from the vegetation clearance site, kitchen waste or sanitation waste from labor shed may cause water Quality deterioration.	Low	Moderate	Minimal adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
C2. Drainage System	About 6.5 km natural drainage system exists in the project area, which system is maintained the surface water irrigation and wet season drainage system of the *Londa* and *Dhankhali* Unions. Drainage system inside the project area may be affected due to illegal encroachment, falling of construction materials and sand dumping materials and lack of management of the drainage system;	High	Moderate	Moderate adverse	ECP 3 and Performance Standards on Environmental and Social Sustainability

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
C3. Erosion and Accretion	Bank protective measures and dredging activities in Rabnabad Channel will impact on the hydro-morphological system of the river; silt dredging impairs water quality and damage productive bottom habitat. The site is easily moved by tides and currents; clogged channels may require frequent dredging, and erosion from surface runoff would increase siltation and sedimentation and pollution of the water resource.	Medium	Moderate	Moderate	ECR 1997, Performance Standards on Environmental and Social Sustainability
D. Land Resources					
D1. Land Type	Natural land form and land type of the proposed Project site and adjoining site is agricultural land. This land would be affected due to excavation of trenches, construction of buildings and sheds, movement of traffic, widening and improvement of existing muddy road, etc. The platform of the Power plant would be raised up to a level higher than the maximum flood level.	High	Moderate	Major adverse	ECP 8 and additional Measures needed
D2. Impact on soil quality	During site preparation, earthworks would degrade the top soils that are enriched with nutrients required for afforested and naturally grown plant growth.	High	Minimal	Minimal adverse	ECP 7
E. Agricultural Resource					
E1. Impact on crop production	During site preparation, earthworks such as leveling and compaction of soil would be done for construction of power plant. This would destroy the crops in the project and adjoining area. Erosion and sedimentation would damage vegetation and nearby cropland.	Medium	Moderate	Moderate adverse	
F. Livestock Resources					

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
F1. Loss of grazing lad and loss of fodder	Acquiring the project area will lead to obstruct the grazing land and fodder for the livestock of the local farmers/households	Moderate	Medium	Moderate Adverse	
G. Fisheries Resources					
G1. Fish habitat condition and quantity	Increased temporary and localized turbidity and destroying of benthos community of river bed during dredging period inhibit the normal growth of the primary producers and retard the fish growth as well. Ramnabad Channel is one the suitable spawning ground for Hilsa, Pangus and shrimp which might be affected because of dredging activities.	High	Medium	Moderate Adverse	Dredging is a 'Red' category activity as per the ECR, 1997. So it may need to be considered separately.
G2. Fish production	With the consequence of aforesaid reasons, estimated net loss to fish production would be 45MT and 170MT per year from the project area and study area respectively.	High	Medium	Moderate adverse	**ECP 15 and other compensation activities**
H. Ecology					
H1. Terrestrial vegetation	Removal of terrestrial vegetation to initiate land development process. It would impacts on existing terrestrial vegetation negatively. In addition, labor shed development and brings construction heavy machineries to project site would impacts also negative to terrestrial vegetation in the roadsides and/close to project location.	High	Moderate	Low	ECP 12
H2. Shorebirds and other wildlife habitat	Pipeline installation for land development process needs labor involvement especially project site to shoreline. The latter area is the feeding ground to waders will face disturbance. The movement of labors will impede their normal activities and they can be displaced. The land development activities would	Medium	Moderate	Moderate Adverse	ECP 13

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	impacts negative to other wildlife, too at the periphery of project area.				
H3. Marine habitat	The existing marine habitat will slightly be impacted negatively due to plying of ship for carrying construction machineries to the project site.	Low	Minor	Low	ECP 12-13
I. Socio-economic Condition					
I1. Land acquisition	A certain amount (around 121) of households will be evacuated from the proposed project site for acquiring the land	Very High	Major	Critical	Land acquisition law, 1982 and applicable IFC guideline and RAP guideline
I2. Extra burden on accommodation	Mobilization of laborers to the site would create extra pressure on the existing accommodation facilities along with the social amenities including sanitation.	Medium	Minor	Minor adverse	Labor Law, 2006
I3. Cultural conflicts	Migrant workers may come from different parts of the country thus a cultural conflict may be created between the migrant workers and the communities.	Medium	Minor	Minor adverse	
I4. Employment of local people	Employment generation of the local people based on their skill will bring positive notion of the local inhabitants towards the Project.	Medium	Minor	Minor beneficial	
I5. Labor Migration	Susceptibility of unconventional relations between the migrant laborers and local vulnerable women may lead to the risk of gender oriented/sexually transmitted diseases like HIV/ AIDS and STI.	High	Minor	Moderate adverse	WHO Guidelines and ILO convention ECP 16, ECP 18
J. Non-Hazardous Waste Generation					
J1. Solid Waste	Aesthetic tiring due to negligence in management of waste generated from vegetation clearance, land development and domestic activities	Moderate	Medium	Moderate adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability, ESMS

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
J2. Kitchen Waste	Aesthetic tiring due to negligence in management of kitchen waste	High	Moderate	Major adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
J3. Liquid Waste and Sewerage	Aesthetic tiring due to negligence in management of waste	Low	Minor	Minimal adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
Environmental Impact during Construction Stage					
(Civil Works, Jetty Construction, Mechanical Structure, Power Evacuation System)					
K. Ambient Air					
K1. Dust and gases from construction equipment and vehicles	Emissions of dust and gases will be generated from excavation of trenches, operation of construction equipment and vehicles, and material transport, which is injurious to human health.	Medium	Moderate	Moderate adverse	ECR 2005 WBG General EHS Guidelines, 2007
L. Ambient Noise					
L1. Noise pollution	Noise would be generated from the moving and idling vehicles and heavy machineries, which may cause disturbance, increased stress level, increased blood pressure etc. on the people who are susceptible to the generated noise.	High	Medium	Major adverse	Noise Pollution Control Act, 2006 of Bangladesh
M. Water Resources					
M1. Drainage System is side the project boundary	After land development of the total project area, construction of drainage system is one of the major challenge. Otherwise, the project boundary, temporary roads or other structure might be damaged due heavy runoff of rainfall	Low	Moderate	Minor Adverse	Good Practices of the EPC contractor
M2 Water Quality	Transportation of equipment and materials may cause water pollution to the adjacent rivers and khals. Moreover, falling of chemicals, oil and polluted water from the project site may contaminate both surface	High	Minor	Moderate Adverse	ECP 1, ECP 2, ECP 15, GIIP etc

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	and ground water in the project areas and adjacent areas.				
M3. Groundwater Availability	Little local impact; no regional impact. Aquifer seasonally fully recharged by Jamuna River.	Medium	Minor	Low	Bangladesh Water Act, 2013
N. Land Resources					
N1. Land Use	During construction phase, the existing agricultural land use might be affected due to construction of Power plant.	Moderate	Medium	Moderate adverse	
N2. Soil Quality	During site preparation, earthworks, transportation, will impact the fertility of top soils of the surrounding areas	Medium	Minimum	Minimum	ECP 7, ESMS
O. Agricultural Resources					
O1. Impact on crop production	During site preparation, earthworks such as leveling the land, transportation and construction works would destroy the crops in the project and adjoining areas	Moderate	Minor	Minor adverse	ECP 7 and ECP 15
O2. Impact on irrigation	At present, BADC have some irrigation facilities in the project area. During the construction stage these DTWs will be out of operation.	High	Minor	Moderate adverse	
P. Livestock Resources					
P1. Effect on the livestock movement	Transportation of the vehicles, movement of the labors may impact on the livestock movement in the study area	Low	Moderate	Minimal Adverse	Best Practices of the EPC contractor
Q. Fisheries Resources					
Q1. Fish habitat quality	Rabnabad channel is rich in Hilsa, Pangus and Shrimp PL which would be affected due to disposal of waste water like ballast and bilge water from the ship/cargo carrying machinery and ancillaries having oil and grease contaminants.	High	Minor	Moderate adverse	ECP 15, ESMS

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
Q2. Fish species diversity and composition	Impact on fish habitats due to spillage of oil, grease, bilge and ballast water from the increased traffic load in the channel. This may result a declining in fish species diversity	Minor	Minimum	Minimum Adverse	ECP 15, ESMS
R. Ecology					
R1. Shorebirds and other wildlife habitat	The movement of labors will disturb shorebirds normal activities and they can be displaced. The land filling activities would impacts negative to other wildlife at the project vicinity. In addition, jetty construction for coal transportation will impact negative to other wildlife, too.	Medium	Moderate	Moderate Adverse	ECP 13
R2 Benthic community	Dredging in order to access ship/cargos to the main river channel will change the existing condition of the benthic community by demolishing them. The aquatic habitat quality will deteriorate through disposal of waste water like ballast and bilge water from the ship having oil and grease contaminants during transportation of machinery and ancillaries.	High	Low	Low	ECA, 2000
S. Socio-Economic Condition					
S1. Extra burden on accommodation	Approximately 100 to 125 laborers and technicians will be engaged in different activities during construction phase by the EPC contractor. Out of which around 50-60% of laborers is expected to be hired and engaged on day basis form the local community. This would alleviate the problems related to accommodation and other social amenities including sanitation. Accommodating the remaining laborers and technicians in the labor camp established on the leased land of BBA would create extra pressure on the local community on different	Medium	Moderate	Moderate adverse	Good House keeping, ECP 16 and ECP 18

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	issues, such as social amenities including sanitation, potable water, market price, prevailing socio-cultural situation, etc.				
S3. Cultural conflicts	Migrant workers may come from different parts of the country thus a cultural conflict may be created between the migrant workers and the communities.	Medium	Minor	Minor adverse	ECP 17 and ESMS
S4. Employment of local people	Employment generation of the local people based on their skill will bring positive notion of the local inhabitants towards the Project.	Medium	Moderate	Moderate beneficial	
T. Non-Hazardous Waste Generation					
T1. Solid Waste	Aesthetic tiring due to negligence in management of waste generated from construction activities and labor sheds	Medium	Moderate	Moderate adverse	ECR 1997, ECP 1, ESMS , ESMS
T2. Kitchen Waste	Aesthetic tiring due to negligence in management of kitchen waste	Medium	Minor	Minor Adverse	ECR 1997, ECP 16, IFC's Performance Standards on Environmental and Social Sustainability
Environmental impacts during operation stage					
U. Ambient Air					
U1. Maximum ground level concentration of pollutants	Emission of exhaust gas from the stack may contribute elevated ground concentration of CO, NOx, PM_{10}, $PM_{2.5}$ etc. at the downwind direction. Cumulative impacts on the sensitive receptors	Medium	Moderate	Moderate adverse	ECR 2005 WBG General EHS Guidelines, 2007
U2. Emission of GHG emission	Emission of GHG from the stacks and other sources during operation stages	Medium	Minimum	Minimal	National GHG emission standard, IFC Performance Standard
V. Ambient Noise					

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
V1. Noise Pollution	Noise producing from the first, second and third units cumulatively would have a tendency of exceeding the noise level standard in some places. This might result in hearing complexity and loss along with increased blood pressure, disturbances and discomfort to the site engineers, technicians and workers and surrounding communities.	Major	Medium	Moderate adverse	Noise Pollution Control Act, 2006 of Bangladesh
W. Water Resources					
W1. Natural Drainage System	Encroachment of internal canals (about 6.5 km) inside the project area may cause severe drainage problem at the upstream of the project area specifically *Londa, Dhankhali, Nisan baria and Madhupara* mauzas;	Medium	Moderate	Moderate	ECR 1997, Performance Standards on Environmental and Social Sustainability
W2. Water Quality	Discharge from the industrial premises may cause decoration of the surface and ground water pollution to the adjacent environment. Sewerage and effluent may mix up with the storm water and pollute the water quality.	High	Major	Major Adverse	ECR, 1997, IFC 2008 and ECP 1
W3. Flooding due to Storm Surge	The project area under the power plant located inside the Polder 54/A. This polder is embanked by about 59 km (29 km sea dyke and remaining portion is interior dyke) embankment. The crest level of embankment is not unique due to land subsistence and soil erosion. Whereas existing crest level of sea dyke is 5.80 m. if the storm surge height is overtopped the crest level of embankment, then create storm surge flooding into the polder and inundate the plant site.	High	Moderate	Major	ECR 1997, Performance Standards on Environmental and Social Sustainability
X. Land Resources					
X1. Soil Quality	Accidental spillage of untreated effluent on the nearby land from the Plant, and during filling the oil tank	Medium	Minimum	Minor adverse	ECP 5

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	leakage of oil pipe may cause spillage of HSD oil to the land either side of the pipe leading to degradation of the soil quality.				
X2. Land Use	Operation of the Power plant might cause the changes in local infrastructures though induce development activities.	Moderate	Medium	Moderate adverse	
Y. Agricultural Resources					
Y1. Crop Production	Operation of the power Plant, might cause the changes in local infrastructures. i.e. Construction of different infrastructures would ultimately impact the crop production of surrounding agricultural land.	Medium	Minor	Minor Adverse	Planned development should be taken consideration
Z. Livestock Resources					
Z1. Reduce of livestock	At this stage, the induce change in land use will ultimately reduce the grazing areas as well as the fodder for the livestock. Moreover, the change in lifestyle will reduce to rearing the livestock.	Low	Moderate	Minimal adverse	
AA. Fisheries Resources					
AA1. Fish species diversity and composition	Water intake from the Rabnabad Channel would entrap fish, crustaceans and other aquatic organisms particularly the sluggish species. Predator-prey relationship might be affected due to spread of invasive species through ballast water. Integrated impact to be caused for withdrawal of 3x1400 m^3/hour of water, daily for three power plants located at the Rabnabad channel may alter the fish diversity due to salinity intrusion	High	Moderate	Major adverse	ECP 15
AA2. Fish production	If the fly ash is not controlled or untreated effluent discharge to the nearby river causes result in gradual decline in fish production.	Medium	Moderate	Moderate Adverse	ECP 15

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
AA3. Fisheries Based Livelihoods	Vehicles movement, water pollution may narrow down the fishing production which consequently squeeze the fisher	Medium	Minor	Minor adverse	ECP 15 and compensation
BB Ecology					
BB1 Terrestrial vegetation	Impedes growth of terrestrial vegetation by reducing transpiration rates due to fly ashes.	Medium	Moderate	Moderate	NCS, 1992
BB2. Shorebirds	Operations of the thermal power plant would impacts negative on shorebirds natural activities due to lighting from plant site and human induced disturbances.	Medium	Moderate	Low	ECP 13
BB3. Marine habitat	The marine habitat within the study area may deteriorate due to transportation of coals for the thermal power plant. Water collection from sea for cooling and make-up process would bring invertebrates and other aquatic species to the cooling tower. It will lead killing of many biota. In addition, discharge of hot water to marine ecosystem would impacts negative to aquatic invertebrates, too.	Medium	Moderate	Low	ECP 13
BB4. Benthic community	Coal droppings would deposit in the bottom of waterways which is the home to benthos. The toxicity of coals could harm too many sensitive species and finally will destroy the existing benthic community structure.	High	Moderate	Low	ECP 13
CC Socio-Economic Resources					
CC 2. Contribution of the project to the local	Implementation of the project may reduce the energy shortfall and revive associated economy. It may	Very high	Moderate	Major beneficial	

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
livelihood and economy of the nation	attract the new entrepreneurs to build new industry for development of the nearby areas to power plant.				
CC3. Employment Generation	Supplementary employment opportunities, in the way to increased prosperity and security due to higher and stable incomes of employed people.	High	Moderate	Major beneficial	
CC4. Expansion of new industry	The construction of the new unit may expand the possibility of developing new small scale industry in the local area.	Medium	Moderate	Moderate beneficial	
CC5 Occupational health and safety	The labors sometimes may attacked by inhaling dust and different accidental issues	High	Minor	Moderate Adverse	ECP 18 and 19
DD Non-Hazardous Waste Generation					
DD1. Liquid Waste and Sewerage	Aesthetic tiring due to negligence in management of waste	Medium	Moderate	Moderate adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
DD2. Kitchen Waste	Large amount of kitchen waste to be generated. This may cause a Aesthetic tiring due to negligence in management of waste.	High	Moderate	Major adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
EE Hazardous Waste Generation					
EE1. Use of Hydrazine in feed water for oxygen scavenging	Hydrazine is geno-toxic carcinogen. Exposure to hydrazine is hazardous to health. The boiler blow down may contain residual hydrazine which may reach to river or canal ultimately.	Very High	Moderate	Major adverse	Hazardous Waste and Ship Breaking Waste Management Rules 2011, CER 1997, The International Conference on Chemicals Management in 2006 IFC's Performance Standards on Environmental and Social Sustainability
EE2. Hazardous sludge from water pre-treatment and treatment plant	Contamination of surface water, ground water and soil if not properly managed	High	Major	Major adverse	Hazardous Waste and Ship Breaking Waste Management Rules 2011, CER 1997, IFC's

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
					Performance Standards on Environmental and Social Sustainability
Coal Transportation					
FF. Fisheries					
FF1. Fish habitat	Increase traffic load in the water course for the three power plants might hamper the fish migration activities. During loading and unloading, coal might fall on Rabnabad channel and deteriorate the water quality of the habitat. Integrated spillage of oil and grease from three power plants along with Payra deep sea port might be occurred either directly or through the bilge water from the water vessels. This may create oil slick which is detrimental for fish and other aquatic organisms along with water fowl.	Medium	Moderate	Moderate adverse	ECP 15 MARPOL IMO standard
GG Ecology					
GG1 Aquatic species and diversity	Movement of water vessels may create harmful situation to aquatic species by dropping coals, oil spill and other waste produced within the vessels due to mishandling.	Medium	Moderate	Moderate adverse	ECP 13-14

7.4 Environmental Impacts during Pre-Construction Stage

7.4.1 Water Resources

Impacts on water quality

Land development works in the project area is important to the project activity and sustainability. The dumping soil will be imported from dredging of- Andharmanik River or Rabnabad Channel. The potential environmental effects of maintenance dredging are generally two-fold, firstly as a result of dredging and secondly the dredged material. At the dredging location, water quality may deteriorate from its baseline situation. It becomes turbid and bed poisonous materials get mixed with surface water. Moreover, at the dumping location, there are a number of natural water bodies existing in the project area, may get mixed with the spoil surface runoff and also may create the surface water pollution. Metal and solid wastes from the river / channel bed may deteriorate the surface and groundwater quality in and around the project area.

On the other hand, in considering the environmental effects of maintenance dredging and disposal, the potential benefits of these operations should not be overlooked. These include the removal of contaminated sediments and their relocation to safe, contained areas and the possible improvement of water quality made by the restoration of water depth and flow in the Rabnabad Channel and Andharmanik River.

Impacts on Natural Drainage System

The natural drainage system within the project area is a very much important environmental component. During this phase, lots of onsite activities will be implemented during the construction works and land filling like as vegetation clearance and site development with minor dressing and leveling. Since the internal drainage system supports the smooth passing of storm water during the monsoon it may create some drainage congestion if the activities under this phase are not done properly. For the off-site, the activities will be limited to construction of labor shed on the leased land. Unplanned disposal of waste material or unnecessary/unused materials/waste from the worker colony may cause unhealthy environment with-in the natural drainage system, especially during the monsoon season creating nuisance to the local inhabitants. The significance of impact is characterized as moderate in **Table 7.4.**

Impacts on Erosion and Accretions

Erosion- accretion rate in the *Rabnabad* channel is very much dynamics. Yearly erosion and accretion rate in the Rabnabad channel is 20 ha, 15 ha respectively. During the construction phase, a huge numbers of vessels will be moved for carrying the construction and equipment materials for implementation of power plant project. The movement of vessels will create huge wave action besides the bank line of the channel, which creates threats for the settlements near the embankment side. During field visits, already there has been observed the erosion besides the bank line. These wave actions will accelerate the erosion of the bank line. The significance of impact is characterized as moderate in **Table 7.4.**

7.4.2 Impacts on Ecosystem

Impact on terrestrial vegetation

The proposed area is an agricultural land including homesteads with various terrestrial vegetation. To prepare land to commence construction works shaving or removal of terrestrial vegetation is a must. In addition, this vegetation would face damage in this phase due to construction of labor shed and movement of vehicles as well as pipeline installation. Moreover, stockpiling of construction materials requires some space and it would damage herbs and shrubs on site and periphery of the project area. By clearing the vegetation coverage, wildlife habitat would be destroyed and they might be displaced from their habitat. Hence, such clearing/damage vegetation imposes high environmental impacts especially ecological functions.

Impact on shore birds and other wildlife habitat

Pipeline installation for land development process requires labor involvement for a short period of time across the feeding ground of waders and beyond. The movement of labors will disturb their normal activities and they can be migrated locally. The land filling process would impacts negative to other wildlife, too in the project vicinity.

Impact on marine habitat

The waterways are the main routes for bring heavy construction materials to the site. In this process, the sea is anticipated as main route to transportation of the construction machineries in this stage. Through transportation the marine habitat supposed to be impacted by oil spills as well as greases discarded from ship/cargo engines.

7.4.3 Impact on fisheries

Construction work including land filling by dredging, sand lifting and physical construction of plant setup etc, which may have impacts on open water fish habitats, fish diversity and hence to some extent on capture fisheries production. Open water fisheries habitats like rivers (Andharmanik, Rabnabad Channel and Tiakhali), *khals*, mangrove and inter-tidal area may be affected due to dredging, traffic movements, and oil and chemical spilling. Dredging activities may also alter the habitat of the bottom feeder fish for short period. This impact is characterized as **Moderate Adverse,** as given in **Table 7.4.**

7.4.4 Land Resources

Impact on Land Type

Natural landform of the proposed Project site and adjoining site is agricultural land. This land would be affected due to excavation of trenches, construction of buildings and sheds, movement of traffic, widening and improvement of existing muddy road, etc. The platform of the Power plant would be raised up to higher than the maximum flood level. This impact is characterized as **Major Adverse**, as given in **Table 7.4.**

Impact on Soil Quality

During earthworks such as leveling and compaction of soil would be done for construction of power plant. This would degrade the top soils that are enriched with nutrients required for afforested and naturally grown plant growth. This might be occurred in the Project site where construction will be done. This impact is characterized as **Minimal Adverse,** as given in **Table 7.4.**

7.4.5 Agriculture Resources

Impact on Crop Production

During earthworks, such as leveling and compaction of soil would be done for construction of power plant. This would deteriorate the crops in the project and adjoining area. This might be occurred in the project site as well as adjoining area where construction will be done. This impact is characterized as **Moderate Adverse,** as given in **Table 7.4.**

Livestock Resources

Acquiring the project area will lead to obstruct the grazing land and fodder for the livestock of the local farmers/households. This impact is characterized as **Moderate Adverse,** as given in **Table 7.4.**

7.4.6 Impacts on Socio-Economic issues

Land Acquisition

Power plant (2x660 MW Coal Fired Thermal Power Plant) is going to be Constructed at Kalapara of RPCL will be constructed on private land in Patuakhali District (**Table 7.5**). The Power plant requires almost 915.65 acres of land for its implementation in three Mouzas in the Project area. Out of 915.65acres of land, highest portion of land have to be acquired from Londa (606.07 acres), Dhankali (184.84 acres) and Nishanbaria (100.13 acres).

Table 7.5: Amount of land to be acquired for Power plant

Upazila	Union	Mouza	Total amount of land (in acre)	No. of land parcels/plots	Percentage of affected of land parcels/plots
Kalapara	Dhankhali	Dhankhali	196.68	120	23.5
		Londa	624.05	235	46.0
	Lalua	Nishanbaria	94.92	156	30.5
Total			915.65	511	100

Source: FGD and KII by Field survey, CEGIS, 2016

Project Affected Household

Land acquisition will affect some people and household negatively. Approximately 121 household will be affected due to the Project intervention, From among the affected land, which contained 560 members. Maximum people will be affected in Londa Mouza about 427 persons almost 76% and rest of them will be affected from Dhankhali and Nishanbaria Mouza. **Table 7.6** shows distribution of the land owners by mouza and sex and details show Appendix-XIII.

People who are involved as sharecropper, lessee and agricultural laborer will also be affected due to the Project intervention.

Table 7.6 Number of project affected Household

Upazila	Mouza	Affected Households (No.)	Affected households member	Percentage of Affected HHs
Kalapara	Dhankhali	11	57	10.2
	Londa	94	427	76.3
	Nishanbaria	16	76	13.6

Cultural Issues

Impacts on other properties than land like trees and structures are highly impacted. However, detailed design may necessitate reviewing Resettlement Plan before implementation of the Project.

A lot of agriculture land (most of them are three crops), homestead along with trees and ponds and two schools a High school named Dhankhali Gazi A Mannan Hafiza Girls High school cum cyclone shelter and a primary school namely Dhankhali Gazi Sofiur Rahman Primary school will be affected for the implementation of the Project.

7.5 Environmental Impacts during construction phase

7.5.1 Impact on Ambient Air

Fugitive dust particles may be generated due to site preparation, material transport, piling up of construction materials, excavation of trenches, batch mixing plant, etc. In addition to these, operation of construction equipment and vehicles may generate PM, CO, CO2, NOx, SOx, etc. Prolonged inhalation of dusts by the site engineers and workers might suffer from lung diseases with symptoms of shortness of breath, coughing, wheezing; chest pain; loss of appetite; tiredness etc.

7.5.2 Impact on Ambient Noise

Noise is often defined as unwanted sound. Sound is defined as any pressure variation heard by the human ear. Human ear is sensitive to a wide range of Sound Pressure Levels (SPL) which is measured on a logarithmic scale with units of decibels (dBA). At present the noise level of project area is about 46-48 dBA during day. Ambient sound is contributing the major and main reasons for this noise level.

Noise pollution during construction phase will be caused by the equipment and process such as operations of construction machines and equipment: trucks, bulldozer, excavator, air compressor, Concrete mixing station, Pile drivers, Earth leveling and Generator operation etc. Noise pollution will directly cause health hazards to construction workers on the site as well as to the residents living nearby the construction site. The construction activities must be regulated within the standard limit of ECR 2006 and IFC, 2008.

According to data provided by US Federal Bureau of Highway, standard limiting levels of noise which can be caused by different construction equipment are summarized in the following **Table 7.7.**

Table 7.7: Noise produced by construction equipment

No.	Plants/Equipment	Traffic Vehicles Noise Level (US Standard) dBA
1	Machinery Hammer	95
2	Drilling Machine	75
3	Truck	75
4	Bulldozer	75
5	Compaction Roller	75
6	Tug Plant	75
7	Leveler	75-80

No.	Plants/Equipment	Traffic Vehicles Noise Level (US Standard) dBA
8	Pave Machine	80
9	Concrete Mixer	75
10	Generator	75
11	Vibrator	75

The equipment and machineries will produce cumulative noise depending on source type and number, weather condition, distances and duration of working period. If a single equipment will produce 90 dB (A) within 1m, it would be reduced gradually to its movement. Without any facility boundary or other barrier/obstructions, the noise level will propagate and attenuate significantly with distance shown in **Figure 7.1**. However, the duration of noise pollution is also important to account the equivalent noise level.

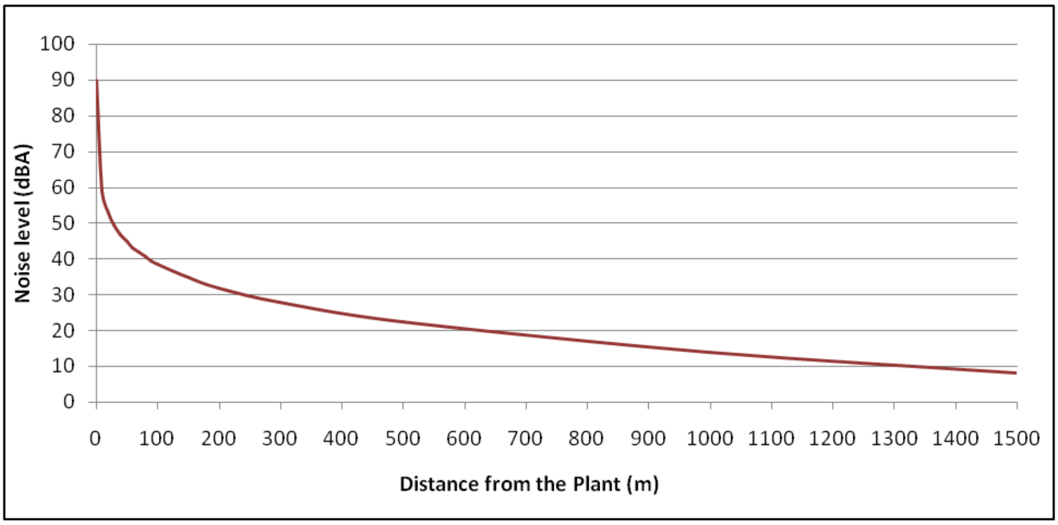


Figure 7.1: Sound pressure level at different distance from the source

The produced noise will traverse to the adjacent communities from the sources. Local inhabitants may feel disturbed while receiving noise from line sources, point sources, non-point sources, and engineering sources individually or collectively.

Vibration is one of the important pollution for the human communities as well as the other living communities. During the construction phase, vibration may be generated by some machines i.e. mainly hammer machines, rammers. However, these machines will be located basically in the western part of the project site i.e. far away from the residential areas. However, potential vibration sources are identified as such hammer machines (04 sets) operating on clay may generate a vibration of 7.0mm/s or rammers (04 sets) with a 30kJ energy may generate a vibration of 4.3mm/s at a distance of 10 meters etc.

Vibration may cause human health hazards such as tiredness, insomnia, mental disorder and working ability reduction. Regarding dwelling houses and other structures, with a vibration of minimum 5.0mm/s may cause harm to structures' life-span

7.5.3 Impact on Water Resources

Water quality

Infrastructure development and other project development activities include equipment or machineries transportation, machineries installation produce liquid wastes as byproduct.

There is a possibility to mix the liquid wastes mixed with local channels due to runoff washout and eventually mixed with the major river system, Rabnabad in the study area. On the other hand, the liquid waste may infiltrated to the surface soil and finally mixed with the ground water table.

The riverbank protection works and intake and out channel construction works includes huge volume concrete consequent of mixing cement and other toxic material with channel water, which may impact the aquatic environment and may change the ambient status of water quality.

7.5.4 Impacts on Fisheries

The ship/cargo carrying machineries and ancillaries may discharge ballast and bilge waste water into the river. This ballast and bilge water may have oil, grease, food waste and other contaminants which might affect the fisheries resources and their habitat quality. Having disposed of such harmful substances into the river water, a localized and temporary disturbance to fish breathing may lead some species to death. Dredging for accessing ship to the jetty will also disturb the benthic habitat which may require a substantial time to recover. Discharge of wash water from the construction site may increase the turbidity of the local fish habitat. This would affect the food supply for fishes temporarily. The impact is characterized as **Major Adverse** in **Table 7 .4**.

7.5.5 Land Resources

Impact on Land Use

During construction phase, the present agricultural land use as crop production would be changed into a different land use as industrial set up with power plant. This change of agricultural land use in the project site is permanent in nature. This impact is characterized as **Moderate Adverse,** as given in **Table 7.4.**

Impact on Soil Quality

During site preparation, earthworks will impact the top soil quality that are enriched with nutrients required for afforested and naturally grown plant growth. This impact is characterized as **Minimal Adverse**, as given in **Table 7.4.**

7.5.6 Agriculture Resources

Impact on Crop Production

During construction stage, office quarter, main building, power plant etc will be constructed. So, a huge volume of work will be done. This would destroy the crops in the project and adjoining area. This might be occurred in the project site as well as adjoining area where construction will be done. This impact is characterized as **Minor Adverse,** as given in **Table 7.4.**

Impact on irrigation

At present, BADC have some irrigation facilities in the project area. During the construction stage these DTWs will be out of operation. This impact is characterized as **Moderate Adverse,** as given in **Table 7.4.**

7.5.7 Livestock Resources

Transportation of the vehicles, movement of the labors may impact on the livestock movement in the study area. This impact is characterized as **Minimal Adverse**, as given in **Table 7.4.**

7.5.8 Impacts on Ecosystem

Impact on terrestrial vegetation

The proposed area is an agricultural land including homesteads with various terrestrial vegetation's. To prepare land to commence construction works shaving or removal of terrestrial vegetation is a must. In addition, this vegetation would face damage in this phase due to construction of labor shed and movement of vehicles as well as pipeline installation. Moreover, stockpiling of construction materials requires some space and it would damage herbs and shrubs on site and periphery of the project area. By clearing the vegetation coverage, wildlife habitat would be destroyed and they might be displaced from their habitat. Hence, such clearing/damage vegetation imposes high environmental impacts especially ecological functions.

Impact on shorebirds and other wildlife habitat

Pipeline installation for land development process requires labor involvement for a short period of time across the feeding ground of waders and beyond. The movement of labors will disturb their normal activities and they can be migrated locally. The land filling process would impacts negative to other wildlife, too in the project vicinity.

Impact on marine habitat

The waterways are the main routes for bring heavy construction materials to the site. In this process, the sea is anticipated as main route to transportation of the construction machineries in this stage. Through transportation the marine habitat supposed to be impacted by oil spills as well as greases discarded from ship/cargo engines.

7.5.9 Impacts on Socio-Economic issues

Labour in-migration may be increased due to the increased opportunities of employment in the power plant. A number of local people will be engaged in project related activities and may have employment opportunity. A segment of traditional occupation/resource user groups have to adopt alternative occupation. The mode of livelihood will be impacted due to creation of the facilities of new business and services sectors. Contamination of water and sanitation system. Handling of heavy construction machineries may create health injury in the project sites. Accidental events during construction. Unsafe and unhygienic labour shades may create a very hazardous health problem.

7.5.10 Non-Hazardous Waste Generation

Solid Waste

During construction, large amount of construction waste that includes unused construction materials, construction debris, excavated spoils, abandoned or broken machine parts, debris, kitchen wastes from labor sheds, packaging materials, used home appliances, etc will be produced. Moreover, food waste, plastic, papers, cock sheet, cartons, metal or plastic binders, etc. may be produced as solid waste during this stage. If these wastes are not disposed and maintained properly, these would have impact on surrounding environment. Space for storage and disposal of stuffs and materials generated along with old and used equipment and materials is limited.

Unarranged piling up and disposal of construction waste will cause unhealthy situation in the area and become visual tiring. If not properly managed, this impact would remain during the life span of the Project but would be extended within the plant premises only. The impact is reversible. It is very likely to take place if proper management is not adopted which is the requirement of national and international environmental regulations. Considering all of these, it can be assumed that the magnitude of the impact would be moderate. Sensitivity of this impact would be medium as the Project has will be taken the waste management plan. From the analysis of sensitivity and magnitude, it is apprehended that the significance of the impact would be moderate adverse.

Kitchen Waste

During construction, it is assumed that around high amount of people will be living at site. Among them, numbers of personnel from EPC contractor, from Owner's Engineers, supervision consultants, environmental consultants, RPCL and rest will be day labour. The **Table 7.8** below shows the estimation of kitchen waste during pre-construction and land development period.

Table 7.8: Estimation of Kitchen Waste during Land Development Period

Sl no	Economic Classes of Employee	Project employee	Rate of kitchen waste generation (kg/day/capita)*
1	High Income Group (>20000 tk/month)	-	0.513
2	Middle Income Group (tk 10000-20000tk /month)	-	0.4
3	Low Income Group (< 10000 tk/month)	-	0.26

**source: (JICA, Pacific Consultant Internationals, & Co, 2005)*

It is estimated that significant amount of waste will be generated each day from the labor-shed and employee's residences. Careless disposal of this waste would create pollution, odor problem, nuisance and aesthetic tiring. However, the impact would be for a temporary period, limited within the plant premises, reversible and may happen only in worst-case scenario (i.e. no management of kitchen waste). On the other hand, sensitivity of this impact to the residence of the rehabilitation villages and adjacent places is high. Thus the significance of the impact would be major adverse and needs to be minimized by EMP.

Liquid Waste and Sewerage

It is assumed that during construction phase around huge amount of labourers will be living at site for construction related activities. Considering the 260L/day per-capita sewerage generation, it is estimated that significant amount of sewerage would be generated from temporary labour sheds and officers' residence. A small portion of this sewerage may escape sewerage collection and disposal system. The fecal sludge would go to the existing septic tank and septic tanks of the temporary toilets.

This added sewerage would not have any significant impact on the existing sewerage system. The magnitude of the impact would be moderate and sensitivity would also be medium. Thus significant of the impact would be **medium adverse** and needs to be controlled by adopting EMP.

7.6 Environmental Impacts during operation phase

7.6.1 Impact on Air Quality

Impact assessment of the ambient air quality is one of the key issues for the coal based power plant Project. This study provides detail emission estimates and air quality dispersion modeling output/result to assess the air quality in Kalapara areas. Construction activities will cause temporary increase in pollutant emission while operation of power plant will be causing emission of pollutants during the Project life leading to increase the ground level concentration of air pollutants. The air pollutants considered in the air quality analysis include Sulfur dioxide (SO_2), Oxides of nitrogen (NO_X), carbon monoxide (CO), and particulate matters less than 10 microns and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$).

Objective and Scope of Air Pollution Dispersion Modeling

The chemical composition of the fuel (Coal) of the proposed power plant is very important for the emission estimation. After burning the coal, a number of pollutants release from the stacks like Carbon dioxides (CO_2), Oxides of Nitrogen (NO_X), Oxides of Sulfur (SO_X), Carbon Monoxide (CO) and Particulate Matters. The objective of the air quality modeling study is to (i) First assess the baseline condition in the air-shed, (ii) Second, assess the impact on air quality due to project case, which includes emissions from the 1320 MW coal based power plant (including line sources and brick kline) and RPCL 1320 MW Power Plant emissions and (iii) Finally, assess the cumulative impact, including future proposed developments in the airshed. USEPA regulatory model CALPUFF is used to predict the effect on ambient air quality for SO_2, NO_2, CO, $PM_{2.5}$ and PM_{10} emissions. There are many different dispersion models available, but CALPUFF was used because (i) it is designed for long-range analysis, more than 50 kilometers from the source, (ii) it can accurately model both simple and complex terrain, (iii) can model urban and rural areas, and (iv) multiple point, line, area, and volume sources can be modeled. This assessment is done as a part of ESIA study of 1320 MW Coal based thermal power plant to be constructed at Kalapara, Patuakhali District to meet the compliance requirement of the Government of Bangladesh (GoB) and secure approval of the DoE to implement the project.

Pollutants of Concern

The power plant will be run though imported coal which will be transported by covered conveyer belt from the the Pyra port coal terminal to the project coal yeard. Emissions from the power plant are a serious concern espacially for the coal based power plant project. In addition, the proposed other coal-fired power plants will also be a significant source of emissions in the air-shed. Potential pollutants of concern released from the proposed coal-fired power plant are Sulfur Dioxide (SO_2), Nitrogen oxides (NOx), Particulate Matter ($PM_{2.5}$ and PM_{10}) and Carbon Monoxide (CO). The amount of SO_2 released is dependent on the properties of the fuel, the higher the sulfur content of the fuel, higher the amount of SO2 will be released. High levels of SO_2 can lead to acid rain, which damages crops, forests, and soils, and acidifies lakes and streams. Combustion of coal can also be a significant source of particulate matter. Ash is the main source of particulate maters. Coal-fired power plants also tend to release a significant amount of particulate matter in the form of soot and fly ash. The formation of thermal NOx is dependent on 3 factors during combustion; (i) oxygen concentration, (ii) peak temperature, and (iii) time of exposure at peak temperature. Fuel combustion releases NOx which is composed of NO and NO_2. NO_2 is of particular concern and is considered a criteria pollutant. NO2 is used as the indicator for the larger group of nitrogen oxides (NOx). In addition to contributing to the formation of ground-level ozone, and fine particle pollution, NO_2 is linked with a number of adverse effects on the respiratory system. Significant health risks are associated with high levels of ambient NO_2, CO and $PM_{2.5}$ concentrations. Emissions from the power plant are estimated for two scenarios (i) Baseline scenario and (ii) project case scenario.

Air quality modeling input data

Regulatory agencies rely on dispersion models as part of their approval processes. The Department of Environment (DoE) in Bangladesh does not recommend any specific models for the impact assessment study. Therefore, this study has considered the USEPA recommended air dispersion model to assess the emission to the adjacent areas of the Project site. However, USEPA does not recommend any individual models, therefore allows the modeler to judge and select a suitable model for assessment.

The latest version of the USEPA regulatory model CALPUFF was used to predict and simulate the effects of criteria pollutants from major emission sources in the project area and analyze the effect on ambient air quality for SO_2, NO_2, CO, $PM_{2.5}$ and PM_{10}. Emissions data for point sources such as the proposed 1320 MW power plant and other industrial sources in the air-shed were calculated based on plant fuel consumption and emission factors from USEPA AP42. This is considered a conservative approach to modeling. A Tier-1 and Tier-2 (Ambient Ratio Method) modeling approach was used for NO_2 prediction as per USEPA guidelines. In the Tier-1 approach it is assumed that 100% of the NO_x emissions are converted into NO_2, this approach gives the most conservative results and tends to over predict maximum ground level concentrations. In the tier-2 (ARM) a regional NO_2/NOx ratio representative of area wide quasi-equilibrium conditions is applied to the model predicted values, this gives more realistic results for maximum ground level NO_2 concentration. NO_2 is the pollutant of concern and is used as an indicator for nitrogen oxides (NO_x) in general.

Since there was very little information available on the power plant emissions, criteria pollutant emissions were calculated based on the plant's fuel consumption and USEPA AP 42 emission factors. This is considered as a conservative approach to modeling. Greenhouse gas emissions were calculated using fuel consumption and IPCC greenhouse gas emission factors.

a) Pollution Abatement Measures

Abatement of Particulate Matter

Handling and storage facilities of coal shall be equipped with dust suppression system. The conveyor belt shall be covered and the transfer point shall be equipped with dust suppression system. Hence, dust generation from coal handling and storage activities shall be minimum and within the standard limit. Nevertheless, sometime, within the close proximity of the handling and storage facilities, SPM of the local air might rise but automatic dust sensor and suppression system shall control the generated dust.

The options of removing particulate matter from exhaust gases using cyclones, bag houses (fabric filters), and ESPs have been reported. Bag houses can achieve removal efficiencies of 99.95% or better for particulate matter of all sizes. ESPs are available in a broad range of sizes for power plants and can achieve removal efficiencies of 99.7% or better for particulate matter of all sizes. The choice between a bag house and an ESP will depend on fuel and ash characteristics, as well as on operating and environmental factors.

As per feasibility study, the coal combustion process will produce maximum 12.77% ash (design specification) from the total coal inflow. In order to maintain the standard limit of particulate matter (e.g. PM_{10}& $PM_{2.5}$) controlling devices must be added before the flue gas emission. Based on technical and economic analysis, Electrostatic Dust Precipitator (ESP) has been selected for each of the unit.

Abatement measures for emission of SOx

The range of options and removal efficiencies for SOx controls is wide. Selection of coal on the basis of sulfur contain is the one of the key way of reducing SOx emission. Pre-ESP sorbent injection can remove 30–70% of sulfur oxides, at a cost of US$50–$100 per kW. Post-ESP sorbent injection can achieve 70–90% SOx removal, at a cost of US$80–$170 per kW. Wet and semidry FGD units consisting of dedicated SOx absorbers can remove 70–95%, at a cost of US$80–$170 per kW. The operating costs of most FGDs are substantial because of the power consumed (of the order of 1–2% of the electricity generated), the chemicals used, and disposal of residues. However, approximately 85% of the flue gas desulfurization units installed are wet scrubbers, 12% are spray dry systems and 3% are dry injection systems. The highest SOx removal efficiencies (greater than 95%) are achieved by wet scrubbers and the lowest (less than 80%) by dry scrubbers. However, the new designs for dry scrubbers are capable of achieving efficiencies in the order of 90%. An integrated pollution management approach should be adopted which will not create other form of pollution such as gypsum in the study area.

A coal-fired power plant utilizes coal (main fuel) and oil (auxiliary fuel for startup). Since the planned output of each of the power plants is 660 MW, the emission standard limit is needed to comply for all the regulation for greater than 500 MW coal based power plant. However, a single stack is confirmed with 275m height for this power plant project.

Abatement of Nitrogen Oxides

The main options for controlling NOx emissions are combustion modifications: low-NOx burners with or without over fire air or re-burning, water/steam injection, and selective catalytic or non-catalytic reduction (SCR/SNCR). Combustion modifications can remove 30– 70% of nitrogen oxides, at a capital cost of less than US$20 per kW and a small increase in operating costs. SNCR systems can remove 30–70% of nitrogen oxides, at a capital cost of US$20–$40 per kW and a moderate increase in operating cost. However, plugging of the pre-heater because of the formation of ammonium bi-sulphate may pose some problems. SCR units can remove 70–90% of nitrogen oxides but involve a much larger capital cost of US$40–$80 per kW and a significant increase in operating costs, especially for coal-fired plants. Moreover, SCR may require low sulfur fuels (less than 1.5% sulfur content) because the catalyst elements are sensitive to the sulfur dioxide content in the flue gas. Both plants will adopt low-NO_x burner and keep the provision of SCR if the level of NO_x may breach the emission standard.

CALMET, CALPUFF and CALPOST Methodology

For the dispersion modeling from the proposed power plant, the CALPUFF model suite was used for. CALPUFF is a suite of numerical dispersion models that is composed of CALMET (the metrology processor), CALPUFF, and CALPOST (the post processor). The CALPUFF suite is used to determine the impact of emissions from a source or group of sources, which can be point, line or area. First, three-dimensional meteorological fields were produced by the diagnostic computer model CALMET based on surface and upper air weather data, digital land use data, terrain data, and prognostic meteorological data. The three-dimensional CALMET meteorological fields were generated using WRF meteorological data and digital terrain and land use data.

Then the three-dimensional fields produced by CALMET were used by CALPUFF, which is a three-dimensional, multi-species, non-steady-state Gaussian puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport. Lastly, CALPOST, a statistical processing program, was used to summarize and tabulate the pollutant concentrations calculated by CALPUFF and produce contour diagrams.

Project Modeling Area

The CALPUFF dispersion model is comprised of a (i) Meteorological grid, (ii) Computational grid, and (iii) Sampling (receptor) grid is 50 km by 50 km with the center point being at Lat: 22.027494 N and Long: 90.303467 E and is the system of grid points at which meteorological parameters such as wind components and mixing heights are defined. The Computational Grid is where the puffs are released and adverted, and is either identical to or a subset of the Meteorological Grid. Around 25 km width was chosen to ensure the emissions impact proposed power plant project to the surrounding sensitive receptors would be adequately assessed. Choosing a computational/sampling area that is to big would significantly increase model run-time. The sampling Grid defines the set of gridded receptors, which must be placed within the computational grid and meteorological grid. In this case, the sampling grid has the same dimensions as the computational grid. However, **Table 7.9** shows salient point features and **Figure 7.2** shows 3 dimensional plant boundary as well as the domain selected for air quality modeling.

Table 7.9: CALPUFF Study Area Coordinates (UTM Zone: N 46)

Model Domain		Easting (m)	Northing (m)
Project Boundary	Stack Point	221640	2438328
	East Corner	222905.63	2438281
	North Corner	221381.08	2439119
	West Corner	220147.99	2437648
	South Corner	221353.97	2436973
Computational Grid	Southwest Corner	196675.36	2413341.39
	Southeast Corner	246649.08	2413266.67
	Northeast Corner	246641.18	2463229.05
	Northwest Corner	196649.12	2463295.97

Source: CEGIS, 2016

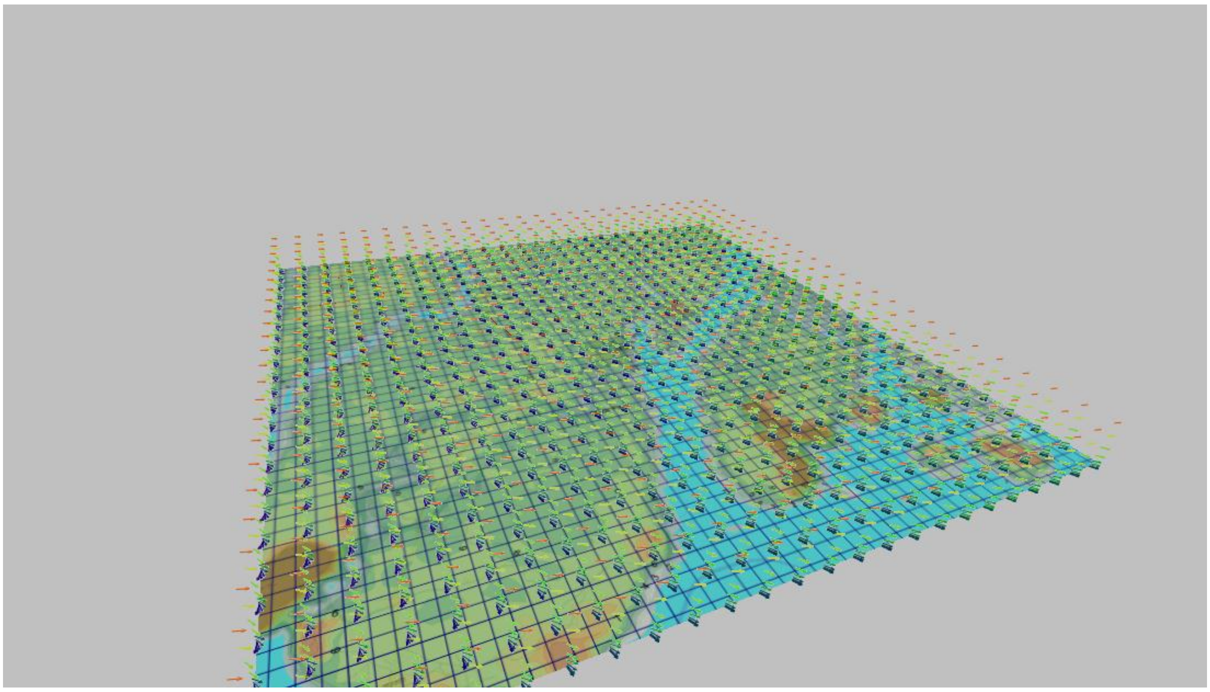


Figure 7.2: Air despersion modelling boundary in 3D

Emissions Inventory

In order to ensure the plant flue gas diffusion, operation facility, stack of RPCL Kalapara 1320MW thermal power plant is designed as 275 m higher than ground level for coal of one stack with two ducts.

