ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

55MW HFO-Fired Power Plant Project at Singair, Manikganj

Final Report

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LIST OF ABBREVIATIONS

AP	Affected Person
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BNBC	Bangladesh National Building Code
BOD	Biochemical Oxygen Demand
BOO	Build operate and Own
BP	Bank Procedures
BPDB	Bangladesh Power Development Board
CAMS	Continuous Air Monitoring Station
CASE	Clean Air Sustainable Environment
CLAC	Central Land Allocation Committee
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
COD	Commercial Operation Date
DCs	Deputy Commissioners
DESA	Dhaka Electric Supply Authority
DG	Director General
DNPGL	Dhaka Northern Power Generations Ltd
DO	Dissolved Oxygen
DoE	Department of Environment
EA	Environmental Assessment
EC	Electrical Conductivity
ECA	Ecologically Critical Area
ECA	Environment Conservation Act
ECR	Environment Conservation Rules
EHS	Environmental, Health and Safety
EMP	Environmental Management Plan
ESIA	Environmental & Social Impact Assessment
FGD	Flue Gas De-sulfurization
FGDs	Focus Group Discussions
GoB	Government of Bangladesh
GR	Game reserve
HFO	Heavy Fuel Oil
HHV	Higher Heating Value
IA	Implementation Agreement
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IPFF	Investment Promotion and Financing Facility
LGRD	Local Government Rural Development
LNG	Liquefied Natural Gas
MoEF	Ministry of Environment and Forests
MoL	Ministry of Land
MWth	Megawatt thermal input
NOC	No Objection Certificate

NP	National Park
OEM	Original Equipment Manufacturer
OP	Operational Policies
OSHA	Occupational Safety & Health Organization
PA	Protected Area
PPA	Power Purchase Agreement
PPR	Public Procurement Rule
PPR	Public Procurement Rule
PSMP	Bangladesh Government's Power Sector Master Plan
PSRB	Power Sector Reforms in Bangladesh
REB	Rural Electrification Board
SPP	Small Power Plant
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
USEPA	United States Environment Protection Agency
WBG	World Bank Group
WHO	World Health Organization
WS	Wildlife Sanctuary

EXECUTIVE SUMMARY

E.1 Background

Dhaka Northern Power Generations Ltd (DNPGL)intends to install 3 units of ultra-efficient MAN 18V48/60 HFO Generator sets with combined capacity of 55MW at the grid at Singair, Manikganj. DNPGL has signed Project Agreements, comprising of Implementation Agreement (IA) and Power Purchase Agreement (PPA) for setting up the 55MW Heavy Fuel Oil Power Project on a Build operate and Own (BOO) basis. Total operation period of the project will be 15 years from the date of COD (Commercial Operation Date).

The proposed power plant falls under "red category" and require carrying out ESIA in accordance with the Environment Conservation Act 1995 and the Environment Conservation Rules 1997 (ECR, 1997). The DNPGL authority has conducted some limited environmental studies in the project area and submitted an Initial Environmental Examination (IEE) report to the Department of Environment (DoE) and obtained the Site Clearance Certificate. The IEE report indicates that there are no particularly sensitive ecological, cultural and archeological targets. The plant installation would not relocate any human settlement, as the project is situated on purchased nonagricultural land. However, since this is a "red category project, a full-scale ESIA is necessary to obtain the final environmental clearance certificate from the DoE. Apart from that, the DNPGL seeks World Bank funds to finance the project through IPFF with Bangladesh Bank acting as a financial intermediary. Therefore, the environmental and social assessment of the proposed project should comply with the policies and legislative requirements of the World Bank. The ESIA of the proposed power plant project presented in this report has been carried out considering the guidelines of the Department of Environment (DoE) of GoB(GoB, 1997) and the relevant safeguard policies and operational guidelines of the World Bank.

E.2 Review of the Existing Policy Framework and Guidelines

To carry out environmental and social assessment of the proposed project, firstly a review of relevant literature on policy, legal and administrative framework focusing on environmental quality and discharge standards, health and safety issues, protection of sensitive areas and endangered species, land use controls, etc. were carried out. In addition to that, the World Bank safeguard policies for environmental protection are reviewed and their applicability to the proposed project was discussed.

E.3 Baseline Environment Survey

The project site is at FordnagarMouza, Dholla Village, Manikgonj. The proposed project would be set up ona 3.7 acre land purchased from local landowner by DNPGL. The

landowner sold their land at market price and before purchasing, the land was vacant with no settlement or temporary squatters. Therefore there is no issue of resettlement.

A baseline survey (including physical, ecological surveys) was conducted during November-December 2014 covering areas in and around the project site (i.e., the study area), in order to update information on "baseline" environment. Informal discussions were held with people living and working in the surrounding areas. The purpose of the baseline survey was to document the existing conditions of physical and biological environment and prevailing socio-economic conditions of the project areas. During field visits, discussions were held with the DNPGL officials and engineers on different issues on recently completed/ongoing projects, and capacity and institutional arrangement for environmental management of the proposed project. Apart from physical and ecological survey, noise level measurements were taken in the study area. Surface water and groundwater samples were also collected (from water bodies/ tube wells located close to the project site) for assessment of water quality in project-surrounding areas. Information on climate, soil and topography for the project surrounding areas was collected from secondary sources. Ambient air quality data were obtained by direct measurements as well as secondary sources. Both primary data and secondary data sources were analyzed to identify historic and cultural resources and land use characteristics in the project surrounding areas.

E.4 Public Consultation

Focus Group Discussions (FGDs) were held at 2 project locations, which were participated by a wide range of stakeholders. The locations were Jaigeer Primary School and Dhalla Govt. Primary School both located in Singair, Manikganj. More than 60 people participated in the FGDs. The participants expressed their opinions regarding different issues including their knowledge about the proposed power project, socio-economic condition of people in their localities, possible impact of the proposed power project on the existing environment and in their localities, and mitigation measures to address adverse impacts. In addition, public consultations (in the form of informal discussion) were also carried out during field visits.

E.5 Environmental and Social Impact Evaluation

As a part of the Environmental and Social Impact Assessment (ESIA), environmental impacts of the specific project activities on different ecological, physical, chemical and socio-economic related parameters, both during the construction phase and the operation phase, have been identified and assessed.

Ecological impact

Based on assessment of the baseline environment at different project locations (during field visits) and the nature and scale of the proposed project, it appears that ecological impacts are not likely to be significant.

Socio-economic impacts:

Possible socio-economic impacts from the project activities to be carried out may include the following: (a) traffic safety (b) public health and (c) generation of employment and commercial activities.

Physical and chemical impacts

Possible physical and chemical impacts from the project activities to be carried out may include the following: (a) Noise pollution, (b) Air pollution, (c) Drainage congestion, (d) Surface water pollution, and (e) Environmental pollution from solid/ construction waste.

It can be seen that the proposed 55MW HFO-fired power plant will not have any lasting adverse environmental impacts on the project area during the construction phase. Implementation of the proposed project would have a limited amount of, short-term, local impacts on flora and fauna, noise level, water resources, air quality, navigation and traffic movement. It is not expected, however, that any of the above effects would persist over an extended period beyond the installation phase of this project. During the operation phase, a number of adverse environmental impacts will be there on the air and noise environment as well as worker health and safety, some of them may be long-term if appropriate mitigation measures (noise barriers, FGD units to reduce SO_2 emission etc) are not taken. Positive impacts include public access to additional electricity, which may trigger direct and indirect positive effect on national economy, industrial development and productivity etc. Movement of river vessels (for fuel transport) will slightly increase the river traffic. Road traffic might also increase as an indirect effect of the power plant due to the increase of commercial activities in the area.

E.6 Environmental Management Plan

A mitigation and abatement plan has been proposed to minimize these short-term and long-term impacts. An environment management plan (EMP), including a monitoring program covering issues like air pollution, noise pollution, traffic congestion, drainage congestion, water resources, has also been presented. Since no adverse social impacts (loss of land and income, harmful effects on social structure or tribal people etc.) are anticipated in this project, a separate social management plan was not deemed necessary.TablesE-1and E-2 show the mitigation measures corresponding to specific adverse impacts during construction and operation phases respectively, along with assignment of responsibilities for their implementation.

Table E-1 Potentially significant environmental impact during construction phase and mitigation measures

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Influx of workers	• Generation of sewage	• Construction of sanitary latrine and	Contractor

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	and solid waste	septic tank system (one latrine for 20 persons) • Erecting "no litter" sign, provision of waste bins/cans, where appropriate • Waste minimization, recycle and reuse • Proper disposal of solid waste (in designated waste bins)	(Monitoring by DNPGL)
	• Possible spread of disease from workers	• Clean bill of health a condition for employment • Regular medical monitoring of workers	
Transportation of equipment, materials and personnel; storage of materials	• Increased traffic/navigation • Generation of noise from vehicles, especially affecting the nearby residential area	• Establishment of minimally intrusive and well-designed traffic and river navigation patterns for onsite construction activities	Contractor (Monitoring by DNPGL)
	• Deterioration of air quality from increased vehicular movement and construction equipment movement, affecting people in the surrounding areas	• Keeping vehicles under good condition, with regular checking of vehicle condition to ensure compliance with national standards • Limiting GHG emission by using modern construction equipment and by prohibiting excessive idling of equipment when not in use.	
	• Wind-blown dust from material (e.g., fine aggregate) storage areas	• Watering unpaved/dusty roads (at least twice a day; cost estimate provided) • Sprinkling and covering stockpiles • Maintain adequate moisture content of soil during transportation, compaction and handling • Covering top of trucks carrying materials to the site and carrying construction debris away from the site	
	• Damage/ reduction of native flora, displacement of wildlife, birds etc., impact on vulnerable species such as the Gangetic Dolphin	• Provide proper compensation if there is any destruction of trees outside the project boundary. • Control intensive movement of heavy construction vehicles. • Temporary stockpiling of materials should be done on non-vegetative surfaces • Revegetation, if required, should be done using native, non-invasive species and by preventing the introduction of noxious weeds • Keep noise level (e.g., from equipment) to a minimum level, as	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		certain fauna may be very sensitive to loud noise. • If native fauna is encountered during construction or land clearing activities, the workers should be advised not to injure or kill it, rather allow it to pass by or displace itself in its own will. (Same for any threatened/vulnerable species). • If the construction crew in the vessels encounters the Gangetic Dolphin, they should reduce the speed of their vessels and wait for it to move away and disappear. No attempt should be made to approach the dolphin or catch it.	
Construction activities, including operation of construction equipment	• Generation of noise from construction activities (general plant and access road construction),	• Use of noise suppressors and mufflers in heavy equipment • Avoiding, as much as possible, construction equipment producing excessive noise at night • Avoiding prolonged exposure to noise (produced by equipment) by workers • Creating a buffer zone between the residential area and construction site to reduce disturbance • Regulate use of horns and avoiding use of hydraulic horns in project vehicles.	Contractor (Monitoring by DNPGL)
	• Deterioration of air quality from wind-blown dust and possible use of equipment, such as stone (aggregate crushers)	• Not using equipment such as stone crushers at site, which produce significant amount of particulate matter • Keeping construction equipment and generators in good operating condition • Using equipment, especially generators with high levels of emission control (e.g., TIER-4). • Immediate use of construction spoils as filling materials • Immediate disposal/sale of excavated materials • Continuous watering of bare areas	
	• Generation of construction waste	• Hauling of construction debris away from the site and their appropriate disposal in a sanitary landfill	
	• Accidents	• Regular inspection and maintenance of equipment • Environmental health and safety briefing • Provision of protective gear	
	• Spills and leaks leading to soil and water contamination with	• Good house keeping • Proper handling of lubricating oil	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	hydrocarbon and PAHs	and fuel • Collection, proper treatment, and disposal of spills • A spill prevention, containment, and countermeasure plan would be prepared. This plan would detail the measures required of all construction, operation, and maintenance personnel for transport, storage, use, spill response/ containment, and disposal of hazardous materials, waste, and debris.	
	• Employment of work/labor force	• Local people should be employed in the project activities as much as possible. • Promote supply from local suppliers	
	• If cultural resources are found during excavation	• Follow the "Chance Find Procedure" World Bank Operational guidelines OP 4.11 (See Annex F)	
	• Drainage congestion during construction activities	• Provide adequate diversion channel, if required • Provide facilities for pumping of congested water, if needed • Ensure adequate monitoring of drainage effects, especially if construction works are carried out during the wet season.	Contractor (Monitoring by DNPGL)
Construction of HFO transmission pipeline from bank of Dhaleshwari river to storage space, construction of service jetty	• Water pollution due to sediment suspension (increase in suspended solids) or washing away of slurry to the water bodies, temporary, localized disruption of fish habitat	• Use directional boring technique for minimally intrusive pipeline construction • Ensuring that no seepage occurs through the borehole (if directional boring is used). After completion of the borehole, all slurry should be removed from the construction site and disposed in an approved site.	
	• Noise and air pollution	• As applicable, adopt similar noise and air pollution mitigation measures stated above for trenching operation, concreting work, mobilization of vehicles and equipment.	
	• Disruption of river navigation	• Design minimally intrusive vessel movement patterns for mobilization of construction equipment	
General Construction activities	• Worker health and safety	• Provide the workers with personal protective equipment for protection against noise. • Contractors should comply with the relevant WBguidelines of occupational health and safety	Contractor (Monitoring by DNPGL)

