NORTH-WEST POWER GENERATION COMPANY LTD., DHAKA
(AN ENTERPRISE OF BPDB)

FINAL REPORT

on

Environmental Impact Assessment (EIA) Study

of

Sirajganj 150MW Peaking Power Plant Construction Project at Sirajganj

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Submitted by:

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ABBREVIATIONS USED

ADB	-	Asian Development Bank
BBS	-	Bangladesh Bureau of Statistics
BIWTA	-	Bangladesh Inland Water Transport Authority
BOD	-	Biochemical Oxygen Demand
BPDB	-	Bangladesh Power Development Board
BWDB	-	Bangladesh Water Development Board
CC	-	Compensation Committee
CCPP	-	Combined Cycle Power Plant
CO	-	Carbon Monoxide
COD	-	Chemical Oxygen Demand
DA	-	District Administration
DO	-	Dissolved Oxygen
DoE	-	Department of Environment
DPP	-	Development Project Proforma
EIA	-	Environmental Impact Assessment
EMP	-	Environmental Management Plan
ETP	-	Effluent Treatment Plant
FGD	-	Focused Group Discussion
FPCO	-	Flood Protection
GOB	-	Government of Bangladesh
GRC	-	Grievance Redress Committee
IAM	-	Impact Assessment Matrix
IECs	-	Important Environmental Components
IEE	-	Initial Environmental Examination
IUCN	-	International Union for Conservation of Nature
JBIC	-	Japan Bank for International Cooperation
JICA	-	Japan International Cooperation Agency
JV	-	Joint Venture
JVT	-	Joint Verification Team
KI	-	Key Informants
KII	-	Key Information Interview
MW	-	Mega Watt
NO_X	-	Oxides of Nitrogen
NWPGCL	-	Northwest Power Generation Company Limited
PAP	-	Project Affected People
PD	-	Project Director
PEIA	-	Post Environmental Impact Assessment
PGCB	-	Power Grid Company of Bangladesh
PSMP	-	Power System Master Plan
PVAT	-	Project Value Assessment Team
R&R	-	Resettlement & Rehabilitation

ABBREVIATIONS USED

RAP	-	Rehabilitation Action Plan
RMS	-	Reducing Metering Station (Gas)
SOx	-	Oxides of Sulfur
SPM	-	Suspended Particulate Matter
SS	-	Suspended Solids
UC	-	Union Council
UNO	-	United Nations Organization
USDOT	-	United State Department of Transportation
WB	-	World Bank

EXECUTIVE SUMMARY

A. INTRODUCTION

Electricity is a major contributory factor in GDP of a country, as agricultural, industrial and other products as well as development of education, largely depend on its reliability and quality of supply. Unfortunately, for the last few years, Bangladesh is acutely suffering from most inadequate supply of this vital commodity. Along with the sectors mentioned, domestic consumers are also suffering due to frequent and unannounced load shedding.

In order to meet the demand of electricity for the next 20 years, in 1995 BPDB prepared a Power System Master Plan (PSMP), with three alternative scenarios, High, Low and Reference. The PSMP was updated in 2005. This document also identified several generation, transmission and distribution projects. Among the generation projects, PSMP selected some which would be installed in order to meet the additional demand during peak hours. The project under consideration, Sirajganj 150 MW Peaking Power Plant Project is one of such projects. The plant is expected to run on natural gas. Until gas is available in the Western Zone, it will run with High Speed Diesel (HSD) Oil.

The proposed power plant is scheduled to be installed in Barashimul Mouza of Saydabad Union of Sirajganj Sadar Thana under the District of Sirajganj. There are other smaller plants in the Western Zone. Power of all these plants, together with the power imported from the Eastern Zone through the existing Interconnector, are not sufficient to meet even the normal demand of the Western Zone, not to speak of the peak demand. It is, therefore, very important to install peaking power plants and PSMP has correctly identified such projects, one of which is the 150 MW Sirajganj Peaking Power Plant.

Under the ongoing Power Sector Reform Program, generation, transmission and distribution branches are being separated from the mother organization, BPDB, and in the process, North West Power Generation Company Limited (NWPGCL) has been created for construction, operation and maintenance of power generation facilities in the North-Western Zone of the country. The present project is also placed under NWPGCL.

Presently, environmental conservation is being given top priority worldwide. In Bangladesh also, for any new project, as well as plants under operation, it is mandatory to obtain environmental clearance from the Depart of Environment (DoE), under Environment Conservation Act 1995, amended from time to time. According to Bangladesh Environment Conservation Rules 1997 (ECR), power plants come under the Red category, so far as environmental impact is concerned. Initial Environment Examination (IEE) followed by Environmental Impact Assessment (EIA), including Environmental Management Plan (EMP) are required for these types of installations for getting environmental clearance from DoE.

NWPGCL has initiated the environmental clearance from DoE and in the process, the company has already obtained IEE clearance from DoE for this project. It is now required to obtain EIA clearance. NWPGCL has engaged Engineers Associates Limited (EAL), an experienced firm for such activities, for

preparation of EIA for the project, for which work order has been issued to EAL vide **Purchase Order No.178-NWPGCL/Siraj-150/2009 dated 01/11/2009.**

B. PROJECT JUSTIFICATION

In fiscal year 2006 the total installed capacity in the country was 5,202 MW, which comprised of thermal generation capacity of 4,972 MW (95.6%), and a hydroelectric generation capacity of 230 MW (4.4%). In terms of fuels, natural gas-fired power stations represented 81.3% of the total capacity. In terms of the installed capacity of different electric power generation companies, as of March 2004 the installed capacity of the BPDB (Bangladesh Power Development Board) was 3,429 MW while that of the IPPs (independent Power Producers) was 1,260 MW. However, the percentage of power generating facilities that were inoperable due to aging was high, between 30% and 40%.

Although natural gas is the central pillar of domestic energy production in Bangladesh, because the gas fields are unevenly distributed, located primarily in the eastern zone of the country, the fuels used and the types of generating facilities differ between the eastern and western regions. In the east, all thermal power stations use natural gas as fuel, but in the west the main fuel is oil and for small portion, coal.

Because there is a chronic supply shortage in Bangladesh, electric power generation companies cannot afford to stop power stations for inspection and maintenance, and because periodic inspections are also not being sufficiently performed, the generating capacities of most thermal power stations is substantially less than the rated power.

As of July 26, 2008, the generation at the time of maximum demand supplied was only 3376 MW although depleted generation capacity is 4830 MW. Examining the reasons, it was found that the shutdown of the power plant resulting from maintenance or trouble corresponded to 603 MW, on the other hand, the shortage of gas supply corresponded to 664 MW.

Further, 80 percent of the power plants in Bangladesh are concentrated in the eastern zone close to the natural gas fields. This requires power transmission of about 200 to 300 MW from east to west. Thus, from the viewpoint of system operation, power generation development in the western zone is an urgent necessity.

BPDB is working out power generation development planning according to the demand assumption of the basic case carried out in PSMP 2006. In this assumption, the maximum load in 2012 is assumed as 7732 MW and the reserve margin percentage of 22 % is taken into account. To meet this assumption, it is necessary to build power plants having total power generating capacity of 4619MW, in addition to the existing power generation capacity.

According to the Projects List in the PSMP 2006, Sirajganj Peaking Power Plant (100 MW in PSMP) is planned as an important one in the western zone, which was planned to commence commercial operation in 2008.

C. DESCRIPTION OF THE PROPOSED PROJECT

Sirajganj 150 MW Peaking Power Plant is planned to be installed within Barashimul Mouza of Saydabad Union of Sirajganj Sadar Thana under the District of Sirajganj, which is about **15 KM** South-East of Sirajganj town. The location of Sirajganj town is shown on the map of Bangladesh, placed at **Figure-E1** and position of the proposed Peaking Power Plant is shown on the map of Sirajganj Thana at **Figure-E2** and the satellite image of Sirajganj Peaking Power Plant is shown at **Figure-E3**.

The proposed Power Station area is located about 7.5 KM south of Sirajganj town, as stated above and beside the Jamuna river. The JMB (Bangabandhu Setu) is on the north of the site, Khas Barashimul village on the south, Jamuna river on the east and Sydabad is on the west side of the power plant site. The proposed site is about **130 km** north-west of the capital city of Dhaka. The location of proposed site is shown below:

Figure-E1: Map of Bangladesh showing the location of Sirajganj Sadar Upazila

Figure-E2: Map of Sirajganj Sadar Upazila showing the location of Proposed Sirajganj 150MW PPP

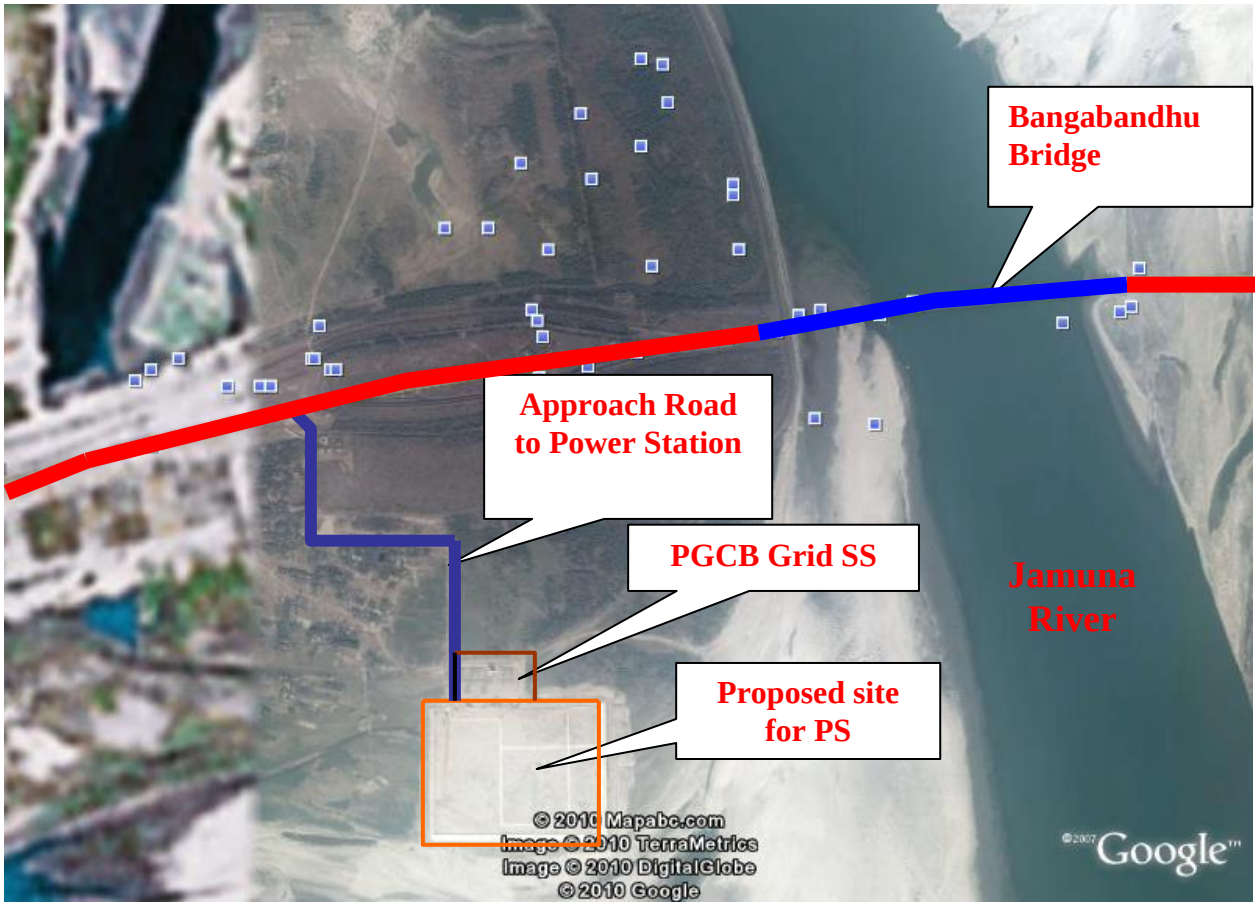


Figure-E3: The Satellite image of location of Proposed Sirajganj 150MW Peaking Power Plant

D. EXISTING ENVIRONMENT: PHYSICAL

A baseline survey was carried out in areas surrounding the proposed Sirajganj 150 MW Peaking Power Plant project site for the purpose of ascertaining Physical Environmental conditions. This has been done in order to gather information on the existing physical environment of the areas in and around the project site. During the survey, air and water samples were collected from pre-determined points in the area and analyzed in laboratory. Noise levels were also measured at definite points.

Relevant information on climate, drainage, hydrology and water resources were also collected.

Climate:

Bangladesh, a small country with generally low lying area, is located at the central part within the Asiatic monsoon region where the climate is tropical. Its climate has moderate variation in terms of temperature, rainfall, relative humidity and wind speeds.

There are two marked seasons in Bangladesh, the rainy season from May to October, during which more than 85% of the total annual rainfall occurs and the dry season from November to April. The beginning and ending of the rainy season vary from year to year. Heavy rains may commence anywhere between mid April and early June and may end anywhere between the end of September

and mid November.

Climatic conditions of the study area were collected from the Meteorological Department at Dhaka and Bogra.
Wind directions at the project site are mostly from the North-West or West towards South-East or East during November to February. The wind directions are the East to the West during March to October. The maximum wind speed of **6.3 knots** prevailed during September, 2004 flowing from East to West and the minimum wind speed of **2.2 knots** in October 2001 from East to West.

Ambient air temperature varies with rainfall. During cool seasons, lowest rainfall occurs. Maximum temperature of **40.5^{0}C** was observed in May, 2007 and minimum temperature was **5.3^0 C** in January, 2003.

Humidity during the wet season is naturally the highest compared to those occurring at other times of the year. The maximum Relative Humidity recorded by Meteorological Department Bogra station was **100%** and the minimum Relative Humidity recorded by Meteorological Department, Bogra station was **8% in April 2009.**

River Water

The Jamuna River, flowing along the eastern side of the proposed power plant site, is a combination of the rivers of Brahmaputra and Jamuna, **both tributaries of the Padma,** which is one of the three major river systems in Bangladesh. The river has no tidal effect. It meets the **Padma River at Goalanda about 40km south** of the site, which in turn ultimately goes to the Bay of Bengal. The highest water level of **15.11m** was found in **August 1988,** whereas the lowest level of **6.19m** was found in **February 2006**.

Groundwater

Ground water will be utilized only for domestic and office consumption. Therefore, ground water investigation/study was not conducted. However, the Department of Public Health Engineeing (DPHE) has investigated ground water at Enayetpur (89.71213^0 Longitude and 24.21168^0 Latitude) under Sadia Chandpur Union of Chauhali Upazila of Sirajganj district. From the investigation of DPHE, it was found that there is one aquifer lying between 6.1m and 79.55 meter depth. The overall quality of ground water is good.

Air Quality

Sirajganj Sadar Thana, particularly the project area, is not heavily industrialized. The present ambient air quality of the concerned area, as a result, is not much contaminated. The air quality was not measured in the past. To ensure safety of power source and security of living beings including human beings, air samples were collected from 2 locations; one sampling point for survey in the proposed power plant and the other sampling point near Dhaka Highway. The air samples were collected by DOE, Bogra and the samples were analyzed by DOE, Bogra. The environmental standards for ambient air quality designated by Bogra Environmental Agency (DOE) in Industrial and Mixed area are 500µg/m^3 for SPM, 120µg/m^3 for SOx and 100µg/m^3 for NOx . It was found

that SPM, SO_x and NO_x of the ambient air in the sampling points are well within the atmospheric environmental standards for the industrial and mixed.

Noise Level

Noise level were measured at three locations – one location is at proposed Power station, Khas Boro Shimul, Sirajgonj Sadar, Sirajgonj (Near Water Pump), 2nd location at near house of Mr. Ibrahim near Khas Boro Shimul, Sirajgonj Sadar, Sirajgonj (Near Dhaka-Bogra Highway) and the third location is at west bank of River Jamuna near Bangabandhu Bridge, Sirajgonj Sadar, Sirajgonj. The noise levels at all locations were measured on December 28 2009. The environmental standards for noise levels designated by Bogra Environmental Agency (DOE) are 70dBA during day hour (06:00 to 21:00hrs) and 60dBA during night (21.00 to 6.00hrs). For the residential area, 55dBA during day hour and 45dBA during night. From the above test results, it is seen that noise level in the project area is well within the Bangladesh Standard limits.

Water Quality

In order to test the quality of the Jamuna River, water samples were collected from two sampling points in the Jamuna river. One sample of Jamuna river water (Surface) near Proposed Sirajgonj Power Station was collected on December 28, 2009 and another sample of Jamuna River water (3m depth) near Sirajgonj town was collected on Dcember 31, 2009. The water samples were collected and tested by DoE, Bogra. From test results, it was found that all parameters (pH, Chloride, Iron, Zinc, TSS, BOD, DO, COD) are within acceptable limit.

E. EXISTING ENVIRONMENT: ECOLOGICAL

Terrestrial Ecosystem

In general terms an ecological system can be defined as an assemblage of organisms (plant, animal and other living organisms - also referred to as a biotic community) living together with their environment (or biotope), functioning as a loose unit. That is, a dynamic and complex whole, interacting as an "ecological unit". Ecosystems are functional units of interacting abiotic, biotic, and cultural (anthropogenic) components. All natural ecosystems are open systems where energy and matter are transferred in and out through the complex interactions of energy, water, carbon, oxygen, nitrogen, phosphorus, sulfur and other cycles.

The project site is located in rural area. As the project area is in char land, there is no natural vegetation or forest cover within the project area. However, appropriate mitigation program should be undertaken to protect the existing ecosystem from gaseous emissions and water discharge from the proposed power plant.

Aquatic Ecosystem

Bangladesh is mainly a deltaic region of the three big rivers, the Ganges, the Brahmaputra and the Meghna and their tributaries. Aquatic ecosystems perform many important environmental functions. For example, they recycle

nutrients, purify water, attenuate floods, recharge groundwater and provide habitats for wildlife. Aquatic ecosystems are also used for human recreation and are very important to the tourism industry. The health of an aquatic ecosystem degrades when the ability of ecosystem to absorb a stress has been exceeded. A stress on an aquatic ecosystem can be a result of physical, chemical or biological alterations of the environment.

Fisheries resources occupy a key position in the agro-based economy of Bangladesh. Fishes are important economically, socially and nutritionally. About 80% of the animal protein in the diet in Bangladeh comes from fish. In the past there was abundance of fishes in water bodies like rivers, floodplains, beels, haors etc. While the large fish species migrate long distances in rivers for breeding, the small fishes migrate over shorter distances or reside in floodplains, beels and canals. Most inland water fishes are small. They are important for nutrition and supplemental income to the vast majority of the rural people, including the landless and the destitute. The miscellaneous species of fish and prawn are termed as "poor people's fish" and provide a support in their struggle against poverty.

During the EIA process, a baseline study of the aquatic ecosystem was undertaken to assess the existing ecological resources in the project area. Water samples at various points of the river Jamuna (near the project site) were collected and analyzed for the parameters such as temperature, pH, DO, BOD, COD, TSS, Chloride, Nitrate, Sulfate, Iron etc. The tests were carried out in the laboratory of DoE, Bogra. Information relating to different species of fish and other aquatic organism were collected from local people.

F. EXISTING ENVIRONMENT: SOCIO-ECONOMIC

The project is located in a semi-urban area of Sirajganj Sadar Thana in the south western part of the district of Sirajganj. Most of the people living in the area are engaged in agriculture. Most of them are people of lower middle class.

The socio-economic information/data have been collected from secondary sources. Sources of secondary data are different official records and published reports of Bangladesh Bureau of Statistics (BBS), Population Census Reports and also reports of other organizations.

Survey has been conducted in the adjoining areas of the proposed site for new power plant in two ways – i. Quantitative approach and ii. Qualitative approach. For quantitative approach, standard questionnaire (socio economic and environmental issues) has been used for interviewing randomly selected respondents in the proposed area. On the other hand, for qualitative approach, focus group discussion guidelines have been followed.

On the basis of present socio-economic status of people in and around the project area, the impact of project implementation on the socio-economic situation can be determined. Decision or measures can then be taken for the implementation of the project with sustainable friendly environment.

G. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATORY MEASURES

The Sirajganj Peaking Power Plant (herein after referred to as (Sirajganj PPP) is planned to be installed in Sirajganj Sadar Thana under Sirajganj District. For this project, a site has been selected and land already acquired, where there is no need for relocation of the inhabitants. A cooling system has been selected where river water will be used which will also be used for construction work. Ground water will be used for residential and office purposes.

In association with construction of the power plant, gas pipeline will also be built. PGCB has constructed a 230/132 KV Substation adjacent to the proposed power plant and requirement of Transmission line to connect the power plant with the grid system is minimal. Since waterborne traffic is used for the transportation of heavy objects, piers will be built in the riverside storage site, and an access road will be built to connect between the pier of the unloading yard and construction site.

Impact assessment was implemented by picking up the factors affecting the environment at the time of construction and operation for all the related facilities.

Table-1 shows the overview of the selected assessment items. **Table-2** shows Overview of the selected assessment items (Construction period).

Table-1: overview of the selected assessment items (Construction Phase)

	No.	Assessment Item	Overall Rating	Construction Phase						
				Temporary impact by undertaking construction	Power Plant			Gas Pipeline	Transmission line	Jetty
					Land formation of Earth work	Operating of construction machinery	Carrying construction materials in and out			
Environmental contamination	1	Air pollution	B			B	B			
	2	Water pollution	B		B	B				B
	3	Solid waste	B	B						
	4	Noise/Vibration	A		B	A	B			
	5	Odor	B	B						
Natural environment	6	Climate								
	7	Hydrology								
	8	Flood								
	9	Underground water	B	B						
	10	Ground subsidence	B	B						
	11	Soil erosion	B		B					B
	\2	Sanctuary								
	13	Terrestrial ecosystem	B		B			B	B	B
	14	River ecosystem	B		B					B
	15	Precious species	B		B			B	B	B
Social environment	16	Involuntary resident resettlement								
	17	Employment /Livelihood	A	B	A			B	B	B
	19	Local economy	A	B	A			B	B	B
	20	Land utilization	A		A			B	B	B
	22	Social infrastructure/service facillities	B	B	B					
	23	River traffic	B				B			B
	24	Land traffic	B		B		B			
	25	Sanitation	B	B						
	31	Risks for infectious diseases such as (HIV/AIDS)	B	B						
	26	Local custom								
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indegenous people and such)	B	B	B			B	B	B
	28	Uneven distribution of benefit and loss(damage)	B	B	B			B	B	B
	30	Utilization/Right of water, including underground water	B	B		B				
	32	Cultural heritage								
	33	Landscape	B	B				B	B	B
Other	34	Accident	B	B	B	B	B	B	B	B
	35	Global warming								

A: Serious impact is expected.
B: Some impact is expected.
No mark: No impact

Table-2: Overview of the selected assessment items (Operation period)

	No.	Assessment Items	Overall Rating	Operation Phase								
				Power Plant						Gas Pipeline	Transmission line	Jetty
				Operation of Facilities				Carrying materials/stuff in and out	Solid waste			
				Intake of cooling water	Gas emissions	Waste water	Others					
Environmental contamination	1	Air pollution	A		A							
	2	Water pollution	B			B						
	3	Solid waste	B						B			
	4	Noise/Vibration	A				A	B				
	5	Odor	B						B			
Natural environment	6	Climate										
	7	Hydrology										
	8	Flood										
	9	Underground water	A	A		B						
	10	Ground subsidence	B	B								
	11	Soil erosion										
	12	Sanctuary										
	13	Terrestrial ecosystem										
	14	River ecosystem	B			B						
	15	Precious species	B			B						
Social environment	16	Involuntary resident resettlement										
	17	Employment /Livelihood	B				B					
	19	Local economy	B				B					
	20	Land utilization										
	22	Social infrastructure/service facilities	B				B					
	23	River traffic	B									B
	24	Land traffic	B					B				
	25	Sanitation	B				B					
	31	Risks for infectious diseases such as (HIV/AIDS :	B				B					
	26	Local custom										
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indigenous people and such)	B				B					
	28	Uneven distribution of benefit and loss (damage)	B				B					
	30	Utilization/Right of water, including underground water	A	A								
	32	Cultural heritage										
	33	Landscape	B				B					B
Others	34	Accident	B				B	B			B	B
	35	Global warming	B		B							

A: Serious impact is expected.
B: Some impact is expected.
No mark: No impact

H. Environmental Management Plan (EMP) and Monitoring Plan

The main objective of the Environmental Management Plan (EMP) and Environmental Monitoring Plan is to ensure implementation of the mitigation measures planned to reduce the environmental impact by the implementation of the power plant project, and to verify and record the environmental impact.

The EMP and Monitoring Plan are worked out based on the following:

- To reduce the environmental impact to the permissible level by the mitigation measures during the period of construction and operation, so that a hazardous impact will not occur.
- To configure a responsible organization for the implementation of the mitigation measures.
- To implement the EMP and Monitoring Plan adequately during the period of construction and operation.

Work Plans and Schedules

Construction Phase

Before starting the construction work, the Project Director (PD) of NWPGCL is required to give sufficient consideration to the details of the construction work, and to make sure that the required EMP and Monitoring Plans are thoroughly understood by the contractor.

Thus, the Project Director (PD) of NWPGCL is required to form the required organization.

Especially, there is an active inflow of the workers and many construction-related vehicles during the construction. The details of the construction work, schedule and mitigation measures should be sufficiently explained to the communities in the surrounding area. The countermeasures should be altered as appropriate, based on the correct understanding of the views of the residents.

The following are the major environmental impacts during the construction work.

- Inflow of workers and an increase in the number of construction-related vehicles
- Generation of construction wastes
- Generation of dust particles, and gas emission from vehicles and machinery
- Generation of noise from vehicles and machinery
- Occurrence of muddy water in the excavation area

Employing workers from local areas during the construction phase will have a favorable impact on the local economy. Sufficient consideration must be given to the local employment, including implementation of the preliminary education and training program of the workers.

Table-3 gives the basic information of the EMP during the construction phase.

The EMP and monitoring plan should be worked out by sufficient discussions between the BPDB and the contractor. To confirm the implemented plan and to study further measures, a report schedule should be worked out in such a way that the contractor will report the current situation of implementation in the form of a written statement. This report should be submitted to the Bogra DoE for further discussion.

Table-3 : Major Environmental Impacts and Mitigation Measures During the Construction Phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Inflow of workers	▪ Generation of sewage and refuse	▪ Installation of sewage treatment facilities ▪ Can and bottle refuse is classified and are supplied to a third party for reuse ▪ Disposal at a predetermined disposal site.	contractor (BPDB or NWPGCL)
	▪ Outbreak of diseases	▪ Installation of sewage treatment facilities ▪ Installation of medical facilities and implementation of periodic health checkups ▪ Education and training on health management of the workers ▪ Prevention of epidemics among workers (HIV/AID, dengue fever, malaria, hepatitis A) ▪ Elimination of potential breeding site for harmful insects, provision of preventive medicine as necessary	
	▪ Safety, accident prevention, land traffic	▪ Use of Bus for worker ▪ Avoidance of the time when students travel between school and home ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon)	
	▪ Employment, income, livelihood, vulnerable groups, uneven distribution of benefit	▪ Priority of employment for local residents, development of employment standard ▪ Utilization of local service (cleaning, catering, materials) ▪ Implementation of the preliminary education and training programs with local authority	
	▪ infrastructure	▪ Installation of medical facilities	

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Installation of construction equipment	▪ Safety, accident prevention, land traffic	▪ Avoidance of the school commuting time ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon)	Contractor (NWPGCL)
	▪ Noise	▪ No traffic at night	
	▪ Gas emission, flying sand and dust particles from vehicles	▪ Periodic inspection and maintenance management ▪ Periodic check of the concentration of vehicle emissions based on laws and regulations ▪ Stop the engine when idling ▪ Use of a cover to protect against dust, and periodic washing of vehicles ▪ Periodic cleaning of the surrounding roads ▪ Monitoring of resident areas	
	▪ River traffic	▪ BIWTA will be consulted to determine appropriate safety and/or scheduling standards to be followed.	
Excavating work and operation of construction equipment	▪ Emission gas from machinery/sand and dust dispersion ▪ Noise	▪ Periodic watering of sediment disposition site and such ▪ Monitoring in residential area ▪ Operation in daytime only in principle ▪ Use of low-noise machinery (silencer, muffler) ▪ Construction of temporary fence around Project site ▪ Restriction of worker's prolonged exposure to noise ▪ Use of Personal Protective Equipment (PPE)	Contractor (NWPGCL)
	▪ Construction debris	▪ Waste management program consisting of reduction, reuse, and recycling of materials.	Contractor (NWPGCL)

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	▪ Soil runoff, turbid water, waste water from equipment cleaning ▪ Leakage of harmful substances ▪ Loss of habitat of flora and fauna ▪ Income, livelihood, vulnerable group	▪ Prohibition on dumping of any contaminating material ▪ Appropriate segregation of waste and disposal into designated disposal site ▪ Installation of temporary settling tanks and sediment fencing ▪ Water used for equipment cleaning is collected in the temporary tank and treated before discharge ▪ Monitoring at the water outlet ▪ Mitigation measures to prevent leakage, installation of cleaning facility ▪ Installation of green buffer ▪ The agricultural products growing on the site is compensated according to the Bangladesh regulation. ▪ Explanation of the construction extent and procedure in the early stage. ▪ Preferentially employ local people predicting decrease in income.	
	▪ Safety, accident prevention, land traffic, infrastructure	▪ Develop a safety management plan and rules ▪ Swift transport to medical facility ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Installation of bypass for farm road and waterway within the site	
Water intake	▪ Lowering of groundwater level ▪ Ground subsidence	▪ Monitoring of underground water level in the surrounding wells ▪ Dig deeper wells as necessary ▪ Monitoring of underground water level in the surrounding wells	Contractor (NWPGCL)
Installation of gas pipeline and	▪ Loss of farm land	▪ Compensation of the expropriated land according to the national regulation	Contractor (NWPGCL)

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
transmission line	▪ Livelihood	▪ Construction conducted during agricultural off-season.	
Jetty construction	Sediment outflow, turbid water ▪ River traffic ▪ Income, Livelihood	▪ Construction of jetty will adopt vertical piles type to minimize the dredging area ▪ Dredging activities will occur during dry season when water levels and flow are the lowest. ▪ Adoption of dredging method that minimizes environmental effect ▪ Use of the floating siltation curtains where appropriate. ▪ Dredged materials will be landed and dried on-site. ▪ Installation of sediment fencing ▪ Conduct dredging activity during dry season with less traffic ▪ Minimization of jetty construction area ▪ Explanation of the construction extent and procedure in the early stage.	Contractor (NWPGCL)

Operation Phase

During the operation phase, the NWPGCL is responsible to form a required organization for environmental management. This organization is responsible for receiving the complaints from the residents of the surrounding area during the operation phase and to take appropriate measures, so that the complaints of the residents will be correctly understood and necessary measures will be taken.

The basic idea is to establish a relationship with the local communities. It is important to sufficiently explain the environmental management procedures taken at the power plant. It is also important to invite the residents and school children to observe the power plant.

The following describes the major environmental impacts during the operation phase.

- Generation of gas emissions and waste water
- Generation of noise from operating machinery
- Generation of solid waste from operation

The operation workers are required to have specialized knowledge. It will be difficult to hire workers from the local area. However, employing local workers will have a favorable impact on the local economy. For the comparatively easy work, sufficient consideration must be given to local employment, including implementation of the preliminary education and training programs for workers.

Table-4 gives the basic information on the EMP during the operation phase.

NWPGCL should prepare a report on the implementation of the EMP and monitoring plan and should submit it to the Bogra DoE and related organizations for further discussion.

Table-4 : Major Environmental Impacts and Mitigation Measures during the Operation Phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Power generation	▪ Generation of gas emissions	▪ Adoption of a high stack ▪ Installation of a continuous monitoring system for gas emissions ▪ Adoption of pre-mixing method and a low-NOx combustor ▪ Monitoring of atmospheric air ▪ Periodic maintenance and management	NWPGCL
	▪ Generation of cooling and waste water	▪ Construction of open channel for a distance for cooling the hot water ▪ Installation of a wastewater treatment system capable of coagulation sedimentation, neutralization, and oil separation ▪ Monitoring of waste water ▪ Monitoring of the river or local water ▪ Blow-off water from cooling tower is cooled by dilution	
	▪ Generation of noise and vibration	▪ Planting trees around the power plant ▪ Adoption of low-noise type machinery and installation of soundproofing covers ▪ Installation of low-vibration type machinery and the use of rigid foundations ▪ Periodic maintenance and management ▪ Monitoring around the border of the site and residential area ▪ Distribution of ear protectors to employees	
Water intake	▪ Lowering of Groundwater level ▪ Ground subsidence	▪ Monitoring the underground water level in the surrounding wells ▪ Did wells of appropriate deepness as necessary	NWPGCL
Generation of waste	▪ Generation of sludge from the	▪ Waste management program consisting of reduction, reuse, and recycling of materials.	NWPGCL

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	wastewater treatment system ▪ Generation of waste oil ▪ Generation of domestic waste	▪ Systematic collection and protected-storage on-site ▪ Prohibition on dumping of any contaminating material ▪ Waste away from the site and their appropriate disposal in a designated municipal dumping site.	
Presence of power plant, inflow of workers	▪ Loss of habitat of flora and fauna ▪ Employment, livelihood, vulnerable people, uneven distribution	▪ Provision of vegetated buffer ▪ Preferential employment of local people ▪ Utilization of local service (cleaning, catering) and materials ▪ Implementation of the preliminary education and training programs with local authority	NWPGCL
	▪ Land traffic	▪ Use of Bas for worker ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Speed limit in residential- and school area	
	▪ Social foundation ▪ Diseases	▪ Provision of emergency medical facility ▪ Medical facility and periodical health checkup ▪ Education and training on health management of the workers	
	▪ Accident and safety management	▪ Tank storage areas will be equipped with oil spill bank and countermeasure for underground oil seepage and designed as physical containment area. ▪ Implement gas leakage prevention procedures and have available on-site all preventive equipment and materials as part of the process of developing emergency plan. ▪ Fire protection equipment and facilities shall be made available at suitable locations in power plant including fixed fire protection system, fire hydrants, portable fire fighting equipment, fire vents, alarm system, fire compartments and fire exit signs. Preparation of safety standard.	