The stack structure is as follows: reinforced concrete block inside which there are ten steel stacks, each steel tube is for one unit. Inside diameter of the steel tube is designed basing on flue volume, outlet flue temperature, flue velocity at the top of the stack, friction loss in the stack. Inside the stack, there is also interior steel support system, ladder system, air ventilation system, working floors for stack operation and maintenance and monitoring during the plant operation period. Outside is equipped with lightning system and aerial alarm light system.

To limit sulfuric acid (H_2SO_4) formation, because of the reduction of flue gas temperature to below dew-point, temperature inside the stack should be maintained as high as possible. With such purpose, the outer side steel flue gas duct outer side is covered by one glass-wool; this layer is protected by stainless steel. Inside shell of the steel flue gas duct is covered by one anti-acid mortar layer. However, the emission rate of various pollutant substances has been presented the **Table 7.10**as per feasibility report.

Table 7.10: Emission Inventories or the Proposed Project

Parameter	Value
Source type	Point
Dispersion Coefficient	For Rural
Receptor Height Above ground	0 m
Emission Rate (CO)	34.52 g/s
Emission Rate (SO2)	122.76 g/s
Emission Rate (NOx)	313.06 g/s
PM10	28.54 g/s
PM2.5	2.14 g/s
Number of Stack	1
Stack Height	275 m

Parameter	Value
Stack inside diameter	7.2 m
Velocity	22 m/s
Stack Gas Exit Temperature	110^0 C
Upper Atmospheric Data	MM5
Terrain	Simple

Emission inventories were prepared for all major point, area, and line sources within the airshed. The major point sources for modeling the baseline and project case are as follows:

- Brick fields
- Vehicles on the road

At present, few brickfields are found in the study area. Vehicles run on the Patuakahli – Kuakata road, Kalapara-Barguna road and brick fields are the key sources of emission. **Table 7.11** shows the major point sources along with input parameters for the baseline study. Emission from the brick fields are determined by the USEPA guideline AP-42 and Emission inventories for the Brickfield in Bangladesh. They are considered as point source during the modeling study.

Table 7.11: Major Point Source Emissions in the Project Area

Type	UTM X (m)	UTM Y (m)	Stack Height (m)	Ext. Temp (K)	Stack Velocity (m/S)	Stack Dia. (m)	CO (gm/S)	SOx (gm/S)	NOx (gm/S)	PM10 (gm/S)	PM2.5 (gm/S)
Brick Field	217280	2432655	38.20	315.00	7.40	1.2	0.08	7.15	0.21	6.44	2.12
Brick Field	217348	2432743	38.20	315.00	7.40	1.2	0.08	7.15	0.21	6.44	2.12
Brick Field	216224	2430563	38.20	315.00	7.40	1.2	0.08	7.15	0.21	6.44	2.12
Brick Field	216027	2430734	38.20	315.00	7.40	1.2	0.08	7.15	0.21	6.44	2.12
Brick Field	215646	2430977	38.20	315.00	7.40	1.2	0.08	7.15	0.21	6.44	2.12
Brick Field	214991	2431770	38.20	315.00	7.40	1.2	0.08	7.15	0.21	6.44	2.12

Major line sources of pollution considered in the model are traffic moves to the Patuakhali-Kuakata and Barguna road. A number of vehicles move every day on this road which causes air pollution from their exhausts. A detail information of the line sources are given in the **Table 7.12**.

Table 7.12: Vehicle information (AADT)

Road	Distance	Heavy Truck	Medium Truck	Light Truck	Large Bus	Mini Bus	Micro Bus	Utility Vehicle	Car	Auto Rickshaw	Motor Cycle
R880	40.65	-	79.00	20.00	80.00	17.00	54.00	25.00	17.00	1096.00	1203.00
R880	31.16	15	84.00	454.00	71.00	73.00	78.00	27.00	48.00	1585.00	1427.00
Z8810	12.71	8	78.00	169.00	13.00	47.00	37.00	14.00	23.00	561.00	481.00

Source: The RMMS Database, Department of Roads and Highways, Bangladesh.

The types and total quantity vehicles were collected from the records Roads and High way Department. In absence of the supply of natural gas on the Barishal region, diesel is considered the main fuel for the maximum vehicles. Emissions from marine vehicles were calculated based on the total estimated fuel used and USEPA AP-42 emission factors. **Table 7.13** shows the emission factors for the N7 Highway.

Table 7.13: Major Line-area Sources in the Project Area (Highway Traffic)

Name	Emission Rate (g/s-m2)					Release Height (m)
	NOx	SO2	CO	PM2.5	PM10	
R880	4.073E-05	3.285E-07	3.169E-04	1.173E-06	8.987E-06	0.5
R880	6.268E-05	4.905E-07	3.930E-04	1.584E-06	1.086E-05	0.5
Z8810	2.398E-05	1.871E-07	1.352E-04	5.752E-07	3.704E-06	0.5

*Note: *Calculated based on The RMMS Database, Department of Roads and Highways, Bangladesh.*

The GoB has taken a master plan to develop the Kalapara areas as a power hub which run though the imported coal facilitated by the Payra Port Authority. A number of Power Companies has already process their initiatives to install their power plants in future. Emission inventories were prepared based on the other similar types of coal based power plants in Bangladesh. The stack emissions and stack parameters of the thermal power plants are given in **Table 7.14**. The rate of pollutant (CO) emission has been calculated based on the emission inventories of USEPA AP-42 Volume-1 (1995); Stationary sources for coal base Power Plant

Table 7.14: Major Point Source Emissions in the Project Area

	No. of Stack	Capacity (MW)	Stack Height (m)	Inner Dia. (m)	Flue Gas Temp. (K)	Emission Rate (g/s)				
						CO	SO2	NOx	PM10	PM2.5
NWPGCL	1	2x660	275	7.2	383	34.52	394.2	368.3	25.19	1.90
APSCL	1	2x660	275	7.2	383	34.52	394.2	368.3	25.19	1.90
SKS	1	2x660	275	7.2	383	34.52	394.2	368.3	25.19	1.90

Source: Other Power Plants document and AP-42

Meteorological Data

Pre-processed hourly 3D meteorological data of the year 2013, 2014 and 2015 was procured from the Lakes Environmental Software (CALMET-Ready MM5, location at 24.386211 N, 89.745619E). This is known as upper atmospheric or air surrounding data which is used in the air dispersion model. The regional meteorological conditions are assessed after analysis of meteorological data of recorded by the Kuakata, BMD station. Detail meteorological phenomenon of the study area are presented in the baseline study of this report. Wind direction, velocity and movement are very much important for dispersion modeling study. **Figure 7.4** shows the frequency distribution of wind passes over the project area. **Figure 7.3** shows the wind rose diagram after statistical analysis of the wind data of the last three years.

Figure 7.3: Wind-rose diagram of last 3 years

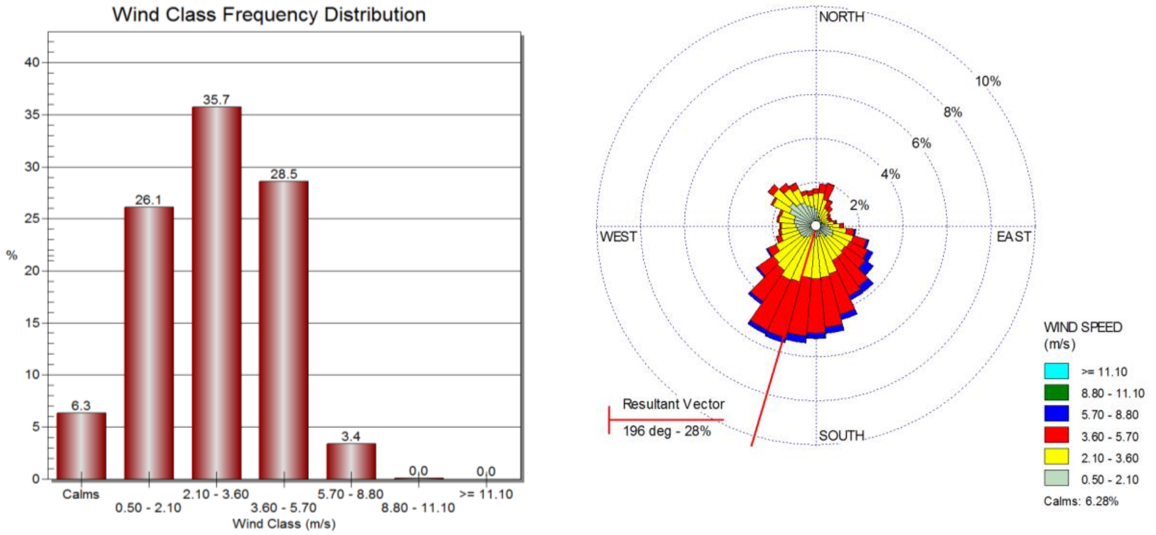


Figure 7.4: Frequency distribution of wind over the Project area

Receptors

Two types of receptors are defined within the Model Domain. These are: A) Nested Cartesian Grid Points and B) Discrete Receptors. Since this study will present the spatial distribution of pollution dispersion, the nested Cartesian Grid are not considered during the modeling study. 25x25 km was taken as the computational grid from the stack point of the Propose RPCL 1230 MW power plant.

Discrete Receptors

In addition, discrete locations corresponding to specific sites of interest are included in this assessment. These receptors are broadly located as the places which are populated with human being especially children and patients since their health is much vulnerable to air pollution. Around 120 numbers of primary school, Madrasa, health complex and Madrasha are selected as discrete receptors around the RPCL Power Project. Moreover, Kuakata Sea beach and extended mangrove forest of Sundarbans are considered as eco-sensitive discrete receptors during this modeling study. Four baseline monitoring points are also included as discrete receptor for future comparison. The effects on air quality at these sensitive sites were also assessed in more details. The list of sensitive receptors, their locations and details are given in **Table 7.15**.

Table 7.15: Details of Sensitive Receptors

Sl No	Name of Sensitive Receptors	Location (m)		Distance from the Stack
		Latitude	Longitude	Km
1	Primary School	215216.55	2421973.94	20
2	Primary School	215750.24	2428207.94	20
3	Primary School	232122.64	2428301.16	20
4	Primary School	210910.09	2428654.96	20
5	Family Welfare Centre	210774.04	2429028.03	20
6	Family Welfare Centre	232433.07	2429565.68	20
7	Primary School	232184.55	2429769.27	20
8	Primary School	208260.16	2430520.14	20
9	Family Welfare Centre	208833.29	2430904.72	20
10	Primary School	233225.49	2432534.74	20
11	Primary School	205860.37	2437629.99	20
12	Primary School	203440.91	2437923.58	20
13	Primary School	236400.56	2438310.14	20
14	Primary School	234525.98	2438744.14	20
15	Family Welfare Centre	207502.93	2439069.72	20
16	Primary School	205732.38	2439330.71	20
17	Primary School	205641.75	2442195.63	20
18	Family Welfare Centre	202271.46	2442378.87	20
19	Primary School	202695.10	2442441.11	20
20	Primary School	204178.12	2444236.28	20
21	Primary School	208725.01	2444298.90	20
22	Primary School	208415.90	2445734.07	20
23	Family Welfare Centre	211763.15	2445976.75	20
24	Primary School	211819.50	2446095.04	20
25	Primary School	231331.80	2448319.29	20
26	Primary School	216465.14	2448577.83	20
27	Primary School	225877.76	2448857.64	20
28	Primary School	223842.71	2449059.92	20
29	Primary School	217618.50	2449110.42	20
30	Primary School	222586.52	2449143.75	20
31	Primary School	216802.52	2449513.24	20
32	Primary School	235358.38	2449584.77	20
33	Primary School	214578.03	2449585.89	20
34	Primary School	213607.35	2449702.96	20
35	Primary School	221626.60	2449906.05	20

Sl No	Name of Sensitive Receptors	Location (m)		Distance from the Stack
		Latitude	Longitude	Km
36	Primary School	234284.21	2450100.89	20
37	Hospital	214197.20	2450102.45	20
38	Primary School	218366.35	2450148.44	20
39	Primary School	224901.57	2450349.68	20
40	Primary School	232889.22	2452539.46	20
41	Family Welfare Centre	220450.87	2452854.98	20
42	Family Welfare Centre	224983.17	2452952.74	20
43	Primary School	214258.92	2453025.58	20
44	Primary School	230669.33	2453178.54	20
45	Community Clinic	225198.38	2453463.20	20
46	Community Clinic	225077.16	2453648.97	20
47	Primary School	221995.62	2453720.10	20
48	Primary School	216714.53	2453830.07	20
49	Primary School	224863.05	2454075.17	20
50	Primary School	226776.80	2454510.09	20
51	Community Clinic	210862.52	2454674.69	20
52	Primary School	220466.54	2455713.48	20
53	Primary School	223806.38	2455742.69	20
54	Hospital	220079.76	2455745.18	20
55	Primary School	227867.61	2456113.52	20
56	Primary School	219050.47	2457337.80	20
57	Family Welfare Centre	218689.74	2429234.82	10
58	High School	218798.30	2429240.69	10
59	Primary School	229720.34	2432359.24	10
60	High School	228098.62	2433130.13	10
61	Community Clinic	213829.58	2434219.85	10
62	Primary School	216421.28	2434257.94	10
63	High School	212225.77	2434587.34	10
64	Primary School	230899.00	2434615.71	10
65	Primary School	212317.54	2434791.28	10
66	Hospital	212782.92	2434907.76	10
67	Madrasa	212389.48	2434953.38	10
68	Primary School	231031.20	2435587.45	10
69	Madrasa	231242.01	2435595.77	10
70	Primary School	212817.88	2436376.92	10
71	Primary School	215262.82	2439293.77	10
72	Family Welfare Centre	212613.54	2439421.88	10
73	Primary School	212469.28	2439720.31	10
74	Primary School	228983.92	2440006.86	10
75	Madrasa	229180.26	2440040.37	10

Sl No	Name of Sensitive Receptors	Location (m)		Distance from the Stack
		Latitude	Longitude	Km
76	Primary School	212802.94	2440348.80	10
77	Primary School	216358.31	2440891.45	10
78	Primary School	214519.72	2441344.39	10
79	Primary School	218555.63	2442809.72	10
80	Primary School	214679.80	2442830.19	10
81	Primary School	225758.64	2443064.35	10
82	High School	225799.58	2443298.72	10
83	Primary School	216601.35	2443514.20	10
84	High School	221932.66	2443830.93	10
85	High School	221706.70	2444128.35	10
86	Primary School	219864.20	2444446.58	10
87	Primary School	218741.72	2444529.30	10
88	High School	218770.14	2444763.57	10
89	Primary School	217267.52	2445008.64	10
90	Primary School	226984.28	2445346.65	10
91	Madrasa	222838.28	2445560.65	10
92	Primary School	223076.68	2445584.39	10
93	Madrasa	217040.00	2445854.59	10
94	Madrasa	217061.36	2445897.81	10
95	Primary School	226223.43	2446571.76	10
96	Madrasa	222460.39	2446818.72	10
97	Family Welfare Centre	220690.76	2447021.46	10
98	Primary School	222416.75	2447035.09	10
99	Madrasa	218908.97	2447142.25	10
100	High School	221005.08	2433032.15	5
101	Primary School	221067.96	2433077.63	5
102	Primary School	221641.54	2434897.29	5
103	Primary School	218492.36	2435484.03	5
104	Primary School	218917.99	2438730.79	5
105	Primary School	218083.48	2439002.57	5
106	Madrasa	218503.45	2439834.87	5
107	Primary School	224027.87	2440162.20	5
108	High School	220205.17	2440502.93	5
109	Primary School	217912.97	2440788.85	5
110	Primary School	223642.11	2441065.07	5
111	Family Welfare Centre	223106.38	2441168.01	5
112	High School	223176.49	2441711.56	5
113	Primary School	219728.95	2438281.49	2
114	High School	223121.20	2438862.29	2
115	Londa kheya ghat, Dhankhali	218994.59	2436673.54	2

Sl No	Name of Sensitive Receptors	Location (m)		Distance from the Stack
		Latitude	Longitude	Km
116	Itbaria village	217435.55	2432798.32	2
117	Dhankhali Ashraf Academy	223182.04	2438787.94	2
118	Islampur, Pujakhola	218627.72	2440238.39	2
119	Kuakata	202412.92	2414963.2	25
120	Extent of Sundarbans Mangrove	201192.7	2424308.29	23

Source: CEGIS, 2016

7.6.2 Air Quality Modelling

In this section, the predicted maximum ground level concentration results and contour maps for maximum concentration levels in ambient air are presented for SO_2, $PM_{2.5}$, PM_{10}, NO_X, and CO for both the baseline and project scenario.

Background Concentration

Background ambient measurements were obtained from the baseline monitoring of the air quality for both dry and wet season. The air quality monitoring location has been selected based on the wind direction and location sensitivity. Air quality data has been collected continuously 8 hr though standard procedure.

The background values for SO_2, $PM_{2.5}$ and PM_{10} are measured for 8-hour averaging period and thus have to be converted to 24-hr and annual averaging period for compatibility with modeled results. NO_X is for 8-hour measurement period and has to be converted to 1 hour and average. Concentration of NO_2 can be estimated from the ration of NO_2/NO_X in the representative areas. Theoretically, equilibrium occurs when the rate of NO_2 formation (from oxidation of NO) equals the rate of dissociation of NO_2 by sunlight[5]. An ambient equilibrium NO_2/NO_X ratio of 0.65 was used, which is based on data from the Narayanganj CAMS monitoring station of DOE. The CO has to be converted from 8 hour to 1 hour average period. Conversions are done using the power law relationship (OMOE, 2014) given below:

$C_{long} = C_{short}(t_{short}/t_{long})P$

Where:

C_{long}= the concentration for the longer averaging time

C_{short}= the concentration for the shorter averaging time

T_{short}= the shorter averaging time

T_{long} = the longer averaging time

p = the power law exponent

For ambient air assessments a p value of 0.28 is used. This methodology is deemed to give conservative estimates and thus is deemed appropriate for this case. The converted background concentration values are given in Table-8.16. The background ambient concentration values were added to the modeled 1-hr, 8-hr, and 24-hr and annual concentration values.

Modeling Output for Baseline and Project Case

5 Use of Ambient Ratios to Estimate Impact of NOx Sources on Annual NO2 Concentrations. In Proceedings of the 84th Annual Meeting & Exhibition, Air & Waste Management Association, 1991

The modeling has been run for predicting the maximum concentration levels of ambient air pollutants like SO_2, $PM_{2.5}$ and PM_{10} for both the baseline and project case. Only, emissions from feasibility study data were modeled and a measured ambient background concentration and the value have been added to the modeled results to predict concentration at the sensitive receptors at the time of operation of the project. The results for different scenarios at the sensitive receptors have been shown in Appendix-VIII.

Concentration of Sulphur Dioxide (SO_2)

Sulphur dioxide is the key concern for the coal based power plant projects. The emission of SO_2 depends on the concentration of Sulfur in coal, rate of combustion and emission control technologies e.g. FGD. The level of SO_2 concentration in the study area has been assessed during the baseline based on the emission from the vehicles, brickfields etc. The maximum concentration of $SO_2$for 24-hr and annual averaging time has shown in **Table 7.16** for both baseline and project case. The spatial Distribution of SO_2 concentration has been shown in **Figure 7.5** both for baseline and project case.

Table 7.16: Air Quality Modeling Data - SO_2

Pollutant SO_2	Averaging Time	Location at Ground Level (UTM: 46)		Concentration (µg/m³)	Standard Limit	
		East (m)	North (m)	Maximum Value	ECR 2005	IFC 2008
Baseline Case	24 Hr	217.436	2432.798	4.7455E+001	365	125 (IT-1)
Project Case		217.436	2432.798	4.8104E+001		
Baseline Case	Annual	217.436	2432.798	6.5068E+000	80	-
Project Case		217.436	2432.798	6.7193E+000		

Source: CEGIS, 2015

Concentration of $PM_{2.5}$

There is very little amount of filterable particulate matter ($PM_{2.5}$) emits through the stacks of the power plant. The maximum concentration of $PM_{2.5}$ for 24-hr and annual averaging time is accounted through the modeling process using the three years meteorological data of the study area. The peak concentration found in the ground level depending on the worst-case meteorological situation. This maximum concentration values have been predicted for both Baseline and project case within the study area (**Table 7.17**). The Modeling data shows insignificant differences of the maximum concentration values of $PM_{2.5}$ for the baseline and project case. The spatial Distribution of $PM_{2.5}$ concentration has been shown in **Figure 7.6** both for baseline and project case.

Table 7.17: Air Quality Modeling Data –$PM_{2.5}$

Pollutant PM2.5	Averaging Time	Location at Ground Level (UTM: 46)		Concentration (µg/m³)	Standard Limit	
		East (m)	North (m)	Maximum Value	ECR 2005	IFC 2008
Baseline Case	24 Hr	217.436	2432.798	1.4076E+001	65	75 (IT-1)
Project Case		217.436	2432.798	1.4397E+001		
Baseline Case	Annual	217.436	2432.798	1.9329E+000	15	35 (IT-1)
Project Case		217.436	2432.798	2.0016E+000		

Concentration of PM_{10}

The condensable particulate maters are generally included into PM_{10}. The highest concentration of PM_{10} for 24-hr and annual averaging time is estimated through the modeling process with the help of three years meteorological data of the study area. The maximum concentration of PM_{10} would only found in the ground level for the worst-case meteorological situation. The peak concentration of this pollutant has been predicted for both the Baseline project case within the study area (**Table 7.18**).The spatial Distribution of PM_{10} concentration has been shown in **Figure 7.7** both for baseline and project case.

Table 7.18: Air Quality Modeling Data –PM_{10}

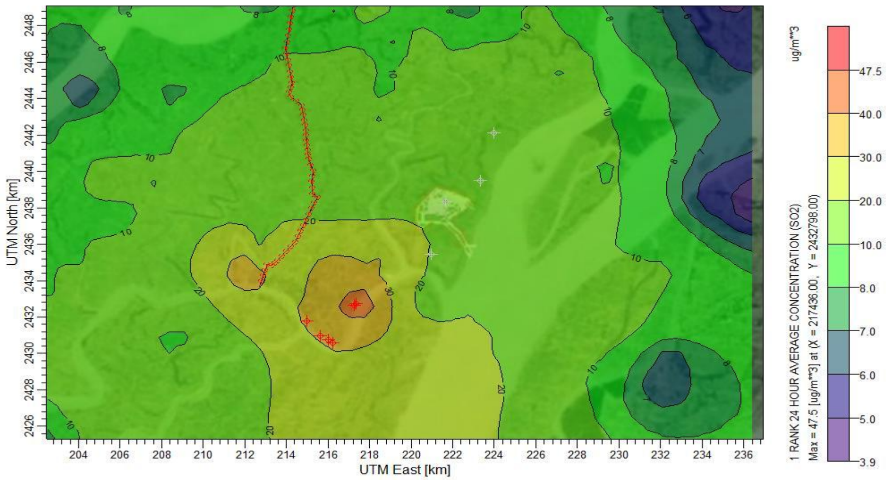
Pollutant PM10	Averaging Time	Location at Ground Level (UTM: 46)		Concentration (μg/m³)	Standard Limit	
		East(m)	North (m)	Maximum Value	ECR 2005	IFC 2008
Baseline Case	24 Hr	217.436	2432.798	4.2784E+001	150	150 (IT-1)
Project Case		217.436	2432.798	4.3782E+001		
Baseline Case	Annual	217.436	2432.798	5.8897E+000	50	70 (IT-1)
Project Case		217.436	2432.798	6.0387E+000		

Concentration of Sulphur Dioxide (NO_X)

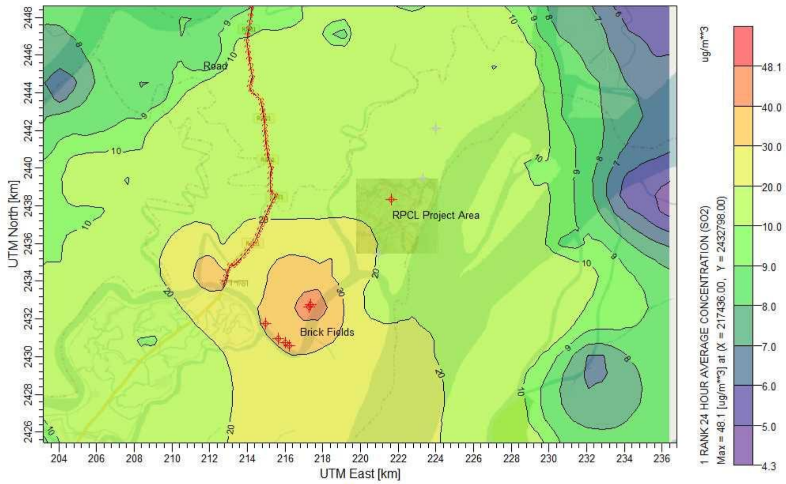
NO_X is the key concern for the coal based power plant projects. The emission of SO_2 depends on the combustion and emission control technologies e.g. LNB (Low-NO_X burner). The level of NO_X concentration in the study area has been assessed during the baseline based on the emission from the vehicles, brickfields etc. The maximum concentration of NO_X for 1-hr and annual averaging time has shown in **Table 7.19** for both baseline and project case. The spatial Distribution of NO_X concentration has been shown in **Figure 7.8** both for baseline and project case.

Table 7.19: Air Quality Modeling Data – NO_X

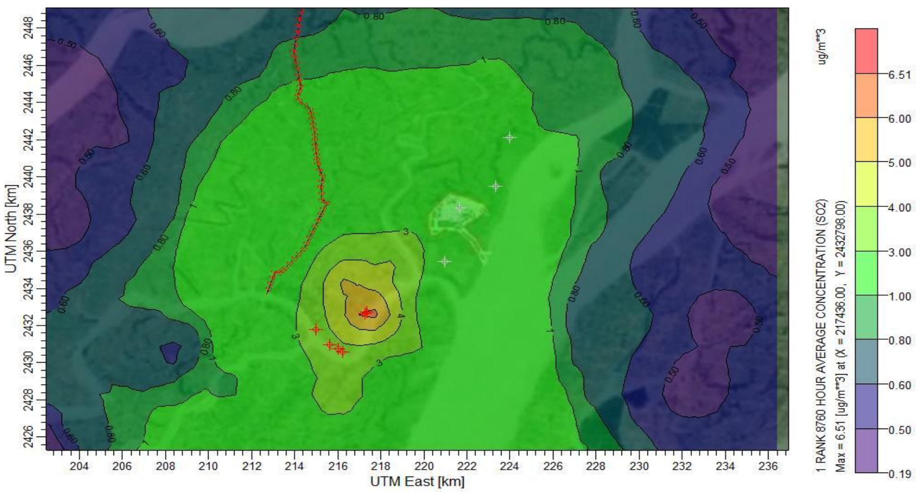
Pollutant NOx	Averaging Time	Location at Ground Level (UTM: 46)		Concentration (μg/m³)	Standard Limit (μg/m³)	
		East(m)	North (m)	Maximum Value	ECR 2005	IFC 2008
Baseline Case	1 Hr	215.263	2439.294	1.4209E+002	-	200
Project Case		218.918	2438.731	2.3662E+002		
Baseline Case	Annual	215.263	2439.294	1.1152E+001	100	40
Project Case		215.263	2439.294	1.1357E+001		



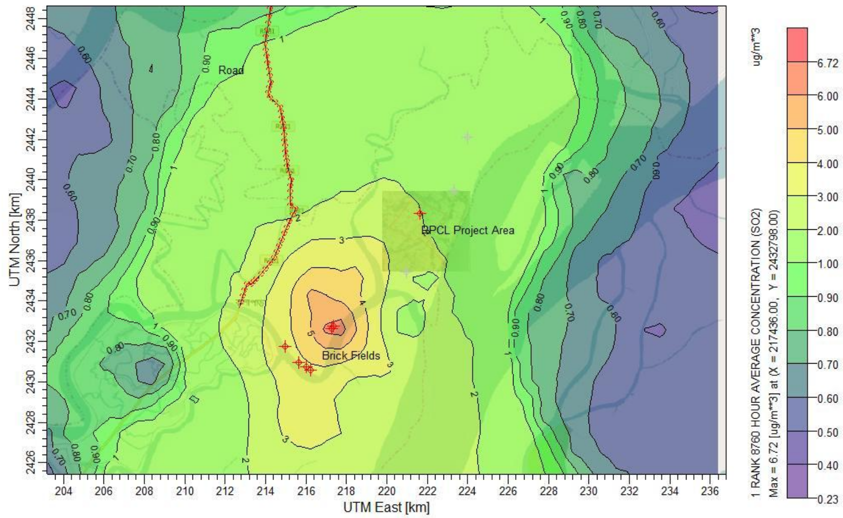
Baseline - SO_2 (24 Hr)



Project - SO_2 (24 Hr)

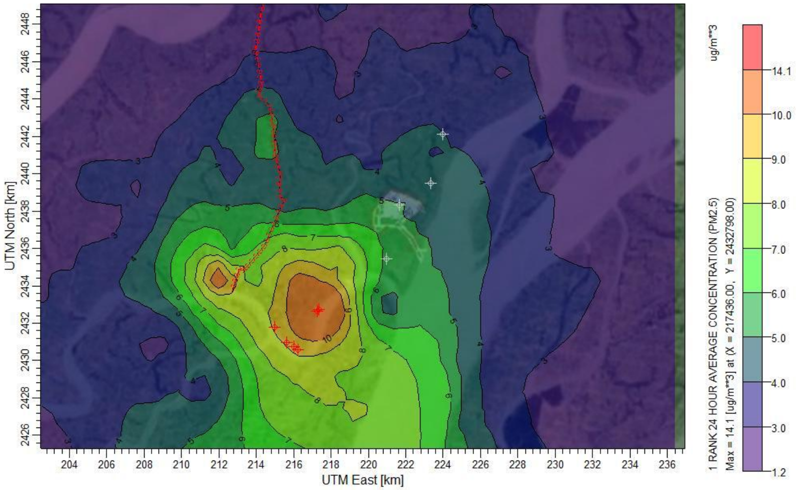


Baseline - SO_2 (Annual)

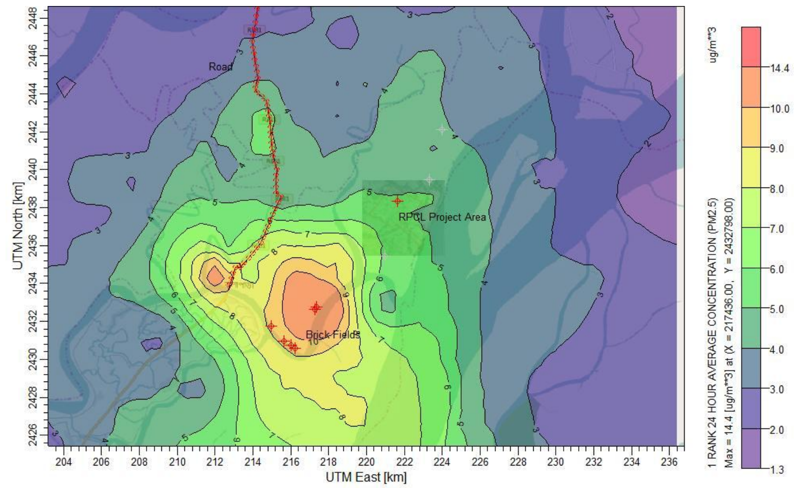


Project- SO_2 (Annual)

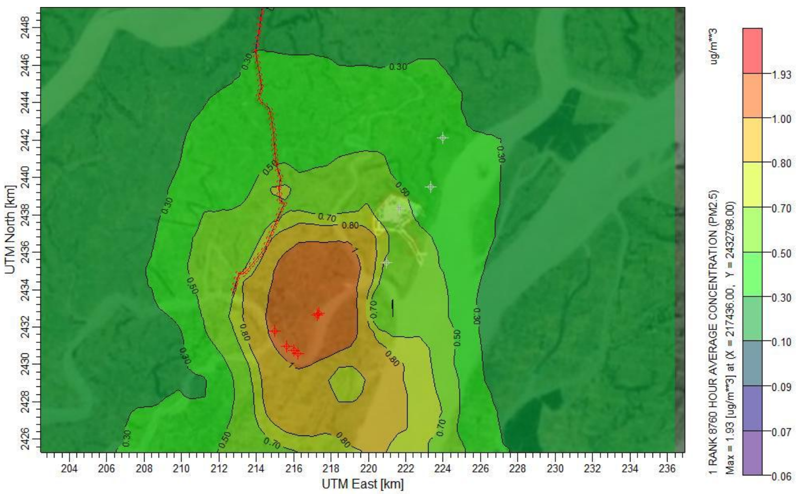
Figure 7.5: Distribution of SO2 both for project and baseline case



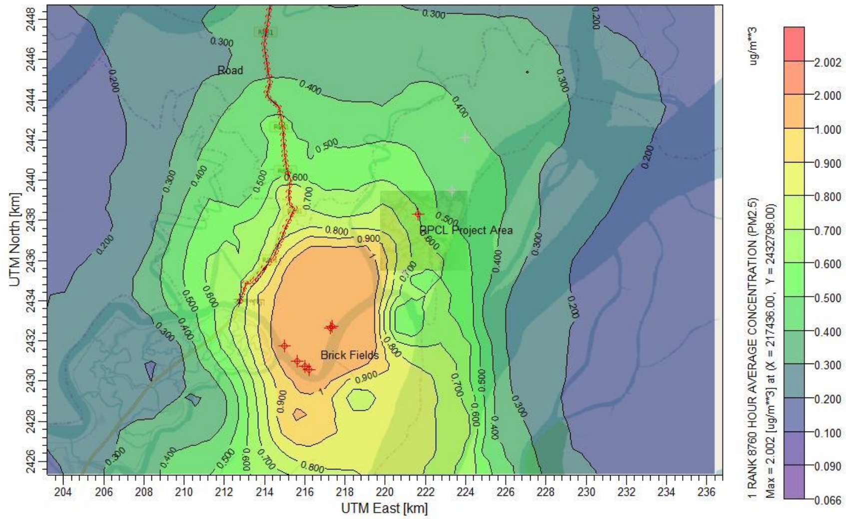
Baseline – $PM_{2.5}$ (24 Hr)



Project – $PM_{2.5}$ (24 Hr)

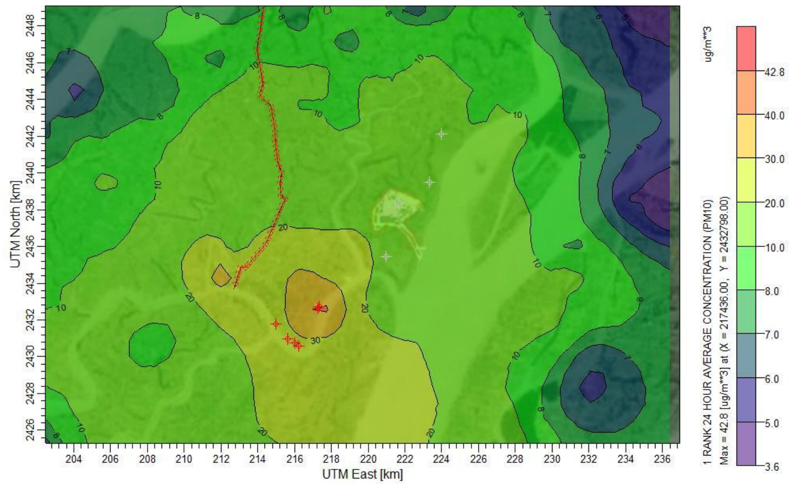


Baseline – $PM_{2.5}$ (Annual)

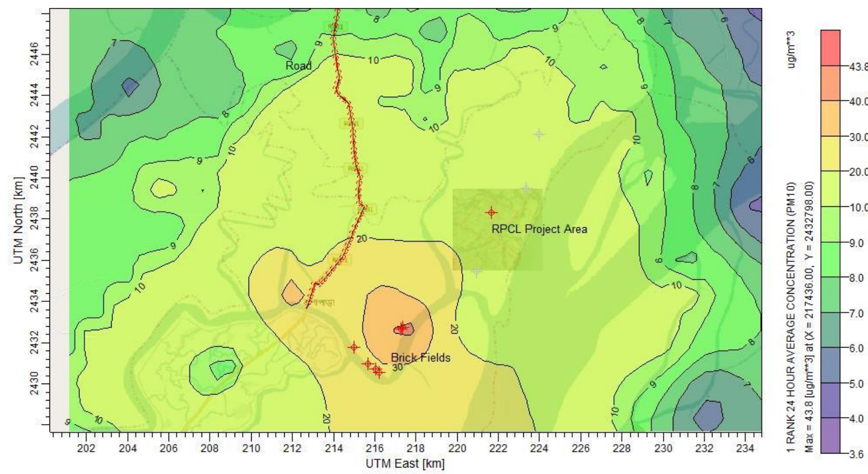


Project – $PM_{2.5}$ (Annual)

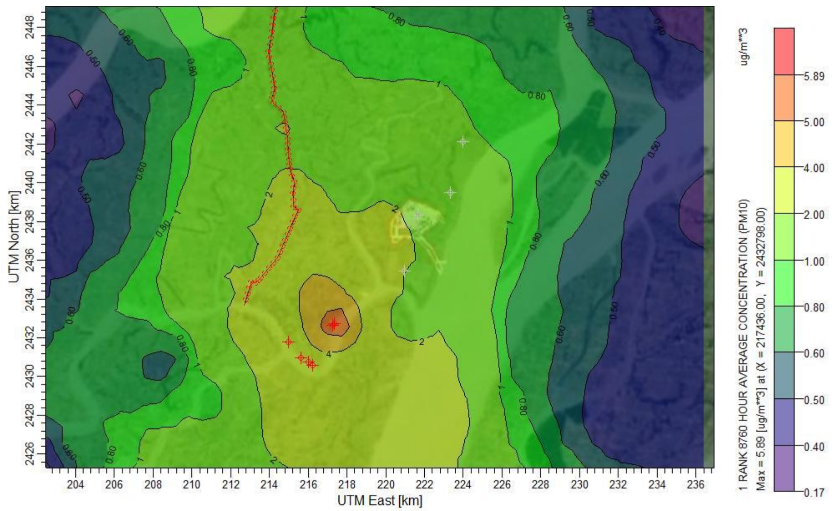
Figure 7.6: Distribution of PM2.5 both for project and baseline case



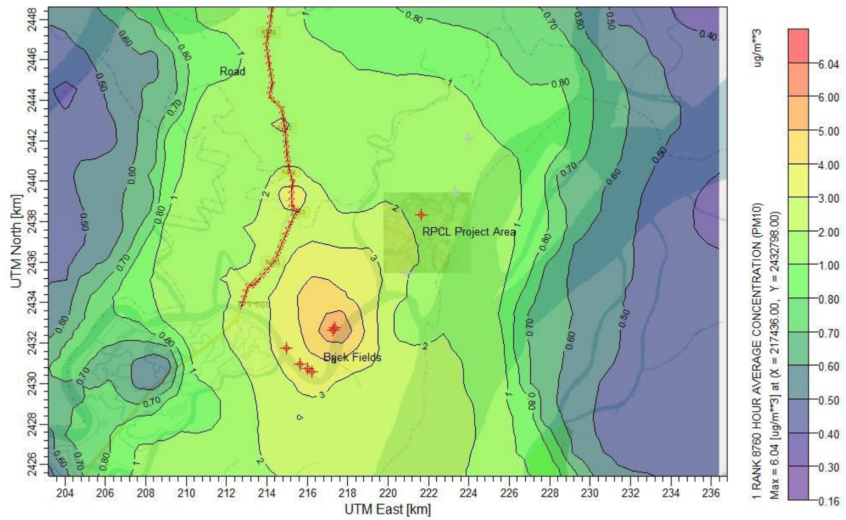
Baseline – PM_{10} (24 Hr)



Project – PM_{10} (24 Hr)

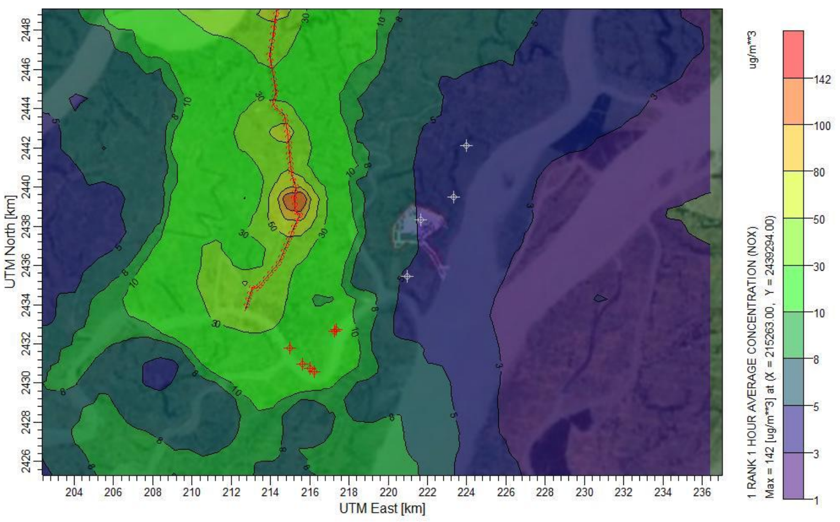


Baseline – PM_{10} (Annual)

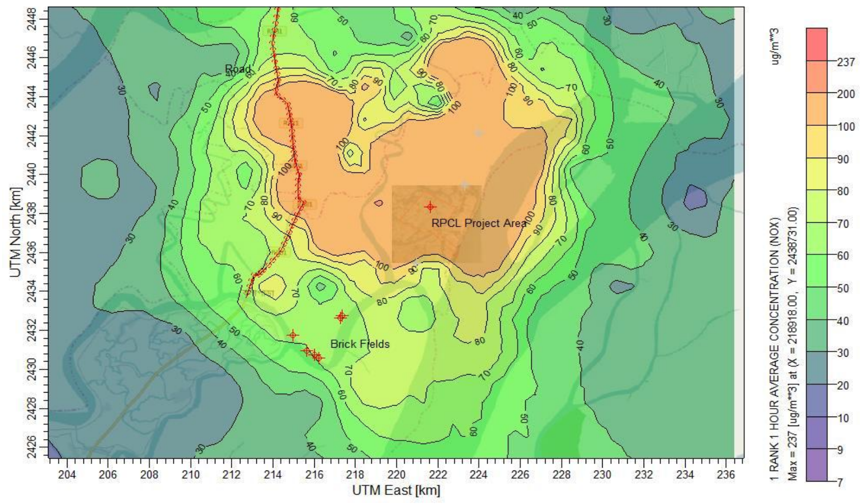


Project – PM_{10} (Annual)

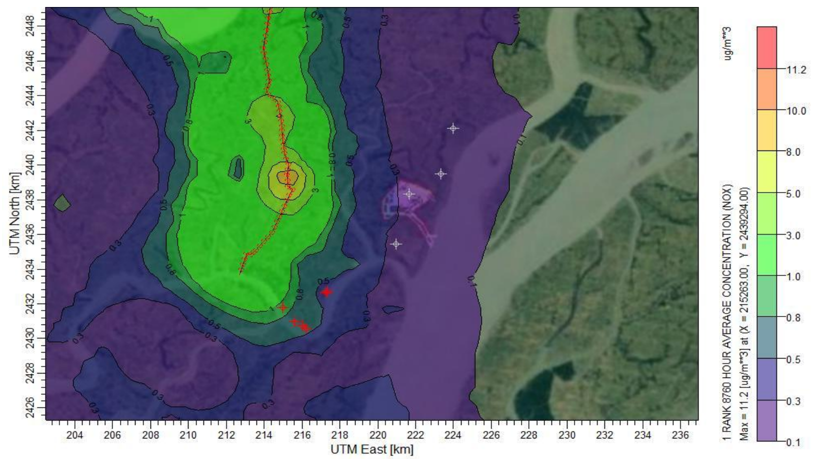
Figure 7.7: Distribution of PM10 both for project and baseline case



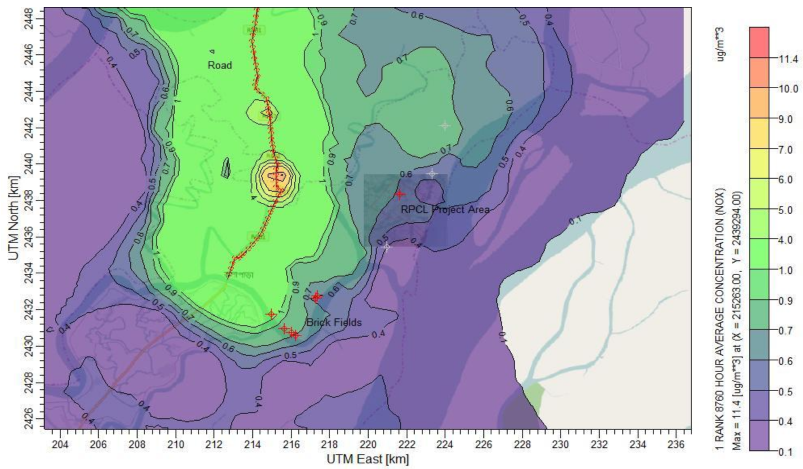
Baseline – NO_X (1 Hr)



Project – NO_X (1 Hr)



Baseline – NO_X (Annual)



Project – NO_X (Annual)

Figure 7.8: Distribution of NO_X both for project and baseline case

7.6.3 Cumulative Impacts on Air Quality

The GoB has taken a master plan to develop the Kalapara areas as a power hub which runs through the imported coal facilitated by the Payra Port Authority. A number of Power Companies has already process their initiatives to install their power plants in future. Emission inventories were prepared based on the other similar types of coal based power plants in Bangladesh. The stack emissions and stack parameters of the thermal power plants are given in **Table 7.20**. The rate of pollutant (CO) emission has been calculated based on the emission inventories of USEPA AP-42 Volume-1 (1995); Stationary sources for coal base Power Plant.

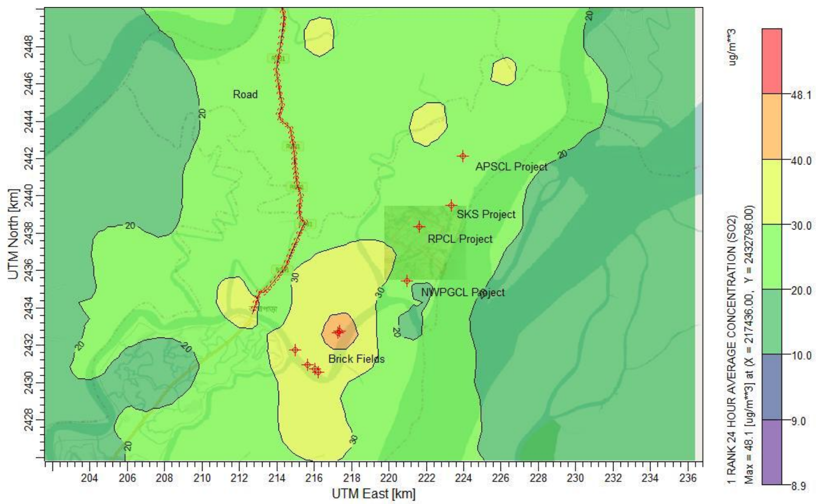
Table 7.20: Major Point Source Emissions in the Project Area

	No. of Stack	Capacity (MW)	Stack Height (m)	Inner Dia. (m)	Flue Gas Temp. (K)	Emission Rate (g/s)				
						NOx	CO	SO2	PM10	PM2.5
NWPGCL	1	2x660	275	7.2	383	183	69	278	42	21
APSCL	1	2x660	275	7.2	383	618	69	242	28	21
SKS	1	2x660	275	7.2	383	183	69	278	42	21

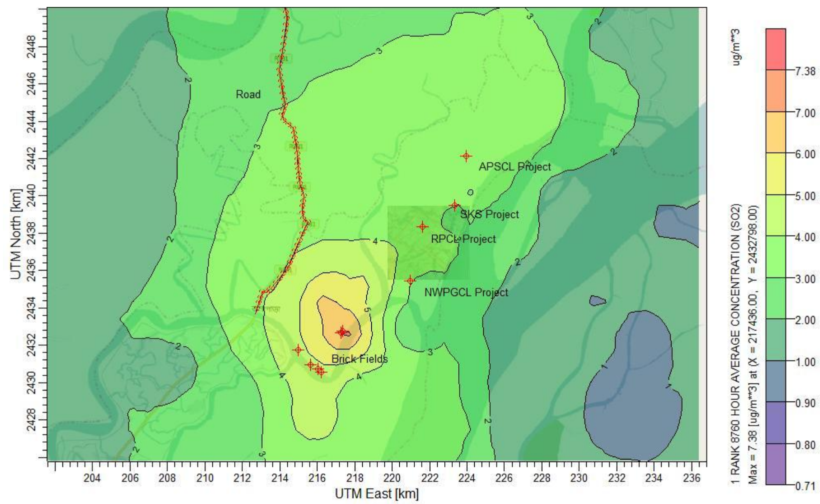
Source: Other Power Plants document and AP-42

The cumulative impact of all major emission sources in the air-shed is assessed in this section, including future developments. In addition to the sources discussed previously, the assessment includes emissions from the power plants of RPCL, APSCL, SKS which will be located close to the RPCL Power plant. The emissions and input parameters for the proposed power plants are given in the above **Table 7.20**.