Table E-2: Environmental impact during operation phase and mitigation measures

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Power Generation	• SO_2 and NO_2Emission from the power plant	• Using stack as per specifications • Using low nitrogen oxide burners/ selective catalytic converters or any other proven technologies available to reduce the NOx emission • Use of Flue Gas Desulfurization (FGD) units to reduce the SOx emission from the power plant • Installation of stack emission monitoring equipment for major pollutants	DNPGL
	• Generation of noise from operation of turbines, engines, air inlet/outlet	• Provision of appropriate silencers forair inlets and exhaust stacks • Adopt of proper acoustic design of engine/ turbine rooms • Planting of trees around the project site • Regular plant maintenance • Regular noise monitoring, especially at the residential area located near the power plant • Use of ear-muffs and ear-plugs by plant personnel working in the generator and turbine facilities of the plant	
	• Crews engaged in the transportation of HFO in water vessels may encounter endangered species in Dhaleshwari river such as the Gangetic Dolphin	• If the crew in the vessels encounters the Gangetic Dolphin, they should reduce the speed of their vessels and wait for it to move away and disappear. No attempt should be made to approach the dolphin or catch it.	
Waste generation	• Inappropriate disposal of sewage causing environmental pollution • Generation of solid waste including sludge from demineralizer. • Generation of FGD gypsum • Possible water pollution from wastewater generated from cooling tower blowdown; wet FGD system discharges; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and	• Good housekeeping • Proper construction and maintenance of domestic wastewater disposal system for the plant premises (septic tank, sewage treatment plant etc.) • Ensuring proper storage, treatment, and disposal of all solid waste • Provision of a treatment plant designed to remove contaminants from plant-generated wastewater to applicable standards. • If the effluent wastestream is a slurry (e.g. FGD waste from scrubber) appropriate dewatering unit has to be constructed to separate/ thicken the solid fraction of the slurry from the liquid wastewater. • Monitoring of effluent quality from treatment plant (monitoring requirement and cost estimate provided) • Monitoring of river water quality (monitoring requirement and cost estimate provided)	DNPGL

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	sumps, laboratory wastes, and backflush from water purification units. • Indiscriminate disposal of used lubricating oils can cause environmental degradation	• Devise innovative ways to utilize FGD residual gypsum in a sustainable manner (e.g. cement industry, agriculture). If no such options can be availed, DNPGL should take necessary steps to convey the accumulated gypsum to the nearest sanitary landfill (in case the Aminbazar landfill operated by the Dhaka City Corporation) after verifying that the generated waste is not hazardous with respect to metal leaching characteristics. In this respect, DNPGL is to take necessary permissions to dispose the gypsum from DCC. If the generated waste has heavy metal leaching characteristics above the USEPA standard limit[1], DNPGL should dispose them in lined pits within their premises. • Used lubricating oil cannot be disposed with the liquid wastestream. The power plant must ensure that certified vendors are there to purchase the used lubricating oil from them.	
General Power Plant Operation	• Worker health and safety	• Provide the workers with personal protective equipment for protection against noise. • Contractors should comply with the relevant WBguidelines of health and safety for thermal power plants in addition to general occupational health and safety guidelines	DNPGL

An environmental monitoring plan has been suggested for both construction and operation phase of the project which delineates the parameters to be monitored, frequency of monitoring alongwith the assignment of responsibility. Monitoring during construction is mainly the responsibility of the Contractor with oversight from DPGL. Monitoring during the plant operation is mainly the responsibility of DNPGL.

E.7Implementation of ESMP

It is recommended that a qualified plant employee should be designated as the focal point who will have overall responsibility for plant's environmental management and monitoring. The focal pont should be supported with required manpower and expertise (i.e., a committee with designated members) to ensure proper environmental monitoring to take appropriate measures to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. This person through his

[1] USEPA."Land Disposal Restriction." 2012.http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol28/xml/CFR-2012-title40-vol28-sec268-40.xml

team will make sure that the Contractor undertake and implement appropriate measures as stipulated in the contract document, or as directed by him to ensure proper environmental management of the project activities. The plant management will hire environmental and social specialists as necessary to him in overseeing these activities. The activities will include preparation of quarterlyreports on Environmental Management activities in the plant.

The Plant Mananagement should set up a procedure to address complaints and grievances (e.g., receiving formal complaints/ grievances, arrange hearing involving all stakeholders and keeping records of such hearings, device and implement mitigation measures).The plant management authority (DNPGL) should be responsible for overall environmental management during operation phase of the project. An implementation schedule for environmental management and monitoring during the construction phase will be prepared by the Contractor as part of construction contract following recommended mitigation measures of potentially significant impacts

E.8Occupational Health and Safety

Working in this power plant involves a certain amount of occupational hazard both during construction and operation. These hazards have been identified and an occupational safety plan has been suggested. It is also emphasized that the Contractor adopts these measures by explicitly stating the plan in his Contract documents.

E.9Power Plant Risk Management

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation, the HFO-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 site-specific risk management plan be devised.

E.10 Grievance Redress Mechanism

A grievance redress mechanism has been proposed to mitigate any complaints from project affected people. DNPGL will be the first line recipient of any grievance. If any complaints cannot be resolved through direct communication with DNPGL, a grievance redress committee will be formed to resolve the issue within one month of receiving the complaint.

E.11 Disclosure

As per World Bank's policy on access to information, DNPGL will make the ESIA document available to the public by publishing it in their websites. In addition, hard copies of these documents in English (including an executive summary in Bengali and English) will be made available in publicly accessible locations in the project site as well as in the head office of DNPGL.

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

1. Dhaka Northern Power Generations Ltd (DNPGL)intends to install 3 units of ultra-efficient MAN 18V48/60 HFO Generator sets with combined capacity of 55MW at the grid at Singair, Manikganj.DNPGL has signed Project Agreements, comprising of Implementation Agreement (IA) and Power Purchase Agreement (PPA) for setting up the 55MW Heavy Fuel Oil Power Project on a Build operate and Own (BOO) basis. Total operation period of the project will be 15 years from the date of COD (Commercial Operation Date).

2. Such ventures by private companies have been encouraged in the Bangladesh Government's policy paper titled Power Sector Reforms in Bangladesh (PSRB) in 2001 which addresses the need to improve the performance of the power sector. PSRB outlined the reform process to gradually remove constraints in the sector through improvements in the sector and corporate governance, introduction of competition, and public private partnerships. The PSRB envisioned in the long term a structure of the power sector based on (i) separation of sector regulation and operation; (ii) autonomy and commercial orientation of the sector entities; (iii) separation of generation, transmission, and distribution; and (iv) increased private sector participation. As per the policy, transmission assets would remain in the public sector, while generation and distribution assets would have both public and private ownership. Such initiatives are also in line with the Bangladesh Government's Power Sector Master Plan (PSMP) 2010, which promotes a diversification of fuel sources for generation of power under the backdrop of diminishing yield of natural gas which has been the dominant fuel for electricity generation so far.

3. The government has declared its vision 2021 to provide access to reliable and affordable electricity for all. According to the PSMP 2010 the estimated demand for power would be 19,000 MW in 2021 and 34,000 MW in 2030. Currently Bangladesh's energy infrastructure is quite small, insufficient and poorly managed. The per capita energy consumption in Bangladesh is one of the lowest (321 kWH) in the world. Noncommercial energy sources, such as wood fuel, animal waste, and crop residues, still account for over half of the country's energy consumption. According to Ministry of Power, Energy & Mineral Resources, Bangladesh's installed electric generation capacity was 10289 MW in January, 2014; only three-fourth of which is considered to be 'available'. Bangladesh presently total electricity generation capacity is 5376 MW. Of this capacity 3331 MW is from public sector and 2045 MW is from the private sector,

which is 62% and 38% respectively of the total generation capacity. To accommodate the future energy scenario and the govt.'s vision 2021, the PSMP 2010 has been undertaken to encourage private and joint venture investment in the Power sector in addition to the government investment and promote diversification of fuel. Considering the fuel diversification issue, the PSMP 2010 aims to obtain the best mix of energy supply with emphasis on coal (50% of the proportion) but including other sources as well such as natural gas (25% of the proportion), liquid fuel (5%)and nuclear energy source(20%). The proposed project by DNPGL intends to use Heavy fuel oil as a source of energy and will install 55MW 3 units of ultra-efficient MAN 18V48/60 HFO Generator sets with combined capacity of 55MW at the grid at Singair, Manikganj, Dhaka.

4. As development activities are of prime importance for the economic growth and fulfillment of basic needs of the society, the environmental aspects of development activities must be taken into account and due attention must be paid to protect the environment. Resource consumption and emissions from power plants may have some impacts on the environment which needs to be assessed and evaluated properly. An Environmental & Social Impact Assessment (ESIA) is a very effective tool, which delineates what needs to be done to make a development activity suitably located and operate in an environment friendly way.

5. The proposed power plant falls under “red category” and require carrying out ESIA in accordance with the Environment Conservation Act 1995 and the Environment Conservation Rules 1997 (ECR, 1997). The DNPGL authority has conducted some limited environmental studies in the project area and submitted an Initial Environmental Examination (IEE) report to the Department of Environment (DoE) and obtained the Site Clearance Certificate (vide letter No.30.26.72.4.100.060513/admin/clearance/26; Date: 30.07.2013; see Annex A). The IEE report indicates that There are no particularly sensitive ecological, cultural and archeological targets. The plant installation would not relocate any human settlement, as the project is situated on purchased nonagricultural land. However, since this is a "red category project, a full-scale ESIA is necessary to obtain the final environmental clearance certificate from the DoE. Apart from that, the DNPGL seeks World Bank funds to finance the project through IPFF with Bangladesh Bank acting as a financial intermediary. Therefore, the environmental and social assessment of the proposed project should comply with the policies and legislative requirements of the World Bank.

6. The ESIA of the proposed power plant project presented in this report has been carried out considering the guidelines of the Department of Environment (DoE) of GoB(GoB, 1997) and the relevant safeguard policies and operational guidelines of the World Bank.

7. The overall environmental and social assessment including the overall project baseline, evaluation of potential environmental (and social) impacts of different project activities. In summary, the ESIA and the ESMF has been prepared based on:

(a) Assessment of environmental practices in the recently completed and ongoing projects of DNPGL;

(b) Evaluation of potential environmental and social impacts of different project activities to be implemented under the proposed project;

(c) Development of activity-specific standard mitigation measures (for negative impacts), enhancement measures (for positive impacts), and monitoring plan;

(d) Identification of institutional barriers and capacity needs for environmental and social management of DNPGL; and

(e) Development of institutional arrangement with assignment of responsibilities for environmental and social management and monitoring of sub-projects.