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Presence of gas pipeline and transmission line	▪ Land expropriation	▪ Guarantee for the continuance of agricultural activity after construction.	NWPGCL
Presence of jetty	▪ River traffic, land use, livelihood	▪ Develop an appropriate maintenance and management schedule	NWPGCL

Environmental Implementation and Training

During operation phase, NWPGCL is responsible for the system organization of environmental management of the power plant and its implementation. The environmental manager, who should be a senior environmental engineer, should take charge of the management of the system to ensure environmental management and monitoring described hereinafter.

The environmental manager should be responsible for reporting the planning and implementation of environmental management plan and environmental monitoring plan to the manager of the power plant through all the phases of the project, and the director should take the final responsibility.

The environmental manager provides preliminary training on environmental management to the staffs prior to the beginning of the operation. The environmental manager should also provide appropriate updated training all through the operation phase.

The environmental manager is also responsible for reporting about the negotiation with local residents and issues of environmental management and monitoring and training to Bogra DoE and relevant organization.

Environmental Monitoring Plan

Table-5 and **Table-6** show the monitoring schedule during the construction and operation phases.

Table-5: Monitoring Schedule during the Construction Phase

Item	Parameter	Place	Frequency
Air quality	SPM, SO_2, NO_2	Residential areas and schools	Monitor SPM every two weeks, and SO_2 and NO_2 every two months.
Water quality	TSS	Drain outlet	Every month
Noise	Noise level	Residential areas and schools	Every week when the amount of construction work is maximized
Underground water	Underground water level Water temperature, heavy metals, (As, etc.)	Residential area	Twice/year (dry season and rainy season)

Table-6 : Monitoring Schedule during the Operation Phase

Item	Parameter	Place	Frequency
Gas emission	SPM, SO_2, NO_2	Flue	Monitor SO_2 and NO_2 on a continuous basis (by a continuous monitoring system), and SPM every month.
Air quality	SPM,SO_2, NO_2	Residential areas and schools	Monitor SO_2 and NO_2 every month, and SPM every two months.
Waste water	Water temperature, DO, SS, oil, BOD, and heavy metals	Drain outlet	Every two months
Water quality	Water temperature, DO, SS, oil, BOD, and precious metals	River	Twice a year (dry and rainy seasons)
Noise	Noise level	On the border of the site and in the residential areas	Twice a year
Underground water	Underground water level Water temperature, heavy metals, (As, etc.)	Residential area	Twice/year (dry season and rainy season)

I. Risk Assessment and Management

POWER PLANT RISKS ASSESSMENT

Managing the Risks

Risk management planning can be done during design and planning stage of the plant as well as during plant operation. While risk management is mainly preventive in nature during the plant operation stage, the design and planning stage of the plant can incorporate changes in basic engineering to include safety design for all processes, safety margins for equipment, and plant layout. The following steps among others are important in managing the risks mentioned.

- Gas storage is to be designed with adequate precautions in respect of fire hazard control.

- Storage of hazardous substances such as acids and alkalis should be sited in protected areas.

- With respect to plant operation, safe operating procedures should be laid

down and followed to ensure safety, optimum operation and economy.

- A fire fighting group with adequate manpower and facilities such as water tank of sufficient capacity, C02 tank, foam tank, portable fire extinguishers should be provided and facilities located at strategic locations e.g. generator area, high voltage panel, control rooms, and fuel tank area.

- Regular checks on safe operating practices should be performed.

In order to achieve the objective of minimizing risks at Sirajganj 150MW PPP, The unit will be trained to act in a very short time in a pre- determined sequence to deal effectively and efficiently with any disaster, emergency or major accident to keep the loss of life, human injury, material, plant machineries, and impacts on the environment to the minimum.

Emergency Response Plan

Emergency response plans are developed to address a range of plausible risk scenarios and emphasize the tasks required to respond to a physical event. The emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

The primary objective of the plan is to keep the loss of life, material, machinery/equipment damage, and impacts on the environment to minimum.

J. PUBLIC CONSULTATIONS

Within the framework of the present study, public consultation process has been initiated with an explicit objective to ensure people's participation. More specifically this was aimed at improving the study, taking into account opinions from the people of the study area.

The consultation sessions included Focused Group Discussions (FGD). one FGD was organized only with male and another with female residents around the project site.

Formal and informal meetings in terms of FGD with different groups and interviews with Key Informants (KIs) of the area were held with the primary objective to understand the people's perceptions regarding relevant issues. Discussion mainly centered on problems of the area relevant to the proposed project and suggested solutions.

Apart from Focus Group Discussion, In-depth interviews were conducted with the different officials of Sirajganj Sadar upazila to grasp their views and opinions.

Some of important points raised in the public consultations are as follows:

- If the lands are used for constructing a 150 MW-Powe Plant, it will be extremely welcome because it is very important to fulfill the needs of

electricity for the National great interest as without electric power, economic and national development is quite impossible.

- To make the food sector of the country sufficient, there are no alternatives to irrigation in the crop fields. The country's industries, offices, educational institutions- all come to standstill without electricity. The nation's prosperity will be achieved by making the proper consumption and increasing generation of electricity by building of power plant,

- The environmental aspects should be put on agenda by the government and foreign companies and standard guidelines must be followed. As a reason, they mentioned that a power plant's noise, waste, etc. causes various damages to crops, river water and human health. Everything must be protected from this kind of damage. And everyone opined that scientific methods should be used to preserve the environment.

- Besides those whose lands (except government land) would be acquired must get proper compensation and should also have advantage in case of employment (at the power plant).

K. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

In this study, the effects of the project activities on physico-chemical, ecological and socio-economic (i.e., human interest related) parameters during both construction and operation phases have been assessed. The impacts have been identified, predicted and evaluated, and mitigation measures suggested for both construction and operation phases of the proposed power plant. The important physico-chemical environmental parameters that are likely to be affected by the project activities include air and noise pollution.

The study suggests that most of the adverse impacts on the physico-chemical environment are of low to moderate in nature and therefore, could be offset or minimized if the mitigation measures are adequately implemented. Since the project site is located in a developed area that does not appear to be very sensitive ecologically, the impact of project activities on most ecological parameters (e.g., wet lands, homestead vegetation, forest cover, bushes and trees, wild life, species diversity) are mostly insignificant.

Some adverse impact during the operation phase of the plant will come from NO2 and SO_2 emission from the power plant. However, modeling study suggests that the effect of increased NO2 and SO_2 in the ambient air due to emission from the proposed power plants will not be very significant.

Noise level has been identified as significant potential impact of the proposed power plant during both the construction and operation phases. The noise generated from construction activities during the construction phase might become a source of annoyance at the residential area close to the project site. However, since residential areas are located away from the site and the trees and boundary walls will have some damping effect, the noise level is expected to come down to tolerable levels within residential area

There is no need for land acquisition. Additionally, there is no settlement in this designated area. Therefore, no population will be displaced and no resettlement will be required for the construction of the power plant.

During operation phase, no significant negative impact is anticipated on socio-economic environmental parameters.

During public consultations carried out as a part of the EIA study, people welcomed the proposed power plant project at Sirajganj. However, they recommended installing a plant of good quality, which will be able to provide uninterrupted power during peak hours and will be able to keep anticipated air and noise pollution to a minimum level.

Recommendations:

The environmental assessment carried out for the proposed Sirajganj PPP, suggests low to moderate scale of adverse impacts, which can be reduced to acceptable level through recommended mitigation measures as mentioned in the EMP. It is therefore recommended that the proposed Peaking Power Plant may be installed, provided the suggested mitigation measures are adequately implemented. It is also recommended that the environmental monitoring plan be effectively implemented in order to identify any changes in the predicted impacts and take appropriate measures to off-set any unexpected adverse effects.

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste, cooling and wastewater disposal as a result of construction and operation activities, the power plant put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. An emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

Chapter 1: INTRODUCTION

1.1 Background

Electricity is a major contributory factor in GDP of a country, as agricultural, industrial and other products as well as development of education largely depend on its reliability and quality of supply. Unfortunately, for the last few years, Bangladesh is acutely suffering from most inadequate supply of this vital commodity. Along with the sectors mentioned, domestic consumers are also suffering due frequent and unannounced load shedding. Against a demand of 4,600 MW in 2009, 4,220 MW was supplied, resulting in load shedding of 380 MW. In the same year, against a demand of 1,202 MW in the Western Zone of the country, 1,047 MW was supplied. Power supplied to the Western Zone includes 480 MW imported at peak hours through existing East-West Power Interconnector. Rajshahi Division is one of the important load centres in the country, where the power supply situation is very serious, as is the case with the whole country.

In 2009, the maximum demand (4,600 MW) of electricity in the country was recorded on 19th September. The daily generation report and the load curve of that day are placed at **Annex-1.1** in the Annex folder. From this load curve it appears that the maximum demand of 4,220MW occurred at 8-00 pm, which is about 43% more than the day time demand. This is the general phenomenon during the whole year. Meeting the demand during peak hours is a major problem for BPDB.

In order to meet the demand of electricity for the next 20 years, in 1995 BPDB prepared a Power System Master Plan (PSMP), with three alternative scenarios, High, Low and Reference. The PSMP was updated in 2005. This document also identified several generation, transmission and distribution projects. Among the generation projects, PSMP selected some which would be installed in order to meet the additional demand during peak hours. The project under consideration, Sirajganj 150 MW Peaking Power Plant Project is one of such projects. The plant is expected to run on natural gas. Until gas is available in the Western Zone, it will run with High Speed Diesel (HSD) Oil.

So far gas has been made available at Sirajganj, through gas transmission line constructed across Jamuna Multi-Purpose Bridge. Because of existence of this Bridge, connecting eastern and western parts of Bangladesh, it has been easy for the gas line to cross the Jamuna river and to construct this gas pipe line, which has already been extended up to Sirajganj.

The proposed power plant is scheduled to be installed in Barashimul Mouza of Saydabad Union of Sirajganj Sadar Thana under the District of Sirajganj. There are other smaller plants in the Western Zone. Power of all these plants, together with the power imported from the Eastern Zone through the existing Interconnector, are not sufficient to meet even the normal demand of the Western Zone, not to speak of the peak demand. It is, therefore, very important to install peaking power plants and PSMP has correctly identified such projects, one of which is the 150 MW Sirajganj Peaking Power Plant.

Under the ongoing Power Sector Reform Program, generation, transmission and distribution branches are being separated from the mother organization, BPDB, and in the process, North West Power Generation Company Limited (NWPGCL) has been created for construction, operation and maintenance of power generation facilities in the North-Western Zone of the country. The present project is also placed under NWPGCL.

Presently, environmental conservation is being given top priority worldwide. In Bangladesh also, for any new project, as well as plants under operation, it is mandatory to obtain environmental clearance from the Depart of Environment (DoE), under Environment Conservation Act 1995, amended from time to time. According to Bangladesh Environment Conservation Rules 1997 (ECR), power plants come under the Red category, so far as environmental impact is concerned. Initial Environment Examination (IEE) followed by Environmental Impact Assessment (EIA), including Environmental Management Plan (EMP) are required for these types of installations for getting environmental clearance from DoE.

NWPGCL has initiated the environmental clearance from DoE and in the process, the company has already obtained IEE clearance from DoE for this project. It is now required to obtain EIA clearance. NWPGCL has engaged Engineers Associates Limited (EAL), an experienced firm for such activities, for preparation of EIA for the project, for which work order has been issued to EAL vide **Purchase Order No.178-NWPGCL/Siraj-150/AC/2009 dated 01/11/2009.**

1.2 Project Outline

Sirajganj 150 MW Peaking Power Plant is planned to be installed within Barashimul Mouza of Saydabad Union of Sirajganj Sadar Thana under the District of Sirajganj, which is about **15 KM** South-east of Sirajganj town. The location of Sirajganj town is shown on the map of Bangladesh, placed at **Annex-1.2(1)** and position of the proposed Peaking Power Plant is shown on the map of Sirajganj Thana at **Annex-1.2(2)**. Location of Proposed Sirajganj 150MW PPP showing on Satellite image is given under **Annex-1.2(3).**

1.3 Policy, Legal and Administrative Framework

DoE, under the Ministry of Environment and Forest, Government of the Peoples' Republic of Bangladesh, is responsible for ensuring application of environmental laws and rules and issuance of necessary clearances in this regard. The Environmental Conservation Act has classified three categories of establishments, so far as degree of environmental pollution is concerned – Green, Amber and Red.

According to the Environment Conservation Rules 1997, power plants, transmission lines and gas pipe lines come under Red category, as has been stated earlier under 1.1 above. Under this Rule, it is mandatory for project proponents to obtain environmental clearance from DoE, by carrying out IEE, followed by EIA, including Environmental Management Plan (EMP). It has also been stated earlier that NWPGCL has already obtained IEE clearance. NWPGCL is now required to obtain EIA clearance from DoE.

In addition to Environmental Conservation Act and Rules, the following relevant National Policies and Legislations (with their amendments) relating to environment are also required to be adhered to for the project:

a) National Conservation Policy, 1992

b) National Conservation Strategy,1992

c) EIA Guidelines for Industries, 1997, issued by DoE

d) Bangladesh Wildlife Preservation Act, 1973

e) Bangladesh Antiquities Act,

f) Power Policy,1995

g) Energy Policy,1996

h) Electricity Act and Rules, 1910 and

i) Industrial Policy.

The project is being financed by Asian Development Bank and Government of Bangladesh

1.4 Study Area

Sirajganj 150 MW Peaking Power Plant is planned to be installed within Barashimul Mouza of Saydabad Union of Sirajganj Sadar Thana under the District of Sirajganj. The area is located about 15 KM south-east of Sirajganj town. The Jamuna Multipurpose (Bangabandhu) Bridge is on the north of the site, Khas Barashimul village on the south, Jamuna river on the east and Sydabad is on the west side of the power plant site. The site is about **130 km** north-west of the capital city of Dhaka.

The EIA study covered an area of about 2 km around the site, where the proposed plant is expected to be located. The study area is shown on **Annex-1.4.**

1.5 Outline of Methodology

1.5.1 Major Activities

For Environmental Impact Assessment study, the following major activities are required to be undertaken:

(a) Study of the relevant documents on policy, legal and administrative framework and their review, particularly on environmental aspects and effluent discharge limits, health and safety requirements, identification of sensitive areas and endangered species, land use etc.

(b) Carrying out an environmental baseline survey covering areas in and 2 km around the project site i.e. Study Area.

(c) Identification of major project activities, both during construction and operational phases of the project.

(d) Identification and prediction of environmental impacts of project activities on the surrounding environment, including cumulative impacts of the proposed power plant and the existing and ongoing projects/industries on selected environmental attributes.

(e) Identification of the most significant environmental and social impacts and suggestions for mitigation measures in order to reduce/eliminate negative impacts and to enhance positive impacts.

(f) Arrangement of public consultation meetings to consult with potentially affected people.

(g) Development of Environmental Management Plan (EMP) for both construction as well as operational phases of the project.

(h) Development of Corporate Environmental Policy for the project authority regarding environmental protection and sustainability.

(i) Analysis of the alternatives to the proposed project site, technology, design and operation.

(j) Identification of environmental and health risks associated with major accidents, natural disasters and external threats and recommendations for measures to be taken for reduction of these risks. A quantitative risk assessment and characterization of individual hazards on human health was not performed due to the very limited time allocated for this study and also due to the lack of pertinent data in the absence of a detailed feasibility study and design of the project.

1.5.2 Study Team and Their Tasks

Study Team

A Study Team was constituted comprising of specialists on various aspects for conducting the environmental impact assessment of the project. The list of team members is given in the following table:

Sl. No.	Position	No. of Specialists
1.	Team Leader	1
2.	Environmental Expert-A (Natural Environment)	1
3.	Environmental Expert-B (Air, Water, Noise)	1
4.	Social Environmental Expert-A (Social Environment Study)	1
5.	Social Environmental Expert-B (Social Investigation)	1

Tasks assigned

Tasks assigned to the individual experts are as follows :

Team Leader

(i) Monitor the activities of Social Environmental survey.

(ii) Monitor the activities of Natural Environmental survey.

(iii) Supervise the preparation of survey reports

(iv) Liaison with Project Director (PD) of the project.

(v) Attend meetings with concerned authorities.

Environmental Expert-A

(i) Guide the Natural Environmental survey team in conducting the survey.

(ii) Investigate and study the relevant documents.

(iii) Compile the results of Natural Environmental survey and document investigation and study.

(iv) Prepare Natural Environmental survey reports.

(v) Attend meetings with the concerned authorities.

(vi) Report to the Team Leader.

Environmental Expert-B

(i) Supervise the measurements of air quality, water quality and noise level in and around the Study Area.

(ii) Guide the Natural Environmental survey team in conducting the survey.

(iii) Compile the results of air quality, water quality and noise level.

(iv) Prepare Natural Environmental survey reports.

(v) Attend meetings with concerned authorities.

(vi) Report to the Team Leader.

Social Environmental Expert-A

(i) Discuss the outcome of all survey results with all Team Members and concerned authorities.

(ii) Summarize all survey reports.

(iii) Attend meetings with concerned authorities.

(iv) Report to the Team Leader.

Social Environmental Expert-B

(i) Develop questionnaire for social survey.

(ii) Organize Focused Group Discussions (FGD) in the project area.

(iii) Train the field supervisors and field investigators in conducting social survey.

(iv) Supervise social survey activities.

(v) Compile the results of survey and prepare survey reports.

(vi) Attend meetings with concerned authorities.

(vii) Report to the Team Leader.

1.6 Report Structure

This EIA report for Sirajganj 150 MW Peaking Power Plant has been prepared after survey of natural and social environments of the Study Area, following the Guidelines for Industries, 1997, issued by DoE and in accordance with Environmental Conservation Act and Rules. The report contains all the elements of an EIA report as required by DoE, along with some additional elements to suit the requirements of the present study.

The report is divided into the following 11 Chapters:

Chapter 1: Introduction

This chapter presents the background and a brief outline of the proposed power plant project. It provides a brief description of the policy and legal framework with regard to the environmental aspects of the project in the context of Bangladesh, where the regulatory requirement of conducting an environmental assessment of the proposed project has been discussed. The chapter provides a brief description of the area covered by the present study and the methodology adopted for environmental assessment of the proposed project.

Chapter 2: Project Justification

It presents an analysis on the justification of the project, with brief discussion on the present demand-supply situation and the consequences of “no-project” scenario.

Chapter 3: Description of the Proposed Project

This provides a description of the different aspects of the proposed project, including project location, site development and construction activities, equipment and processes to be employed,

electricity generation and transmission, gas transmission, water management, waste and emission management, fire fighting and operation and maintenance. An environmental baseline survey has been carried out within the Study Area as part of the present study. During the baseline survey, detailed information on the existing physical, ecological and socio-economic condition of the Study Area were collected.

Chapter 4: Existing Environment - Physical

This chapter provides a description of the existing physical environment of the Study Area. The elements of the physical environment of the Study Area described here include climate, topography and drainage, geology and soils, hydrology and water resources, air quality, noise level and water quality.

Chapter 5: Existing Environment - Ecological

It describes the existing ecological environment, including the terrestrial and aquatic eco system of the Study Area and the presence of rare and endangered species.

Chapter 6: Existing Environment – Socio-Economic

The existing socio-economic condition of the Study Area has been summarized in this chapter. It provides description of the land use and utilities, demographic characteristics, education, employment and economics of the Study Area. It also briefly describes the industry, agriculture, public health and transport issues of the Study Area.

Chapter 7: Potential Environmental Impacts and Mitigation Measures

This describes the potential environmental impacts of the proposed power plant project and the mitigation measures to reduce or eliminate adverse impacts, along with measures to enhance and monitoring positive impacts. For this purpose, the project activities have been divided into two phases – construction phase and operation phase. The major environmental impacts of the project activities during each phase have been identified. This chapter then provides an evaluation of these potential impacts and presents suggested measures to reduce or eliminate adverse impacts and enhance positive impacts. An economic assessment of the impacts has also been presented at the end of the chapter.

Chapter 8: Environmental Management Plan and Monitoring

It presents the environmental management and monitoring plan for the proposed project, both during the construction and operation phases. Among other issues, it addresses the detailed monitoring plan (including monitoring parameters, monitoring schedule and

resource requirements), occupational health and safety issues and institutional arrangement.

Chapter 9: Risk Assessment and Management

This chapter identifies common risks in a power plant associated with accidents that may occur, natural disasters and external threats and outlines important measures to minimize those risks.

Chapter 10: Public Consultations

It presents the findings of various consultations carried out as part of the environmental assessment, including consultation with statutory and non-statutory bodies and public consultations.

Chapter 11: Conclusions and Recommendations

This chapter presents the conclusions and recommendations of this environmental assessment study.

Chapter 2: PROJECT JUSTIFICATION

2.1 Introduction

In fiscal year 2006 the total installed capacity in the country was 5,202 MW, which comprised of thermal generation capacity of 4,972 MW (95.6%), and a hydroelectric generation capacity of 230 MW (4.4%). In terms of fuels, natural gas-fired power stations represented 81.3% of the total capacity. In terms of the installed capacity of different electric power generation companies, as of March 2004 the installed capacity of the BPDB (Bangladesh Power Development Board) was 3,429 MW while that of the IPPs (independent Power Producers) was 1,260 MW. However, the percentage of power generating facilities that were inoperable due to aging was high, between 30% and 40%.

Although natural gas is the central pillar of domestic energy production in Bangladesh, because the gas fields are unevenly distributed, located primarily in the eastern zone of the country, the fuels used and the types of generating facilities differ between the eastern and western regions. In the east, all thermal power stations use natural gas as fuel, but in the west the main fuel is oil and for small portion, coal.

Because there is a chronic supply shortage in Bangladesh, electric power generation companies cannot afford to stop power stations for inspection and maintenance, and because periodic inspections are also not being sufficiently performed, the generating capacities of most thermal power stations is substantially less than the rated power.

Table 2.1.1 Power Generating Facilities using Fuel

Fuel	MW	%
Natural Gas	4,228	81.28
Heavy Oil	280	5.38
Diesel	214	4.11
Hydraulic Power	230	4.42
Coal	250	4.81
Total	5,202	100.0

(Source) BPDB Annual Report 2006/2007

Table 2.1.2 Power Generating Facilities using a Generation Method

Generation Method	MW	%
Hydro-Electric Power	230	4.42
Steam Turbine	2,638	50.71
Gas Turbine	1,106	21.26
Combined Cycle	990	19.03
Diesel	238	4.58
Total	5,202	100.0

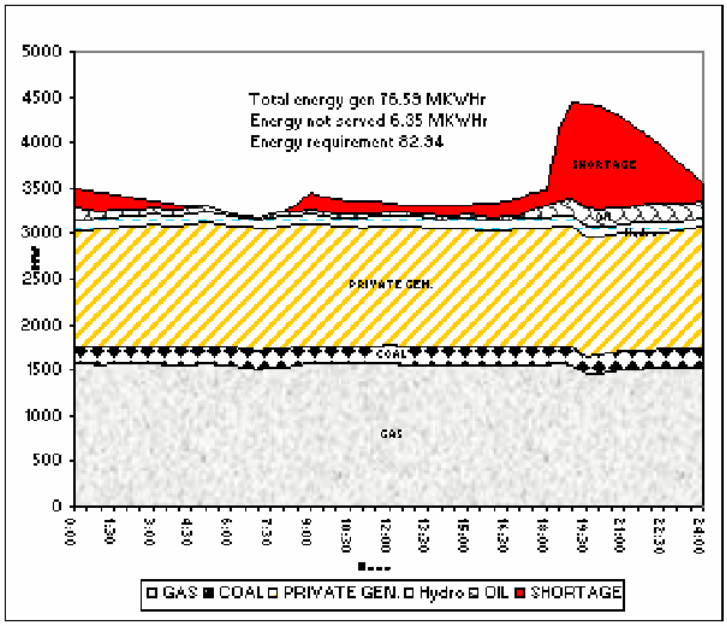
(Source) BPDB Annual Report 2006/2007

2.2 Demand-Supply Situation

As of July 26, 2008, the generation at the time of maximum demand supplied was only 3376 MW although depleted generation capacity is 4830 MW. Examining the reasons, it was found that the shutdown of the power plant resulting from maintenance or trouble corresponded to 603 MW, on the other hand, the shortage of gas supply corresponded to 664 MW.

Figure 2.2.1 shows the load curve of the same date. It shows that a shortage of power supply occurred at all times. Especially as shown in **Table 2.2.1**, load shedding of 825 MW occurred at the time of maximum demand at 20:00. Should the aforementioned gas supply shortage problem be solved, there is still a shortage of electric power generating capacity of 161 MW. This requires quick action to be taken to launch a new power generation development project. **Table 2.2.1** also shows the situation as on September 18, 2009.

Further, 80 percent of the power plants in Bangladesh are concentrated in the eastern zone close to the natural gas fields. This requires power transmission of about 200 to 300 MW from east to west. Thus, from the viewpoint of system operation, power generation development in the western zone is an urgent necessity.



(Source) BPDB homepage

Figure 2.2.1 Load curve as of July 26, 2008

Table 2.2.1 Load shedding as of July 26, 2008 & September18, 2009

Zone	Area	Load Shedding MW	
		26.7.2008	18.9.2009
East	Dhaka	224	134
	Cittagong	120	103
	Comilla	27	55
	Mymensing	59	28
	Sylhet	40	17
East Sub-Total		470	337
West	Khulna	162	92
	Rajshahi	100	39
	Barisal	24	8
	Rangpur	69	16
West Sub-Total		355	155
Total		825	492

(Source) BPDB homepage

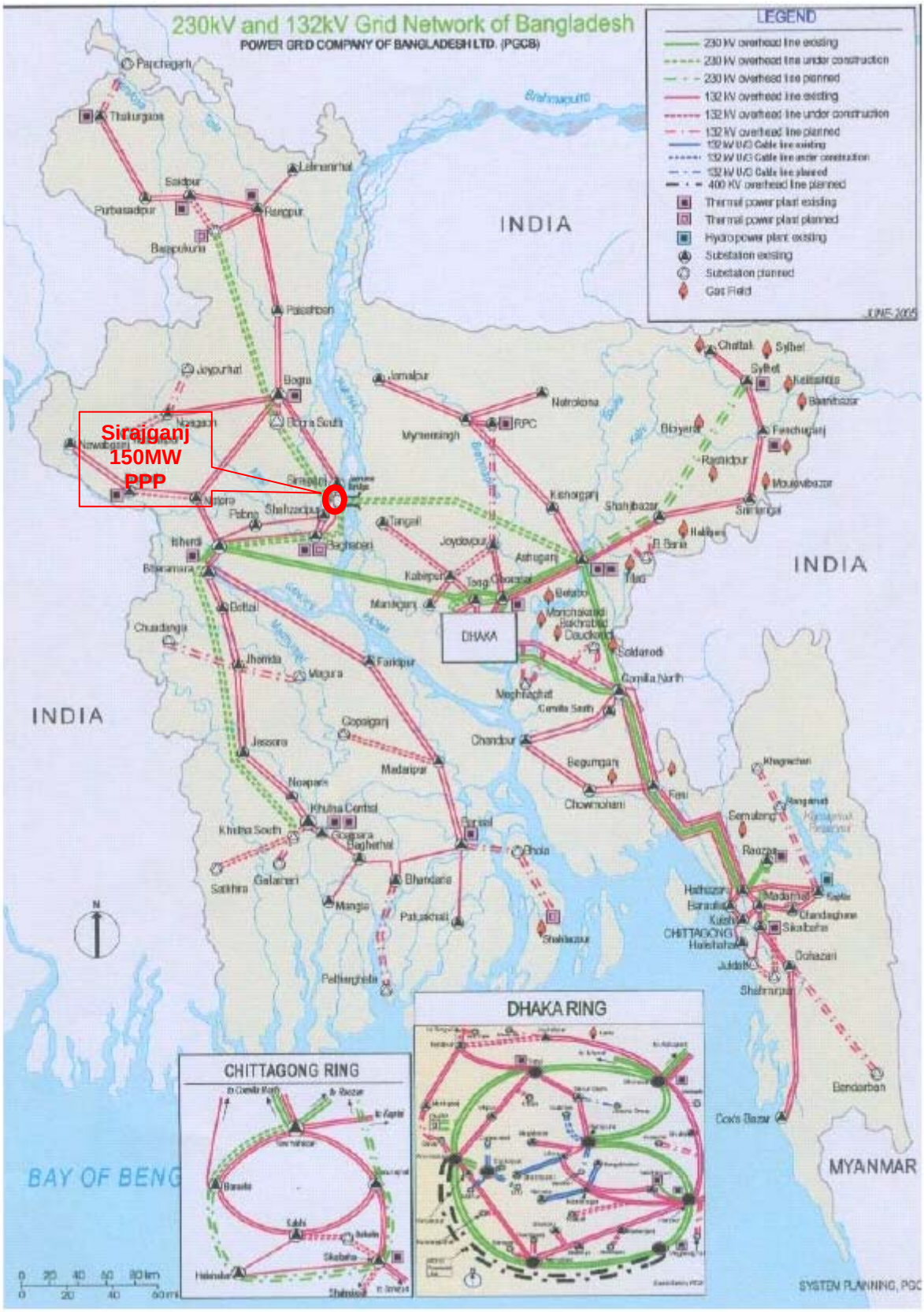
BPDB is working out power generation development planning according to the demand assumption of the basic case carried out in PSMP 2006. In this assumption, the maximum load in 2012 is assumed as 7732 MW and the reserve margin percentage of 22 % is taken into account. To meet this assumption, it is necessary to build power plants having total power generating capacity of 4619MW, in addition to the existing power generation capacity.

According to the Projects List in the PSMP 2006, Sirajganj Peaking Power Plant (100 MW in PSMP) is planned as an important one in the western zone, which was planned to commence commercial operation in 2008.

In Sirajganj 150 MW Power Plant, Availability of three factors -- water, fuel, and power transmission -- are crucial for its operation. However, it is provided with these factors as shown below:

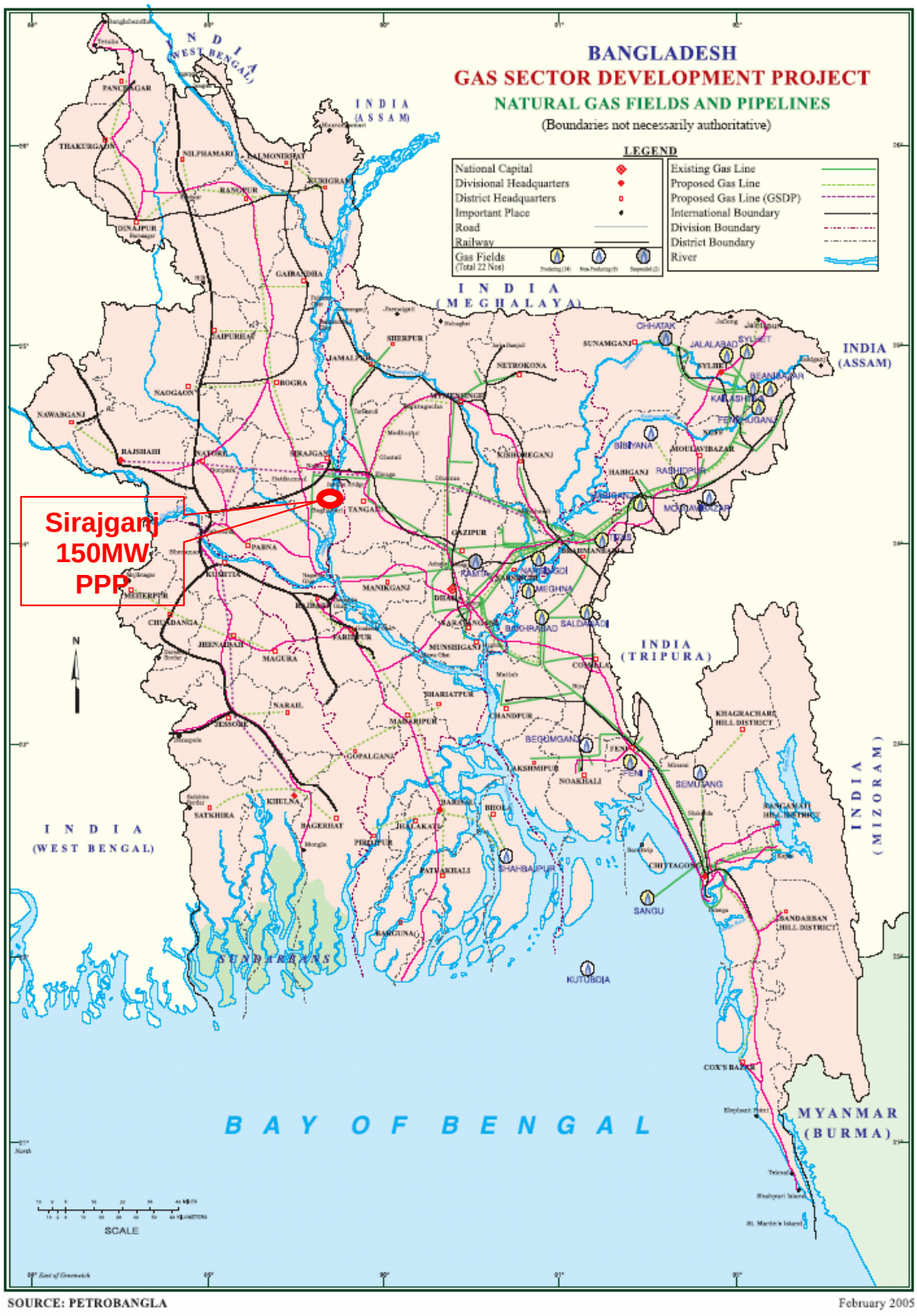
- In the Sirajganj area, the planned construction site of the 150 MW Sirajganj Peaking Power Plant is located adjacent to the 230/132 kV Sub-station owned by PGCB. This provides good access for the power, produced from the power plant to transmission grid system **(FIgure2.2.2).**

- So far gas has been made available at Sirajganj, through gas transmission line constructed across Jamuna Multi-Purpose (Bangabandhu) Bridge. Because of existence of this Bridge, connecting eastern and western parts of Bangladesh, it has been easy for the gas line to cross the Jamuna river and to construct this gas pipe line, which has already been extended up to Sirajganj. **(FIgure2.2.3).**



(Source Power System Master Plan 2006)

Figure 2.2.2 Grid map



(Source PETROBANGLA)

Figure 2.2.3 Gas Transmission Network in Bangladesh

2.3 Consequences of No-Project Situation

It has been stated under Chapter 1 that in 2009, against a demand of 1,202 MW in the Western Zone of the country, 1,047 MW was supplied. Power supplied to this Zone includes 480 MW imported at peak hours through existing East-West Power Interconnector. Power shortage of 155 MW it the Western Zone occurred during peak hours. Rajshahi Division is one of the largest load centres in the country, where the power supply situation is very serious, particularly in the evening. This is also the case with the whole country.