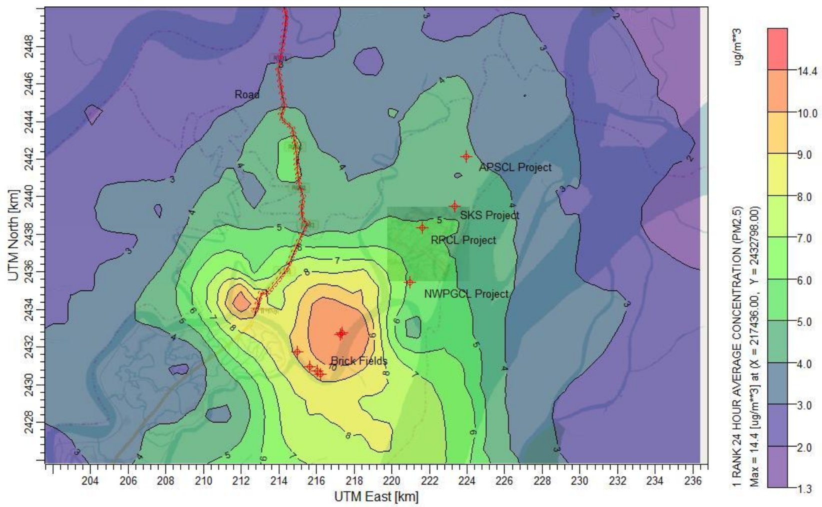
During the cumulative impact assessment all of the potential sources are taken into the predicted maximum ground level 24-hr and annual concentrations are given in **Table 7.21**. The table shows that the predicted SO_2, $PM_{2.5}$and PM_{10}concentrations for cumulative case are within the Bangladesh Ambient Air Quality Standards (ECR, 2005) but SO_2 and PM_{10} significantly higher than the WBG Guideline Values. Note that Bangladesh Standards for 24-hour SO_2 and PM10concentration is quite higher compared to WBG Guidelines and standards of other countries. There is a substantial increase in 24-hr and annual predicted concentrations from the project case to cumulative case and there is also a slight increase in overall annual concentrations. The predicted 24-hr and annual averaging value but meet the interim target (IT) value – II of WB guideline. However, Department of Environment have a plan to conduct the SEA study considering all of the future development works like power plants, industries, roads, rail always industries, airport to assist the regional Master Plan with respect to the environmental carrying capacity.



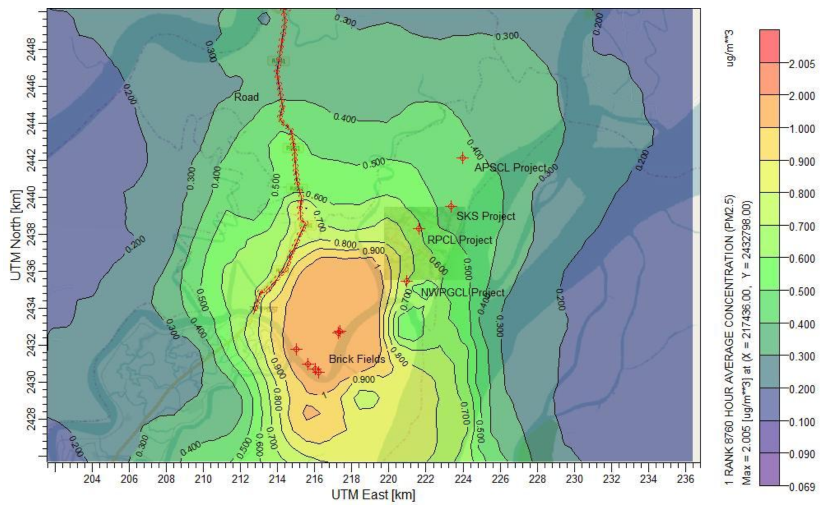
Cumulative - SO_2 (24 Hr)



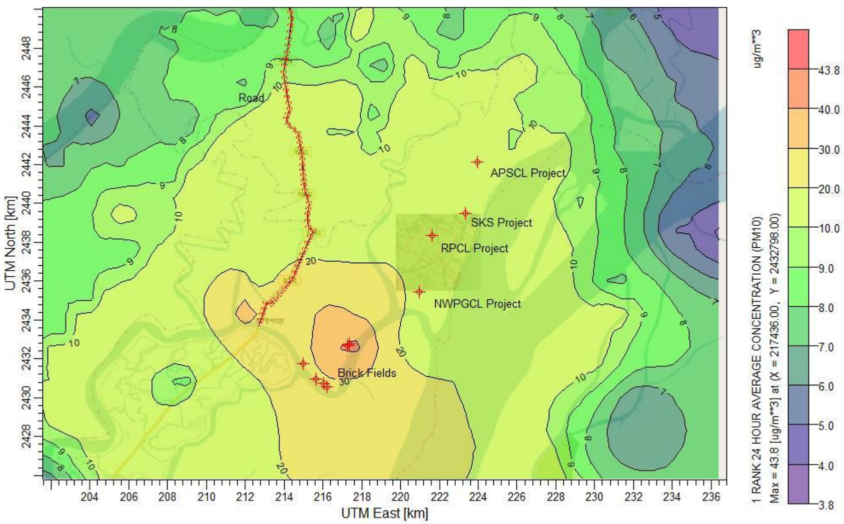
Cumulative - SO_2 (Annual)



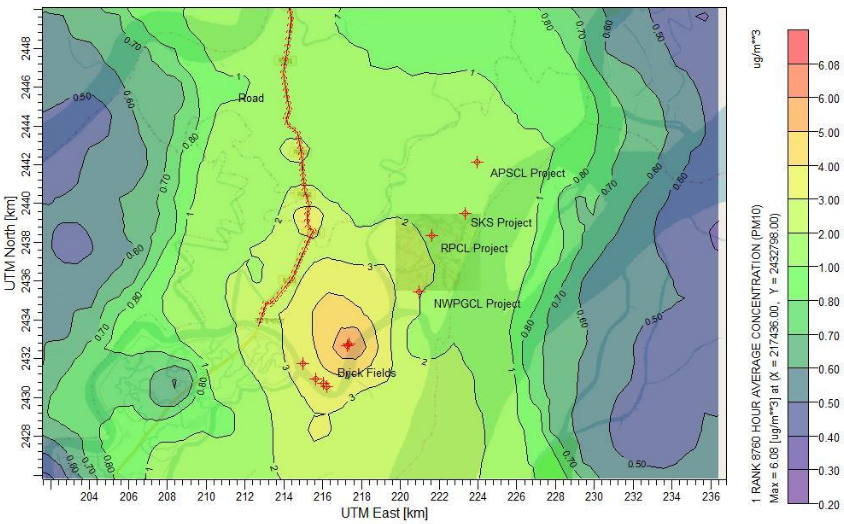
Cumulative – $PM_{2.5}$ (24 Hr)



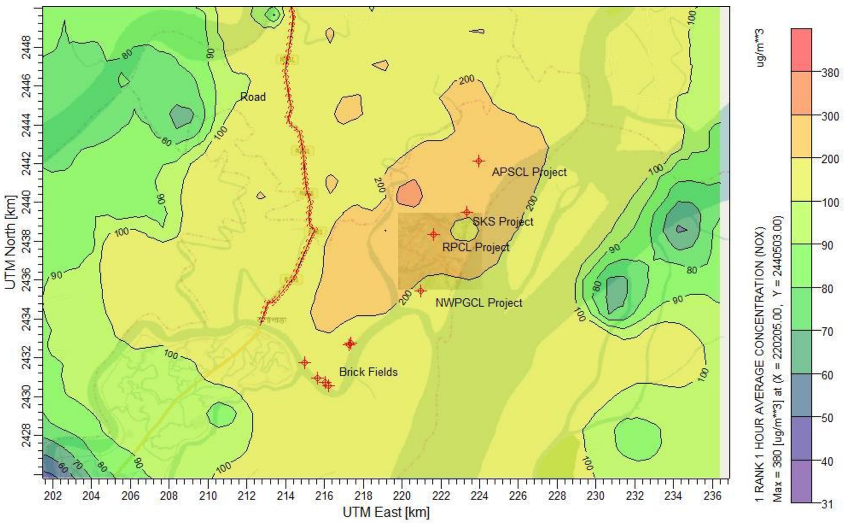
Cumulative – $PM_{2.5}$ (Annual)



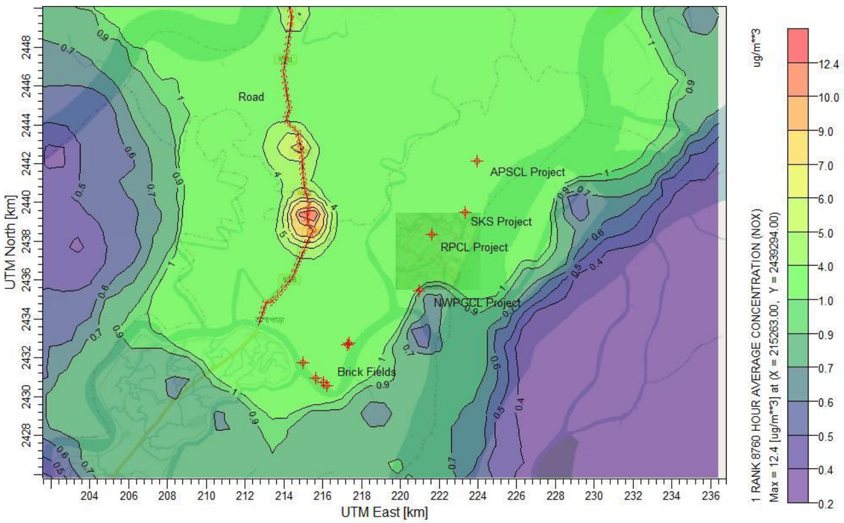
Cumulative – PM_{10} (24 Hr)



Cumulative – PM_{10} (Annual)



Cumulative – NOx (1 Hr)



Cumulative – NOx (Annual)

Figure 7.9: Cumulative Concentration of SO_2, $PM_{2.5}$, PM_{10} and NOx

Table 7.21: Maximum GLC of SO_2, PM_{10} and $PM_{2.5}$ for cumulative case

Cumulative Result	Averaging Time	Location at Ground Level (UTM: 46)		Concentration (µg/m³)	Standard Limit	
		East(m)	North (m)	Maximum Value	ECR 2005	IFC 2008
SO_2	24 Hr	217436	2432798	48.1	365	20
NOx (1hr)		220205	2440503	380	-	200
PM_{10}		217436	2432798	43.8	150	50
$PM_{2.5}$		217436	2432798	14.4	65	25
SO_2	Annual	217436	2432798	7.38	80	-
NOx		215263	2439294	12.4	100	40
PM_{10}		217436	2432798	6.08	50	20
$PM_{2.5}$		217436	2432798	2.005	15	10

7.6.4 GHG Emission

Since the onset of the industrial age, CO_2 concentrations in the Earth's atmosphere have increased about 1-2 ppm per year. Electricity generation using carbon based fuels is responsible for a large fraction of carbon dioxide (CO_2) emissions worldwide. Among all the fossil fuels, coal is much more carbon intensive than oil or natural gas, resulting in greater volumes of CO_2 emissions per unit of electricity generated.

The coal fired power plants generate the majority of the electricity and produce the highest rate of CO_2 per kilowatt hour (Department of Energy and Environmental Protection Agency, Washington DC, 2000). **Table 7.22** shows the CO_2 emissions and power generation from various sources.

Table 7.22: Emissions from Various Power Generation Technologies

Technology	CO2 Emissions (Kg/MWh)
PC-fired subcritical	850
PC-fired supercritical	800
IGCC	670
NGCC	370
Nuclear	0

Source: Narula et al., 2002

7.6.5 Abatement Measures

Potential reductions in greenhouse gas emissions, particularly CO_2, are gaining significant attention. A cost effective and readily available option to reduce CO_2 emissions per unit of electricity generated is to increase the generating plant's efficiency, so that less coal is burned per MWh generated. In response to this challenge a number of technologies capable of significantly reducing emissions of criteria pollutants. A novel process for CO_2 sequestration is proposed utilizing a supercritical oxygen-fired PC boiler. The proposed power plant has been envisaged adopting ultra-supercritical boiler technology.

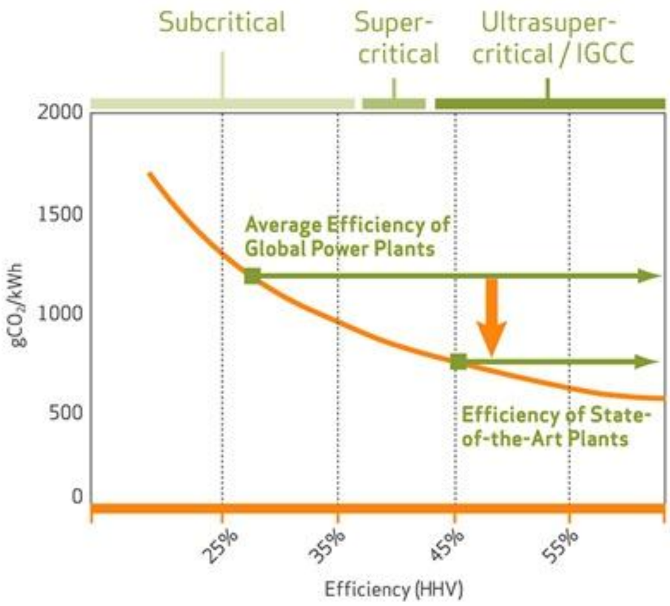


Figure 7.10: CO_2 emission from coal based power plants

As per the estimation shown in **Figure 7.10**above, the proposed power plant will run more efficiently (e.g. > 45%) than supercritical or convention power plant. Such power generation process with the implementation of energy efficiency programs in power sectors and in other infrastructures would not only make the production cost-effective but also reduces greenhouse gas emissions. The emission of GHG has been estimated following the guideline of IPCC, 2006 for National Greenhouse Gas Inventories. **Table 7.23** shows annual GHG emission from the proposed 1320MW coal based power plant project.

Table 7.23: GHG emissions in baseline and repowering conditions

Annual GHG emission	Emission Factors (Kg/TJ)6	RPCL – 2x660 MW (million Ton Per Year)
CO_2	96,100	11.30
CH_4	1	0.02
N_2 O	1.5	0.55
CO_2 - equivalent		11.9

Notes: GWP of 1, 21, and 310 used for CO_2 , CH_4 and N_2 O, respectively for 100 years global worming potential (IPCC 2006)

7.6.6 Impact on Ambient Noise

Noise often is not constant and fluctuates over time because of the characteristics of the source. For example, traffic noise will fluctuate from changes in traffic volumes, vehicles types, and vehicles speed. This fluctuation makes it difficult to describe adequately the many aspects of noise through a single value. Major sources of the RPCL 1320 MW coal based power plant are generators, turbine, boiler, ID/FD fan, vehicles movement, parking lot, and equipment movement etc. during the operation period of the power plant project.

6Default Emission factors for Stationary Combustion in the Energy Industries AP-42

Simulation of noise propagation during the operation of the plant was done by using SoundPlan Essential 3.0 software. It has combined a simplified, intuitive user interface. The level of surface noise generated from the river/sea vessels are accounted through the SoundPlan essential 3.0. Noise emitted by various sources propagates and disperses over a given terrain in accordance with the laws of physics. The majority of environmental noise simulations are small to medium projects tasked with checking the legal compliance of a planned route or an expansion to an industrial facility. Noise modeling software suited for these projects must be specially designed to quickly acquire the model data via an import interface or to allow digitizing the essential data on top of an aerial map. A number of standard processes can be calculated through this soundPlan model. ISO-9613 calculation process is used for this modeling purpose. Different factors are considered for predicting the noise level, such as, amount of noise generating from the source, number of vehicles passes on the road, noise from generator, turbine haul, Boiler, parking lot area, ambient environment, etc.

For running the model, the average daytime temperature and relative humidity was approximated as 28^0C and 80%. The land type of the project site was remarked as flat. Different types of noise generating sources such as turbo generators, ID/FD fan rotating machineries etc. would be used during the operation phase of the power plant. As per guideline of the model, typically a power generator produces approximately 92 dBA level of noise. **Figure 7.11a and Figure 7.11b** shows the sources and receptors of the Power Plant.

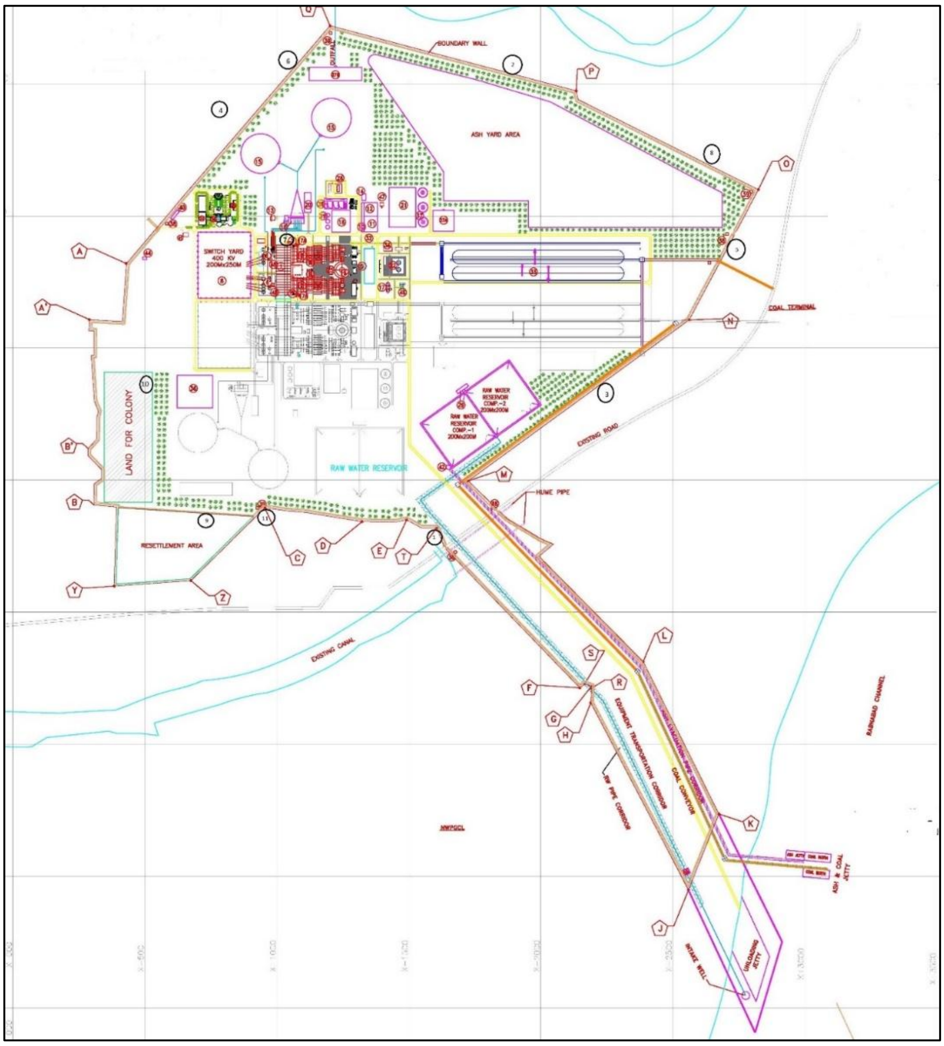


Figure 7.11a: Sources and Receiptors around the Power Plant

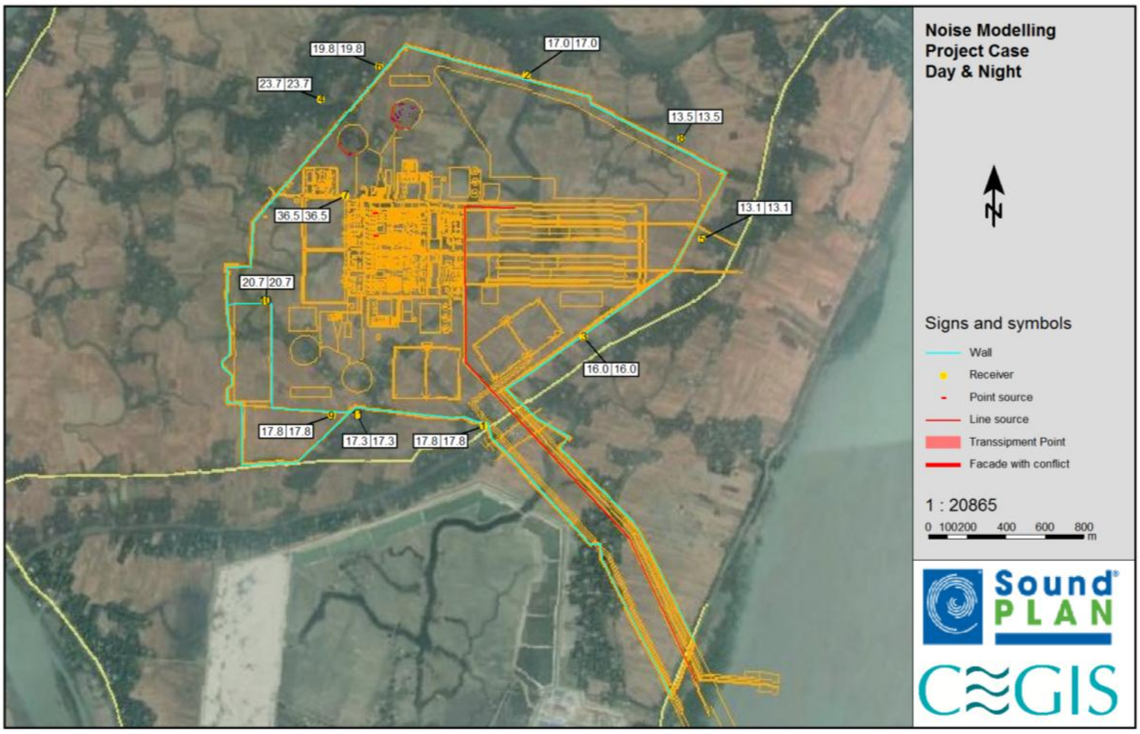


Figure 7.11b: Sensetive receiptors around the Power Plant Projects

The purpose of noise impact assessment is to determine whether noise levels at any sensitive receiver in the project area exceed applicable noise level standards e.g. ECR 2006. If so, abatement measures will be required to reduce the impact either at the source level through engineering design or provide PPEs to the workers if the source is a construction vehicle or equipment. The receivers are placed in the modeling depending on the potentiality of the noise impact form the power plant activities as well as the sensitivity of the receptors. Around 11 number of sensitive receiver are identified in and around the project site shown in **Figure 7.11**. The predicted noise level at those receivers are presented in **Figure 7.12** and **Figure 7.13** during day and night time.

The spatial distribution of noise highly depends on the protective structures or measures. This modeling has been done considering the boundary wall, green belt development and grass loan etc. Therefore, highest noise level would be found near the administrative buildings of the power plant and near the road side. Proper development of the green belt, the generated noise from different sources would have minimum effect of the sensitive receiver points like residential areas or rehabilitation areas and the outside the boundaries of the power plant.

Figure 7.12: Propagation of noise from the sources (Day time)

Figure 7.13: Propagation of noise from the sources (Night Time)

Cumulative Noise Level

The cumulative noise level (adding of background and source noise level) has been assessed at different sensitive location at different distances from the sources. The background noise level of day time was collected during the field visit. Following the rule of addition in logarithmic scale, the collective of the noise level was done. It can be seen from **Table 7.24** that, the impact of generated noise from the sources in the selected location would be insignificant.

Table 7.24 shows the combined effect of the resultant sound at various points where the baseline noise levels were measured. The resultant cumulative noise (in presence of a 2 meter high brick wall barrier around the project boundary) complies with both the Bangladesh and World Bank (WB) standard of noise level in residential area. The level of propagated noise can further be reduced by creating well designed thick green belt around the project boundary.

However, as we can see from **Figure 7.10**, the level of noise inside the plant, especially near the sources would be higher. Therefore, use of personal protective measures for the workers susceptible to high level of noise should be made mandatory.

Table 7.24: Resultant noise assessment

No	Receiver name	Predicted Noise dB(A)		Measured Noise dB(A)		Resultant Noise dB(A)		ECR, 2006 Noise dB(A)	
		Day	Night	Day	Night	Day	Night	Day	Night
1	Near Approach Road (Outside Boundary)	17.8	17.8	49	38	49	38	60	50
2	Coal Yard (Outside Boundary)	17.0	17.0	46	-	46	-	75	70
3	Eastern Boundary (Community outside)	16.0	16.0	50	36	50	36	55	45
4	Middle of Western Boundary (Community)	23.7	23.7	43	-	43	-	55	45
5	Near Coal Conveyer	13.1	13.1	47	33	47	33	60	50
6	Near North Corner (Outside Community)	19.8	19.8	46	-	46	-	55	45
7	Near The Technical Building	36.5	36.5	42	-	43	-	75	70
8	North East side (Community)	13.5	13.5	47	-	47	-	55	45
9	Project Residential Area	17.8	17.8	43	-	43	-	55	45
10	Rehabilitation Village	20.7	20.7	48	-	48	-	55	45
11	Southern Corner (Outside Community	17.3	17.3	45	35	45	35	70	60

7.6.7 Impact on Water Resources

Impacts on Natural Drainage System

The present power plant project is located into the Polder 54/A. Already this area is a converted ecosystem. All the water resources system within the polder is being maintained by control way by the Water Management Groups. If the project implementation activities would not informed to the WMGs by the project authority, it would create drainage problems into the polder and surrounding areas of the power plant project. Whereas, into the project area about 6 km natural drainage system is exists. The impact is characterized as moderate in **Table 7.4**.

Impacts on storm surge flooding

The existing peripheral embankment effectively protects the power plant area from cyclonic storm surge and regular tidal flooding. However, a vulnerable location of sea dyke (GPS: 0224062, 2439360) at Debpur Villages may breach in near future and will be affected by tidal flooding and storm surge flooding. A flood frequency analysis is being done by using Log-normal distribution method (**Table 7.25**) by using the BIWTA's water level data from 1977 to 2007. During analysis, it has been observed the water level of the river would be 3.74 mPWD, whereas the level of flood water is low from the crest level of embankment (embankment crest level is 5.8 in sea dyke). It should be mentioned here that, during SIDR and AILA, the water level of river is below the crest level of embankment. The level of river water from the embankment crest level was 1.15m below during SIDR and 1.35m below during Aila.

Table 7.25: Flood frequency analysis

Return Period (yr)	FL (mPWD) using Log-normal method
5	4.750
10	4.922
25	5.139
50	5.300
100	5.460

Source: CEGIS estimation, 2016

If the river water level during the storm surge overtopped the embankment crest level it would be threat for the power plant project. The significance of this potential unmitigated impact has been assessed as Major on the basis of impact magnitude and receptor sensitivity.

7.6.8 Impacts on Fisheries

Accidental spillage of untreated effluents and spillage of HSD oil from ship/ cargo into the nearby river, *Khal* and open water fish habitats may cause leading to degradation of the capture fish habitats. Continuous loading of such contaminated effluent may become harmful for the local capture fisheries.

Coal based power plant has a tendency to emit heavy metals during production period. If the wastes and fumes are released untreated way it will cause a serious pollution in surrounding fisheries resources.

Abstraction of river water at the rate of 1400 m^3/hr for operating power plant may cause crisis for river water availability during dry season around the Project site. This incident may cause the reduction of fish productivity of the capture habitats. Withdrawal of another 1400 m^3/hr for each of two power plants may further aggravate the situation. This impact is characterized as **Major Adverse**, as given in **Table 7.4**.

7.6.9 Land Resources

Impact on Land Use

Operation of power plant would lead to development of more industries. As a result, more agricultural land would be acquired in Dhankhali and adjacent areas. PGCB would construct transmission tower to evacuate this power. This will also be required lands. So, it is anticipated that operation of the plant would create serious pressure on the existing agricultural land use of the area. This impact is characterized as **Moderate Adverse**, as given in **Table 7.4.**

Impact on Soil Quality

Accidental spillage of untreated effluent on the nearby land from the Plant, and during filling the oil tank leakage of oil pipe may cause spillage of HSD oil to the land either side of the pipe leading to degradation of the soil quality. This is characterized as **Minor Adverse**, as given in **Table 7.4.**

7.6.10 Agriculture Resources

Impact on Crop Production

Generation of more power would lead to development of more industries around the Project site on the agriculture land. So, operation of the plant would create serious pressure on the existing land use of the area. For this reason, agricultural land might be converted to non-agricultural land i.e. construction of different infrastructure which would ultimately impact the crop production of surrounding agricultural land. However, sensitivity of this impact is characterized as **Minor adverse**, as given in **Table 7.4.**

7.6.11 Livestock Resources

At this stage, the induce change in land use will ultimately reduce the grazing areas as well as the fodder for the livestock. Moreover, the change in lifestyle will reduce to rearing the livestock. This is characterized as **Minimal Adverse,** as given in **Table 7.4**.

7.6.12 Impacts on Ecosystem

Impact on terrestrial vegetation

Built-in measures for arresting fly ash that could have the adverse impact on vegetation in photosynthesis would be bare minimum. Also measures for limiting the emission of SO_x, NO_x and SPM will be within the MoEF's standard. With such measures in effect the emissions would exert less impact on vegetation of the study area. On the other hand, development of greenbelt in and around the project area in rows will improve the vegetation coverage as well as enhance the capacity of carbon sinking.

According to the estimated result, maximum possible 1-24hr average concentration of SOx and NOx would be insignificant near to the greenbelt and remain below the ECR-1997 standards of ambient air quality. Therefore, transpiration process of the vegetation would not be deteriorated in this phase. But vegetation growth will impede through dust particulates generated by the vehicle and public movements in this project area.

Impact on shorebirds and other wildlife

The project area is close to Rabnabad channel of the Bay of Bengal having diversified wintering and resident waders. The use of channel for coal transportation will hamper normal activities of shorebirds in large. Lighting of the plant site would impacts negative to the shorebirds activities especially the nocturnal. On the other hand, the greenbelt (to be developed) for the project shall provide important habitat to different wildlife, local common birds, and others.

Impact on marine habitat

The marine habitat is very resourceful and home to many tiny to large aquatic biota. Coal transportation through this aquatic system has some risk of polluting water by capsizing ship, dropping of coals, release of oil and greases from engines. Toxicity of such matter would harm to minor phyla and tiny species in the long period of time.

Impact on benthic community

Due to transportation of coal for power plant it can drop coals from cargo/ships whether protection measures are not taken before departure from loading point. Coal dropping would lead deposit toxic elements in the bottom of waterways which is home to the benthos. The benthos is sensitive to pollutants and pollutants can destroy the total structure of their communities by toxicity.

7.6.13 Impacts on Socio-Economic issues

Implementation of the project will create new employment opportunities and ensure employment opportunities for the communities as well as in the country as electricity is the main need for industrial development. This Project will encourage in establishing industries which will obviously provide employment opportunities to a large number of population. The affected people may face a temporary unemployment situation. Newly developed industries may appear as a strong source of livelihood. Land price of the adjacent areas of the project will increase significantly. The sale value of land will be increased due to immigration of people as well as technical people in this area. A variety of new industries may be developed for the availability of electricity to meet the demand of industries. Environment especially water and sanitation may be disturbed by the labors. Health injury may be occurred in power plant for handling of heavy machineries.

7.6.14 Impact of Non Hazardous waste

Waste Water

Generally, effluents from the proposed power plant would be boiler blow down, cooling tower blow down, back flash from ion exchanger and iron filter of water treatment plant, floor and yard drains (cleaning), oily water from turbine hall and sub-station yard, etc. Generally this waste water is contaminated with Chlorine, Chromium, Copper, Iron, Zinc, and heavy metals. The detail sources and quantity of the waste water is clearly described in Water Balance Diagram and reflected in Table 7.26. From the water balance diagram it is estimated that a significant quantity of the effluent from the power plant (excluding effluent from domestic water use) would be around released from different sources and discharged maintaining the concept of zero discharge law.

Table 7.26: Effluent Sources and discharge pathway

Sl no	Sources	Discharge Pathway
1	Water Pre-treatment Plant: Clarifier Tank, Sand Filter and Sludge thickening Plant	Waste Water Sump >ETP > Discharge Channel >Gardening or Irrigation
2	Cooling Tower blow Down and boiler Blow Down	
3	Water Demineralization Plant Blow Down	
	Total	

Source: CEGIS, 2016

The proposed project considers an Effluent Treatment Plant (ETP) will be used to treat the industrial waste collected from different sources and the capacity will be around $34m^3$/hr. Therefore, no waste water will be discharged to the river or canal without treatment and satisfying the MoEF's standard of effluent quality.

Kitchen Waste

During operation, it is assumed that a certain amount of people will be living at site. The **Table 7.27** below shows the estimation of kitchen waste during operation.

Table 7.27: Estimation of Kitchen Waste

Sl No	Economic Classes of Employee	Rate of kitchen waste generation (kg/day/capita)*
1	High Income Group (>20000 tk/month)	0.513
2	Middle Income Group (tk 10000-20000tk / month)	0.4
3	Low Income Group (< 10000 tk/month)	0.26

**source: (JICA, Pacific Consultant Internationals, & Co, 2005)*

The generated kitchen waste will be collected through a process from the residential area of the proposed unit. Careless disposal of this waste would create pollution, odor problem, nuisance and aesthetic tiring.

However, the impact would be for long term but would be limited within the plant premises, reversible and may happen only in worst-case scenario (i.e. no management of kitchen waste). On the other hand, sensitivity of this impact to the residents of the Project is high. Thus the significance of the impact would be **moderate adverse** and needs to be minimized by EMP.

Sewerage

It is assumed that during operation phase a certain amount of employees including staffs will be living at site. Therefore, it is estimated that significant amount (considering 260 L/day per capita sewerage generation) of sewerage would be generated from the staff and officers' residence. A small portion of this sewerage may escape sewerage collection and disposal system. The fecal sludge would go to the existing septic tank.

This added sewerage would not have any significant impact on the existing sewerage system. The magnitude of the impact would be moderate and sensitivity would also be moderate. Thus significant of the impact would be **medium adverse** and needs to be controlled by adopting EMP.

7.6.15 Impact of the Hazardous waste

Oil and Oily Water

Lube oil is generally used in the power plant in different equipment like bearing, turbine hydraulic system, etc. Wash water or drained water from turbine hall, substation yard, etc may contain oil and oily water. However, the proposed plant considers to install an Oil Water Separation Unit integrated with a central water treatment plant. Therefore, the impact would **not be significant**. On the other hand, this proposed third unit would bring a means of treating oily water from existing unit.

Sludge from Water Treatment Plant

Concentrated sludge would be generated from water pre-treatment plant, demineralization plants, waste water treatment plants and oily water separation unit. These sludge would go to the sludge sump for dewatering and thickening. Disposal of the dry sludge might contaminate ground water of surface water if it is not properly managed. The magnitude of the impact major and sensitivity is also high. Therefore, significance of the impact is **major adverse** that calls for adoption of proper EMP.

8. Mitigation of Impacts

8.1 Preamble

The boiler technology for the proposed power plant is Ultra-Super Critical. To protect the environment, a number of technologies, equipment and standard will be adopted for this power plant project. The mitigation measures has been suggested based on the carrying capacity of pollution load in the AOI. Considering the impacts collectively from the power plants, and sensitivity of each of the receptors in the environment, the mitigation measures are framing out. However, the specific mitigation measures are figured out gradually.

8.2 Change in the project layout

It is proposed to include the following items in the project layout developed by the engineering consultant. The position of the ash disposal areas, township and Turbine hall, generators, power evaluation bay, coal yard and oil tanker are evaluated on the basis of individual and community risk aspects. Those issues will be reviewed at different stages consultation with the stakeholders and feasibility team.

8.3 Engineering design

8.3.1 Alternative to use of Hydrazine in Feed Water

Hydrazine is generally used as an oxygen scavenger for corrosion control in thermal power plants. Although hydrazine is very effective in this application, it is a geno toxic carcinogen. Instead of using Hygrazine, it is recommended to use alternative oxygen scavenging chemical e.g. Helamin, Diethylhydroxylamine, etc in feed water for corrosion protection in boiler. However, the design of boiler and water treatment can also be changed to avoid use of any oxygen scavenger. There are two alternatives for that:

- Combined Water Treatment (CWT) or oxygen treatment for through-flow boilers
- All Volatile Treatment (AVT) Oxidizing +High-AVT (treatment by a volatile substance with a high pH value without using Hydrazine)

However, freedom can be given to EPC contractor to find an appropriate alternative of using Hydrazine.

8.4 Mitigation measures for major impacts

The following sections present the mitigation measures for the major and few moderate adverse impacts identified in Chapter 8 of the EIA report. Minor and some moderate impacts will be managed and mitigated using environmental code of practices (**Appendix-VI**) and Contractors' good practice.

8.4.1 Pre-Construction Stage

C. Water Resources

C2. Drainage System

The following mitigation measures to be followed by the concerned authority:

- Keeping the existing channels as it is in the project area according to the RS or CS.
- Dredging may maintain at the neap tide.
- Fencing the project periphery.
- Alteration of sediment pathways.
- Imposing the night time dredging.
- Provision of proper setting time to use the surface water in the project area and at the dredging location.

D. Land Resources

D1.Land development

Power plant construction leads to a huge area acquisition. Crop production will be stopped from the construction stage. To compensate it, new areas should be explored. In this aspect Chakamaiya would be a good choice. Soil quality of this area is similar to that of Dhankhali (project area). Besides this, both of these areas are situated in polder. Only close and intensive monitoring can improve the crop production of Chakamaiya. To facilitate this, sluice gates and other facilities of the polder should be reconstructed. If BADC and DAE shift their existing facilities of Dhankhali to Chakamaiya, crop production of Chakamaiya would be similar to Dhankhali. At present, most of the lands of Chakamaiyaare single cropped, while croplands of Dhankhali cultivated duble to triple a year.

E. Agricultural Resources

E1. Loss of crop production

After the acquisition of the land for the project, crops will be permanently lost. Any kind of land acquisition leads to no mitigation process. So RPCL should allocate money to the affected farmer to compensate this loss. But the compensation might be done by introducing proper management to other specific areas (Chakamaiya). This plan is described in detail in EMP section.

E2. Loss of grazing land and fodder

Land acquisition for the project area shorten the grazing land and fodder of that locality. So farmers have to start domestic farming process rather than depending on open grazing land. They could also cultivate high yielding grass varieties to solve the fodder problem of livestock.

G. Fisheries Resources

G2 Mitigation the loss of fish production

After the acquisition of the land for the project, a significant water bodies will be lost which has been used as culture fisheries. However, the designated water bodies in the Moza map must be protected as it is. The proponent himself or the villagers can culture appropriate fisheries project on that khals.

H Ecology

H2 Mitigation of the impacts on shorebirds and other wildlife habitat

The land development for installation of thermal power plant in the coastal belt requires engagement of labours and equipment. This work should follow specific guidelines before commencing the designed tasks to avoid shorebirds habitat damage or disturbance. It is important to select barren area for installation of pipelines and work should follow specific season and timeframe. It is wise to avoid winter season for construction works to reduce pressures on shorebirds.

I Socio-Economic

I1 Land /acquisition/development and resettlement

Land price should be considered as per current market price of land. The affected families should be resettled in better places especially in Londa Mouza or at Pancjonia mouza as early as possible. Resettlement and compensation plan should be governed by the Resettlement Action Plan (RAP) study. The proposed project will need to resettle of around 120 numbers of households **(Appendix- XIII)** and acquisition of around 915.7 acres **(Appendix – XIV).** The Mouzas are compensation process should be easier and it would be helpful for the local people if the activities could be done by local Union Parishad. New resettled village should include allied facilities as roadway communication, Madrasah, school, mosque and cyclone shelter. The project activities should be initiated after compensating properly to the affected people. Local labor both for technical and non-technical should be recruited for the Project related activities.

I5 Labor migration

The project proponent should trained up to the local people who will be engaged during the land filling stages. Prioritize local labor should be recruited as workforce during by the project authority. The remaining external labor should also be trained up regarding the cultural and religious values in the study area. Working code of practice should be developed and maintained properly. The contractor will put in place a referral healthcare facility to deal with medical aspects of HIV/AIDS treatment with specialized services. The in-house medical facility will diagnose for STD/STI and TB infection among the workers and provide treatment as necessary. Ensure working opportunities for the local people in different sectors. Bangladesh Labor Act, 2006 and ILO act must be followed. Child labor and Forced labor must be abandoned. Compensation should also be provided to the persons those who are dependent on the activities of the land for income generating activities.

J No-hazardous waste generation

J2 Kitchen Waste

A good practice of kitchen waste collection and disposal system should be adopted. Some temporary bins with color marking indicating degradable and non degradable waste might be installed at labor shed and work places to prevent scattered throwing of wastes. There should be a designated site or scientific landfill area for kitchen waste disposal for controlling bad odor and leachate having susceptibility to contaminate water.

8.4.2 Construction Stage

K Ambient Air quality

K1 dust and gases generation

Regular watering of the unpaved roads and open areas inside the project boundary which may be increased during high wind and excavation/granding. Dust suppressants should be applied or cover to soil stockpiles and disturbed areas when inactive for more than two weeks. The vehicle speeds will be limited 10 mph during the dry seasons inside the project area. The truck must be covered when hauling material that could be entrained during transit. The diesel fueled equipment should be ultra-low sulfur (15 ppm sulfur) containing. Moreover, limiting diesel heavy equipment idling to less than 5 minutes to the extent practical.

L Noise Level

L1 Noise level

During construction activity, noise might be generated from the moving and idling vehicles, heavy machineries and different other construction related activities. The machines/vehicles/equipment thus should be turned off when not in use, to minimize noise generation. The equipment used during the construction phase should be with proper silencer where applicable and properly maintained as proper maintenance can decrease the level of sound level significantly. For protecting the workers from the adverse impacts of high noise level, Personal Protective Equipment (PPEs) such as air plug/earmuffs should be provided. The use of the PPE should be made mandatory to the site engineers, workers and other staffs who are susceptible to high noise.

M Water Resources

M2 Mitigation measures for the water quality

The project labor must follow the ECP 1, 2 and 15 where the EPC contractor regularly monitoring the good practices. The hazardous chemicals and oily substances will be levelized, kept in a demarcated land and handle them carefully. Onsite effluent treatment plant can be introduced. Sewerage from the workers colony would be treated before final disposal. The construction raw materials should be properly stockpiled, used, handled and managed so that the dust or any chemical or contaminant cannot reach to the surface water through rainfall runoff. Direct disposal of liquid waste from the construction activities to the surface water should be prohibited. The construction materials that would be brought to the site through the river/road way, are to be properly covered and the unloading process should be carried out with due care.

The members of the worker colonies should obey the guideline of best practices in order to avoid or minimize the domestic waste from the workers colony. Chemical substances and scrap should be kept on a specified covered areas so that contaminants from such substances cannot come into the natural environment. The workers must be trained or made aware of about their duties during abnormal or agencies situation like oil spill, chemical spill, etc. The above mentioned steps could positively mitigate the possibility of the surface water quality deterioration during the construction stage.

N Land Resources

N1 Land Use

After the land development in the project site, a lot of activities will be taken places as per detail design of the project. The concurrent land use will also be changed for installation of the mechanical and electrical equipment according taking care of the EMP of this study. Green belt must be introduce at this stages. Good housekeeping will reduce any kind of accidental events.

O Agricultural Resources

O1 Mitigation of the irrigation problem

To facilitate the operation of sluice gates and other facilities in the polder can improve the irrigation facilities though LLP instead of BADC deep tube well. Even if BADC and DAE shift their existing facilities of Dhankhali to Chakamaiya, crop production of Chakamaiya would be increased.

Q Fisheries Resources

Q1. Fish habitat quality

The habitat quality for the fisheries will be protected if the ships and vehicles follow the IMO and MARPOL convention during the construction period. They should not discharge the ballast, bilge water and other toxic chemicals form the ships. The ships must ensure from any of the alien invasive species. The EPC contractor should follow the site specific ESMS for not to pollute any surface water bodies which are passing besides or inside the project areas.

R Ecology

R1 Shorebirds and other wildlife habitat

The construction activities should maintain specific guidelines to avoid disturbance to shorebirds as well as other wildlife habitat. In relation to that, the construction area should boundary wall and specific route to transportation and labour movement. Lights of the construction area should install downwardly to avoid disturbance to the wildlife and shorebirds. In addition, construction activities should not continue at night. The proposed project site is very close to feeding ground of wintering birds and it is suggested not to select winter season (October-February) for construction works.

S Socio-Economic Condition

S1. Extra burden on accommodation

The labor should follow the environmental code of practice (ECP 16 and ECP 18) during construction. Recruitment of the local labor will reduce the accommodation problem in the project. Moreover, the EPC contractor should make available standard labor sheds which includes sanitation facilities, drinking water facilities, first aid support etc. Health and safety trainings and motivational works should be provided regularly.

T Non-Hazardous Waste Generation

T1 Solid Waste

Solid waste from the project installation units, administrative buildings, and scrub materials will be kept into demarcated places. Those have to store in a covered roof and bottom lined places. A number of bins with proper signed should be applied to separate the waste during disposal. On site solid waste treatment might be considered or store it and finally dispose it outside the project area designed by Kalapara Local Adminstration.

8.4.3 Operation Stage

U Ambient Air

U1 Ground level concentration of criteria pollutants

During operation, the appropriate mitigation measures are to reduce potential air emissions before they are emitted. This is accomplished by the careful design of the project, including the installation of the Best Available Control Technology (BACT) to minimize air emission. Use of ESP which reduce 99.92% of fly ash and maintain the emission standard of IFC, 2008 for degraded airshed. Built-in Low-NO_x burner or SCR will reduce the NO_x emission below 510 mg/N-m^3. Use of FGD will control SOx emission maintaining the IFC emission standard for degraded air shed. CEMS technology must be installed at the stack to record pollutant emission rate and avoid any uneven situation.

V Noise Level

V1 Mitigations of noise pollution

Loud noises generated from the plant operation activities can lead to hearing complexity and loss along with increased blood pressure; disturbances and discomfort to the site engineers, technicians, workers, staffs and surrounding communities. The machines/equipment/vehicles, which are not in use, should be turned off to limit noise generation. The machineries should be maintained properly according to the provided instructions as proper maintenance can decrease the level of noise significantly. The rotating machinery, such as turbines, pumps, fans etc. should be covered with noise proof hood to limit the spread of noise. Silencer should be used wherever possible. A green belt consisting of trees of different heights and canopy coverage should be developed along the boundary wall of the power plant area. The green belt should be of at least 3.5 m width consisting two rows of plantation with the gradual increase of height of plant from inside row to outside row.

W Water Resources

W1 Mitigation measures for impacts on Natural Drainage System

The natural drainage system in the project area should only be used to serve the purpose to what it is built specially for the storm water release during the monsoon or rainy day. Any sort of waste or effluent disposal from the plant, encroachment should not be allowed to pass through the internal drainage system. All the natural drainage system in the power plant project area should be kept as RS Mauza. No water control structures should be implemented by the project authority into the natural drainage system.

W2 Water Quality

This project will install CETP to purify the effluent release from the plants. Oily water, DM water, blow down from the equipment and other sources will be collected at sump and discharge it to the ETP which include clarifier, physical treatment, chemical treatment, biological treatment. Oil separator is used to separate the oil from industrial effluents.

This plant will also use STP for treating the sewerage discharge from the township areas and administrative buildings. Solid waste and septic tank should be lined to protect the ground water contamination.

W3 Mitigation of storm surge flooding

Slope protection work along with Rabnabad Channel should be constructed to protect tidal flooding during high tide, cyclonic storm surge and natural calamities. Regular monitoring of seepage of surface waters from external rivers of the polder area through the regulators will be checked by the power plant project authority with existing Water Management Organizations during pre-monsoon and monsoon seasons and necessary steps will be taken to check seepage, if any. And Afforestation program will be taken at both side of the embankment, which will help to protect the power plant project and livelihood of the polder.

X Land Resources

X2 Land Use

Availability of power supply will encourage new industrialization in the study area. As a result, new land acquisition will create an induce pressure on study area land. Under this situation, agricultural lands will face threat. So, a detail plan of the study area should prepare for the betterment of agricultural land conservation.

Z Livestock Resources

Z1 Mitigation for reduction of livestock

Induce change in land use squeeze the grazing land a fodder. As a result, open grazing will restricted. To compensate this, domestic farming should encouraged and high yield grass should introduce in the study area.

AA Fisheries Resources

AA1. Fish species diversity and composition

Accidental spillage of untreated effluents and spillage of HSD oil from ship/ cargo into the nearby river, *Khal* and open water fish habitats may cause leading to degradation of the capture fish habitats. Continuous loading of such contaminated effluent may alter fish species diversity and composition.

AA2. Fish production

Abstraction of river water at the rate of 1400 m^3/hr for operating power plant may cause crisis for river water availability during dry season around the Project site. This incident may cause the reduction of fish productivity of the capture habitats.

BB Ecology

BB1 Terrestrial vegetation

To avoid low transpiration rate of plants it is suggested to use sprinkle of waters in the roads and nearby area at 2-hour interval to reduce the rate of dust particulates which will be generated by vehicle movements.

CC Socio-Economic

CC5 Occupational health and safety

Facilitate to recruit local people according to their skill. Awareness building, available doctors, emergency medical treatment facilities should be ensured. Sanitation, electricity and road facilities for the workers. Steps should be taken for supplying safe drinking water and Safe sanitation system. Special or contingency fund must be available for health and safety management. PPEs must be used during work. Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods.

DD Non-Hazardous Waste Generation

DD1. Liquid Waste and Sewerage

It is recommended to construct and commission a central sewerage treatment plant (STP) for treating sanitary waste as a large numbers of employee will be residing inside the power plant complex. The sewerage treatment plant might be of biological type or in combination with physical, chemical and biological type. Generally, a STP consists of screening devices, aeration, active sludge treatment, sedimentation, clarification and separation/recirculation of sewage sludge. Membrane bio reaction is a good alternative. The EPC contractor should construct a STP including the sewerage collection network. The STP should have capacity corresponding to the numbers of employee in the first three units of the SPS. The Plant should be designed in a way that would comply the effluent standard (sewerage) of IFC and MoEF. The provision of reusing the treated waste should be considered in the design. The treated water can also be supplied to the nearest agricultural lands for irrigation.

The sludge from STP should be disposed in compliance with the IFC standard and ECR 1997.