1.2 ESIA METHODOLOGY

8. To carry out environmental and social assessment of the proposed project, firstly a review of relevant literature on policy, legal and administrative framework focusing on environmental quality and discharge standards, health and safety issues, protection of sensitive areas and endangered species, land use controls, etc. were carried out. A baseline survey (including physical, ecological surveys) was conducted during November-December 2014covering areas in and around the project site (i.e., the study area), in order to update information on "baseline" environment. Informal discussions were held with people living and working in the surrounding areas. The purpose of the baseline survey was to document the existing conditions of physical and biological environment and prevailing socio-economic conditions of the project areas. During field visits, discussions were held with the DNPGL officials and engineers on different issues on recently completed/ongoing projects, and capacity and institutional arrangement for environmental management of the proposed project. Apart from physical and ecological survey, noise level measurements were taken in the study area.Surface water and groundwater samples were also collected (from water bodies/ tubewellslocated close to the project site) for assessment of water quality in project-surrounding areas. Information on climate, soil and topography for the project surrounding areas was collected from secondary sources. Ambient air quality data were obtained by direct measurements as well as secondary sources. Both primary data and secondary data sources were analyzed to identify historic and cultural resources and land use characteristics in the project surrounding areas. Focus Group Discussions (FGDs) were held at 2 project locations, which were participated by a wide range of stakeholders. The participants expressed their views on different aspects of the proposed project, including possible environmental and social impacts of the project and possible mitigation/ abatement measures. In addition, public consultations (in the form of informal discussion) were also carried out during field visits.

9. Major project activities, both during the construction and operational phases of the project were identified as well as their associated impacts on the surrounding physico-chemical environment. The impacts on noise and air environment were assessed quantitatively using the aid of commercially available prediction tools/ software. Identification of the most significant environmental and social impacts and suggestion of mitigation measures to reduce or eliminate negative impacts and to enhance positive impacts has been made. An Environmental Management Plan (EMP) for both the construction and operational phases of the project was prepared taking into account the above considerations. In addition to this, environmental and health risks associated with major accidents, natural disasters and external threats have been identified and recommendations of measures to reduce these risks have been outlined.

10. As a part of the environmental and social impact assessment (ESIA), discussions were held with DNPGL officials and engineers on different aspects of project implementation and management, particularly focusing on existing capacity and institutional arrangement for environmental management of the proposed project components.

1.3 REPORT STRUCTURE

11. This report presents the Environmental Assessment (EA) of the 55 MW HFO-based Power Plant to be constructed in Singair, Manikgonj with financial assistance from the World Bank. The EA report has been prepared and presented following the structure. It contains all the elements of an ESIA report as suggested by the Department of Environment (DoE, 1997), along with some additional elements to suit the requirements of the World Bank Safeguard policies.

12. Chapter 1 (Introduction) presents the background and motivation of the proposed power plant project including the methodology followed for conducting the ESIA. Chapter 2 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 also summarized applicable World Bank Safeguard policies relevant to the project. Chapter 3 (Project Description) presents 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, water management, waste and emission management, and operation and maintenance.. Chapter 4 (Baseline Environment) provides a description of the existing physical, ecological and socio-economic environment of the study area. The elements of the physical environment of the study area that have been described here include climate, topography and drainage, geology and soils, hydrology and water resources, air quality, noise level, and water quality. The ecological environment includes the terrestrial and aquatic ecosystem of the study area,

and the presence of rare and endangered species. The existing socio-economic condition 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 5 (Assessing Environmental Impacts) describes the potential environmental impacts of the proposed power plant project. For this purpose, the project activities has been divided into two phases - construction phase and operation phase - and the major environmental impacts of the project activities during each phase have been identified. This Chapter then provides an evaluation of these potential environmental impacts. Chapter 6 (Public Consultations) 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 7 (Environmental Management Plan) presents the environmental management and monitoring plan for the proposed project, both during construction and operation phases. This includes the mitigation measures to reduce or eliminate adverse impacts, along with measures to enhance positive impacts. 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. This chapter also discusses 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. Finally, Chapter 8 presents the conclusions and recommendations of this environmental assessment study.

CHAPTER 2

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

13. The proposed 55MW Power Plant project by DNPGL will be implemented in compliance with applicable environmental laws and regulations. Bangladesh has a wide range of laws and regulations related to environmental protection, natural resources conservation as well as social issues, which are mostly cross-sectoral and would be applicable to the proposed project. The World Bank also has certain social and environmental safeguard policies, which needs to be adhered to for the purpose of the implementation of this project. This Section presents an overview of the major national environmental and social laws, policies and regulations that are relevant and may apply to activities supported by the project and World Bank safeguard policies.

2.1 NATIONAL ENVIRONMENTAL POLICIES, LAWS AND REGULATIONS

Industrial Policy 1991

14. The Industrial Policy of 1991 sets 16 objectives towards achieving high industrial growth as well as protecting the environment. The policy describes "to take appropriate measures for preventing environmental pollution and maintaining ecological balance". One of the 32strategies of the policy relates to environment pollution control. It states that "effective measures will be taken for controlling environmental pollution and maintaining ecological balance".

National Environmental Policy 1992

15. The concept of environmental protection through national efforts was first recognized and declared in Bangladesh with the adoption of the Environment Policy, 1992 and the Environment Action Plan, 1992. The major objectives of Environmental policy are toi) maintain ecological balance and overall development through protection and improvement of the environment; ii) protect country against natural disaster; iii) identify and regulate activities, which pollute and degrade the environment; iv) ensure environmentally sound development in all sectors; v) ensure sustainable, long term and environmentally sound base of natural resources; and vi) actively remain associate with all international environmental initiatives to the maximum possible extent.

National Energy Policy 1995

16. The National Energy Policy (1995) addresses both energy conservation and environmental issues. The national Energy policy suggest utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy sources and ensure environmentally sound and sustainable energy development programs causing minimum damage to the

environment.TheEnvironment Policy and the Energy Policy have seven recommendations; three of theseare relevant to the proposed project:

- ●Environmental Impact Assessment should be made mandatory and should constitute anintegral part of any new energy development project.
- ●Use of economically viable environment friendly technology is to be promoted.
- ●Popular awareness to be promoted regarding environmental conservation.

Bangladesh Environmental Conservation Act (ECA), 1995 amended 2002

17. This umbrella Act includes laws for conservation of the environment, improvement of environmental standards, and control and mitigation of environmental pollution. It is currently the main legislative framework document relating to environmental protection in Bangladesh, which repealed the earlier Environment Pollution Control ordinance of 1977.

The main provisions of the Act can be summarized as:

- Declaration of ecologically critical areas, and restrictions on the operations and processes, which can be carried or cannot be initiated in the ecologically critical area;
- Regulation in respect of vehicles emitting smoke harmful for the environment.
- Environmental Clearance;
- Regulation of industries and other development activities with regards to discharge permits;
- Promulgation of standards for quality of air, water, noises and soils for different areas for different purposes;
- Promulgation of standard limits for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines;

18. The first sets of rules to implement the provisions of the Act were promulgated in 1997 (see below: "Environmental Conservation Rules 1997"). The Department of Environment (DoE) implements the Act. DoE is headed by a Director General (DG). The DG has complete control over the DoE and the main power of DG, as given in the Act, may be outlined as follows:

- Identification of different types and causes of environmental degradation and pollution;
- Instigating investigation and research regarding environmental conservation, development and pollution.
- Power to close down the activities considered harmful to human life or the environment.
- Power to declare an area affected by pollution as an Ecologically Critical Area. Under the Act, operators of industries/projects must inform the Director General of any pollution incident. In the event of an accidental pollution, the Director General may take control of an operation and the respective operator is bound to

help. The operator is responsible for the costs incurred and possible payments for compensation.

19. The Act was amended in 2006 (SRO No. 175-Act/2006 dated August 29, 2006) on collection and recycling of used/non-functional batteries for conservation of environment, improving environmental standard and control and prevention of environmental pollution. According to this amendment, no recycling of battery will be permitted without environmental clearance of DoE. This also restricted the improper disposal of used batteries or any parts of used battery in open place, water bodies, waste bins etc. All used batteries must be sent to the DoE approved battery recycling industry at earliest convenience. No financial transaction was allowed for used/non-functional batteries. However, the act was amended on same issue again in 2008 (SRO No. 29-Act/2008 dated February 11, 2008) to allow financial transaction on mutually agreed fixed cost.

Environment Conservation Rules (ECR) 1997 amended 2005

20. These are the first set of rules, promulgated under the Environment Conservation Act 1995. Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) requirement for and procedures to obtain Environmental Clearance, and (iii) requirements for IEE/EIA according to categories of industrial and other development interventions.

21. However, the rules provide the Director General a discretionary authority to grant '*Environmental Clearance*' to an applicant, exempting the requirement of site/location clearance, provided the DG considers it to be appropriate.

22. Presently, "EIA Guidelines for Industries" published by the Department of Environment and the "Environment Conservation Rules 1997"are the formal documents providing guidance for conducting Environmental Assessment. Any proponent planning to set up or operate an industrial project is required to obtain an "*Environmental Clearance Certificate*" from the Department of Environment (DoE), under the Environment Conservation Act 1995 amended in 2002.

23. The first step of obtaining *Environmental Clearance* for the project the proponent is to apply for it in prescribed form, together with a covering letter, to the Director/Deputy Director of respective DoE divisional offices. The application should include a project feasibility study report, the EIA report, *No Objection Certificate* (NOC) of the local authority; Mitigation Plan for minimizing potential environmental impacts; and appropriate amount of fees in 'treasury chalan' (in the present case the amount is BDT 50,000). The DoE authority reserves the right to request additional information, supporting documents, or other additional materials for the proposed project. Under the conditions specified in the Environment Conservation Rules-1997, the DoE

divisional authority must issue environmental site clearance certificates within 60 working days from the date of submitting the application, or the refusal letter with appropriate reasons for such refusal. The clearance issued remains valid for a one-year period and is required to be renewed 30 days prior to its expiry date.

24. Environment Conservation Rules-1997 ensures the right of any aggrieved party to appeal against the notice order or decision to the appellate authority. The appeal should be made to the appellate authority with clear justification and the attested copy of the specific notice, order, or decision of the respective DoE office against, which the appeal is to be made. Prescribed fee is to be paid through treasury Chalan of BDT 50,000 and the relevant papers for the appeal must be placed.

25. Rule 7 of Environment Conservation Rules (ECR) has classified the projects into following four categories based on their site conditions and the impacts on the environment; (a) Green, (b) Orange A, (c) Orange B and (d) Red. Various industries and projects falling under each category have been listed in schedule 1 of ECR 1997. According to the Rules, Environmental Clearance Certificate is issued to all existing and proposed industrial units and projects, falling in the Green Category without undergoing EIA. However, for category Orange A and B and for Red projects, require location clearance certificate and followed by issuing of Environmental Clearance upon the satisfactory submission of the required documents. Green listed industries are considered relatively pollution-free, and therefore do not require *site clearance* from the DoE. On the other hand, Red listed industries are those that can cause 'significant adverse' environmental impacts and are, therefore, required to submit an EIA report. These industrial projects may obtain an initial *Site Clearance* on the basis of an IEE based on the DoE's prescribed format, and subsequently submit an EIA report for obtaining *Environmental Clearance*. Figure 2.1 shows the process of application leading to environmental clearance for all four categories of projects.