From the load curve of September 18, 2009, placed at **Annex-1.1**, it appears that the maximum demand of 1,202 MW in the Western Zone occurred at 8-00 pm, which is about **100%** more than the day time demand. This is the general phenomenon during the whole year. Meeting the demand during peak hours is a major problem for BPDB.

If the present project is not implemented, the load shedding in the zone will further increase, aggravating the sufferings of the consumers of electricity.

Chapter 3: DESCRIPTION OF THE PROPOSED PROJECT

3.1 Project Location

It has been stated in Chapter 1, paragraph 1.2 that Sirajganj 150 MW Peaking Power Plant is planned to be installed within Barashimul Mouza of Saydabad Union of Sirajganj Sadar Thana under the District of Sirajganj, which is about 15 KM south-east of Sirajganj town. The location of Sirajganj town is shown on the map of Bangladesh, placed at **Annex-1.2(1)** and position of the proposed Peaking Power Plant is shown on the map of Sirajganj Thana at **Annex-1.2(2).** The possible layout plan of Sirajganj Peaking Power Plant is shown at **Annex-3.1**.

The proposed Power Station area is located about 15 KM south-west of Sirajganj town, as stated above and beside the Jamuna river. The JMB (Bangabandhu Setu) is on the north of the site, Khas Barashimul village on the south, Jamuna river on the east and Sydabad is on the west side of the power plant site. The proposed site is about **130 km** north-west of the capital city of Dhaka. This site lies between N $24^0$23'4" and N $24^0$23'16" and between E $89^0$44'33" and $89^0$44'51".

3.2 Site Development and Construction

Land development for the proposed site has been completed by NWPGCL. Construction of necessary internal roads in the site as per Layout plan have been completed. Boundary wall of the whole site has been already constructed.

It is expected that the proposed plant will consist of heavy plant equipment to be delivered to the site. The main components, gas turbine, generator and transformer, will be assembled overseas and delivered to the site using river routes. The remaining plant and equipment will be erected at the site. For the construction and erection of the plant, heavy equipment, like cranes etc will also be utilized. For unloading heavy equipment, a suitable jetty has to be constructed.

3.3 Equipment and Processes

The possible layout of Sirajganj 150 MW Peaking Power Plant is as shown in **Annex-3.1.** The layout has been prepared based on the following considerations:

- Location of the 230/132 KV Sub-station is fixed, as it is already constructed by PGCB, which is adjacent and to the North of the proposed plant.

- Position of air intake of the Gas Turbine (GT) is important, as intake air temperature will influence the efficiency of the machine. Air intake position should be considered to minimize the influence of outlet of cooling water as well as GT exhaust. According to the meteorological data, the main wind direction during the summer season at the site is from the south. That is why the location of both cooling water outlet as well as exhaust from the GT is towards the north of the site.

- Water of the Jamuna River, from where the cooling water will be taken, has been tested. Treatment of this water is required in order to make it suitable for the plant.

- Control panels of the new plant, Auxiliary power supply control panels and battery with charging equipment will be set up in the turbine building.

- HSD oil tanks will be constructed for the new plant. The capacities of these tanks are expected to be 10 million liters, which is sufficient for 7 days' operation. A Day Tank of 1 million liters will, however, have to be constructed close to the new plant.

- 132 KV control panels will be installed in the existing Grid Control Room.

- The GT building will house the GT and generator with associated supporting mechanical/electrical/control equipment.

- Natural gas, when available at the site, will be supplied from the City Gate Station (CGS) of the gas company near the plant. Terminal point will be located close to the gas intake point of the plant. Natural gas will be compressed up to the required pressure level for the GT.

3.4 Electricity Generation and Transmission

Electricity will be generated in the proposed power plant at 10 – 11 KV, which is the normal voltage for such generators. The voltage will be stepped up to 132 KV through a step-up Transformer, to be installed close to generator outlets. This high voltage (132 KV) supply will be connected to the existing 132 KV Sub-station, through 132 KV conductors of required specifications. In order to connect these conductors to the Sub-station, the later (Sub-station) has to be extended, for which sufficient space has been kept. The detailed design of this extension has not yet been decided.

3.5 Gas Pipe Line for Power Generation

Gas will be supplied to the proposed plant through the gas pipe line already constructed along the JMB. A CGS will be installed by the gas company, near the power station and the volume of gas supplied to the power plants will be measured by the CGS.

The gas pipe line from the downstream side of the CGS to Sirajganj 150 MW Peaking Power Plant will be laid along the route to be decided later on. The CGS inlet pressure is expected to be 1,000 psig and the outlet pressure between 300 and 350 psig. The gas pressure at the plant site is, therefore not expected to be higher than 350 psig, which is much lower than the pressure required by the proposed plant. It will, therefore, be necessary to install gas pressure boosters near the plant.

3.6 Water Management

Potable and sanitary water will be supplied from a deep water pump and overhead tank to be constructed. But cooling/process water for the plant, fire fighting water and water for miscellaneous services will be obtained from the

Jamuna river, which is required to be treated through pretreatment system in a Water Treatment Plant (WTP). A conceptual flow diagram of the two sources of water is shown in **Annex-3.6(1)**.

Water, after cooling of lubricating oil and compressor wet washing, shall be treated and cleaned in separate equipment in the WTP. Sewerage and sanitary waste water shall be treated in purifying facilities. Floor drains from the GT and contaminated yard drains from the Transformer area shall be treated in oil/water separators. After treatment, these clean waste water streams shall be discharged through the main drainage pipe to the river. A conceptual flow diagram of the waste water flow is shown in **Annex-3.6(2)**.

3.7 Waste and Emission Management

Waste generated during the construction phase of the project include construction debris and wastes (e.g. scrap iron, steel, wood, piping etc.) and some other solid wastes (e.g. from labor sheds), human wastes from people working at the project site and some liquid wastes from construction processes. Emissions would include those from operations of construction equipment and machineries, vehicles carrying construction materials to the site and taking construction debris out of the site. If construction equipment, such as stone crushers, are used at the site, this may result in significant emission of particulate matters during its operation. Since construction of the proposed power plant would most likely involve significant earthwork, increase in particulate matters in the air from wind-blown dust is also a concern, especially considering the close proximity of the residential area to the project site. Noise pollution from movement of vehicles and operation of construction equipment is also a concern for the same reason.

The proposed Sirajganj 150 MW Peaking Power Plant is of relatively cleaner technology for production of electricity. Emission from the plant is expected to produce minimum impact on the surrounding environment, other than temperature.

The appropriately designed wastewater disposal facilities of the proposed power plant will take care of human wastes to be produced within the plant. Solid wastes from offices of the power plant, to be generated during the operation of the plant would not be significant.

Management of wastes and emissions generated during the construction and operation phases of the project is a very important issue, details of which have been discussed in Chapter 8 of this report. In general, construction debris and other solid wastes generated at the construction site should not be mixed with domestic solid wastes generated within the complex. These solid wastes should be handled separately. It should be the responsibility of the contractor to properly store these wastes at the project site and then dispose them off in an appropriate manner (e.g. in a municipal land fill/waste dumping ground) outside the complex. Human wastes e.g. those generated in the labor sheds, should be appropriately disposed off, e.g. through construction of septic tank system.

Appropriate measures, as detailed in Chapter 8 should be taken to minimize generation of air pollutants during construction phase. Such measures may include, among others, controlled movement of vehicles and operation of

equipment considering school hours, covering of construction materials (e.g. sand) and keeping exposed land surface wet to limit wind-bound dust concentration, no or limited operation of equipment producing excessive noise during school hours and late at night etc. Measurement of air quality and noise level during both construction and operation phases would also be part of the waste and emission management scheme (see details in Chapter 8).

3.8 Fire Fighting and Protection System

3.8.1 Fire Safety Philosophy

The proposed Gas Turbine Plant will be designed and built with the provision of a safe operating environment both for plant and personnel. This will be achieved by separation and segregation of equipment with sufficient distances and by selection of suitable materials and equipment.

Hazardous areas will be designated and suitable equipment will be selected for use in these. Different fire fighting systems will be installed depending on the operational characteristics of the equipment, area and building to be protected. The capacity of the proposed fire fighting plant will be such that it can operate continuously for 2 hours according to NFPA 850 and will be of a minimum of 300m^3 and pressure of approximately 10 bars (Table 3.8.1).

The proposed plant will have its own water system for fire fighting, with a pump house. The fire water will be provided from the river/raw water tanks.

The new pump house will consist of :

- One (1) 100% electric jockey pump
- One (1) 100% electric driven main pump and
- One (1) 100% diesel engine driven main pump.

The water demand and required pressure under the worst condition will be ensured by electrically driven main pump. The diesel engine driven pump shall be on stand-by, for the case of main supply failure. The engine driven pump will be of the same capacity as the electric driven main pump.

Table 3.8.1 : List of Protected Areas and Types of Fire Fighting and Detection System

Sl. No.	Building or Area	Fire Fighting System
1.	Gas Turbine	CO_2 extinguishing system
2.	Generator Unit, Auxiliary and Step up Transformer	Spray water dry type
3.	Oil Tanks	Form system, Dike protection
4.	Control Room	Cable basement: sprinkler system Control room: argonite or similar
5.	Electrical/Switchgear	Sprinkler system, if required and portable fire extinguisher
6.	Yard	Hydrants
7.	Common	Protective signaling for fire and gas detection systems with main panel in the control room

3.8.2 Fire Fighting System Description

The fire protection system of Sirajganj 150 MW Peaking Power Plant will be provided for the plant as described in the following paragraphs. The fire protection system will generally follow the applicable stipulations of NFPA codes.

Extinguishers will be sized, rated and spaced in accordance with NFPA 10. Local buildings fire alarms, automatic fire detectors and the fire signaling panel will be in accordance with NFPA 72.

It will be assured that a dedicated two (2) hour fire water supply to cover the system design flow rate is available for the facility in accordance with NFPA.

A main firewater pipeline will be provided to serve strategically placed yard hydrants and supply water to the sprinkler and spray system.

The firewater distribution system will incorporate sectionalizing valves so that a failure in any part of the system can be isolated while allowing the remainder of the system to function properly.

Fuel oil tanks are furnished with foam fire fighting systems.

3.9 Operation and Maintenance

Major equipments of the power plant are gas turbine, generator, sub-station equipment etc. Generally gas turbine has the most frequent failure among such major equipments. Therefore, the maintenance quality for the gas turbine makes great influence on the availability of the power plant.

During the operation of the gas turbine, consequently the degradation / damage of blades are more severe than any other part and it requires more frequent interval for inspection / repair / replacement. The expected life of those hot parts of gas turbine is specified by the original equipment manufacture (OEM) and the specified inspection / repair are required up to the life end. **Table 3.9.1** shows the example of the inspection interval.

Generally there are three types of inspection according to the equivalent operating hours.

Table 3.9.1: An example of inspection interval

Type of Inspection	Inspection Interval / Equivalent Operating Hours
Combustion Inspection	8,000 hours
Turbine Inspection	16,000 hours
Major Inspection	48,000 hours

3.10 Others

3.10.1 Facilities for Construction

(a) Jetty and Crane

A suitable jetty has to be constructed at the site, equipped with cranes of suitable capacities, for unloading of equipment and materials during construction as well as operation of the plant.

(b) Storage Yards

Storage yards are very important for construction of a plant, like the Sirajganj 150 MW Peaking Power Plant. It will be apparent from **Annex- 3.1** that there is sufficient space for storage of power plant equipment as well as civil construction materials at the same time. It will, therefore, be not necessary to schedule the construction in such a way that civil construction e.g. machinery foundation and building works are completed just before the arrival of power plant equipment and remaining civil construction materials are removed from the site to make room for equipment storage.

Chapter 4: EXISTING ENVIRONMENT: PHYSICAL

4.1 Introduction

A baseline survey was carried out in areas surrounding the proposed Sirajgonj 150 MW Peaking Power Plant project site for the purpose of ascertaining Physical Environmental conditions. This has been done in order to gather information on the existing physical environment of the areas in and around the project site. During the survey, air and water samples were collected from pre-determined points in the area and analyzed in laboratory. Noise levels were also measured at definite points.

Relevant information on climate, drainage, hydrology and water resources were also collected.

The data collected on different items, results obtained from laboratory tests and measurements made are detailed in this Chapter. It describes the existing physical environment of areas in and around the project site based on the baseline survey and other studies carried out as a part of the present study. Air quality, noise level, water quality and other physical environmental conditions of the project site, as have been described in this Chapter, are very important in obtaining clearance from DoE. These are also very essential for designing the equipment for the project.

4.2 Climate

Bangladesh, a small country with generally low lying area, is located at the central part within the Asiatic monsoon region where the climate is tropical. Its climate has moderate variation in terms of temperature, rainfall, relative humidity and wind speeds.

There are two marked seasons in Bangladesh, the rainy season from May to October, during which more than 85% of the total annual rainfall occurs and the dry season from November to April. The beginning and ending of the rainy season vary from year to year. Heavy rains may commence anywhere between mid April and early June and may end anywhere between the end of September and mid November.

Climatic conditions of the study area were collected from the Meteorological Department at Dhaka and Bogra. Rainfall, temperature, relative humidity and wind speed are described in the following paragraphs.

4.2.1 Rainfall

During the monsoon (June to September), wind direction from the southwest brings moisture laden air from the Bay of Bengal, when the heaviest rainfall occurs. Average monthly rainfall values for the study area are given in **Table 4.2.1**.

Table 4.2.1 : Rainfall characteristics of the study area, 2000-2008

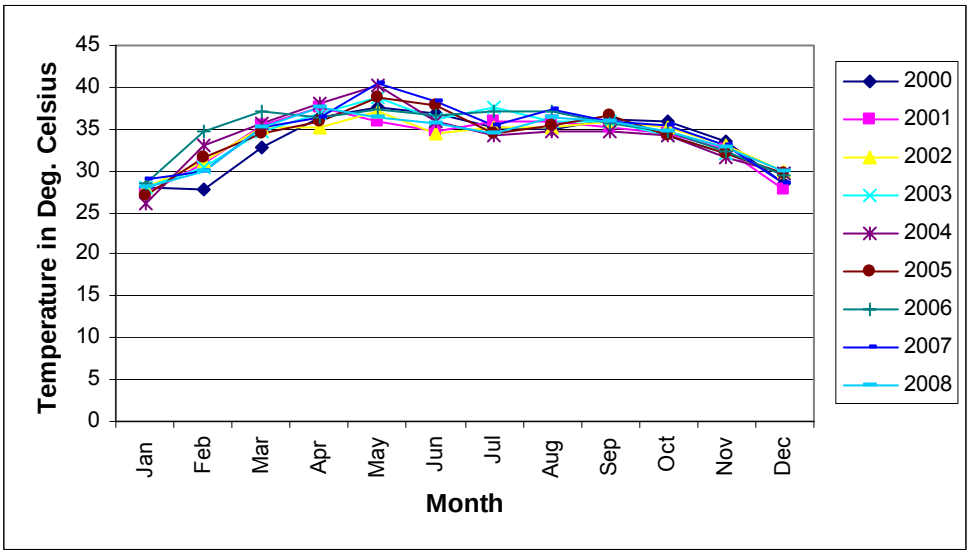
Station : Bogra Monthly & Yearly Total Rainfall(mm)

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Year Total
2000	18	37	76	158	272	250	190	289	466	84	0	0	1840
2001	0	0	0	22	223	299	185	115	344	203	8	0	1399
2002	7	0	13	284	132	254	476	496	326	27	21	0	2036
2003	4	53	72	113	214	364	219	220	156	264	0	13	1692
2004	0	0	45	90	137	638	529	261	206	251	0	0	2157
2005	5	9	58	72	138	130	471	328	356	523	0	1	2091
2006	0	0	12	143	193	184	192	138	174	69	1	0	1106
2007	0	18	25	28	92	732	320	256	302	131	15	0	1919
2008	27	0	22	20	213	393	474	374	109	159	0	0	1791
2009	0	3	3	49	205	128	111						

Source: Bangladesh Meteorological Department, Dhaka

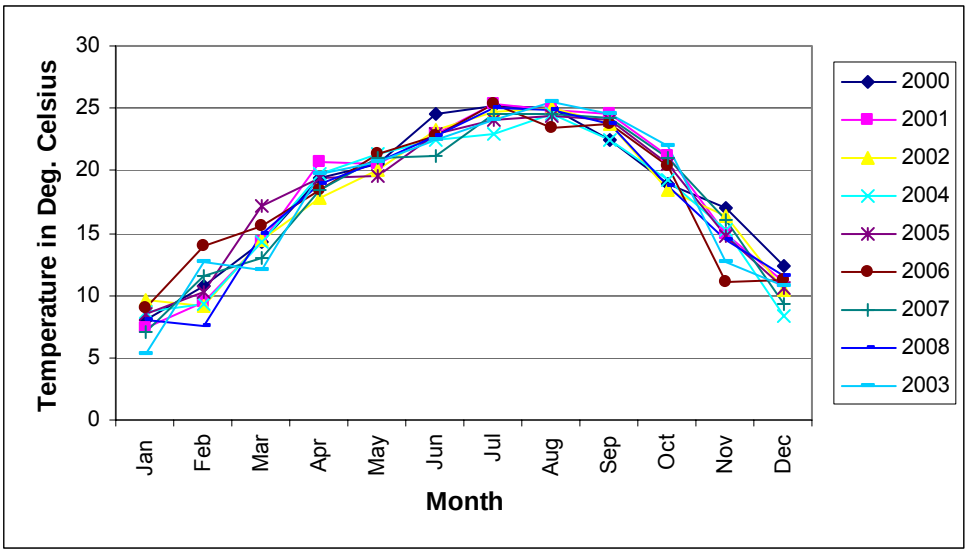
4.2.2 Ambient Air Temperature

Ambient air temperature varies with rainfall. During cool seasons, lowest rainfall occurs. Monthly maximum and minimum temperatures recorded at Bogra Meteorological Station are shown in **Figure 4.2.2(1) and Figure- 4.22(2) respectively.** Maximum temperature of **40.5^{0}C** was observed in May, 2007 and minimum temperature was **5.3^0 C** in January, 2003.



Station: Bogra, BMD

Figure 4.2.1(1): Monthly Maximum Temperature



Station: Bogra, BMD

Figure 4.2.1(2): Monthly Minimum Temperature

Monthly Maximum & Average temperature of the project area for the period of year 2000-2008 recorded at Bogra Meteorological Station are shown in **Table 4.2.2(1)** and Monthly Minimum & Average temperature of the project area for the period of year 2000-2008 recorded at Bogra Meteorological Station are shown in **Table 4.2.2(2).**

Table 4.2.2(1): Monthly Max. & Av. Temp. at Bogra, 2000-2009

Year	Item	Monthly Temperature in Degree Celsius											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	Maximum	28	27.7	32.8	36.4	37.5	36.8	35.1	35	36.2	36	33.4	28.4
	Average	24.6	25.2	30	31.9	32.2	32.9	32.5	32.5	31.1	32.2	30.5	27.1
2001	Maximum	27.4	30.8	35.5	37.6	35.8	34.8	36	35.8	35.2	34.5	32.5	27.8
	Average	24.1	27.8	31.9	34	32.3	32.2	32.7	33.2	32.4	31.8	29.8	25.9
2002	Maximum	28	31	35.2	35.1	37	34.4	35.2	35.2	36	35.1	33	30
	Average	25.4	28.1	31.2	31.2	31.7	32	31.4	32.1	32.7	32.2	30	25.3
2003	Maximum	28	30.5	34.6	36.8	38.7	36.2	37.5	35.8	35.8	34.3	32	29.8
	Average	21.3	26.9	29	33.2	33.3	31.6	33	33.1	32.4	30.7	29.9	26.3
2004	Maximum	26	33	35.6	38	40.1	36	34.2	34.7	34.7	34.3	31.5	29.7
	Average	****	27.9	32.1	32.1	35	32.5	31.5	33	31.1	30.8	29.7	26.8
2005	Maximum	27	31.7	34.4	36	38.7	37.7	34.5	35.4	36.6	34.2	32	29.8
	Average	24.2	28.1	31	33.4	32.7	34.1	32	32.7	33.5	30.1	29.3	27.2
2006	Maximum	28.6	34.8	37	36.3	37.3	36.6	37	37	35.7	34.6	32.2	29.5
	Average	24.2	30.1	32.3	32.5	33.7	33.1	33.3	33.5	32.6	32.7	29.4	26.9
2007	Maximum	28.9	30	35.2	36.5	**40.5**	38.2	35.4	37.4	36	35.5	33.1	28.4
	Average	24.2	25.9	30.2	32.9	35.6	32.4	32.2	32.9	32.6	32	30.6	26.1
2008	Maximum	28	30	35.2	37.5	36.4	35.6	34.5	36.3	36	34.8	32.7	30
	Average	24	25.9	31	34	34.4	32.1	31.8	32.2	33.1	31.9	30.3	25.6
2009	Maximum	27.5	32.2	34.3	39.1	39	38.2	35.3					
	Average	24.8	29.2	31.7	34.5	33.1	34.6	33.5					

Station: Bogra, BMD

Table 4.2.2(2): Monthly Min. & Av. Temp. at Bogra Station, 2000-2009

Year	Item	Monthly Temperature in Degree Celsius											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	Minimum	8	10.7	14.3	19.4	20.5	24.6	25.2	25	22.4	19	17	12.4
	Average	12.1	13.5	18.5	22.7	24.2	26.2	26.6	26.6	25.2	24.1	19.6	14
2001	Minimum	7.3	9.5	14.2	20.7	20.5	23	25.3	24.8	24.5	21.2	15	11
	Average	10.7	14.5	18.5	23.2	23.8	25.8	26.7	27	26.1	24.1	19.9	13.6
2002	Minimum	9.7	9.2	14.5	17.8	20	23.2	24.7	25	23.8	18.5	16.4	10.5
	Average	13.2	14.8	19.4	22	24.1	25.6	26.1	26.5	25.6	23	19	14.1
2003	Minimum	**5.3**	12.7	12	19.8	20.7	22.5	24	25.5	24.5	22	12.6	10.7
	Average	9.5	15.2	18.4	23.1	23.9	25.7	26.8	26.8	26.1	24.1	18.1	14.6
2004	Minimum	8.6	9.3	14.2	19.8	21.4	22.5	23	24.5	22.4	19.3	15.2	8.4
	Average	11.7	14.4	20.9	22.7	25.1	25	25.8	26.6	25.4	22.5	17.5	14.5
2005	Minimum	8.5	10.3	17.2	19.4	19.6	23	24	24.4	24	20.5	14.7	10.6
	Average	12.1	16	20.6	22.8	23.2	26.3	26.2	26.7	26.2	23.5	18.1	13.9
2006	Minimum	9	14	15.5	18.5	21.4	22.8	25.4	23.4	23.7	20.3	11	11.2
	Average	11.9	17.9	19.3	22.4	24.4	26.1	26.8	26.5	25.8	23.4	18.4	14.1
2007	Minimum	7	11.5	13	18.4	21	21.2	24.5	24.6	24.2	21	16	9.3
	Average	10.7	15.5	17.8	23.3	25.3	25.4	26.3	26.7	26.1	23.8	19.1	12.9
2008	Minimum	8	7.6	15	18.9	20.7	22.8	25	24.8	23.7	18.8	14.4	11.6
	Average	12.5	13	20.5	23.2	24.4	25.8	26.1	26.4	26.1	23	17.9	16.1
2009	Minimum	9	10.5	13.6	20.4	20.5	22.4	0					
	Average	13.1	13.9	19.1	23.7	24.1	26	26.7					

Station: Bogra, BMD

4.2.3 Relative Humidity

Humidity during the wet season is naturally the highest compared to those occurring at other times of the year. The monthly maximum relative humidity from year 2000 to year 2009 and monthly minimum relative humidity from year 2000 to year 2009 are given in **Table 4.2.3(1)** and **Table 4.2.3(2)** respectively.

Table 4.2.3(1) Monthly Maximum Relative Humidity

Year	Monthly Relative Humidity (Maximum) in %											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	**100**	98	99	98	98	97	98	98	100	98	98	96
2001	97	**100**	94	94	97	98	98	98	98	98	98	98
2002	99	98	94	97	97	**100**	98	**100**	**100**	**100**	98	**100**
2003	**100**	99	96	98	98	98	98	98	97	**100**	98	99
2004	**100**	97	98	97	96	98	**100**	97	98	**100**	98	98
2005	**100**	97	98	96	95	96	98	98	98	99	98	97
2006	**100**	99	97	96	96	98	98	97	97	98	100	99
2007	**100**	**100**	99	96	**100**	**100**	97	97	97	98	96	**100**
2008	98	99	97	96	**100**	97	99	99	98	98	98	**100**
2009	**100**	97	93	97	97	97	**100**					

Station: Bogra, BMD

Table 4.2.3(2) Monthly Minimum Relative Humidity

Year	Monthly Relative Humidity (Minimum) in %											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2000	26	15	24	27	45	53	57	54	52	42	32	30
2001	24	21	15	19	46	57	55	58	58	49	34	35
2002	29	26	23	36	53	63	70	58	62	41	40	36
2003	30	25	18	21	22	49	56	55	56	47	25	35
2004	30	24	24	43	22	48	59	50	58	38	30	37
2005	34	23	29	23	23	48	56	55	53	45	32	29
2006	28	22	17	39	41	53	54	52	53	40	26	26
2007	21	31	21	29	24	48	53	54	45	42	32	29
2008	32	19	32	27	43	55	57	51	54	44	27	36
2009	29	18	16	**8**	28	51	55					

Station: Bogra, BMD

From the above tables, the maximum Relative Humidity recorded by Meteorological Department, Bogra station was **100%** and the minimum Relative Humidity recorded by Meteorological Department, Bogra station was **8% in April 2009.**

4.2.4 Wind Speeds and Direction

Wind directions at the project site are mostly from the North-West or West towards South-East or East during November to February. The wind directions are the East to the West during March to October. From **Table 4.2.4** it is found that the maximum wind speed of **6.3 knots** prevailed during September, 2004 flowing from East to West and the minimum wind speed of **2.2 knots** in October 2001 from East to West.

Table 4.2.4 : Yearly and Monthly Wind Speed and Direction, 2002-2009

Unit: Spd in knots

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir	Spd	Dir
2000	2.9	NW	3.5	W	3.3	E	3.8	E	4.3	E	4.3	SE	4.2	E	3	E	3.4	E	3.6	E	3	NW	2.9	NW
2001	2.9	NW	3.7	W	3.5	W	4.8	E	3.3	E	4.3	E	3.5	SE	3.2	SE	3	SE	**2.2**	E	2.3	N	3.2	NW
2002	2.7	NW	3.4	W	3.4	E	4.4	E	3.8	E	3.2	SE	3.2	SE	3.6	SE	3.5	E	2.9	E	3	NW	2.5	W
2003	3.1	NW	3.2	W	4	E	3.6	SE	3.8	SE	4.3	E	3.7	SE	4.2	E	2.9	SE	3	NE	2.8	NW	2.9	NW
2004	3.3	NW	3.3	W	4.3	S	3.8	E	3.4	SE	3.5	SE	3.8	SE	4.5	E	**6.3**	E	3.4	NW	3.8	NW	3.7	NW
2005	3	NW	4.7	W	3.7	SE	3.7	E	4.3	E	4.1	E	3.9	SE	3.9	SE	3.8	E	4.4	E	3.4	NW	2.9	NW
2006	3.3	W	3.8	W	3.9	W	4	E	3.8	E	3.6	SE	4.7	E	4.2	E	5.3	E	2.7	N	2.5	NW	2.9	NW
2007	2.5	NW	3.5	W	4.3	W	3.9	E	4	SE	4.1	E	2.6	S	4.5	E	4.1	E	5.2	W	3.1	N	3.4	NW
2008	2.9	NW	3.4	W	3.1	S	3.4	SE	3.6	SE	3.5	SE	2.9	SE	4.1	E	3.9	E	4.7	E	2.7	NW	3	NW
2009	3.3	W	3.1	W	3	W	3.4	SE	3.8	E	2.8	SE	4.2	E										

Station : Bogra, BMD

4.2.5 Seismic Data

Before we discuss the Seismicity of the region, we are to know the basic geological structure of the area. The Gangatic plain was originally a deep depression or trough lying between the peninsula and the mountain region. The depression was, perhaps due to a sagging or subsidence of the northern part of the peninsula. As it arrested the orogenic movement or southward advance of the Himalyan mountain waves, the depression was rapidly filled up by alluvial deposits, which have completely shrouded the old land surface to a depth of several thousand feet. The deposition of the debris and the sinking of the trough must have proceeded side by for about 30 million years, throughout the Miocene Pliocene and Pleistocene periods of Gaenozoic Era. The Bengal basin from Rajmahal Hills to Assam Hills, is, however, of latest origin.

So far as the Geology of Bangladesh is concerned, it is the part of this Bengal Basin, most of which has been slowly subsiding due to tectonic forces responsible for building the Himalayas. The Himalayas, though the loftiest mountains of the world, have not yet attained their Maximum elevation but are syill rising. The slow subsidence is estimated to be about one inch per year in the coastal regions, as is evident from the present position of tree stumps cleared about a century back, in the Sundarban region, in the districts of Khulna and Barisal. This has practically nullified the sedimentation effect of huge amount, estimated to be about 2000 million tons per year of silt carried by the Ganges, the Jamuna and the Meghna. On the whole the coast line has not extended more than what had been mapped by James Rennel about 200 years ago in 1770. Rather a net loss of land area is observed.

This goes to show that the strata under the Himalayas and the adjoining area lying at their feet are in a state of tension and have not yet settled down to their equilibrium planee. By far the largest number of disastrous Indian earthquakes have occurred along these tracts.