DD2. Kitchen Waste

Standard practice of kitchen waste collection and disposal should be implemented. Some temporary bins with color marking indicating degradable and non-degradable waste might be installed in the staff colony and work places to prevent scattered throwing of wastes. There should be a designated site or scientific landfill area for kitchen waste disposal for controlling bad odor and leachate having susceptibility to contaminate water. Moreover, it should be protected from the scavenging by birds and animals, washing out by rain fall runoff, etc. Furthermore, a site should be designated for biodegradable kitchen waste disposal. Above all, for managing such wastes in a hygienic way a set of cleaners should be involved permanently.

EE Hazardous Waste Generation

EE1. Hazardous Sludge from Water Treatment Plant

The feasibility study proposes thickening and dewatering of sludge, in the form of dry cake, generated from water treatment plant. The dry cake of sludge should be managed properly so as to avoid leaching of heavy metals in the rainfall run off. Dry cake that would be mostly iron sludge has market potential in steel rolling mill. However, the EPC contractor should consider this issue and propose a sustainable management plan for sludge handling.

EE2. Hazardous sludge from water pre-treatment and treatment plant

The feasibility study proposes thickening and dewatering of sludge, in the form of dry cake, generated from water treatment plant. The dry cake of sludge should be managed properly so as to avoid leaching of heavy metals in the rainfall run off. Dry cake that would be mostly iron sludge has market potential in steel rolling mill. However, the EPC contractor should consider this issue and propose a sustainable management plan for sludge handling.

8.4.4 Coal Transportation

FF. Fisheries

Coal based power plant has a tendency to emit heavy metals during production period. If the wastes and fumes are released untreated way it will cause a serious pollution in surrounding fisheries resources.

GG1 Aquatic species and diversity

All the vessels must be followed the standard of IMO, MARPOL. They should follow the ECR, 1997 of DOE for releasing any kind of pollutant from the ships/burges. Any kind of alien species must be quarantined before transshipments. The jetty must have a polluted water storage tank/pit to receive the bilge water from the ships. Moreover, site specific EMP must be developed though another EIA study of coal transportation and handling for this power plant.

9. Hazard and Risk Assessment

9.1 Introduction

Hazard is considered those that can cause harm or has the potential to cause harm; whereas, risk is the likelihood of hazard being occurred and its severity. Thus a risk assessment is conducted, to carefully examine the potential hazards, how they occur and the measures to prevent such hazards. Mismanagement of one particular hazard can have consequences that simultaneously impact to a varying degree on several risk types.

In this EIA report, detailed assessment has been carried out to identify and mitigate the potential hazard associated with various stages of coal based power plant project, to be constructed in Kalapara, Patuakhali so that those hazards can be avoided by incorporating safety plans in both planning and design process.

9.2 Hazard assessment process

In the EIA stage, potential hazards are identified and discussed in detail along with risk assessment. An inclusive safety management plan is also developed accordingly. The steps followed in this preliminary hazard and risk assessments are mentioned below:

I. Identification of Hazards
II. Analysis of Causes
III. Assessment of Likelihood
IV. Identification of Existing Safeguards
V. Risk Ranking for Prioritization of Corrective Actions
VI. Recommended Actions and Safety Measures

9.3 Potential Hazard and Risk during different stages

The potential hazards and risk during construction, and erection are listed in **Table 9.1**.

Table 9.1: Potential hazard and risk during construction, and erection

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
Pre-construction				
• Machinery and equipment	• Bringing in machines, equipment and vehicles for site clearance activities	• Trips and falls • Cuts and bruises	• Fatigue or prior sickness • Mechanical failure • Lack of safety training • Not abiding to general health and safety and traffic rules	• Health injury • Disability • Life loss
Construction and Erection				
• Construction site	• Construction of building, steel structure and its foundation, cutting, welding, painting works, drilling work, etc	• Accidents (burns, electric shocks etc.) • Injuries from falls and slips • Inhalation of dust • Cuts and bruises	• Fatigue or prior sickness • Electric failure • Equipment failure • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night (for those working overtime)	• Physical injury • Disability • Life loss
	• Work at heights	• Accidents • Injuries from falls and slips (e.g. broken bones, fractures, traumas, etc.) • Fatalities	• Fatigue or prior sickness • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage • Not maintaining enough lighting during the night	• Health injury • Disability • Life loss
	• Vehicle and vessel movement	• Noise generation • Accident (e.g. vessel capsize) • Emission from vehicles • Spread of dust and minute particles due to vehicle movement.	▪ Running engine, hydraulic horns, sirens etc. ▪ Mechanical failure • Old engine or engine parts/lack of maintenance	• Injuries • Health problems (e.g. respiratory, hearing and/or cardiac problems) • Fatalities • Disabilities
	• Coal stockyard and/or chemical storage area	• Accidental release of coal dust/ chemicals	▪ Lack of safety protocols ▪ Carelessness (e.g. smoking near coal stockyard/chemical	• Health injuries (burns, anxiety,

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
	• Handling of hazardous chemical	• Acute/chronic toxicity from exposures to chemicals • Fire/explosion	storage area) ▪ Not covering the coal stockyard from releasing dust ▪ No proper bounding of chemical storage area • Improper chemical storage (e.g. faulty/leaky containers, improper containers, improper sealing of containers etc.)	depression etc.) • Disabilities • Fatalities • Loss of properties
	• Occupational Hazard	• Cuts, bruises and burns • Falls, slips and trips • Health injuries • Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Improper hygiene ▪ Prior sickness or illness • Heavy workload	• Health injuries (burns, anxiety, depression etc.) • Disabilities • Fatalities

9.4 Potential Hazard and Risk during Operation

The potential hazards and risk during operation are listed in **Table 9.2**.

Table 9.2: Potential hazard and risk Operation

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
• Turbine, generator and its ancillary components	• Electricity generation	• Mechanical hazard • Fire hazard/explosion • Electrical hazard • Noise generation	▪ Mechanical failure • Lack of sound buffers	• Health injury • Fatalities • Property damage • Environmental damage
• Cable gallery • Power transformer • Switchyard • 400KV Switchyard control room	• Transmitting electricity from generator to unit transformer • High voltage (400KV) power transmission • Open air power transmission • Controlling and monitoring the power transmitting system	• Fire due to resulting arc flash/arc blast • Other electric hazard due to unprotected cables • Slips and trips from unorganized/lose cables lying in the floor	▪ Short circuit in control room and switch gears ▪ Faulty cables and wires ▪ No safe connection to earth ▪ Using cables with different voltage and current ratings • Unorganized cables	• Health injury from electric shock, fires etc. • Fatality from electrocution, fires etc. • Electric burns

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
• Boiler and pressure parts • Compressed air system and pipeline • Live steam line	• Coal combustion and steam generation • Operate pressure valve, switch and control system • Flows live high pressure steam from boiler to turbine	• Fire (near burner) • Release of high pressurized steam • Explosion	▪ Failure of the water pumps ▪ Mechanical failure of safety switch and valves ▪ Busting of furnace and pressurized pipes ▪ Presence of contaminant in fuel • Accidental leakage, lack of heat sink for combustion process and nonfunctional safety and bypass valve.	• Incomplete combustion • Equipment damage • Health injury • Loss of life • Environmental degradation
• Coal stockpile	• Fuel supply to the boiler	• Fire hazard and explosion • Self-combustions in coal stock pile	▪ Degradation of coal quality • Lack of maintenance of storage system and monitoring	• Damage to equipment • Health injury • Fatality • Loss of air quality
• Water treatment and waste water treatment plant	• Produce clarified, dematerialized water for steam generation and treat effluent water before discharge	• Chemical hazard	▪ Spillage/accidental release • Mishandling and misuse	• Health injury (chronic or acute toxicity) • Disability • Loss of life, • Degradation of air, water and soil quality
• Chemical storage	• Use for water treatment in different phases of dematerialized water, cooling water and potable water.	• Toxic accidental release due to multifunction of equipment & callousness of operator.	▪ Chemical spillage ▪ Chemical fires • Mishandling and misuse	• Health injury (chronic or acute toxicity) • Disability • Loss of life • Degradation of air, water and soil quality
• SO_x absorber	• Use for maintaining rate of sulfur emission as per design standard	• Accidental toxic substance release • Air pollution	• Discharge of sulfuric acid due to technical failure in sulfur absorption system	• Damage of air quality as well as surrounding ecosystem
• Blocked filter (particulate filter system)	• Filter out particles during combustion	• Toxic particulate release • Atmospheric pollution	• Generation of excess coarse size particles due to incomplete combustion of coal	• Hazard to human health (particularly respiratory and cardiovascular systems) and surrounding environment
• Non-functional ESP	• Remove fine particulate fly ash	• Accidental toxic particulate release	▪ Malfunction of device and equipment failure	• Equipment damage and environmental degradation

Location of hazard	Project Activities	Potential hazard	Root Causes	Consequences
			• Lack of monitoring	
• Air circulating system	• Generating air flow both in and out of boiler	• Non-functional air circulating system	• Mechanical failure	• Equipment damage and risk to human health and surrounding environment
• Non-functional lightning arrestor	• Keeping the equipment safe from lightning.	• Fire hazard	• Malfunction or faulty equipment	• Equipment damage • Fire due to arc flash/arc blast
• Occupational hazard	• Daily plant activities	• Cuts, bruises and burns • Falls, slips and trips • Health injuries • Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Prior sickness or illness ▪ Heavy workload • Unsafe working environment.	• Health injury • Disability • Electric shock • Sickness • Anxiety and depression
• Conveyor belt • Mother vessel • Barge • Jetty site	• Coal transportation	• Vessel capsize/sinking • Water pollution • Environmental degradation • Health hazard to humans and aquatic species	▪ Lack of safety awareness ▪ Carelessness in following maritime protocols ▪ Overloading of vessels/barges ▪ Miscommunication • Mismanagement at jetty site (e.g. during unloading of coal)	• Health injuries • Loss of life • Aquatic environment degradation

9.5 Hazardous Chemicals

As per feasibility study, the project will use significant quantity of HSD, HCl and NaOH during operation period of the power plant. In most of the cases stored quantities of liquid fuel and chemicals are considered in hazard identification. **Table 9.3**provides the details of storage of the hazardous fuel and chemicals.

Table 9.3: Name of the hazardous chemicals

Material Stored	Mode of Storage
HSD (Naptha)	Combustible liquid -2 tank
HCl (31%)	Hazardous, reactive but non-flammable
NaOH (30%)	Hazardous, corrosive, oxidizer and non-flammable

9.6 Storage Scenario developments

The identification of specific scenarios is based on the assessment of likely events and incidence of failures.Fire and chemical release may occur due to the storage of fuel and chemicals. Those potential hazardous chemicals, in case of failure of the systems, the likely incidents to occur are listed in **Table 9.4**.

Table 9.4: Incident considered for consequence analysis

Fuel/Chemicals	Incident
HSD	Pool Fire and Tank top fire
HCl	Puddle inside the bund
NaOH	Puddle inside the bund

The proposed project will use HSD as secondary fuel and start-up fuel respectively. The typical Material Safety Data Sheets (MSDS) of the hazardous chemicals are appended in the Appendix-IX. Among the three chemicals (i.e. HSD, HCl and NaOH) HSD is highly flammable, HCl is highly reactive and NaOH is highly oxidizing agents. HCl and NaOH will produce puddle after failure of the storage tank. Since, these two chemicals are not flammable and containment within the bund, the consequence modeling would not require for consequences modeling.

9.7 Frequency analysis

Failure frequencies need to be calculated in order to determine a probabilistic risk assessment. Generally, a number of techniques are available to determine such frequencies. This study does not account the frequency of failure from different sources data. This study only assessed the potential zones under risk of chemical explosion e.g. risk zoning of the hazardous substances.

9.8 Consequence Analysis

Consequence analysis is that part of risk analysis which considers individual failure cases and extent of damages. To predict the hazardous outcome of accidents and their possible effects, consequence analysis is generally employed. The analysis is carried out on a variety of preconceived scenarios. The purpose and benefits that are likely to be derived by carrying out consequence analysis include: BLEVE and Pool Fire.

The particular outcomes modeled depend on source terms (conditions like fluid, temperature, pressure etc.) and release phenomenology. The current understanding of the mechanisms occurring during and after the release is included in our consequence analysis models and tools.

9.9 Consequence Modeling Tools

This study includes the use of ALOHA for consequence modeling. ALOHA is one of the tools developed by EPA's Office of Emergency Management (OEM) and the National Oceanic and Atmospheric Administration Office of Response and Restoration (NOAA), to assist front-line chemical emergency planners and responders. ALOHA is an atmospheric dispersion model used for evaluating releases of hazardous chemical vapors. ALOHA allows the user to estimate the downwind dispersion of a chemical cloud based on the toxicological/physical characteristics of the released chemical, atmospheric conditions, and specific circumstances of the release. ALOHA can estimate threat zones associated with several types of hazardous chemical releases, including toxic gas clouds, fires, and explosions ALOHA software is used for consequence modeling, where the consequence is displayed according to the type of release. The ALOHA output is a graph showing the release effect at the specified standard radiation levels or overpressure according to the type of release. The graphs from ALOHA are then turned into a digital format in the form of a table showing the distances in all directions at each radiation level.

HSD is a compound, flammable hydrocarbons which consist of a number of organic hydrocarbons like N-hexane, Xylene, Toluene etc. However, the tank of storage HSD burst and leakage are subjected to consequence analysis. The outcome of this analysis provides information about possible hazards due to accidents or tank failures.

9.9.1 Assumption and considering factors

Fuel oil is a combustible liquid, which will burn if the temperature of the liquid exceeds the flash point and the vapor generated at the liquid surface is ignited. The resultant incident is a pool fire that radiates heat to the surrounding area resulting in potential equipment damage and or injury/fatality.

Fuel oil is also a contaminant to the biophysical environment and its release can damage sensitive environmental areas surrounding the storage area in the event a leak occurs and escapes to the environment. Fuel will also float on water and be carried a significant distance from a leak point by a water course.

The ALOHA model has been running for identifying the potential zone of threat during pool fire. The High Speed Diesel composes of a number of chemical hydrocarbons. This study considers only the N-hexane or Xylene which presence significantly in HSD. Pool formation occurs through HSD storage tank release causing different levels of thermal radiation incident. However, the pool fire will remain confined within dyke provided around storage tanks.

POOL FIRE THREAT ZONE:

SITE DATA:

Location: KALAPARA, BANGLADESH

Building Air Exchanges per Hour: 0.50 (enclosed office)

Time: July 21, 2016 1211 hours ST (using computer's clock)

CHEMICAL DATA:

Chemical Name: N-HEXANE Molecular Weight: 86.18 g/mol

AEGL-1 (60 min): N/A AEGL-2 (60 min): 2900 ppm AEGL-3 (60 min): 8600 ppm

IDLH: 1100 ppm LEL: 12000 ppm UEL: 72000 ppm

Ambient Boiling Point: 68.7° C

Vapor Pressure at Ambient Temperature: 0.26 atm

Ambient Saturation Concentration: 258,149 ppm or 25.8%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2.5 meters/second from WNW at 10 meters

Ground Roughness: open country Cloud Cover: 3 tenths

Air Temperature: 31° C Stability Class: B

No Inversion Height Relative Humidity: 75%

SOURCE STRENGTH:

Leak from hole in vertical cylindrical tank

Flammable chemical is burning as it escapes from tank

Tank Diameter: 16 meters Tank Length: 12 meters

Tank Volume: 2,413 cubic meters

Tank contains liquid Internal Temperature: 31° C

Chemical Mass in Tank: 1678 tons Tank is 97% full

Opening Length: 1 meters Opening Width: 0.3 meters

Opening is 0.5 meters from tank bottom

Max Flame Length: 70 meters

Burn Duration: ALOHA limited the duration to 1 hour

Max Burn Rate: 13,000 kilograms/min

Total Amount Burned: 756,285 kilograms

Note: The chemical escaped as a liquid and formed a burning puddle.

The puddle spread to a diameter of 51 meters.

THREAT ZONE:

Threat Modeled: Thermal radiation from pool fire

Red : 125 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 178 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 276 meters --- (2.0 kW/(sq m) = pain within 60 sec)

9.9.2 Results of HSD Tank failure

Consequence analysis was carried out for identified selected failure cases. Consequence analysis quantifies vulnerable zones. For the selected accidental scenarios, after vulnerable zone is defined, measures can be proposed to minimize the damages.

HSD tank at the plant site is located in the plant area. The tanks (2X2000 m3) on fire scenario are presented on the above. The distance of occurrence of 2 kW/m2 radiation intensity, sufficient to cause first degree burn, has been calculated at 276 m. Plant personnel or other sensitive point should be avoided or protected within this range (**Figure 9.1**).

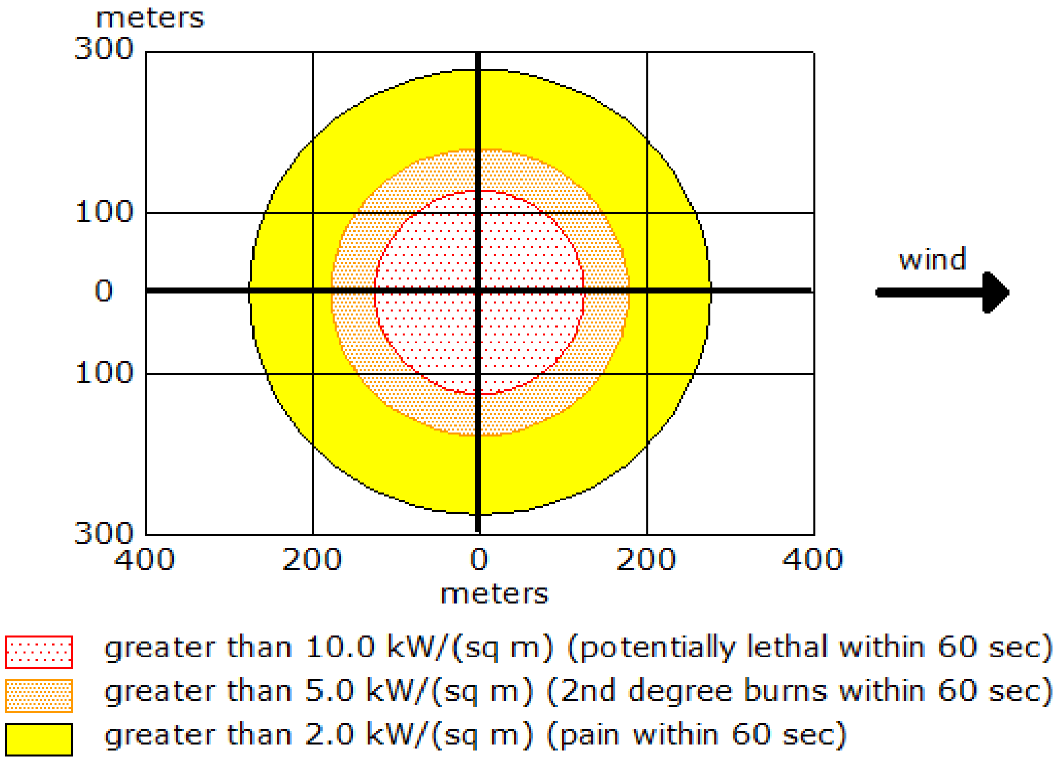


Figure 9.1: Threat zone assessment

BLEVE THREAT ZONE:

SITE DATA:

Location: KALAPARA, BANGLADESH

Building Air Exchanges Per Hour: 0.50 (enclosed office)

Time: July 21, 2016 1211 hours ST (using computer's clock)

CHEMICAL DATA:

Chemical Name: N-HEXANE   Molecular Weight: 86.18 g/mol

AEGL-1 (60 min): N/A   AEGL-2 (60 min): 2900 ppm   AEGL-3 (60 min): 8600 ppm

IDLH: 1100 ppm   LEL: 12000 ppm   UEL: 72000 ppm

Ambient Boiling Point: 68.7° C

Vapor Pressure at Ambient Temperature: 0.26 atm

Ambient Saturation Concentration: 258,149 ppm or 25.8%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 2.5 meters/second from WNW at 10 meters

Ground Roughness: open country Cloud Cover: 3 tenths

Air Temperature: 31° C Stability Class: B

No Inversion Height Relative Humidity: 75%

SOURCE STRENGTH:

BLEVE of flammable liquid in vertical cylindrical tank

Tank Diameter: 16 meters Tank Length: 12 meters

Tank Volume: 2,413 cubic meters

Tank contains liquid

Internal Storage Temperature: 31° C

Chemical Mass in Tank: 1678 tons Tank is 97% full

Percentage of Tank Mass in Fireball: 100%

Fireball Diameter: 667 meters Burn Duration: 32 seconds

THREAT ZONE:

Threat Modeled: Thermal radiation from fireball

Red : 1.3 kilometers --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 1.9 kilometers --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 2.9 kilometers --- (2.0 kW/(sq m) = pain within 60 sec)

9.9.3 Damage Criteria

HSD released accidentally will normally spread out and form a pool. If its pool finds ignition source, a fire is likely to occur. Any person caught in the fire is likely to suffer severe burn injuries. Therefore, in the consequence analysis, the distance to which Lower Flammable Limit (LFL) value persists is taken to indicate the area which may be affected by fire. Any other combustible materials within fire zone are also likely to catch fire and secondary fire may occur. Hence due to HSD spillages pool fire may result if there is an immediate ignition source.

Thermal radiation due to fire may cause various degrees of burns on human bodiesif it is considered to be BLEVE. Moreover, their effects on inanimate objects like equipment, piping or vegetation also need to be evaluated to assess the impact. The effects due to intensity and escape time respectively are presented in the following tables.

Finally, **Table 9.5, 9.6 and 9.7** are detailed out the lists out tolerable intensities of various objects as given in “Guidelines for Chemical Process Quantitative Risk Analysis” and “Process Plant Layout”.

Table 9.5: Damage due to incident radiation intensity

Incident Radiation Intensity (kW/m2)	Types of Damages
62.0	Spontaneous ignition of wood
37.5	Sufficient to cause process equipment damage
25	Minimum energy required to ignite wood at infinitely long exposure (non piloted)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
4.5	Sufficient to cause pain to personnel unable to reach over within 20 sec; however blistering of skin (Ist degree burns) is likely
1.6	Will cause no discomfort during long exposure

Table 9.6: Heat radiation and escape time

Radiation Intensity (kW/m2)	Time to pain Threshold (Seconds)
1.39	60
1.74	40
2.33	30
2.9	16
4.7	9
6.93	6
9.5	5
11.66	4
19.9	2

Table 9.7: Tolerable intensities for various objects

Object	Tolerable Intensity (kW/m^2)
Drenched Tank	38
Special Buildings (No Windows, fire proof doors)	25
Normal Buildings	14
Vegetation	10-12
Escape Route	6 (up to 30 seconds)
Personnel in Emergencies	3 (up to 30 seconds)
Plastic cables	2
Stationary Personnel	1.5

9.10 Hazard Consequence &Frequency Scales

The potential impacts of the project have been scaled and prioritized based on the magnitude of those potential impacts (consequence) and the likelihood of them occurring (frequency). The consequence of the said impacts are classified and illustrated in **Table 9.8**.

Table 9.8: Hazard Consequence Scale

Parameter	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
Duration of potential impact	Temporary with no detectable potential impact	Limited to construction period	Medium Term (1 to 2 years)	Long term (more than 2 years)	Permanent Damage

Parameter	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
Spatial extent of the potential impact	Specific location within project component or site boundaries with no detectable potential impact	Within project boundary	Beyond immediate project components, site boundaries or local area	Widespread far beyond project boundaries with some community and wildlife habitat coverage	Beyond project boundaries extending to widespread communities and wildlife habitat
Reversibility of potential impacts	Baseline remains almost constant	Baseline returns naturally or with limited intervention and within a few months	Potential impact requires a year or so for recovering with some interventions to return to baseline	Potential impact is long-term, requiring considerable intervention to return to baseline	Potential impact is effectively permanent, with little to no chance of returning to baseline
Compliance to Legal Standards before Mitigation Measures	Complies with all minimum requirements only some improvement opportunities to strengthen good practices	Meets minimum national standard limits or international guidelines	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Complies partially with limits given in national standards but breaches international lender guidelines	Completely breaches national standards and or international guidelines/ obligations
Extent of health injuries	Minor pain, scratch, discomfort requiring no medical attention	Health injuries can be cured with first aid and/or some medical attention	Health injury requires hospitalization; may require long term recuperation; may lead to long term absence from work	Health injury may lead to permanent disability; few fatalities of workers and or community people	Fatalities of workers more than 5 and or community people more than 2
Impact on wildlife	Minimal disturbance within compliance	Disturbing habitat of wildlife causing discomfort	Disturbing habitat of wildlife causing decrease of preys and forcing them to relocate	Impact leading to deaths of any endangered species and decrease of their food source	Impact may lead to deaths of 2 or more endangered marine mammals and-or 5 of other endangered species

Criteria for determining the frequency of the potential hazardbeing occurred are outlined in **Table 9.9**.

Table 9.9: Criteria for Determining Frequency of the Potential Hazard

Frequency Scale Determination	Definition
1 (Rare)	Rare chance of occurrence, if not at all
2 (Low)	Very minimal chance of occurring
3 (Medium)	May occur considering if the conditions are abnormal or exceptional
4 (High)	Occurs more frequently and without any prior warnings
5 (Almost Certain)	Occurs under typical conditions

9.11 Developing Risk Matrix

Following the consequence and frequency scales, a risk matrix can be developed after analyzing the potential hazards for the Project. The table below (Table 9.10) shows the risk matrix for the potential hazards and how frequently they may occur. In Table 9.11, the risk evaluation based on the type of activities and potential hazards are shown.

Table 9.10: Risk Matrix of Potential Hazards/Impacts

Frequency (F) of Hazards ↓	Hazard Consequence (C) →				
	1 (Insignificant)	**2 (Minor)**	**3 (Moderate)**	**4 (Major)**	**5 (Severe)**
1 (Rare)	1	2	3	4	5
2 (Low)	2	4	6	8	10
3 (Medium)	3	6	9	12	15
4 (High)	4	8	12	16	20
5 (Almost Certain)	5	10	15	20	25

Color Legend:

Red (15-25)	≡ Top Priority	: Action with follow-up Verification & Validation by Authority needed before allowing work
Orange (10-14)	≡ High Priority	: Action needed under follow-up Supervision before allowing work
Yellow (5-9)	≡ Medium Priority	: Need maintaining with routine monitoring & reporting
Green (1-4)	≡ Low Priority	: Only for awareness; no Intervention Action needed to start work

The risk for the potential hazard/impact is evaluated based on the combination of the hazard consequence and their frequency (NHS, 2008). In order to calculate the potential risk, the frequency of impact is multiplied with consequences. E.g. Level 1 of frequency of an hazard (Rare) is multiplied with Level 1 of hazard consequence (insignificant) to give a total score of 1 (1X1=1) and so on. In that regards, a score between 1 to 4 is considered low priority; a score between 5 to 9 is considered mediumpriority and; a score between 10 to 14 is considered high priority and; a score between 15 to 25 is considered top priority.

9.12 Risk Estimation, Evaluation and Management Plan

Based on the hazard consequence and frequency scales in Table 9.9 and Table 9.10 potential risk of a particular hazard/impact is estimated and given a score. The score is given in terms of the presence and absence of safeguards. The final evaluation of the potential risks is determined based on combined score of hazard consequence and its frequency. The following table (Table 9.11) shows the risk evaluation (risk ranking) of the project activities and its subsequent hazards (both before and after implementing safety measures).

Table 9.11: Risk Evaluation for the proposed coal based power plant

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)		Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
Pre-construction Phase										
Machinery and equipment	• Bringing in machines, equipments and vehicles for site clearance activities	• Trips and falls ▪ Cuts and bruises	• Fatigue or prior sickness • Mechanical failure • Lack of safety training ▪ Not abiding to general health and safety and traffic rules	3	3	**9**	• Arranging toolbox meeting before going out for work • Regular inspection and maintenance of equipment • A thorough lorry driver selection process via interviews, checking whether they have the proper licenses and from past experiences • Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road after the selection process is complete • Limiting movement of vehicles after sunset and before sunrise • Regular health and safety training to all construction workers and lorry drivers, including the proper use of PPEs.	2	1	2
Construction and Erection Phase										
Construction site	▪ Construction of building, steel structure and its foundation, cutting, welding, painting works, drilling work, etc	• Accidents (burns, electric shocks etc.) • Injuries from falls and slips • Inhalation of dust ▪ Cuts and bruises	• Fatigue or prior sickness • Electric failure • Equipment failure • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside people) • Not maintaining a designated place for backfilling storage ▪ Not maintaining enough lighting during the night (for those working overtime)	3	2	**6**	• Arranging toolbox meeting before going out for work (during each construction activities.). Provide each worker with a safety checklist and safety permit (based on their work) before starting work. • Regular inspection and maintenance of equipment, machineries and especially, safety harness. Maintain a registry for any faulty equipment found; inform site contractors and have they replace those immediately. No work should be done until the faulty machineries are replaced and tested. • Regular health and safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. • Enclosing the area with yellow barricade tape and restricting outside access to local people during the whole construction process. • Spraying water on dust to minimize its spread via wind; put stockpile at a designated place and cover them with GI sheet; put up GI sheet fencing around the construction site. • Equipment, machineries and electric wires should be checked for current and voltage ratings. When using an extension cable, its wire rating should match with the equipment wire rating. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken ▪ Maintenance of an accident registry book	2	2	4
	▪ Work at heights	• Accidents • Injuries from falls and slips (e.g. broken bones, fractures, traumas,	• Fatigue or prior sickness • Lack of safety protocols (e.g. not putting up warning signs or enclosing the area to prevent entry of outside	4	3	12	▪ Regular inspection and maintenance of equipment, machineries and especially, safety harness. Maintain a registry for any faulty equipment found; inform site contractors and have they replace those immediately. No work should be done until the faulty machineries are replaced and tested. • Recording of any unusual activities and issuance of fines or suspensions if any rules	3	2	**6**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)		Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
		etc.) ▪ Fatalities	people) • Not maintaining a designated place for backfilling storage ▪ Not maintaining enough lighting during the night				are broken ▪ Maintenance of an accident registry book.			
	ehicle and vessel movement	▪ Noise generation ▪ Accident (e.g. vessel capsize) ▪ Emission from vehicles ▪ Spread of dust and minute particles due to vehicle movement.	▪ Running engine, hydraulic horns, sirens etc. ▪ Mechanical failure ▪ Old engine or engine parts/lack of maintenance	3	3	**9**	• Regular inspection and maintenance of equipment, machineries and vehicles. • Training of traffic rules and maritime regulations, including maintaining vehicle/vessel speed limit for different categories of road and rivers. • Spraying water on dust at plant site to minimize its spread via wind or vehicle movement. • Regulate the use of hydraulic horns/sirens during construction. Set a limit on the amount of noise generated as stipulated in schedule III of ECR, 1997. • Switch off engines/generators/equipment when not in use. ▪ Monthly health checkup of workers for any illness. Provide treatment accordingly	2	1	**2**
	▪ Coal stockyard and/or chemical storage area ▪ Handling of hazardous chemical	▪ Accidental release of coal dust/ chemicals ▪ Acute/chronic toxicity from exposures to chemicals ▪ Fire/explosion	▪ Lack of safety protocols ▪ Carelessness (e.g. smoking near coal stockyard/chemical storage area) ▪ Not covering the coal stockyard from releasing dust ▪ No proper bounding of chemical storage area ▪ Improper chemical storage (e.g. faulty/leaky containers, improper containers, improper sealing of containers etc.)	4	3	**12**	▪ Coveting of coal stockyard with GI sheet to minimize dust release ▪ Putting up "fire hazard" and "chemical hazard" warning sign near coal stockyard and chemical storage areas respectively. Set up awareness programs on how to handle/store coals and chemicals ▪ Check containers for leaks, faults and cracks. Change them immediately if found. ▪ Labeling chemical storage containers for easy recognition. Put up MSDS in chemical containers along with appropriate warning labels (e.g. corrosive, toxic, flammable etc.) ▪ Storing different types of chemical separately. All flammable or corrosive chemicals should be stored separately and should have proper bounding ▪ A fire extinguisher/ fire hydrant should be installed nearby in case of any fire breakout. Emergency contact details for fire fighters and ambulance service should also be placed there. ▪ In case of a spillage, keep flammable substance away from the spillage area and inform on site EPC contractor immediately. • Recording of any unusual activities and issuance of fines or suspensions if any rules are broken.	3	2	**6**
	▪ Occupational Hazard	▪ Cuts, bruises and burns ▪ Falls, slips and trips ▪ Health injuries ▪ Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Improper hygiene ▪ Prior sickness or illness ▪ Heavy workload	3	3	**9**	▪ Regular inspection and maintenance of equipment, machineries and vehicles. ▪ Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and firefighting drills to all construction workers, including the proper use of PPEs during work. ▪ Training of traffic rules and regulation, including maintaining vehicle speed limit for different categories of road. ▪ Maintenance of hygiene at construction site and providing appropriate training to workers in hygiene maintenance ▪ Supplying workers with safe drinking water ▪ Monthly health checkup of workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital. ▪ Work load should be managed effectively. Workers working every 2 hours should be given a mandatory 30 minutes break as stipulated in chapter 9 of Bangladesh Labour	2	1	**2**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)		Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
							Rules, 2015[7]. ▪ Employment of child labour (children below the age of 18), pregnant women and elder citizens in hard labour and dangerous activities must be prohibited. ▪ All other facilities (toilet, canteen, overtime hours, leaves etc.) should be followed as stipulated in Labour Rules, 2015.			
Operation Phase										
▪ Turbine, generator and its ancillary components	▪ Electricity generation	▪ Mechanical hazard ▪ Fire hazard/explosion ▪ Electrical hazard ▪ Noise generation	▪ Mechanical failure ▪ Lack of sound buffers	4	3	**12**	▪ Installing machines with computerized control and monitoring system for detecting any faults in the machines ▪ Installing machines with environment friendly and safe design (e.g. with noise buffers, energy efficiency, manual override, automated kill switch etc.) ▪ Test running the machines and its safety systems before going into final operation. Do a monthly inspection and maintenance. ▪ Install automated fire alarms and fire hydrant system in turbine and generator room.	3	2	**6**
▪ Cable gallery ▪ Power transformer ▪ Switchyard ▪ 400KV Switchyard control room	▪ Transmitting electricity from generator to unit transformer ▪ High voltage (400KV) power transmission ▪ Open air power transmission ▪ Controlling and monitoring the power transmitting system	▪ Fire due to resulting arc flash/arc blast ▪ Other electric hazard due to unprotected cables ▪ Slips and trips from unorganized/lose cables lying in the floor	▪ Short circuit in control room and switch gears ▪ Faulty cables and wires ▪ No safe connection to earth ▪ Using cables with different voltage and current ratings ▪ Unorganized cables	4	3	**12**	▪ Monitoring. Installation of fire defense and fighting systems. ▪ Checking the insulation of the wire, along with the wire's voltage and electric ratings. Change wires if ratings do not match with the power supply or if the insulation is damaged ▪ Proper earthing should be made to avoid electric shocks. ▪ Open wires should be passed through a plastic pipe to avoid exposing them with outside contact. ▪ Switch off power before doing any electrical work. Inform supervisor and respected machine operator before starting any electrical work. Inform them again after the electrical works are done. ▪ All power transformers and transmission should be fitted with lightning arrester to protect from lightning strikes. ▪ Switchyards should be fitted with circuit breaker in case of short circuit or during an unusual surge of electrical current. ▪ When working with exposed live wire/machines, the maintenance worker should maintain distance of 6 meters from the live exposed part[8]. ▪ Maintain a safe distance from the rights-of-way (RoW). Don't raise any construction under the RoW. ▪ Any cranes or vehicles passing through a high voltage overhead transmission line should have a minimum 1 meter distance from the overhead transmission line. ▪ Place "electrical hazard" or "high voltage" signs on all switchboards and power transformers. ▪ Restrict access to power transmission area, switchyards and control to power plant officials and maintenance workers only.	3	2	**6**
▪ Boiler and pressure parts ▪ Compressed air system	▪ Coal combustion and steam generation ▪ Operate pressure valve, switch and	▪ Fire (near burner) ▪ Release of high pressurized steam ▪ Explosion	▪ Failure of the water pumps ▪ Mechanical failure of safety switch and valves ▪ Busting of furnace and pressurized pipes	4	3	**12**	▪ Control system to monitor and regulate temperature, intake air and furnace system. ▪ Monitoring fuel quality & safety system. Provision of fire fighting and safety ▪ Check pipelines for leaks and cracks. Conduct quarterly inspection of pipelines ▪ Inspection and maintenance of safety valve, pipelines and steam line ▪ Restrict entry except authorized personnel	3	2	**6**

[7] Bangladesh Labour Rules (2015). *Ministry of Labour and Employment*. Retrieved from http://www.dpp.gov.bd/upload_file/gazettes/14079_83432.pdf.

[8] http://electrical-engineering-portal.com/electrical-safety-standards-for-lvmvhv-part-2#16

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)		Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
and pipeline ▪ Live steam line	control system ▪ Flows live high pressure steam from boiler to turbine		▪ Presence of contaminant in fuel ▪ Accidental leakage, lack of heat sink for combustion process and nonfunctional safety and bypass valve.				▪ Install control system to monitor required pressure at different points. ▪ Installation of fire defense and fighting systems.			
▪ Coal stockpile	▪ Fuel supply to the boiler	▪ Fire hazard and explosion ▪ Self-combustions in coal stock pile	▪ Degradation of coal quality ▪ Lack of maintenance of storage system and monitoring	4	3	**12**	▪ Availability of appropriate fire hydrant with auto water sprinkler and Regular monitoring	3	2	**6**
▪ Water treatment and waste water treatment plant	▪ Produce clarified, dematerialized water for steam generation and treat effluent water before discharge	▪ Chemical hazard	▪ Spillage/accidental release ▪ Mishandling and misuse	3	3	**9**	▪ Safe use of chemical. Using appropriate MSDS to aware people of chemical properties, storage and handling procedures. ▪ Limited entry except authorized personnel ▪ Training and use of appropriate PPE ▪ Make spill kits available in case of accident. ▪ Install safety shower, eye wash and first aid facilities	2	2	**4**
▪ Chemical storage	▪ Use for water treatment in different phases of dematerialized water, cooling water and potable water.	▪ Toxic accidental release due to multifunction of equipment & callousness of operator.	▪ Chemical spillage ▪ Chemical fires ▪ Mishandling and misuse	3	3	**9**	▪ Putting up “chemical hazard” warning sign in the entry of chemical storage areas. Set up awareness programs on how to handle/store chemicals ▪ Check containers for leaks, faults and cracks. Change them immediately if found. ▪ Labeling chemical storage containers for easy recognition. Put up MSDS in chemical containers along with appropriate warning labels (e.g. corrosive, toxic, flammable etc.) ▪ Storing different types of chemical separately. All flammable or corrosive chemicals should be stored separately and should have proper bounding ▪ A fire extinguisher/ fire hydrant should be installed nearby in case of any fire breakout. Emergency contact details for fire fighters and ambulance service should also be placed there. ▪ In case of a spillage, keep flammable substance away from the spillage area and inform on site EPC contractor immediately. ▪ Recording of any unusual activities and issuance of fines or suspensions if any rules are broken.	2	1	**2**
▪ SO_x absorber	▪ Use for maintaining rate of sulfur emission as per design standard	▪ Accidental toxic substance release ▪ Air pollution	▪ Discharge of sulfuric acid due to technical failure in sulfur absorption system	4	3	**12**	▪ Regular monitoring of absorption system ▪ Sourcing of energy efficient yet low sulfur content coal (e.g. super critical/ultra super critical)	2	2	**4**
▪ Blockedfilter (particulate filter system)	▪ Filter out particles during combustion	▪ Toxic particulate release ▪ Atmospheric pollution	▪ Generation of excess coarse size particles due to incomplete combustion of coal	4	3	**12**	▪ Regular maintenance of filters; change filters when necessary ▪ Install alarm system to alert temperature, oxygen and CO changes.	2	2	**4**
▪ Non-functional ESP	▪ Remove fine particulate fly ash	▪ Accidental toxic particulate release	▪ Malfunction of device and equipment failure ▪ Lack of monitoring	3	3	**9**	▪ Proper monitoring of combustion process and functioning of boiler.	2	1	**2**
▪ Air	▪ Generating air flow	▪ Non-functional air	▪ Mechanical failure	3	3	**9**	▪ Regular maintenance and monitoring control system	2	1	**2**

Hazard points	Project Activities	Potential hazard	Root causes	Hazard Consequence (Before Safety Measures)		Risk Ranking (Evaluation) (Before Safety Measures)	Suggested Safety measures (Risk Management Plan)	Hazard Consequence (After Safety Measures)	Hazard Frequency (After Safety Measures)	Risk Ranking (Evaluation) (After Safety Measures)
circulating system	both in and out of boiler	circulating system					▪ Inspecting the functioning of FD, ID fans and vacuum systems.			
▪ Non-functional lightning arrestor	▪ keeping the equipment safe from it.	▪ Fire hazard	▪ Malfunction or faulty equipment	4	2	**8**	▪ Regular testing and maintenance following the specification provided by the manufacturer	2	1	**2**
▪ Occupational hazard	▪ Daily plant activities	▪ Cuts, bruises and burns ▪ Falls, slips and trips ▪ Health injuries ▪ Sickness and illness	▪ Lack of safety awareness ▪ Carelessness in maintaining safety protocols ▪ Use of faulty machineries and equipment ▪ Prior sickness or illness ▪ Heavy workload ▪ Unsafe working environment.	3	3	**9**	▪ Regular inspection and maintenance of equipment, machineries and vehicles. ▪ Raising awareness on occupational hazards. Arrange monthly health and safety training, electrical safety training and fire fighting drills to all officers and plant workers, including the proper use of PPEs during work ▪ Monthly health check up of officers and workers for any sickness or illness. Provide treatment/consultation accordingly. In serious cases of injuries or sickness, an ambulance should be on standby for transporting them to nearby hospital ▪ Keeping all safety & precaution measure in order such as, maintaining first aid & well equipped primary health center on plant site.	2	2	**4**
▪ Conveyor belt ▪ Mother vessel ▪ Barge ▪ Jetty site	▪ Coal transportation	▪ Vessel capsize/sinking ▪ Water pollution ▪ Environmental degradation ▪ Health hazard to humans and aquatic species	▪ Lack of safety awareness ▪ Carelessness in following maritime protocols ▪ Overloading of vessels/barges ▪ Miscommunication ▪ Mismanagement at jetty site (e.g. during unloading of coal)	4	4	**16**	▪ Awareness of maritime regulations; maintaining vessel speed limit and barge type based on river route and depth. ▪ Ship captain should maintain communication with Payra Port Authority and plant jetty officials before sailing. ▪ Limiting vessel movement to daytime only. ▪ Ensuring the right type of barge is commissioned. Avoid overloading.	3	3	**9**

9.13 Occupational Health and Safety Plan

Occupational health and safety in Bangladesh is still in developmental stage. Here, the term "occupational health and safety" mainly refers to the needs of workers of industries or some manufacturing processes but does not completely cover all occupations of the country. Although the government has some kind of occupational health care services for the workers and labors, the responsibility for ensuring health and safety at work is generally placed on the employer. However, it is also the responsibility of the workers/employees to follow the health and safety guidelines set out by the employer diligently to ensure no harm befalls them. Every workplace is different, so it is important to develop an OHS program that addresses the specific needs of the operation. This OHS Program Template serves as a starting point to help employers develop an OHS program for all the personnel involved in the pre-construction, construction and operation of the 2x660MW Coal based Thermal Power Plant.

The proposed construction will be implemented by an Engineering, Procurement and Construction (EPC) contractor supervised by a RPCL appointed Owner's Engineer (OE). The EPC contractor is to be involved in erection of new equipment including civil works and expected to sub-contract the civil, mechanical, electrical, instrumentation and control components to local Bangladeshi contractors. Prior to the construction, the EPC contractor will develop an Occupational Health, Safety and Environment (OHSE) Plan that will address OHSE aspects associated with the each phases of the project.

During the operational phase, RPCL will develop, rollout and implement a formal OHSE management system for the operation of the power plant. The EPC contractor will need to ensure that their OHSE plan also complies with stipulated laws and regulations.

The OHSE activities should not be strictly limited to the aforementioned plan. The plan, once developed, needs to be reviewed and updated as seen fit to identify the strengths and weaknesses of the program. In some cases, reliance on basic common sense could be the difference between averting a major disaster or death.

9.13.1 OHS Policies in Bangladesh

Bangladesh does not have its own specific OHS policy. There are a number of laws and regulations that are have some provisions related to occupational health and safety. Some of these laws have provisions on occupational hygiene, occupational diseases, industrial accidents, protection of women and young persons in dangerous occupations and also cover conditions of work, working hours, welfare facilities, holidays, leave etc. However, most of the laws lack in standard values and are rather general in nature. The laws and regulations that falls into OHS aspects include:

- The Fatal Accidents Act,1855
- The Explosives Act, 1884
- The Explosive Substances Act, 1908
- The Poisons Act, 1919
- The Dangerous Cargoes Act,1953
- The Fire Prevention and Protection Act, 2003
- The Labour Act, 2006
- The RailwayAct,1890

- The Motor Vehicles Ordinance, 1983
- The Highways Act, 1925
- The Building Construction Act, 1952
- National Energy Policy
- Any other Act/Rules applicable to particular situation/activity/operation.

9.13.2 Who is Accountable?

All OHS activities related to pre-construction, construction and operation will be governed by the (OHSE Manager). He will be tasked with delineating OHS responsibilities to his subordinates. He will also be the responsible person in ensuring that OHS processes are being incorporated to his staff members. He will also provide appropriate OHS training to other officers, plant foreman, supervisors and workers.

9.13.3 OHS Training

The on-site OHSE Manager in conjunction with the (health and safety officer, environmental officer and relevant stakeholders/organization heads) will be responsible for the development of the OHS training plan. The (OHSE Manager) will be responsible for ensuring that the appropriate employees receive training required under the plan. The company's human resources representative will be responsible for ensuring that all employees receive introductory training on the OHS Management System.

9.13.4 Training Procedure

Task-Specific Training

- A training program will need to be developed to ensure that employees are capable of accomplishing the tasks required to meet OHSE objectives and targets. The program will identify training topics, who should receive the training, when training should be given, and the training method. The program will also distinguish between training conducted to comply with OHS regulations and other training.
- A training needs assessment for the employees needs to be made. The OHSE Manager will review past training and the nature of the employee's work. Based on this review, specific training requirements for each employee or type of employee will need to be documented.
- The OHSE Manager shall document the OHSE Training Program.
- The training plan shall be implemented by the OHSE Manager. Upon completion of training by employees, the OHSE Manager shall make the (Superintendent Engineer and Chief Engineer) aware of the training completed.
- The (OHSE Manager) shall document the training completed form and Training Log.
- Specific documentation pertaining to training received shall need to be maintained by the operational work areas for a minimum of two years, or as required by regulation.
- Training effectiveness will need to be evaluated to ensure that the OHS Management System is being implemented effectively when changes are made to significant risks, objectives, targets or operational controls. Improvements to the training plan will need to be made accordingly.

General EMS Training

- All employees shall receive introductory training to make them aware of the OHS Management System.
- The human resources representative shall be responsible for coordinating the effort to assure that all new and existing employees have received suitable training.

9.13.5 Frequency of training

The training plan shall be updated whenever changes are made to the significant risks, objectives, targets, or operational controls. General OHS training shall be made available on a continual basis to ensure that new employees are made aware of the OHS MS. A draft training plan has shown in Table 9.12.

Table 9.12: Draft OHSE Training Plan

Training Subject	Target Personnel
OHS Management System awareness	All staffs members (including contractors)
Emergency response and management	IRT, ERG and IMT team
Handling, use & disposal of hazardous material	Workers with authorized access to hazardous material storage areas and required to use hazardous material during their works
Waste Management	All staffs members
Defensive and Evasive training- Efficient & safe driving practices, including road & vehicle restrictions	Drivers & mobile plant operators
Actions to be taken in the event of major or minor pollution event at river/plant site	All staff
Use of flexible booms and surface skimmers in event of pollution event in water	All crew members stationed at the Pollution Control Vessel
Pollution prevention: Best practice	All staffs
Health & Safety: Safe way to work & hazard awareness	All staff members
Health & Safety: Safe use of cranes and equipment	Operators of cranes& equipment
Front line leadership and project management training	Senior management of RPCL
Health & Safety: Working at height	Crane operator
Health & Safety: Working near/on water	All staffs working on jetty strengthening and unloading coal from ship
Health & Safety: Use of PPE	All staff members
Emergency procedures and evacuation	All staffs
Fire fighting	All staffs
Health & Safety: Confined space entry	Designated workers
Health & Safety: Lifting and rigging	Crane operator and all riggers
Awareness raising on risks, prevention and available treatment of vector-borne diseases	All staffs
Cultural sensitivities of the local population	On induction of all non-local staff

9.14 Emergency Response Plan

Emergency Response Plans are developed to address a range of plausible hazard scenarios that are unplanned and emphasize the tasks required to respond to a physical event. The Emergency Response Plan for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a predetermined sequence if it is to deal major and minor accidents effectively and efficiently. The primary objective of the plan is:

- Providing clear lines of authority and communication during incident and crisis events
- Providing means by which trained people and resources are available to those managing the incident or crisis event
- Keeping the workplace safe and to achieve minimal incidents for health hazard; as well as keeping the impacts on the environment, materials, machineries and equipment from these unplanned events to a minimum.

Possible emergency events include:

- Fire and explosion;
- Immediate medical emergency due to injuries;
- Leakage of hazardous materials;
- Natural disaster and;
- Civil disturbance/terrorist activities

A detailed emergency response plan for the abovementioned emergency events is illustrated in a separate report.

Emergency events are broken down to three level tiers; tier 1, 2 and 3. Tier 1 having the lowest threat level and Tier 3 having the highest threat level

In the case of an emergency event, the Incident Response Team (IRT) at plant site would be mobilized with the Emergency Response Group (ERG) (chaired by the Chief Engineer of RPCL located at RPCL head office in Uttara) coordinating and overseeing arrangements to ensure that the IRT meets its emergency management obligations. In the case of Tier 1 emergencies, the cases are escalated primarily to site specific IRTs only. Tier 2 involves ERG providing tactical response, support, assistance and advice to all incident and emergency situations at site/location and for providing operational response to any emergency situation which may occur in the affected(such as, fire, explosion, coal spillage and various social crisis). The Incident Management Team (IMT) (also located at RPCL head office in Uttara) is activated in the case of Tier 3 incidents and responsible to define and control strategy for those incidents. The following table (**Table 9.13**) shows the emergency response escalation protocol for different levels of emergencies.