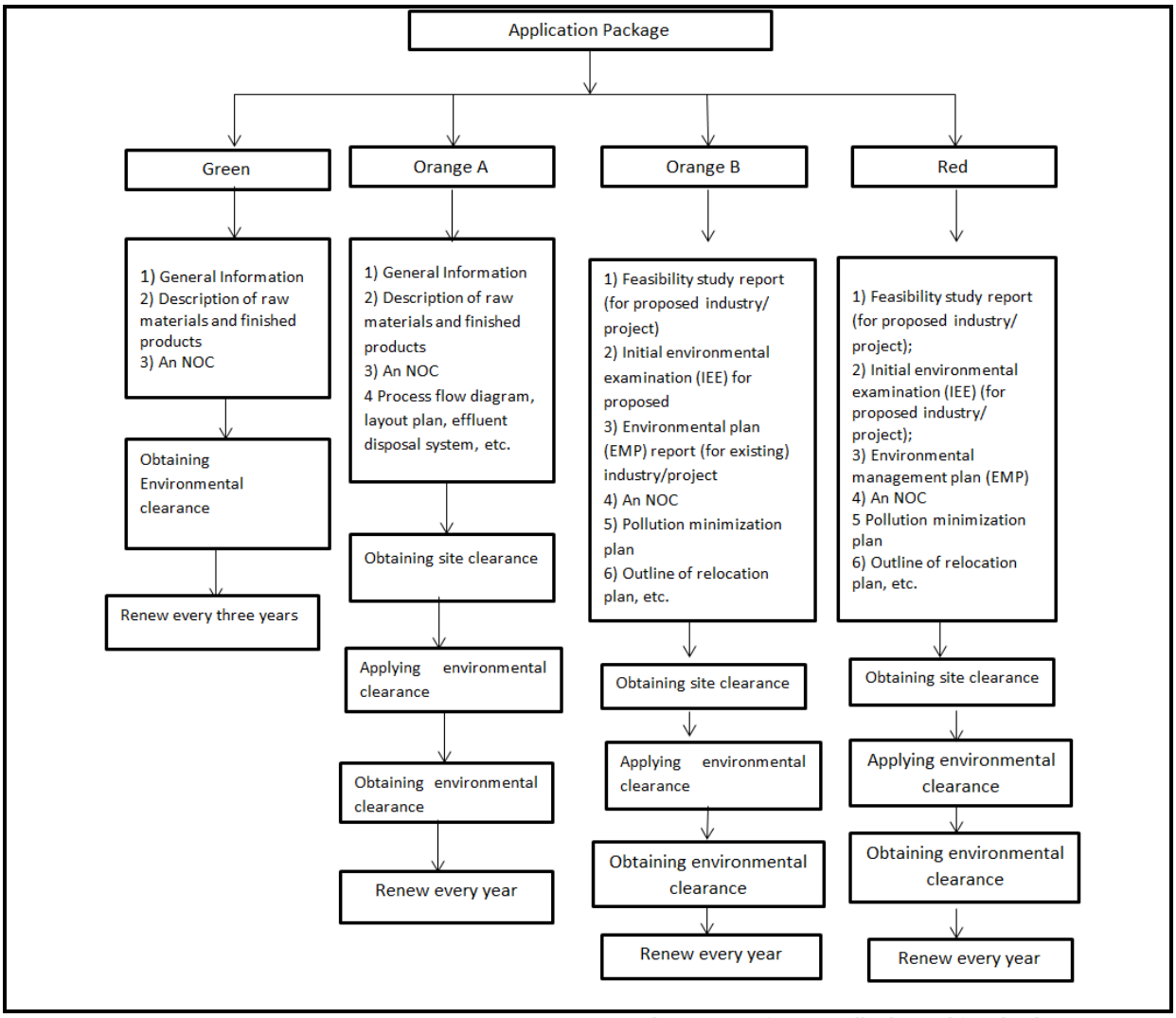
26. The ECR 1997 was amended in 2005 to incorporate new standards for ambient air quality and a variety of emissions.

National Land-use Policy, 2001

27. The Government of Bangladesh has adopted national Land use Policy, 2001. The salient features of the policy objectives relevant to the proposed are as follows:

- To prevent the current tendency of gradual and consistent decrease of cultivable land for the production of food to meet the demand of expanding population;
- To ensure that land use is in harmony with natural environment;
- To use land resources in the best possible way and to play supplementary role in controlling the consistent increase in the number of land less people towards the elimination of poverty and the increase of employment;
- To protect natural forest areas, prevent river erosion and destruction of hills;
- To prevent land pollution; and

- To ensure the minimal use of land for construction of both government and nongovernment buildings.



NOC=No Objection Certificate, usually obtained from local government.

Figure 2.1: Process of application for environmental clearance in Bangladesh (Source: ECR 1997)

Environment Court Act, 2000

28. The aim and objective of the Act is to materialize the Environmental Conservation Act, 1995 through judicial activities. This Act established Environmental Courts (one or more in every division), set the jurisdiction of the courts, and outlined the procedure of activities and power of the courts, right of entry for judicial inspection and for appeal as well as the constitution of Appeal Court.

Bangladesh Labor Act, 2006

29. This Act pertains to the occupational rights and safety of factory workers and the provision of a comfortable work environment and reasonable working conditions. In the Chapter VI of this law safety precaution regarding explosive or inflammable dust/

gas, protection of eyes, protection against fire, works with cranes and other lifting machinery, lifting of excessive weights are described. And in Chapter VIII, provision of safety measures like appliances of first aid, maintenance of safety record book, rooms for children, housing facilities, medical care, group insurance etc. are illustrated.

Public Procurement Rule (PPR), 2008

30. The rule includes the adequate measure regarding the "Safety, Security and Protection of the Environment' in the construction works. This clause includes mainly, the contractor shall take all reasonable steps to (i) safeguard the health and safety of all workers working on the Site and other persons entitled to be on it, and to keep the Site in an orderly state and (ii) protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of the Contractors methods of operation.

Bangladesh National Building Code

31. The basic purpose of this code is to establish minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of all buildings within Bangladesh in order to safeguard, within achievable limits, life, limb, health, property and public welfare. The installation and use of certain equipment, services and appurtenances related, connected or attached to such buildings are also regulated herein to achieve the same purpose.

32. Part-7, Chapter-3 of the Code has clarified the issue of safety of workmen during construction and with relation to this, set out the details about the different safety tools of specified standard. In relation with the health hazards of the workers during construction, this chapter describes the nature of the different health hazards that normally occur in the site during construction and at the same time specifies the specific measures to be taken to prevent such health hazards. According to this chapter, exhaust ventilation, use of protective devices, medical checkups etc. are the measures to be taken by the particular employer to ensure a healthy workplace for the workers.

33. Section 1.4.1 of chapter-1, part-7 of the BNBC, states the general duties of the employer to the public as well as workers. According to this section, "All equipment and safeguards required for the construction work such as temporary stair, ladder, ramp, scaffold, hoist, run way, barricade, chute, lift etc. shall be substantially constructed and erected so as not to create any unsafe situation for the workmen using them or the workmen and general public passing under, on or near them".

34. Part-7, Chapter -1 of the Bangladesh National Building Code (BNBC) clearly sets out the constructional responsibilities according to which the relevant authority of a particular construction site shall adopt some precautionary measures to ensure the safety of the workmen. According to section 1.2.1 of chapter 1 of part 7, "in a

construction or demolition work, the terms of contract between the owner and the contractor and between a consultant and the owner shall be clearly defined and put in writing. These however will not absolve the owner from any of his responsibilities under the various provisions of this Code and other applicable regulations and bye-laws. The terms of contract between the owner and the contractor will determine the responsibilities and liabilities of either party in the concerned matters, within the provisions of the relevant Acts and Codes (e.g.) the Employers' Liability Act, 1938, the Factories Act 1965, the Fatal Accident Act, 1955 and Workmen's Compensation Act 1923". (After the introduction of the Bangladesh Labor Act, 2006, these Acts have been repealed).

35. To prevent workers falling from heights, the Code in section 3.7.1 to 3.7.6 of chapter 3 of part 7 sets out the detailed requirements on the formation and use of scaffolding.

Constitution of Bangladesh

36. Article 24 of the constitution of Bangladesh says that the state shall adopt measures for the protection against disfigurement, damage or removal of all monuments, objects or places of special artistic or historic importance or interest.

Antiquities Act, 1968

37. This Act provides the modes of protection and preservation of things which are part of our national history and heritage. Article 24 states that if the Government is of the opinion that for the purpose of protecting or preserving any immovable antiquity it is necessary so to do, it may, by notification in the official Gazette, prohibit or restrict, within such area as may be specified therein, mining, quarrying, excavating, blasting and other operations of a like nature, or the movement of heavy vehicles, except under and in accordance with the terms of a license granted and rules, if any, made in this behalf.

Water Act, 2013

38. The Water Act 2013 has been promulgated with an aim to preserve and protect water resources as well as to exert control on water use in Bangladesh. Through different provisions under this Act, restrictions have been imposed in attempting to alter the natural flow in water by landfilling and other activities. The other issues that are addressed in this Act involve protection of potable water sources and management, provision for declaration of water stress areas, provision for declaration of flood control zone and its management, restrictions on storing natural water in artificial or natural reservoirs, restriction on abstraction of total water from any water source, water pollution control etc. Any violation of compliance or protection order will result in an offence, which would be punishable in various degrees including fines, compensation and imprisonment.

2.2 NATIONAL SOCIAL POLICIES, LAWS AND REGULATIONS

39. There is no national policy in Bangladesh governing social effects of infrastructure development projects on the project area communities. However, the Constitution of Bangladesh provides some rights to the affected persons, communities and groups those are not upheld in the Ordinance II of 1982, which is the instrument, followed for land acquisition. The active instruments under the legislative and regulatory framework in Bangladesh are discussed below:

Constitution of Bangladesh

40. The fundamental rights under the Constitution indicate the general guidelines for a policy on resettlement/rehabilitation of citizens adversely affected (whatever be the mechanism) due to any activity of the State. Article 40 of the constitution states categorically that every citizen has the right to practice any lawful occupation which implies that anything impeding such right (a) should not be done or (b) there should be supplementary measures to make good the losses incurred by the citizen. Resettlement and rehabilitation of adversely affected people due to infrastructure projects very clearly falls within this requirement for supplementary measures. However, as per Article 42, sub-clause 2, no law with provision of compensation for acquisition of land can be challenged in a court on the ground that such compensation has been inadequate.

The Acquisition and Requisition of Immovable Property Ordinance, 1982

41. The principal legal instrument governing land acquisition in Bangladesh is the Acquisition and Requisition of Immovable Property Ordinance, 1982 (Ordinance II of 1982 with amendments up to 1994) and other land laws and administrative manuals relevant to land administration in Bangladesh. According to the Ordinance, whenever it appears to the Government of Bangladesh that any property in any locality is needed or is likely to be needed for any public purpose or in the public interest, the Government can acquire the land provided that no property used by the public for the purpose of religious worship, graveyard and cremation ground. The 1982 Ordinance requires that compensation be paid for (i) land and assets permanently acquired (including standing crops, trees, houses); and (ii) any other damages caused by such acquisition. The Deputy Commissioner (DC) determines (a) market value of acquired assets on the date of notice of acquisition (based on the registered value of similar property bought and/or sold in the area over the preceding 12 months), and (b) 50% premium on the assessed value (other than crops) due to compulsory acquisition. The 1994 amendment made provisions for payment of crop compensation to tenant cultivators. The law specifies methods for calculation of market value of property based on recorded prices obtained from relevant Government departments such as Registrar (land), Public Works Department (structures), Department of Forest (trees), Department of Agriculture (crops) and Department of Fisheries (fish stock). Given that people devalue land during

title transfer to minimize tax payment, compensation for land paid by DC including premium largely remains less than the actual market price.

42. The Ministry of Land (MoL) is authorized to deal with land acquisition. The MoL delegates some of its authority to the Commissioner at Divisional level and to the Deputy Commissioner at the District level. The Deputy Commissioners (DCs) are empowered by the MOL to process land acquisition under the Ordinance and pay compensation to the legal owners of the acquired property. Khas (government owned land) lands should be acquired first when a project requires both khas and private land. If a project requires only khas land, the land will be transferred through an inter-ministerial meeting following the acquisition proposal submitted to DC or MoL as the case may be. The DC is empowered to acquire a maximum of 50 standard bigha (6.75 ha) of land without any litigation where the Divisional Commissioner is involved for approval. Acquisition of land more than 50 standard bigha is approved from the central land allocation committee (CLAC) headed by the chief executive of the Government of Bangladesh proposed by the MOL.

43. The landowner needs to establish ownership by producing record-of-rights in order to be eligible for compensation under the law. The record of rights prepared under Section 143 or 144 of the State Acquisition and Tenancy Act 1950 (revised 1994) are not always updated and as a result legal land owners have faced difficulties trying to "prove" ownership. The affected person (AP) has also to produce rent receipt or receipt of land development tax, but this does not assist in some situations as a person is exempted from payment of rent if the area of land is less than 25 bighas (3.37 ha).

2.3 INSTITUTIONAL ARRANGEMENTS AT NATIONAL AND SUB-NATIONAL LEVELS

44. As outlined in the National Environment Policy (1992) and National Forest Policy (1994), the Ministry of Environment and Forests (MoEF) acts as the guide and custodian for the conservation and development of the environment and, in the pursuit of that goal, to ensure through appropriate laws and regulations that natural resources, including land, air, water and forests, are exploited and managed in an environmentally sustainable manner. The Department of Environment (DoE), formed in 1989 with a mandate for environmental management later formalized under the Environment Conservation Act, 1995 (ECA'95), acts as the technical arm of the Ministry and is responsible for environmental planning, management, monitoring and enforcement. A Director General heads the DoE, with Divisional offices in Dhaka, Chittagong, Bogra, Khulna, Barisal and Sylhet. The Environment Conservation Rules (1997) provide the Director General a discretionary authority to grant 'Environmental Clearance' to an applicant, exempting the requirement of site/location clearance, provided the DG considers it to be appropriate.