Based on the seismicity, Bangladesh has been divided into three seismic zones as follows:

Zone-I : Severe (Seismic Factor - 0.08g)

Zone-II : Moderate (Seismic Factor – 0.05g

Zone-III : Minor (Seismic Factor – 0.04g)

Seismic Zones of Bangladesh are shown in **Figure 4.2.5(1)**

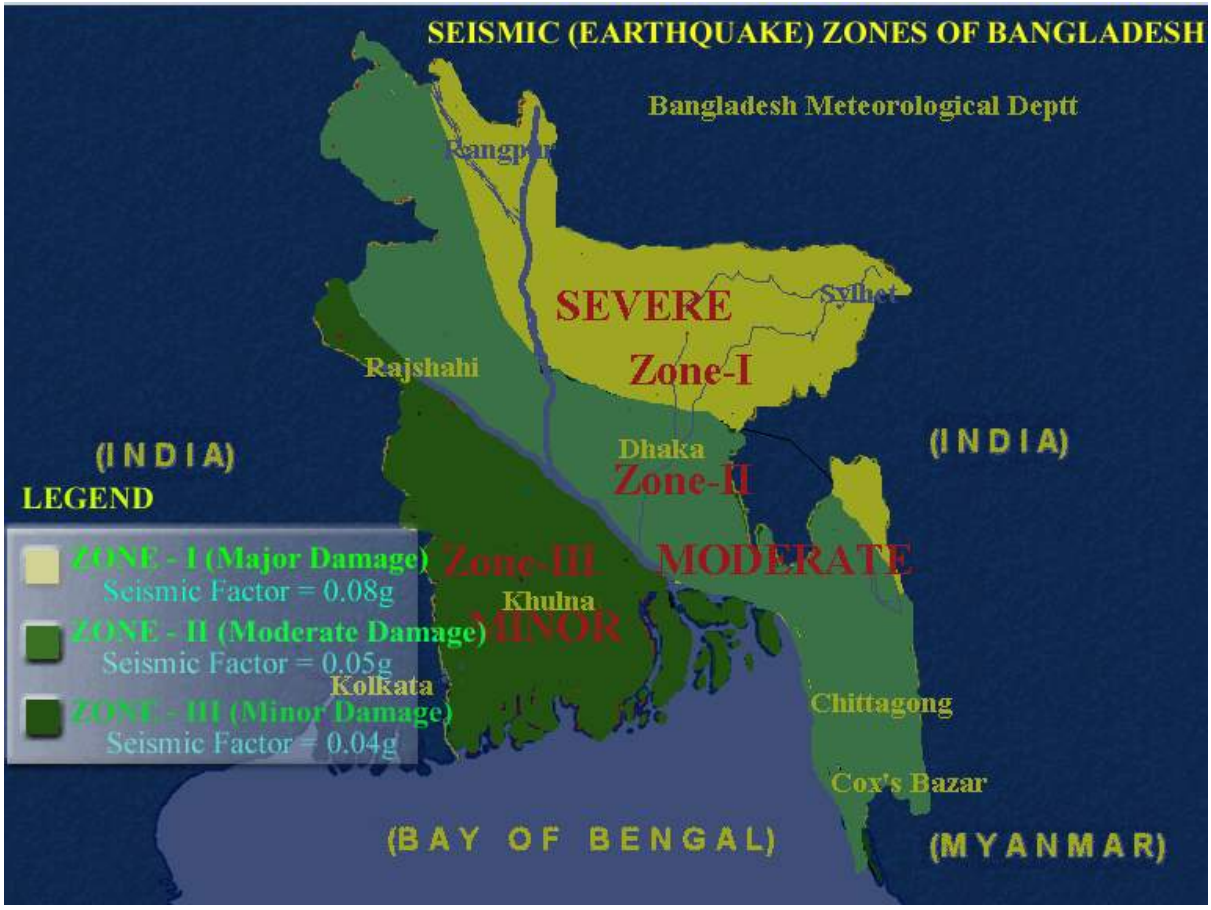


Figure 4.2.5(1) : Seismic Zones of Bangladesh

The proposed Sirajgonj 150 MW Peaking Power Plant falls under **Zone-II (Moderate Damage), whose Seismic Factor is 0.05g.**

Earthquake frequency of the whole of Bangladesh for the period from 1918 to 2008 is given in **Figure 4.2.5(2).**

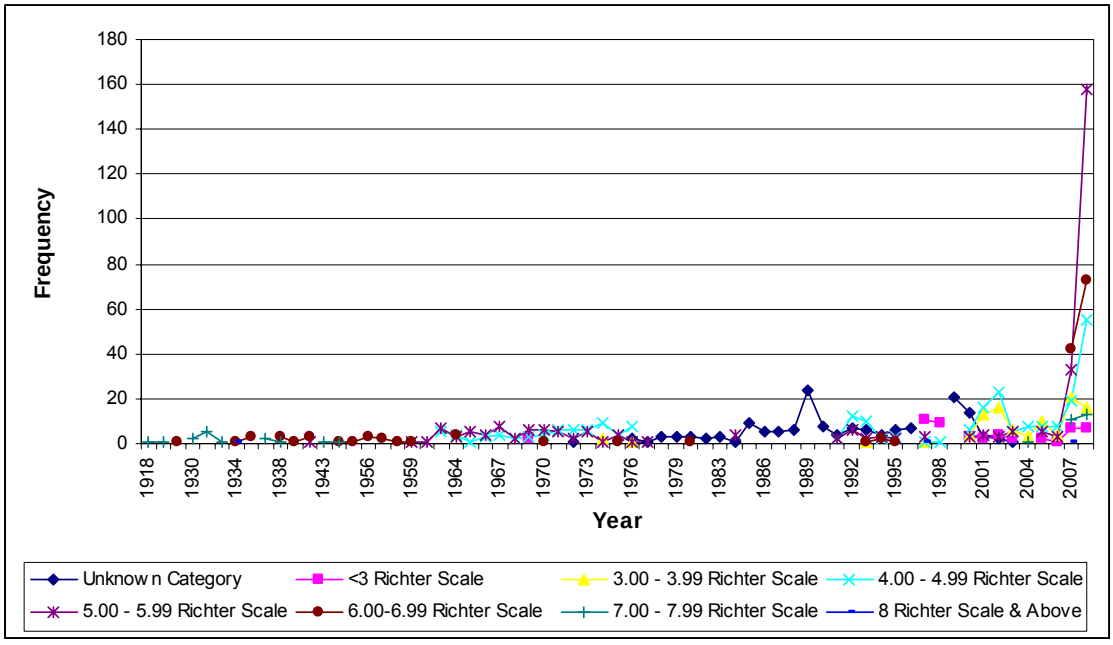


Figure 4.2.5 : Earthquake frequency statement of Bangladesh

Earthquake frequency and magnitude in Bangladesh from the year 1918 up to the year 2008 is enclosed at **Annex-4.2.5**.

4.3 Topography and Drainage

The Sirajganj Peaking Plant project area occupies the active Brahmaputra-Jamuna Flood Plain. The average elevation in the proposed location is about **16.75m**. The general slope is from west to east. However, attempts have been made to sandfill the land of the proposed Power Plant in almost the same level. Since the land adjacent to the Jamuna River is slightly at a lower level and the slope is from west to east, the floodwater does not stand resulting no water logging. The topography does not inhibit drainage in the project site area.

No settlements were observed in the project area during the survey. However there is population, on the western side of the project site, but outside the proposed power plant area.

The land types in Bangladesh are flood depth phases of flood plain soils and are designated according to the maximum depth prevailing for a minimum three-day period during the peak season and occurring with an annual probability of about 1.5 (FPCO, 1992). According to the previous 30 years of flood record in the Jamuna River, it indicates that no large floods occurred in this area.

The drainage pattern of the project area follows the land gradient, sloping from west to east, towards the Jamuna River. As the general slope of the project area is gradually from west to east, it (the slope) allows rapid drainage during the monsoon and post-monsoon periods.

4.4 Geology and Soils

4.4.1 Geology

Geology of Bangladesh is generally dominated by poorly consolidated sediments deposit over the past 10,000 to 15,000 years (Holocene age). The geology of the study area consists of Quaternary deltaic sediments, which have been strongly influenced by tectonic movements on deep-seated faults. The area lies on a tectonic block, which has been uplifted relative to the surrounding areas. In terms of crop production, the soils of Bangladesh can be categorized into three main classes: floodplain, terrace and hill soils. The proposed site is on a floodplain or alluvial soils. This type of soil mainly comprises sandy barns and sandy clay barns and tends to be gray to dark gray in poorly drained basins and brown on higher and better drained land.

Due to the erosion control and bank protection infrastructure, carried out by BWDB, the project area is free from Active Flood. All the sediments below this area are mainly sandy / silty of Brahmaputra-Jamuna Floodplain deposits. The thickness of these alluvial sediments is more than a km. The detailed investigation can provide the actual strata graphic sequences of the area.

The project area falls in the seismic **Zone-II**. This is major affecting zone. The seismic co-efficient or load factor of this zone is **0.05 g**. The texture of soils of the project area is silt loam to sandy loam.
(Source: Geological Survey of Bangladesh)

4.4.2 Soils

The proposed site is located in Khas Barashimul Mouza of Sirajganj Sadar Thana in Sirajganj District. The proposed site is surrounded by the Jamuna Bridge on the north, Barashimul Panchasona Mouza and Saidabad Union on the west and Jamuna river on the east. The land of the proposed plant is now lying vacant.

According to the national classification, the proposed site is a part of the Brahmaputra-Jamuna River floodplain. In this region, the soil is predominantly sandy with fine silt.

Soil investigation in the proposed site is to be conducted. Regarding the subsoil formation of the project area, the followings soil conditions are required to be determined:

a. Whether the layers of soil are found regular in between the Boreholes.

b. Whether the entire sub soil formation of the project site, thorough out up to the depth of the investigation, is of non-plastic nature.

c. Whether these non-plastic soil comprises of silty soil, sand-silt mix or silty fine sand up to the depth of the investigation.

d. Whether the top layer of the non-plastic silty soil, extending roughly to the depth of 8.0m generally are in a very loose to loose state.

e. Further below, whether the layers of the non-cohesive silty soil & sand-silt mix extending to a variable depth of 8.0m to 19.0m generally are in a medium dense and occasionally in a loose state.

f. Whether the subsequent deep layers of the non-cohesive sand-silt mix and silty fine sand generally are in a dense and very dense state.

g. Whether due to the poor relative density as well as the poor bearing capacities of the investigated soils roughly up to the depth of 4.0m 8.0m measured from the EGL, providing shallow foundations are feasible or not, for the existing subsoil condition.

4.5 Hydrology and Water Resources

The hydrological regime of the project area is governed by the Jamuna river. Historically, spills from this river were carried and sand deposited to the site. It is the main drainage channel of the area. The general runoff pattern is from west to east through the Jamuna river.

The mean monthly water level of the Jamuna river at Sirajganj gauge shows that there was no major flood in the project area which may cause any damage to homesteads, agriculture, industries or infrastructure.

4.5.1 River Water

4.5.1.1 River Network

The Jamuna river, flowing along the eastern side of the proposed power plant site, is a combination of the rivers of Brahmaputra and Jamuna, **both tributaries of the Padma,** which is one of the three major river systems in Bangladesh. The river has no

tidal effect. It meets the **Padma River at Goalanda about 40km south** of the site, which in turn ultimately goes to the Bay of Bengal.

4.5.1.2 River Water Level

Jamuna river Water level data of nearby **BWDB Station 49** for the period 1988-2008 is given in **Table-4.5.1.2.** The highest water level of **15.11m** was found in **August 1988,** whereas the lowest level of **6.19m** was found in **February 2006**. The data showed that the water levels of the river are not much influenced by tidal effect and also indicate wide variation between water levels in monsoon and dry seasons. There is rise in water level with commencement of monsoon rainfall from May/June till September/October.

Table-4.5.1.2 Jamuna River Water level in meter at Sirajganj (BWDB Station No. 49)

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.
1988	max	7.87	7.30	8.61	9.17	12.20	12.42	14.05	**15.11**	15.00	12.94	10.93	8.98
	min	7.27	6.97	7.21	7.82	8.94	10.96	11.88	12.97	12.07	11.08	8.87	8.08
1989	max	8.05	7.67	7.70	9.36	12.00	12.91	13.65	13.36	13.63	13.35	11.04	9.09
	min	7.50	7.38	7.45	7.55	9.16	11.48	12.27	12.66	12.84	11.14	9.14	8.13
1990	max	8.11	7.97	7.99	10.50	11.31	13.39	13.97	13.90	13.57	13.69	10.83	9.14
	min	7.64	7.61	7.81	7.97	10.13	11.24	12.84	12.96	12.58	10.93	9.18	8.32
1991	max	8.29	7.76	8.31	9.83	12.06	13.60	14.37	13.72	13.88	13.05	10.88	9.03
	min	7.77	7.63	7.61	8.34	9.02	11.32	12.75	12.73	12.99	10.99	9.06	8.35
1992	max	8.35	7.76	8.81	10.29	11.04	13.14	13.25	12.92	12.90	11.89	10.60	8.73
	min	7.77	7.61	7.56	9.15	9.78	10.25	12.35	12.05	11.85	10.70	8.77	7.95
1993	max	8.01	8.13	8.28	9.05	11.24	12.61	13.76	13.66	13.74	13.05	10.71	9.04
	min	7.76	7.56	7.68	8.05	8.98	10.59	12.43	12.86	12.45	10.81	9.09	8.15
1994	max	8.13	7.68	9.41	9.74	10.84	12.49	12.50	13.05	12.63	11.85	9.93	8.50
	min	7.70	7.48	7.44	8.85	9.64	10.61	11.59	12.27	11.81	10.03	8.53	7.72
1995	max	7.70	7.22	7.49	8.65	12.38	13.59	14.69	13.97	13.71	13.63	10.37	9.02
	min	7.19	7.03	7.16	7.52	8.90	11.50	12.77	12.51	12.39	10.49	9.05	8.23
1996	max	8.22	7.67	8.80	10.27	11.58	12.74	14.01	13.33	13.29	12.22	10.55	8.27
	min	7.69	7.30	7.31	8.43	9.70	10.68	12.87	12.55	11.32	9.78	8.29	7.30
1997	max	7.30	7.05	8.35	8.33	10.16	12.26	13.58	12.93	13.19	12.67	9.26	8.50
	min	7.08	6.62	6.62	7.79	7.90	9.84	11.79	11.50	11.34	9.32	8.51	8.24
1998	max	8.28	7.21	8.02	9.04	11.28	12.96	14.08	14.36	14.76	11.96	11.11	8.46
	min	7.24	7.02	7.03	8.23	9.09	10.86	12.85	13.60	11.92	10.09	8.39	7.44
1999	max	7.42	6.94	6.81	7.84	10.72	13.28	13.53	14.10	13.93	12.20	11.01	8.65
	min	6.95	6.59	6.52	6.65	7.88	10.57	12.83	12.08	12.08	11.12	8.67	7.64
2000	max	7.63	7.16	7.48	9.16	10.89	13.44	13.23	14.04	13.73	12.72	9.40	8.16
	min	7.17	6.84	6.79	7.44	9.03	10.97	12.59	12.81	12.76	9.41	8.19	7.35
2001	max	7.32	6.96	6.84	8.56	10.02	11.92	12.91	13.44	13.34	12.57	9.89	8.41
	min	6.90	6.74	6.63	6.68	8.58	10.00	11.23	11.83	11.72	9.95	8.43	7.69
2002	max	7.68	7.41		9.56	10.82	12.69	14.38	14.02	12.68	12.88	9.81	8.70
	min	7.21	7.35		7.65	9.11	10.10	12.12	12.73	11.30	9.84	8.72	7.95
2003	max	7.94	7.44	7.92	9.15	9.71	12.88	14.34	13.10	13.25	13.03	10.83	9.13
	min	7.45	7.35	7.33	7.86	8.94	9.75	12.68	12.57	12.63	10.90	9.15	8.30
2004	max	8.29	7.78	8.39	10.56	12.02	13.76	14.81	13.44	13.58	13.19	10.49	8.85
	min	7.79	7.40	7.37	8.75	9.08	10.98	12.70	12.60	11.82	10.50	8.88	8.05
2005	max	8.04	8.05	9.33	10.22	10.45	12.43	13.14	13.30	13.31	12.05	10.16	7.90
	min	7.58	7.37	7.92	9.13	9.55	10.34	11.85	11.81	10.50	9.86	7.92	7.05
2006	max	7.02	6.41	7.13	9.10	9.44	12.70	12.73	12.54	12.94	11.34	9.24	7.98
	min	6.42	**6.19**	6.41	6.47	7.93	9.45	11.91	10.72	11.20	9.28	7.93	7.20
2007	max	7.19	6.77	6.88	9.76	11.40	13.50	14.90	14.95	14.71	11.97	10.40	8.73

Year		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov.	Dec.
	min	6.65	6.59	6.67	6.87	8.84	11.04	12.34	13.09	12.05	10.47	8.78	7.71
2008	max	7.69	7.17	7.62	9.10	10.02	12.52					10.52	8.34
	min	6.99	6.85	6.70	7.65	9.03	9.94					8.36	7.43

Source: BWDB

4.5.2 Groundwater

Ground water will be utilized only for domestic and office consumption. Therefore, ground water investigation/study was not conducted. However, the Department of Public Health Engineeing (DPHE) has investigated ground water at Enayetpur (89.71213^0 Longitude and 24.21168^0 Latitude under Sadia Chandpur Union of Chauhali Upazila of Sirajganj district . From the investigation of DPHE, the following Lithology and Hydrostratigraphy in the investigation area were found:

Lithology

Depth to Top (m)	Depth to Base (m)	Lithologic Desccription
0.00	6.10	Silty Clay
6.10	19.20	Very Fine Sand
19.20	28.65	Fine sand
28.65	37.79	Fine to Medium Sand
37.79	62.79	Medium to Coarse Sand
62.79	68.88	Medium sand
68.88	79.55	Medium to Coarse Sand

Hydrostratigraphy

Depth to Top (m)	Depth to Base (m)	Hydrostratigraphy
0.00	6.10	Aquitard 1
6.10	79.55	Aquifer 1

4.6 Air Quality

Sirajganj Sadar Thana, particularly the project area, is not heavily industrialized. The present ambient air quality of the concerned area, as a result, is not much contaminated. The air quality was not measured in the past.

To ensure safety of power source and security of living beings including human beings, air samples were collected from 2 locations; one sampling point for survey in the proposed power plant and the other sampling point near Dhaka Highway. The air samples were collected by DOE, Bogra and the samples were analyzed by DOE, Bogra. The Test results of Survey of Air quality in the Project Area is given in **Table-4.6.**

Table 4.6: Result of Survey of Air Quality

Date	Sampling Point	Duration	SPM/PM_{10} µg/m^3	SO_x µg/m^3	NO_x µg/m^3
28 /12/2009	Proposed Power plant , Khas Boroshimul, Sirajgonj sadar, Sirajgonj (Near Water Pump)	8 hours	192	18.8	12.4
28 /12/2009	House of Mr. Ibrahim, Khas Boroshimul, Sirajgonj Sadar, Sirajgonj (Near Dhaka highway)	8 hours	393	28.7	17.5
Bangladesh Standard for Industrial and Mixed			500	120	100

Test Result of Air Quality in the project area certified by DOE is given under **Annex-4.6**

4.7 Noise Level

4.7.1 General

Sound or noise is one of the most important factors in environmental pollution. Excessive sound has adverse effect on human health. It is, therefore very important to bring sound levels within limits of human tolerance. Sound is usually measured in decibels (dB). Sound (noise) levels can be measured and quantified using logarithmic decibel (dB) scale. The dB scale is logarithmic to accommodate the wide range of sound intensities found in the environment. **Table-4.7.1** shows typical sound levels generated by common indoor and outdoor activities, along with its effect on human.

Table-4.7.1: Sound Levels and Human Response

Common Sounds	Noise Level	Effect
Rocket launching pad (no ear protection)	180	Irreversible hearing loss
Carrier deck jet operation; Air raid siren	140	Painfully loud
Thunderclap	130	Painfully loud
Jet takeoff (200 feet); Auto horn (3 feet)	120	Maximum vocal effort
Pile driver; Rock concert	110	Extremely loud
Garbage truck; Firecrackers	100	Very loud
Heavy truck (50 feet); City traffic	90	Very annoying Hearing damage (8 hours)
Alarm clock (2 feet); Hair dryer	80	Annoying
Noisy restaurant; Freeway traffic; office	70	Telephone use difficult
Air conditioning unit; Conversational speech	60	Intrusive
Light auto traffic (100 feet)	50	Quiet

Common Sounds	Noise Level	Effect
Living room; Bedroom; Quiet office	40	Quiet
Library/soft whisper (1 5 feet)	30	Very Quiet
Broadcasting studio	20	Very Quiet
	10	Just audible
Threshold of hearing	0	Hearing begins

Source: Davis and Cornwell (1998)

4.7.2 Noise Sources

Noise attenuation is typically described as a set reduction in decibel level per doubling of distance from the source. Depending on the nature of the noise source, sound propagates at different rates. Measures of sound level from a source should specify the distance from the source. The standard reference distance for sound levels at the source is 50 feet. The two most common types of noise are point source and line source. These are briefly discussed below.

4.7.3 Point Source Noise

Point source noise is associated with noise that remains in one place for extended periods of time, such as with construction activities. A few examples of point sources of noise are pile drivers, jackhammers, rock drills or excavators working in one location. Noise from a single traveling vehicle is also considered point source noise. Point source noise is commonly measured in peak decibel levels or the highest value of a sound pressure over a stated time interval. Noise from a point source spreads spherically over distance where the wave spreading creates a dome effect, traveling in all directions equally from the source. The standard reduction for point source noise is 6 dB per doubling of distance from the source.

4.7.4 Line Source Noise

Line source noise is generated by moving objects along a linear corridor. Highway traffic is the best example of line source noise. Line source noise levels are measured as an average over time rather than peak levels as measured in point source noise. Noise from a line source spreads cylindrically, spreading outward along the length of a lime. The standard reduction for line source noise is 3 dB per doubling of distance from the source (compared to 6 dB for point source noise). **Table 4.7.5** provides an example of noise attenuation of point and line source decibel levels at different distances from the source.

4.7.5 Noise Reduction Factors

Natural factors such as topography, vegetation and temperature can further reduce noise over distance. This section covers a few of the common factors and their applicability in increasing the noise reduction per doubling of distance from the source. Examples of noise reduction are shown in **Table 4.7.5.**

Table 4.7.5: Example of noise reduction over distance from 95 dB source showing variation between point source and line source.

Noise Attenuation		
Distance from the source (ft)	Point source (-6dB)	Line source (-3dB)
50	95	95
100	89	92
200	83	89
400	77	86
800	71	83
1600	65	80
3200	59	77
6400	53	74

Source : NYDEC (2001)

4.7.6 Hard versus Soft Sites

Concrete, hard packed soils etc. are considered as hard sites and reflective grounds. Such surfaces do not provide any sound attenuation. On these kinds of surfaces, sound is not absorbed easily and it travels away from the sound source for greater distances. The standard attenuation rate for hard site conditions is 6 dB per doubling of distance for point source noise and 3 dB per doubling of distance from line source.

Soft sites are those where ground is covered with normal unpacked earth. When such sites exist between the sound source and receptor, the ground becomes absorptive to sound energy. Such surfaces effect an additional noise reduction at the rate of 1.5 dB per doubling of distance. Added to this standard reduction rate for soft site conditions, point source noise attenuates at a rate of 7.5 dB per doubling of distance, and line source noise decreases at a rate of 4.5 dB per doubling of distance.

4.7.7 Topography, Vegetation and Atmospheric Factors

Approximately, 5 dB reduction of sound level occurs, when there is a break in the line of sight between the noise source and the receptor. Dense vegetation also reduces noise levels by 5 dB for every 100 feet of vegetation, up to a maximum reduction of 10 dB (USDOT, 1995). Atmospheric conditions can also affect the rate of sound attenuation. During periods of high humidity and also in colder temperatures, sound travels for greater distances. Wind can also reduce noise levels by as much as 20 to 30 dB at long distances (USDOT, 1995).

It is often impossible to quantify the noise reduction due to the influences of vegetation, topography and atmospheric conditions. When there is no such barrier, sound travels farther. These factors are, generally, not taken into account in environmental noise analysis, as these are likely to result in predicted noise levels that are higher than actual ones.

4.7.8 Baseline Noise Conditions

In order to determine potential disturbances which might be caused by project activities existing ambient noise levels can serve as a baseline. These are also required to

design the machinery of the power plant, so that ultimate noise levels are within limits prescribed by DoE.

4.7.9 Environmental Conditions

Environmental factors can greatly affect baseline noise. It can elevate baseline noise near the source, masking construction noise. The same environmental factors occurring near the receptor can change the receptor's perception of how loud construction noise is or hide it completely.

Wind or rainfall can increase baseline noise. It can also increase in locations near rivers or streams. Since these environmental factors are widely variable, they are rarely taken into account.

4.7.10 Traffic Noise

Baseline (ambient) noise condition also depends on traffic noise, which in turn, is dependant on amount and type of traffic, e.g. the volume of highway traffic (particularly volume of trucks), the speed of the traffic in the flow etc. (USDOT, 1995). Generally, when traffic is heavier, traffic speed is increased and when a greater proportion of the traffic flow is heavy trucks, the loudness of traffic noise increases. When traffic volume is 2,000 vehicles per hour, sound intensity is twice as loud as (or is 10 dB higher than) when traffic flow is 200 vehicles per hour (USDOT, 1995). This means that a noise that is increased by 10 dBA, sounds twice as loud to the listener.

Vehicle noise is a combination of noises produced by engines, exhaust and tires. The loudness of traffic noise can also be affected by the condition and type of roadway, road grade and the condition and type of vehicle tires. Predictions of noise from vehicles are usually based on *reference energy mean emission levels,* which correspond to the noise level expected from a single vehicle at the standard distances of 15m.

4.7.11 Construction Noise

Noise generated during various activities in the construction of a project is one of the easiest things to identify, but hardest to quantify. It is necessary to ascertain how much noise will construction activities generate, how often will it occur and how long will it last. In this section introduction is given to equipment noise characteristics that might be expected in typical construction projects. Noise associated with different phases of construction can vary greatly. General construction equipment, however, can be placed into one of three categories according to similarities in noise sources. These are : heavy equipment, stationary equipment or impact equipment.

(a) Heavy Equipment

(i) Earth-moving equipment, e.g. excavating machinery (excavators, backhoes, front loaders), (ii) handling equipment like graders, pavers, rollers and dump trucks can be defined as heavy equipment. From several studies, it has been found that noise levels vary between about 72 to 97 dB (Table 4.7.11) at a distance of about 50 feet away from heavy equipment. It has also been observed that noise is generated more or less at a constant level during those phases of construction when heavy equipments are deployed. Noise range at 50 ft. from construction equipment is shown in **Table 4.7.11.**

Table 4.7.11 : Noise ranges at 50 feet from common construction equipment

Equipment	DBA	Equipment	dBA
Heavy trucks (avg.)	82-96	Backhoe (avg.)	72-90
Grader (avg.)	79-93	Paver (+grind) (avg.)	85-89
Excavator (avg.)	81-97	Front Loader (avg.)	72-90
Crane (avg.)	74-89	Generator (avg.)	71-82
Pile driver (peak)	81-115	Jackhammer/rock drills (avg.)	75-99
Concrete mixer (avg.)	75-88	Roller (avg.)	72-75
Compressor (avg.)	73-88	Pumps (avg.)	68-80

Source : Western Highway Institute (1971)

(b) Stationary Equipment

Pumps, power generators, air compressors etc. can be termed as stationary equipment. Such equipments generally run continuously at relatively constant power and speed. At a distance of 50 feet from stationary equipment, noise levels can vary between 68 to 88 dB, with pumps typically in the quieter range. For each stationary equipment, a constant noise level may be assumed because of its fixed location and constant noise pattern.

(c) Impact Equipment

This category includes equipment where a tool bit touches the work with impact. Examples of such equipment are pile drivers, jackhammers, pavement breakers, rock drills and other pneumatic tools. The noise from these comes from the impact of the tool against the material. Noise levels can vary depending on the type and condition of the material. Impact equipment, including jackhammers and rock drills, can create noise levels between 75 to 99 dB at a distance of 50 feet away from the equipment.

Vibratory hammers can also be used on projects. Because vibratory hammers are not impact tools, noise levels are not as high as with impact pile drivers. However, piles installed with a vibratory hammer must often be proofed, which involves striking the pile with an impact hammer to determine its load-bearing capacity, possibly with multiple impacts. In this case, noise is elevated to levels associated with impact pile driving.

Impact of the hammer dropping on the pile, particularly when hollow steel piles are used, results in the highest in-air noise from pile driving. Noise assessments made by 'USDOT have documented peak levels of 110 dB and 105 dB, 50 feet away from driving steel piles. Pile driving noise consists of a series of peak events. For the purposes of this study, 110 dB is considered as typical peak noise levels associated with pile driving.

4.7.12 Combined Effect of Multiple Noise Sources

From studies in the past, the following information have been gathered:

(a) The combined effect of two separate sound sources are not directly additive. For example, if a sound of 50 dB is added to another sound of 50 dB, the total effect is only

a 3 dB increase (to 53 dB), not a doubling to 100 dB. Thus, every 3 dB change in sound levels represents a doubling (or halving) of sound energy. Related to this is the fact that a change in sound levels of less than 3 dB is imperceptible to the human ear.

(b) Another property of sound is that if one source of noise is 10 dB (or more) louder than another source, then the total sound level is simply the sound level of the louder source. For example, impact of one source of sound at 60 dB combined with a second source of sound at 47 dB is 60 dB. The loudest sound is, therefore, most important, which should be considered in this study.

The sound level meter used to measure noise is a standardized instrument (American National Standards Institute [ANSI], 1983). It contains "weighting scales" to adjust the frequency response of the instrument to approximate that of the human ear under various circumstances. The weighting scale used for community noise surveys is the A-weighted scale (dBA). Sounds are reported as detected with the dBA of the sound level meter. A-weighted sound levels emphasize the middle frequency (i.e., middle pitched – around 1,000 Hertz sounds) and de-emphasize lower and higher frequency sounds. The dBA most closely approximates how the human ear responds to sound at various frequencies. Because the sounds in the environment vary with time, they cannot simply be described with a single number. Several sound level metrics commonly reported in community noise monitoring are described below.

- The equivalent level is the level of a hypothetical steady sound that would have the same energy (i.e., the same time-averaged mean square sound pressure) as the actual fluctuating sound observed. The equivalent level is designated L_{eq} and is also A-weighted. The equivalent level represents the time average of the fluctuating sound pressure and is close to the maximum level observed during the measurement period.

- The maximum sound level (designated L_{eq}) is the greatest sound level measured within a stated time interval.

- Day-night average sound level, abbreviated as DNL and symbolized as L_{dn}, is the 24-hour average sound level, in dBs, obtained after addition of 10 dBs to sound levels during the night (from 10:00 pm to 7:00 am). The hourly L_{eq} sound level metric is used to calculate the L_{dn}.

4.7.13 Field Noise Level Data

Noise level were measured at three locations – one location is at proposed Power station, Khas Boro Shimul, Sirajgonj Sadar, Sirajgonj (Near Water Pump), 2nd location at near house of Mr. Ibrahim near Khas Boro Shimul, Sirajgonj Sadar, Sirajgonj (Near Dhaka-Bogra Highway) and the third location is at west bank of River Jamuna near Bangabandhu Bridge, Sirajgonj Sadar, Sirajgonj. The noise levels at all locations were measured on December 28 2009. The environmental standards for noise levels designated by Bogra Environmental Agency (DOE) are 70dBA during day hour (06:00 to 21:00hrs) and 60dBA during night (21.00 to 6.00hrs). For the residential area, 55dBA during day hour and 45dBA during night.

The present situation of the noise level around the site (**December 28, 2009**) is as shown in **Table 4.7.13**.

Table 4.7.13 Result of Noise Measurement at Proposed Power Plant Site

Date	Location	Time	dBA	
			Highest	Lowest
28/12/2009	At proposed Power station, Khas Boro Shimul, Sirajgonj Sadar, Sirajgonj (Near Water Pump	12:40pm	40	36
28/12/2009	At near house of Mr. Ibrahim near Khas Boro Shimul, Sirajgonj Sadar, Sirajgonj (Near Dhaka-Bogra Highway) and the third location is at west bank of River Jamuna near Bangabandhu Bridge, Sirajgonj Sadar, Sirajgonj.	1:00pm	66	60
28/12/2009	At west bank of River Jamuna near Bangabandhu Bridge, Sirajgonj Sadar, Sirajgonj.	3:00pm	62	56
	Bangladesh Standard		Day – 70, Night - 60	

Note: Day 6am to 9pm. Night- 9pm to 6am

From the above test results, it is seen that noise level in the project area is below the Bangladesh Standard limit. DOE's Test Result of Noise level in the project area is given under **Annex-4.7.13.**

4.8 Water Quality

4.8.1 River Water

In order to test the quality of the Jamuna River, water samples were collected from two sampling points in the Jamuna river. One sample of Jamuna river water (Surface) near Proposed Sirajgonj Power Station was collected on December 28, 2009 and another sample of Jamuna River water (3m depth) near Sirajgonj town was collected on Dcember 31, 2009. The test was carried out by DoE, Bogra. The DOE's test Report on the river water quality is enclosed under **Annex-4.8.1.** The present situation of the water quality is given in **Table 4.8.1.**

Table 4.8.1 : Test Report of Jamuna River Water

Item/Parameter	Unit	Near Proposed Sirajgonj Power Station	Near Sirajgonj town	Acceptable Limit According to ECR'97
		28/12/2009	31/12/2009	
Temperature	^{o}C	18.2	18.4	40^{0}C
pH		7.9	7.5	6.5-8.5
Chloride	mg/l	17	16	<150
Iron	mg/l	0.22		<1.0
Zinc	mg/l	1.2		<5
TSS	mg/l	47	51	150
DO	mg/l	8.1	7.6	4.5 - 8
BOD	mg/l	1.1	1.2	50
COD	mg/l	32	36	200

From the test results, it is seen that all parameters are within acceptable limit.