Table 9.13: Emergency Response Escalation Protocol

Impact/ Consequence	Health & Safety	Natural Environment	Reputation Government Community Media	Financial $	Civil Unrest Hartals		Definition	Country Threat Level	Escalation				Site specific IRT Members
Tier 1	Minor injury – First Aid treatment.	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Incident reporting according to routine protocols.	Minimal impact to reputation.	Financial loss <$50,000	Situation generally stable with some protests / Hartals against government		Incidents that are containable by the Operations' Site Incident Response Team (IRT)	**Insignificant Low**	Operation Sites	Plant Manager	**IRT**	ERG Leader	Plant Manager other **IRT** members **ERG - as required**
Tier 2	Moderate injury- Medical Treatment , Lost Time injury	Impact on fauna, flora and/or habitat but no negative effects on ecosystem, may require immediate regulator notification.	Moderate to small impact on business reputation.	Financial loss >$50,000	Security unrest appears to escalate to regular outburst - but **authorities appear to be capable of maintaining control**		Incidents that require Dhaka based ERG, governmental and regulatory support	**Medium High**	**ERG**	ERG Leader	Chief Engineer RPCL**activates Dhaka ERG**	**Inform Executive Director**	ERG Leader – Chief Engineer other ERG members **ERG - activated for EHS / Security issues**
Tier 3	Injury requiring ISOS activation. Permanent disabling injury and or long term off work and fatality.	Long term impact of regional significance on sensitive environmental features, likely to result in regulatory intervention/action	Significant impact on business reputation/ or international media exposure.	Financial loss greater than $100,000.	Confirmed direct threat to foreign business interest or against expatriates **Situation certain to escalate further beyond Government control**		Incidents when there are multiple injuries or fatalities requiring IMT support and also international support, regulatory and public relations assistance.	**High Extreme**	**IMT**	IMT Leader **activates IMT**	**Executive Director**	**Managing Director** **IMT**	**IMT** other **IMT** members **IMT - activated**

9.14.1 The Incident Response Team (IRT)

The Incident Response Team (IRT), based at plant location, is trained and responsible for dealing with all envisaged incidents and emergency situations which may occur at the location. Where additional support in the way of resources and advice may be required by the IRT at a remote location this will be requested through and provided by the Emergency Response Group (ERG) of Dhaka Office. On all occasions when an IRT is mobilized due to an incident or emergency situation, the ERG Manager must be notified immediately.

The IRT will be headed by the Plant OHSE Manager and will include senior staff from the Human Resources (HR), Health Safety Environment (HSE) and Logistics department within the plant.

9.14.2 The Emergency Response Group (ERG)

The Emergency Response Group (ERG) is based in the RPCL Head Office in Uttara, Dhaka and will be chaired by the (Chief Engineer (Operation and Maintenance)). He will also nominate an Emergency Response Coordinator to coordinate with representatives from various agencies and also senior staff from HR, Finance, HSE, Logistic, Security, IT, and public affairs department within RPCL. ERG will be responsible for providing tactical response, support, assistance and advice to all incident and emergency situations at site/location and will provide operational response to any emergency situation that may occur. The function of the ERG is to coordinate and oversee arrangements to ensure that the IRT meets its emergency management obligations. ERG should develop a plan, in consultation with the appointed OHSE Manager where it should describe how to handle both the "technical" crises e.g. fire, explosion, oil spill, and "social" crises e.g. illness, injury, kidnap, civil unrest. On all occasions that the ERG is mobilized due to an incident or emergency situation the Managing Director must be notified immediately.

9.14.3 The Incident Management Team (IMT)

The Incident Management Team (IMT) is the corporate body located in the RPCL headquarters in Uttara, Dhaka, with the responsibility to define and control strategy for major incidents. A strategic response is defined as a situation arising from a single or multiple incidents or emergencies that escalate to a point beyond which significant damage to the Company's business could result, including commercial and reputation damage, significant financial loss, shareholders' loss of confidence and damages resulting from litigation. When a potential strategic situation appears the IMT will be mobilized to manage issues pertaining to the reputation and the continued commercial wellbeing of the Company. The IMT may however also be called upon to address some of the tactical roles that would normally be the responsibility of the ERG, for example, if the Dhaka Office were out of action or in the event of an evacuation from a country, which may equally limit the ERG's capability.

The IMT is chaired by the Managing Director of RPCL and includes high level representation from the Ministry of Power, Energy and Mineral Resources, Army, Police Department, Fire Department, District Commissioner's Office and the Disaster Management Bureau (DMB) of the Bangladesh Government.

The detailed Emergency Response Plan is prepared in a separate report titled "Emergency Response Plan of 2x660MW Thermal Power Plant at Kalapara, Patuakhali."

9.14.4 Safety Training

In order to reduce the risks associated with accidents, internal and external threats, and natural disaster a safety training program is essential for workers in plant operation. There should be regular training programs on safety for the workers to increase their awareness and also to reduce the risks. Provision of yearly professional training for health and safety, would enhance the effectiveness of safety. Safety training should be planned for the local people living around the project area so that they can be aware about the risk possessed by the Power Plant and can take appropriate preparedness (Table 9.14).

Table 9.14: Training schedule that should be adopted for safety

Target trainee	Training schedule
Worker	Four trainings per year
Professional	Two trainings per year
Local people	Two trainings per year
Drivers	Four trainings per year
Safety professional	Two trainings per year

In addition, there must be a discussion and awareness session for increasing awareness on safety in each and every kind of meeting. Tool box meeting and job safety analysis should be regularly practiced by the employee. Further details on the type of trainings to be provided will be discussed in the separate Emergency Response report.

9.14.5 Documenting and Reporting

Implementation status of the safety plans should be monitored and documented regularly. Monthly monitoring report should be prepared based on regular inspection and should be submitted to the Superintending Engineer of the Power Plant. Any kind of incidents or even near misses should be documented and reported to the Superintending Engineer.

9.14.6 Occupational Health, Safety and Environment Team

There should be provision of Occupational Health, Safety and Environment Team with responsibility of implementation, inspection, documentation, and reporting of the safety plans. The team will also be responsible for implementing emergency plans under the Directorate of Environment, Health and Safety. The team should be a combination of multi-disciplinary professionals. The team composition could be as:

- Occupational Health, Safety and Environment Manager (Team Leader)
- Health and Safety Officer
- Environmental Officer
- Fire Safety Manager
- Chief Security Officer
- Security Officer
- Chief Medical Officer
- Medical Officer
- Rescue Officer

10. Environmental Management Plan

10.1 Introduction

The Environmental Management Plan (EMP) includes several plans for implementing mitigation and enhancement measures including Emergency Response Plan (ERP), Occupational Health and Safety Plan (OHSP), and Environmental Code of Practices (ECPs). ***Generally, the impacts, which are minor or moderate, are to be mitigated by adopting Environmental Code of Practices (ECP) (Appendix-VI) and Contractor's best practices during project implementation***. On the other hand, impacts and risks which are critical or major will be mitigated or prevented by adopting mitigation measures are discussed earlier chapter where specific plans are discussed in this Chapter.

10.2 Objectives of EMP

The basic objective of the EMP is to manage adverse impacts of the Project interventions in a way, which minimizes the impacts on the environment and people of the study area. The specific objectives of the EMP are to:

- Facilitate the implementation of the mitigation measures identified in the EIA and comply with regulatory requirements
- Maximize potential project benefits and control negative impacts.
- Draw responsibilities for project proponent, contractors, consultants, and other members of the Project team
- Maintain essential ecological process, preserving biodiversity, and where possible restoring degraded natural resources.

The EMP will be managed through a number of tasks and activities. One purpose of the EMP is to record the procedure and methodology for management of mitigation and enhancement measures identified for each negative and positive impacts of the Project respectively. The management will clearly delineate the responsibility of various participants and stakeholders involved in planning, implementation, and operation of the Project.

10.3 Various Categories of Mitigation Measures

The EMP includes various categories of mitigation measures and plans: (i) general and non-site-specific measures in the form of Environmental Codes of Practices (ECPs) presented in **Appendix-VI** to address general construction and operation matters identified as moderate and minor insignificance prior to mitigation in **Table 8-4 of Chapter 8 (Environmental Impacts)**; (ii) project specific and to the extent possible, site-specific mitigation measures discussed in **Chapter 8** and (iv) Construction Environmental Action Plan (CEAP) with site-specific and construction-specific management plans to be prepared by the contractor, which include pollution prevention, occupational health, safety and environment, and emergency response.

10.4 Development of Environmental and Social Management System

The EMP of the EIA report will guide the environmental and social aspects of the project during pre-construction and operation stage of the project. During the approval process of EIA, DoE will also make certain condition for better performance of the project. The proponent will also develop of its own EHS policy. The EPC contractor has its own policy during construction phases. Combining those policies, detail design, DoE conditions and EMP of the EIA study, a site specific environmental and social management system (ESMS) will be developed before initiation of the construction works. This ESMS will regularly check and updated through the findings from the environmental and social monitoring reports and stakeholder consultation findings and suggestion from the regulatory authorities.

10.5 Inclusion of EMP in Contract Documents

In order to make the Contractor fully aware of the implications of the EMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in the EIA as well as financer's General Environmental Health and Safety Guidelines. The Contractor must be made responsible through contract records for the commitments with respect to the environmental and social components of the Project.

10.6 Environmental Code of Practices

A set of Environmental Code of Practices (ECPs) has been prepared for various environmental and social management aspects: ECP 1: Waste Management; ECP 2: Fuels and Hazardous Goods Management; ECP 3: Water Resources Management; ECP 4: Drainage Management; ECP 5: Soil Quality Management; ECP 6: Erosion and Sediment Control; ECP 7: Top Soil Management; ECP 8: Topography and Landscaping; ECP 9: Quarry Areas Development and Operation; ECP 10: Air Quality Management; ECP 11: Noise Management; ECP 12: Protection of Flora; ECP 13: Protection of Fauna; ECP 14: Protection of Fisheries; ECP 15: Road Transport and Road Traffic Management; ECP 16: Construction Camp Management; ECP 17: Cultural and Religious Issues; ECP 18: Workers Health and Safety, and ECP 19: Construction and Operation Phase Security. The Contractors will be contractually obligated to comply with these ECPs, presented in **Appendix-VI.**

The Contractor will prepare one Construction Environmental Action Plan to address pollution prevention, occupational health, safety and environment, and emergency response including the requirements of ECPs and EMP. These will be reviewed and approved by Owner's Engineer (OE), EHSU Circle, and PIU before implementation of construction works.

10.7 Environmental Management Plans during Pre-Construction

10.7.1 Land and resettlement action plan

Land acquisition is the prime issue for successful implementation of this project. RPCL has processed to acquire the land for the 1320 MW power plant project. The land acquisition process was completed according to the Land acquisition and antiquity act, 1982 of GoB. The project authority has demarcated an area for the resettlement of the people from their project cost but not yet been ready. Therefore, the people of Dhankhali Union is very much worried about the existing one as well as to the upcoming projects also. Considering these issues, the proponent should exercise land acquisition and resettlement action plan in more realistic and pragmatic away. They should prepare a resettlement action plan as per IFC guideline which have already practiced in WB financed project in Bangladesh. The proponent may negotiate with the PAPs in association with the DC office Patuakhali for shaping a sustainable compensation package for the PAPs. The updated land acquisition status has been figured out in **Appendix –XV.** The project authority has already demarcated an area for the resettlement village near the project site. A tentative layout has been shown in Figure 10.1a and Figure 10.1b for the resettlement village.

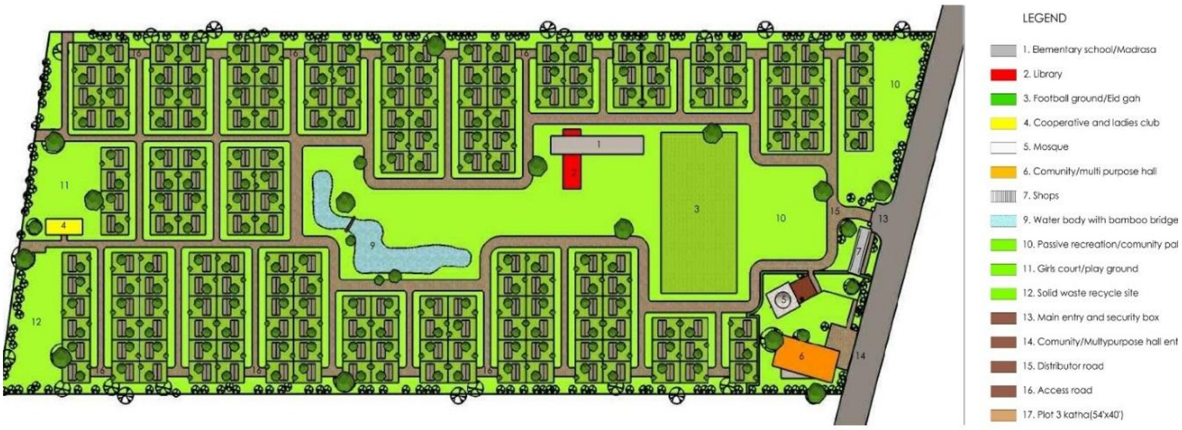


Figure 10.1a: 2D Layout of the resettlement village

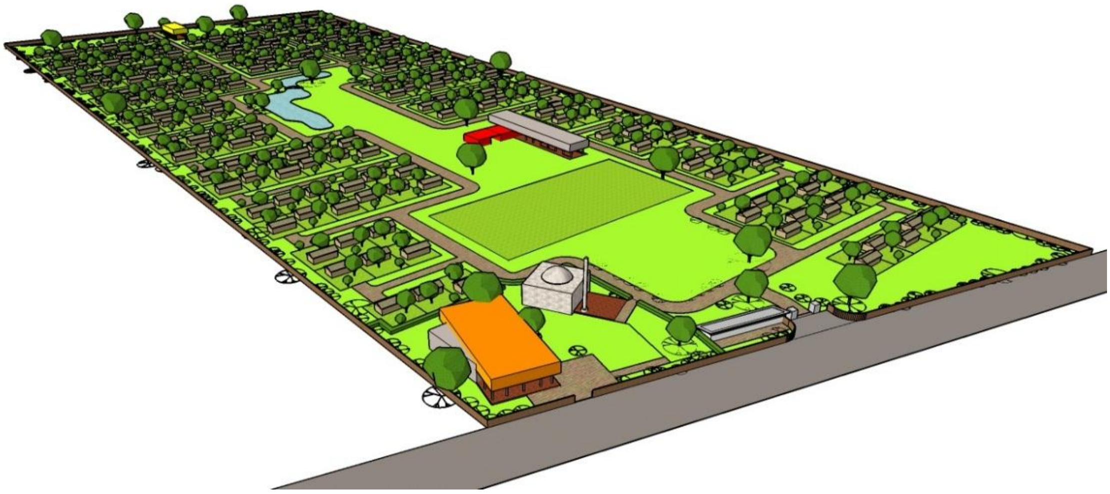


Figure 10.1b: 3D Layout of the resettlement village

10.7.2 Stakeholder engagement plan

The stakeholders must be engaged for smooth continuation of the Project in all the initiation, construction and operation stages. The project authority will identify the range of stakeholders who are directly and indirectly impacted and relevant with the project related activities. The authority will develop a stakeholder engagement plan in detail before implementation of the project construction works. The proponent will disclose the relevant project information and securing their opinions to overcome the adverse situation for project implementation. The project authority will prepare the grievance redress mechanism to resolve the social problems related to the project implementation. In this regard they may prepare formal grievance redress cell to address the issues and resolve them on early basis. The stakeholders will be engaged at every steps of the project development in integrated way.

10.7.3 Site Development Plan

Site developments activities will be continued through dredging from the approach channel. So far, any part of site development, it is required to encompass the site development demarcated and well-compacted earthen ring dyke initially. So that, no loose earthen materials can fall to the charra, khals by rainfall runoff. Before dumping of dredging materials, base stripping of top soil has to be made for proper bonding and stripped materials has to be kept in safe place for reuse after completion of site development. Protect the pre-designed channel or khals and maintain the available depth for runoff of rainfall properly. Backfilling has to be made layer by layer ensuring proper compaction and water spraying, so that no dust can be emitted in air causing air pollution as well as the safety of the projects.

10.7.4 Water Resources Management Plan

Water quality and drainage system might be affected during land development stages. Regional water modeling and morphological study should be carried for Dhankhali Union before the massive development activities. The local administration and local government and WMC of BWDB should include as important stakeholder before the side development activities. Regular monitoring of the important water quality parameters like pH, DO, BOD, EC, Salinity and COD must be conducted as per recommendation of EIA and DoE.

10.7.5 Drinking Water Supply and Sanitation Plan

A separate water supply and sanitation provisions might be needed for the temporary facilities, labor camp and workshops, in order not to cause shortages and/or contamination of water. A Plan will be prepared by the Contractor on basis of ECP 3. The Plan will be submitted to the OE for review and approval before contractor mobilization.

10.7.6 Soil and Agriculture Management Plan

Soil or land compensation process may be carried out by RPCL to the affected farmers and associated peoples of the locality. New lands should be taken under cultivation to compensate the lost crops of the proposed area. In this aspect, Chakamaiya could be a better choice. The detailed plan is described in **section-10.8.7**.

10.7.7 Site Preparation Plan

The site preparation would require base stripping, felling of timber trees and clearance of vegetation. The contractor will prepare a site preparation plan on the basis of ECP 4, ECP 5, ECP 7, ECP 8, ECP 12, and ECP 13 to ensure safeguarding of environment. This plan must be submitted to OE for review and approval.

10.7.8 Fisheries Resources Management Plan

A massive dredging might be required for land development of the power plant area. The dredging operation would affect the aquatic habitats, particularly the benthic organisms of the river channel to be dredged nearby the plant. The EMP includes the followings:

- Suggest to carry out dredging activities avoiding fish breeding season
- Ensure appropriate benthic survey prior to the dredging activities
- Enforcement of ECR 1997, IMO Conventions to avoid or little disturbance to aquatic habitats

10.7.9 Kitchen Waste Disposal Plan

A good practice of kitchen waste collection and disposal system should be adopted during pre- construction stage. They should follow the good housekeeping as per ECP. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Some temporary bins with different colors indicating disposal of degradable and non-degradable wastes might be installed at labor shed. There should be a designated site for kitchen waste disposal. Scattered throwing and burning of waste should be prohibited.

10.7.10 Labour recruitment plan

The labor recruitment policy should be formulated in such a way that the local laborers can get preference in employment of the project. As these labourers have no previous experience on such type of technical jobs, it is suggested that, the authority can recruit them in non-technical posts of the project or the authority can facilitate technical trainings for them.

10.7.11 Employment generation plan

Scope of employment opportunity in project related activities such as land filling, earthwork, construction, preparation of materials etc. will be created for the local people. Furthermore, increasing supply of electricity directly or indirectly promotes the economic productivity, industrialization and changing local economy may create additional and alternative employment for a number of populations. During project implementation period the affected people and local people shall have to be given priority in hiring and employing construction workers, labors, and professionals. Besides, local businessmen should be given priority in hiring supplying agent for food, construction materials, vehicles and other daily supplies.

10.7.12 Grievance Redress Plan

Complication may arise regarding land purchase such as some owners may not receive their actual price, payment of some owners may be delayed, complicacy on land ownerships (multiple owners), interference of local interest groups and so on. It is anticipated that it in turn, may lead to social unrest situation in the locality. Therefore, a Grievance Redress Committee (GRC) comprising of project authority, stakeholders and local government representatives should be formed so that the victim can submit their allegation to it for taking further necessary action.

10.8 Environmental Management Plans during Construction

The followings are some of the plans proposed in this EMP to guide the Contractor to prepare a Construction Environmental Action Plan (CEAP). The Contractor will expand the plan to address site specific measures.

10.8.1 Air quality management plan

Construction activities generate large volume of particulate matter and sometime significant volume of greenhouse gases. However, with these project activities, a large amount of particulate matter might be generated. Hence, an efficient air quality management plan has to be adopted. The mitigation plan includes limiting PM generating activities, adopting dust suppression system, limiting vegetation clearance activities, avoiding earthen road for traffic movement, covering of stockpiles, traffic management etc.

10.8.2 Acoustic management plan

Noise to be generated from different mechanical equipments and vehicles to be used in construction activities shall have to be managed to ensure ECR, 2006 and IFC, 2007 defined standard. Adopting the necessary mitigation measures might reduce the generation of noise.

10.8.3 Construction waste management plan

The waste to be generated from construction work should be managed properly. Rate of waste generation should be minimized through prior take up efficient technique and limiting waste generating activities. The essential possible measures for controlling construction waste may include limiting site clearance activities, planned stocking and gathering of construction materials and equipment with covering, fencing around the construction yard, maintaining existing right of way to carry construction materials, adopting proper sanitation system for employees, banning of waste burning and quality housekeeping. A waste dumping place should be pre allocated and provided with efficient waste collection and disposal techniques. No waste should be dumped to the nearby river or to the surface water body around the site. Appropriate measures provided with run-on and run-off system might be constructed from controlling run off from construction yard and liquid waste. Initiatives must be taken to reuse and recycle of waste materials and they should not be dumped anywhere of the plant site. Hazardous material from construction site including fuel and other combustible materials shall have to be stored with highest care and caution. Spillage, accidental release must be controlled adopting hazardous material handling guideline. Liquid waste management is again in important issue. No liquid waste during the construction activities should be discharged or released straight to the open environment or internal drainage system. There must remain separate and isolated drainage procedure to release and manage the liquid waste outside the project premises.

10.8.4 Kitchen Waste Management Plan

A large number of labours will work during construction phase of the power plant. They should follow a good practice of kitchen waste management for well disposal. There will be specific locations for taking processing food and taking meal both for the local and project labour. Numbers of bins and disposal point should be assigned to put the degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc separately. EPC contractor should employee sweepers to collect the kitchen waste or other solid waste for collection and transportation regularly. Finally, a temporary on site dumping place should be selected for safe disposal or make a communication with the Kalapara Upazila Parishad for offside kitch waste disposal.

10.8.5 Good Handling and Operation of Construction Equipment

The equipment and machinery for construction activities should be handled and operated in a way that would ensure low noise, low emission of SOx, NOx, smoke, no oil leaks, no accidental event, etc. A detail plan of handling and operation of construction equipment will be prepared by each Contractor on the basis of ECP 2, 10 and 11. The Plan will be submitted to the OE for review and approval before contractor mobilization.

10.8.6 Fuel and Hazardous Substances Management Plan

The plan will be prepared by each Contractor on the basis of ECP 2 as well as the mitigation plans given in this EIA and in accordance with the standard operating procedures, relevant guidelines, and where applicable, material safety data sheets. The Plan will include the procedures for handling oils and chemical spills. The Plan will be submitted to the OE for review and approval before contractor mobilization.

10.8.7 Communication Plan

A communication plan has been prepared and presented in **Table 10.1** while carrying out the communication plan modifications of process and planning may be done as per the Project's requirement.

Table 10.1: Communication Plan Adopted for the Project

Stakeholder	Information/Message	Communication Means	Timing/Frequency	Responsibility
PAPs	Project awareness (general project information, etc.)	Consultations with the PAPs	Scoping session in the preparation of Draft EIA	EIA Consultant, supervised by Project Implementation Unit (PIU)-RPCL
	Project findings (environmental and social concerns)	Disclosures: Though Presentation; Meeting, RPCL website and formal & informal consultations	Immediately after preparation of Draft EIA	EIA Consultant, Financer, RPCL, supervised by PIU
	Employment opportunities	Set procedure followed by the Proponent for this project, Job circular publish through print media, digital media and other formal process of RPCL	4 weeks before recruitment / job opening	PIU, RPCL
	Complain against the project construction process and other	Consultations, Complain register or other formal procedure	During construction and operation of the plant	PIU- RPCL
	Operation of the proposed Plant (grievance redress)	Consultations, Complain register and other formal procedure	At the commissioning of the Plant	Independent monitor, supervised by PIU- RPCL
General population (Local)	Skilled and unskilled labour employment opportunities	Poster, local daily newspaper, or On-spot interview	3 to 4 weeks before recruitment	PIU- RPCL
Local Administration	Incidents, safety and security issues, Public mob	Telephone, cell Phone, Letter	Inform an any anticipated worst situation	PIU- RPCL
Fire Service	Incidents of disasters	Telephone, cell phone	Immediately when any incident is detected	Shift Engineer (PIU)

Stakeholder	Information/Message	Communication Means	Timing/Frequency	Responsibility
Police Station	Incidents of disasters and security issues	Telephone, cell phone	Immediately when any incident is detected	Shift Engineer (PIU)
DoE, Barishal	Renew of ECC, Regular checking, Any changes in layout, coal quality and pollution control technologies	Letter, Telephone, Website	Yearly, before contradicts the conditions imposed by DoE	PIU- RPCL

10.8.8 Labour recruitment plan

The labor recruitment policy should be formulated in such a way so that the local laborers especially the PAPs in the Dhankhali Union can get preference in employment in the project activities. If these laborers are found to have no previous experience on such type of technical jobs, it is suggested that, the authority can recruit them for non-technical activities of the project or the authority can facilitate technical trainings for them.

10.8.9 Soil and Agriculture Resources Management Plan

Power plant construction leads to a huge area acquisition. Crop production will be stopped from the construction stage. To compensate it, new areas should be explored. In this aspect Chakamaiya would be a good choice. Soil quality of this area is similar to that of Dhankhali (project area). Besides this, both of these areas are situated in polder. Only close and intensive monitoring can improve the crop production of Chakamaiya. To facilitate this, sluice gates and other facilities of the polder should be reconstructed. If BADC and DAE shift their existing facilities of Dhankhali to Chakamaiya, crop production of Chakamaiya would be similar to Dhankhali. At present, most of the lands of Chakamaiya is single cropped, while croplands of Dhankhali cultivated twice to thrice a year.

10.8.10 Fisheries Resources Management Plan

Fisheries management plan has been developed with the aim of avoiding pollution causing activities and to protect fisheries of the Andharmanik and Tiakhali River and Rabnabad channel. The EMP includes the followings:

- Enforcement of ECR 1997, IMO Conventions to avoid or little disturbance to aquatic habitats
- Ensure non dumping of ballast water, non-spillage of oil, non-discharge of waste water and non-dumping of wastes
- Enforcement of fishing ban in the Andharmanik river during breeding/nursing period

10.8.11 Ecosystem management plan

Ecosystem management plan is an integral part of the EMP. Implementation of this management plan is essential for safeguarding the ecosystem. The following measures should be undertaken during different stages of the power plant:

10.8.12 Green belt development program

About 32% of the total project area will be covered with greenbelt. The tree plantation will be done considering maximum yearly average wind direction and tree height. The landscape pattern showing the green belt area has been shown in layout plan (**Appendix V**). The green belt will be developed following the guideline of the Department of Forest and Department of Environment. Along with following guidelines during green belt development will be considered.

- Limiting vegetation clearance and base stripping within project boundary
- Local and indigenous species should be chosen for green belt development
- In green belt plant composition should be made considering plant of different height and different canopy size to facilitate deposition of ash
- Protect existing Mangrove along the Jalkader Khal and enhance mangrove patches at foreshore area of the project site
- Along the project area, local species *e.g.* Rain tree (*Albiza saman*), Pabon Jhau (*Casuarina equisetifolia*). Sil Koroi (*Albizia procera*) Narikel(*Cocos nucifera*),Aam(*Mangifera indica*), etc. should be planted
- Plantation should be made following the guideline of the Department of Forest

10.8.13 Community Liaison

During construction, a close liaison with community and local government institution should be maintained. The local community and local government institution should be made aware of all the construction activities and possible environmental and socio-economic disturbances. A community liaison officer or Health and Safety Manager should be given responsibility for maintaining close communication with community groups, local government institutions and concerned government departments.

10.8.14 Occupational health and safety

Use of Personal Protective Equipment (PPEs) should be made mandatory for each project personnel, worker and even the visitor. Necessary training should be provided to project employees. Awareness program should be arranged regularly. Safety talk, safety meeting, safety motto, etc. are good techniques of raising awareness.

10.8.15 Labour recruitment plan

The labor recruitment policy should be formulated in such a way that the local laborers can get preference in employment of the project. As these labourers have no previous experience on such type of technical jobs, it is suggested that, the authority can recruit them in non-technical posts of the project or the authority can facilitate technical trainings for them.

10.9 EMP during operation phase

With reference to the possible significant environmental impacts during operation stage identified in **Chapter 8**, impact specific EMP have been prepared to address those impacts. The plans are prepared on the basis of mitigation measures proposed in **Chapter 8**. In the following sections these plans are discussed.

10.9.1 Air pollution management plan

Air pollution management plan includes operation and maintenance of boiler, ESP; stack has to be carried out regularly as per instruction mentioned in the manufacturer's maintenance manual. At the same time, the quality of the coal has to be maintained as per design of the boiler. The ash handling system must be regularly inspected and tested to evaluate its performance as per the standard. Regular inspection of boiler, FD and ID fans, separation and handling system and other ancillaries shall also be inspected and tested regularly whether this level remains lower than the allowable limit. Safety measures shall have to be ensured for all components and accessories throughout the entire life period of the project. During operation phase, the air quality will be measured via Continuous Emission Monitoring System (CEMS) which shall be situated on the chimney flue duct (not wind shield). $PM_{2.5}$, PM_{10}, SO_2 and NOx from stack emissions will be monitored by CEMS. Usually, air quality has to measure at the points where the flue gas flow is laminar. This will be at a minimum distance of 2D from the entry point where it becomes laminar and 8D from top. The D is diameter of flue can.

There will be additionally two more continuous Ambient Air Quality (AAQ) stations will be used to monitor the criteria pollutants at the sensitive location inside the plant depending on the wind speed and wind direction. The ambient environment outside the plant will be monitored through discrete monitoring system. The location of air quality monitoring will be selected as per the recommended monitoring location in EIA. The location, pollutants type and frequency of monitoring can be updated according to the project activities or environmental sensitivity in future.

Emission level of SO_2, NO_x and PM shall also have to be monitored regularly. The Environment Manager shall be responsible for regular monitoring of emission level, inspection and testing of mitigation measures, environmental efficiency of the plant and regular reporting of the inspection. The monitoring and inspection report shall have to be submitted to DoE for renewal of Environmental Clearance Certificate.

10.9.2 Dust suppression system (DSS)

The major source of dust is stockyard. The entire stockyard should be covered with water sprinkler provided with moisture sensor. Sprinkler system provided with electrically operated valves and pumps are standard. Entire system *i.e.* sensor, valves, pumps should be connected with computerized monitoring and control system.

An automated system must be adopted to suppress the dust maintaining moisture level of coal surface not below 7%– 8%. Dust suppression systems have to be installed at coal receiving terminal and plant site. The system functions (dust suppression) replenishing the evaporated moisture. An integrated system has to be installed to control dust at ship's hold, ship un-loader, loaders, stackers, re-claimers, conveyor system (including each transfer point) and stock yard. Sprinklers have to be set up in a way that will spray maximum water in the form of mist so that no surplus water will be generated. However, water collecting and recycling system also needs to be installed in line with dust suppression system. Furthermore, the conveyor system might be covered typed so that coal dust from wind action can be controlled. At transfer points, water sprinkler should be installed.

In case of ship's holds, water sprinkler jets should be provided at the bottom of the boom of the un-loaders so that the operator will be able to operate the sprinkler as and when required. In such cases, no need to install automated sensor.

10.9.3 Acoustic management plan

All equipment and mechanical machineries shall have to be maintained in good working order. Noise level should be monitored at different selected location within power plant and nearest community. The greenbelt shall be planted with the aim of lowering the noise level. The boundary wall will also dampen the noise level further. If possible, mechanical parts with high noise potential shall be provided with acoustic hood. Noise generated from other sources like vehicle, vessel etc must be controlled adopting mitigation measures. An Environment Manager shall be given responsibility of monitoring the efficiency of the management plan and regular monitoring of noise level.

10.9.4 Sewerage Treatment Plan

The EPC contractor should develop a detail management plan for sewerage management and treatment.

The STP might be consisting of screening devices, aeration, active sludge treatment, sedimentation, clarification and separation/recirculation of sewage sludge. Membrane bio reaction is a good alternative. There should be an efficient network of sewerage collection and draining system. The treatment plant should be designed in a way that would satisfy the effluent standard of ECR 1997 and IFC.

The treated water might be reused in gardening, or supplied to nearest community for irrigation. The sludge from STP should be disposed in compliance with the ECR 1997 and IFC standard.

10.9.5 Waste Water Management Plan

Presently rejected water, sludge and slurry from different water treatment plants (e.g. coagulation, clarification, demineralization, etc.) of the first unit are directly drained to respective drainage system for disposal. A Effluent Treatment Plant (ETP) is proposed to treat raw and effluent water generated from the Plant complex. The ETP will include a central Effluent Treatment Plant, Sludge and Slurry Treatment Plant, Sludge and Slurry disposal system, Treatment facilities for feed water using environment friendly oxygen scavenger (e.g., Helamin, Diethylhydroxylamine) and demineralization water using reverse osmosis process, domestic waste water treatment facilities, etc. The Contractor will design the Plant according to the type, characteristics, quantity, and regulatory guideline of DoE and financer EHS Guidelines on Water and Sanitation. All waste water generated from various processes of third unit and liquid wastes will be treated in the CETP before discharging or disposing to the natural environment.

RPCL may consider increasing the capacity of the CETP to treat raw and effluent water of other units of RPCL by charging a fee to others. RPCL may take this matter to the policy level with the support of DoE.s

10.9.6 Hazardous Sludge from Water Treatment Plant

The sludge from water treatment plant should be disposed properly considering its hazardousness and usability. Iron rich sludge from water pre-treatment and demineralization plant might be utilized in the industries which use iron as raw materials. The EPC contractor should explore the market of the iron sludge. Generally, there is a good demand of iron sludge in steel re-rolling mills. The sludge from oily water separation unit should be managed properly with due treatment and disposing in scientific pit. It should be disposed in accordance with the Hazardous Waste and Ship Waste Rules 2011.

10.9.7 Kitchen Waste Management Plan

A chain of practice should be developed for kitchen waste disposal system. The employee should obey the good practice of kitchen waste management. The aim should be reduction of the waste generation. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Proper number of waste bins with different colors indicating disposal of degradable and non-degradable wastes might be installed at the staff colonies/residential areas, work places and walkways to prevent scattered throwing of solid wastes. Project authority may talked to the local administration for safe disposal of the solid biodegradable waste during operation period.

10.9.8 Solid Waste Management

PROJECT AUTHORITY shall develop a waste prevention strategy, which will significantly reduce the total amount of waste. The strategy will focus on recycling and the facility wise implementation of recycling plans, considering the following items (as per Financer/IFC Guidelines):

- Evaluation of waste production processes and identification of potentially recyclable materials
- Identification and recycling of products that can be reintroduced into the operation of the plant
- Investigation of external markets for recycling by other power plant operations located in the neighborhood or region of the facility (e.g., waste exchange)
- Establishing recycling objectives and formal tracking of waste generation and recycling rates
- Providing training and incentives to employees in order to meet these objectives.

10.9.9 Coal yard management

Coal stocking, handling and other activities generate considerable amount of coal dust. Proper aeration system and water spraying system must be installed to control coal dust and self-heating of coal in stock pile. The dimension and height of the stockpile should be designed considering self-heating, aeration, wind effect etc. There should be continuous monitoring of the inside temperature of coal stockpile.

Coal is a self-combustible material. The surface moisture of the coal should be maintained in such a way that would limit propensity to combust and produce dust spontaneously. Generally, with surface moisture of at least 7%, coal shows low propensity to self-combustion and producing dust. Water must be sprayed on the stockpile if surface moisture goes below 8%. There should be an automated monitoring and water spraying system. In addition, water must be applied on coal:

- As it moves through the conveyor belt
- At transfer points
- At stockpile

Care should be taken to control aerosol formation after water spraying. The runoff and wash off from the stockpile and coal unloading system should be treated properly before discharging it to open environment. However, wash off and runoff from stock pile should be limited. The water spraying approach should be, to moisten the coal not to wet the coal. The recommended practice is to fog spray or mist the stockpile surface as frequently as necessary to maintain the surface of the coal in moist condition, not in wet condition. This will minimize propensity of self-combustion and dust generation and accordingly no runoff water will be produced.

Provision of regular monitoring has to be kept for inspection in proper pathway with entry and exit should be provided in stockpile area and conveyor belt.

10.9.10 House Keeping

PROJECT AUTHORITY should implement a good house-keeping practice, such as the sorting and placing loose materials generated from different repairing activities in the established areas away from common workspace, cleaning up excessive waste debris and liquid spills regularly, locating electrical cords and ropes in common areas and marked corridors.

10.9.11 Occupational Health Safety and Environment

A detail Occupational Health, Safety and Environment (OHSE) Plan has been prepared and presented in the relevant section**.** The Plan includes the following:

- Occupational Hazard Identification and Control Plan
- Inspection and Auditing Plan
- Leadership and Administration Plan
- OHSE Communication Plan
- Required PPEs
- Site Security Plan
- HSE Program for the Contractors/Sub-Contractors
- Preventative Maintenance Plan
- Incident Investigation Mechanism
- Safe Work Practices and Procedures.

The plan has been prepared in a way, which will be applicable for entire life cycle of the Project. Application of the OHSE plan is responsibility of all including management, employee, contractors, sub-contractors, vendors in their daily activities. The plan also proposes a management and administration system (Organogram) for OHSE Plan application. It is suggested that RPCL develops an OHSE Management System program activities and commitment and ensure the programs are implemented during each phases of the third unit construction Project. **Table 10-2** presents OHSE management systems and key responsibilities, for detailed information specific Section number in the detailed report are referenced.

10.9.12 Community exposure to diseases

The project authority will evaluate the risks and impacts to the health and safety of the affected communities during the project life cycles. They will design, construct and decommission the structural elements or components of the project considering the safety risk to the communities. An emergency preparedness and response mechanism should be developed accompanying with the affected community people so that immediate initiative can be taken.

10.9.13 Grievance Redress Mechanism

A grievance redress mechanism should be developed by the project authority in combination with the local people. All sorts of encountered problems during operation period will be placed to the grievance redress cell. The authority, therefore, will take necessary immediate action to mitigate the problems.

The implementation and monitoring of EMP shall have to be ensured. Therefore, a team of Environmental Specialist and Environmental Auditor has to be engaged with responsibility of strong monitoring during implementation of EMP and their environmental and social consequences.

10.9.14 Soil and Agriculture Management Plan

With reference to the possible significant environmental impacts on land and agriculture resources during operation stage identified in Chapter 8, impact specific Environmental Management Plans have been prepared to address those impacts. The plans are prepared on the basis of mitigation measures proposed in Chapter 9. In the following sections these plans are discussed.

Agricultural crop land might reduce for the infrastructural and industrial development in the study area. So food security should be assured by increasing crop production and cropping intensity. It should be done through the use of modern technology in the crop production and the fallow lands should be under cultivation. There should be concerned to avoid agricultural land for infrastructural development. Infertile lands should be brought under infrastructural development. Moreover; insect infestation might increase in the surrounding agricultural land due to lighting of the plant site. So, farmers should be properly trained about the system and management of Good Agricultural Practices (GAP) Integrated Crop Management (ICM).

10.9.15 Fisheries Resources Management Plan

Fisheries management plan has been developed with the aim of avoiding pollution causing activities and to protect fisheries of the Andharmanik and Tiakhali River and Rabnabad channel. The EMP includes the followings:

Measures for navigational activities

- Enforcement of ECR 1997, IMO Conventions, etc
- Ensure non dumping of ballast water, non-spillage of oil, non-discharge of waste water and non-dumping of wastes
- Awareness growing for fisher and facilitate the fisher to use nets/boats provided with signals and marking
- Reduce speed if net is seen across the navigational route
- Ensure implementation of other EMP for coal transportation

Measures for plant operation

- Should follow the EMP for effluent discharge
- On-site wastewater should be treated to achieve maximum reuse and recycling.

Measures for Water Intake Structure

- The water supply pipeline intake point from the feeder canal should be provided with sufficient screening to filter out larger aquatic organisms (e.g., fish, frogs, and toads) and foreign matter, preventing this material from being drawn into the pumps
- Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible.
- The water velocity in the intake channel should be below 0.5 m/s during normal conditions.

- Temporary water reservoir can be built for water storage rather than direct abstraction from river.
- Monitoring should continue to ensure that the deterrents are working effectively.
- Fish Conservation Program
- Enforcement of fishing ban in the Andharmanik river during breeding/nursing period

10.9.16 Coal transportation and handling plan

The vessel to be used for coal transportation shall have to satisfy all national laws and IMO conventions signed by GOB. Bangladesh is a signatory 25 of IMO Conventions and Maritime Protocols to protect marine and terrestrial environment of the country. All of these conventions and protocols have been discussed in Chapter 2. Therefore, all activities related to shipment of coal through the Port shall have to be done strictly in compliance with the standards set by the IMO, particularly following the conventions, protocols and agreements. Shipping, barging and transferring should be regularly monitored by the relevant authorities. The BIWTA is to ensure enforcement of these conventions and protocols. Coast guard might be given responsibility for inspecting whether the vessels are adopting mitigation measures, complying with national and international rules of safety and environmental conservation. Besides, an Environment Manager shall be given the responsibility of monitoring the transportation activities and auditing environmental efficiency of the transportation system.

Proper dust suppression and self-combustion mitigation system must be adopted. Practice to moisten the coal but not wet them should be followed. However, water filtering plant should be planned and constructed for management of runoff and wash off water from coal stockpile and unloading system. The unloading system and conveyor system should be enclosed type that would reduce generation of fugitive dust particles from coal. The plan should also include the specific measures which are pointed out below:

- Establish check post for monitoring activities of Foreign ships during coal transportation
- Enforce the relevant law of restricting ballast water dumping in project territory
- Enforce existing law of controlling oil spillage
- Limit coal Spillage and escape during unloading to feeder/lighter vessel
- Follow standard practice for shipping and barging operation
- Restrict blowing of whistle within Kutubdia Island
- Introduce speed limitation for vessel in Kutubdia Island
- Anchorage should be allowed at particular location within the project area
- Enforce Forest Protection Acts
- Restrict blowing of whistle near bird colony
- Restrict trapping, killing of migratory birds and local birds
- No trapping and killing of Dolphin and Turtle
- Plan measures for accidental oil spillage, refueling
- Anchorage of water vessel only in designated sites
- Restrict outside lighting of the water vessel during navigation across/near the Kutubdia, Maheshkhali and Sonadia Island
- Restrict the beaming of searchlight on Forest area
- Use low beam of searchlight during navigation across the Kutubdia channel.
- Restrict night lights at places where necessary
- Outdoor lights with shade directed downwards
- Cut-off time to switch off unnecessary lights at night

10.9.17 Ash management plan

Ash is the prime coal combustion products that release as fly ash during the operation of power plant. In order to avoid airborne dust about 99.7% fly ash has to be captured in the ESP and temporary storage at ash silo. Ash carries out to the ash pond mixing with water. Closed cycle water system should be implemented during ash transfer process. The following measures should be taken for proper management of ash.

- Engineering control measures should be considered to maintain the ash dust concentration as low as is reasonably practicable
- The capacity of ash pond should be higher
- Additional ash disposal facilities should be planned as for contingencies
- Proper planning is necessary for local and national marketing of the ash
- Regular monitoring of the ash disposal facilities
- Avoid prolonged skin contact especially where the product is dampened
- Wear protective clothing; good working practices as well as high standards of housekeeping and personal hygiene should be maintained

10.9.18 Rural Electrification Plan

Locality of the power plant area may be benefited by allocating certain loads from the national grid if possible. Relevant authority may formulate necessary rural electrification plan in order to satisfy both affected and unaffected people of that region.

10.10 Mitigation Plan

The mitigation plan presented in **Table 10.2** is organized around various project activities and includes various actions identified under the mitigation measures discussed in previous Chapter-8, define responsibilities for implementation as well as supervision of each action, and also indicate the timing of these actions. After this assessment stage, if there are any changes to the Project design or methods of construction and operation, the impacts and mitigation measures discussed may need to be revised. To address the changes, the environmental and social implications will require re-addressing.