45. The mandate of the Department has expanded over time, evolving from an exclusive focus on pollution control to include natural resources and environmental management, now covering:

- monitoring environmental quality;
- promoting environmental awareness through public information programs;
- controlling and monitoring industrial pollution;
- reviewing environmental impact assessments and managing the environmental clearance process; and,
- establishing regulations and guidelines for activities affecting the environment

46. Thus, the GoB has well-defined legal/regulatory systems for safeguarding environment issues through the Ministry of Environment and Forest in the policy level and the Department of Environment in the implementation level. Although the environmental legal framework is relatively modern and is in an advanced state in connection with the environmental assessment, the main limitations are in the capabilities of the regulatory agencies to enforce and promulgate these legal tools. The existing resources (manpower, technical tools etc.) of regulatory agencies are deemed largely inadequate to monitor compliance with existing rules.

47. The environmental management system in Bangladesh constitutes an extremely centralized and partially de-concentrated model of environmental management. At the divisional level, there is a Divisional Environmental Advisory Committee headed by the Divisional Commissioner with representation from various government agencies. The DoE does not have any representation below this level. An important gap in existing formal rules (the Constitution and other laws) is that the divisions, districts, upazilas, unions do not have a clearly defined role to play in environmental management. Lack of an appropriate mandate and institutional arrangements below the divisional level is a key factor contributing to difficulties in implementing environmental policies and regulations.

2.4 NATIONAL POLICIES AND LAWS RELATED TO POWER GENERATION

Bangladesh Energy Regulatory Commission Act, 2003 (Amended 2005, 2010)

48. In order to create an atmosphere conducive to private investment in the generation of electricity and transmission, transportation and marketing of gas resources and petroleum products, to ensure transparency in the management, operation and tariff determination in these sectors and to protect consumers' interest and to promote the creation of a competitive market an independent and impartial regulatory commission was established through this act. The functions of the commission pertinent to electricity generation are as follows:-

(a) to determine efficiency and standard of the machinery and appliances of the institutions using energy;

(b) to ensure efficient use, quality services, determine tariff and safety enhancement of electricity generation
(c) to issue, cancel, amend and determine conditions of licenses, exemption of licenses and to determine the conditions to be followed by such exempted persons;
(d) to approve schemes on the basis of overall program of the licensee and to take decision in this regard taking into consideration the load forecast and financial status;
(e) to collect, review, maintain and publish statistics of energy;
(f) to frame codes and standards and make enforcement of those compulsory with a view to ensuring quality of service;
(g) to develop uniform methods of accounting for all licensees;
(h) to encourage to create a congenial atmosphere to promote competition amongst the licensees;
(i) to extend co-operation and advice to the Government, if necessary, regarding electricity generation
(j) to resolve disputes between the licensees, and between licensees and consumers, and refer those to arbitration if considered necessary;
(k) to ensure appropriate remedy for consumer disputes, dishonest business practices or monopoly;
(l) to ensure control of environmental standard of energy under existing laws; and
(m) to perform any incidental functions if considered appropriate by the Commission for the fulfillment of the objectives of this Act for electricity generation, quality of services, tariff fixation and safety improvement.

Power System Master Plan, 2010

49. A Master Plan for the attainment of stable power supply in the People's Republic of Bangladesh up to year 2030 has been developed in consideration of the diversification of fuel resources, including an optimum power development plan, power system plan, and identification of the potential power plant sites based on the fuel diversification study. The power sector was heavily dependent on gas. Even two/three years back almost 90% of the electricity used to be generated from the natural gas of the country and rest by hydroelectricity and coal. The power sector master plan 2010 has stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel etc as well as renewable energy sources. In this Master Plan, the target composition of power supply as of 2030 is set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas and 25% for other sources such as oil, nuclear power and renewable energy.

Electricity (Amendment) Act, 2012

50. This act lays out the responsibilities of the utilities entrusted to generate electricity (for capacities not below 25 MW). As per this act, the duties of a generating utility shall be to establish, operate and maintain generating stations, tie-lines or inter-connection lines, and associated sub-stations, to supply electricity to any licensee in accordance with the provisions of this Act or the rules or regulations made under the

act, submit technical details regarding its generating stations to the Commission, co-ordinate with the Transmission Utility, for transmission of the electricity generated by it; and liaise with the ISO for dispatch of electricity generated by each of its generating stations. It shall also be the duty of every generation utility to develop a time bound plan to diversify its fuel source and to ensure that the electric energy it sells to consumers is generated using a diverse range of fuels and technologies, including renewable technologies under a pre-determined principle of least-cost generation.

Private Sector Power Generation Policy of Bangladesh 1996 (Revised 2004)

51. The Recognizing that the likelihood of securing the substantially high volume of investment for power generation requirements for future alone through the public sector is remote and that there are competing demands on government resources and declining levels of external assistance from multilateral/bilateral donor agencies for public investment in the power sector, GoB amended its industrial policy to enable private investment in the power sector and to promote private sector participation in the generation of electricity in order to attain higher economic efficiency. In this policy, the Government has expressed its commitment to attract private investment for installing new power generation capacity on a build-own-operate (BOO) basis. The modalities of implementation, tariff for bulk purchase of power, financial incentives for the private sector and foreign investors are laid out in this policy. The Power Cell has a mandate to lead private power development, recommend power sector reforms & restructuring, conduct study on tariffs and formulation of a regulatory framework for the power sector. The Power Cell shall facilitate all stages of promotion, development, implementation, commissioning and operations of private power generation projects and suitably address the concerns of project sponsors. It will also assist project sponsors to secure necessary consents and permits from GoB where such consents and permits would be needed.

Policy Guideline for Small Power Plant (SPP) in private sector, 1998 (revised 2008)

52. This document outlines the guidelines for private sector investors to establish Small Power Plants (SPP) on a fast track basis, for generation of electricity for own use and sell the surplus to other users. The plant size could be in the order of 10 MW, which could be built up in stages as necessary, and depending on the potential market and load growth. However, if required, permission may be accorded by the government for setting up higher size plant. The SPPs will be developed on a Build- Own-Operate basis. The summary of the guidelines is as follows:

- The type of plant is open and the sponsor will be allowed to select plant of any configuration provided the electrical characteristics of the plant match that of the power system in Bangladesh.
- Where available, a subsidiary of Petrobangla may supply natural gas to the sponsor on a commercial basis at a price determined by the Energy Regulatory Commission. Alternatively, the sponsor may arrange his own fuel.

- It will be the responsibility of the sponsor to find customers for electricity. The distribution system required for the supply of electricity to the contracted customers may be built by the sponsors themselves or they can use the existing transmission and distribution systems, if there is adequate capacity.
- In areas covered by BPDB/DESA/REB, the tariff announced by GoB from time to time shall apply.
- As per Electricity Act, 1910, the Sponsors will be required to obtain license from the GoB. The SPP will need to comply with all laws of Bangladesh including Environmental Standards.
- GoB support will be provided on "First Come First Serve" basis. Necessary advice and other assistance will be provided by the Power Cell for the establishment of SPPs.
- The sponsors under this policy including the Captive Independent Power Producer and the sponsors of Captive Power Generation who will set up power plants within a period of three years from the date of its statutory notification under this policy will enjoy the "Fiscal Incentives" and "Other Facilities and Incentives for Foreign Investors" provided under Section 5.0 and 6.0 respectively of the "Private Sector Power Generation Policy of Bangladesh"

2.5 WORLD BANK ENVIRONMENTAL AND SOCIAL SAFEGUARD POLICIES

53. The objective of these policies is to prevent and mitigate undue harm to people and their environment in the development process. Safeguard policies provide a platform for the participation of stakeholders in project design, and act as an important instrument for building ownership among local populations. The effectiveness and development impact of projects and programs supported by the Bank has substantially increased as a result of attention to these policies. The World Bank has ten environmental, social, and legal safeguard policies which are listed in the following:

Environmental policies:

OP/BP 4.01 Environmental Assessment
OP/BP 4.04 Natural Habitats
OP/BP 4.09 Pest Management
OP/BP 4.11 Physical Cultural Resources
OP/BP 4.36 Forests
OP/BP 4.37 Safety of Dams

Social Policies

OP/BP 4.10 Indigenous Peoples
OP/BP 4.12 Involuntary Resettlement

Legal Policies

OP/BP 7.50 International Waterways
OP/BP 7.60 Disputed Areas

54. Operational Policies (OP) are the statement of policy objectives and operational principles including the roles and obligations of the Borrower and the Bank, whereas Bank Procedures (BP) is the mandatory procedures to be followed by the Borrower and the Bank. Apart from these, the World Bank Groupguidelines for Environmental Health and safety have been adopted by the World Bank which is also relevant for environmental protection and monitoring. In addition to that the Policy on Access to Information of World Bank also relates to environmental safeguard. The environmental relevant safeguard policies, access to information policy as well as the World Bank Groupguidelines are discussed below:

OP/BP 4.01 Environmental Assessment

55. This policy is considered to be the umbrella safeguard policy to identify, avoid, and mitigate the potential negative environmental and social impacts associated with Bank lending operations. In World Bank operations, the purpose of Environmental Assessment is to improve decision making, to ensure that project options under consideration are sound and sustainable, and that potentially affected people have been properly consulted. The borrower is responsible for carrying out the EA and the Bank advises the borrower on the Bank's EA requirements. The Bank classifies the proposed project into three major categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts:

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

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

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

OP/BP 4.04 Natural Habitats

56. The conservation of natural habitats is essential for long-term sustainable development. The Bank therefore supports the protection, maintenance, and rehabilitation of natural habitats and their functions in its economic and sector work, project financing, and policy dialogue. The Bank supports, and expects borrowers to apply, a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. The Bank does not support projects that involve the significant conversion or degradation of critical natural habitats.

OP/BP 4.11 Physical Cultural Resources

57. Physical cultural resources are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Their cultural interest may be at the local, provincial or national level, or within the international community. The Bank assists countries to avoid or mitigate adverse impacts on physical cultural resources from development projects that it finances. The impacts on physical cultural resources resulting from project activities, including mitigating measures, may not contravene either the borrower's national legislation, or its obligations under relevant international environmental treaties and agreements. The borrower addresses impacts on physical cultural resources in projects proposed for Bank financing, as an integral part of the environmental assessment (EA) process.

OP/BP 4.36 Forests

58. Forest is defined as an area of land of not less than 1.0 hectare with tree crown cover (or equivalent stocking level) of more than 10 percent that have trees with the potential to reach a minimum height of 2 meters at maturity in situ. A forest may consist of either closed forest formations, where trees of various stories and undergrowth cover a high proportion of the ground, or open forest. The definition includes forests dedicated to forest production, protection, multiple uses, or conservation, whether formally recognized or not. The definition excludes areas where other land uses not dependent on tree cover predominate, such as agriculture, grazing or settlements. In countries with low forest cover, the definition may be expanded to include areas covered by trees that fall below the 10 percent threshold for canopy density, but are considered forest under local conditions. The Bank's forests policy recognizes the importance of forests to reduce poverty in a sustainable manner integrates forests effectively in economic development, aims to reduce deforestation, promote afforestation and enhance the environmental contribution of forested areas. The Bank assists borrowers with the establishment and sustainable management of environmentally appropriate, socially beneficial, and economically viable forest plantations to help meet growing demands for forest goods and services.

OP/BP 4.12 Involuntary Resettlement

59. This policy is triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimize and mitigate its adverse social and economic impacts. It promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement. The policy prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers

prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.

OP 4.10 Indigenous People

60. The term "Indigenous Peoples" is used in a generic sense to refer to a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:

- self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and
- an indigenous language, often different from official language of the country/ region.

61. The Bank provides project financing only where free, prior, and informed consultation results in broad community support to the project by the affected Indigenous Peoples. Such Bank-financed projects include measures to (a) avoid potentially adverse effects on the Indigenous Peoples' communities; or (b) when avoidance is not feasible, minimize, mitigate, or compensate for such effects. Bank-financed projects are also designed to ensure that the Indigenous Peoples receive social and economic benefits that are culturally appropriate and gender and inter-generationally inclusive.