4.8.2 Ground Water

Department of Public Health Engineering (DPHE) have investigated ground water at Enayetpur under Chauhali upazila near the project site. The test well identified as geo-code 5882747317001 was drilled in 1996 at Enayetpur mouza under Chauhali upazila (Longitude 89.71213, Latitude 24.21168) with total depth of 79.55m. Water quality of this test well is given in **Table 4.8.2.**

Table 4.8.2 Ground Water Quality

Sl. No.	Parameter	Unit	Quantity
1.	As	mg/l	-
2.	Fe	mg/l	5
3.	Cl	mg/l	30
4.	Mn	mg/l	-

Chapter 5: EXISTING ENVIRONMENT: ECOLOGICAL

5.1 Terrestrial Ecosystem

In general terms an ecological system can be defined as an assemblage of organisms (plant, animal and other living organisms - also referred to as a biotic community) living together with their environment (or biotope), functioning as a loose unit. That is, a dynamic and complex whole, interacting as an "ecological unit". Ecosystems are functional units of interacting abiotic, biotic, and cultural (anthropogenic) components. All natural ecosystems are open systems where energy and matter are transferred in and out through the complex interactions of energy, water, carbon, oxygen, nitrogen, phosphorus, sulfur and other cycles.

The project site is located in rural area. As the project area is in char land, there is no natural vegetation or forest cover within the project area. However, appropriate mitigation program should be undertaken to protect the existing ecosystem from gaseous emissions and water discharge from the proposed power plant.

5.1.1 Terrestrial Flora

Terrestrial plants found during survey in and around the project area, on homesteads, roadside and agricultural lands have been listed. The project area provides the following major species of natural plants including herbs, shrubs, grasses and plants which are important both economically as well as for environmental sustainability of the area. The flora in and around the project area are dominated by the fruit plants, flower and ornamental plants.

The common fruits are the **mango, jackfruit, banana, papaya, guava, lemon, coconut, palm, tamarind, ata (*Anama reticulata*), karamcha (*Carissca carandas*), safeda (*Achras sapota*), wood apple, lichi, plums, watermelon, sweet melon etc. Non-fruit plants are arjun (*Terminalia arjun*), sandal tree, banayan tree, krishnachura (*Delonix regia*),** palash etc. Local, English and scientific names of the species found are given in the following **Table 5.1.1**.

The flowering plants are fairly common in the project area where rose, kamini, champa (*Michelia champa*) etc. are available. The area produces good amount of vegetables and spices of which eggplant, okra, coriander, potato, pointed gourds, gourds, long beans, country beans, chilly, cabbages, bitter gourds etc. are worth mentioning.

Table 5.1.1 : List of plants confirmed around the site

No.	Local Name	English Name	Scientific Name
1	Lichu	Lichi	*Lichi Chinensis Sonn*
2	Am	Mango	*Mangifera indica L.* (Anacard)
3	Kathal		*Artocarpus heterphyllus Lamk*
4	Pepe	Papaya	*Carica papaya L* (caricaceae)
5	Golap	Rose	*Rosa centifolia L.* (Rosaceae)
8	Beli		*Jasmin sambac* Ait (Olea)
10	Narikel	Coconut	*Cocos nucifers L.* (Palmae)
11	Chameli		*Jasminum grandiflorum L.* (Oleace)
12	Patabahar	Patabahar	*Codiaeum variegatum*
14	Peyara	Guava	*Psidium Guajava* (*L*) Bat. (Myrtaceae)
15	Kola	Banana	*Musa Paradisica*
18	Rangan		*Ixora rosea Will* (Rubiceae)
19	Gashpul		*Zephyranthes tubispatha Herb.* (Amaryllidaceae)
20	Sajina		*Moringa Oleifera Lamk.* (Moringa)
21	Supari	Betel leaf	
22	Jam		*Syzygium cumini skiel.* (Myrtaceae)
23	Shimul		*Bombax ceiba L.* (Bombacaceae)
24	Kamranga		*Averrhoa carambola*
26	Sofeda		*Manilkara Zapota*
27	Kadbel		*Feronia limonia* (*L.*)
28	Bel		*Aegle marmelos* (*L*).
29	Tal		*Borassus flabellifer L.* (Palmae)
30	Krishnachura		*Delonix regia* (*Boj.*) *Raf.* (Leguminosae)
32	Bot	Banayan tree	*Ficus benghalensis L.* (Mora)
33	Pakur		*Ficus Infectoria*
34	Madar		*Erythriana variegata L.* var. *orientalis Merr.*
35	Jaba		*Hibiscus rosa sinensis L.* (Malvaceae)
36	Man Kochu		*Alocasia indica*
37	Kachu		*Colocasia esculenta* (*L.*)
38	Jambura		*Citrus grandis*
39	Dumur		*Ficus hispida*
40	Koroi		*Derris robusta Benth.*
42	Lebu	Lemon	*Citrus aurantifolia*
43	Mehogini		*Swietenia mahagoni*
44	Kowa nim		*Melia sempervirens*
45	Shimul		*Bombax ceiba*
46	Pui Shak		*Basella alba L.*
47	Rain tree		*Samea Samon*
48	Dol Kolme		*Ipomoea fistolosa*
49	Bansh pata		*Podocarpus nerifolia*
50	Mankata		*Xeromphis spinosa*
51	Babla		*Acacia nilotica*
52	Ulatkambal		*Abroma augusta*
53	Basak		*Adhatoda zeylanica*
54	Muktajhuri		*Abroma augusta*
55	Rashun	Garlic	*Allium sativum*
56	Shatamuli		*Asparagus racemosus*
57	Neem		*Azadirachta indica*

No.	Local Name	English Name	Scientific Name
58	Nayantara		*Catharanthus roseus*
59	Thankuni		*Centella asiatica*
60	Kalo Dhutra		*Datura metel*
61	Mehedi		*Lawsonia inermis*
62	Ashoke		*Saraca asoca*
63	Arjun		*Terminalia arjuna*
64	Methi		*Trigonella foenum-graecum*
65	Ashwagondha		*Withania somniferum*
66	Ada		*Zingiber officinale*

5.1.2 Forest and Homestead vegetation

There is no natural or social forest in and around the project area. However, there are dense vegetations in areas opposite the site, on the northern bank of the river Jamuna. Trees have been planted in the residential area close to the project site. Although there is no forest, but trees planted and homestead vegetation play an important role in environmental balance and economic life of the people of the project areas in terms of food and nutrition, construction material, biomass fuel, fodder, shelter and shade, windbreaks, organic matter, erosion control and balance between flood and drought.

5.1.3 Biodiversity

The project area has distinctive terrestrial and aquatic habitats. The homesteads and roads are the major components of the terrestrial habitat with flora and fauna. The aquatic habitats include mainly the river.

5.1.4 Terrestrial Fauna

The animals found 1 km around the site include a total of **46** species -- **ten** species of mammalian animals, **31** species of birds, **two** species of reptiles, and **36** species of amphibians. Of these, the animals given on the 2007 Red List of the International Union for Conservation of Nature (IUCN) contain two species of mammalians and two species of birds. All of them fall under the category of Least Concern (LC). **Table 5.1.4** shows the terrestrial animals having been found.

Table 5.1.4 : List of animals found 1 km around the site

No.	Local Name	English Name	Scientific Name	IUCN Red data Category (2007)
MAMMALS				
1	Ban biral	Jungle cat	*Felis chaus kutas*	LC
2	Mecho Biral	Fishing cat	*Felis viverrinus*	
3	Biral	Cat	*Felis : Catus*	
4	Kukur	Dog	*Cannis Familiaris*	
5	Shial	Fox	*Vulpes vulpes*	LC
6	Chagol	Goat	*Capra Hircus*	
7	Bhera	Sheep	*Bovidae : Ovis*	
8	Goru	Cow		
9	Katbirali	Squirrel	*Rodentia : Sciurus*	

No.	Local Name	English Name	Scientific Name	IUCN Red data Category (2007)
10	Khorgosh	Rabbit	*Leporidae : Cuniculas*	
BIRDS				
1	Chorai	Sparrow	*Passer domesticus*	
2	Kak	Crow	*Corvus splendens*	
4	Shalik	Indian mynah		
5	Doyel	Magpie Robin	*Copsychus saularis*	
6	Paira	Pigeon	*Columba livia domestica*	LC
8	Dahuk			
9	Chil	Pariah Kite	*Milvus migrans*	LC
10	Finge	Black Drongo	*Dicrurus macrocercus*	
11	Tia			
12	Bak	Intermediate Egret	*Mesophoyx intermedia*	
14	Machhranga	Kingfisher	*Halcyn smyrensis*	
15	Bulbuli			
16	Tuntuni	Tailorbird	*Orthotomus sutorius*	
17	Kat Thokra	Woodpecker	*Picoides pubescens*	
18	Babui			
19	Mohan Chura.	Hoopoe	*Upupa epops*	
20	Hottiti			
21	Pan kouri			
22	Ghughu	Spotted dove	*Streptopelia chinesis*	
24	Konch Bak.	Pond Heron.	*Ardeola grayii*	
25	Banspaati	Green Bee-eater	*merops orientalis*	
26	Shamuk Khol.	Open Billed Stork	*Anastomus oscitans*	
27	Sipahi Bulbul	Red Whiskered Bulbul	*Pycnonotus jocosus*	
28	Kokil	Asian Koel	*Eudynamys scolopacea*	
29	Rajhaans	Goose		
30	Hash	Duck	*Anatidae : Anseriformes*	
31	Pecha	Owl	*Nocturnalis : Strigiformes*	
REPTILE				
1	Tiktiki	Lizard	*Sauria : Lacertidae*	
2	Bezi			
AMPHIBIA				
1	Geso Beng	Canyon treefrog	*Hyla arenicolor* Cope	
2	Brischik	Scorpion	*Archinida1 : Scorpionida*	
3	Beng	Frog	*Anura : Ranidae*	

Note : Category "LC" means "Least Concern Species"

5.2 Aquatic Ecosystem

5.2.1 General

Bangladesh is mainly a deltaic region of the three big rivers, the Ganges, the Brahmaputra and the Meghna and their tributaries. Aquatic ecosystems perform many important environmental functions. For example, they recycle nutrients, purify water, attenuate floods, recharge groundwater and provide habitats for wildlife. Aquatic ecosystems are also used for human recreation and are very important to the tourism industry. The health of an aquatic ecosystem degrades when the ability of ecosystem to absorb a stress has been exceeded. A stress on an aquatic ecosystem can be a result of physical, chemical or biological alterations of the environment.

Fisheries resources occupy a key position in the agro-based economy of Bangladesh. Fishes are important economically, socially and nutritionally. About 80% of the animal protein in the diet in Bangladeh comes from fish. In the past there was abundance of fishes in water bodies like rivers, floodplains, beels, haors etc. While the large fish species migrate long distances in rivers for breeding, the small fishes migrate over shorter distances or reside in floodplains, beels and canals. Most inland water fishes are small. They are important for nutrition and supplemental income to the vast majority of the rural people, including the landless and the destitute. The miscellaneous species of fish and prawn are termed as "poor people's fish" and provide a support in their struggle against poverty.

During the EIA process, a baseline study of the aquatic ecosystem was undertaken to assess the existing ecological resources in the project area. Water samples at various points of the river Jamuna (near the project site) were collected and analyzed for the parameters such as temperature, pH, DO, BOD, COD, TSS, Chloride, Nitrate, Sulfate, Iron etc. The tests were carried out in the laboratory of DoE, Bogra. Information relating to different species of fish and other aquatic organism were collected from local people.

The Jamuna river, flowing along the eastern side of the proposed power plant site, is a combination of the rivers of Brahmaputra and Jamuna, both tributaries of the **Padma,** which is one of the three major river systems in Bangladesh. The river has no tidal effect. It meets the **Padma River at Goalanda about 40km south** of the site, which in turn ultimately goes to the Bay of Bengal.

5.2.2 Aquatic Flora

The freshwater dependant plants such as halencha (*Altermanthere philoxeroides*), kalmi (*Ipomoea aquatica*), dolkalmi (*Ipomoea fistulosa*), ichadal (*Potamo seton*) and water hyacinth (*Eichhomia crassipes*) are common in the ponds, borrowpits, ditches, canals and rivers around the project area. Khuda pana (*Lemna minor*), topapana (*Pistia stratiotes*) and chaicha (*Saipus articulatus*) are also common.

5.2.3 Aquatic Fauna

The Jamuna River abounds with fishes and crustaceans. They are the target of the fishing industry.

Good number of prawns including the most expensive ones, the giant prawns (*Macrobrahcium Rosenbergii*), are available in the river, adjacent to the Project area. The crabs are also common in the river, ditches and ponds. Fresh water snails (*Charonia Variegate*) and mussels (*Mytilus Edilis*) are the common or fairly common molasses.

The Serajgonj Sadar Upazila Fisheries Department has listed **58 species** of aquatic animals considered to inhabit the Jamuna River close to the site. The list of Fishes infhabiting in the Jamuna River is given in **Table 5.2.3.**

Table 5.2.3 : List of fish inhabiting the Jamuna River

No.	Local (Bangladeshi) Name	Scientific Name
1	Hilsa	*Hilsa hilsa*
2	Rui	*Labeo rohita*
3	Katla	*Catla Cattla*
4	Mrigal	*Cirrhinus mrigala*
5	Kalibaush (kalbasu)	*Labeo calbasu*
6	Air/Aor (Long Whiskered cat fish)	*Aorichthys* (*Mystus*) *aor*
7	Guijja Air (Giant River Cat Fish)	*Aorichthys* (*Mystus*) *seenghala*
8	Tengra (Assamese Batasio)	*Batasio Tengana*
9	Baghair (Gangetic Goonch)	*Bagarius yanvelliisykes*
10	Sisor / Chenua (Sisor cat fish)	*Sisor rhabdophorus*
11	Cheka / Chega (Indian Chaca)	*Chaca chaca*
12	Ek Thota (Wrestling half beak)	*Dermogenys pusilla*
13	Kucha / Kuchia (Gangetic Mud Eel)	*Monopterus cuchia*
14	Ritha	*Rita rita*
15	Bata	*Liza melinoptera*
16	Khorshola	*Labeo dero*
17	Raikh bata	*Rhinomugil corsula*
18	Boal	*Wallago attu*
19	Shole (snake head)	
20	Gojar/ Gojal (Giant snake head)	
21	Pungash	*Pangasius pagasius*
22	Ghaura (Gaura Bacha)	*Clapisoma gaura*
23	Bacha(Batchwa Bacha)	*Eutropicchthys vhacha*
24	Shilong (Silondia V cha	*Silonla Silondia*
25	Bele	*Awaous grammepomus*
26	Banshpata	*Damio devario*
27	Piali	-
28	Bhagna	-
29	Golsa/ Golsa Tengra (Gangetic Mistus)	*Mystus cavaslus*
30	Kani Pabda / Boali Pabda (Indian Butter cat fish)	*Ompak bimaculatus*
31	Pabda (Pabo Cat fish)	*Ompak pabo*
32	Chanda / nama chanda (Elongate glass perchlet)	*Chanda nama*
33	Ranga Chanda / Lal Chanda (Indian Glassi Fish)	*Pseudembassis ranga*
34	Meni / Bheda/ Rayan/ Bheduri (Mottled nandus, mud perch)	*Nandus nandus*
35	Napit Koi/ Koi Banedi (Dwarf Chemeleon fish Badis)	*Badis badis*
36	Neftani (Indian Paradise Fish)	*Clenops nobolis*
37	Puti	*Puntius puntio* (*Hamilton*)
38	Khalisha	*Colisha faciata*
39	Chitol (Humped Featherback	*Nototeruse chitala*
40	Foli (Grey Featherback)	*Notopterus notopterus*
41	Bamos / Baobaim (Indian Long Fin Eel)	*Anguilla bengalensis*
42	Elong/Sefatia(Bengal barb)	*Bengala Elanga*
43	Kash Khaira (Indian Glass barb)	*Chela laubuca*
44	Tatkini/Bata/Bangla (Reba carp)	*Cirrhinuss reba*
45	Kala Bata (Gan Getic latia)	*Crossocheilus latius*
46	Bhangon Bata/Bata (Bata labeo)	*Labeo Boga*
47	Ghonia/Gonainya (Kuria baleo)	*Labeo gonius*

No.	Local (Bangladeshi) Name	Scientific Name
48	Nandina / Nandil (Nandi Labeo)	*Labeo nondina*
49	Dhela/ Dipali/ ketti(Cotio)	*Osteobrama cotio*
50	Sarputi / Swarnaputi (Olive barb)	*Puntias Sarana*
51	Titputi (Ticto barb)	*Puntias Ticto*
52	Darkina (Gangetic scissortail rasbora)	*Rasbora rasbora*
53	Rani / Beti (Necktie Loach)	*Batia Dario*
54	Rani/ Putul /Beti (Y-Loach)	*Botia lohachata Chaudhuri*
55	Kajli / Banshpata (Jamua ailiz)	*Ailia punctata*
56	Telo Taki / Rana Cheng/ Ganchua (Asiatic snake head)	*Channa Orientalis*
57	Tara Baim (One Strip spiny eel)	*Macroganthus aral*
58	Shal baim/ Baim /Bam(Tire track spiny eel)	*Mastecembelus armatus*

Source: Fisheries Department, Sirajgonj

5.3 Water quality

Water quality is very important for Aquatic Ecosystem. It includes physical, chemical and biological variables that affect fish production. Fish growth is not only dependant on water and food availability but also to a great extent on the favorable water quality. Macrophytes were present in some places near shore-line, the most prominent being water hyacinth (Kochuripana). According to fishermen, water quality is satisfactory during wet season. However, the ecosystem and water quality deteriorate rapidly due to low water level during dry season. The results of analysis of river water are tabulated under **Section 4.8.1 of Chapter 4.**

5.3.1 Temperature

The growth, reproduction and other biological activities of aquatic organisms are influenced by the temperature of the external environment. Water temperature closely follows air temperature; but in a tropical climate during both dry and wet seasons, the water temperature is high enough for good growth of fish (Boyd, 1990). Temperature at various points of the river Jamuna were measured on **14/12/2009**. It varied from **24^0 C to 24.5°C** on the surface and between **22.5^0C to 23^0C** at depth of 2 meters.

5.3.2 Dissolved Oxygen

Dissolved Oxygen is a critical factor for the survival of fish. Success or failure in fish farming often depends upon the availability of the appropriate quantity of dissolved oxygen. Prolonged exposure to sub-lethal low concentration of dissolved oxygen is harmful to fish (Boyd, 1990). Dissolved oxygen (DO) in the samples of water collected from the Jamuna River near the project site were found about **8.1 mg/l** near the surface, which is suitable for fish growth.

5.3.3 pH

pH is the negative logarithm of hydrogen ion concentration. It indicates whether, water is acidic or alkaline. Fish cannot survive in waters below pH 4 and above pH 11 for very long periods. The optimum pH for fish is 6.5 to 9. It was found that

pH of the stretch of the Jamuna river from where the samples were collected in **December 28, 2009** varied from **7.5 to 7.9.** Hence Jamuna river water is very suitable for fish growth.

5.3.4 Transparency

Transparency, inversely related to turbidity is measured by Secchi disk to indicate light penetration into water. Turbidity refers to how opaque the water is. The greater the amount of total suspended solids (TSS) in the water, the higher the measured turbidity. The major source of turbidity in the open water zone is typically phytoplankton, but closer to shore, particulates may also be clays and silts from shoreline erosion and organic detritus from stream and/or waste water discharges. Dredging operations, canalization, increased flow rates and floods increase the turbidity of water. Very high levels of turbidity for a short period of time may not be significant and may even be less of a problem than a lower level that persists longer. TSS was found within a range from **47 to 51** mg/l, which are just within the limits suitable for fish.

5.3.5 Nitrogen-Nitrate

Inorganic forms of nitrogen found in water are nitrite, nitrate, ammonia and ammonium. The proportion of ammonia and ammonium varies with pH and temperature. Nitrogen is also present in soluble organic compounds and as a constituent of living and dead particulate organic matter. Ammonia has some toxic effects on fish. The European Inland Fisheries Advisory Commission stated that toxic concentration of NH_3 for fresh water fish for short term exposure are between 0.7 and 2.4 mg/L as NH_4^+.

5.4 Protected Area (Sensitive Area)

Four types of natural protected areas including national parks are stipulated in Bangladesh. There is no nature conservation area, conservation forest or protected forest around the Power Plant site.

From reconnaissance survey and discussion with Upazilla administration, it appeared that there **is no** protected (sensitive) area around the proposed site, except the existing Jamuna Multipurpose Bridge.

Through collection of data and information from the local people of the project and its surroundings areas as well as from the local Fisheries officer, the fish breeding place in the Jamuna river is detected. This breeding place is situated within **½ km** upstream to **½ km** downstream of the project site.

According to the opinion of the local people in and around the project area, migrating birds come into the Jamuna River every winter. Their place of wandering is situated between **1 km** upstream and **2 km** downstream from the project site.

5.5 Rare and Endangered Species

5.5.1 Rare and Endangered Fish Species

According to Dhaka DOE, rare or endangered species are not stipulated in the laws and regulations of Bangladesh. Some of the terrestrial animals listed in the IUCN red data were observed around the protected site of the power plant, but the plants or aqueous animals and plants listed in this data have not been observed.

Though this river is enriched with different species of fresh water fishes, but **11 nos.** of important species have been detected in the Jamuna River by the Sirajgonj Upazila Fisheries Department. The list of the species are given in **Annex-5.5.1**.

5.5.2 Migratory Bird Species

List of Migratory birds is given under **Annex-5.5.2**.

Chapter 6: EXISTING ENVIRONMENT: SOCIO-ECONOMIC

6.1 Introduction

The project is located in a rural area of Sirajganj Sadar Thana in the south western part of the district of Sirajganj. Most of the people living in the area are engaged in agriculture. Most of them are people of lower middle class.

The socio-economic information/data have been collected from secondary sources. Sources of secondary data are different official records and published reports of Bangladesh Bureau of Statistics (BBS), Population Census Reports and also reports of other organizations.

On the basis of present socio-economic status of people in and around the project area, the impact of project implementation on the socio-economic situation can be determined. Decision or measures can then be taken for the implementation of the project with sustainable friendly environment.

6.2 Land Use and Utilities

Land use pattern of Sirajganj District is not available in the Statistical Yearbook. However, data for previous Pabna District for the years 2002-2003, 2003-2004, 2005-2006 and 2006-2007 is given in **Table 6.2.1.**

Table 6.2.1 : Land use Pattern of previous Pabna District for 2002-2003, 2003-2004, 2005-2006 and 2006-2007

Area in 000 acres

Sr. No.	Type of Land Use	2002-2003	2003-2004	2005-2006	2006-2007
1.	Forest area	448	0	0	0
2.	Non-cultivable area	8	441	426	416
3.	Cultivable Waste area	6	8	7	8
4.	Current Fallow area	186	6	44	33
5.	Single Cropped area	411	173	161	159
6.	Double Cropped area	142	421	429	443
7.	Triple Cropped area	139	152	134	142
8.	Net Cropped area	1,434	746	724	744
	Total cropped area	1,532	1,471	1,421	1,471

Source : Statistical Yearbook of Bangladesh 2006 & 2008

The land use pattern around the project area is covered by different rural infrastructure. The proposed Power Plant and its infrastructures will be located on the BPDB land, which was found vacant during the survey. The Jamuna Multipurpose Bridge is located on the north, Khas Barashimul Mouza on the south, Jamuna river on the east and Saidabad Union on the west of the site.

6.3 Utilization of River Water

The Jamuna River is flowing on the eastern side of the project area. This river is playing vital and important role in the lives of the people of the project area and

its surrounding areas also. The people of the area use this river water for household purpose. Transportation by boat, engine boat, launches are kinds of communication system in the area. Fishing activities are going on in the river by fishermen in the area.

6.4 Utilization of Underground Water

The groundwater is used around the project area from shallow level and deep aquifer also. The shallow level ground water is used for household purpose by using hand tube wells. The shallow pumps are used for irrigation purpose in the area. But shallow level ground water **is arsenic contaminated** at increasing rate. Use of shallow level ground water is, therefore, hazardous for both household and irrigation purposes. Further study of the present deep aquifer has been carried out for its quality (arsenic free) and its total volume or quantity before its utilization for the project.

6.5 Landscape

The project area is a plain land. The slope of the ground directs from west to east. There is no undulation or there is no basin like depression in the project area. The area has been sand filled by dredging the river near the site.

6.6 Demographic Characteristics

The best source of the population and demographic profile is the population census of 1991 and 2001 reports of the BBS. The key features of the population and demographic profile of Sirajganj Sadar Upazilla area has been presented in **Table 6.6.1.**

Table 6.6.1 : Base year household and population of Sirajganj Sadar Upazila, 1991 & 2001

Locality		All Areas	Urban	Rural
Geographic Unit	Number of			
	Upazilla	1	0	0
	Unions/Wards	25	15	10
	Mauzas	269	52	217
	Villages	299	0	299
Population Census 2001	Number of			
	Households	95,194	11,328	83,866
	Population	472,505	57,991	414,514
	Male	247,019	30,668	216,351
	Female	231,120	64,765	166,355
Population Census 1991	Number of			
	Households	71,511	20,182	51,329
	Population	389,160	106,153	283,007
	Male	200,577	55,123	145,454
	Female	188,583	51,030	137,553
% Change	Households	39.52	38.48	39.92
	Population	24.41	27.32	23.33

Source : Population Census-2001. Zilla : Sirajganj.

From **Table 6.6.1**, yearly growth rates of household and population have been determined. Considering the same growth rates, number of households and population have been estimated and projected for 2010 and 2015. These are given in **Table 6.6.2.**

Table 6.6.2 Projected household and population of Sirajganj Sadar Upazilla, 2010 & 2015

Items	1991	2001	Yearly Rate of Increase	Estimated Figures	
				2010	2015
Household	71,511	95,194	2.90	123,125	142,045
Male	200,577	247,019	2.10	297,826	330,439
Female	188,583	231,120	2.05	277,431	307,057

Most of the population is Muslim; Hindus are the second largest community, but very below in terms of percentage. There are very few members of other religious beliefs. Information on population on religion in Sirajganj Sadar Upazilla as per Population Census-2001 has been presented in **Annex-6.6.**

6.7 Education, Employment and Economics

6.7.1 Education

Table 6.7.1/1 shows rate of school attendance in Sirajganj Sadar Upazila from 2001 census. Rate of school attendance is higher in the urban area compared to the rural area and the rate is higher for those older than 10 years of age.

Table 6.7.1/1 : Rate of school attendance in Sirajganj Sadar Upazila

(Unit : %)

Locality	5 – 9 Years		10 – 14 Years		15 – 19- Years		20 – 24 Years		5 – 24 Years	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Upazila	40.67	41.24	57.51	61.51	41.81	37.47	24.41	10.31	43.17	38.56
Urban	42.87	43.88	59.47	61.88	44.89	43.35	34.55	16.92	46.68	42.21
Rural	39.94	40.35	56.75	61.36	40.48	34.66	19.82	7.54	41.80	37.08

Source: Population Census-2001. Zilla : Sirajganj

Age Group-wise educational status of Sirajganj Sadar Upazila as per Population Census-2001 is given in **Table 6.7.1/2.** The overall literacy rate is **47.44%.**

Table 6.7.1/2 : Educational Status of Sirajganj Sadar Upazilla

Age Group	Male			Female			Both Sexes		
	Total	Literate		Total	Literate		Total	Literate	
		No.	% of Male		No.	% of Female		No.	% of Total
07-09	19,575	2,230	11.39	16,956	1,989	11.73	36,531	4,219	11.55
10-14	33,798	18,417	54.49	29,185	17,177	58.86	62,983	35,594	56.51
15-19	27,041	19,002	70.27	23,591	16,107	68.28	50,632	35,109	69.34
20-24	19,046	12,231	64.22	25,360	13,256	52.27	44,406	25,487	57.40
25-29	18,692	10,202	54.58	23,376	10,262	43.90	42,068	20,464	48.65
30-34	16,710	8,482	50.76	15,679	6,540	41.71	32,389	15,022	46.38

Age Group	Male			Female			Both Sexes		
	Total	Literate		Total	Literate		Total	Literate	
		No.	% of Male		No.	% of Female		No.	% of Total
35-39	16,784	8,364	49,83	13,086	5,063	38.69	29,870	13,427	44.95
40-44	14,335	7,209	50.29	11,179	3,804	34.03	25,514	11,013	43.16
45-49	10,589	5,522	52.15	7,958	2,738	34.41	18,547	8,260	44.54
50-54	8,997	4,350	48.35	6,307	1,804	28.60	15,304	6,154	40.21
55-59	5,105	2,545	49.85	3,889	1,008	25.92	8,994	3,553	39.50
60 +	15,875	6,697	42.19	12,932	2,873	22.22	28,807	9,570	33.22
All ages	206,547	105,251	50.96	189,498	82,621	43.60	396,045	187,872	47.44

Source: Population Census-2001. Zilla : Sirajganj.

6.7.2 Employment

Annex-6.7.2 shows the present situation with regard to employment/main occupation of the people in Sirajganj Sadar Upazilla according to Population Census-2001, Zilla Sirajganj.

It is seen from the table that the situation is for only men since most of the women are engaged in housework. "Not working" here stands for day workers without regular jobs. Setting aside this "Not working" category, most of the workers are engaged in farming.

6.7.3 Economics

Economics of the people of Sirajganj Sadar Upazilla could not be found nor for the District of Sirajganj. However, the income, expenditure etc of the whole of Bangladesh may be seen in **Annex-6.7.3**.

6.7.4 Land Value

As a whole, the land value is increasing all over the country. Although the project land lies within the BPDB area, at present the land value adjacent to and around the project area is about **Tk. 6,000.00** per decimal according to the opinion of local people.

6.8 Industry

In and around the project site, there are no big industries. Only some cottage industries e.g hand loom etc. are available around the site. Anyway, **Annex-6.8** shows the number of manufacturing industries by major Industrial Groups for the whole of Bangladesh.

6.9 Agriculture

The proposed project site falls within the Lower Brahmaputra-Jamuna Floodplain area of National Classification. Apart from the Jamuna Multipurpose Bridge, no other important establishment is located within the impact area of the site. Aggricultural products have become the prime economic activity in the

area. The farmers are cultivating HYV Boro and HYVT, Aman, vegetables, chilly, eggplant, beans, cauliflower, cabbage, radish, carrots etc. Banana and sugar cane are also cultivated. HYVT Aman is cultivated in Kharif season and HYV Boro in Rabi season.

Main agricultural products in the former District of Pabna are tabulated in **Table 6.9.1** below.

Table 6.9.1: Main Agricultural Products in former Pabna District

Area in 000 acres & production in 000 Tons

Product	Area & Production	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008
Rice	Area	898	897	917	933	904	901	939	853
	Production	917	845	890	937	959	984	1,078	1,099
Wheat	Area		208	202	210	196	129	115	84
	Production		187	181	172	149	96	87	74
Ground -nut	Area	0.815	0.720	1.455	1.286	3.315	2.520	5.765	5.447
	Production	0.415	0.380	0.860	0.635	1.830	1.615	3.060	2.998
Sum. & Win. Til	Area	3.985	3.795	4.165	3.735	3.855	6.880	11.615	11.674
	Production	1.090	1.045	1.125	0.915	1.015	1.896	4.870	4.642
Tobacco	Area	0	0	0	0	0	0	0	0
	Production	0	0	0	0	0	0	0	0
Banana	Area		2.450	2.460	2.466	1.990	2.066	1.550	0.945
	Production		13.990	14.605	14.860	7.140	8.930	7.030	8.040
Mango	Area	5.650	5.625	5.635	5.650	1,724	1.736	1.679	1.889
	Production	8.100	8.045	9.375	9.380	63.150	29.955	36.275	41.612
Jackfruit	Area	2.650	2.670	2.830	0.526	0.554	0.576	0.570	-
	Production	9.185	9.220	9.645	80.640	90.135	93.380	63.023	-
Lichi	Area	0.465	0.465	0.455	0.475	2.183	1.365	1.376	1.814
	Production	0.496	0.475	0.470	0.460	3.930	4.810	4.770	4.631
Coconut	Area	1.370	1.370	1.385	1.496	0.097	0.045	-	-
	Production	1.606	1.586	1.605	1.815	13.655	7.425	12.915	13.860

Source Statistical Yearbook of Bangladesh, 2008

6.10 Fisheries

In and around the project area there are culture fisheries and open water fisheries in the adjacent Jamuna River. There are no ponds within the project site. There is, therefore, no opportunity of fish culture within the project area.

According to Sirajganj Sadar Upazila Fisheries Department, open season for commercial fishing in Jamuna River is from September to July. The mainly fishing area in the River is around **2km up and down the streams** of project site. The main fishing areas in the Upazila are canals, ponds and so on.

According to the interview done with the fishermen around the construction site , fish catch reaches the peak in October to November. Fishing tools used are Drag net, Gill net, Trap, long lines etc. for Pangas, Air, Kalibaush, Ritha, Bata, Khorsola, Shole, Bacha, Bele, Bashpata, Pabda etc..

6.11 Public Health

There is Sirajganj Zila Sadar Hostptal located at Sirajganj town to provide public health services in the area. Apart from this Zila Sadar Hospital, there are several health centers in Sirajganj Sadar Upazila. There are three private

hospitals, one heart disease clinic, one Palli Treatment Center, six satellite clinic, nine family welfare center, one mother & child welfare center, one child hospital, one eye hospital, one diabetic clinic, six private clinics and one Sandhani Donor Club in Sirajganj Sadra Upazila.

Different NGOs like BRAC, Proshika, NGO Forum, Manabmukti, TMSS etc. are conducting awareness raising programs on different health services as well as hygienic promotion activities through their sanitation programs. Department of Public Health Engineering (DPHE) is providing sanitary latrines, ring slab toilets through sanitation health program from their Upazila office. They are providing arsenic free water supply to the people of the area.