Table 10.2: Mitigation Plan

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
Pre-Construction Phase				
A Ambient Air				
A1. Dust generated for land development activities and vehicles movement	• Dust will be generated from site development, Transpiration of land filling materials and vehicular movement	• Dust suppression system like water sprinkler should be adopted control dust emssion from the site development areas • Unpaved land should be water sprinkled two times in a day except the rainny days • EMP of dredging activites must be maintained incase of dredging the adjacent rivers	Contractor	OE/ESHSU
B Noise level				
B1. Noise level	• Noise will be generated from the moving and idling vehicles and machineries used for land development. • Noise from the dredger causes high annoyance to the adjacent communities	• The machines/equipments/vehicles should be turned off when not in use. • Dredgers near to the community must be limited to 9.00 am to 5.00 pm. • Use of damper to the equipments for reduing the noise level	Contractor	OE/EHSU
C Water bodies				
C1. Surface Water Quality	• Improper storage and handling of fuels, lubricants, chemicals, hazardous goods/materials on-site, wash down of plant and equipment, and potential spills	• Oils, lubricants and other hazardous materials should be bunded and stored separately so as to limit the spillage. • Workers should be trained on safety precautions on using/handling such hazardous materials. • The workers should be encouraged to use PPEs everytime when handling oils, lubricants, chemicals and other hazardous materials.	Contractor	OE/EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	may contaminate the water bodies and harm the environment and health of construction workers.			
C2. Internal Drainage System	• Some drainage congestion caused by irregular dumping of construction waste, waste water near/inside the drainage channel and domestic activities from labor colony	• The liquid waste disposal system should not be linked with the existing internal drainage system. • Separate drainage channel should be there to disposed the construction liquid waste. • No waste materials should be dumped in a unplanned manner and blocking the drainage facilities.	NWPGCL and EHS officers	EHSU
Erosion and accretions	• impacts on erosion and accretions	• The right bank of Rabnabad Channel besides the power plant should be protected by the revetment works.	**Project proponent**	**BWDB**
D Land Resources				
D1 Land Type	• Land area is developed in this stage. As a result land type changed.	• Lands should be raised in such a way that surrounding lands are not affected.	Ministry of Land(MoL), Local Government Institute(LGI) DAE	DC Office, RPCL
E Agriculture Resources				
E1. Impact on crop production	• The local farmers will loss a significant amount of crop production linked to livelihoods. It may cause local food security for the marinal	• Timeliy and sufficient compensation should be given not only the owner of the land but also the farmers depends on the land propsed for the project area. • Include to direct or indirect PAPs as labors or other activites of the proposed project	Contractor/PA	PA/Local Goverment

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	farmers depending on this land.			
F Livestock Resources				
F1. Loss of grazzing land and loss of fodder	• Acquiring the project area will lead to obstruct the grazing land and fodder for the livestock of the local farmers/households	• High yielding grass varieties could be introduced in the study area to compensate this problem	Government Institute(LGI) DAE, DLR	DC Office, RPCL
G Fisheries Resources				
G1 Fish habitat condition and quantity	• Increased temporary and localized turbidity and destroying of benthos community of river bed during dredging period inhibit the normal growth of the primary producers and retard the fish growth as well. • Ramnabad Channel is one the suitable spawning ground for Hilsa, Pangus and shrimp which might be affected because of dredging activities.	Installation of bamboo/hessian barrier to arrest suspended sediments within the dredging perimeter Sand filling should be done by making chamber/or by fencing. Dredging activities must be restricted during Hilsha (September - October) and Pangus (June - July) spawning period and peak shrimp PL (February – March) collection periods. Spatial spoil management plan must be developed through suitability analysis before dredging.	Contractor in collaboration with Upazila Fisheries Office and local fishers.	RPCL and Upazila Fisheries Office
G2 Fish production	• With the consequence of aforesaid reasons, estimated net loss to fish production would	Watery sand would not be allowed to flow to the nearby khals, ponds and rivers	Upazila Fisheries Office in collaboration	RPCL and Upazila Fisheries Office

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	be 9Mt and 125Mt per year from the project area and study area respectively.		with local fishers.	
H Ecology				
H1. Terrestrial vegetation	Removal of terrestrial vegetation to initiate land development process would impacts on existing terrettrial vegetation negatively. In addition, labor shed development and bring construction heavy machineries to project site would impacts negtative to terrestrial vegetation in the roadsides and/close to project location.	Follow specific guidelines to initiate clearing/site preparation for land development ; Demarck and prepare of dyke is a must before commencing land filling process; and Do not install pipeline across the mangrove vegetation to minimize vegetation loss.	Contractor/RPCL	DoE
H2 Shorebirds	Pipeline installation for land development process requires labor involvement for a short period of time across the feeding ground of waders. The movement of labors will disturb their normal activities and they can be migrated locally. The land filling process would impacts negative to	Follow specific guidelines before commencing the designated tasks to avoid shorebirds' habitat damage or disturbance; Select barren area to install pipelines; and Avoid winter season to reduce disturbance on shorebirds feeding habitat.	Contractor/RPCL	DoE

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	other wildlife, too in the project vicinity.			
H3. Marine hanitat	The waterways are the main source of communication especailly during carrying heavy construction materials to the site. In this process, the sea is the main route to getting transportation of the construction machineries in the pre-construction phase. Through this activities the marine habitat supposed to be impacted by oil spills as well as greases discarded from ship/cargo engines.	Prohibit release of oil or greases during transportation period to the destination; Engines should check prior to initiate shipment; and Crews and other staffs of the cargo/ship should well aware of the consequence of oil spills.	Contractor/RPCL	DoE
I Socio-economic resources				
I1 Land acquisition	About 1000 acre of land is required for the implementation of this project. Land acquisition is an important issue for this project	The affected people should be compensated properly	DC office, Patuakhali	DC office, RPCL
I4 Employment opportunity	Many people may workless as they will lose their agricultural land. The local people may engage in the land development	Engagement of local people in the project activities or alternative occupation should be ensured	Contractor/RPCL	RPCL

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	and non- technical activities			
Health safety	Occupational health safety may disturbed and sexually transmitted diseases may arises in the locality due to the flow of outsiders	There should have facility to deal with medical aspects of HIV/AIDS treatment with specialized services	Contractor	PA/ RPCL
Non-Hazardous Waste Generation				
J1. Solid Waste	• Poor aesthetic view due to the dumping of backfilling materials and storage of the equipment, materials and pipeline of the dredger etc.	• Fencing the proposed project and demarketed the layout for land development • The dredger pipeline should be transferred under the soil especially crossing point of road. • All solid wastes, should be stored in designated sites prior to final disposal	Contractor	Health and Safety Officer
J2. Kitchen Waste	Waste from the labor sheds may create annoyance to the local residence	Onsite waste disposal system must be adopted Sanitation system must be developed substantially	Contractor	Health and Safety Officer
Construction Phase				
L Ambient Air				
L1. Dust and gases generated from excavation, construction equipments, and vehicles	• Emissions of dust and gases will be generated from excavation of trenches for infrastructure development; costruciton works, material transport may	• DSS must be applied regularly • Protect the project boundary wall. • Low air pollution emitting vechiles should be applied • Monitoring must be continued continously on the sensitive receiptors • Minimize the area that is disturbed • Minimize cutting trees and vegetation • Truck hauling materials should be equipped with cover to cntrol dust	EPC	OE/ESHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	cause local ambient air pollution. • Nuisance and health hazard for local people and workers reduce visual quality of sites	• Restricting excavation activities such as top soil removal during the periods of high wind. • Establishing and enforcing vehicle speed limmit to minimize the dust generation. • Bare earth should be graded and seeded as soon as after completion as possible. • Restricting the burning of waste		
L Ambient noise				
L1. Noise level	• Noise will be generated from the moving and idling vehicles, welding operation, and heavy machineries may cause annoyance to the labours as well as to the adjacent communities	• The machines/equipments/vehicles should be turned off when not in use. • Using PPEs during construction work. • Use of noise mufler or barrier to obstruct the propagation of noise • Limit the noise emission during the night period • Ensuring all equipment is ion good repair and operated in the correct manner.	EPC	OE/EHSU
M Water Ressources				
M1. Drainage system inside the project boundary	• Without or improper drainage system may cause washout of the boundary wall, backfilling materials, roads or other infrastructure and may affect drainage system of the adjacent areas	• The construction work should be done after construction of the drainage system for the project • Construction debris should not be discharged into the drainage channel. • Monitoring the drainage system regularly • WMGs under BWDB will be authorized to monitor the natural drainage system in the polder area; and • Storm water runoff from all fuel and oil storage areas, workshops and vehicle parking areas is to be directed into an oil and water separator before being discharged into any water resources	**EPC** **WMGs of Polder 54/A.**	**WMGs of Polder 54/A. PA** **The local government (Union Parishad)**

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
		• All construction fill and material storage areasshall have diversion drains installed above the work areas to intercept storm runoff. • Install temporary sedimentation basin in suitable locations to trap silt /sediment from runoff and slow the flow of water reducing erosion and pollution. • If stored on site, bulk diesel fuel will be dispensed from the elevated tanks surrounded by impermeable bunds. The height of the will be sufficient to contain 110% of the fuel stored on-site. • All fuel storage areas and refueling vehicles are to be provided with spill containment kits. • An emergency spill contingency plan shall be prepared by the contractor as part of the SEMP • Peoperly planned and designed ETP/STP/septic systems are required • Adequate capacity of septic tank and hygenic sludge management plant may be adopted in the corresponding stage of the power plant.		
M2 Water quality	• Discharge of liquid waste like oil and grease, chemical materials and swearge from the construction site may cause water pollution to the adjacent surface water system	• Temporary effluent treatment plan may be adopted on the working site to treat the leachate, industrial liquid waste etc • Onsite sewerage treatment plant may be adopted • Monitoring the water quality as per recommendation of the EIA	EPC	EHSU
N Land Resources				
N1 Land Type	• Land type and land use change to	• Lands should be raised in such a way that surrounding lands are not affected.	Ministry of Land(MoL), Local	DC Office, RPCL

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	accumulate the power plant and ensure its safety.	• Khals or irrigation canals should open during construction stage.	Government Institute(LGI) DAE	
O Agriculture Resources				
O1. Impact on crop production O2. Impact on irrigation	• Crop production of that area totally wiped out. Agricultural lands might be converted to non-agricultural land due to Power plant induced infrastructure developed.	• Chakamaiya would be a good choice for shifting crops from Dhankhali (project area). • BADC and DAE shift their existing operatioons of Dhankhali to Chakamaiya, if this possible, crop production of Chakamaiya would be similar to Dhankhali. • A regional/local development plan should be prepared by the concerned Government Authority to guide the induced development in a planned way and to conserve agricultural land from the invasion. • Khas/fallow land should be brought under cultivation. • Infertile land should be under future infrastructure development. • Capacity building and awareness rising of the farmers should be carried out to practice Integrated Crop Management (ICM) and Good Agricultural Practices (GAP).	Ministry of Land(MoL), Local Government Institute(LGI) DAE	DC Office, RPCL
Q Fisheries Resources				
Q1 Fish habitat quality	Rabnabad channel is rich in Hilsa, Pangus and Shrimp PL which would be affected due to disposal of waste water like ballast and bilge water from the ship/cargo carrying machinery and ancillaries	Vessel movement should be limited during Hilsa (September - October) and Pangus (June - July) spawning period and peak shrimp PL (February – March) collection periods. Ballast water and oil spillage must be controlled from the ships, vessels and construction site. Foreign ships must be checked for protecting the migration of invasive species	Upazila Fisheries Office in collaboration with local fishers.	RPCL and Upazila Fisheries Office

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	having oil and grease contaminants.			
Q2 Fish species diversity and composition	Impact on fish habitats due to spillage of oil, grease and bilge water from the increased traffic load in the channel. This may result a declining in fish species diversity	Fish breeding and fish spawning seasons should be avoided for transporting construction materials and machinery as well as ancillaries through waterways. Oil spillage from vehicle/water vessel should be controlled efficiently	Upazila Fisheries Office in collaboration with local fishers.	RPCL and Upazila Fisheries Office
R Ecology				
R1 Shorebirds and other wildlife habitat	The movement of labors will disturb to shorebirds normal activities. The construction activities would impacts negative to other wildlife at the vicinity of project site by putting light, high frequent sound, stockpilling of construction to wildlife passages, labor and vehicle movements. In addition, jetty construction for coal transportation will impacts negative to wildlife both terrestrial wildlife and shorebirds.	Develop specific guidelines in avoiding disturbance to shorebirds as well as other wildlife habitat; Construction area should boundary wall and specific route for transportation of goods and labour movement; The construction machineries should low sound emission or emission free; Light of construction area should install downwardly to avoid disturbance to the wildlife and shorebirds; Construction activities should not continue at night; and Winter season (October-February) should avoidas construction period.	Contractor/RPCL	DoE
S Socio-economic resources				
S1. Healthy and safety to	• During construction and installation stage of the power plant may	• Special attention should be provided for supplying safe drinking water, safe sanitation system for the	EPC	OE/EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
the worker and residence	threats for human safety to the technical and non-technical labor • • Welding operations during laying of pipeline may cause fire accidents if proper care is not taken	labor sheds. Registered doctor and assistants should be employed during construction phase • All arc welding and cutting operations shall be shielded by non-combustible or flameproof screens which will protect welders and other persons working in the vicinity from the direct rays of the arc. In addition, the welders should use (i) hand shields to protect against flashes and radiant energy, (ii) see his skin is covered completely to prevent burns and other damage by ultraviolet rays, (iii) Welding helmets shall be free of leaks and openings, and free of highly reflective surface, and (iv) welding trucks shall be equipped with approved fire extinguishers and first aid.		
S4 Employment opportunity	The local people may engage in the land development and non-technical activities and it will create in migration in the project area	Engagement of local people in the project activities or alternative occupation should be ensured	Contractor/RPCL	PA
T Non-Hazardous Waste Generation				
T1. Solid Waste Storage space and visual effect	• Poor aesthetic view due to the storage and disposal of old and used equipment and materials. Moreover, spillage and leakage from improper storage can result in contamination in soil.	• Rubbles generated from the construciton site should be stored in approriate bins/skips, well-covered and later buried in an approved landfill site. • All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal	Contractor	Health and Safety Officer
Operation Stage				
U Ambiant Air				

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
U1 Ambient Air G1. Maximum ground level concentration of air pollutants	• Emission of exhaust gas from the stack may contribute elevated ground level concentration of SOx, CO, NOx, PM10, PM2.5etc. at the sensitive receiptors	• Use of 275 m stack, FGD, ESP, Low-NOx burner etc will reduce the GLC of the pollutants • Similarly, emission level of $PM_{2.5}$ will also be within the standard but PM_{10} has the exceedance in respect of World Bank guideline but compliant with the Bangladesh standard. • Monitoring the rate at stack and ambient GLC of the criteria pollutants at the sensitve receiptors	Power plant operation Unit	EHSU
V Noise level				
V1. Noise level inside the control room, turbine hall	• Hearing complexity and loss along with increase blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities due to noise generated from rotator machineries at exceedance level.	• Install 3 m high brick boundary walls and thick plantation to attenuate noise in the sensitive receptors. • Replace the sealing of doors and windows of the control room and office building for making noise proof the workspace. • The machines/equipments/vehicles should be turned off when not in use. • The turbines, pumps, fans etc. should be covered with soundproof dampeners to limit the spread of noise. • Greenbelts should be developed around the power plant area to limit the spread of noise to the nearby community. • Workers should use appropriate PPEs (soundproof earpiece, earmuffs etc.) while working close to noise equipment.	Power plant operation Unit	EHSU
W Water Resources				

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
W1 Natural drainage system	• Impacts on Natural Drainage System	• All the natural drainage system in the power plant project area should be kept as RS mauza. • No water control structures should be implemented by the project authority into the natural drainage system.	Project proponent	BWDB and Union Parishad
W2. Water Quality	• Disposal and dumping of hazardous material and garbages on the surface water may deteriorate the water quality of Rabnabad Channel and other local channels.	• Provision of solid waste management system. • Purification of hazardous material before disposal according to the ECR.	RPCL	EHSU
W3 Storm surge flooding	• Impacts on storm surge flooding	• Slope protection work along with power plant site of Rabnabad Channel • Afforestation program will be taken at both side of the embankment	Project proponent	BWDB and Department of Forest
X Land Resources				
X1. Soil Quality	• Soil quality can be deteriorating due to oil spill and heavy metal contamination from power plant operation.	• All kinds of safety measures should be maintained to avoid accidental events.	Ministry of Land(MoL), Local Government Institute(LGI) DAE	DC Office, RPCL
X2. Land Use	• Proposed power plant would trigger new industries in that locality. As a result, more agricultural lands would be acquired.	• Fallow lands should be selected to avoid this problem in future. • If there is no option to avoid this scenario, proper compensation and mitigation measures should be introduced here.	Ministry of Land(MoL), Local Government Institute(LGI) DAE	DC Office, RPCL

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
Y Agriculture Resources				
Y1. Crop Production	• Agricultural lands might be converted to non-agricultural land due to Power plant induced infrastructure developed.	• Similar to construction stage	Ministry of Land(MoL), Local Government Institute(LGI) DAE	DC Office, RPCL
Livestock Resources				
Z1. Reduce of livestocks	• Reduction of the livestocks may affect on the livelihoods of few farmers. Ultimately, it reduce the local livestocks gradually	Introduce farming though training and incentives to the farmers Faclitate the BDS for the livestocks management in the study area	PA/ DAE/LGI Agriculture and livestock training center	Local Adminstraion/ PA
AA Fisheries Resources				
AA1 Fish species diversity and composition	• Water intake from the Rabnabad Channel would entrap fish, crustaceans and other aquatic organisms particularly the sluggish species. • Predator-prey relationship might be affected due to spread of invasive species through ballast water. Integrated impact to be caused for withdrawal of 3x4250 m3 of water, daily	Water intake velocity will not be more than 0.5ft/s at the screen of the intake channel. Intake point of the feed water pipeline should be provided with sufficient screen i.e. fish deterrence machine to filter out aquatic organisms like fish, frogs, and toads. Foreign ships must be checked for protecting the migration of invasive species. To use bio-indicator for monitoring the health of the aquatic ecosystem.	Upazila Fisheries Office in collaboration with local fishers.	RPCL and Upazila Fisheries Office

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	for three power plants located at the Rabnabad channel may alter the fish diversity due to salinity intrusion			
AA2 Fish production	If the fly ash is not controlled, the nearby fish habitat as well as their quality may be cumulatively damaged. This may result in gradual decline in fish production.	Highly efficient electrostatic precipitator should be used to control the emerging fly ash. Continuous monitoring of emerging fly ash should be ensured and necessary measures are to be taken as well if the electrostatic precipitator is found to be defunct.	Upazila Fisheries Office in collaboration with local fishers.	RPCL and Upazila Fisheries Office
BB Ecology				
BB1 Terrestrial vegetation	Vegetation growth impedes by blocking transpiration pores through dust particulates generated by the vehicles and public movements in this project area.	Use sprinkle of waters in the roads and nearby areas at 2-hour interval to reduce the rate of dust particulates generated by vehicle movements.	RPCL	DoE
BB2 Shorebirds	The project area is close to Rabnambad channel of the Bay of Bengal having diversified wintering and resident waders. The use of channel for coal transportation will hamper the normal activities of the shorebirds in a large. Lighting of the plant site would impacts negative to	Lights in the south side of plant area should installed downwardly to avoid disturbance to the shorebirds and other wildlife especially the nocturnal.	RPCL	DoE

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	the shorebirds activities especially the nocturnal. On the other hand, greenbelt (to be developed) for the project shall provide important habitat to different wildlife, local common birds, and other aquatic birds.			
BB3 Marine habitat	The marine habitat is very resourceful and home to many tiny to large aquatic biota. Coal transportation through this aquatic system has some risk of pollution by capsizing ship, dropping of coal, oil and grease release from engines. Toxicity of such matter would harm to minor phyla and tiny species in the long run.	Dropping of coals from cargo/ship should be protected to avoid marine pollution; The shippers should well aware about release of other pollutants like oil, grease, etc.	RPCL	DoE
BB4 Benthic community	Contamination of river/seabed through coal droppings during shipment.	Use cover over the loaded coals to protect coals from dropping down; Shippers should well aware of coal contamination by handling the shipment with good management.	RPCL	DoE
CC Socio-economic resources				
CC3 Diversity of occupation	Different occupational facilities may be created after the implementation of	Let the local people be engaged in the project related activities as well as in the other industrial activities	Contractor/RPCL	RPCL

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	this project in the study area			
CC5 Human safety	Accidental issues may occurs during the operation period. It may create a problem in housing facility, treatment facility, sanitation and drinking water facility issues	Emergency team, ambulance, contact number and hospital should be available. Emergency response plan should be implemented during operation periods.	Contractor/RPCL	RPCL
DD Non-Hazardous Waste Generation				
DD1. Liquid Waste and Sewerage	Untreated liquid waste will damage the surface and ground water quality in the study area	Waste will be minimize though reuse, recycle and recovery The project must use ETP and Cooling Tower to treat the water within ECR 1997 and IFC 2008 standard. The project will run through zero discharge concept where the discharge form the ETP will be used for gardening or irrigation Monitoring the water quality as per the design of EIA	Project Proponent	EHSU
DD2. Kitchen Waste	Waste generated from the kitchen may cause bad smell and damage the local environment	The project must maintain the sewerage line and STP properly. Monitoring the water quality at the recommended place and frequency in the EIA study On site and off site Solid waste management system should be run properly	Project Proponent	EHSU
EE Hazardous Waste Generation				
EE1. Use of Hydrazine and Clorine for water treatment and Oil in	Hydrazine and clorine are highly toxic for aquatic life. Oil from the transformer, chemical from the water treatment plant, hydrazine	Use of halamine in stead of Hydrazine and clorine may be substituted by other environmental friendly chemicals. SF6 might be use for transformer for insulation. Monitoring the water quality at the recommended place and frequency in the EIA study	Project Proponent	EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
Transformer as insulation	and chlorine discharge may damage the surface and ground water quality.			
EE2. Hazardous sludge from water pre-treatment and treatment plant	Sludge from the STP, ETP, WTP and solid waste dumping places may affect the ambient environment in the project site	All of the treatment plant must run properly and maintain them regularly. Generated sludge must be dispose scientifically at a designated places Monitoring the soil and water quality at the recommended place and frequency in the EIA study	Project Proponent	EHSU
Coal Transportation				
FF1 Fish habitat	Increase traffic load in the water course for the three power plants might hamper the fish migration activities. Coal during loading and unloading might fall on Rabnabad channel and deteriorate the water quality of the habitat. Integrated spillage of oil and grease from three power plants activities along with Payra deep sea port is detrimental for fish and other aquatic organisms along with water flow.	The crew should be advocated to maintain a certain path and abstain from dumping solid and liquid wastes particularly during fish breeding season. Coal handling should be made efficiently so that negligible amount of coal can fall in the water.	Upazila Fisheries Office in collaboration with local fishers.	RPCL and Upazila Fisheries Office

10.11 Administrative Setup and Organogram

RPCL is an owned subsidiary of the Rural Electrification Board (REB). This company was created in order to meet the prevailing demand of electricity. The proposed organogram of the RPCL is presented in **Figure 11.1.**

10.11.1 Project Implementation Unit (PIU)

For the operation of proposed1320 MW Coal based Power Plant, RPCL has created a project implementation unit (PIU) as in **Figure 10.2**, under the office of the Chief Engineer, Operation and Maintenance. The PIU is lead by a Project Director (PD) followed by one Executive Engineer, acting as a Deputy Project Director.

Proposed Organogram for Project Implementation Unit (PIU) of 1320 MW Coal Fired Thermal Power Plant at Kalapara, Patuakhali

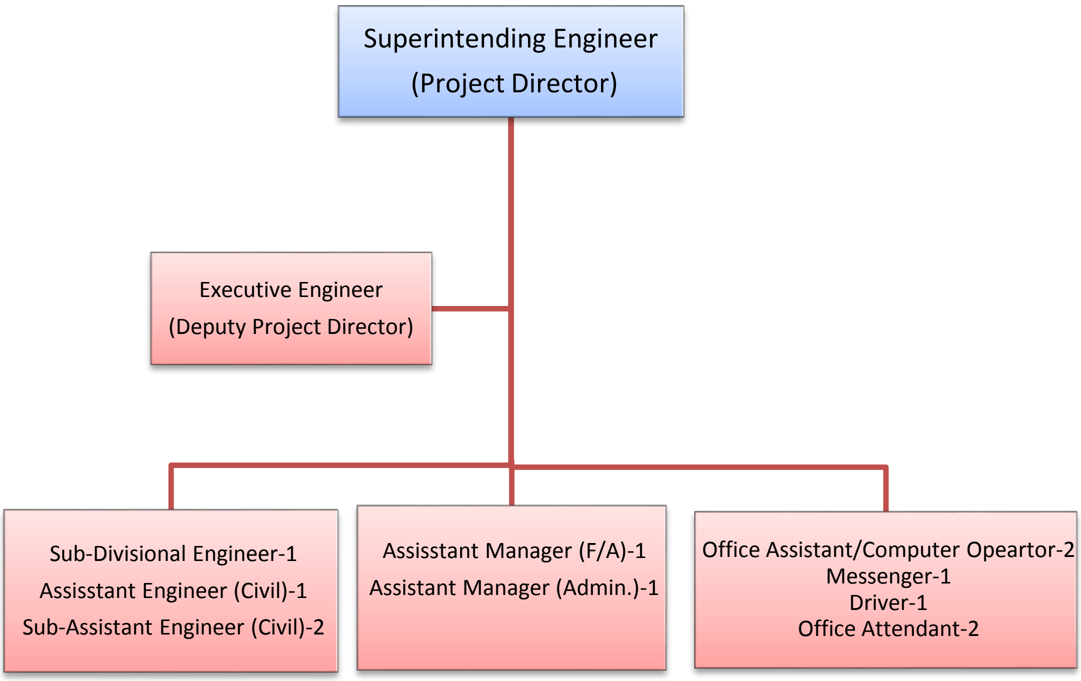


Figure 10.2: Proposed RPCL Organogram for PIU

To strengthen the PIU, additional resources are needed as illustrated in **Figure 10.3**. Detailed qualification, required number of people in each post and responsibility of each position is depicted in **Table 10.3.**.

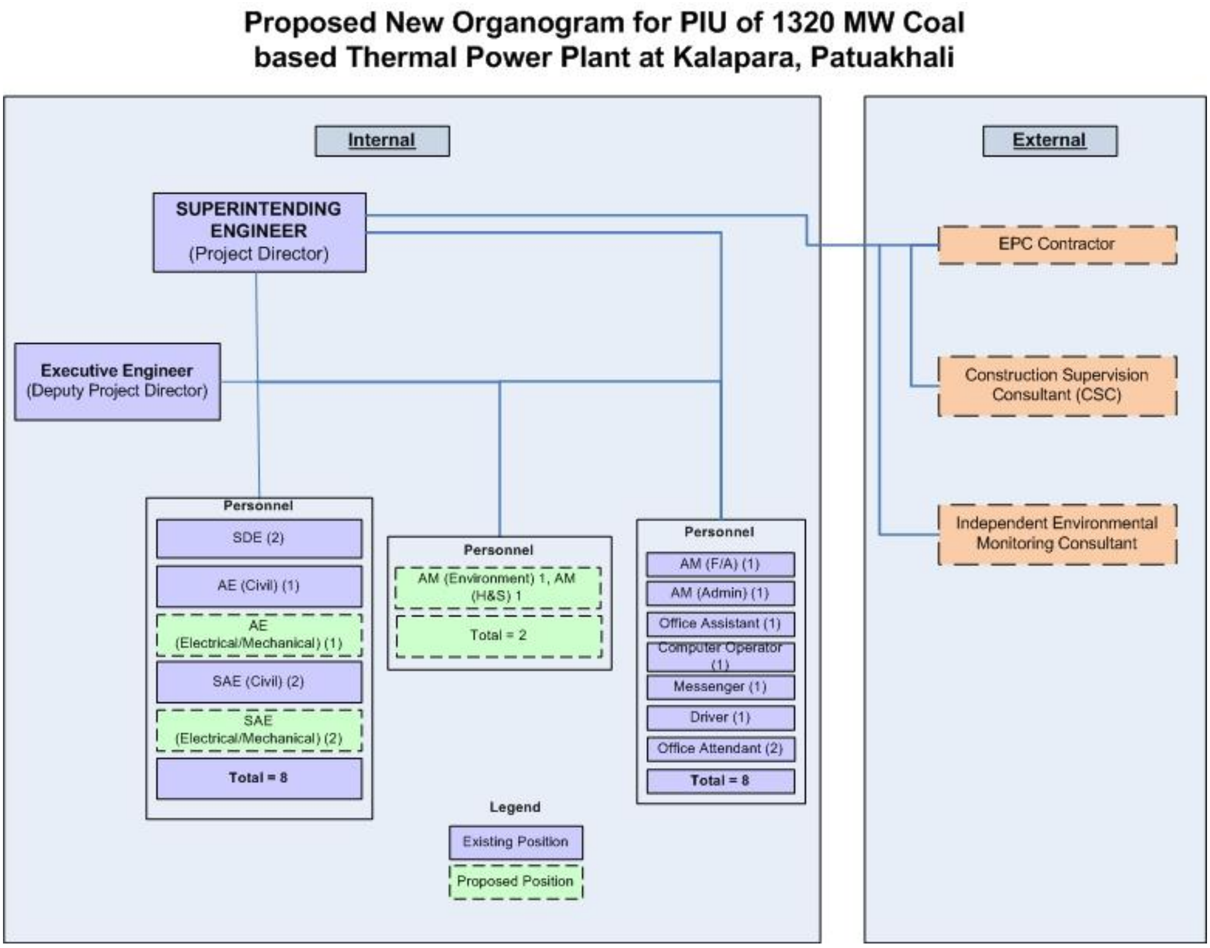


Figure 10.3: EIA Study proposal for PIU

External Monitor

Besides internal monitoring and evaluation by the PIU for environmental management and monitoring, independent external monitors will be retained by RPCL, to undertake monitoring of all compliance. These external monitors will carry out monitoring implementation of the different components and submit an independent monitoring and appraisal report to the PIU, and to RPCL.

Contractor

Each Contractor procured under this Project (especially EPC Contractor) will be recommended to be a compliant of ISO 14001, Environmental Management System (EMS) certification. Further conditions of compliancy for OHSAH 18000 (2007) related Occupational Health and Safety (OHS) and SA 8000 (Social Accountability) could also be imposed on the Contractors. Each contractor will be recommended to have one Environmental Specialist and one Occupational, Health and Safety Specialist, who will be working in close coordination with the environmental staff of Owner's Engineer and PIU.

Other Relevant Organizations

Other relevant organizations involved in the implementation of EMP are: (a) Department of Environment (DOE), who will oversee the implementation of all development projects in the country verifying that the environmental requirements are fulfilled, government guidelines and procedures are followed and environmental quality standards are maintained properly. DOE will be consulted in case of complicated issues and if it requires any further environmental clearance certificates (ECC), (b) Department of Fisheries (DoF) is responsible for fisheries resources, (c) Department of Public Health Engineering (DPHE) is responsible for maintaining the quality of drinking water and addressing sanitation issues, and (d) District administration and municipality are responsible for traffic management, law and order and resolving the social disputes that may arise during construction activities.

10.11.2 Human Resources Plan for EHS Cell

Institutional Strengthening of EHS Cell

Presently, the proposed power plant has four (4) circles which are Programme Planning and EHS, Design and Development, Procurement and Contract and Operation and Maintenance. A proposal for a separate Environmental Health and Safety department has been made by the EIA consultant to create an EHS Cell headed by a manager, a deputy manager supporting the manger and two assistant managers; one for environment and another one for health and safety. Two technical assistants (one chemist and one socio-economist), two firemen, and a medical officer and a nurse are also proposed. Currently the PIU of the proposed plant has no staff with previous experience in implementing environmental management and monitoring plan. In order to implement the environmental management plan (EMP) as proposed in this EIA, an effective PIU with dedicated staff will be of crucial significance. Without qualified full time staff it would be nearly impossible to minimize and/or eliminate the effects of environmental hazards and risks and ensuring a safe working environment for the workers, staffs and staff family members, who are residing in the project compound. The detail of the revised organogram from the EIA consultant is shown in **Figure 10.4**.

PIU Dedicated EHS Staff Requirements

Under the proposed Organogram there has been no provisions made for dedicated staff to ensure compliance to EHS issues. For effective and meaningful implementation of the EMP, it is recommended that one Manager (EHS) and one Deputy Manager (EHS) – with requisite training and practical experiences in implementing and/or monitoring environmental, health and safety issues pertaining to power sector – are recruited. This team of two would be supported by two Assistant Managers (one experienced in environmental management and other in Health and Safety).

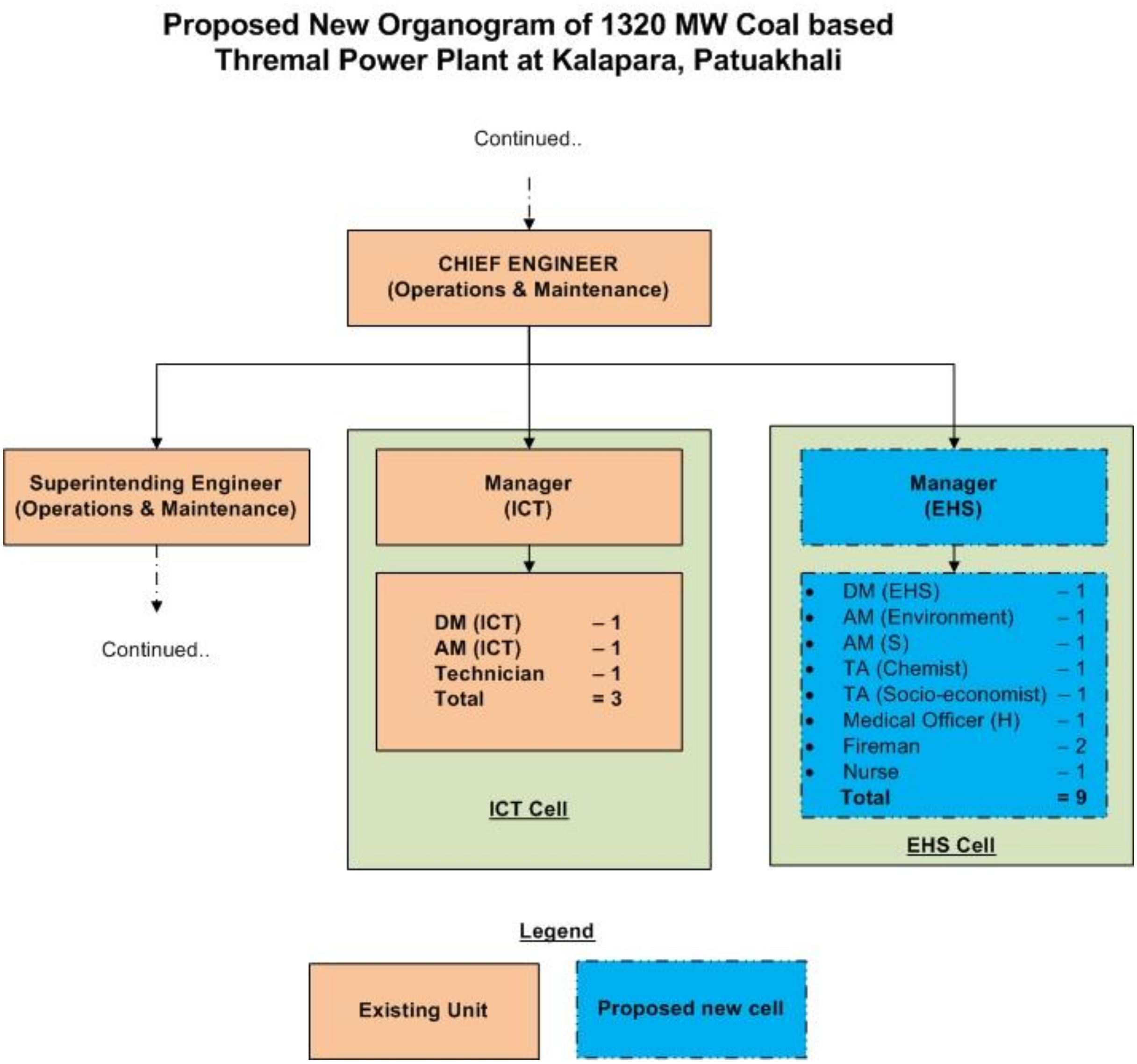


Figure 10.4: Organogram of the proposed Power Plant proposed by the consultant

The following table (**Table 10.3**) shows the revised number of staffs to be required for the proposed Power Plant

Table 10.3: Proposed positions for the Power Plant by EIA Consultant

Designation	Allocation
Office of the MD	9
Engineering Department	35
EHS Cell	9
Finance Department	19
Company Secretariat	5
HR & Admin Department	34
Total	**111**

10.11.3 Responsibility Matrix

The job descriptions of the PIU staff with preferred responsibilities and qualifications are presented in **Table 10.4**.

Table 10.4: Qualification and Responsibilities of the PIU Staffs

Sl no.	Name of the post	Quantity	Qualification	Responsibility
1	Project Director (Superintending Engineer)	1	B.Sc. Engineering or as per RPCL's Service Rule	Responsible to implement the project on time and furnishing both financial and physical progress report of the project for deliberation on the progress in the monthly Pre-steering and Steering meetings.
	Deputy Project Director (Executive Engineer)	1	B.Sc. Engineering or as per RPCL's Service Rule	To assist the Project Director in all respect. In the absence of the PD, responsible for implementing the project. Co-ordinate Environmental Health and Safety (EHS) issues to Superintending Engineer. Supervision of contractor's work during the construction of the proposed power plant as per the design and scope of works outlined in the contract document. Report on work progress from time to time to the PD.
2	Sub-Divisional Engineer	2	B.Sc. Engineering or as per RPCL's Service Rule	Providing all support to the Deputy Project Director (DPD) and PD in the supervision of file works of proposed power plant project. Monitor all issues related to (EHS). One of the two SDEs should be fully assigned to cover EHS issues. Work with AM (Environment and EHS) in finding solutions to issues related to environment and worker's health and safety.
3	Assistant Engineers (Civil)	1	B.Sc. Civil Engineering or as per RPCL's Service Rule	Providing all support to the DPD in the supervision of file works of proposed power plant project. In-charge of preserving and maintaining the blueprints and design maps of boilers and machineries. Construct maps and blue prints regarding setting up structures (boilers, HRSG etc.) for the proposed development. Look for any mechanical/design flaws of any structures and mobilizing workers in rectifying them.

Sl no.	Name of the post	Quantity	Qualification	Responsibility
				Working with other AEs, AMs and SAEs in smooth operation of the plant. Reporting to DPD/PD of any issues related to power plant structure.
4	Assistant Engineers (Electrical/Mechanical)	1	B.Sc. Electrical Engineering or as per RPCL's Service Rule	Providing all support to the DPD in the supervision of file works of proposed power plant project. In-charge of electrical works inside the power plant vicinity. Ensuring smooth operation of boilers and other machineries. Working with other AEs, AMs and SAEs in smooth operation of the plant.
5	Sub-Assistant Engineers (Civil + Mechanical/Electrical)	4	Diploma Engineering	Assisting AEs/PD/DPD in plant operation related activities
6	Assistant Manager (Environment)	1	Minimum B.Sc. and M.Sc. in Environmental Sciences or any related background	Co-ordinate and monitor environmental issues. Assisting EPC contractor, Construction Supervision Consultant (CSC) and Independent Environmental Monitoring Consultant in monitoring and reporting any environmental issues related to the project and in conducting regular audits. Maintaining close relationship with DoE and Ministry of Finance related to Health. Reporting to DPD/PD of any electrical issues related to power plant operation.
7	Assistant Manager (Health and Safety)	1	Minimum B.Sc. and M.Sc. in Environmental Sciences/ Engineering or any related background with trainings on Occupational Health and Safety and Hazard and Risk Assessment is also preferred	Co-ordinate and monitor worker's health and safety related issues. Assist EPC contractors and other independent monitoring agencies in conducting regular audits on worker's physical and mental health, work environment and instruments, PPEs and machineries. Reporting to Deputy Project Director on issues related to worker's health and safety. Maintaining close relationship with DoE and Ministry of Finance related to Health.
8	Assistant Manager (Accounting & Finance)	1	Bachelors and Masters in Accounting/Finance	Maintaining general ledger book, processing of contractor's bill for payment, preparation of monthly

Sl no.	Name of the post	Quantity	Qualification	Responsibility
			Engineering or as per RPCL's Service Rule	accounts statement for the project related financial transaction. Also responsible for all personnel and administrative matters as per delegation of authority.
9	Assistant Manager (Admin)	1	Bachelors and Masters in Human Resource and Development or as per RPCL's Service Rule	The Assistant Manager is responsible for the general administration of office operations of the power plant. Responsibilities include, but are not limited to, reception, administrative and clerical support; dealing with plant's workers and attendants (e.g Drivers, Gardeners, Security Guards, MLSS etc.); supporting PD and DPD, Managing transport, important documents and blueprints, worker's salaries, purchase receipt. etc.
10	Accounts Assistant	1	Masters/Graduate or as per RPCL's Service Rule	Assisting AM (A&F) in maintaining accounting related activities.

Source: CEGIS, 2016

The job descriptions of the key EHS staffs of EHSU Circle with preferred responsibilities and qualifications are presented in **Table 10.5**.

Table 10.5: Job descriptions and responsibility with qualifications

Positions	No. of positions	Job Responsibilities	Qualifications
Manager EHS	1	• Supervise environmental management plan during construction and operation stages including compliance and effects monitoring • Ensure the occupational health and safety and security of all employees and supervise contractors' compliance of EMP obligations. • Maintain the EHS management system and ensure all electricity generation related work in compliance with all the requirements of health and safety programs. Maintenance of all documentation. • Initiate actions for improvement of all environmental and health & safety programs based on periodical audits of the EHS management system. • Working closely with deputy managers of EHS and Chief Chemist to ensure all works are done in	• At least a Master's Degree in Environmental Engineering or Environmental Science with experience in Occupational Health and Safety or related field. • At least 15 years of experience in power sector and a minimum of 5 years working experience in development Bank financed Projects preferably in power sector. • Must have adept knowledge of national policies, such as the Labour Act, 2006, The

Positions	No. of positions	Job Responsibilities	Qualifications
		compliance with ISO 14000 and ISO 31000 standards. • Monitor the progress of boiler decommissioning and safe disposal of Hazardous Wastes. • Ensure compliance with all RPCL policies and administrative rules, including the Health and Safety policy and other environmental requirements. • Practice safe work habits in accordance with Occupational Safety & Health Administration (OSHA) guidelines, Factories Act, 1965 and Environmental Conservation Rules, 1997.	Factories Act, 1965, Environmental Conservation Rules, 1997 as well as International OHSA standards such as ISO 14001, ISO 31000 and other related OHSA guidelines.
Deputy Manager (EHS)	1	• Manage and supervise environmental management and monitoring activities of the plant. • Monitor environmental mitigation and compensation measures carried out by the contractors along with the consultants as outlined in the project's EMP. • Conduct periodic consultations with various stakeholders, focus group discussions, and community consultation to monitor the progress of the EMP implementation. • Participate in grievance redress committee and resolve issues related to environmental concerns raised by the communities. • Assists in the preparation, implementation, monitoring and controlling of annual budget for the Circle. • Review quarterly and annual environmental monitoring reports and submit them to SPS, RPCL and development partners. • Play a lead role in acquiring environmental permits, licenses, and approvals from regulatory agencies (e.g., DoE) in support of boiler decommissioning and new boiler erection projects. • Perform any other relevant and lawful duties as assigned by the Manager of EHSU from time to time.	• Master's degree from a reputed institution on Environmental Engineering or Science or any related field • Must have good knowledge on various environmental and occupational health and safety policies and standards, both national and international. • Minimum 10 years of working experience on power sector projects or any environmental related projects that are funded by development Banks and a diploma in OHS from a reputed institution (e.g. NEBOSH or anything similar)

Positions	No. of positions	Job Responsibilities	Qualifications
		• The Environmental Specialist should adhere to the rules and regulations of Bangladesh and of development partners such as World Bank, ADB, etc. • Ensure a safe and healthy working environment and systems of work through sensitizing employees on occupation health and safety. • Advise SPS management of areas not in compliance with Environmental Conservation Rules, 1997; Factory Act, 1965; Bangladesh Labour Act, 2006 and OSHA guidelines. • Train workers on how to recognize hazards; environmental and OSHA regulations; how to properly use personal protective equipment (PPEs); fire safety drills etc. • Evaluate the probability and severity of accidents. Supervise the preparation of accident reports and continually update these reports and inform them to the EHSU Manager.	
Assistant Manger (Environment)	1	• Conduct environmental screening and scoping and assist in environmental impact assessments of all SPS and donor funded projects. • Monitor environmental mitigation and compensation measures carried out by the contractors along with the consultants as outlined in the project's EMP. • Conduct periodic consultations with various stakeholders, focus group discussions, and community consultation to monitor the progress of the EMP implementation. • Participate in grievance redress committee and resolve issues related to environmental concerns raised by the communities. • Prepare the implementation of a range of environmental compliance documents required for project approval and implementation, such as IEE, EIA, EMPs, etc.. • Perform any other relevant and lawful duties as assigned by the Manager of EHSU from time to time.	• Bachelor of Science degree in Environmental Science from a reputed institution • Must have good knowledge on various environmental policies and standards, both national and international. • Working experience in power sector projects or any environmental related projects are preferred.

Positions	No. of positions	Job Responsibilities	Qualifications
Assistant Manger (Health and safety)	1	• Monitor all health and safety activities carried out by the contractors along with the consultants as outlined in the project's EMP. • Conduct, arrange and report periodic inspections of all installations/ laboratories/ workshops to identify risks and safeguard of all persons from death or injury. • Provide personal protective equipment (PPE) to operation sections where necessary and monitor the adequacy of contractor's PPE at construction site. • Conduct fire safety audits on all SPS buildings to ensure that facilities are compliant with safety rules and ensure that appropriate procedures to minimize risks are in place. • Prepare monthly and quarterly reports on occupational health and safety and providing updates on health and safety issues. • Perform any other relevant and lawful duties as may be reasonably assigned.	• Bachelor of Science degree in occupational Health and safety or public health or related field from an international accredited institution and a minimum 2 years of working experience or a diploma in OHS from a reputed institution. • Must have adept knowledge of national policies, such the Labour Act, 2006, The Factories Act, 1965, Environmental Conservation Rules, 1997 as well as International OSHA standards such as ISO 14001, ISO 31000 and other related OSHA guidelines.

Source: CEGIS, 2016

10.12 Record keeping and reporting

Record keeping and reporting is one of the requirements of any QA/QC system and essentially of a good management tool. Properly maintained records of construction, training, equipment maintenance, operation, fault detection and remedy can help in reducing risks of accidents, legal costs and thereby overall cost of operation of a plant. Records also help in identifying causes of any accident and elimination of the same accident in future. Records may be maintained for the proposed plant as follows.

Implementation status of the safety plans should be monitored and documented regularly. Monthly monitoring report should be prepared based on regular inspection and should be submitted to the Managing Director of the Power Plant. Any kind of incidents or even near misses should be documented and reported to the Managing Director.

10.13 Coal Washery

Coal continues to play a major role for power generation over the world. Coal is highly variable with respect to the physical and chemical properties that affect its use. Plants or industries that use coal specify a range of properties that are required for their intended process. The quality and quantity of coal for Banshkhali Power Plants are specified which to be carried by mother vessels through distant countries like Indonesia or South Africa.

Coal suppliers try to find coals that most closely match those requirements. For effective utilization, it is necessary to beneficiate them. Therefore, earlier coal mines of South Africa and presently Indonesia has adapted to coal washery accompanied with other systems for processing the coal after mining. Coal is treated in a process called “beneficiation” to prepare a material that meets the customers’ need and is as homogenous as possible. Therefore, coal washery will not be affecting the surroundings of the power plant.

10.14 CDM Intent

The proposed project will harness the benefits of CDM as use of supercritical boilers for coal and combined cycle for gas turbine power plant. However several green building concepts will be used in the project. Production of electricity will simultaneously accelerate CO_2 emission to the environment. Therefore, implementing energy efficiency programs in power sectors and other electricity consumers not only makes the production cost-effective but also reduces greenhouse gas emissions. The recommendations for reducing green house gas emission are given below:

The township should be designed with ‘Green Buildings’ concept. Guidelines issued by the Building Code, 2006 should be followed. Compact Fluorescent Lamps (lighting system), energy efficient refrigerators and air-conditioners, water-cooled screw type HVAC system, CFC and HCFC free refrigerants and chillers, solar water heaters on major buildings are some recommended energy saving devices that should be considered in this project.
Energy efficient building materials should be considered for construction of structures. For external walls and boundary wall fly ash bricks and blocks may be considered. Fly ash, which is a waste of power plant should be mixed with cement to make concrete. Rat trap cavity brickwork using fly ash bricks / blocks should be considered. Natural ventilation system comprising screen walls, low emissive double glazed glass with U value of less than 2.8 W/m^2k, shading coefficient of 0.5 should be considered for the buildings. Moreover, green belt and spot green should be developed maximum allowable areas.

Energy efficient process and building structures should achieve 20% reductions in energy consumption. It is recommended that the project authorities should undertake yearly energy audit for their entire manufacturing process and ancillary facilities. Green banking should be promoted.

10.15 Budget for EMP

The cost of implementing the EMP including monitoring is about USD 12.5 million. Details of EMP and associated costs are given in **Table 10.6**.

Table 10.6: Estimated cost of EMP

Items	Unit	Quantity	Unit Rate	Amount (USD)
EPC Contractor (Investment Cost)				
Continuous Stack Emission Monitoring System	No	1	65,000	65,000
Central Water Effluent Treatment Plant	Included in Project Cost			
Electrostatic Precipitator (ESP)	Included in Project Cost			
Flue Gas Desulphurization Plant (FGD)	Included in Project Cost			

Items	Unit	Quantity	Unit Rate	Amount (USD)
Continuous Ambient Air Quality Monitoring Station	No	2	75,000	150,000
Low Noise generating equipment and protecting door, room etc	Included in Project Cost			
Noise Protecting Equipment and damper	LS	1	250000	250,000
Environmental Laboratory	No	1	1,900,000	1,900,000
Revetment and Slope protection works	Include in the Project Development Cost			
Emergency Response Equipment	LS	1	600000	600,000
Occupational health, safety, and sanitation	Once	1	15000	15,000
EHS Staffs of Contractor (2)	LS	1	100000	100,000
Plantation Program and Green Belt Development	LS	1	800000	800,000
			Sub Total	3,880,000
Studies and Services				
Ecological survey and analysis (Diversity Index, Richness, Productivity, Prawn and Shrimp PL availability, etc. Habitat suitability)	Per Month	18	30000	810,000
Social Survey and analysis (Census of the PAPs, FGD, Stakeholder consultation, awareness)	Per Year	18	20000	360,000
Ecosystem Improvement Services	Per Year	3	100000	300,000
Social Improvement Services	Per Year	9	25000	225,000
	Sub-Total			2,495,000
Environmental Monitoring Plan (As per the framing of chapter-11)				
Pre-construction, Construction (3 yrs) & Commissioning (3 yrs)		1	217500	217,500
Independent Monitoring (Construction and Commissioning)		1	150000	150,000
Environmental Monitoring Plan (5 Yrs)	Once	80	15,000	1,200,000
Occupational Health, Safety and Security	Per Year	3	10000	30,000
Community Health Safety and Security	Per Year	3	10000	30,000
Discharge from ship/cargo on Rabnabad Channel	Per Year	9	10000	90,000
Effluent discharge points	Per Year	9	10000	90,000
	Sub Total			1,807,500
Institutional Arrangements				
EHS Consultant of Owner's Engineer		1	1200000	1,200,000
EHS Staffs of EHSU Circle (3 Years)		3	700000	2,100,000
Capacity Building and Training		1	500000	500,000
Independent Monitor (Fees), Operation		1	900000	900,000
Environmental Compliance Audit	30 years	30	5000	150,000
	Sub Total			4,850,000
			Grand Total=	13,032,500

11. Environmental Monitoring Plan

11.1 Monitoring Plan

A three-tier monitoring program has been proposed comprising of compliance monitoring, impact monitoring, and external or independent monitoring, as one of the key suggestion of the EIA study. The main purpose of this monitoring program is to ensure that the various tasks those detailed out in the environmental management plan, particularly the mitigation measures which are to be implemented efficiently and effectively, and also to evaluate project's impacts on the key environment and social parameters. Various types of monitoring are presented in the following sections and the locations of monitoring are mostly to the places where the baseline data are collected.

11.1.1 Compliance Monitoring

Compliance monitoring is a very important tool/aspect of environmental management to safeguard the environment. The compliance monitoring plan is presented in Table 11.1 and Table 11.2. The monitoring will comprise surveillance to check whether the contractor is meeting the compliance provisions of the contract during construction and operation of the Project including the responsible agencies for implementation and supervision.

For monitoring of physico-chemical parameters, locations near the baseline sampling points are suggested. Actual monitoring time and location will be decided by the Owner's Engineer (OE) and RPCL. The Contractor will be responsible for carrying monitoring all the parameters as required with frequency is shown in the following table. This monitoring will be carried out by its own cost during the construction phase. The measurement values are to be compared with the IFC's General EHS Guidelines, where relevant standards are specified, or the national standards (Environmental Conservation Rules, 1997 and amended in 2005)..

11.1.2 Impacts Monitoring during Construction

The purpose of the impact monitoring is to ensure that the contractor implements the mitigation measures given in the EMP efficiently, effectively and timely. This monitoring will generally be carried out by the Owner's Engineer (OE) with the help of checklists prepared on the basis of the impact monitoring Plan (Table 11.3).

11.1.3 Independent/External Monitoring

RPCL will engage an independent organization for monitoring the implementation of EMP. The main purpose of the Independent monitoring is to ensure that all key entities including EHSU, Owner's Engineer (OE), and contractors are effectively and adequately fulfilling their designated role for EMP implementation. All the EMP requirements are being implemented efficiently, effectively and timely.