World Bank Group Environmental, Health and Safety General Guidelines

62. The Environmental, Health and Safety (EHS) Guidelines of the World Bank Group (WBG), 2008 is the safeguard guidelines for environment, health and safety for the development of the industrial and other projects. They contain performance levels and measures that are considered to be achievable in new facilities at reasonable costs using existing technologies. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment.

World Bank Group Environmental, Health and Safety Guidelines for Thermal Power Plants

63. This document on thermal power plants includes information relevant to combustion processes fueled by gaseous, liquid and solid fossil fuels and biomass and designed to deliver electrical or mechanical power, steam, heat, or any combination of

these, regardless of the fuel type, with a total rated heat input capacity above 50 Megawatt thermal input (MWth) on Higher Heating Value (HHV) basis. It applies to boilers, reciprocating engines, and combustion turbines in new and existing facilities.

World Bank Policy on Access to Information

64. In addition to the safeguard policies, the Access to Information Policy also relates to safeguards. To promote transparency and facilitate accountability, Bank Access to Information Policy supports decision making by the Borrower and Bank by allowing the public access to information on environmental and social aspects of projects in an accessible place and understandable form and language to key stakeholders. The Bank ensures that relevant project-related environmental and social safeguard documents, including the procedures prepared for projects involving subprojects, are disclosed in a timely manner before project appraisal formally begins. The policy requires disclosure in both English and Local language and must meet the World Bank standards.

2.6 IMPLICATIONS OF NATIONAL POLICIES AND REGULATIONS ON THE PROPOSED PROJECT

65. The Environmental Conservation Rules (ECR) 1997 (DoE, 1997) classifies projects into four categories according to potential environmental impacts: (1) Green; (2) Orange A; (3) Orange B; and (4) Red. Green category projects are those with mostly positive environmental impacts or negligible negative impacts; Orange A category projects are those with minor and mostly temporary environmental impacts for which there are standard mitigation measures; Orange B category project are those with moderately significant environmental impacts; while Red category projects are those with significant adverse environmental impacts. The environmental classifications for industrial projects in Bangladesh are based on "inclusion lists" given in the ECR97. Power Plant is listed in the '**Red Category**' in ECR97 (i.e., serial no.6 in the ECR97 Red list in Schedule-1.). Therefore a full-scale ESIA would be necessary to obtain environmental clearance for the proposed power plant by DNPGL from the DoE.

66. The BNBC, PPR 2008, Bangladesh Labor Act 2006 outlines guidelines for ensuring worker's health and safety during construction works which would have direct implications in the proposed project. It would be the responsibilities of the contractors to make sure that these guidelines are followed in the workplace environment.

2.7 IMPLICATIONS OF WORLD BANK SAFEGUARD POLICIES ON THE PROPOSED PROJECT

67. As mentioned earlier, The World Bank Operational Policy (OP) 4.01 classifies projects into three major categories (category A, B and C), depending on the type, location, sensitivity and scale of the project, and nature and magnitude of potential

impacts. The proposed 55MW HFO-based power plant by DNPGL will be a category B project according to World Bank classification.

68. Environmental issues during the construction phase of the power plant may include impacts on terrestrial and aquatic habitat. Therefore the World Bank policy related to conservation of Natural Habitats (OP/BP 4.04) will be triggered. The possible impact on natural habitats will be addressed through the ESMP.

69. The proposed project site does not encompass areas of physical cultural resources. Hence, the OP 4.11 (Physical Cultural Resources) will not be immediately relevant to this component of the project. However, during excavation activities, there is a possibility of triggering OP 4.11 if any substance of cultural or archaeological importance is found. The activities of the project will not involve any pesticide application, do not affect forest areas or relate to protection of dams. Hence OP 4.09, 4.36 and OP 4.37 will not be relevant as well. The project will not intrude in areas of indigenous people and hence the OP 4.10 will not be relevant to this component of the project. Furthermore the project will not require any involuntary resettlement since the required land was purchased on a willing buyer willing seller basis. The undertaking of willing buyer-willling seller along with land purchase deeds are attached as Annex-J Hence, OP 4.12 will not be triggered for this sub-project. Hence, OP 4.12 will not be triggered for this sub-project.

70. The project components do not involve any infrastructure development in international waterways or in disputed areas. Therefore the World Bank safeguard policies OP/BP 7.50 and OP/BP 7.60 will not be triggered.

71. The WBGguidelines (both general and for thermal power plants) provide guidance on certain EHS issues, which include standards for environmental parameters (ambient air quality, water and wastewater quality, noise level, waste management), hazard and accident prevention, occupational and community health and safety (during commissioning and decommissioning works) etc. These guidelines will be directly applicable to the proposed project. As a general rule, the WBGguidelines should complement the existing Bangladesh guidelines or standards. In case the Bangladesh guidelines or standards differ from the WBGguidelines, project is expected to follow the more stringent ones.

72. The World Bank access to information policy would be directly followed. The project will make the ESIA document available to the public by publishing it in their websites. In addition, hard copies of these documents in English (including an executive summary in Bengali and English) will be made available in publicly accessible locations in the project site as well as in the head office of DNPGL. Any public notices (or any other means of communication) posted ahead of the construction work at a certain

location should also contain the information as to where the ESIA documents would be available.

CHAPTER 3

PROJECT DESCRIPTION

3.1 INTRODUCTION

73. The Dhaka Northern Power Generations Ltd. (DNPGL) has made a Power Purchase Agreement with its buyer, Bangladesh Power Development Board (BPDB) and is going to install a 55 MW Heavy Fuel Oil (HFO) based power generation plant. The power plant is designed for continuous base load operation. The Plant efficiency will be 90% and it will run round the year according to the electricity demand expect the scheduled maintenance outage time. Electrical power will be generated by 3 units of MAN 18V 48/60 TS engine with each engine having a capacity of 19.3 MW. The engines are capable of running at rated output continuously. For other conditions the power will be adjusted. The plant will not involve any relocation of human settlement, as the project is situated on the purchased vacant land previously owned by private individuals.

74. There are no particularly sensitive ecological, cultural and archeological sites in the area. The area enjoys necessary infrastructure facilities, which include transport, electricity, telecommunication etc. For all construction activities for the plant, the provisions of Bangladesh National Building Code (BNBC) will be followed that include structural designs and seismicity tolerance. All the relevant social and environmental risks and potential impacts will be taken due care of as part of the assessment in compliance of the Performance Standards set by the World Bank besides following the guidelines set forth by DoE.

75. The basic data of the Dhaka Northern Power Generations Limited are furnished in Table3.1

Table3.1: Basic data on Dhaka Northern Power Generations Limited

Particulars	Basic Project Data
1. Name of the Project	Manikgonj 55 MW Power Plant
2. Project Proponent	TahzeibAlam Siddique
3. Project Location	Fordnagar Mouza, Vill- Dholla, Singair, Manikganj.
4. Corporate Office	House # 426, Flat #D, Road # 30, New DOHS, Mohakhali, Dhaka-1206
5. Main Sponsor	Doreen Power Generations and Systems Ltd. Rupali Engineers and Traders Ltd.

Particulars	Basic Project Data
6. Type of Business	Power Generation
7. Raw Materials	The main raw material of the project is HFO (Furnace Oil)
8. By-product, if any	None
9. Net Plant Capacity	55 MW
10. Project Cost	BDT 3516.11 Million
11. Total Area of Land	3.7 Acres
12. Total Covered Area	3.7 Acres
13. Employment	Administration -15, Production - 47 and Environmental Management - 3 Total 65 Persons
14. Fuel Requirement	Heavy Fuel Oil (furnace oil), 68808960 liter/year, Imported

3.2 SITE DESCRIPTION

3.2.1 Location of the Project

76. The proposed power plant will be set up at Singair, Manikganj, Bangladesh. The project site is at FordnagarMouza, Dholla Village, Manikgonj. The proposed project would be set up on the land purchased from local landowner by DNPGL. The landowner sold their land at market price and before purchasing, the land was vacant with no settlement or temporary squatters. Therefore there is no issue of resettlement.

77. The project area situated at the northern site of Dhaka-Manikganj highway. The river Dhaleshwari is situated on the east site of the proposed project. The "ShahidRafiq" bridge above the river Dhaleshwari is situated on the south east side of the proposed project. The bridge has eased the transportation system and connected Dhaka to Manikganj perfectly. All infrastructure facilities like electricity, labor, telecommunication, etc. are available at the project site. The location is well communicated by both road and river ways. The site covers an area of 3.7 acres of land. The Manikganj District map, the SingairUpazila map, a satellite map of the projectareaand a schematic location map are presented in Figures3.1, 3.2 and 3.3. A tentative layout of the proposed plant is shown in Figure 3.4.

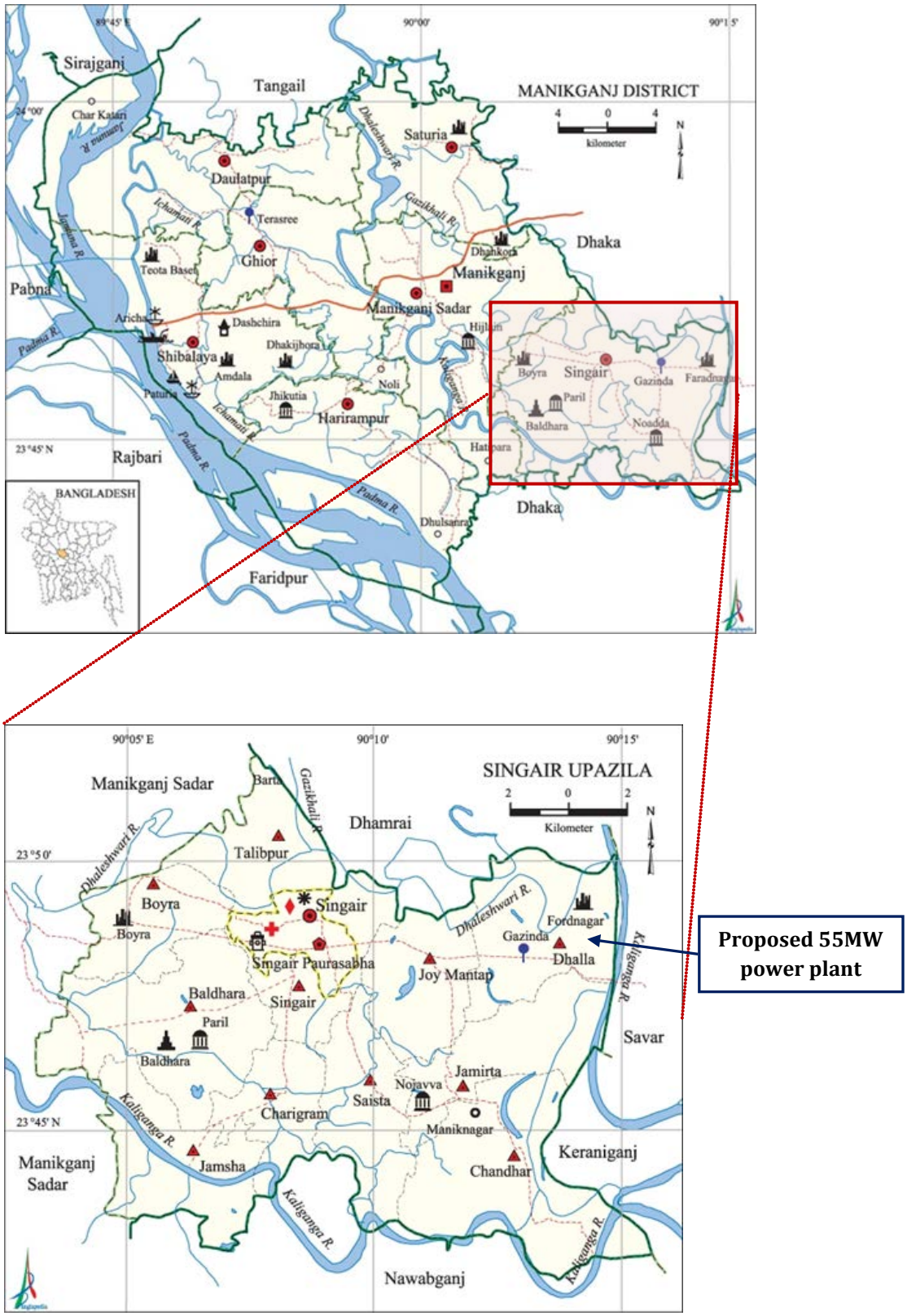


Fig: 3.1: Location of the proposed 55MW power plant of Dhaka Northern Power Generations Limited in Singair, Manikganj (Map source: www.banglapedia.org)