6.12 Transport

Road transport, railway communication and river transport are available in the area. On the northern side of the project area Dhaka – Sirajganj - Bogra national highway, on the eastern side river communication through Jamuna River and on the western side through Saidabad railway station easy communication with the site is established. Since the Jamuna River is adjacent to the project area, the river communication is an additional advantage. As a result, road, railway and river communication and consequently, transportation system with the project area is well established.

6.13 Heritage

Sirajganj District has two cultural heritages under Antiquities Act .XIV (1968 , which do not belong to Khalishpur Upazila but to another Upazila.

Jamuna Bridge is an important heritage of the District. If evidence of any other ancient heritage or any archeological symbol is found during execution of the project, actions will be taken in accordance with relevant GOB acts and rules.

6.14 Social Environment around the Project Site

6.14.1 Introduction:

Electrical power is very essential for improvement of socio-economic condition of people in Bangladesh through industrialization and creating more employment opportunities. But at present there is huge shortage of electrical power. In order to overcome this power crisis in Bangladesh, it is necessary to install new power plants immediately. In this regard, socio-economic survey is to be conducted before constructing any new power plant. For this, a social survey has been conducted in the proposed area.

6.14.2 Methodology:

Survey has been conducted in the adjoining areas of the proposed site for new power plant in two ways – i. Quantitative approach and ii. Qualitative approach. For quantitative approach, standard questionnaire (socio economic and environmental issues) has been used for interviewing randomly selected respondents in the proposed area. On the other hand, for qualitative approach, focus group discussion guidelines have been followed.

For Quantitative approach, 153 respondents have been randomly selected from the adjacent villages, Char Panchasona and Char Bara Shimul of Siadabad union under Sirajgonj Sadar upazila.

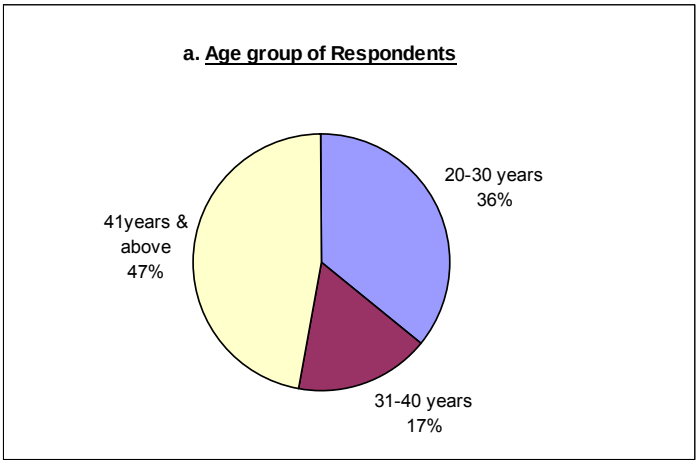
For Qualitative approach, two Focus Group Discussions – one for fishermen group and another for female group were conducted in the proposed area. Apart from FGDs, in-depth interview was conducted with local administrative authorities.

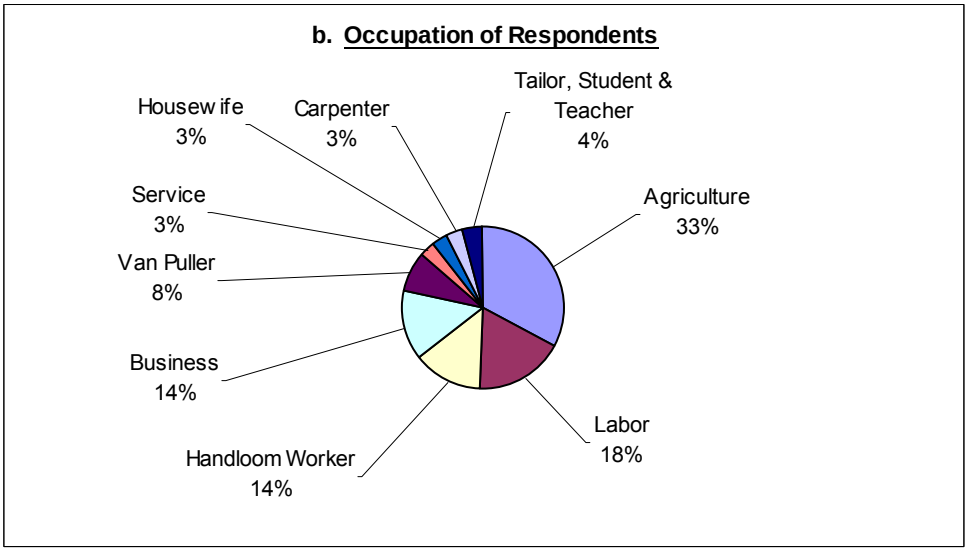
Survey report has been prepared compiling all data / information collected from the above approaches.

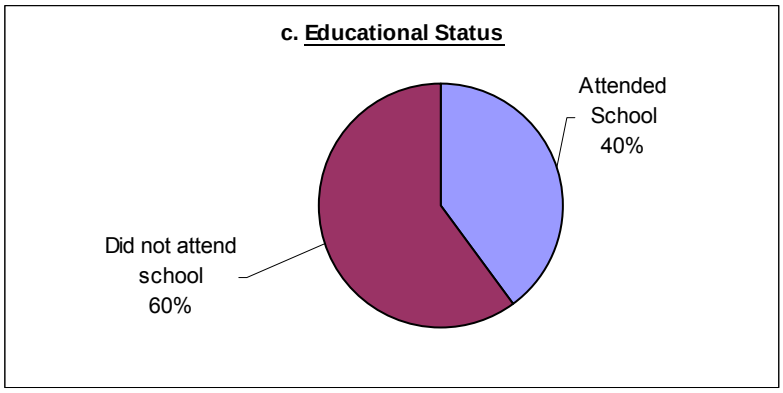
6.14.3 Findings of Quantitative Approach:

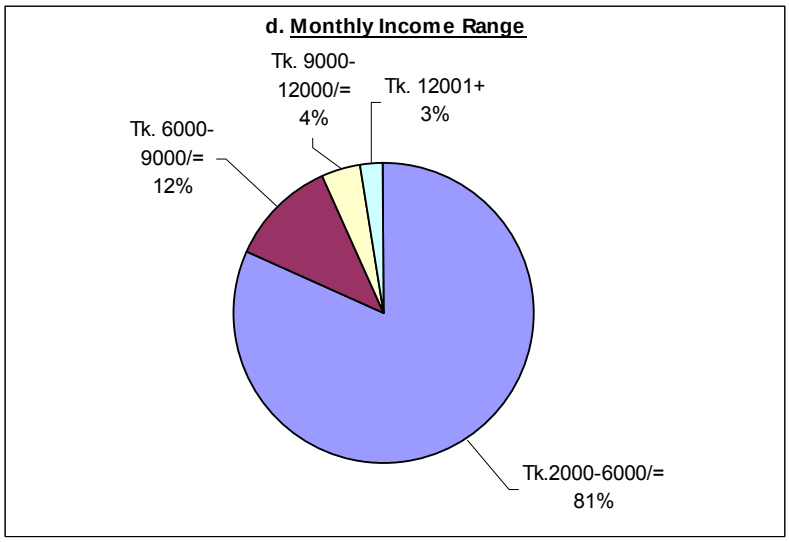
6.14.3.1 Respondents' background:

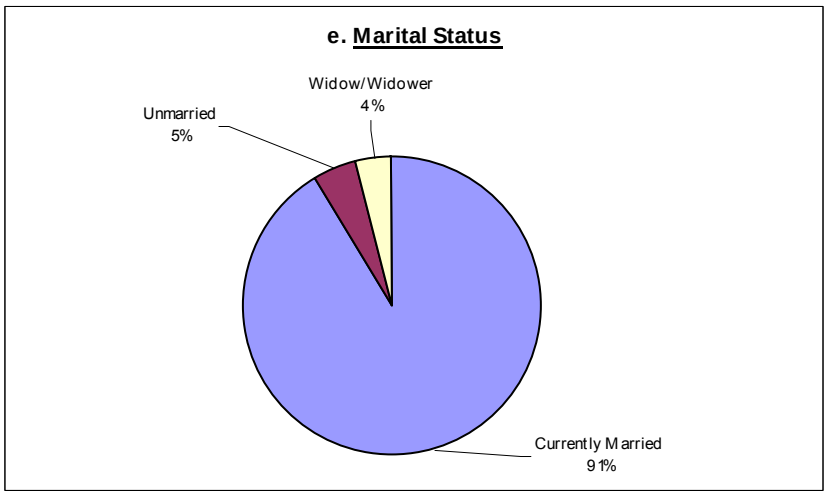
General interview was conducted with 153 respondents of Char Panchasona and Char Bara Simul Villages of Saidabad Union. The background of the respondents are given below:











f. Family Size of the Respondents

No .of Respondents	Total Family member	No. of Member Sex		< 5 Year Child		Average Family Size	Remarks
		Male	Female	Male	Female		
153	858 (100%)	456 (53%)	402 (47%)	40	25	5.61	

g. Respondent's Migrating In.

No. of Respondents	Own Birth Place	Migration in	Reason for Migrating in	No. of Respondents
153 (100%)	Nil	100 (100%)	* Due to erosion of river	117 (76%)
			* Due to not self owned land	36 (24%)

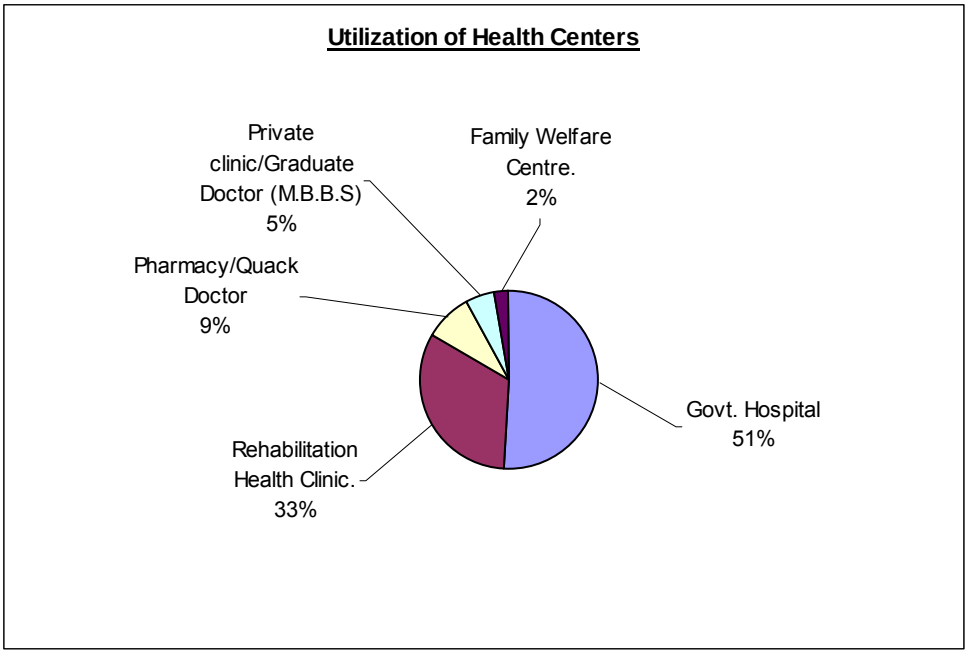
6.14.3.2 Health Care:

Among the total 153 respondents, the maximum number of respondents goes to Govt. Hospital for their medical treatment, and the number of respondents going there are 85. The rest of the respondents go to different places to seek medical attention, namely, 55 respondents goes to Pharmacy or Quack Doctor, 09 respondents goes to Private clinic or to some Graduate M.B.B.S Doctor. There are 55 such respondents who go to Rehabilitation health centre to get medical attention and the rest of the four family members go to the family welfare centre for maternal and child health treatment.

*Treatment Purpose average per house holds cost taka 345/= per month.

* 132 House holds does not have any children.

* Vaccination of children – (i) BCG= 6; (ii) DPT/HP-6; (iii) Polio = 6 (iv)Measles- 5



6.14.3.3 Homestead:

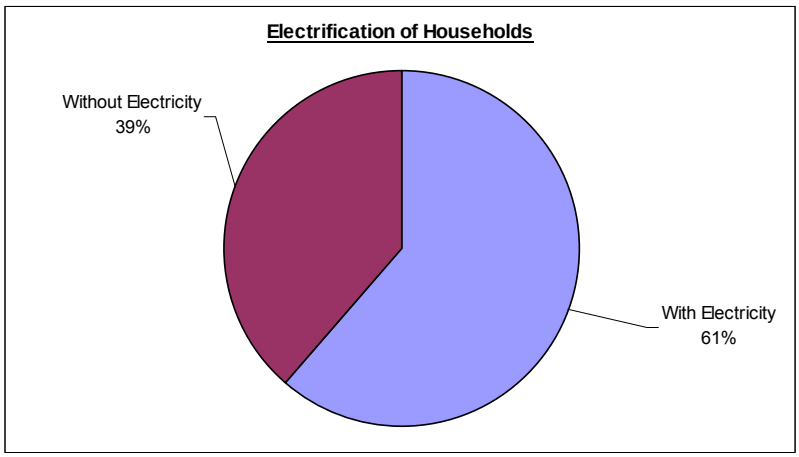
In most of the houses, the roof is made of Tin. The walls are made of either Tin or Concrete or Thatch/hay. The floors of the houses are made of either concrete or clay.

6.14.3.4 Source of Drinking Water

Total 153 (100%) respondents said they use and drink the tube well water and also said that there is no arsenic in the tub well water and it is completely pure. This water is used by the respondents in various purposes like, bathing, cooking, cleaning etc. But, they use only tube well water as their only source of drinking water.

6.14.4 Electrification of Houses:

Among the 153 respondents, there are 94 (61%) respondents that have electricity in their households and 59(39%) of respondents do not have electricity in their households.



6.14.5 Fuel used for household works:

The major fuels for household works are as follows:

a. Wood

b. Natural Grabge

c. Manure

d. LP/Liquid Gas

e. Electric Heater

f. Kerosene

6.14.6 Household Assets:

The list of assets owned by the respondents is given in Table-6.14.6.

Table-6.14.6 House holds Assets of the Respondents

S.L No.	Household Assets	No. of Respondents
01	Radio	12
02	TV	66
03	By Cycle	30
04	Sewing machine	10
05	Al Mira	32
06	Bed	153
07	Chair/Bench	119
08	Watch	35
09	Mobile	98
10	Refrigerator	03
11	Rickshaw/Van	15
12	Land Phone	Nil
13	Motor Cycle	Nil

Chapter 7: POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATORY MEASURES

7.1 Selection of Assessment Items

The Sirajganj Peaking Power Plant (herein after referred to as (Sirajganj PPP) is planned to be installed in Sirajganj Sadar Thana under Sirajganj District. For this project, a site has been selected and land already acquired, where there is no need for relocation of the inhabitants. A cooling system has been selected where river water will be used which will also be used for construction work. Ground water will be used for residential and office purposes.

In association with construction of the power plant, gas pipeline will also be built. PGCB has constructed a 230/132 KV Substation adjacent to the proposed power plant and requirement of Transmission line to connect the power plant with the grid system is minimal. Since waterborne traffic is used for the transportation of heavy objects, piers will be built in the riverside storage site, and an access road will be built to connect between the pier of the unloading yard and construction site.

Impact assessment was implemented by picking up the factors affecting the environment at the time of construction and operation for all the related facilities.

For the impact assessment, reference has been made of the guidelines of Bangladesh and international organizations:

- EIA Guideline for Industries (DoE, 1997)
- ADB Environmental Assessment Guideline 2003
- JICA Guideline for Environmental and Social Considerations (JICA, 2004)
- JBIC Guideline for Confirmation of Environmental and Social Consideration (JBIC, 2004)[&] &
- Pollution Prevention and Abatement Handbook (WB,1999)

[&] The ODA department of JBIC has been integrated with JICA since 2008. The guideline used here is the previous one before integration.

To implement impact assessment, the impacts anticipated from various projected activities were picked up, and measures for avoiding or alleviating such impacts were studied. The impacts assumed to be particularly serious were estimated on a quantitative basis whereby impact assessment was performed.

Whenever required, further measures for mitigating the impact were

studied. Consideration was also given to the comments and views on the Sirajganj PPP presented by the inhabitants in the survey on the surrounding community and environment and at the stakeholders' meeting.

Table 7.1.1(1) shows the overview of the selected assessment items during construction period and Table 7.1.1(2) shows the overview of the selected assessment items during operation period.

Table 7.1.1 (1) Overview of the selected assessment items (Construction period)

	No.	Assessment Item	Overall Rating	Construction Phase						
				Temporary impact by undertaking construction	Power Plant			Gas Pipeline	Transmission line	Jetty
					Land formation of Earth work	Operating of construction machinery	Carrying construction materials in and out			
Environmental contamination	1	Air pollution	B			B	B			
	2	Water pollution	B		B	B				B
	3	Solid waste	B	B						
	4	Noise/Vibration	A		B	A	B			
	5	Odor	B	B						
Natural environment	6	Climate								
	7	Hydrology								
	8	Flood								
	9	Underground water	B	B						
	10	Ground subsidence	B	B						
	11	Soil erosion	B		B					B
	\2	Sanctuary								
	13	Terrestrial ecosystem	B		B			B	B	B
	14	River ecosystem	B		B					B
	15	Precious species	B		B			B	B	B
Social environment	16	Involuntary resident resettlement								
	17	Employment /Livelihood	B	B	B			B	B	B
	19	Local economy	B	B	B			B	B	B
	20	Land utilization	B		B			B	B	B
	22	Social infrastructure/service facillities	B	B	B					
	23	River traffic	B				B			B
	24	Land traffic	B		B		B			
	25	Sanitation	B	B						
	31	Risks for infectious diseases such as (HIV/AIDS)	B	B						
	26	Local custom								
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indegenous people and such)	B	B	B			B	B	B
	28	Uneven distribution of benefit and loss(damage)	B	B	B			B	B	B
	30	Utilization/Right of water, including underground water	B	B		B				
	32	Cultural heritage								
	33	Landscape	B	B				B	B	B
Other	34	Accident	B	B	B	B	B	B	B	B
	35	Global warming								

A: Serious impact is expected.
B: Some impact is expected.
No mark: No impact

Table 7.1.1 (2) Overview of the selected assessment items (Operation period)

	No.	Assessment Items	Overall Rating	Operation Phase								
				Power Plant						Gas Pipeline	Transmission line	Jetty
				Operation of Facilities				Carrying materials/stuff in and out	Solid waste			
				Intake of cooling water	Gas emissions	Waste water	Others					
Environmental contamination	1	Air pollution	A		A							
	2	Water pollution	B			B						
	3	Solid waste	B						B			
	4	Noise/Vibration	A				A	B				
	5	Odor	B						B			
Natural environment	6	Climate										
	7	Hydrology										
	8	Flood										
	9	Underground water	A	A		B						
	10	Ground subsidence	B	B								
	11	Soil erosion										
	12	Sanctuary										
	13	Terrestrial ecosystem										
	14	River ecosystem	B			B						
	15	Precious species	B			B						
Social environment	16	Involuntary resident resettlement										
	17	Employment /Livelihood	B				B					
	19	Local economy	B				B					
	20	Land utilization										
	22	Social infrastructure/service facilities	B				B					
	23	River traffic	B									B
	24	Land traffic	B					B				
	25	Sanitation	B				B					
	31	Risks for infectious diseases such as (HIV/AIDS :	B				B					
	26	Local custom										
	27	Burden on vulnerable groups (women, children, aged, impoverished, minorities, indigenous people and such)	B				B					
	28	Uneven distribution of benefit and loss (damage)	B				B					
	30	Utilization/Right of water, including underground water	A	A								
	32	Cultural heritage										
	33	Landscape	B				B					B
Others	34	Accident	B				B	B			B	B
	35	Global warming	B		B							

A: Serious impact is expected.
B: Some impact is expected.
No mark: No impact

7.2 Impact assessment and measures for avoiding or mitigating the Impact

Impact assessment has been made by studying the measures for avoiding or mitigating the impact with respect to various forms of environmental items. The measures for avoiding or mitigating the impact are shown in the Environment Management Plan (EMP) in **Chapter-8.**

7.2.1 Construction phase

The gas pipeline and transmission line to be constructed and existing unloading pier are not very large in size and, the construction work will be carried out adjacent to the plant. Thus, the impact is small in almost all items, and no big problem will be raised in terms of the total construction work.

Some of the items where the need for impact assessment by construction work is assumed are separately described below:

7.2.1.1 Environmental pollution

1) Air pollution

IMPACTS:

With the progress of construction work, SOx, NOx, smoke and soot will be generated from the construction machinery and transportation vehicles and earth, sand and dust particles will be scattered. This may cause air pollution.

MITIGATION MEASURES:

Periodic inspection and maintenance control will be conducted to reduce exhaust discharged from construction machines and vehicles. To minimize scattering of earth, sand and dust particles, protective covers will be provided, and washing of the vehicles and cleaning of the surrounding roads will be performed on a periodic basis, whereby impact of air pollution will be reduced.

2) Water pollution

IMPACTS:

Drainage caused by rainfall, effluent resulting from washing the

equipment, sewage and sanitary wastewater will be generated during the work. Waste will also be produced from washing of aggregate and sand.

If these are inadequately handled, river water and underground water will be contaminated.

Contamination will occur during the civil construction work. This may cause river pollution.

MITIGATION MEASURES:

To prevent earth and sand from flowing out due to rainfall, a fence against earth and sand deposition will be installed around the site where excavation is performed. To drain the sewage, a settling tank will be installed on a temporary basis, whereby the supernatant will be removed.

Regarding effluent resulting from washing the equipment, a tank will be installed on a temporary basis, because chemicals may be used at the time of washing the equipment. Then the waste water will be discharged after having been adequately handled.

The waste generated with the progress of the construction work will be adequately handled according to the procedures shown in the following item.

In the civil construction work and washing of aggregate and sand, adequate fencing will be constructed around aggregate and sand storages and around construction site, so as to prevent flow of waste into the river along with water.

To avoid contamination by sewage, adequate sanitary tanks will be constructed and sewage will be thoroughly treated before the resulting water is discharged into the river.

These measures will minimize the impact of contamination of river water and underground water.

3) Solid Waste

IMPACTS:

Solid Waste resulting from the construction work includes metal chips, waste plastic, wood shavings, waste glass and waste oil. Further, the household solid waste discarded from the camping

ground of the workers includes cans, bottles and food remnants. If such waste is inadequately handled, underground water and river water will be contaminated, and sanitation problems will arise.

MITIGATION MEASURES:

Basically, a waste management program including the plan for reduction in the amount of waste, reuse and recycling of waste will be worked out regarding Metal chips, waste plastic, wood shavings, waste glass and waste oil. Measures taken include adequate classification of waste and adequate disposal at the disposal site for each type of waste.

To reduce the amount of solid waste discarded by the workers during the construction work, efforts will be made to employ the local workers wherever possible, so that the amount of household solid waste will be minimized.

The aforementioned measures will be taken to ensure that water pollution or sanitary problems resulting from waste do not arise.

4) Noise and vibration

IMPACTS:

With the progress of construction work, noise will be generated from the construction machinery and transportation vehicles. Sufficient consideration must be given to minimize the noise impact.

Sirajganj PPP is responsible for the following major construction work:

- Installation of power plant
- Installation of gas pipeline
- Construction ion of unloading Jetty.

Out of these work items, installation of gas pipeline is characterized by shorter distance and smaller amount of work. Further, the size of the unloading Jetty is also small.

MITIGATION MEASURES:

In the actual construction work, the scheduled management will be performed to ensure leveling of the sound level of construction work

wherever possible, and the state-of-the-art low-noise equipment will be introduced. Thus, efforts will be made to minimize the noise impact.

Material and equipment transportation vehicles will be placed under the scheduled management to ensure that the sound level of the construction work will be leveled. Measures for reducing generation of noise such as requirements for installation of mufflers and speed reduction in the residential area will be taken wherever possible, whereby vehicle noise impact will be minimized.

5) Odor

IMPACTS:

The amount of household solid waste will increase due to inflow of a great number of workers. If such waste is inadequately handled, odor may be produced by putrefaction.

MITIGATION MEASURES:

Before starting the construction work, the workers will be instructed to classify and collect garbage. Garbage will be disposed on a periodic basis to ensure that odor is not produced by putrefaction. These measures will be taken to minimize generation of odor.

7.2.1.2 Natural environment

1) Underground water

IMPACTS:

The surrounding wells may be affected by reduction of underground water level resulting from underground water intake during the construction work.

MITIGATION MEASURES:

For construction work, the maximum amount of the water taken is estimated at **2,000 m3** per day. This amount is very small, and is about 1/5th of the amount of water taken for residential and office uses.

It is estimated that groundwater can be taken without any substantial decrease of the water level even in the period of high water intake during summer.

For this reason, it is presumed that no significant decline of groundwater level at surrounding wells will occur due to water intake used for construction. Monitoring of groundwater levels of the wells for residential and office use will be conducted for confirmation.

2) Ground subsidence

IMPACTS:

If there is a considerable reduction of underground water level resulting from underground water intake during the construction work, ground subsidence may occur.

MITIGATION MEASURES:

As described above, there will be no substantial reduction in the underground water level of the surrounding wells as a result of underground water intake during the construction work. This indicates that there will be no ground subsidence as a result of underground water intake.

3) Soil erosion

IMPACTS:

With the progress of excavation work, earth and sand together with muddy water may flow into the surrounding area at the time of heavy rainfall.

The unloading yard will be built on the side of the river, and earth and sand may flow out at the time of rainfall.

MITIGATION MEASURES:

Measures will be taken to avoid outflow of the earth and sand where a fence will be installed against subsidence of earth and sand.

As a mitigation measure, the actual civil construction will be implemented during dry seasons.

4) Terrestrial ecosystem

IMPACTS:

With the progress of excavation work, the habitat of the plants and animals may disappear.

The power plant site and its surrounding areas have already been converted into the agricultural land and are used for artificial purposes. There is no natural forest in these areas.

The area to be modified by installation of gas pipelines and Jetty is small, and there will be not much impact on plants and animals.

With the progress of excavation work, the habitat of the plants and animals may disappear.

MITIGATION MEASURES:

The plants are restricted to fruit trees and ornamental plants.

5) River ecosystem

IMPACTS:

With the progress of construction work, river water pollution will occur due to inadequate handling of waste water and may have an adverse effect on many forms of life in the river.

Contamination will occur due to civil construction work. This may have an adverse effect on many forms of life in the river.

MITIGATION MEASURES:

The measures indicated in the description of "Water pollution" will be taken against the river water pollution resulting from drainage during the construction work and installation of equipment, whereby the impact on the river plants and animals will be minimized.

6) Precious species

IMPACTS:

With the progress of excavation work, the habitat of the plants and animals will not be affected. However, the life of the precious species, if any, may be endangered.

Around the Power Plant site, there are **four** species falling under the category of the light concern species (LC) of the IUCN red list. They are a **jungle cat, fox, pigeon and kite**. They are all characterized by a high degree of mobility. The concerned area is not their major living place for building nests, for example. Accordingly, they will not be much affected by the construction work.

With construction work, water pollution will occur due to inadequate handling of waste water and may have an adverse effect on precious species of plants and animals in the river.

MITIGATION MEASURES:

The Jamuna River is inhabited by fishes as precious species of Sirajganj district. The impact of river water pollution will be minimized by the measures indicated with reference to "Water pollution".

7.2.1.3 Social environment

1) Employment and livelihood, land utilization, burden on vulnerable groups, uneven distribution of benefit and loss

IMPACTS:

The construction work requires a great number of workers. There are a high percentage of day workers around the site. They want to be hired on a steady basis as regular employees.

The Power Plant site is the landed property of the BPDB.

When the Jamuna River will be used to transport heavy items, activities relating to fishery may be interfered.

There will be a need for land expropriation to acquire the required land for installation of Gas pipeline and Transmission line.

MITIGATION MEASURES:

Before starting the construction work, priority will be given to employment of the local residents.

It is assumed that the inhabitants around the site have deficiency in technical level required for the construction work. Measures are required to be taken so that those prospective indigenous workers can acquire relevant skills for construction through preliminary education and training program in cooperation with local municipalities from an early stage of construction, so that local people are given priority for employment opportunity.

In addition, the guideline for employment will be developed so as to assure fair opportunity as a mitigation measure. The aforementioned priority employment policy will be implemented to ensure that their

livelihood will not be affected by the reduced income, if any.

Regarding operating plan, the schedule will be explained to local fishermen at an early stage in order not to cause any effect to their fishery activities.

For the transmission line and gas pipeline installation work, compensation for land expropriation will be given to the people according to the laws and regulations of Bangladesh. At the same time, the construction work will be performed during the off-season period wherever possible, so that there will be suspension of farming.

Further, the scope and processes of the construction work will be explained so that relocation of the work site can be achieved quickly.

2) Local economy

IMPACTS:

The potential increase in income of inhabitants and local companies owing to this project may be contributed to local economic revitalization.

MITIGATION MEASURES:

As described with reference to "Employment and livelihood", before starting the construction work, priority will be given to employment of the local residents.

Cleaning and catering services as well as local materials supply will be provided by the local companies.

In addition, compensation for land acquisition will be conducted complying with relevant national laws, in parallel with the mitigation measures so that income levels of local people and fishermen will not be declined.

Moreover, it is important to corporate for the fostering of new local industries through consultation with local municipality.

3) Infrastructure and service facilities

IMPACTS:

Local workers will be hired wherever possible; as such, construction of new infrastructure facilities will not be necessary.

An increase in the number of vehicles for construction work may affect the access of the inhabitants to the infrastructure and service facilities of the community.

The local inhabitants desire additional medical facilities to be built.

MITIGATION MEASURES:

Regarding material installation and staff mobilization vehicles due to the construction work, measures will be taken as is shown in '5) Land traffic' described below.

Efforts will be made to ensure that the existing medical facilities for the workers can be improved and expanded and also can be used by construction workers as well.

4) River traffic

IMPACTS:

Large-sized heavy equipment will be transported for maintenance and management by ship. Transportation will be carried out in the rainy season when a sufficient water depth is ensured.

MITIGATION MEASURES:

In the rainy season, the river width will increase and there will be little impact on the river traffic of the local inhabitants.

5) Land traffic

IMPACTS:

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

MITIGATION MEASURES:

Measures such as use of buses, inspection of the traffic rules, introduction of the traffic signs and markings and education on safe driving will be taken to alleviate the impact.

6) Sanitation

IMPACTS:

About 150 Engineers/ Workers will be engaged in the construction of

the power plant. There may be a shortage of sanitary facilities such as toilet facilities.

MITIGATION MEASURES:

These measures include the installation of the septic tank treatment system conforming to the number of employees and an education and training course on sanitation management.

7) Risk of infectious disease

IMPACTS:

Workers and Engineers coming from the outside area may carry infectious disease, which may spread among other workers.

MITIGATION MEASURES:

The following measures will be taken against infectious diseases:

- Installation of medical facilities and periodic medical checkup
- Education and training for sanitation management of the workers
- Protection of construction workers against HIV/AID, dengue fever, malaria and hepatitis A,

8) Utilization and Right of water (including groundwater)

IMPACTS:

There is a possibility to have a negative effect to fishery activities in the river due to water pollution caused by inappropriate waste water disposal generated by construction activities.

Furthermore, turbidity generated by the construction also may cause an adverse effect to the fishery activities in the river.

Regarding the effect of water use at surrounding wells due to groundwater level decrease, although it is presumed that no significant decline of the water level will occur, as is shown in '1) Underground water of b) Natural environment'.

MITIGATION MEASURES:

These possible causes of water pollution (waste water disposal and the civil construction) will be reduced through the mitigation measures

indicated in the section of 'Water Pollution '.

Monitoring of the water levels at residential wells will be conducted for confirmation.

9) Landscape

IMPACTS:

Fences will be installed around the site on a temporary basis during the period of construction work.

The construction work period is limited, and impact on landscape will be small.

MITIGATION MEASURES:
Not required.

10) Accident

IMPACTS:

Inadequate construction work may cause accidents. The percentage of traffic accident may rise by an increase in the number of vehicles movement.

MITIGATION MEASURES:

During the construction work, a safety management program setup regulation will be worked out, and various forms of safety measures will be implemented based on this regulation. To ensure traffic safety, various forms of measures will be taken, as exemplified by inspection of traffic rules, installation of traffic signs and markings, education on safe driving, reduction of the vehicle speed in the school-commuting roads and residential areas, and avoidance of driving during the school commuting time zone.

7.2.2 Operation period

7.2.2.1 Environmental pollution

1) Air pollution

IMPACTS:

Natural gas will be used as the fuel for operation. Light oil (HSD) will also be used on the temporary basis. The exhaust gas due to combustion of gas from a gas turbine during the operation may lead to air pollution by NOx.

The amount of exhaust gas from a power plant into the atmosphere is greater than that in other industries. During the operation, there is estimated to be impact on air quality by exhaust from the gas turbine.

DoE standard of ambient air quality is given in the following table.

DoE Standard of Ambient Air Quality Unit: $\mu g/m^3$

Sl. No.	Area	Suspended Particulate Matter (SPM)	Sulfur Dioxide	Carbon monoxide	Nitrogen oxides
a)	Industrial & mixed	500	120	5000	100
b)	Commercial & mixed	400	100	5000	100
c)	Residential & Rural	200	80	2000	80
d)	Sensitive	100	30	1000	30

The current air quality in the project area is below the limit of the environmental standards of Bangladesh. Appropriate measures must be taken to ensure that the standards will be met in future as well.