Table 11.1: Environmental Compliance Monitoring up to construction stage

SL	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented By	
						Monitoring	Supervision
1	**Environmental Monitoring during Pre-construction and Construction Phase**						
1.1	Ambient Air Quality	SPM, PM10, PM2.5	Near Resettlement Village Plant site especially at the workers colony Dhankhali College Premises	Continuous during civil construction	Continuous	EPC Contractor	OE, RPCL
1.2	Ambient Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) Leq, L10, L90 (dBA)	Near resettlement village Near the residential area of Londa Bazar 4 points along the boundary wall as mentioned in the monitoring location Map 12-1	Daily during construction work in progress	Three Samples during day time and one sample during night, for noise, 15 min sampling each time. by using: ANSI Type II Noise Meter	EPC Contractor	OE, RPCL
1.3	Water Quality	pH, DO, BOD, Temp. EC, TDS	8 Points in and around the project site and 2 Ground water sampling	Quarterly Monitoring	Composite	EPC Contractor	OE, RPCL
1.4	Embankment Protection and Revetment works	Rain cut and breeching	Full embankment of the polder	Pre-monsoon, Monsoon and Post-monsoon	Observation	Project proponent with existing WMGs of the Polder	BWDB
1.5	Occupational Noise	Leq (dBA)	Two locations: Construction site, Labor shed	Daily during construction work in progress	Same as sl. no. 1.2	EPC Contractor	OE, RPCL
1.6	Workers Health, Safety and Security	Availability of Potable Water, Drinking water	Power Plant Complex	Six-Monthly	Inspection and interview of labor, project personnel	EPC Contractor	OE, RPCL

SL	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented By	
						Monitoring	Supervision
		quality, Availability of Hygienic Toilet					
		Implementation of ECP 18	As specified in the ECP	Quarterly	Inspection and interview of labor, Project personnel followed by a checklist	EPC Contractor	OE, RPCL
1.7	Fish Diversity and Composition	Capture Fisheries Diversity Index, Richness, Productivity, Prawn and Shrimp PL availability, etc.	Rabnadad Channel and Andharmanik river around 1-5 km away from the Project site	Six monthly	Fish Catch Assessment Survey, Fishing Survey and Fishers' interview	EPC Contractor	DoF and PRCL
1.8	Fish habitat	Habitat Suitability Index	Rabnadad Channel and Andharmanik river around 1-5 km away from the Project site	4 times in a year	Habitat observation and water quality	EPC Contractor	DoF and PRCL
1.9	Ecosystem and Biodiversity	Plant Growth, Canopy Coverage, Disease, etc.	Green belt area within the project site	Six-monthly	Plot Survey	EPC Contractor	OE, RPCL
		Species composition and population of planktons and Benthos	Two sites (one nearby the jetty) and one within 1km reach of Rabnabad Channel	Six-monthly	Plankton and Benthos Survey	EPC Contractor	OE, RPCL
1.10	Agricultural Production	Crop Production Loss	Three locations: in the study area within 0.5-3 km from the project site	Six monthly following cropping patterns	Agricultural Survey	EPC Contractor	OE, RPCL

Table 11.2: Environmental Compliance Monitoring Plan during Operation

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
2	**Environmental Monitoring During Operation**						
2.1	Stack Emission	SOx, NOx, CO, PM_{10}, $PM_{2.5}$	Stack	Continuous	Continuous	EHSU	Independent Monitor/ RPCL
2.2	Ambient Air Quality	NOx, SOx, SPM, PM10, PM2.5, CO, O3	Within the Project Boundary Dhankhali Bazar	Continuous	Moveable analyzer, 24 hour	EHSU/	Independent Monitor/ RPCL
			Nishanbaria Londa Bazar Londa-NW corner of the project area	Quarterly	24 hour	EHSU/	Independent Monitor/ RPCL
2.3	Ambient Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) LAeq, L10, L90	outdoor Noise: Resettlement villages Dhankhali College premises Eight points surrounding the boundary wall (four corner points, one point between two corners at each side) One at Jetty Point Indoor Noise: Administrative building Health care unit Residential buildings	Monthly	Three Sample during day time and one sample during night, 15 min sampling each time.	EHSU/	Independent Monitor/ RPCL
2.4	Meteorology	Temperature, Rainfall, Humidity, wind speed, wind direction	One in Plant Area	Continuous	Microclimatic station 24 hrs	EHSU	Independent Monitor/ RPCL
2.5	Effluent (Waste Water)	pH, EC, TDS, Temperature	Effluent Discharge Channel	Continuous	Continuous	EHSU	Independent Monitor/ RPCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
		Oil and grease, Total Residual Cl, TSS, COD, BOD	Effluent Discharge Channel	Weekly	Grab Sampling	EHSU	Independent Monitor/ RPCL
2.6	Storm Water	Oil and grease, Total Residual Cl, TSS, COD, BOD	Combined Discharge Channel	Weekly during monsoon season	Grab Sampling	EHSU	Independent Monitor/ RPCL
2.7	Water Quality: Surface Water	pH, TSS, TDS, Oil and Grease, Total Residual Cl, Total Cr, Fe, Ca, Zn, Pb, Cd, Hg, As, total alkalinity, Ammonium Nitrogen, Free Ammonia, BOD5, COD, EC , Temperature outside the mixing zone, etc.	Jetty Point of the project at Rabnabad channel 500 m u/s of the jetty at Rabnabad Chanel 500m d/s from the the Jetty at Rabnabad channel Confluence point of Andharmanik river and Rabnabad channel Londaghat of Tiakhali Khal 750 m u/s from Londaghat in Taikhali khal	Quarterly	Grab Sampling	EHSU	Independent Monitor/ RPCL
2.8	Water Quality: Ground Water	pH, Total Hardness, Cl, F, Fe, Mn, As, PO4, SO4, etc.	Groundwater tank/pump at plant site	Quarterly	Grab Sampling	EHSU	Independent Monitor/ RPCL
2.9	Generation of Non Hazardous Solid Waste (Domestic waste, Office Waste,)	Collection system, Proper disposal, waste sprawling	Designated Site	15 days	Visual Inspection, waste classification	IM	RPCL
2.10	Generation of Hazardous Solid Waste	Types and Quantity, Materials screening,	Waste Disposal Point, Waste Generation Sources	Monthly	Visual Inspection and grab sampling	IM	RPCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
		Associated hazards, disposing method					
2.11	Generation of Hazardous Liquid Waste, Sludge (return from Water Treatment Plant, Sludge from clarifier, neutralization pond)	Types, quantity, materials screening	Output of ETP	Monthly	Visual Inspection, grab sampling	IM	RPCL
2.12	Plant Health	Plant Growth, Canopy Coverage, Disease, etc.	One at greenbelt area in plant Complex and two at the rehabilitation village and the study area	Yearly	3 plots (25m x 25m) in the study area	IM	RPCL
2.13	Disturbance to Wildlife	Wildlife behavior to noise	Two meeting in the study area	Yearly Stakeholder Consultation	2 hrs meeting/ FGD	IM	RPCL
2.14	Land use and Land Cover change	Land cover and Land use	5km radius area of the Plant	Once in three years	Stakeholder Consultation	IM	RPCL
2.15	Agricultural Production	Crop Production Loss	Agricultural land around the RPCL complex	Yearly	Farmers' Interview, Secondary Data from DAE	IM	RPCL
2.16	Fish Diversity and Composition	Capture Fisheries: Diversity Index, Richness, Composition, Habitat Suitability Index, hatchling availability, etc.	Rabnadad Channel and Andharmanik river around 1-5 km away from the Project site	Yearly Stakeholder Consultation	Fish Catch Assessment Survey, Fishing Survey and Fishers' interview	IM	DoF and PRCL
2.17	Fish production	Catch Assessment Survey (CAS)	Rabnadad Channel and Andharmanik river	Yearly Stakeholder Consultation	Production estimation using catch data and	IM	DoF and PRCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
		within the study area	around 1-5 km away from the Project site		fishermen's perception		
2.18	Health and Sanitation	General Health Condition, Hearing health, skin disease, etc.	Workers involved in the Plant operation and maintenance	Quarterly	Health Check up	Project Authority	RPCL
		Availability of Potable Water	Power Plant Complex	Six Monthly	Visual Inspection and Record Checking	IM	RPCL
		Drinking water quality (pH, TS, EC, F, Cl, As, Mn, Fe, Total Hardness, Total Coliform, PO4, SO4)	Water Supply System	Monthly	Three samples from Drinking water supply system	IM	RPCL
		Availability of Hygienic Toilet	Office Building, Township Area, Common Places, etc.	Monthly	Visual Inspection	IM	RPCL
2.19	Community Health	Status of Communicable Diseases	Plant area, Residential area	Yearly	Inspection of Disease Profile/Records in Health unit, nearby Hospital	IM	RPCL
		Status of Vector Borne Diseases					
2.20	Safety and Security	Emergency Preparedness and Response of SPS	N/A		Visual Inspection and Record Checking	IM	RPCL
		Community Relation Program/ Community Awareness Program, Training	N/A		Visual Inspection and Record Checking	IM	RPCL
2.21	Social Development Program	Number of benefited person/family	N/A	Yearly	Stakeholder Consultation	IM	RPCL/Local Administration

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
2.22	Water supply system	Number of additional hectare of farmland	N/A	Yearly	Stakeholder Consultation	IM	RPCL/ Local Administration
2.23	HealthCare/Development Program	Number of benefited person/family	N/A	Yearly	Stakeholder Consultation	IM	RPCL/ Local Administration
2.24	Other Aid to Community	Number of benefited person/family	N/A	Yearly	Stakeholder Consultation	IM	RPCL/ Local Administration

Note: These monitoring parameters will be revised after monitoring the effluent water quality from the discharge channel. Some parameters might become redundant if the effluent water does not contain in the effluents.

Table 11.3: Impact Monitoring Plan

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
During Construction					
Hydrocarbon and chemical storage	Construction area	Visual Inspection of storage facilities	Monthly	EPC Contractor	OE/ Independent Monitor
Damage to local roads	Approach Roads to the construction sites and Crossing point of Dhankhali college road	Visual inspection to ensure local roads are not damaged	Monthly	EPC Contractor	OE/ Independent Monitor
Traffic Safety	approach Roads and vessels in the Rabnabad channel	Visual inspection to see whether proper traffic signs are placed and flag-men for traffic management are engaged	Monthly	EPC Contractor	OE/ Independent Monitor
Air Quality (dust, -smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (e.g., spraying of waters) are in place.	Daily	EPC Contractor	OE/ Independent Monitor

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
	Batch mixing Plant	Visual inspection to ensure batch plant is located >500 m from residential areas	Monthly	EPC Contractor	OE/ Independent Monitor
	Material storage sites	Visual inspection to ensure proper maintenance i.e. covering, dust suppression etc. as per ECP	Monthly	EPC Contractor	OE/ Independent Monitor
Noise	Construction sites	Physical inspection to ensure good standard equipment are in use	Daily	EPC Contractor	OE/ Independent Monitor
	Construction sites	Visual inspection to ensure ear plugs/earmuffs are in use by the construction workers	Daily	EPC Contractor	OE/ Independent Monitor
		Ensure work restriction between 20:00-06:00	Daily	EPC Contractor	OE/ Independent Monitor
Plantation	Designated sites	Visual inspection to observe growth of saplings as per provided green belt design(subjected to the initiation of plantation)	Monthly	EPC Contractor	OE/ Independent Monitor
Waste Management	Construction area	Visual inspection that solid waste is disposed at designated site and are managed in efficient way	Weekly	EPC Contractor	OE/ Independent Monitor
Hazardous Waste Handling	Hazardous Material Storage Area Hazardous Waste Disposal Area	Visual Inspection of safe handling and storage of hazardous waste and hazardous materials	Fort-nightly	EPC Contractor	OE/ Independent Monitor
Drinking water and sanitation	Labor shed, offices	Ensure the construction workers are provided with potable water and sanitation facilities in the site	Fort-nightly	EPC Contractor	OE/ Independent Monitor

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	EPC Contractor	OE/ Independent Monitor
Safety of workers Monitoring and reporting accidents	At work sites	Visual inspection of usage of Personal Protective equipment, Safety Sign, Safety Documentation, safety training, etc.	Daily	EPC Contractor	OE/ Independent Monitor
Emergency Response Facilities	At project sites	Inspection of Emergency Preparedness and Response mechanism and facilities	Monthly	EPC Contractor	OE/ Independent Monitor
Grievance Mechanism	At project site	Inspection of the complain register	Monthly	EPC Contractor	OE/ Independent Monitor
Fisheries	Discharge from ship/cargo on Rabnabad Channel	Interviewing local fishermen	Six monthly	IM	RPCL and DoF
During Operation and Maintenance					
Monitoring of Environmental Quality (Ambient Air, Noise, Water, effluent, Soil, etc.)	As specified in Table12-1 and 12-2	Inspection and Record checking of Monitoring activities carried out by EHSU circle of	Quarterly	Independent Monitor/ PIU	RPCL
Environmental Laboratory	Complex	Inspection of laboratory Condition, accreditation and certification (from GoB) status	Six-monthly	PIU	Independent Monitor, RPCL
Meteorological Condition	Temperature, Rainfall, Humidity, Wind direction and flow	Checking and compiling climatic data collected and recorded by micro weather station installed in	Quarterly	Independent Monitor/PIU	RPCL
Ambient Noise Level	Residential area, Administrative area and nearby community	Noise nuisance/ disturbance perceived by power plant personnel and nearby community to be surveyed by interview and FGD	Yearly during stakeholder consultation	Independent Monitor	RPCL

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
Fisheries	Effluent discharge points and Water intake point	Interviewing local fishermen	Yearly during stakeholder consultation	Independent Monitor	RPCL
Plant Health	Green belt area and influence zone	Visual inspection	Yearly	Independent Monitor	RPCL
Land use and land cover	5km radius area the Power Plant	Stakeholder consultation	Yearly	Independent Monitor	RPCL
Hazardous Waste and Hazardous Material Handling	Hazardous Material Storage Area and Use Area Hazardous Waste Disposal Area	Visual Inspection of safe handling and storage hazardous waste and hazardous materials	Quarterly	EHSU Circle	Independent Monitor, RPCL
Grievance Mechanism	At project site	Inspection of the complaint register/grievance form and interviewing local people	Six-monthly	EHSU Circle	Independent Monitor, RPCL
Emergency Response Plan	Project site	Inspection of Emergency Preparedness and Response mechanism	Quarterly	EHSU Circle	Independent Monitor, RPCL
Health and Safety Preparedness	SPS Complex	Inspection of training list, safety meetings records, means of awareness growing	Quarterly	EHSU Circle	Independent Monitor, RPCL
Community Relation	SPS Complex, Nearby Community	Inspection of community relation maintaining procedures, relation building activities, FGD with community	Quarterly	EHSU Circle	Independent Monitor, RPCL
CSR Program (if any)		Inspection of record completed and planned CSR programs and activities	Six-monthly	Independent Monitor	RPCL
Fisheries	Effluent discharge points	Interviewing local fishermen	Yearly during stakeholder consultation	IM	RPCL and DoF

11.2 Implementation of Environmental Monitoring Plan

11.2.1 Responsible Agency

The Chief Engineer of the Kala Para 1320 MW coal based power plant is the responsible authority for administering and implementing the Project and implement environmental monitoring program during construction where the Plant Manager will implement monitoring plan during operation stage. During construction stage, the Environmental Compliance Monitoring will be conducted by the Contractor(s) supervised by the Owner's Engineer (OE) and Environmental Impact Monitoring will be carried out by the Owner's Engineer (OE) with the support of the Contractor(s). In addition, an independent Monitor will also be retained by PIU during three years of construction and by during three years of post-construction (operation stage). The EHSU Circle of will implement the monitoring program during operation stage.

11.3 Action during Emergent Operation

The Plant can have an Emergent operation if there is a major failure of control system, plant component, grid failure, etc. Normally the modern distributed control system (DCS) is good enough to handle all such emergencies. Otherwise, the plant operator/shift in-charge can change the plant control to manual mode and adjust the process variables and finally change the plant back to auto mode. The proposed project will have DCS control system with modern sensors and a proper interface with the existing old sensors/system.

The plant will be operated ensuring all pollution control devices are in order. In case of any event of malfunction of a pollution control device, immediate action of resolving the problem will be taken. If any emergent situation arises during operation, the shift in-charge will be immediately notified to take corrective measures and action.

11.4 Performance Indicators

For evaluating the performance of the environmental management and monitoring plan, performance indicators are identified for efficient and timely implementation of measures/actions proposed in EMP. The indicators are defined both for construction and operation phases. OE will be responsible for compiling the information on these indicators and report to RPCL.

Separate performance indicators for each environmental issue have been specified in Table 12-1, 12-2 and Table 12-3. To measure the overall environmental performance of the project, an additional list of performance indicators is provided below:

Number of inspections carried out by OE per month

- Number of non-compliances observed by OE or EHSU.
- Continuous period of non-compliance
- Number of grievances received.
- Number of grievances resolved.
- Number of construction and occupational related accidents.
- Timely reporting of documents (as defined in EMP and monitoring plan)
- Availability of environmental and H&S specialists in EHSU.

- Availability of environmental and H&S specialists in OE.
- Availability of environmental specialists and H&S with contractors.
- Number of trainings imparted to stakeholders/other capacity building initiatives

11.5 Reporting and Feedback Mechanism

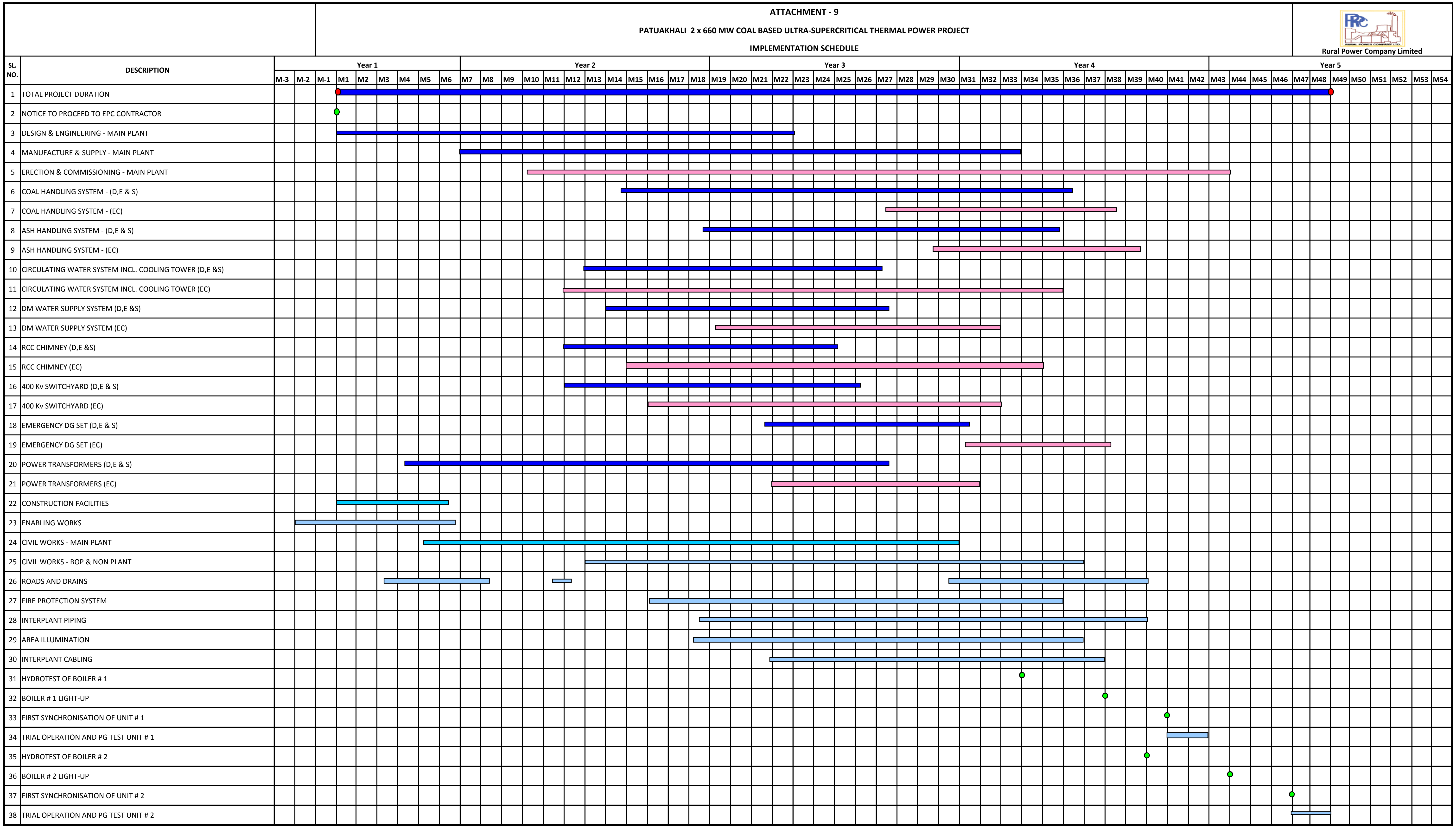
The monitoring activities will require proper documentation. In case of independent monitor, the monitoring results and relevant document should be properly reported to the project implementation authority. The project authority would submit the report to the Department of Environment and to the Financer.

During construction stage, the environmental specialist of OE will be engaged in monthly discussion meeting with the project implementation unit and the Contractor(s) for giving necessary feedback. The project implementation unit may arrange a discussion meeting quarterly with the financer regarding environmental compliance.

During the operation phase, the EHSU Circle will carry out the monitoring activities and keep all the records and results of monitoring with proper documentation and will produce quarterly reports on Environmental Monitoring. Besides, the third party Independent Monitor would prepare and submit environmental compliance monitoring report annually to the power plant authority. All the reports should be submitted to DoE which is a condition of renewing the Environmental Clearance Certificate from DoE and to the financer for post-completion monitoring and evaluation of the Project.

During operation, the EHSU Circle will give necessary feedback instantly to the person in concern. The EHSU Circle will arrange a monthly meeting to disclose the results of environmental monitoring to the personnel.

12. Project Work Plan Schedule



13. Benefit-Cost Analysis

13.1 Introduction

The feasibility is a process of checking technical feasibility, economic viability, social accountability and environmental sustainability of a project. The cost-benefit analysis (CBA) is usually carried out to examine the project feasibility and is widely used for financial and economic appraisal tool of a project. It is particularly useful when a choice has to be made out of several alternatives and when the project involves a stream of benefits and costs over time. Other issues like achieving national goal, reducing regional imbalance, national strategic planning, environmental externalities etc. are also significantly important for the project feasibility studies.

In the power sector, CBA is used as an essential tool for the policy formulation and decision making in multiple aspects like site selection, construction, operation, decommissioning, fuel quality and selling prices. The basic idea here is to evaluate whether the investment in construction, operational and maintenance costs of the power plant is justified in terms of a higher electricity production with lower external cost. Cost- Benefit is a standardized tool, but can take several forms, and is usually complemented with a number of processes. The process of cost- benefit assessment is estimated on the following process.

Financial and Economic analysis

Benefit *Cost Ratio (BCR)* – Ratio of the present value (PV) of total incremental benefits over the PV of total incremental costs

Net Present *Value (NPV)* – the difference between the PV of total incremental benefits and the present value of the total incremental costs

Internal *Rate of Return (IRR)* – The discount rate at which the PV of benefits equals the PV of costs

The financial analysis has been carried out through using of the financial model. Environmental and social protection and improvement cost are also integrated in this feasibility to assess the ultimate BCA ensuring environmental and social protection for making it acceptable. However, the environmental and social cost and benefit assessment are attempted to estimate in tangible and intangible forms as presented below.

- Externalities – Potentially to affect the third parties
- Categorize for valuation of the potential affected resources
- Environment, social protection and enhancement cost estimation
- Opportunity cost - Include the value of forgone opportunities
- Benefits of the projects – both for tangible and intangible benefits

13.2 Financial analysis

The client carried out financial analysis for 2x660 MW Coal Fired Thermal Power Plant project at Kalapara, Patuakhali. The main objective of financial analysis is to determine the requirements of funds/timing and the expected returns on investment from the points of view of the various parties involved in the financing the project. The project financial estimation has been done based on two options in the feasibility study.On the basis of certain assumptions;

the estimated cost of the project is around USD 2450 Million – USD 2775 Million. Depending on the source of funding and repayment schedules etc., the annual tariff will be computed in line with the provisions of the standard PPA terms of BPDB. The summaries of levelised tariff over 25 years are given in Table-13.1.

Table 13.1: Summary of the tariff

Case No.	Coal Jetty	Coal Quality	Levelised Tariff (25 Years)		Total Tariff		Entry Tariff
			Fixed	Variable	Labelised	1st Year	Cents/Unit
1	No	Design	2.641	2.337	4.978	6.48	8.1
2	Yes	Design	2.867	2.337	5.204	6.96	8.7
3	No	Best	2.641	2.312	4.952	6.46	8.0
4	No	Worst	2.642	2.379	5.021	6.53	8.2

Note: all tariffs are in Taka per kWh unless otherwise mentioned (FR, 2016)

13.3 Environmental and social cost – benefit assessment

Environmental and social cost – benefit is related to the externalities of the project. Carrying out this Environmental Impact Assessment (EIA) is mandatory for any power plant project in order to impede the negative externalities[9] and promote the benefit of the project. Therefore, attempts have been made to identify externalities. The importance of externalities are required for the following aspects

Specification of power stations and related facilities

- Setting of regulations in terms of technology or emissions standards and regulations based on fiscal incentives (e.g. emissions charges or laws, emissions caps etc.)
- Planning and development of power systems at the state and regional level, taking account of the environmental costs

13.4 Assessment of the externalities

The approach followed for assuming external costs is illustrated through the 'impact pathway' (Table 13.2). The impacts are assessed not just for generation stage but also for the full life cycle of the implementation process (e.g. Pre, during and post construction), including the extraction of the fuel, its transportation, transformation into electric energy, disposal of the waste, and the transport of the electricity. Emissions from a source are traced when they disperse in the environment, following which the impacts of the dispersed pollutants was estimated. The dispersion modeling takes account of the distance dispersion of the pollutants especially SOx, NOx and SPM from the power plant that causes noticeable health impacts, ecosystem impacts and aesthetic impacts. Finally, these impacts are valued both in tangible and intangible forms. All the primary, secondary and tertiary impacts are evaluated at the respective phases of the power plant projects.

[9] External costs arise when the actions of one party have impacts on another and the first party does not account for these impacts. These are normally considered to include the direct and indirect effects of air and water pollution as well as some consequences of waste disposal, land degradation, forest loss, loss of biodiversity etc.

Table 13.2: Impacts pathways of the electricity generation

Impact Category	Pollutant/Burden	Effects
Human health mortality	PM10, PM2.5, SOx, NOx, O3	Increasing of health coast, Reduction in life expectancy
Morbidity for the living beings	PM10, PM2.5, SOx, NOx, O3, CO Accidental risk	Respiratory problem, heart failure, hypertension, asthma attacks Risk of injuries from traffic and work place accidents
Detrimental to building materials	Acid rain deposition, combustion particles ,shoot, accidents	Ageing galvanized steel, limestone, paint, corrosion, soiling of the building and accidental damage
Crops and fisheries production	Loss of land, SOx, NOx, Acid deposition	Reducing production , Change in yield of wheat, tobacco, rye, sunflower seed Increased expenditure on liming
Amenity losses	Noise, visibility, artificial structure	Changing the natural habitats, ecosystems, tourisms
Ecosystem damage	Land loss, water and air pollution, anthropogenic activities, accidents	Decreasing the natural resources, Pressure on other resources, reduces eco-protection, reducing the services of ecosystem
Global warming	Emission of CO_2	Sea level rise, increasing the intensity and magnitude of natural hazards, shifting regime, salinity intrusion
Social unrest	Land procurement, employment process, benefit sharing among the whole society, accidents, livelihood security	Migration, production failure, explosion, crime or terrorisms, political agitation etc

13.5 Categorize for valuation of the potentially affected resources

The potential impacts can be categorized depending on different valuation process. The valuation process is important to determine the cost includes harnessing the potential benefits, are expressed bellow.

Direct values: These are related to the production and consumption of goods and services (e.g. primary, secondary) that could be easily traded (so that the value becomes visible) Example: Land, crops, fish, wage labor, dredging, electricity etc.

Indirect values: These are derived more from the ecological functions of the forest, which support and protect other economic activities Example: watershed protection, cyclone and storm surge protection, health, carbon sequestration, dredging spoil management, tourism, social improvement etc.

Option values: This describes the potential values that can be accrued from both direct and indirect use of the potential affected areas. Example: Coastal protection of the forests, ground water resources, benthos communities, soil microbes etc.

Non-use values: The value derived from the conserving things from for existing satisfaction and future generations. People may place an implicit value on this without any direct or indirect use. Example: Heritage, archeological site, spiritual or sacred places etc.

Intrinsic value: The value of living resources in its own right, unrelated to human utilization. Example: Asiatic elephant, Irrawaddy dolphin etc.

Monetary valuation is generally difficult for ecosystems. A number of effects including neonatal mortality, morbidity, behavioral effects, neurological disorders, allergies, innovations, life loss and intra-generational views are the major limitations of the valuation process. Not any single valuation process could count the total values of the cumulative impacts and benefit from a power plant. Moreover, valuation of environmental externalities is very difficult considering its multidimensional aspects like determination of statistical life loss, willingness to pay for developing countries etc. Therefore, this report has the limitation in valuation of the intangible variables into monetary terms.

13.6 Measures to control pollution and enhance the benefits

The use of technology and measures are clearly very important as technologies differ in the emissions generated from the power plant and finally the location of the plant remains a key factor. Air and water pollutants disperse quite widely and over long period of time, resulting the risk of damages occurring outside the normally considered range. To avoid any kind of damages and keep the environment clean as present, a number of modern technologies have been strictly adopted and multiple measures have been taken care of. This Plant will consist of ultra-supercritical boiler, ESP,FGD, Advanced LNB, Cooling Tower, provision of SCR, Ash impoundments, high stack, multi cylinder design condensing type steam turbine directly coupled with hydrogen cooled generator suitable for indoor installation will be the major pollution abatement /benefit enhancement measures of this project. Those have been elaborated in the respective sections of the project description and environment management plan appended in earlier chapters.

13.7 Cost of the environmental measures

The project covers 915.7 acres of land that is mainly occupied with agricultural land and smaller homesteads. The process of land procurement has been completed maintaining a good compensation package. The PAPs have taken it an opportunity to resettle them in condition which is the main mandate as per WB rehabilitation and resettlement plan.

Advanced technical measures have been adopted to control the pollution from the power plant and regular monitoring of the ambient environment will be carried out for ensuring a health environment for the living bodies. A number of management plans will be implemented for sustainable operation of the project in association with ecosystem and social sustainability. However, the estimated costs for environmental protection, monitoring, and management plans will have be included in the project cost for project financing.

The Project Authority should have to decide spending a significant fund for CSER (Corporate Social and Environmental Responsibility) in order guide social protection as well as regional social development activities.

13.8 Opportunity cost

The opportunity cost is the "cost" (as a lost benefit) of a forgone product after making a choice. It is the sacrifice of benefit related to the second best choice through the use of resources. Existing use 915.7 acres of land resources for agriculture, fisheries and households and other purposes are the main alternatives instead of the power plant project. Thus, opportunity costs are not restricted to monetary or financial costs: the real cost of output forgone, lost time, pleasure or any other benefit that provides utility should also be considered opportunity costs. However, the benefit from this land (according to feasibility report) will cover the entire opportunity cost satisfactorily.

13.9 Benefit of the projects

The benefit of the project has been estimated into tangible and intangible terms. The prime objective of this power plant project is to ensure reliable supply of electricity and enhance the energy scenario of the country. This project will add 320 MW electricity to the national grid. Coal has been selected as fuel in consideration to reduce pressure on the national natural gases reserve and lowering the production cost of electricity. The project site has been selected through considering the techno-economic feasibility and all environmental relevant concern.

In order to capture all relevant benefits associated with electricity generation, the externalities will be categorized in life cycle subcategories, including construction; fuel acquisition and transportation; operations and maintenance; and waste and decommissioning. Benefits have also been organized into three broad categories e.g. environmental, socioeconomic and national energy security.

Proper monitoring and proposed control measures will ensure a healthy environment around the project site. Other associated activities, control measures and programs will ensure the sustainability of the ecosystem and regional social development. The positive externalities or benefits are pointed out bellow.

13.9.1 National energy security

Each power plant will generate around 98289 GW electricity per year at 85% PLF. The levelized tariff is USD 4.9-5.2 Tk/kWhr. National energy security externalities include the potential benefits associated with increasing energy independence in contrast to import direct electricity or virtual electricity. National economy will be based on human capital and natural capital which simultaneously will be influenced by the regional economies. Ensuring the supply of electricity may trigger the regional development directly or indirectly.

Industrial development: Reliable supply of electricity will accelerate the development of Patuakhali industrial zone as well as associated areas.

Development of irrigation system: At present, the irrigation facility is not well developed in Bangladesh because of electricity shortage. Supply of sustainable electricity to the national grid will facilitate increasing irrigation coverage, cropping intensity, more crop production and agro-based industries significantly.

Quality of life improvement: Availability of power supply will promote accessibility of the mass population to standard quality of life. Generation of electricity will increase the domestic household coverage as well as per capita rate of energy consumption. Other accessories facilities, cultural values and recreation activities are likely to be enhanced after reliable electricity supply.

13.9.2 Socio-economic benefits

Socioeconomic externalities associated with the electricity generation include a wide range of social, cultural, and direct economic impacts. During one or more phases of an electricity generation life cycle there can be impacts related to view sheds, infrastructural development, regional tourism, recreational activities, and cultural resources etc. In general, well-established methodologies exist to measure or estimate the magnitude of these impacts.

Aesthetic resources: The Net impacts are considered since intangible benefits may be derived from perceived visual improvements (e.g. planned industrial area, green belt development etc.).

Social development program: The project authority will spend significant amount of money against CSER (Corporate Social and Environmental Responsibility) fund for regional social and environmental development activities on the following major headings -

- Construction of roads
- Improvement of water supply and sanitation
- Regional electricity supply
- Establishment and development of educational institutions
- Initiation of educational scholarships
- Improvement of health and Medicare facilities
- Development of cultural and sports facilities
- Skill or capacity build up training program
- Livelihood development
- Improvement of the quality of life style

Infrastructure development: High investment projects like power plant projects generates a number of secondary benefits. It will be tempting to include as many of them as possible. Enough secondary benefits calculation will support to accept this project remarkably. In regional macro-economic investment, a certain development will result in such sectors as roads, railways and waterways, hotels, health complexes, institutions, industries, communication and service sector improvement etc. A large project has linkages to the rest of the economy, buying materials and inputs, paying workers etc. Therefore, national product continues to increase through this multiplier effect.

Employment opportunity: It is evident that the increasing supply of electricity directly or indirectly promote the economic productivity. It will be not only for the power plant related services but also for other industries. Factories, farms, organizations, business house will create opportunity which will reduce regional unemployment as well as disguised employment.

Health improvement: Development of employment opportunities, quality of life and ambient environmental monitoring will ultimately improve the health facilities of the project area remarkably.

Urbanization: Development of new townships, industrial zone, infrastructures, institutions etc. will promote the project area towards urbanization and improve the facilities of existing urban areas.

Institutional development: High investment for a particular development projects will influence multiple sectors to share the benefit. A number of institutions will be created related to the project activities over the year. Creation of service sectors will assist the population in achieving standard quality of life. However, this project will indirectly assist to achieve the important national goal especially Education for all and quality of health facilities.

Improve communication facilities: Development of existing roads will facilitate the regional communication systems. Moreover, dredging for coal import will play a crucial role in the communication system.

13.9.3 Environmental benefits

The proposed project may have sensitivity to environment and thus some measures have been taken beyond regulatory requirements that are introduced in the EIA and EMP. Those measures include: corporate social responsibility, green belting around the proposed project site, social service related facilities etc.

Positive and negative externalities associated with the environment fall into two general categories. A second category of environmental impact involves benefits and costs associated with the generation of atmospheric emissions and waste streams released to the natural environment, particularly during operation of a generation facility. Utilization of pollution abatement measures and monitoring the ambient environment (e.g. air, water, acoustic) will keep a pollutant free environment. In order to compensate the negative impacts, some of the offsetting initiatives will have to be adopted which are describe bellow-

- Ecosystem improvement facilities: The afforestation program, fisheries management program, dolphin and turtle conservation program etc will mitigate the negative impact of the project and ensure enhancement of the ecosystem.
- Disaster management program: Structural development and creating awareness program will enrich the disaster management system in that region.
- Ambient environmental quality: Regular monitoring of air, water and acoustic environment at specific locations will ensure the quality of the environment.
- Green development: Afforestation, community forestry, buffer zone creation are aimed at developing a green belt around the projects. Moreover, coastal protection works and regular monitoring will indirectly reduce the risk of tidal surge inundation.
- Market development: Development of any project invariably increases market facilities, communities, infrastructure etc. Therefore, enhanced facilities of value chain for the products, reduction of transportation costs and regional industries and business development will be significant.

However, this power plant project will generate a productive surge to the industrial, agriculture, domestic and service sectors. Sufficient supply of energy will assist to fulfill our domestic demand as well as stir each of the productive sectors to compete in international markets in order to improve the national growth rate. Otherwise, import of electricity will increase pressure to the national economy as well as dependency on the imported countries.

13.10 Measures under corporate social and environmental responsibility (CSER)

Corporate Social and Environmental Responsibility (CSER) has become an important part of corporate obligations reflecting non-financial aspects of an organization’s performance such as RPCL. These CSER activities have significant implications for a company’s internal and external stakeholders, including nearby communities, civil society organizations, regulators, international financial organizations, NGOs and news media. Local people have the concern about corporate accountability and the impact of corporate strategies and operations on the physical, economic, and socio-political environments. Financial analysts often view adverse public opinion on corporate social performance as a measure of long-term reputational risk to a company's market value. Thus, CSER have become a competitive tool in promoting an organization's practices and values when compared with those of its peers and competitors. In connection of the CSR activities as described above, the proposed RPCL-Pyra power plant project has outlined the following proposals:

- The health facility presently available in the project study area is not adequately supportive to the present human resources and particularly during implementation of the proposed project. It needs to expand its extent considering the human resources for this proposed project. This facility can also be available for the poor people around the project site and appropriate security measures may be taken for all these facilities as well;
- Providing sanitation facilities, such as setting up of public toilets at different hot spots around the Project site particularly most sensitive areas. Management of those toilets may be based on lease system, so that it remains usable over a long period to a large number of people;
- Training of local youth to be conducted so that they can, in turn, be employed during project construction and operation period. Bangladesh is one of the major manpower supplying countries of the world. But it supplies non-skilled to semi-skilled manpower particularly in the Middle East and South East Asian countries and earns low foreign currency compared to the countries which provide skilled manpower. There is a huge demand of technicians in the power sector. So, there is a scope of developing manpower in regard to technicians capable to work in power sector which help to earn more foreign currency. Therefore, this Project can facilitate capacity development of the local youths through relevant training programs.
- Develop socio-cultural facilities such as mosques, playgrounds and community centers for the community.
- Capture fisheries conservation plan and promoting culture fisheries in the study area though training and building up cooperatives
- The irrigation cost per hectare of land is about Taka 10,500.00, if the water is directly withdrawn from the ground water aquifer. But the use of treated waste water and cooling water discharge for irrigation purpose will reduce cost significantly.

13.11 Greenbelt Development

To avoid dust particulates and other environmental pollutants i.e. noise from project site a plantation plan has been developed to implement. The five tier protection system is designed towards the control of environmental pollution to ensure healthy environment in and around the project area. The greenbelt will minimize the ambient noise generated from the power plant as well as help attenuate dusts. In this sense broadleaved, rough barked and tall trees are in plan to execute the plantation program. Of the five rows, the first row will be with some medicinal and ornamental plants, and the rest are mixed of medicine, timber and fruiting species (**Figure 13.1**)

Figure 13.1: A typical greenbelt around the proposed Thermal Power Plant (TPP)

14. Public Consultation and Disclosure

14.1 Introduction

Stakeholder consultation is the way to involve the stakeholders (both direct/indirect and/or primary/secondary) in the project cycle. In preparation and execution of the Environmental Impact Assessment (EIA) and Resettlement Plan (RP) of a development Project, the Public and stakeholder consultation and their participation is mandatory.

Public and stakeholder consultation is a part of EIA and RP aimed at involving the Project stakeholders into the Project development and implementation process. During the consultation process of the proposed "Power plant", the Project interventions and their likely impacts were shared with the Project stakeholders in the formal/informal meetings/discussion sessions.

In the consultation process, the stakeholders got involved with the Consultants and Project Proponent, and share their problems, needs and aspirations in a participatory way. In this process RPCL as the Project Proponent would obtain stakeholders' views and feedbacks on the proposed interventions and perceptions on the probable changes likely to be happened in future within the Project area.

14.2 Approach

Participatory approach was followed for identifying the participants as well as conducting the consultation meetings/discussion sessions. Initially, the study team consulted with the Project Proponent for understanding the Project interventions and the potential stakeholders. The key stakeholders including occupational groups were identified through consultation with local knowledgeable people and representatives of the local government institutions (LGIs). The meeting ensured common and equal platform of the participants so that stakeholders can express their opinion in an enabling environment. The Consultants unfolded the issues and in return, the participants gave feedback on these issues and in some cases opened two-ways discussions in the meeting. The consultation process was intended to generate an enabling participatory environment between the Project Proponent and the potential stakeholders through the intermediaries of the Consultant.

14.3 Methodology

14.3.1 Identification of stakeholders

Stakeholders include all those who are being affected by policies, decisions or actions within a particular system. Stakeholders can be groups of people, organizations, institutions and sometimes even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

14.3.2 Primary stakeholders

Primary stakeholders are those people who would be directly benefited or impacted by a certain project intervention. In the context of the proposed Project, the primary stakeholders include the people living within the vicinity of the Project area. The primary stakeholders of the

Project include the farmers, fishermen, local business community who would lose their land, crop and trees.

14.3.3 Secondary stakeholders

This category of stakeholders pertains to those who may not be directly affected but have interests that could contribute in preparing the project; play a role in implementation of RP at some stage; or affect decision making on Project aspects. NGOs, government departments concerned, and line agencies fall under this category.

Secondary stakeholders for this Project include RPCL, LGIs, NGOs, local knowledgeable/influential persons and general stakeholders.

14.4 Venue, date and time of consultation

Venue, date and time of meeting/discussion was selected in consultation with the representatives/officials of LGIs, local knowledgeable people, and the Project Proponent. The venue was selected considering the closeness to the proposed interventions, easy accessibility to the venue and which is likely to be neutral. Date and time was also finalized in this way considering availability of the participants, ensuring the maximum participation, weather and compliance with other arrangement.

14.4.1 Enlisting and Invitation

A comprehensive list of potential stakeholders was prepared through the consultation with local knowledgeable people. This list was intended to cover all sorts of interest groups, occupational groups, socially acceptable and knowledgeable people. Using the LGIs channel and local influential people, necessary invitation was made to the participants and also communicated by the study team over telephone for ensuring their presence in the meeting.

14.4.2 Consultation Instrument

Checklist: A comprehensive checklist covering all possible issues was prepared through consultation with the study team. This checklist was used in the meeting/discussion to unveil peoples' perception and opinion along with suggestions.

Attendance list: An inventory of the participants was maintained in attendance sheet containing name and contact number. List of participants is presented in the **Appendix -XIV.**

Camera: For visualizing the participants, photographs were taken using camera. These photos are presented in this chapter.

14.4.3 Consultation Process

The EIA study team conducted the meeting/discussion. During consultation meeting, the following process was followed.

Greetings: At the outset of consultation meeting, the team exchanged greetings with all participants, welcomed them for attending the meeting and explained the entire design of the meeting/discussion.

Introduction: The team members introduced themselves to the participants and gave detail description of the Project, spelled out about the objectives and anticipated outcome of the meeting/discussion.

Respect to the participants: The study team showed respect to all participants. They respected not only to the individuals but also to their values, cultural practices and social structures.

Ensuring peoples' voice: generally, not all participants can participate equally. In fact, a large number of participants tend to remain silent in any meeting. However, the study team encouraged all to participate willingly through explaining the ethics of the study.

Note taking: Study team discussed issues and wrote opinions in notebook carefully giving equal importance to all issues.

Recapitulation and closing the session: At the end, the study team recapitulated the session and responded to the quarries. Finally, the facilitator closed the session thanking the participants.

14.5 Objectives of the Consultation

The main objective of the stakeholder consultation is to involve the stakeholders in the project cycle and explore stakeholders' perception and attitude regarding the proposed Project. The specific objectives were to:

- Ensure peoples' participation in the proposed Project;
- Share experiences of the participants regarding such project over the years;
- Explore problems of the Project area;
- Understand probable solution of the problems;
- Unfold stakeholder's attitudes towards the project;
- Unveil the potential negative or positive impacts of the proposed project;
- Outline potential mitigation measures for negative impacts and enhancement measures for the positive impacts;
- Obtain the demand and aspirations of the stakeholders; and
- Create highest possible advancement from the project.

14.6 Locations of Stakeholder Consultation Meetings

A number of formal and informal consultation meetings/discussions were conducted at different locations in and around the proposed Project area. The meetings/discussions locations are presented in **Table 14.1.**

Table 14.1: Different locations of consultation meetings

District (s)	Upazila (s)	Unions	Meeting Place	Date
Patuakhali	Kalapara	Dhankhali	South Dhankhali	26/06/2016
Patuakhali	Kalapara	Dhankhali	Londa	28/06/2016

14.7 People's perceptions on Project problems and suggested measures

The Consultants have discussed with the participants about the proposed Project interventions and the process of peoples' participation in preparing the EIA and RP. The people of the Project area have already learned about the proposed Project from the officials of RPCL and Consultants who frequently visited the Project area. The people of the Project area are aware of probable impacts of the Project.

Local people identified some problems in the consultation meeting. Major problems likely to be happened are:

- Number of farmers will lose agricultural production land;
- The Power plant may damage the agricultural lands permanently;
- A number of people will be venerable due to land acquisition;
- Some peoples occupation may be change; and
- Number of households will be disturbed during Project implementation.

The local people also expressed concern that it may be difficult to cultivate crop close to the power plant area. It also may create problems for cattle rearing throughout the year.

14.8 Feedbacks on consultations

The stakeholders identified the prediction as well as problems of the Project and recommended solutions as per their perceptions. The recommendations were duly recorded in the meeting, and documented in the EIA and RP. The concerns, issues, and recommendations are presented in various tables (**Table 7.2 to Table 7.4**) below.

During the consultations, the stakeholders perceived the overall benefit and adverse impacts of the Project. **Table 14.2** presents the perceived outcomes of the proposed Project as discussed in the meetings/discussions.

Table 14.2: Perceived outcomes of the Project

Issues	Observations by the participants
Benefits of the Project	• Generating electricity and added to national grid • Ensure continual electricity supply with full voltage; • Setting up new industrial area along with heavy and medium industry using the generated power; • Creating probability to grow up commercial; • Deep sea port will be promoted more efficiently • Communication (roadway and waterway) facility may be developed
Adverse impacts of the Project	• Local people will lose their lands; • The number of jobless families (land based) will increase due to the land acquisition; • Affected people will lose their work, wages and employment which will have an impact on income and livelihood; • Sound and air pollution will increase during construction of the Power Plant; • Cropped land, crops and perennials will be lost due to the establishment of Power Plant.

The general issues and concerns that were discussed in the consultation meetings are presented in **Table 14.3.** The stakeholders opined that, the selection of area for the Project interventions should be done properly through intensive surveys in the field along with necessary consultation with the local community. The effect of the land acquisition on asset and income of the communities as perceived by the community are given below in the table.

Table 14.3: Impacts of land acquisition as perceived by the stakeholders

Issues	Observations made at the stakeholders meetings/discussions
Project area (Power plant)	• The Project implementers should consider avoidance of settlement, local establishments, crops and other assets as much as possible; • Consider barren agriculture field/fallow land for Power Plant;
Effect of the land acquisition on asset	• Some affected person (AP) will lose their land , crops • Project affected people will lose their livelihood • As a result of land acquisition, agriculture/fish production/income will be reduced to some extent.
Effect of the land acquisition on work /source of income	• Acquisition of agricultural land will reduce the current scope of employment; • The APs would lose their jobs, income and wages to some extent; • Temporary loss of jobs/work will hamper income sources to some extent from agricultural crop/labor wage; • Disturbance of income sources will cause insecurity of food, accommodation, education facilities etc. for some of the APs. • Day laborers/landless people will lose work; therefore, livelihoods

The opinion on compensation issues e.g. type and form of compensation; mechanism and modalities of compensation payment including suggestions offered by the people are given in **Table 14.4.**

Table 14.4: Issues and concerns regarding compensation

Issues	Concerns regarding compensation and suggestions
Compensation against loss	• Real land owners and sharecroppers should be identified through proper survey; • APs should be provided replacement value of land and other assets according to the current market price considering the land value of the external area of the project; • Loss of standing crop, trees, ponds etc. should be compensated at market price; • Transparent and hassle-free compensation payment mechanism is expected by the APs; • At a time the compensation for land has to be paid in full to the poor APs; • The payment of compensation should be accomplished without any harassment.
Compensation for vulnerable population	• The needs of women and vulnerable groups (VGs) should be identified properly and special attention should be given to them; • Employment and income of subsistence to improve VGs' status/livelihoods; • Potential VG members should be engaged as unskilled laborers during the construction period; • Provision should be kept for social and economic development support, • Alternative assistance should be given to affected small/marginal/tenant farmers so that they can become resilient. • Creating income generating opportunities for the vulnerable population;
Mechanism of compensation	• A neutral monitoring agency should be engaged for monitoring the compensation activities; • Compensation money should be given to the APs in the presence of LGIs;

Issues	Concerns regarding compensation and suggestions
	• External monitoring agency should be engaged for monitoring the compensation activities to be conducted by INGOs; • Payment of compensation by bank check or by deposit into the bank account may be introduced to reduce immediate opportunities of extortion; • The grievance redress committee should play a proper role in determining the ownership of land.

14.9 Summary of Consultation Output

Based on the discussions at the consultation meetings, the Project stakeholders have identified probable losses, potential impacts and mode of compensation payment for the affected households (AHs). It was explained clearly at the meetings that land for land as an alternative was not an option in this Project; however, adequate compensation will be paid against the losses. The following summary (Table 14.5) findings of the consultation meetings/discussions would help the Project Proponent in carrying out the RP properly:

Table 14.5: Summary findings from the consultation meeting/discussion

Issues	Problems	Suggested measures
Impact on agriculture	• Agricultural land will be reduced; • Cropped land will be lost;	• Avoid agricultural land for acquisition; • Barren/fallow land should be selected for power plant;
Impact on Fisheries	▪ According to the opinion of the participants, the river Andharmanik has declared as Hilsa sanctuary by government and plays an important role in national capture fisheries. The Rabnabad channel is one of the significant spawning of Deshi Pangus, Prawn and Shrimp. These Prawn and Shrimp PL are harvested from the Rabnabad channel during February to July by fine mesh nets and sell out to the prawn and shrimp farmers of Khulna, Jeshore, and Satkhira. ▪ Today, there were lots of fishermen including boat dwelling fishermen fishing in the river and linked water bodies. However, their numbers are gradually reduced. ▪ Release of untreated effluent may hamper the local aquatic habitat quality and the Pangus fingerling, Prawn and Shrimp PL availability as well. Overfishing, by fine mesh nets (unconventional), also lead to the death of many fingerlings and fish species. ▪ In the coming years when more power plants shall come under operation, the amount of effluent will be increased manifold. As such there would be a huge possibility of deterioration of water quality and thus the habitat quality as well. ▪ Extraction of river water may decrease the river Water Availability in the dry season and thus capture fish production may be declined.	▪ Effluent should be released in the open environment through proper drainage system with due treatment complying with national and international standards, so that habitat quality remain congenial for the inhabitants. ▪ Rain water can be harvested during rainy season and would be used in the dry season based on the project situations and other dependent issues.