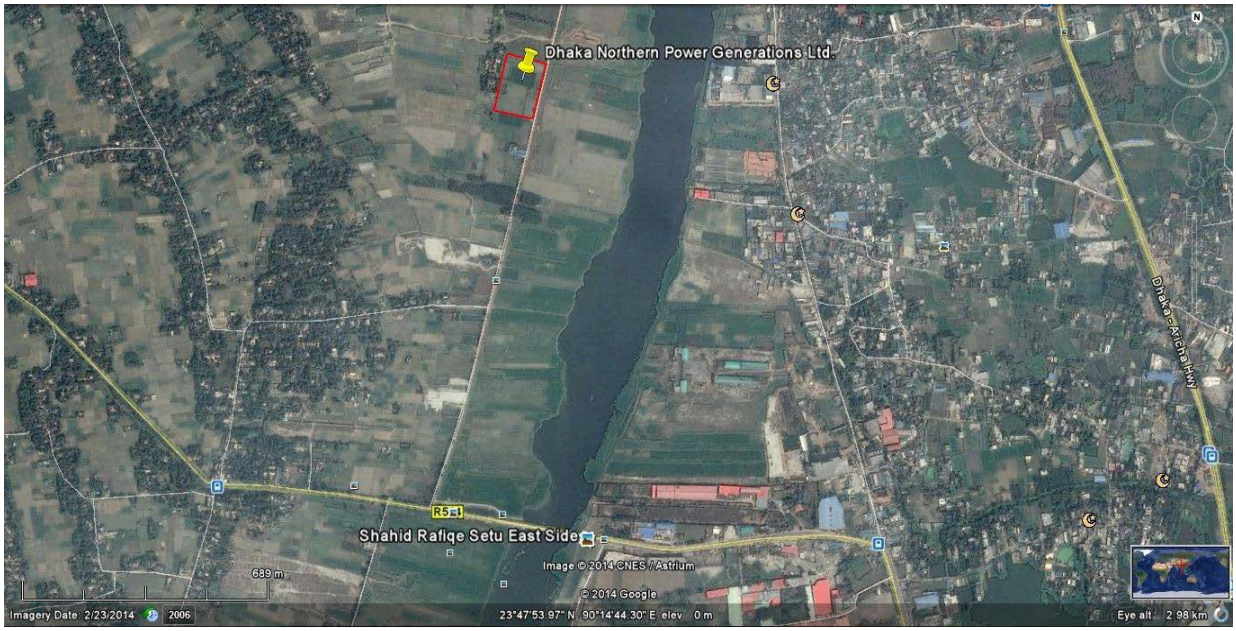


Figure 3.2: Satellite Map of the Proposed 55MW Power plant site (image source: maps.google.com)

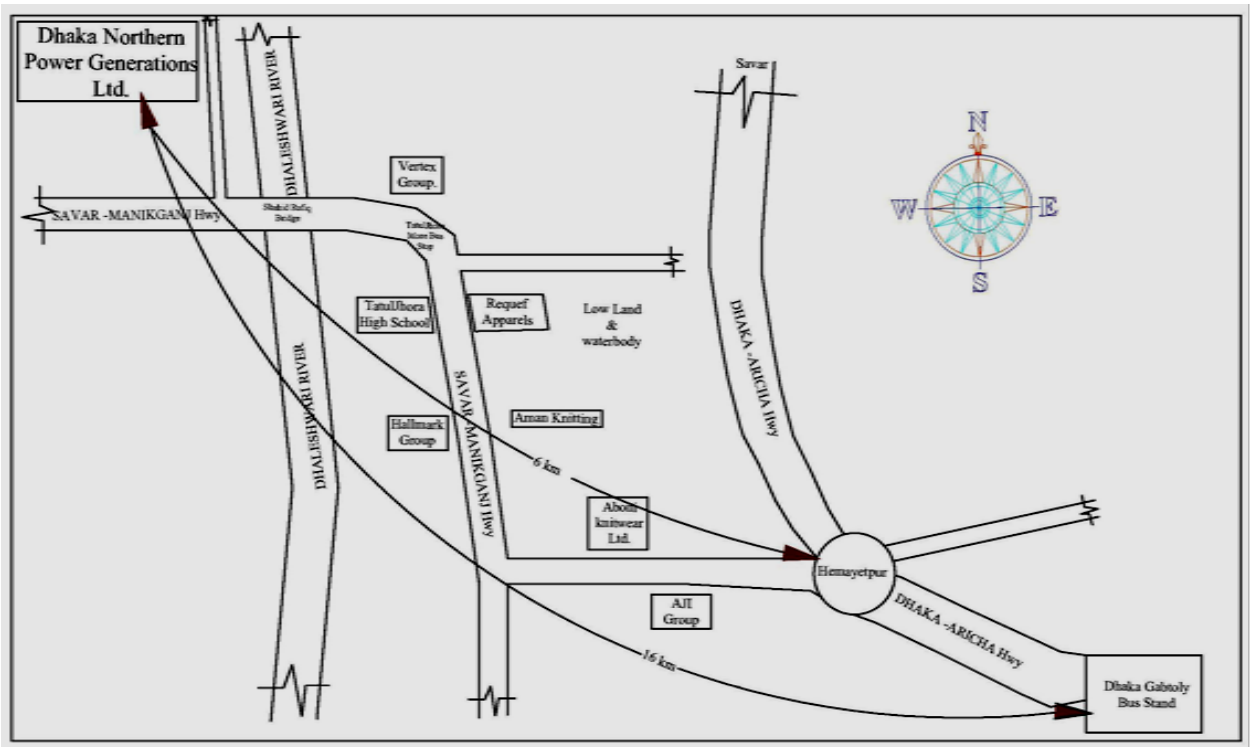


Figure 3.3: Location Map of the Proposed 55MW Power plant site (image source: IEE report for the 55MW power plant)

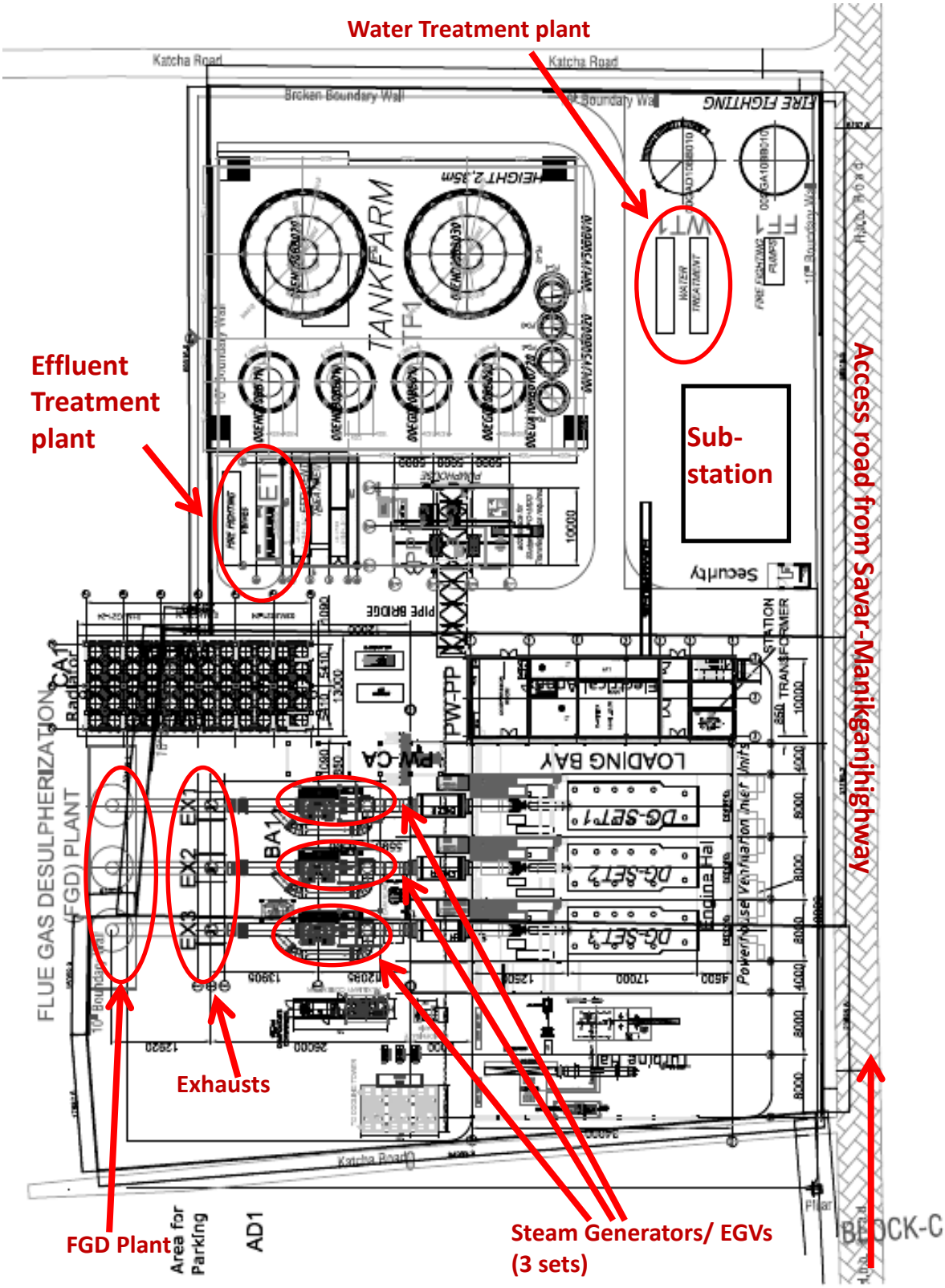


Figure 3.4: layout plan of the proposed DNPGL power plant

3.2.2 Electrical Interconnection for power Evacuation

78. The proposed project is situated in a place where more than one sub-stations are available near the project. The Singair-4 S/S 20 MVA FORDNAGAR sub-station is only 2

km away from the proposed project. The Singair-2 8/8 10 MVA, DHOLLA sub-station is 6km away from the proposed project.

3.2.3 Fuel Transportation and Storage

79. The proponent will arrange the supply and delivery to the facility of required quantities of HFO for use as fuel. DNPGL is responsible for fuel receiving, handling and transportation up to the facility. Imported fuel will be collected from the Chittagong Exclusive Economy Zone (EEZ) via a mother vessel to Karnafuli River. From there fuel will be transported to the plant location near Dhaleshwari river via 1000 tonne capacity Marine Department certified inland barge. The reason for not choosing a higher capacity barge is that it will not be able to navigate the Dhaleshwari river which allows a limited draft of operation for these river vehicles. Jetty/pontoon will be constructed at the plant site for the purpose of pumping the HFO from the jetty to the storage tank in the power plant. Monthly 7000 tonnes of HFO will be transported in this way.

80. Petroleum storage tanks shall be located in dyked enclosures. Each dyke shall have roads all around for access for normal operation and maintenance as well as for emergency handling. Dyked enclosure shall be able to contain the complete contents of the largest tank in the dyke in case of any emergency. A free board of 200 mm above the calculated liquid level or 10% of calculated dyke capacity whichever is higher shall be provided for fixing the height and capacity of the dyke. The dyke wall made up of earth, concrete or solid masonry shall be designed to withstand the hydrostatic load and shall be impervious. Dyke enclosure area (inside area of the dyke) shall be also impervious to prevent the ground water pollution.The dyke and the enclosures will be inspected for cracks, visible damage etc. every six months (pre and post monsoons) and after every major repair in the tanks / dykes etc. so as to keep it impervious. Piping thru' dyke wall if any shall be properly sealed to make dyke impervious. The dyke area shall have proper slope outward of tank pad towards the inner periphery of the dyke enclosure to prevent reverse flow.

3.2.4 Topography of the Site & Surrounding Land

81. The River Dhaleshwari, situated in the east side to the project. The location is well connected by road and river ways. The site covers an area of 3.7 acres of land. The surrounding terrain is a low land which is seasonally flooded during rainy season. Although the entire area surrounding the project is almost rural in nature, there is presence of significant number of industries on the opposite bank of the Dhaleshwari river.