MITIGATION MEASURES:

Environment conciliatory measure as a prerequisite for estimation

- Fuels used

The Sirajganj PPP will adopt the method of using natural gas for combustion of the gas turbine.

Basically, this method reduces the load on the environment as follows

- Sulfur content and ash are not included in the natural gas
- Basically, complete combustion of the fuel occurs in the gas turbine. Almost no CO or SPM is produced.
- A low-NOx burner is used to minimize generation of the nitrogen

oxides.

The exhaust concentration will be kept below 40 ppm and below the emission standard. This value is sufficiently below the guideline of the World Bank.

Table 7.2.2.1 NOx emission concentration

Item	New installation (natural gas)	Emission standard of Bangladesh	IFC/World Bank guideline (PPAH)
NOx emission concentration	< 40 ppm	40 ppm	165 mg/m^3 (80 ppm)

A high smokestack having a height of 60 meters is adopted to minimize the impact of the major building within the aforementioned site. Further, to minimize the chance of the building affecting diffusion, arrangement is so configured that high buildings will not be located to the leeward in the north and south as the main wind direction.

When light oil is used, there is a great deal of the emission of sulfur oxides and nitrogen oxides, as compared to the case where natural gas is used. The Sirajganj PPP will use light oil when the supply of natural gas is suspended. It will be tried to run the plant for very short time on light oil.

2) Water pollution

IMPACTS:

River water will be used in the cooling system and therefore, thermal discharge will be produced. In addition, plant effluent and domestic wastewater will be generated, and waste will also be produced. If they are inadequately handled, river water and underground water will be contaminated.

To dispose of the waste water produced by operation of the power plant, waste water treatment facilities capable of precipitation by condensation, neutralization and oil separation and household waste water treatment facilities will be installed. Further, leakage of light oil as a preliminary fuel can be assumed.

MITIGATION MEASURES:

To dispose of the waste water produced by operation of the power plant, waste water treatment facilities capable of precipitation by condensation, neutralization and oil separation and sanitary waste water treatment facilities will be installed. When the aforementioned measures are taken, the waste water level will not exceed the waste water reference level of Bangladesh.

The bottom surface of the tank in the current power plant is lined with concrete. The newly installed tank will be provided with measures to protect underground water against contamination by oil.

In order to minimize the effect of discharge of hot water in the river, water will be carried away as far as possible from the source, either through canal or pipe line and water will be discharged over a wide concrete surface near the river bank. These combined actions will cool the hot discharge water. However, the temperature of discharge waste water should not exceed **3^0C** compared to the temperature of intake water.

3) Solid Waste

IMPACTS:

The industrial waste produced during the operation includes the waste oil and sludge from the wastewater treatment equipment. Further, the household solid waste such as cans, bottles and food remnants discarded by employees is also generated.

If such waste is inadequately handled, river water and underground water will be contaminated, and sanitation problems will arise.

MITIGATION MEASURES:

For the waste produced in the process of operation of the power plant, the waste management program including the reduction, reuse and recycling of the waste will be worked out. To put it more specifically, the measures to be taken includes systematic solid waste collection at the worksite, prohibition of dumping contaminated substances, appropriate classification, and disposal at the disposal site determined for each class of waste.

4) Noise and vibration

IMPACTS:

The noise generation source during the operation includes workers' commutation, traffic of vehicles for carrying the periodic inspection materials and operation of the power generation facilities.

Noise problem has been taken up by the inhabitants of the surrounding area. Noise of the power generation facilities is produced even during the nighttime, so sufficient consideration must be given to the impact of noise and vibration.

MITIGATION MEASURES:

In the field of more detailed designing for future, efforts must be made to achieve the estimated noise level resulting from the operation of the power generation facility, for example, by introduction of the state-of-the-art low-noise equipment.

5) Odor

IMPACTS:

Facilities or equipment that produce odor are not included in the power generation facilities.

The household solid waste of the employees will be produced. If such waste is inadequately handled, odor may be produced by putrefaction.

MITIGATION MEASURES:

Garbage will be subjected to separate collection, and garbage will be disposed of on a periodic basis to make sure that odor by putrefaction will not be produced.

7.2.2.2 Natural environment

1) Under Groundwater

IMPACTS:

Since no additional underground water will be lifted, there will be no additional impact.

MITIGATION MEASURES:

Since no additional impact is expected, no mitigation measure is necessary.

2) Ground subsidence

IMPACTS:

If there is a considerable reduction of underground water level resulting from underground water intake, ground subsidence may occur.

MITIGATION MEASURES:

It is estimated that there will be no substantial reduction in the underground water level in the surrounding area by the underground water intake.

3) Terrestrial ecosystem

IMPACTS:

The power plant site and its surrounding areas have already been converted into the agricultural land and are used for artificial purposes. There is no natural forest in these areas.

The area to be used in the power plant is comparatively small and will have little impact on plants and animals.

Further, after the gas pipeline has been laid, the site will be backfilled, and the transmission line except for the scaffolding will be put back to the current state. There will be almost no impact on the terrestrial ecosystem.

MITIGATION MEASURES:

The buffer zone will be planted with fruit trees.

4) River ecosystem

IMPACTS:

Water pollution will occur due to inadequate handling of waste water and may have an adverse effect on many forms of life in the river.

MITIGATION MEASURES:

As discussed with reference to "Water pollution", measures will be taken to prevent water pollution in the river so that the impact on the plants and animals living in the river will be minimized.

5) Precious species

IMPACTS:

For the precious land species having been verified around the Sirajganj PPP site, the industrial and agricultural area is not their major living place for building nests. Accordingly, impact on these species will be very small.

Water pollution will occur due to inadequate handling of waste water and may have an adverse effect on precious species of plants and animals in the river.

MITIGATION MEASURES:

The buffer zone will be planted with trees.

The Jamuna River is inhabited by fishes as precious species of this Sirajganj district. The impact of river water pollution will be minimized by the measures indicated with reference to "Water pollution".

7.2.2.3 Social environment

1) Employment and livelihood, Land utilization, Burden on vulnerable groups, Uneven distribution of benefit and loss

IMPACTS:

There are a high percentage of day workers around the Sirajganj PPP site. They want to be hired not only during the period of construction work but also during the operation of the power plant.

The site is the landed property of the BPDB.

When large-sized heavy equipment will be transported for maintenance and management by ship, activities of fishery may be interfered.

Materials may be unloaded at the time of maintenance and management.

MITIGATION MEASURES:

It is assumed that the inhabitants around the site are very deficient in high technical level applied to the operation work.

Measures are taken that local people are prioritized at employment opportunity in simple work like cleaning.

In addition to this, prospective indigenous workers can acquire relevant high skills for operation through preliminary education and training program in cooperation with local municipalities from an early stage , so that hiring of as many people as possible is conducted within local area.

Moreover, the guideline for employment will be developed so as to assure fair opportunity as a mitigation measure.

After the gas pipeline has been laid, the site will be backfilled, and the transmission line except for stubs will be put back to the current state. There will be no impact on the livelihood of the farmers.

Regarding operating plan, the schedule will be explained to local fishermen at an early stage in order not to cause any effect to their fishery activities.

2) Local economy

IMPACTS:

The potential increase in income of inhabitants and local companies owing to this project may be contributed to local economic revitalization.

MITIGATION MEASURES:

As described with reference to "Employment and livelihood", even in the operational phase, local inhabitants will be prioritized at employment as many as possible.

Cleaning and catering services as well as supply of materials will be provided by the local companies.

In addition, compensation for land acquisition (for gas and transmission lines) will be conducted complying with relevant national laws, in parallel with the mitigation measures so that income levels of local farmers, fishermen will not be declined.

Moreover, it is important to corporate for the fostering of new local industries through consultation with local municipality.

3) Infrastructure and service facilities

IMPACTS:

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

The local inhabitants desire new and increased medical facilities to be built so that the current medical care system will be improved.

MITIGATION MEASURES:

Regarding commuting vehicles, measures will be taken as is shown in '5) Land traffic' described below.

The existing medical facilities will be expanded and improved, so that the construction workers can also be benefited.

4) River traffic

IMPACTS:

Large-sized heavy equipment will be transported for construction as well as maintenance by ship. Transportation will be carried out in the rainy season when a sufficient water depth is ensured.

MITIGATION MEASURES:

In the rainy season, the river width will increase and there will be little impact on the river traffic of the local inhabitants.

5) Land traffic

IMPACTS:

Workers' commutation and traffic of vehicles for carrying the periodic inspection materials may affect land traffic in the surrounding area.

MITIGATION MEASURES:

Measures such as use of buses, inspection of the traffic rules, introduction of the traffic signs and markings and education on safe driving will be taken to alleviate the impact.

6) Sanitation

IMPACTS:

About 150 employees will be engaged in the operation of the power plant. There may be a shortage of sanitary facilities such as toilet facilities.

MITIGATION MEASURES:

These measures include the installation of the septic tank treatment system conforming to the number of employees and an education and training course on sanitation management.

7) Risk of infectious disease

IMPACTS:

Workers coming from the outside area may carry infectious diseases.

These workers coming from the outside area will receive health checkup before being employed.

MITIGATION MEASURES:

Further, the following measures will be taken:

- Installation of medical facilities and periodic health checkup
- Education and training of workers on sanitation management.

8) Utilization and Right of water (including groundwater)

IMPACTS:

Since no additional underground water is planned to be used, surrounding wells may not be adversely affected.

As discussed with reference to "Underground water", water for domestic and office use can be supplied sufficiently without the underground water level being substantially reduced.

MITIGATION MEASURES:

No additional mitigation measure is envisaged.

9) Landscape

IMPACTS:

The building of the power plant is higher than the surrounding structures, and this may affect the landscape.

The power generation facility contains a smokestack having a height of 60 meters, a turbine building having a height of 35 meters.

MITIGATION MEASURES:

The area of the Sirajganj PPP site is limited and there will be little impact on landscape.

10) Accident

IMPACTS:

Possible accidents may include leakage of light oil as a standby fuel or breakage of the gas pipeline in terms of equipment. Further, various forms of operation or maneuvering errors may occur during the operation.

Possible accident may be breakage of the transmission line due to cyclone and others.

MITIGATION MEASURES:

The following measures are taken against possible accidents:

- Creating and implementing a sanitation and safety education program
- Installation of emergency measure facilities and quick introduction of a transport system into the medical facilities
- Working out a management program for gas leakage prevention and setting up the leakage preventive equipment as part of the leakage risk management program
- Installation of fire prevention equipment and facilities at proper positions inside the power plant.

- Installation of fixed type fire prevention equipment, fire hydrant, fire extinguisher, escape hatch, fire alarm, fire prevention zoning facilities and emergency exit.
- Working out safety regulations.

11) Global warming

IMPACTS:

CO2 as a warming substance will be discharged from the power plant.

About **250,000 tons** of CO2 as a warming substance is estimated to be discharged from the power plant every year.

MITIGATION MEASURES:

The present project uses a power generation system characterized by high efficiency and a reduced amount of CO2 produced per unit of electricity produced.

Chapter 8: ENVIRONMENTAL MANAGEMENT PLAN (EMP) AND MONITORING PLAN

8.1 Scope of EMP

The main objective of the Environmental Management Plan (EMP) and Environmental Monitoring Plan is to ensure implementation of the mitigation measures planned to reduce the environmental impact by the implementation of the power plant project, and to verify and record the environmental impact.

The EMP and Monitoring Plan are worked out based on the following:

- To reduce the environmental impact to the permissible level by the mitigation measures during the period of construction and operation, so that a hazardous impact will not occur.
- To configure a responsible organization for the implementation of the mitigation measures.
- To implement the EMP and Monitoring Plan adequately during the period of construction and operation.

The permissible level mentioned above is determined based on the national standard of Bangladesh listed below

(1) Air Quality

a) Ambient Environment

Table 8.1.1 shows the atmospheric environmental standard. In Bangladesh, although strategic area including industrial area and school and hospital are designated, the classification of other lands, either “commercial” or “residential”, is determined by DoE in charge according to the situation. The project site is classified as “residential area” by Bogra DoE.

Table 8.1.1 : Ambient Air Quality Standard

(Unit: $\mu g/m^3$)

Sl. No.	Area	Suspended Particulate Matter (SPM)	Sulfur Dioxide	Carbon monoxide	Nitrogen oxides
a)	Industrial & mixed	500	120	5000	100
b)	Commercial & mixed	400	100	5000	100
c)	Residential & Rural	200	80	2000	80
d)	Sensitive	100	30	1000	30

Note :1) National monuments. Health-center/Hospital, Archeological site. Educational Institute and area declared by Government (if applicable) are included under Sensitive Area.

2) Industrial units not located in designated industrial area shall not discharge or emit any pollutant which may deteriorate the air quality in the areas (c) & (d) of above Table.

3) Suspended Particulate Matter (SPM) means airborne particles of diameter of 10 microns of less.

b) Gas emissions

The emission standard regarding the operation of the power plant is shown in **Table 8.1.2**. Natural gas is used for fuel in the power plant and SOx and particulate matter are not emitted: NOx is the only concern. The emission standard of NOx for Sirajganj PPP is **40ppm**.

Diesel oil will be used in case gas is not available, and the regulation value for dust emission is 150 mg/Nm3. Regarding SOx, regulation for emission amount applies as well as concentration. The regulation applies only to coal-fired power plant.

Table 8.1.2 : Gas Emission Standard for Industrial Facilities

No.	Parameter	Unit	Standard Limit
1.	Particulates a) Electric Power Station of 200 Megawatts and above	mg/Nm^3	150
	b) Electric Power Station less than 200 Megawatts	mg/Nm^3	350
2.	Chlorine	mg/Nm^3	150
3.	Hydrochloric Acid gas & mist	mg/Nm^3	350
4.	Total Fluoride (F)	mg/Nm^3	25
5.	Sulfuric Acid mist	mg/Nm^3	50
6.	Lead particle	mg/Nm^3	10
7.	Mercury particle	mg/Nm^3	0.2
8.	Sulfur Dioxide		
	a) Sulfuric Acid manufacture (DCDA process)	kg/ton	4
	b) Sulfuric Acid manufacture (SCSA process) Minimum Stack height for Sulfuric Acid emission	kg/ton	10
	Lowest height of stack for dispersion of sulfuric acid a) Coal Fired Electric Power Station	m	
	i) 500 Megawatts & above	m	275
	ii) 200-500 Megawatts	m	220
	iii) Below 200 Megawatts	m	$14\ (Q)^{0.3}$
	b) Boiler	m	
	i) For Steam up to 15 tons/hour	m	11
	For steam above 15 tons/hour	m	$14\ (Q)^{0.3}$
9.	Nitrogen Oxides		
	a) Nitric Acid manufacture	kg/ton	3
	b) Gas Fired Electric Power Station		
	i) 500 Megawatts & above	ppm	50
	ii) 200-500 Megawatts	ppm	40
	iii) Less than 200 Megawatts	ppm	30
	c) Metal Treatment Furnace	ppm	200
10.	Soot & Dust Particles		
	a) Air Ventilated Furnace	mg/Nm^3	500
	b) Brick-field		1000
	c) Cooking Furnace		500
	d) Limestone Furnace		250

Note:Q=SO_2 emission in kg/hour

2) Water quality

a) Ambient Water Quality

The classification of water area is determined by the DoE in charge, as in the case of air quality. Jamuna River flowing near the project site is classified as “water used for pisciculture” by Bogra DOE. For other parameters, the water quality standard for drinking water applies.

Table 8.1.3 : Ambient Water Quality Standard (Inland Surface Water)

Sl. No.	Best Practice based classification	pH	BOD mg/1	Dissolved Oxygen (DO), mg/l	Total Coliform Bacteria quantity/ml
a)	Potable Water Source supply after bacteria freeing only	6.5-8.5	2 or less	6 or above	50 or less
b)	Water used for recreation purpose	6.5-8.5	3 or less	5 or above	200 or less
c)	Potable Water Source Supply after conventional processing	6.5-8.5	3 or less	6 or above	5000 or less
d)	Water used for pisciculture	6.5-8.5	6 or less	5 or above	5000 or less
e)	Industrial use water including chilling & other processes	6.5-8.5	10 or less	5 or above	
f)	Water used for irrigation	6.5-8.5	10 or less	5 or above	1000 or less

Note :1) Maximum amount of ammonia presence in water are 1.2 mg/l (as nitrogen molecule) which is used for pisciculture.

2) For water used in irrigation, Electrical Conductivity-2250 micro mho/cm (at 25^{o}C). Sodium less than 26 mg/l* Boron less than 2 mg/l*

Table 8.1.4 : Environmental Water Quality Standard (Drinking Water)

Sl. No.	Parameter	Unit	Standard limit
1.	Aluminum	mg/l	0.2
2.	Ammonia (NH3)	”	0.5
3.	Arsenic	”	0.05
4.	Barium	”	0.01
5.	Benzene	”	0.01
6.	BOD : 5 20^{O}C	”	0.2
7.	Boron	”	1.0
8.	Cadmium	”	0.005
9.	Calcium	”	75
10	Chloride	”	150-600 **
11	Chlorinated Alkanes	”	
	Carbon tetrachloride		0.01
	1.1 Dichloroethylene	”	0.001
	1.2 Dichloroethylene	”	0.03
	Tetrachloroethylene	”	0.03
	Trichloroethylene	”	0.09

Sl. No.	Parameter	Unit	Standard limit
12.	Chlorinated phenols	"	
	Pentachlorophenol		0.03
	2.4.6 Trichlorophenol	"	0.03
13.	Chlorine (residual)	"	0.2
14.	Chloroform	"	0.09
15.	Chromium (hexavalent)	"	
16.	Chromium (total)	"	
17.	COD	"	
18.	Coliform (fecal)	n/100 ml	0
19.	Coliform (total)	"	0
20.	Color	Huyghens	15
21.	Copper	mg/l	1
22.	Cyanide	"	0.1
23.	Detergents	"	0.2
24.	DO	"	6
25.	Fluoride	"	1
26	Alkalinity (as CaCo3)	"	200-500
27.	Iron	"	0.3
28.	Nitrogen (Total)	"	1
29	Lead	"	0.05
30.	Magnesium	"	30-35
31.	Manganese	"	0.1
32.	Mercury	"	0.001
33.	Nickel	"	0.1
34.	Nitrate	"	10
35.	Nitrite	"	Less than 1
36.	Odor	"	Odorless
37.	Oil & Grease	"	0.01
38.	pH	"	6.5-8.5
39.	Phenolic compounds	"	0.002
40.	Phosphate	"	6
41.	Phosphorus	"	0
42.	Potassium	"	12
43.	Radioactive Materials	Bq/l	0.01
44.	Radioactive Materials	"	0.1
45.	Selenium	mg/l	0.01
46.	Silver	"	0.02
47.	Sodium	"	200
48.	Suspended solid	mg/l	10

Sl. No.	Parameter	Unit	Standard limit
49.	Sulfide	”	0
50.	Sulfate	”	400
51.	Total soluble matter	”	1000
52.	Temperature	0C	20-30
53.	Tin	mg/l	2
54.	Turbidity	J.T.U	10
55.	Zinc	mg/l	5

Note : ** In coastal Aera 1000

b) Waste water

Table 8.1.5 shows waste water discharge standard. As waste water treated within the power plant is discharged into the Jamuna River, the standard value for “Inland Surface Water” applies.

Table 8.1.5 : Water Discharge Standard.

Sl. No.	Parameter	Unit	Inland Surface Water	Public Sewer at secondary treatment plant	Irrigated Land
1.	Ammoniacal Nitrogen	mg/l	50	75	75
2.	Ammonia (free ammonia)	mg/l	5	5	15
3.	Arsenic (As)	mg/l	0.2	0.05	0.2
4.	BOD5 200C	mg/l	50	250	100
5.	Boron	mg/l	2	2	2
6.	Cadmium (Cd)	mg/l	0.05	0.5	0.5
7.	Chloride	mg/l	600	600	600
8.	Chromium (total Cr)	mg/l	0.5	1.0	1.0
9.	COD	mg/l	200	400	400
10.	Chromium (hexavalent Cr)	mg/l	0.1	1.0	1.0
11.	Copper (Cu)	mg/l	0.5	3.0	3.0
12.	Dissolved Oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
13.	Electrical Conductivity	micro	1200	1200	1200
14.	Total Dissolved Solids (TDS)	mg/l	2,100	2,100	2,100
15.	Fluoride (F)	mg/l	7	15	10
16.	Sulfide (S)	mg/l	1	2	2
17.	Iron (Fe)	mg/l	2	2	2
18.	Total Kjeldahl Nitrogen (N)	mg/l	100	100	100
19.	Lead (Pb)	mg/l	0.1	1.0	0.1
20.	Manganese (Mn)	mg/l	5	5	5

Sl. No.	Parameter	Unit	Inland Surface Water	Public Sewer at secondary treatment plant	Irrigated Land
21.	Mercury (Hg)	mg/l	0.01	0.01	0.01
22.	Nickel (Ni)	mg/l	1.0	2.0	1.0
23.	Nitrate (N molecule)	mg/l	10.00	Undetermined	10.0
24.	Oil & grease	mg/l	10	20	10
25.	Phenol	mg/l	1.0	5	1
26.	Dissolved Phosphorus (P)	mg/l	8	8	10
27.	Radioactive Materials.	As			
28.	pH		6-9	6-9	
29.	Selenium	mg/l	0.05	0.05	0.05
30.	Zn (Zn)	mg/l	5.0	10.0	10.0
31.	Total Dissolved solid	mg/l	2,100	2,100	2,100
32.	Temperature	Centigrade			
	Summer		40	40	40
	Winter		45	45	45
33.	Total Suspended Solid	mg/1	150	500	200
34.	Cyanide (CN)	mg/1	0.1	2.0	0.2

Note : 1) These standards shall be applicable to industrial units or projects other than those given under Quality Standards for Classified Industries (Schedule 12).

2) These quality standards must be ensured at the moment of going into trial production for industrial units and at the moment of going into operation for other projects.

3) The value must not exceed the quality standard during spot check at any time ; if required, the quality standards may be more strict to meet the environment terms in certain areas.

4) Inland Surface Water shall mean drain, pond, tank, water body or water hole, canal, river, spring and estuary.

5) Public sewer shall mean sewer connected with fully combined processing plant including primary and secondary treatment.

6) Irrigated land shall mean appropriately irrigated plantation area of specified crops based on quantity and quality of waste water.

7) Inland Surface Quality Standards (Schedule 13) shall be applicable for any discharge taking place in public sewer or land not defined in Notes 5

3) Noise level

The applicable category of zone and noise standard for noise level are determined by the DoE in charge. The Bogra DOE determined the noise standard in the surrounding area of the power plant as follows: along the vehicle road, 70dBA in daytime and 60dBA in nighttime; in the residential area, 55dBA in daytime and 45 dBA in nighttime (**Table 8.1.6**).

Table 8.1.6 : Noise Standard

Sl. No.	Zone Class	Limits in dBA	
		Day	Night
a)	Silent Zone	45	35
b)	Residential Zone	50	40
c)	Mixed Zone (this area is used combinedly as residential, commercial and industrial purposes)	60	50
d)	Commercial Zone	70	60
e)	Industrial Zone	70	70

Note: 1) The day time is considered from 6 a.m. to 9 p.m. The night time is considered from 9 p.m. to 6 a.m

2) From 9 at night to 6 morning is considered night time.

3) Area within 100 meters of hospital or educational institution or government designated / to be designated / specific institution / establishment are considered Silent Zones. Use of motor vehicle horn or other signals and loudspeaker are forbidden in Silent Zone.

8.2 Work Plans and Schedules

8.2.1 Construction Phase

Before starting the construction work, the Project Director (PD) of NWPGCL is required to give sufficient consideration to the details of the construction work, and to make sure that the required EMP and Monitoring Plans are thoroughly understood by the contractor.

Thus, the Project Director (PD) of NWPGCL is required to form the required organization.

Especially, there is an active inflow of the workers and many construction-related vehicles during the construction. The details of the construction work, schedule and mitigation measures should be sufficiently explained to the communities in the surrounding area. The countermeasures should be altered as appropriate, based on the correct understanding of the views of the residents.

The following are the major environmental impacts during the construction work.

- Inflow of workers and an increase in the number of construction-related vehicles
- Generation of construction wastes
- Generation of dust particles, and gas emission from vehicles and machinery
- Generation of noise from vehicles and machinery
- Occurrence of muddy water in the excavation area

Employing workers from local areas during the construction phase will have a favorable impact on the local economy. Sufficient consideration must be given to the local employment, including implementation of the preliminary education and training program of the workers.

Table 8.2.1 gives the basic information of the EMP during the construction phase, and **Section 8.4** describes the Environmental Monitoring Plan.

The EMP and monitoring plan should be worked out by sufficient discussions between NWPGCL and the contractor. To confirm the implemented plan and to study further measures, a report schedule should be worked out in such a way that the contractor will report the current situation of implementation in the form of a written statement. This report should be submitted to the Bogra DoE for further discussion.

Table 8.2.1 : Major Environmental Impacts and Mitigation Measures During the Construction Phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Inflow of workers	▪ Generation of sewage and refuse	▪ Installation of sewage treatment facilities ▪ Can and bottle refuse is classified and are supplied to a third party for reuse ▪ Disposal at a predetermined disposal site.	contractor BPDB or NWPGCL
	▪ Outbreak of diseases	▪ Installation of sewage treatment facilities ▪ Installation of medical facilities and implementation of periodic health checkups ▪ Education and training on health management of the workers ▪ Prevention of epidemics among workers (HIV/AID, dengue fever, malaria, hepatitis A) ▪ Elimination of potential breeding site for harmful insects, provision of preventive medicine as necessary	
	▪ Safety, accident prevention, land traffic	▪ Use of Bus for worker ▪ Avoidance of the time when students travel between school and home ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon)	
	▪ Employment, income, livelihood, vulnerable groups, uneven distribution of benefit	▪ Priority of employment for local residents, development of employment standard ▪ Utilization of local service (cleaning, catering, materials) ▪ Implementation of the preliminary education and training programs with local authority	
	▪ infrastructure	▪ Installation of medical facilities	

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Installation of construction equipment	▪ Safety, accident prevention, land traffic	▪ Avoidance of the school commuting time ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Implementation of safety program(traffic sign, speed limit, lighting of track, load restriction, checkup of auto parts (brake, klaxon)	Contractor (NWPGCL
	▪ Noise ▪ Gas emission, flying sand and dust particles from vehicles	▪ No traffic at night ▪ Periodic inspection and maintenance management ▪ Periodic check of the concentration of vehicle emissions based on laws and regulations ▪ Stop the engine when idling ▪ Use of a cover to protect against dust, and periodic washing of vehicles ▪ Periodic cleaning of the surrounding roads ▪ Monitoring of resident areas	
	▪ River traffic	▪ BIWTA will be consulted to determine appropriate safety and/or scheduling standards to be followed.	
Excavating work and operation of construction equipment	▪ Emission gas from machinery/sand and dust dispersion ▪ Noise	▪ Periodic watering of sediment disposition site and such ▪ Monitoring in residential area ▪ Operation in daytime only in principle ▪ Use of low-noise machinery (silencer, muffler) ▪ Construction of temporary fence around Project site ▪ Restriction of worker's prolonged exposure to noise ▪ Use of Personal Protective Equipment (PPE)	Contractor (NWPGCL
	▪ Construction debris	▪ Waste management program consisting of reduction, reuse, and recycling of materials.	Contractor (NWPGCL

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	▪ Soil runoff, turbid water, waste water from equipment cleaning ▪ Leakage of harmful substances ▪ Loss of habitat of flora and fauna ▪ Income, livelihood, vulnerable group	▪ Prohibition on dumping of any contaminating material ▪ Appropriate segregation of waste and disposal into designated disposal site ▪ Installation of temporary settling tanks and sediment fencing ▪ Water used for equipment cleaning is collected in the temporary tank and treated before discharge ▪ Monitoring at the water outlet ▪ Mitigation measures to prevent leakage, installation of cleaning facility ▪ Installation of green buffer ▪ The agricultural products growing on the site is compensated according to the Bangladesh regulation. ▪ Explanation of the construction extent and procedure in the early stage. ▪ Preferentially employ local people predicting decrease in income.	
	▪ Safety, accident prevention, land traffic, infrastructure	▪ Develop a safety management plan and rules ▪ Swift transport to medical facility ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Reduction of vehicle speed in resident areas and close to schools ▪ Installation of bypass for farm road and waterway within the site	
Water intake	▪ Lowering of groundwater level ▪ Ground subsidence	▪ Monitoring of underground water level in the surrounding wells ▪ Dig deeper wells as necessary ▪ Monitoring of underground water level in the surrounding wells	Contractor (NWPGCL
Installation of gas pipeline and	▪ Loss of farm land	▪ Compensation of the expropriated land according to the national regulation	Contractor (NWPGCL

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
transmission line	▪ Livelihood	▪ Construction conducted during agricultural off-season.	
Jetty construction	Sediment outflow, turbid water River traffic income, Livelihood	▪ Construction of jetty will adopt vertical piles type to minimize the dredging area ▪ Dredging activities will occur during dry season when water levels and flow are the lowest. ▪ Adoption of dredging method that minimizes environmental effect ▪ Use of the floating siltation curtains where appropriate. ▪ Dredged materials will be landed and dried on-site. ▪ Installation of sediment fencing ▪ Conduct dredging activity during dry season with less traffic ▪ Minimization of jetty construction area ▪ Explanation of the construction extent and procedure in the early stage.	Contractor (NWPGCL

8.2.2 Operation Phase

During the operation phase, the NWPGCL is responsible to form a required organization for environmental management. This organization is responsible for receiving the complaints from the residents of the surrounding area during the operation phase and to take appropriate measures, so that the complaints of the residents will be correctly understood and necessary measures will be taken.

The basic idea is to establish a relationship with the local communities. It is important to sufficiently explain the environmental management procedures taken at the power plant. It is also important to invite the residents and school children to observe the power plant.

The following describes the major environmental impacts during the operation phase.

- Generation of gas emissions and waste water
- Generation of noise from operating machinery
- Generation of solid waste from operation

The operation workers are required to have specialized knowledge. It will be difficult to hire workers from the local area. However, employing local workers will have a favorable impact on the local economy. For the comparatively easy work, sufficient consideration must be given to local employment, including implementation of the preliminary education and training programs for workers.

Table 8.2.2 gives the basic information on the EMP during the operation phase, and Chapter 9.4 describes the environmental monitoring plan.

NWPGCL should prepare a report on the implementation of the EMP and monitoring plan and should submit it to the Bogra DoE and related organizations for further discussion.

Table 8.2.2 : Major Environmental Impacts and Mitigation Measures during the Operation Phase

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Power generation	▪ Generation of gas emissions	▪ Adoption of a high stack ▪ Installation of a continuous monitoring system for gas emissions ▪ Adoption of pre-mixing method and a low-NOx combustor ▪ Monitoring of atmospheric air ▪ Periodic maintenance and management	NWPGCL
	▪ Generation of cooling and waste water	▪ Construction of open channel for a distance for cooling the hot water ▪ Installation of a wastewater treatment system capable of coagulation sedimentation, neutralization, and oil separation ▪ Monitoring of waste water ▪ Monitoring of the river or local water ▪ Blow-off water from cooling tower is cooled by dilution	
	▪ Generation of noise and vibration	▪ Planting trees around the power plant ▪ Adoption of low-noise type machinery and installation of soundproofing covers ▪ Installation of low-vibration type machinery and the use of rigid foundations ▪ Periodic maintenance and management ▪ Monitoring around the border of the site and residential area ▪ Distribution of ear protectors to employees	
Water intake	▪ Lowering of Groundwater level ▪ Ground subsidence	▪ Monitoring the underground water level in the surrounding wells ▪ Did wells of appropriate deepness as necessary	NWPGCL
Generation of waste	▪ Generation of sludge from the	▪ Waste management program consisting of reduction, reuse, and recycling of materials.	NWPGCL

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
	wastewater treatment system ▪ Generation of waste oil ▪ Generation of domestic waste	▪ Systematic collection and protected-storage on-site ▪ Prohibition on dumping of any contaminating material ▪ Waste away from the site and their appropriate disposal in a designated municipal dumping site.	
Presence of power plant, inflow of workers	▪ Loss of habitat of flora and fauna ▪ Employment, livelihood, vulnerable people, uneven distribution	▪ Provision of vegetated buffer ▪ Preferential employment of local people ▪ Utilization of local service (cleaning, catering) and materials ▪ Implementation of the preliminary education and training programs with local authority	NWPGCL
	▪ Land traffic	▪ Use of Bas for worker ▪ Observation of traffic regulations, installation of traffic signs, and education on driving safety ▪ Speed limit in residential- and school area	
	▪ Social foundation ▪ Diseases	▪ Provision of emergency medical facility ▪ Medical facility and periodical health checkup ▪ Education and training on health management of the workers	
	▪ Accident and safety management	▪ Tank storage areas will be equipped with oil spill bank and countermeasure for underground oil seepage and designed as physical containment area. ▪ Implement gas leakage prevention procedures and have available on-site all preventive equipment and materials as part of the process of developing emergency plan. ▪ Fire protection equipment and facilities shall be made available at suitable locations in power plant including fixed fire protection system, fire hydrants, portable fire fighting equipment, fire vents, alarm system, fire compartments and fire exit signs. Preparation of safety standard.	