Issues	Problems	Suggested measures
Ecological impact	• Terrestrial vegetation will be demolished due to site clearing, stockpiling of construction material and labor shed development; • Waders both resident and migratory will impacts negatively during construction and operation phases; • The benthos of water ways where dredging is designated will be destroyed totally.	• Limit vegetation loss during clearing sites for land development, stockpiling of construction materials and labor shed development; • Avoid waders' feeding ground during construction and operation period; • Implement construction works segment-wise to minimize negative impacts to benthic community.
Socio-economic impact	• Farmer can't buy agricultural land; • Lack of employment opportunity due to impact on agriculture sector	• Distribute Khas land to the APs of small/marginal farmers; • Give proper compensation to the land losers; • Avoid the homestead areas; • Local people should be engaged in the construction activities, thus employing them; • Compensating the affected people who would be losing their lands

14.10 Disclosure of the EIA study

The Center for Environmental and Geographic Information Services (CEGIS) organized a public disclosure meeting for exposure of the proposed "Kalapara 1320 MW coal based power plant Project" at the Kalapara Upazila Parishad conference room on August 18, 2016.

14.10.1 Approaches of the Public Disclosure Meeting

The main purpose of the PDM was to disclose the findings of EIA study to the key stakeholders and take suggestions from them. To serve that purpose it was mandatory to gather key stakeholders at a certain venue (Upazila Parishad conference room). To make the meeting successful and to ensure maximum participation, an advertisement was published in the local daily newspaper, invitation card was distributed to the stakeholders, postering at the public places. During the disclosure meeting, leaflets were distributed among the participants for awaring to the PAPs about the power plant. Moreover, the program has been recorded for future reference. The list of the participants and few photos of the disclosure meeting are presented in Table – 14.7 and Photo – 14.3.

আল্লাহ্ ছাড়া কাউকে ভয় করে না

আজকের বার্তা

বরিশালের সর্বাধিক প্রচারিত রঙ্গীন দৈনিক

প্রতিষ্ঠাতা ঃ কাজী নাসির উদ্দিন বাবুল

হন্ডুরাসের মাথা ব্যথা কারণ নেইমার
বার্তা ডেস্ক ॥ এবারের অলিম্পিকের ফুটবলে শুরুটা ভালো হয়নি স্বাগতিক দেশ ব্রাজিলের। প্রথম দুই ম্যাচে ড্র করে কোয়ার্টার ☞ পাতা ২ কলাম ১

সোনালী অগ্রণী রূপালী ব্যাংকে নতুন এমডি
বার্তা ডেস্ক ॥ সরকারি মালিকানাধীন তিন বাণিজ্যিক ব্যাংকে সোনালী, অগ্রণী ও রূপালী ব্যাংকে নতুন ব্যবস্থাপনা পরিচালক ☞ পাতা ২ কলাম ১

জেএমবির ৪ নারী সদস্য গ্রেফতার
বার্তা ডেস্ক ॥ রাজধানীর বিভিন্ন এলাকা থেকে নিষিদ্ধ জঙ্গি সংগঠন জামাআতুল মুজাহিদীন বাংলাদেশের (জেএমবি) ☞ পাতা ২ কলাম ১

প্রতিষ্ঠাবার্ষিকীতে সরকারের সহযোগিতা চায় বিএনপি
বার্তা ডেস্ক ॥ দলের ৩৮তম প্রতিষ্ঠাবার্ষিকী উপলক্ষে রাজধানীতে জনসভা ও র‍্যালি করতে চায় বিএনপি। একইসঙ্গে ☞ পাতা ২ কলাম ২

রেজিঃ নং-কেএন ৩২৭ ॥ বর্ষ ২৫ ॥ সংখ্যা ২০৪ ॥ বরিশাল ॥ বুধবার ॥ ১৭ আগস্ট ২০১৬ ॥ ২ ভাদ্র ১৪২৩ ॥ ১৩ জিলকদ্ ১৪৩৭ হিজরী ॥ ৪ পৃষ্ঠা ॥ মূল্য ৪ টাকা। www.ajkerbarta.com

বিজ্ঞপ্তি

রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, ২০১০' এর আলোকে দেশের সকল ঘরে বিদ্যুৎ সরবরাহ করতে বর্তমান সরকার প্রতিশ্রুতিবদ্ধ। সে লক্ষ্যে রুরাল পাওয়ার কোম্পানী লিঃ (RPCL) পটুয়াখালী জেলার কলাপাড়া উপজেলাধীন ধানখালী ইউনিয়নে কয়লাভিত্তিক তাপ বিদ্যুৎকেন্দ্র নির্মাণ করে ১৩২০ মেগাওয়াট বিদ্যুৎ উৎপাদনের লক্ষ্য নির্ধারণ করেছে। উক্ত প্রকল্প বাস্তবায়নের ফলে উদ্ভূত পরিবেশগত ও আর্থ-সামাজিক প্রভাব সমীক্ষা নিরূপণের জন্য পানি সম্পদ মন্ত্রনালয় অধীনস্থ সরকারী ট্রাস্ট, CEGIS-কে দায়িত্ব দেয়া হয়েছে। এরই অংশ হিসেবে জনগণের সুচিন্তিত মতামত ও পরামর্শ গ্রহণের লক্ষ্যে আগামী ১৮ আগষ্ট, ২০১৬ ইং তারিখ রোজ বৃহস্পতিবার বেলা ১০:০০ ঘটিকায় কলাপাড়া উপজেলা পরিষদ সম্মেলন কক্ষে একটি মতবিনিময় সভার আয়োজন করেছে। উক্ত মতবিনিময় সভায় উপস্থিত থেকে উপরোক্ত বিষয়ে আপনাদের সুচিন্তিত মতামত প্রদান করার জন্য সাদরে আমন্ত্রণ জানানো যাচ্ছে। ধন্যবাদ।

Note: Advertisement to the local news paper

পত্র প্রাপ্তির কমান্ড(জেষ্ঠ্যতার ক্রমানুসারে নয়)ঃ

ক্রমিক নং	পত্র প্রাপকের নাম ও ঠিকানা	পত্র গ্রহনকারীর স্বাক্ষর ও তারিখ
১	জনাব মোঃ সুলতান মাহমুদ,সাবেক ভাইস চেয়ারম্যান, উপজেলা পরিষদ,কলেজ রোড, খেপুপাড়া	[illegible]
২	জনাব এস এম রাকিবুল আহসান, সাবেক মেয়র, কলাপাড়া পৌরসভা, এতিমখানা রোড, কলাপাড়া	[illegible]
৩	জনাব এস এম মনজুরুল আহসান, সভাপতি দূর্নীতি প্রতিরোধ কমিটি, ফেরীঘাট, কলাপাড়া	[illegible]
৪	জনাব এবি এম মোশাররফ হোসেন, সভাপতি, উপজেলা বিএনপি, এতিম খানা রোড, কলাপাড়া	[illegible]
৫	জনাব মোঃ দেলোয়ার হোসেন, অধ্যক্ষ, এমবি ডিগ্রী কলেজ	[illegible]
৬	জনাব সৈয়দ নাসির উদ্দিন, সাবেক অধ্যক্ষ, মহিলা কলেজ, নতুন বাজার, খেপুপাড়া	[illegible]
৭	জনাব নুর বাহাদুর তালুকদার, সাবেক উপাধ্যক্ষ এমবি ডিগ্রি কলেজ, এতিম খানা রোড, কলাপাড়া	[illegible]
৮	জনাব হাজী মোঃ হুমায়ুন সিকদার, সাবেক মেয়র,কলাপাড়া পৌরসভা, মাদরাসা রোড, কলাপাড়া।	[illegible]
৯	জনাব নুরুল হক মুন্সি, সভাপতি ব্যবসায়ী সমিতি, পশু হাসপাতাল রোড, কলাপাড়া	[illegible]
১০	জনাব দিদার উদ্দিন মাসুম বেপারী, সহ সভাপতি, পৌর আওয়ামীলীগ, মাদরাসা রোড, কলাপাড়া।	[illegible]
১১	জনাব সৈয়দ আখতারুজ্জামান কোক্কা, সাবেক ইউপি চেয়ারম্যান, টিয়াখালী, এতিম খানা, কলাপাড়া	[illegible]
১২	জনাব মোঃ মনজুরুল আলম, সাংগঠনিক সম্পাদক, উপজেলা আওয়ামীলীগ, রহমতপুর, কলাপাড়া	
১৩	জনাব মোঃ শহিদুল আলম, উপাধ্যক্ষ, এমবি ডিগ্রী কলেজ, কলাপাড়া	[illegible]
১৪	জনাব [illegible] হোসেন, সভাপতি, জাতীয়পার্টি, কলেজ রোড	[illegible]

পত্র প্রাপ্তির কমান্ড(জ্যেষ্ঠতার ভিত্তিতে নহে)

ক্রমিক নং	পদবী ও ঠিকানা	পত্র গ্রহন কারীর স্বাক্ষর ও তারিখ
১	উপজেলা মৎস্য অফিসার, কলাপাড়া।	
২	উপজেলা কৃষি অফিসার, কলাপাড়া।	
৩	প্রাণি সম্পদ কর্মকর্তা, কলাপাড়া।	
৪	উপজেলা প্রকৌশলী, কলাপাড়া।	
৫	উপজেলা ভাইস-চেয়ারম্যান (পুরুষ),কলাপাড়া।	
৬	উপজেলা ভাইস-চেয়ারম্যান (মহিলা),কলাপাড়া।	
৭	মুক্তিযোদ্ধা কমান্ডার, কলাপাড়া।	
৮	সভাপতি, উপজেলা আওয়ামীলীগ, কলাপাড়া।	
৯	সাধারণ সম্পাদক, উপজেলা আওয়ামীলীগ, কলাপাড়া।	
১০	স্বাস্থ্য ও পরিবার পরিকল্পনা কর্মকর্তা, কলাপাড়া।	
১১	মাধ্যমিক শিক্ষা অফিসার, কলাপাড়া।	
১২	পল্লী উন্নয়ন কর্মকর্তা, কলাপাড়া।	
১৩	মহিলা ও শিশু বিষয়ক কর্মকর্তা, কলাপাড়া।	
১৪	সমবায় অফিসার, কলাপাড়া।	
১৫	সমাজসেবা অফিসার, কলাপাড়া।	
১৬	আনসার-ভিডিপি কর্মকর্তা, কলাপাড়া।	
১৭	প্রকল্প বাস্তবায়ন কর্মকর্তা, কলাপাড়া।	
১৮	উপজেলা যুব উন্নয়ন অফিসার , কলাপাড়া।	
১৯	প্রাথমিক শিক্ষা অফিসার, কলাপাড়া।	
২০	মেয়র, কলাপাড়া পৌরসভা, কলাপাড়া।	

Note: Invitation cards were distributed to the stakeholders including the local PAPs

কলাপাড়া ২x৬৬০ মেগাওয়াট কয়লা ভিত্তিক তাপ বিদ্যুৎ প্রকল্প, কলাপাড়া, পটুয়াখালী

আজকের সভার মূল উদ্দেশ্য হচ্ছে প্রস্তাবিত ২x৬৬০ মেগাওয়াট কয়লাভিত্তিক তাপ বিদ্যুৎ প্রকল্প স্থাপিত হলে প্রকল্প সংলগ্ন এলাকায় কী ধরণের পরিবেশগত ও আর্থ-সামাজিক প্রভাব পড়তে পারে এবং নিরূপিত প্রভাবের প্রতিকার সম্বন্ধে এলাকার জনগোষ্ঠীর মতামত গ্রহণ করা। একই সাথে প্রকল্প নকশা ও নির্মাণ পর্যায়ে জনগণের প্রস্তাব নেওয়া যাতে প্রকল্প বাস্তবায়নে তাদের আকাঙ্খার প্রতিফলন ঘটে।

- বাংলাদেশ সরকার ক্রমবর্ধমান বিদ্যুতের চাহিদা মেটানোর নিমিত্তে একটি মহাপরিকল্পনা (PSMP) বা জ্বালানী নীতিমালা প্রণয়ন করে যার মূল প্রতিপাদ্য বিষয় সমূহ ছিল:
  - জ্বালানীর বিভিন্নমুখী করণ যেমন: গ্যাস, কয়লা, ফার্নেস অয়েল, এলএনজি ইত্যাদি
  - জ্বালানীর উৎস সনাক্তকরণ ও এর সর্বোত্তম ব্যবহার নিশ্চিত করণ
  - জ্বালানী উৎসের ও সরবরাহের সুবিধাদির ভিত্তিতে বিদ্যুৎ প্রকল্প নির্মাণের স্থান নির্বাচন করণ
  - বিদ্যুতের ক্রমবর্ধমান চাহিদার উপর ভিত্তি করে উৎপাদন ক্ষমতা বৃদ্ধি করা যা জাতীয় বিদ্যুৎ গ্রীডকে সংহত করার মাধ্যমে নিরবিচ্ছিন্ন বিদ্যুৎ সরবরাহ ঘাটতি মেটাতে পারে।

- রূপকল্প-২০২১ অনুযায়ী 'পাওয়ার সিস্টেম মাস্টার প্লান, ২০১০' এর আলোকে দেশের সকলের নিকট বিদ্যুৎ সরবরাহ করতে বর্তমান সরকার প্রতিশ্রুতিবদ্ধ। সে লক্ষ্যে রুরাল পাওয়ার কোম্পানী লি: (RPCL) পটুয়াখালী জেলার কলাপাড়া উপজেলাধীন ধানখালী ইউনিয়নে কয়লাভিত্তিক বিদ্যুৎকেন্দ্র নির্মাণ করে ২x৬৬০ মেগাওয়াট বিদ্যুৎ উৎপাদনের লক্ষ্য নির্ধারণ করেছে।

- এ কথা সত্য যে প্রস্তাবিত প্রকল্পে প্রায় ৯১৫ (নয়শত পনের) একর জমি হুকুম দখল করা হবে যার বিনিময়ে সরকারি নিয়মে ক্ষতিপূরণ প্রদান করা হবে। এসব বিষয়ের প্রতি লক্ষ্য রেখেই সিইজিআইএস (CEGIS) পরিবেশগত ও আর্থসামাজিক সমীক্ষা প্রতিবেদন তৈরি করছে যাতে এ ব্যাপারে বিস্তারিত আলোচনা ও প্রস্তাবাদি সন্নিবেশিত করা হচ্ছে।

- প্রস্তাবিত বিদ্যুৎ প্রকল্পের মূল বিষয় বস্তু সমূহ হলো:
  - কয়লা বিদেশ থেকে আমদানী করা হবে
  - মান অনুসারে এক টন কয়লা ব্যবহারে প্রায় ৯. ৪-১০ মে.ও. বিদ্যুৎ পাওয়া যাবে
  - এই প্রকল্পে ১টি Steam টারবাইন, ১টি Ultra-supercritical Boiler থাকবে।
  - প্লান্ট মেক-আপ ও অন্যান্য কাজে পানির প্রয়োজন: ৩১৪৭ ঘনমিটার/ঘন্টা
  - চিমনীর উচ্চতা ন্যূনতম ২৭৫ মি. হবে যাতে প্লান্ট হতে নিঃসরিত ধোঁয়া বৃহত্তর এলাকায় ছড়িয়ে পড়বে ফলে পরিবেশকে ক্ষতিকর প্রভাব থেকে রক্ষা করবে

- CEGIS এ প্রকল্পটির পরিবেশগত ও আর্থ-সামাজিক প্রভাব বিশ্লেষণে দায়িত্বপ্রাপ্ত হয়ে বিভিন্ন পর্যায়ে এলাকার জনগনের সাথে এ বিষয়ে আলাপ করে পরিবেশ ও আর্থ-সামাজিক প্রেক্ষাপটের বর্তমান অবস্থা বিশ্লেষণ করার চেষ্টা করছে।
- CEGIS এই বিষয়টির গভীরভাবে পর্যবেক্ষণ করার জন্য সংশ্লিষ্ট অফিসগুলো থেকেও তথ্য সংগ্রহ করে, যেমন:
  - কৃষি অফিস থেকে ফসল, ফসলী জমি ও সেচ সংক্রান্ত তথ্য
  - মৎস্য অফিস থেকে মাছ ও মাছের আধার সংক্রান্ত তথ্য
  - ইউনিয়ন পরিষদ থেকে সামাজিক ও অর্থনৈতিক সংক্রান্ত বিভিন্ন তথ্য

- প্রকল্প এলাকার বিভিন্ন বৈশিষ্ট সঠিকভাবে বিশ্লেষণ করার নিমিত্তে নিম্নলিখিত পরীক্ষা-নিরীক্ষা করা হয়:
  - ভূ-তাত্বিক জরিপ যার মাধ্যমে প্রকল্প এলাকার মাটি ও ভূ-গর্ভস্থ পানি সম্বন্ধে ধারণা পাওয়া যাবে।
  - Topography Survey এর মাধ্যমে ভূমির বন্ধুরতা/উঁচু-নীচু অবস্থা বুঝা যায় ও কতটুকু মাটি কাটতে ও ভরাট করতে হবে তা জানা যাবে।
  - পানির গুণাগুণ বোঝার জন্য ভূ-গর্ভস্থ ও ভূ-পরিস্থ পানি পরীক্ষা-নিরীক্ষা করা।
  - বায়ুর দূষণ মাত্রা বোঝার জন্য বায়ু পরীক্ষা-নিরীক্ষা করা।
  - শব্দ দূষণ মাত্রা বোঝার জন্য শব্দ দূষণ পরিমাপক যন্ত্র ব্যবহার করা এবং প্লান্ট থেকে ১ কি.মি. চারপাশে শব্দ দূষণ পরিমাপক যন্ত্রের মাধ্যমে শব্দের তীব্রতা মাপা।

- পরিবেশগত ও সামাজিক প্রভাব বিশ্লেষণের জন্য প্লান্টকে কেন্দ্র করে চারপাশে ১০ কি.মি এরিয়া পর্যবেক্ষণ ও সমীক্ষা করা হয়েছে

- পরিবেশগত ও সামাজিক বর্তমান অবস্থা বিশ্লেষণ:
  - শব্দ দূষণ
  - বায়ু দূষণ
  - খরা মৌসুমে পানির প্রাপ্যতা
  - ধান চাষে পানির প্রাপ্যতা
  - গবাদি পশুর খাবার প্রাপ্যতা

- দূষণ মোকাবেলায় প্রস্তাবিত করণীয় ব্যবস্থাদি:

- বায়ু দূষণ:
  - বায়ুতে SOx – এর পরিমাণ নিয়ন্ত্রনের জন্য উচ্চ ক্ষমতাসম্পন্ন FGD-এর ব্যবস্থা থাকবে
  - বায়ুর NOx নিয়ন্ত্রণ করতে বয়লার Dry Low NOx Burner লাগানো থাকবে
  - Fly Ash এবং SPM নিয়ন্ত্রনের জন্য উচ্চ ক্ষমতাসম্পন্ন Electro Static Precipitator (ESP)/ ফেব্রিক ফিল্টারের ব্যবস্থা থাকবে।
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা বায়ু দূষণের প্রভাবকে প্রশমিত করবে।
  - চিমনীর উচ্চতা ন্যুনতম ২৭৫ মি. হবে যাতে প্লান্ট হতে নিঃসরিত ধোঁয়া বৃহত্তর এলাকায় ছড়িয়ে পড়বে ফলে পরিবেশকে ক্ষতিকর প্রভাব থেকে রক্ষা করবে।

- পানি দূষণ:
  - প্লান্ট উদ্ভূত পানি যথাযথ পরীক্ষা-নীরিক্ষার পর পূণ:ব্যবহার/ জলসেচন কাজে ব্যাবহার করা হবে যা পরিবেশের উপর কোন ক্ষতিকর প্রভাব ফেলবে না
  - তেল ও গ্রীজ পানি থেকে আলাদা করণের জন্য সেন্ট্রিফিউগাল যন্ত্রের ব্যবহারের ব্যবস্থা রাখা হয়েছে। আলাদাকৃত তেল এলাকার ভেন্ডরদের কাছে বিক্রি করা হবে ও পানি যথাযথ পরীক্ষা-নীরিক্ষার পর পূণ:ব্যবহার/ জলসেচন করা হবে।
  - কঠিন বর্জ্য পূর্ব নির্ধারিত নির্দিষ্ট স্থানে ফেলা হবে।

- শব্দ দূষণ:
  - আধুনিক প্রযুক্তি সম্বলিত কম শব্দ উৎপাদনকারী মেশিনারী স্থাপন করা হবে
  - ঘূর্ণন মেশিনারীর জন্য শব্দ দূষণ প্রতিরোধী হুড বা ঢাকনার ব্যবস্থা থাকবে
  - প্লান্ট এলাকার চতুর্দিকে ও খোলা যায়গায় সবুজ বেষ্টনী তৈরীর ব্যবস্থা রাখা হয়েছে যা শব্দ দূষণের প্রভাবকে নিয়ন্ত্রণ করবে
  - ঘূর্ণন মেশিনারীর আশেপাশে যারা কাজ করবে তাদেরকে অবশ্যই PPE যেমন: ইয়ার প্লাগ, মাফলার ইত্যাদি পরতে হবে
  - শব্দের মাত্রা কমানোর জন্য মেশিনারীতে সাইল্যান্সারের ব্যবস্থা থাকবে
  - শব্দ প্রশমনীয় দেয়াল নির্মাণ করা হবে

- মেশিনের কম্পন:
  - কম্পন রোধে সীম (প্লেট ১/১০০০ ইঞ্চি) প্রযুক্তির ব্যবহার করা।

Note: Leaflet to the PAPs at a glace of the Proposed Power Plant

14.10.2 Discussion of the meeting

The Chief Guest of the Public Disclosure Meeting was Abdul Motaleb Talukder, Chairman, and Kalapara Upazlia Parishad. The program was presided over by A.B.M Sadikur Rahman. Upazila Nirbahi Officer (UNO) of Kalapara Upazila. Different government officials, Union Parishad (UP) Chairmen of different unions, NGO representatives, Journalists, political leader, freedom fighter, UP members, farmers and fishermen from the study area were present in the meeting. Mr. Faisal Ahmed, Junior Specialist, CEGIS, started the meeting with an introductory speech. Mr. Pronab Kumar Halder, Junior Specialist, CEGIS, made a power point presentation of the key report of the project.

Following the presentation, all the participants took part in an open discussion. They made various types of comments after the presentation of Mr. Pronab Kumar Halder. A glimse ofthe people's opinions and queries shared in the open discussion are given below:

Mr. Abdul Motaleb Talukder, Chairman, Kalapara Upazlia Parishad

- It is good to hear that the power plant will be established in Patuakhali. The proposed power plant can accelerate the development of the area and benefit the local people.
- There is a disagreement about who be affected by the construction of the power plant at Dhankhali union.
- It is not apparent whether the matter has been discussed with local people and how will the existing homesteads and agricultural lands be affected during project implementation?
- There should be a written agreement about compensation method among land owner, implementing authority and Deputy Commissioner.
- Alternative location can be chosen for the establishment of proposed power plant.

A.B.M Sadikur Rahman. Upazila Nirbahi Officer (UNO) of Kalapara Upazila

- Implementation of the project will be supportive to improve the overall socio economic condition of the study area.
- A Land Acquisition section has been activated at the Dhankhali Union parishad due to reduce the sufferings of the land owners and make the compensation process easier.

Abdul Motaleb Talukder, Chairman, Kalapara Upazlia Parishad

- NWPGCL authority has not compensated and rehabilited to the affected people yet
- Is it possible to purchase land for resettlement with the amount of money given as compensation?
- Let us know about the negative environmental impacts of a coal based power plant
- The power plant may be relocated to the Char areas like Char Rangabali and Gongarchar
- What will be the price of proposed land? Will it be possible to purchase land at the current price?
- Although the local people welcome the idea of power plant, it must be ensured that poor affected families are compensated for land acquisition.

Md. Mustafa Kamal, Vice Chairman, Upazila Parishad, Kalapara, Patuakhali

Implementing authority should consider the other unions for this project but what measures have been taken for resettlement of the people of the project area?

14.10.3 Concluding Remarks

The answers to all questions were given by Mr. Mr. Selim Bhuiya, Executive Director, RPCL following the open discussion session. Then the chief guest Abdul Motaleb Talukder, Chairman, Kalapara Upazlia Parishad expressed his opinion and showed his positive attitude towards the project. Then the president of this assembly A.B.M Sadikur Rahman. Upazila Nirbahi Officer (UNO) of Kalapara Upazila concluded the PDM by thanking all the participants.

Including the local PAPs (Project Affected Peoples) invitation cards were also distributed to the above key stakeholders

14.11 Grievance Redress

Grievance is an issue, concern, problem, or claim that an individual or community group wants to be addressed and resolved by the Project Authority. The fundamental objectives of the Grievance Redress Mechanism (GRM), implemented through the Grievance Redress Committees (GRC) serving as a para-legal body, are to resolve any resettlement-related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of the social and environmental action plans.

14.11.1 Guideline to Redress Grievances

The Project Proponent would establish a procedure to deal with and resolve any queries as well as address complaints and grievances about any irregularities. In this regard, a policy and/or guideline and grievance redress mechanism (GRM)will be prepared. Grievance Redress Committees (GRC) will be formed to receive and resolve complaints as well as grievances from aggrieved persons from the local stakeholders including the Project-affected persons.

14.11.2 Composition of Local GRC

The Grievance Redress Committee (GRC) will be established locally at Project sites and centrally at the Project level to receive as well as settle grievances from the affected persons and other local stakeholders. Two type of GRC will be established such as union/municipal level (LGRC), the first tier, and Project GRC at the central level (PGRC), the second-tier.The local level GRC will be constituted with representation of the local UP Chairman and affected people ensuring women’s representation. The Project-level GRC will be constituted with representation from the Project Management Unit (PMU) and one independent person from the civil society having knowledge about land acquisition law of Bangladesh and involuntary resettlement.

14.11.3 Grievance Resolution Process

The implementing agency will keep a close liaison with the affected people and discuss any type of issues, observation, complaints at focus group meetings on a weekly or fortnightly basis. Most of the issues will hopefully be settled in the focus group meeting but some issues requiring formal hearing and resolution will be brought to the Grievance Redress Committee (GRC) for resolution in form of a formal complaint. All complaints will have to be received at the local (Union) level GRC (LGRC) and resolved within a certain period as per circular of the MPEMR (gazette notification). The GRC will request the aggrieved person to apply to the Deputy Commissioner (DC) for resolution or the GRC may refer such issues to the DC office for consideration. All cases will be heard at LGRC within four weeks from the date of receiving the complaints.

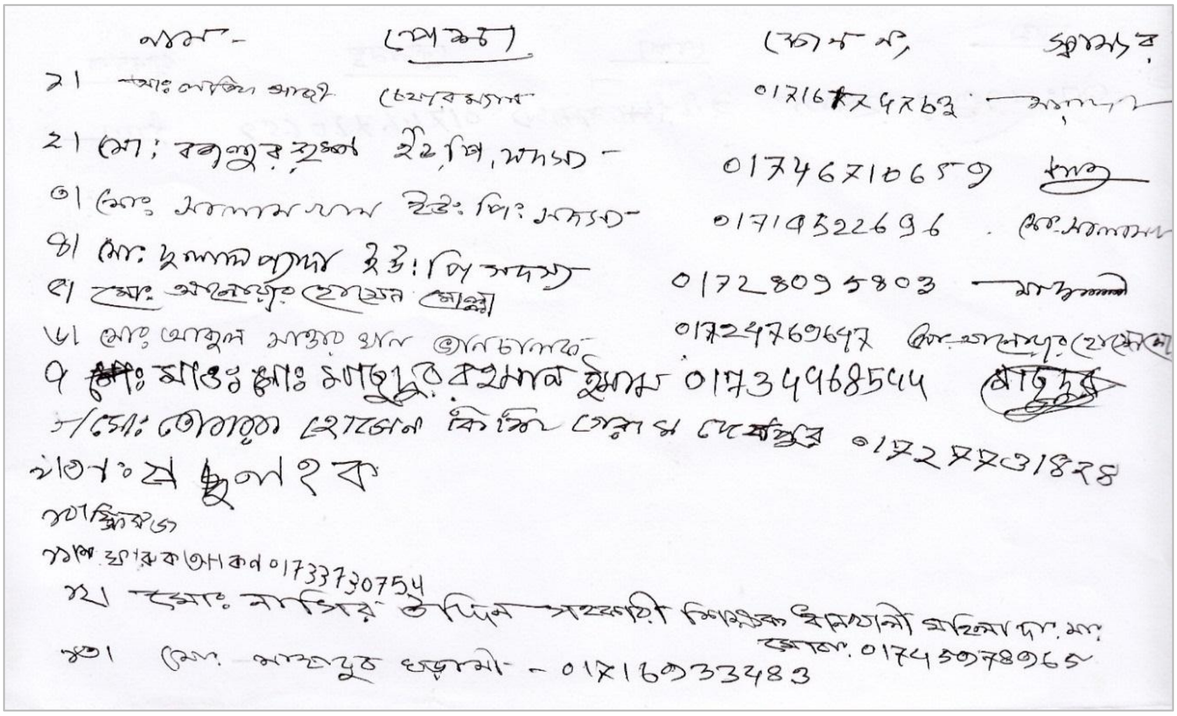
If the resolution attempt at the local level fails, the LGRC will refer the complaint with the minutes of the hearings to the ProjectGrievance Redress Committee (PGRC). In case of failure at PGRC, the complaint with the minutes of the hearings of PGRC will be sent to the

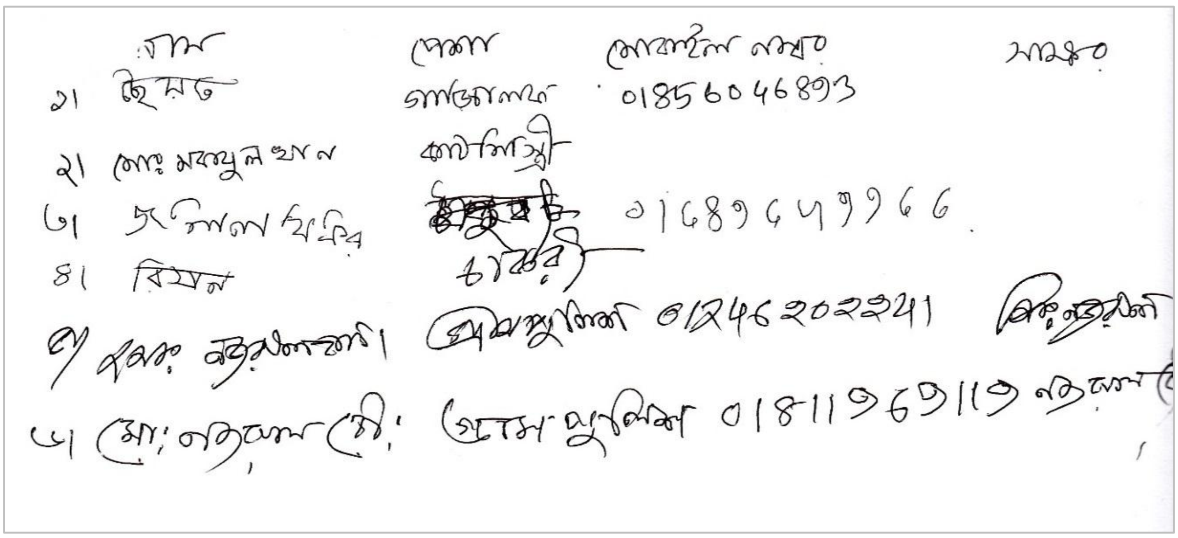
Project Director at PMU for further review. The Project Director will assign the Environment and Social Development Unit (ESDU) under the PMU to review the grievance cases and to assist the Project Director in making decision. The cases are to be resolved at PGRC within five weeks from the date of receiving the file from the LGRC. If a decision at this level is found unacceptable by the aggrieved person(s), he/she may go to court for verdict. Aggrieved persons are always allowed to go to court of law for settlement of any unresolved issues.

14.12 Participant List

The total numbers of meeting/discussion participants were 41 (Forty-one). The name of the participants of different meetings, and address including cell phone number are provided in the Table -14.6 below. Deatial name and address of the participants are presented in Appendix-XIV.

Table 14.6: Participants list of the public consultation meetings and FGDs





Source: PCM and KII at field, CEGIS, 2016

Photo 14.1: Stakeholders Consultation Meeting

Photo 14.2: Consultation Meeting at SourthDhansagor and Londa

Table 14.7: Participants list of the public disclosure meeting

"প্রস্তাবিত কলাপাড়া ১৩২০ মেঘাওয়াট বিদ্যুৎ কেন্দ্র স্থাপন" উন্নয়ন প্রকল্পের পরিবেশগত ও সামাজিক প্রভাব
নিরূপণ, প্রশমনের উপায় ও ব্যবস্থাপনা বিষয়ক
মতবিনিময় সভায় অংশগ্রহনকারীদের তালিকা

স্থান ঃ কলাপাড়া উপজেলা পরিষদ মিলনায়তন, কলাপাড়া
সময় ঃ সকাল ১০:০০ তারিখঃ ১৮আগষ্ট, ২০১৬

ক্র.নং	নাম	পদবী/ ঠিকানা	মোবাইল নং	স্বাক্ষর
১/	মো: মোস্তফা [illegible]	চেয়ারম্যান [illegible] কলাপাড়া - ইউনিয়ন	01716538157	[illegible] ১৮.৮.২০১৬
২	মো: সেলিম ভূঁইয়া	নির্বাহী প্রকৌশলী RPCL	01748337594	১৮/৮/১৬
৩	বিলকিস জাহান	V.C. উপজেলা পরিষদ কলাপাড়া	01710703241	১৮-৮-১৬
৪	মো: মোস্তাফিজুর রহমান	V.C. উপজেলা পরিষদ কলাপাড়া	01718640795	১৮.৮.১৬
৫	এ.বি.এম. সাদিকুর রহমান	UNO, Kalapara	01733334155	১৮/৮/১৬
৬	এস.এম রাকিবুল আহসান	সাবেক মেয়র	[illegible]	১৮/৮/১৬
৭	সুলতান মাহমুদ	সাধারণ সম্পাদক প্রেস ক্লাব কলাপাড়া	[illegible]	১৮/৮/১৬
৮	ড: কাজী নূর [illegible]	Environmental Advisor, CEGIS	01817549619	১৮/৮/২০১৬
৯.	প্রেমল চন্দ্র শীল	সি.ডি.এস যুব উন্নয়ন অফিস	01703396996	১৮/৮/১৬
১০/	মো: রবিউল ইসলাম	চাকরী	01758757366	১৮/০৮/২০১৬
১১	মো: [illegible] মো: [illegible]	ব্যবসায়ী	01784685355	১৮/০৮/১৬
১২	আবু বকর	শিক্ষক	01747132077	
১৩	মো: গোলাম মোস্তফা	F.S, ইউনিয়ন পরিষদ	01714-668943	১৮/৮/১৬
১৪	মো: বেলায়েত হোসেন	শিক্ষক	01719835296	Belayet 18.8.16
১৫	মো: হানিফ	কৃষক		হানিফ
১৬	মো: আব্দুল আলিম	কৃষক	01727654286	[illegible]
	[illegible]	[illegible]	01716400541	[illegible]

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সময় ঃ সকাল ১০:০০

তারিখঃ ১৮আগষ্ট, ২০১৬

ক্র.নং	নাম	পদবী/ ঠিকানা	মোবাইল নং	স্বাক্ষর
১।	আবুল হাসেম	ম্যানেজার ডিভ ইসলামী ব্যাংক	০১৭১২৮-৩৮৪৩৭	[illegible]
২।	মুনতাসির মাহমুদ	জেলেদের নেতা	০১৮১৯৪৫৯৫৮	[illegible] ১৮/৮/১৬
৩।	জাকির	ব্যবসায়ী	01737258150	জাকির ১৮/৮/১৬
৪।	সরদার মোস্তাফিজুর রহমান	বীমাজীবী	01761509334	মস্তাফিজুর রহমান ১৮/৮/১৬
৫।	মো: নুরুল হুদা	[illegible]	01733264196	[illegible] ১৮/০৮/১৬ইং
৬	মো: [illegible]	কৃষিজীবী	01713964419	[illegible]
৭।	মো: সুমন ফকির	মরিচবুনিয়া	01745033259	[illegible]
০৮.	মো: জামাল হোসেন	AFO(CLEVE) Caritas, Kalapara	01719733360.	[illegible]
০৯	মাও: মোঃ আ: রশিদ সরদার	[illegible]	01713961866	[illegible]
১০	মোসা: শাহিদা বেগম	উপ: আনসার ও ভিডিপি অফিস, কলাপাড়া	01721059834	[illegible] ১৮/৮/১৬
১১	সৈয়দ মো: [illegible] হোসেন	[illegible] পটুয়াখালী [illegible] সমিতি	01715452135 mota_pus@yahoo.com	[illegible] ১৮/৮/১৬
১২।	মো: [illegible] ইসলাম	[illegible]	01712699838	[illegible]
১৩।	মো: শরিফুল ইসলাম	উপজেলা [illegible] কর্মকর্তা	01717886116.	[illegible] ১৮/৮/১৬
১৪	[illegible] আক্তার	UWAO	01720494734	[illegible]
১৫	[illegible] নজরুল হক	[illegible]	01718924912	[illegible]
১৬	[illegible]	[illegible]	01722420911	[illegible]
১৭	মো: [illegible]	[illegible]	01724995966	[illegible]

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স্থান ঃ কলাপাড়া উপজেলা পরিষদ মিলনায়তন, কলাপাড়া
সময় ঃ সকাল ১০:০০ তারিখঃ ১৮আগষ্ট, ২০১৬

ক্র.নং	নাম	পদবী/ ঠিকানা	মোবাইল নং	স্বাক্ষর
১৮।	এস.এম রাকিবুল হাসান	সাবেক মেয়র	০১৭১৬০৪৪৯৮২	[illegible] ১৮।৮।১৬
১৯।	মেজবাহউদ্দিন মান্নু	সভাপতি প্রেসক্লাব	০১৭১৫৬০৫৬৮৭	[illegible] ১৮।৮।১৬
20।	মো: হাফিজুর রহমান	সম্পাদক মুক্তিযোদ্ধা সংসদ	01716127265	হাফিজুর রহমান
21	মো: মুনসুর আহমেদ	সমাজ সেবক	01745319217	[illegible]
২২	মো: মনিরুল ইসলাম	সহকারী শিক্ষক	01757959386	[illegible]
2৩	মো: জসিমউদ্দীন	কৃষক	01739261261	[illegible]
24	মো: মাহমুদুল হক	সমাজ সেবক	01817626255	[illegible] ১৮।৮।১৬
25	মো: হেমায়েত আলী খাঁ	[illegible]	01747695730	[illegible]
৩০।	মো: সাইদুল ইসলাম	সমাজ সেবক	01748922375	মো: সাইদুল
৩১	মো: আমিনুল হক	[illegible]	01710021114	মো: আমিনুল
৩2	গাজী নিজামউদ্দিন	PC PGUK	01719562583	[illegible]
৩৩	মো: ফজলুল হোসাইন খান	AM DAM	01712461333	[illegible]
৩4	মো: নওয়াব আলী	UTL CODEC	01718787943	[illegible]
৩৫	রাজীব বিশ্বাস	WORLD CONCERN BANGLADESH	01725023742	[illegible]
৩৬	জুয়েল হাসান	UPO: [illegible]	01312626480	[illegible]
৩৭	মো: [illegible]	শিক্ষক	01725498463	[illegible]
৩৮	মো: [illegible]	[illegible]	01722958226	[illegible]

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স্থান ঃ কলাপাড়া উপজেলা পরিষদ মিলনায়তন, কলাপাড়া

সময় ঃ সকাল ১০:০০

তারিখঃ ১৮আগষ্ট, ২০১৬

ক্র.নং	নাম	পদবী/ ঠিকানা	মোবাইল নং	স্বাক্ষর
৩৯।	মো: ইকবাল করিম	নির্বাহী প্রকৌ:	01788-111333	[illegible]
৪০	সৈয়দ হাবিবুর রহমান	ব্যবসায়ী	01712-600233	[illegible]
	মো: সুজন মিয়া		01727454073	
৪১.	মো: মোতালেব	আমিগুল সহকারি	01704842046	মো: মোতালেব
৪২.	শেখর চন্দ্র রায়	জনিয়র সহকারি	01748250946	[illegible]
৪৩	মো: রফিকুল ইসলাম	অফিস সহকারী	01722955581	[illegible]
৪৪	মো: রাকিব	ছাত্র	017	[illegible]
৪৫	মো:- খাইরুল	ছাত্র	01797465527	Khairl
৪৬	নিরব	ছাত্র	01786676925	নিরব
৪৭	শান্ত সিকদার	ছাত্র	01706054903	[illegible]
৪৮	মো: সজিব	ছাত্র		সজিব
৪৯	মো: আলআমীন	চাকুরী	01716318121	[illegible]
৫০	মো: ফিরোজ	চাকুরী	01739909173	ফিরোজ
৫১	আফিকুজ্জামান তানিম	ছাত্র	01210854139	Tanim
৫২	মো: ইমন	ছাত্র		ইমন
৫৩	মো: রিয়াদ	ছাত্র	01961703431	রিয়াদ
৫৪	মো: রিজু	ছাত্র	01673385816	রিজু

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স্থান ঃ কলাপাড়া উপজেলা পরিষদ মিলনায়তন, কলাপাড়া

সময় ঃ সকাল ১০:০০ তারিখঃ ১৮আগষ্ট, ২০১৬

ক্র.নং	নাম	পদবী/ ঠিকানা	মোবাইল নং	স্বাক্ষর
৫৫	টুটুল চন্দ্র নাথ	ব্যবসায়ী	01744776764	Tutul
৫৬	মো: সালাহ উদ্দিন	"	01716192279	সালাহউদ্দিন
৫৭	মো: রাসেল	চাকরী	01751012277	[illegible]
৫৮	মো: আল আমিন	চাকরী	0175702614[illegible]	[illegible]
৫৯	মো: আব্দুস সালাম	জেলে -	01740997070	[illegible]
৬০	আনোয়ার -	জেলে	017267249[illegible]	[illegible]
৬১	[illegible] -	জেলে -	01782840541	[illegible]
৬২	ওমর ফারুক	জেলে -	017[illegible]670	[illegible]
৬৩	[illegible]	জেলে	01722815038	[illegible]
৬৪	[illegible] -	[illegible]	01726066675	[illegible]
৬৫	[illegible]	[illegible]	01915872822	[illegible]
৬৬	মো: জোবায়ের	ছাত্র	01762586669	[illegible]
৬৭	মো: [illegible]	ব্যবসায়ী	01713950021	[illegible]
৬৮				
৬৯				
৭০				
৭১				

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Photo 14.3: Public Disclosure Meeting at Kalapara Upazila Parishad

15. Conclusion and Recommendation

Following conclusions are being made after the comprehensive study with detail investigation.

Based on the recommendation of PSMP 2010 for diversification of fuel for power generation and to achieve the target of 40,000 MW by 2010, the Rural Power Company Limited (RPCL) has planned to construct a 2x660 MW coal based ultra-supercritical power plant at Nishanbaria, Londa and Dhankhali Mouza, Dhankhali Union, Kalapara Upazila, Patuakhali district.

With the purpose of obtaining Environmental Clearance Certificate from Department of Environment under Environment Conservation Act, 1995, RPCL entrusted CEGIS the responsibility of Environmental Impact Assessment study.

The scope of this report is to present the Environmental Impact Assessment study. The study has been carried out following the Environmental Impact Assessment Guideline of DoE and other international bodies that includes multidisciplinary tools and techniques of Physical, Water resources, Agriculture, Land and soil, Fisheries, Ecology and Socio-economic surveys and investigation. Participation of local people was ensured through PCM and discloser approach. Therefore, it is a complete participatory study.

RPCL has selected the construction site through a comparative study of four pre-selected sites of proponent. They are in Upazila Banskhali, in Magnama, Upazila –Pekua, in Upazila Zajira, in Kalapara Upazila, The project area has been reconciled optimizing the minimum land requirement ensuring minimum displacement of local people. The selected area is 915.7acres that shall displace 121 households.

The proposed coal based thermal power plant will have two units (2x660 MW) of ultra-supercritical pulverized coal fired boilers. Besides, it also includes residential and social facilities, water treatment plant, sub-station, coal handling system and coal silo, ash handling and disposal facilities, and switchyard including substation. The project design and technology to be used will be reconciled with the DoE standard. In order to fulfill objectives, the existing environmental and socio-economic condition, detail assessment was made to prepare environmental and socioeconomic baseline condition.

Attempts were made to assess all the predicted environmental and social impacts with evaluating the nature, temporal and spatial extent, reversibility and livelihood of the predicted impacts. Finally, the predicted impacts were summarized in a qualitative scale of consequence. The assessment includes impacts on physical setting, impacts on air quality, impacts on water resources, impacts on land and agricultural resources, impacts on fisheries, impacts on ecosystem resources, and impacts on socio-economic environment. Displacement of 121 number of household for land acquisition, acquisition of agricultural land, emission of gaseous pollutants within the standard limit are the key predicted impacts.

Acquisition of agricultural land and some homestead settlements are the key impacts during pre-construction phase that requires proper compensation, resettlement and rehabilitation. Negative impact during construction phase includes air and noise pollution and disturbance to society due to increase of noise level. On the contrary, the construction works will create employment opportunity and better livelihood to local people.

The proposed project has been planned with compliance to ECR, 1997. The stack height shall be 275 m as per the rule. The emission rate for Particulate Matter ($PM_{2.5}$ 2gm/Sec, PM_{10} 28.3gm/sec), SO_2 (242.16g/s) and NO_X (618 g/s) shall satisfy the emission standards. The dispersion model (CALFFUF) estimates that the annual average ground level concentration cumulatively for SO_2, PM2.5 and PM10 would be 4.66 μg/m^3 , 4.34 μg/m^3 and 32.8 μg/m^3 respectively. The resultant concentration in the air satisfy MoEF's standard and it would not be significant to cause air pollution.

It is not very likely that the long term ground level concentration of the SOx, NOx, SPM will increase during operational phase of the thermal power plant as the pollutant concentration in emission is very low and depression and cyclone is very regular phenomenon in this region. Unstable atmosphere will dilute the possibility of acid rain.

The plant adopts closed cycle cooling system. It has been accounted that power plants will intake about 5117 m^3/hr in total and discharge about 2573 m^3/hr after treatment. Hence, no thermal plume shall be discharged to the river. The project has been planned to provided with an integrated water management including central effluent treatment plant, recycling and reuse of water, sludge and slurry disposal system, etc. No waste water shall be discharged to river without satisfying MoEF's Standard (ECR 1997). Hence, there may not be any major impact on surface water quality. The required water can easily be taken from Rabnabad channel. This will not causes any significant impact on aquatic flora and fauna. There is no anticipated significant impact on ground water resources during plant operation as the domestic and other activities will be fulfilled from the supply of Rabnabad channel water after treatment.

Impact on ecosystem will also be minimum due to adoption of different pollution abatement measures. No thermal plume shall be discharged to the river which is the major issue in case of any thermal power plant. Ash collection and management system comprise of Electrostatic Precipitator (ESP) that have 99.99% efficiency to arrest fly ash. Hence, ash deposition on the surrounding ecosystem habitat and components may be minor. Nevertheless, there may be risk of accidental release of ash particles, chemical and fire explosion for which the safety measure and hazard management plan have been prescribed in the hazard and risk assessment sections.

With the purpose of identifying environmental concern needed to consider during planning and designing of the plant, hazard and risk assessment has also been carried out in the scope of EIA. The risk of potential hazards includes mechanical, electrical, chemical, fire and explosion, and risk of failure mode. The assessment has been made with identifications of specific safety measures. Besides, occupational health and safety assessment has been carried out with extensive safety plan. At the end a hazard management plan including Fire safety, Explosion safety, Electrocution safety, Health safety, Hazardous material management plan with emergency preparedness have been established. The study also recommends setting up of a team for safety monitoring and emergency preparedness.

The proposed coal based power generation will reduce the dependency of power generation on our limiting natural gas reserve. The proposed project will create enormous potentiality of economic and social development of the region. The present electricity crisis and rising electricity demand urge installation of new power plant. It will offer large number of job opportunity during its life time where the local people will get priority. The potential benefits of the project will compensate the negative impact if the prescribed EMP were implemented and compensation were paid to the affected person.

Recommendations

Finally, the following recommendations are made on the basis of IEE and EIA study that should be considered for achieving the goal of optimum minimum environmental impact and optimum benefits:

- Proper Resettlement and Rehabilitation plan is necessary for proper compensation to Project Affected People
- People (not owner) dependent on the land to be acquired should also be compensated and created scope for alternative livelihoods
- Findings and suggestion of EIA study in project planning, design and operation should be considered and implement with strong monitoring
- All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP
- Environmental Management Plan and, Hazard and Safety Management Plan should be implement at every suggested steps of plant construction and operation
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety in Project Management Unit during pre-construction, construction and operation phases of the project
- Strong environmental compliance monitoring activities to be ensured during pre-construction, construction and operation phases of the project
- The Plant should be operated ensuring all pollution abatement measures e.g. ESP, FGD, SCR, De-NOx burner, Effluent Treatment Plant, etc all are in order.
- The project will follow the ISO-14001 and OHAS-18001 standers

The plant should be operated ensuring all pollution abatement measures e.g. ESP, FGD, SCR (if required), De-NOx burner, effluent treatment plant, etc are in order and regular monitoring has to be done to evaluate.

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