Factor	Potential impact	Planned environmental mitigation measures	Responsible person
Presence of gas pipeline and transmission line	▪ Land expropriation	▪ Guarantee for the continuance of agricultural activity after construction.	NWPGCL
Presence of jetty	▪ River traffic, land use, livelihood	▪ Develop an appropriate maintenance and management schedule	NWPGCL

8.3 Environmental Implementation and Training

During operation phase, NWPGCL is responsible for the system organization of environmental management of the power plant and its implementation. The environmental manager, who should be a senior environmental engineer, should take charge of the management of the system to ensure environmental management and monitoring described hereinafter.

The environmental manager should be responsible for reporting the planning and implementation of environmental management plan and environmental monitoring plan to the manager of the power plant through all the phases of the project, and the director should take the final responsibility.

The environmental manager provides preliminary training on environmental management to the staffs prior to the beginning of the operation. The environmental manager should also provide appropriate updated training all through the operation phase.

The environmental manager is also responsible for reporting about the negotiation with local residents and issues of environmental management and monitoring and training to Bogra DoE and relevant organization.

8.4 Environmental Monitoring Plan

8.4.1Monitoring Parameters

a) Construction Phase

Table 8.4.1 shows the monitoring condition during the construction phase.

- Air quality monitoring: SPM, SO_2, and NO_2 are used as parameters for the measurement. Air quality will be monitored in the residential areas in principle. If there are any places susceptible to impact such as schools, select those places as the target of the measurement.

- Waste water monitoring: TSS will be used as a parameter for the measurement. Waste water will be monitored at the outlet from the settling tank.

- Noise monitoring: Noise level will be used as the parameter for the measurement. Noise will be monitored in the residential areas in principle. If there are any place susceptible to impact such as schools, those places will be selected as the target of the measurement.

- Underground water monitoring: The underground water level , Water temperature, and precious metals As , etc is used as the parameter for the measurement. Underground water will be monitored in the tube wells used for drinking water which are used in the surrounding residential areas.

b) Operation Phase

Table 8.4.2 shows the monitoring condition during the operation phase.

- Gas emission monitoring: SPM, SO2, and NO2 will be used as parameters for the measurement. Gas emissions will be monitored in the flue.

- Air quality monitoring: SPM, SO2, and NO2 will be used as parameters for the measurement. Air quality will be monitored in the residential areas in principle. If there are any place susceptible to impact such as schools, select those place as the target of measurement.

- Waste water monitoring: Water temperature, DO, SS, oil, BOD, and precious metals will be used as parameters for the measurement. Waste water will be monitored at the outlet where the waste water is discharged from treatment plant.

- Water quality monitoring: Water temperature, DO, SS, oil, BOD, and precious metals are used as parameters for the measurement. Water quality will be monitored at river or local.

- Noise monitoring: Noise level will be used as the parameter for the measurement. Noise will be monitored on the boundary of the site and in the residential areas in principle. If there is any place susceptible to impact such as schools, select those places as the target of the measurement.

- Underground water monitoring: The underground water level, Water temperature, and precious metals As , etc will be used as the parameter for the measurement. Underground water will be monitored in the tube wells used for drinking water which are used in the surrounding residential areas.

8.4.2 Monitoring Schedule

Tables 8.4.1 and **8.4.2** show the monitoring schedule during the construction and operation phases.

Table 8.4.1 : Monitoring Schedule during the Construction Phase

Item	Parameter	Place	Frequency
Air quality	SPM, SO_2, NO_2	Residential areas and schools	Monitor SPM every two weeks, and SO_2 and NO_2 every two months.
Water quality	TSS	Drain outlet	Every month
Noise	Noise level	Residential areas and schools	Every week when the amount of construction work is maximized
Underground water	Underground water level Water temperature, heavy metals As, etc	Residential area	Twice/year (dry season and rainy season)

Table 8.4.2 : Monitoring Schedule during the Operation Phase

Item	Parameter	Place	Frequency
Gas emission	SPM, SO_2, NO_2	Flue	Monitor SO_2 and NO_2 on a continuous basis (by a continuous monitoring system), and SPM every month.
Air quality	SPM SO_2, NO_2	Residential areas and schools	Monitor SO_2 and NO_2 every month, and SPM every two months.
Waste water	Water temperature, DO, SS, oil, BOD, and heavy metals	Drain outlet	Every two months
Water quality	Water temperature, DO, SS, oil, BOD, and precious metals	River	Twice a year (dry and rainy seasons)
Noise	Noise level	On the border of the site and in the residential areas	Twice a year
Underground water	Underground water level Water temperature, heavy metals As, etc	Residential area	Twice/year (dry season and rainy season)

8.5 Occupational Health and Safety

8.5.1 General Requirements

In Bangladesh the main law related to occupational health and safety is Labor Law 2006. The law has provisions on occupational hygiene, occupational diseases, industrial accidents, protection of women and young persons in dangerous occupation.

8.5.2 Workplace Environmental Quality

The proposed power plant project has several phases - the construction of infrastructure and installation and commissioning of plant equipment, operation of the plant etc.

The construction phase includes site preparation and plant construction, access road construction etc. The health hazards associated with these activities are mainly due to dust and noise pollution. Excessive noise contributes to loss of hearing and triggers physiological and psychological body changes. Dust pollution can cause eye and respiratory irritation and in some cases allergic reactions. The inhalation of exhaust gases from vehicles and machinery are also harmful for health. Stress can be caused by working in shifts, high work load, poor living condition of workers etc.

Remedial measures

To minimize the hazards arising from the activities at different phases of plant construction and operation, the following measures should be taken:

Employees should be informed of the potential health impacts they are facing. The employer should inform his employees of these potential hazards, arrange proper medical examination prior to and during employment, as well as tests and analyses necessary for the detection of diseases. Works with volatile toxic chemicals should be undertaken in a well ventilated place. Laborers handling offensive toxic chemicals should be provided with and forced to use protective clothing. Workers exposed to an excessive amount of noise should be provided with protective gear and be relieved frequently from their post. Workers exposed to large amounts of dust should be provided with adequate protective gear. Frequent spraying of water should be undertaken to minimize dust pollution. Persons undertaking construction and installation works should have access to amenities for their welfare and personal hygiene needs such as sanitary toilets, potable drinking water, washing facilities, shelter sheds etc. Proper disposal of waste and sludge should be arranged. Health education and information on hygiene should be provided to the workers. Regular checks on food quality should be arranged within the work site

(a) Safety

Safety implies the reduction of risk of accidents at the work site. Accident prevention is more valuable than any mitigatory or compensatory measures. This may be achieved through strict rules and procedures for the execution of specific tasks, enforcement of the rules, discipline amongst workers,

maintenance of machineries used and by providing all necessary gear or equipment that may enhance the safety of the workers.

The following guidelines should be followed to maintain the safety of the workers:

- Workers have to be informed about the possible damage or hazards related to their respective jobs.
- If pedestrian, traffic or plant movements at or near the site are affected by construction works, the person with control of the construction project must ensure that these movements are safely managed so as to eliminate or otherwise to control any associated health and safety risks.
- Must ensure sufficient lighting in the area where a person performs construction work or may be required to pass through, including access ways and emergency exit or passage without risk to health and safety.
- Construction site needs to provide safe access to and egress from all places where they may be required to work or pass through.
- This includes the provision of emergency access and egress route that must be free from obstructions.
- Adequate perimeter fencing should be installed on the site before construction work commences and that should be maintained during the construction work and signs should be placed which is clearly visible from outside the site including emergency telephone numbers.
- Must ensure that electrical installations materials, equipment and apparatus are designed, installed, used, maintained and tested to eliminate the risk of electrical shock, burns, fire or explosion.
- Construction site should be kept orderly and tidy. Access ways should be kept clear of materials and debris and maintained in a non-slippery condition. Materials should be stored in an orderly manner so that it does not pose any risk to the health or safety of any person.
- Arrangements of first aid facility should me made accessible when construction work is being undertaken.

8.5.3 Work in Confined Spaces

In the operational phase of the plant, the work will mainly be limited in confined spaces.

In this phase, noise pollution may pose risk to health. It has been observed that the measured noise level near the generators and turbines ranged from 90 dBA to 110 dBA.

This level of noise limits the continuous exposure to the workers from 2 to 4 hrs beyond which hearing impairment may be caused. If the installation of

generators and turbines are within a confined space and monitored through glass windows, it will not pose any serious threat. However precautions should be undertaken during routine inspections and maintenance works. Supervisors, inspectors and related personnel should wear noise protectors like ear plugs or ear muffs. Wearer should be given a choice between ear muffs and plugs as muffs are easy to use but may be a nuisance in a confined work space and be uncomfortable in hot environment. Whereas ear plugs don't get in the way in confined spaces but may provide little protection if not used carefully.

As the employees will work in confined spaces, the air pollution may not pose a health risk. However, the ambient temperature may be high due to plant operation and measures should be taken to keep temperature within a comfortable limit. Where damage to plant presents an electrical hazard, the plant should be disconnected from the electricity supply main and should not be used until the damaged part is repaired or replaced.

8.5.4 Hazardous Material Handling and Storage

During construction of the plant, commercially available chemicals (paints, thinners etc) will be used and stored in the construction area. Hence small amount of unused or spent chemicals (used paints, motor oils) will be generated. Hazardous wastes likely to be generated during routine project operations include oily water, spent catalyst, lubricants and cleaning solvents.

Operation and maintenance of the plant also generates some hazardous wastes. These include waste oil, boiler bottom ash, spent solvents, batteries, fluorescent light tubes, lubricating oils etc. The project will also involve the construction and operation of gas pipe line and handling of large amount of natural gas. Natural gas poses some risk of both fire and explosion.

Used lead acid batteries contain lead, sulfuric acid and several kinds of plastics which are hazardous to human health. Therefore the following set of storage guidelines should be adopted:

- the storage place must be sheltered from rain and other water sources and if possible , away from heat sources
- the storage place must have a ground cover
- the storage place must have an exhaust ventilation system in order to avoid gas accumulation
- the storage place must have a restricted access and be identified as a hazardous material storing place
- any other lead materials which may eventually arise, such as plumbing, should be conveniently packaged and stored in accordance with its characteristics

It is recommended that where dangerous goods are stored and handled, that premises should be provided with fire protection and fire fighting equipment. These equipments should be installed, tested and maintained in accordance

with the manufacturer's guidelines. The employer must ensure that a procedure for dealing with emergencies is in place, implemented, maintained and communicated to persons on the premises who may be affected by or respond to an emergency.

Ignition sources in hazardous areas should be eliminated. The facility staff should be trained and equipped with personal protective gear such as rubber gloves, boots, hard hats, apron or splash suit and a face shield with safety glasses or goggles.

8.5.6 Training

Training is an integral part of a preventive strategy. The target groups requiring training should be managers, supervisors, and technicians and related staff who may be exposed to risk at work.

Employee representatives should represent the views of workers to management about occupational health and safety and report to workers about management policy. Persons likely to be exposed to risks should be provided with information and instruction in safety procedures associated with the plant at the work place.

Relevant health and safety information should be provided to persons involved in installation and commissioning, use and testing of the plant.

Information on emergency procedures relating to the plant should be displayed in a manner that can be readily observed by persons who may be affected by the operation of the plant.

Training should be provided to use fire fighting equipment when necessary.

Facility staff needs to be trained in the safety procedures that are to be implemented during unloading, transfer and storage of hazardous materials.

8.5.7 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, installation, 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.

Construction phase

A person with control of a construction project or control of construction work should retain records for a reasonable period after the completion of the construction project of the occupational health and safety induction training and any other training given to persons directly engaged or trained by them to undertake construction work on the project.

Operation phase

During operation of the plant, arrangements should be made to keep records on any relevant tests, maintenance, inspection, commissioning and alteration of the plant, and make those records available to any employee or relevant health and safety representative.

All other records, including assessment reports not indicating a need for monitoring and/or health surveillance and records of induction and training, shall be maintained for at least five years in a suitable form.

Chapter 9: RISK ASSESSMENT AND MANAGEMENT

9.1 Introduction

The problem of protecting human health and the environment may best be defined as the management of risk. The failure to manage risk effectively and to establish priorities rationally translates ultimately into a failure to protect health, safety, and the environment. Through the use of risk assessment, concerned authorities can estimate the relative level of risks posed by different substances, products and activities and can establish priorities in determining whether, and how, to regulate.

Risk assessment is the technical process for estimating the level of risks posed by operational processes or products, i.e. the probability that a given harm will occur as a result of the processes or products. Risk assessment is applied to a substance, proceeds in four major steps:

Hazard identification: determining what kinds of adverse health effects a substance, product or activity can cause

- Dose - response assessment: predicting the degree of adverse effects at a given exposure level
- Exposure assessment: estimating the amount of exposure, and
- Risk characterization: combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

Risk management options are then evaluated in a proposed solution to provide reduction of risk to the exposed population. Specific actions that are identified and selected may include consideration of engineering constraints as well as regulatory, social, political and economic issues related to the exposure. Quantitative assessment of risks associated with hazard identification, dose-response assessment, exposure estimation and risk characterization were beyond the scope of the present study. However, this study takes a qualitative approach to identify common hazards within the power plant and recommends measures for managing these risks with accidents and external threats.

9.2 Power Plant Risks Assessment

The process of electricity generation from oil or gas is by no means risk free because of high temperature and pressure conditions within the plants, rotating machineries and high voltages involved. Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation, the oil/gas fired power plants put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. It is therefore essential that a risk management plan should be devised in order to both reduce risk of accident and to take the correct action during accidents. Important risks of accidents in thermal power plants leading to disasters or emergency situations may occur during following events:

- Risks during emergency: Fire, Explosion, Oil/acid spillage, Toxic chemical spillage, Electrocution

- Risks due to natural disasters: Flood, Cyclone, Earthquake, Storm, Lightning,

- Risks due to external threats: Sabotage, War situation, Water/food poisoning

In power plants, accidents can occur at two different levels. First, these may occur due to fires, explosions, oil or chemical spillage and spontaneous ignition of inflammable materials. In such events, operators working inside the plant and at various strategic hazard locations will be affected.

Second, risks are also associated with external threats of sabotage. Failure of automatic control/warning systems, failure of fuel oil storage tanks and chemical release from acid and alkali stores and handling also pose great degree of associated risks.

9.3 Managing the Risks

As mentioned earlier, in order to reduce the risks associated with accidents, internal and external threats, and natural disasters, a risk management program is essential. Risk management planning can be done during design and planning stage of the plant as well as during plant operation. While risk management is mainly preventive in nature during the plant operation stage, the design and planning stage of the plant can incorporate changes in basic engineering to include safety design for all processes, safety margins for equipment, and plant layout. The following steps among others are important in managing the risks mentioned.

- Gas storage is to be designed with adequate precautions in respect of fire hazard control.

- Storage of hazardous substances such as acids and alkalis should be sited in protected areas.

- With respect to plant operation, safe operating procedures should be laid down and followed to ensure safety, optimum operation and economy.

- A fire fighting group with adequate manpower and facilities such as water tank of sufficient capacity, C02 tank, foam tank, portable fire extinguishers should be provided and facilities located at strategic locations e.g. generator area, high voltage panel, control rooms, and fuel tank area.

- Regular checks on safe operating practices should be performed.

In order to achieve the objective of minimizing risks at the Sirajganj PPP, the unit will be trained to act in a very short time in a pre- determined sequence to deal effectively and efficiently with any disaster, emergency or major accident to keep the loss of life, human injury, material, plant machineries, and impacts on the environment to the minimum.

9.4 Emergency Response Plan

Emergency response plans are developed to address a range of plausible risk scenarios and emphasize the tasks required to respond to a physical event. The emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

The primary objective of the plan is to keep the loss of life, material, machinery/equipment damage, and impacts on the environment to minimum.

9.4.1Emergency Response Cell

It is highly recommended that an Emergency Response Cell (ERC) adequately equipped with highly trained manpower and appropriate gears is established within the power plant in order to effectively implement the emergency response plan. The main functions of the emergency response cell should include the following.

- Identification of various types of emergencies
- Identification of groups, communities, and areas those are vulnerable to different kinds of emergencies
- Preparing service teams for various operations within the organization through extensive training
- Establishment of early detection system for emergencies
- Developing reliable, instant information and communication system
- Mobilizing all units in the plant within a very short time to address any emergency

9.4.2Emergency Preparedness

The ERC headed by a trained Manager should establish an Emergency Control Room with links to all plant control rooms and all other services.

The team will be responsible for preparing and executing a specific emergency response plan for the power plant . The team should meet at regular intervals to update the plan, based on plant emergency data and changes in support agencies.

The team should undertake some trial runs, e.g. fire drill, in order to be fully prepared and to improve upon the communication links, response time, availability and workability of emergency gears and other critical factors.

Upon receiving information about an accident, the ERC team will assemble in the Emergency Control Room within the shortest possible time and formulate emergency control procedure.

9.4.3Fire Fighting Services

The Fire Officer will be the commanding officer of the fire fighting services. The FO will head a fire fighting team of trained officers and workers. Adequate fire fighting equipment e.g. fire extinguishers of different types appropriate for different strategic locations must be planned according to requirements of existing and future plants.

Depending on the scale of emergency, the fire fighting team will work in close association with security and maintenance personnel of plant. Additional assistance may also be sought from outside fire stations when required.

Preparedness is extremely important for efficient and effective fire fighting services at the time of emergency. This can be better achieved by organizing fire drills at regular intervals, e.g. once every two weeks during dry summer, months and once every two months during wet months involving all team members, all other service groups, all staff of the power plant, and utilizing all fire fighting gears.

9.4.4Emergency Medical Services

The Chief Medical Officer will be responsible for providing medical services within the power plant at the time of any emergency. The services should also be rendered to people living in the close vicinity of the plant and affected by any accident within the plant.

The Medical room of the Sirajganj PPP must be equipped with adequate medical personnel and equipment for providing emergency services in addition to normal Medicare services to population of the plant.

A team of well trained Medical Officers specializing in burn injury, orthopedics, electrocution, chemical toxicity or poisoning, and shock treatment must be available at the power plant Medical room. The number of officers may be determined considering the total number of staff and their family members in the plant. Special attention must be given to child injury treatment.

The following services must be on alert at all times in the plant.

First aid services for attending patients on the spot. The Medical room should provide training on first aid services to some designated staffs of important areas of operation, e.g. boiler area, turbine hall, transformer area, electrical rooms, and chemical storage facilities, for immediate attention to the injured.

Ambulance services should be available for transport of casualties from spot to Medical room of the plant, and from Medical room to outside hospital, as necessary. Facilities for transportation of fatalities to appropriate hospital or to relatives or to the police following prescribed procedure should be available.

All potential areas for emergency1 accidents in the plant must have an information chart including contact phone numbers of relevant services.

9.4.5Rescue Services

Without going for additional manpower, the rescue team can be formed with potential staffs of the Power Plant, e.g. from medical services, security services and fire fighting services, for conducting rescue operations following an emergency. A senior member can be designated Rescue Officer who will be responsible for formulating rescue plan and guiding the team.

9.4.6Security Services

Sirajganj PPP will have a strong independent security team headed by the Chief Security Officer and will be responsible for the overall security of the plant , its equipment, machineries, buildings, utilities. The security office shall maintain liaison with other emergency services at the time of emergency and during normal hours.

9.4.7Public Relations Services

The Public Relations Officer (PRO) of the Power Plant will be responsible for communicating emergency related information to concerned officials within the power plant. The PRO however, will consult the Emergency Manager before communication with outside agencies.

The PRO will be responsible for warning people in and around the plant against potential fire hazards, or possible chemical contamination of water.

The PRO will keep close contact with outside local community and provide direction, and participate along with management team in the welfare services for the affected communities.

9.5 Concluding Remarks

Apart from the services mentioned above, the Environmental Management Unit and the Emergency Response Cell must ensure that all staffs working within the Power Plant are oriented, through orientation programs, about the dos and don'ts during emergencies as well as overall environmental aspects and issues related to power plant operations.

It is however, to be emphasized that the emergency response plan (ERP) outlined above is to be used as guide only and that the Environmental Management Unit and the Emergency Response Cell shall develop their own environmental management system (EMS) following ISO 14001 and the emergency response plan (ERP) respectively in consultation with and involving the Sirajganj PPP and the NWPGCL Management.

Chapter 10: PUBLIC CONSULTATIONS

10.1 Introduction

Public consultation forms an important part of the EIA study. The main objective of the consultation process is to apprise the local inhabitants about the proposed project and to seek their opinions regarding the possible impacts of the project. It was recognized that their opinions would be more useful as they are accustomed to construction and operation of a number of power plant units in the locality in last few years.

Public involvement is a fundamental principle of any environmental assessment study. The inclusion of the views of the affected and interested public helps to ensure that the decision making process is equitable and fair and leads to more informed choice and better environmental outcomes. The findings from the public consultations carried out as a part of the EIA study were utilized in the development of the EMP (presented in Chapter 8), especially in identifying the significant impacts of the proposed project and developing the corresponding mitigation measures.

10.2 Approach and Methods

Within the framework of the present study, public consultation process has been initiated with an explicit objective to ensure people's participation. More specifically this was aimed at improving the study, taking into account opinions from the people of the study area.

The consultation sessions included Focused Group Discussions (FGD). one FGD was organized only with male and another with female residents around the project site.

Formal and informal meetings in terms of FGD with different groups and interviews with Key Informants (KIs) of the area were held with the primary objective to understand the people's perceptions regarding relevant issues. Discussion mainly centered on problems of the area relevant to the proposed project and suggested solutions.

Apart from Focus Group Discussion, In-depth interviews were conducted with the different officials of Sirajganj Sadar upazila to grasp their views and opinions.

The study also took into consideration the findings of questionnaire survey carried out as part of the EIAs conducted for other power plants, (positive and negative impacts), the socio-economic and political situation and peoples' perception about the project.

Consultation was undertaken at early stages of the EIA study so that potentially affected groups/people could provide meaningful input to the EIA. The dialogue, both formal and informal, was continued throughout the period. All consultations and meetings were documented including responses to the questionnaire.

10.3 Public Consultations

10.3.1 General:

Survey has been conducted in the adjoining areas of the proposed site for new power plant in two ways – i. Quantitative approach and ii. Qualitative approach. For quantitative approach, standard questionnaire (socio economic and environmental issues) has been used for interviewing randomly selected respondents in the proposed area. On the other hand, for qualitative approach, focus group discussion guidelines have been followed.

For Quantitative approach, 153 respondents have been randomly selected from the adjacent villages, Char Panchasona and Char Bara Simul of Saidabad union under Sirajgonj Sadar upazila.

For Qualitative approach, two Focus Group Discussions – one for fishermen group and another for female group were conducted in the proposed area. Apart from FGDs, in-depth interview was conducted with local administrative authorities.

10.3.2 General Interview:

For Quantitative approach, 153 respondents have been randomly selected from the adjacent villages, Char Panchasona and Char Bara Simul of Saidabad union under Sirajgonj Sadar upazila. The Comments of the Respondents are as follows:

- The new power plant should be established away from the residential area.
- There should be no Noise Pollution.
- Exhaust smog and noise pollution should be controlled.
- Employment Opportunity will be created.
- Load shedding will decrease.
- The problem of shortage of power in Bangladesh will be minimized.
- Power Plant should be established in such an area where there is no existence of any residence.
- The chimney of power station should be at a greater height and have to be environmental friendly.
- The local people of Sirajganj will be benefited.

10.3.3 Focus Group Discussion:

FGD-1 (Female Group)

- Venue: House of Rozob Ali.
- Village: Ponchoshona (Purnobashan)

- Union: Saidabad, Thana Sadar. District: Sirajganj.
- Group : Female.
- Time: 3:00 PM.
- Date: 16-11-09

Profile of Participant:

SL.No.	Name of the participant	Husband/Father's Name	Age	Occupation	Education	Monthly income	Marital status	Member of Association
01	Rokeya Parveen	Rozob Ali	25	Service	H.S.C	3000/=	Married	Nil
02	Sufiya Khatun	Abu Kalam	30	House wife	Signature Only	5000/=	Married	Manob Mukti Shongho
03	Rashida Khatun	Ripon	22	House wife	08	10000/=	Married	Nil
04	Lakhi	Tajirul Islam	23	House wife	08	8000/=	Married	-
05	Rahima Khatun	Abdul Latif	35	House wife	Nil	6000/=	Married	Manob Mukti Shongho
06	Shahinur	Kalilur Rahman	18	Student	09	10000/=	Unmarried	Nil
07	Bokul	Rahim	19	House wife	Signature Only	6000/=	Married	Manob Mukti Shongho
08	Sahanaz	Abu Talab	30	House wife	07	5000/=	Married	NDP
09	Angidan	Bokkor Mondol	45	House wife	Signature Only	20000/=	Married	Manob Mukti Shongho
10	Lili	Ibrahim	25	House wife	-	5000/=	Married	-
11	Lal Banu	Abdul Mazid	50	House wife	-	3000/=		-

Outcome of FGD-1:

- The women participating are all from Panchashona village, Union: Saidabad,Sadar Upazila, Zila-Sirajganj.

- The numbers of participants were 11. Ten participants of them were married. Amongst them only 5 can read and write and the rest of the 6 can only sign their name. All women present were housewives except one was service holder.

- The monthly income of the participants are about Taka 7,550.00. Most of the participants who were present were somehow related with any sort of corporation, related with any sort of business or interest related issues. The age groups of the participants are within the same range. The participants used to live in various areas before moving into here. Some had to leave their own land because of the construction of the Jamuna Bridge. But most of them were bound to move here (Panchashana) because they were a victim of the river erosion. The present participants were living in this area for about years. The participants used to get their medical treatment upon their financial capability. They get their medical treatment from Sirajganj Sadar Hospital, Private Hospital, Village Doctor, Pharmacy etc.

- All the participants used to drink tube well water. According to the participants, there were some tube wells in the area which were affected by arsenic. The participants mentioned that the depth of water in their area was about 60 to 120 feet below. They mentioned that it was really hard to get water in the summer. They blamed the Jamuna Bridge for this problem for which there are presence of sand in the Jamuna River. All the participants used to use sanitary latrine. They were very aware of their hygiene. They think that they can stay away from diseases if they stay

hygienic and clean. They raised the names of various kinds of diseases during the entire conversation.

- About the grid substation they said, there is no problem to the people of their locality due to the presence of the grid substation, in fact the electricity they were using are from the Sirajganj Palli Bidyut Samity. They are not using the electricity of the grid substation directly. They mentioned the merits of using electricity in the conversation. They think that, the name of their village will reach greater heights if a new power station is established in their proposed area. They rate of employment will increase. The problem of lack of power supply in the country will decrease. But they also mentioned that, some cultivated lands will be destroyed in the area when the power station will be established. This will disrupt the farming system of their area.

- In present times, fruit trees e.g. mango, jackfruit, coconut, plum, guava, black berry (jam), etc are available in the participant's area. Before the establishment of the substation, there was only sand in this area, according to the participants.

FGD-2 (Male Group):

i. Venue: House of Mr**.** Samsul Haque
ii. Village: Ponchoshona.
iii. Union: 10 number Saidabad, Upazilla Sadar, District Sirajganj.
iv. Group : Male.
v. Time: 8:15 pm
vi. Date: 18-11-09

Profile of Participant:

SL.No.	Name of the participant	Age	Occupation	Education	Monthly income	Marital status	Member of Association	Taken loan
01	Md. Samsul Haque	50	Fisher man	Nil	5000/=	Married	Member	Nil
02	Md. Rowshan Ali	50	Fisher man	-	4500/=	Married	Nil	
03	Md. Rofiqul Islam	32	Fisher man	-	5000/=	Married	-	-
04	Md. Sahad Ali	20	Fisher man	-	4000/=	Married	-	--
05	Md. Abdul Motalab	25	Fisher man	Five Pass	4500/=	Married	--	-
06	Md. Al-Amin	23	Fisher man	Eight Pass	4200/=	Married	-	-
07	Md. Rohom Ali	28	Fisher man	Nil	4500/=	Married	-	-
08	Md. Abdur Rashid	30	Fisher man	-	5000/=	Married	-	--
09	Md. Ruhul Islam	28	Fisher man	-	4500/=	Married	-	-

SL.No.	Name of the participant	Age	Occupation	Education	Monthly income	Marital status	Member of Association	Taken loan
10	Md. Shafiqul Islam	26	Fisher man	-	5000/=	Married	-	-
11	Md. Ismail Hossain	25	Fisher man	-	4500/=	Married	-	-
12	Md. Jahangir Hossain	30	Fisher man	-	5000/=	Married	-	-
13	Md. Khokon Molla	25	Fisher man	-	4500/=	Married	-	-

Outcome of FGD-2:

- All participants are associated with the fishing profession. They used to catch fish to make their livelihood. At present, Aeir, Baus, Bashpatari, Shrimp, Hilsha, etc. fishes having weight between one and half to two kilograms are normally caught whose selling price ranges from Tk. 350 to Tk. 400. Present participants have been fishing for the last 20 to 35 years in average. More fishes could be caught in the past than now. At present, less numbers of fishes are being caught by every fisherman. The main reason is that more people are joining the fishing profession at present. Besides, population has increased and rivers and canals have dried up. Water consumption has increased. There are no floods now compared to the past. As a result, the breeding places available to the fishes have narrowed. Present participants informed that various fishes like Pangas, Rui, Katla, Boal, Pabda, Puti, Koi, etc. are getting extinct and the government should take steps to protect these species. For this, dredging of rivers and canals are necessary. Also, breeding places should be conserved.

- All participants know about the grid sub-station and they reported that it causes no trouble to the environment. Other than this, all are aware of the nearby new power plant's establishment. Electricity is necessary in all fields. Due to a new power plant, local industries would boom. Knitting industries will expand. Poultry farms would increase and scarcity of electricity will be met. Economic development will be achieved through jobs. Children will have good education and there will be no problems in transportation. To sum up, life quality will be better.

- All participants are rehabilitated in this village by the government due to the erosion of Jamuna River Banks. They want to attract the government's attention towards creating employment for the local manpower in case of a new power plant during construction period and operation period as well.

10.3.4 In-depth Interview

In regard to the construction of 150MW Peaking Power Plant at Char Bara Shimul in Saidabad Union under Sirajgang Sadar Upazila, an in-depth

interview was conducted. We have collected opinions from the Thana Nirbahi officer (TNO), Agriculture Officer, Fisheries officer, Education officer, Social Welfare officer etc. The following information were gathered by discussion with the above mentioned officers.

- If this lands are used for constructing a 150 MW-Powered Plant, it will be extremely welcome because it is very important to fulfill the needs of electricity for the National great interest as without electric power, economic and national development is quite impossible.

- To make the food sector of the country sufficient, there are no alternatives to irrigation in the crop fields. The country's industries, offices, educational institutions- all come to standstill without electricity. The nation's prosperity will be achieved by making the proper consumption and increasing generation of electricity by building of power plant,

- The environmental aspects should be put on agenda by the government and foreign companies and standard guidelines must be followed. As a reason, they mentioned that a power plant's noise, wastages etc. cause various damages to crops, river water and human health. Everything must be protected from this kind of damage. And everyone opined that scientific methods should be used to preserve the environment.

- Besides those whose lands (except government land) would be acquired must get proper compensation and should also have advantage in case of employment (at the power plant).
- In the above mentioned location there are no historical monuments

Chapter 11: CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

In this study, the effects of the project activities on physico-chemical, ecological and socio-economic (i.e., human interest related) parameters during both construction and operation phases have been assessed. The impacts have been identified, predicted and evaluated, and mitigation measures suggested for both construction and operation phases of the proposed power plant. The important physico-chemical environmental parameters that are likely to be affected by the project activities include air and noise pollution.

The study suggests that most of the adverse impacts on the physico-chemical environment are of low to moderate in nature and therefore, could be offset or minimized if the mitigation measures are adequately implemented. Since the project site is located in a developed area that does not appear to be very sensitive ecologically, the impact of project activities on most ecological parameters (e.g., wet lands, homestead vegetation, forest cover, bushes and trees, wild life, species diversity) are mostly insignificant.

Some adverse impact during the operation phase of the plant will come from NO2 and SO_2 emission from the power plant. However, modeling study suggests that the effect of increased NO2 and SO_2 in the ambient air due to emission from the proposed power plants will not be very significant.

Noise level has been identified as significant potential impact of the proposed power plant during both the construction and operation phases. The noise generated from construction activities during the construction phase might become a source of annoyance at the residential area close to the project site. However, since residential areas are located away from the site and the trees and boundary walls will have some damping effect, the noise level is expected to come down to tolerable levels within residential area

There is no need for land acquisition. Additionally, there is no settlement in this designated area. Therefore, no population will be displaced and no resettlement will be required for the construction of the power plant.

During operation phase, no significant negative impact is anticipated on socio-economic environmental parameters.

During public consultations carried out as a part of the EIA study, people welcomed the proposed power plant project at Sirajganj. However, they recommended installing a plant of good quality, which will be able to provide uninterrupted power during peak hours and will be able to keep anticipated air and noise pollution to a minimum level.

11.2 Recommendations

The environmental assessment carried out for the proposed Sirajganj PPP, suggests low to moderate scale of adverse impacts, which can be reduced to acceptable level through recommended mitigation measures as mentioned in the EMP. It is therefore recommended that the proposed Peaking Power Plant may

be installed, provided the suggested mitigation measures are adequately implemented. It is also recommended that the environmental monitoring plan be effectively implemented in order to identify any changes in the predicted impacts and take appropriate measures to off-set any unexpected adverse effects.

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste, cooling and wastewater disposal as a result of construction and operation activities, the power plant put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. An emergency response plan (ERP) for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

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