3.2.5 Ancillary Facilities

82. The list of ancillary facilities of the power plant (subject to the ESIA) are listed below:

Name of Ancillary Facility	Description	Land requirement and/or acquisition status
Jetty Pontoon	Pontoon moored with river bed, permission taken from BIWTA. Pump and flow meter has been installed for oil transmission.	No
Access / Approach road	Compacted road	50 decimal land has been purchased
HFO transmission line	8 inch HFO line on 998 ft approach road	

Figure 3.5: Present status of the project site

Figure 3.6: Present status of the access road to the project site

3.3 PROJECT ACTIVITIES

3.3.1 Site Preparation

83. Site preparation would comprise the partial land filling and compaction of around 3.7 acres of land. Prior to construction a 300 mm thick carpet of crushed stone should be spread in the lay-down areas and on the working surface. All known

underground services should be flagged up and all redundant services coming onto the site should be blanked off and removed.

3.3.2 Piling and Foundations

84. The proposed power plant will be founded on piles. The piles could be bored, augured or driven and the type will depend upon the geotechnical data available. Design load tests should be made on test piles for design purposes (design piles). Design piles are normally loaded until the failure of the bearing soil as an aid to the pile design in similar conditions. Foundations should be designed to British Standard Code of Practice BS 8004 or equivalent Bangladesh National Building Code. The design of foundations for all structures and equipment are to be such that differential and total settlements or other movements should not exceed acceptable limits and ensure safe and maintenance free operation of the plant. Detail design parameters for the civil works would be provided by the relevant consultant. The nature of the fill material and the construction techniques used should be such that the less heavily loaded equipment and the buildings may be founded on rafts or spread footings.

3.3.3 Roads

85. The access roads will be designed to be capable of carrying all the vehicles likely to be used during construction and throughout the life of the plant including articulated vehicles and transporters used for the removal and replacement of major items of the plant. The road pavements should be of reinforced concrete and in conformity with relevant British or equivalent Bangladesh National Code of Practice.

3.3.4 Drainage

86. The storm water and foul (sewage and oily water) drainage systems should be separate and designed in accordance with BS EN 752 Parts 1 to 4 "Drain and sewer systems outside buildings". Manhole and chamber covers should be heavy duty throughout. The capacity of the surface water drainage system should be sufficient to deal with a storm return period of 1 in 5 years. The surface water drainage should include all necessary gutters, down pipes, gullies, traps, catch pits, manholes etc. Figure 3.7 shows the drainage layout plan of the DNPGL power plant complex. The stormwater collected from the roofs will be channeled through covered drains towards two outlets located at the northern and southern end of the plant. These outlet pipes will go beneath the access roads where it will follow the natural slope of the river bank towards the Dhaleshwari river.

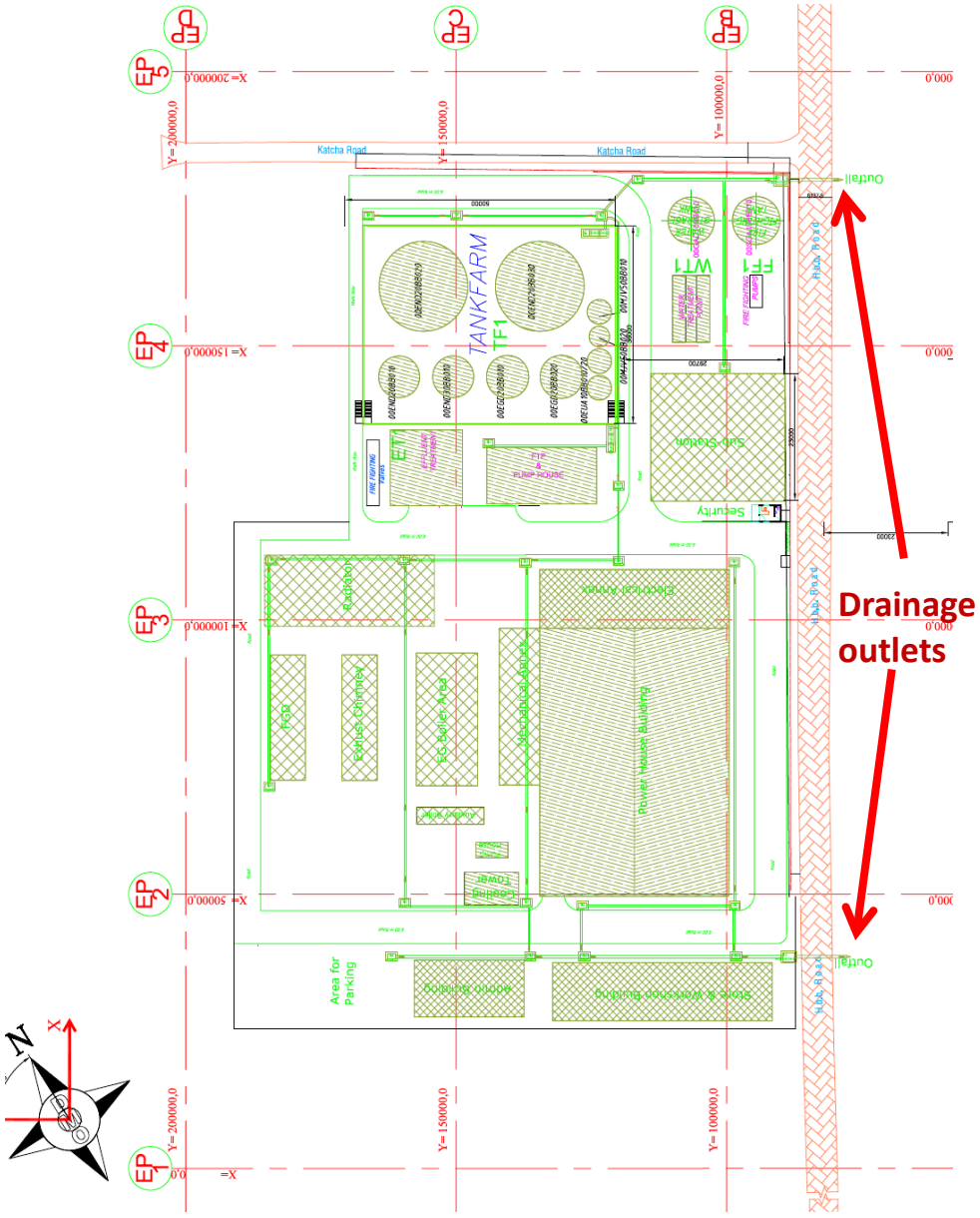


Figure 3.7: Drainage layout of the proposed power plant by DNPGL

3.3.5 Sewage Discharge

87. All sewage drainage should be taken to a septic tank. A septic tank is a long retention time tank where solids deposit out in an anaerobic bottom layer. The capacity of the septic tank is sufficient to cater for the normal and incidental load arising from the power station. The septic tank should be connected to a soak way by means of an overflow pipe whereby the liquid effluent can be drained.

3.3.6 Power Station Buildings

88. The various buildings within the compound should have a common architectural concept in order to unify the various elements and should be suitable for the operating and climatic conditions at site. The design should make selective use of

materials to produce a pleasing concept throughout and a working environment, which is safe, durable and functional. The dimension of all the buildings should be such as to provide generous space for the safe installation and proper operation and maintenance of the plant and its equipment. In particular generous space should be provided immediately in front of, behind and beside all items of the plant. In all rooms or buildings housing switchgear, a clear working space should be provided around switchboards of at least 1.0 m behind and in front of the fully withdrawn trucks. It is recommend that the floors should be constructed in reinforced concrete and designed to accommodate all foreseeable static and dynamic loads. They should be provided with surface finish appropriate for their intended usage and properly drained bounded areas should be provided wherever necessary to contain accidental spillage of oil or other harmful liquids. The design of all buildings must ensure that noise, vibration and temperature levels are within permissible limit.

3.3.7 Sub-station

89. Transformer compounds should be constructed with oil containment facilities. Compounds should each be provided with suitable fencing and a lockable access gate. Fences to transformer compounds and other electrical areas within the site boundary should be of 2.4 m minimum height. The tank should be fitted with a suitable overflow system, air vents, access hatches, ladders, a sump and a means of emptying the tank.

3.3.8 Site Fencing

90. A security fence should be provided around the permanent boundary of the site that should be 3 m high above the site formation level. Gates should be fabricated from galvanized steel and as a minimum provide the same level of security as the perimeter fence. All gates should be provided with suitable locking devices.

3.3.9 Oil Loading Terminal

91. All arrangements required for the supply of liquid fuel to the facility including construction of jetty/pontoon, necessary arrangement, pipe line up to the storage facility, fuel measuring and testing system, internal fuel supply system, fuel heating and purification/treatment system as per requirement of the proposed plant will be installed by DNPGLat its own cost and responsibility. Figure 3.8 shows a schematic of the oil loading jetty and fuel transportation arrangement. A 90 feet by 20 feet pontoon with a 100 feet long and 6 feet wide gangway will be constructed at Dhaleshwari river. The pontoon will have arrangements for pumping the HFO at a rate of 500 tonnes/hour through a pipe of 12" diameter over a 700 feet long and 6 feet wide strip of land (owned by DNPGL) upto the Fordnagar road (the access road to the plant) from which it will go below the road to the HFO storage tank. The pipe will be laid over a Cement Concrete foundation over the 700 feet long strip of land. The design of the HFO transfer system is spill protected to make any spillage of HFO highly unlikely.

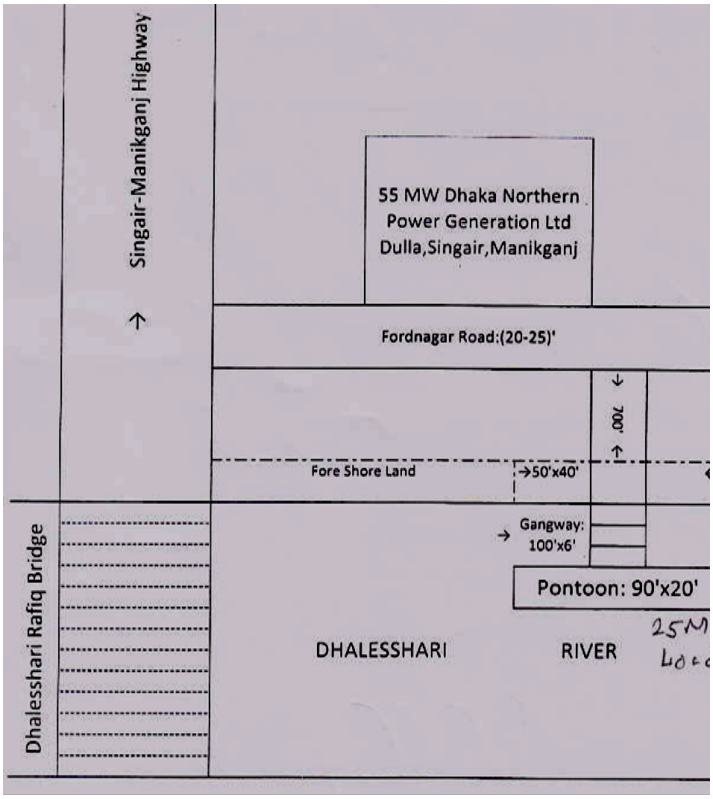


Figure 3.8: Schematic of the fuel loading terminal at the bank of Dhaleswari river near the proposed power plant

3.4 EQUIPMENT AND PROCESS FLOW

92. The proposed power plant will use imported Heavy Fuel Oil for generation of electricity. The fuel after purification will burn in internal combustion engine for complete combustion; the generated heat will operate the generator sets by some rotating mechanism and will produce electricity. The heat of exhausted gas will be used for the boilers that will produce steam. These steams will be used for the steam turbines for producing more electricity. Sophisticated machineries will be imported and will be installed for generating power in the power plant. The project will have 03 units of MAN 18V 48/60 TS engine with each engine having a generating capacity of 19.3 MW. These engines are duel turbo charged and with high fuel efficiency. The full engine specifications are attached as Annex I. The engine will be run in operation mode 1 with the following performance characteristics:

Table 3.1: Performance characteristics of MAN 18V48/60TS Engine under operation mode 1

Performance parameter	**Data**
Power per cylinder	1050 kW
Total Engine power	18900 kW
Tot. el. genset power	18428 kW
Spec. fuel oil consumption	171.5 g/dWh
Heat rate	7325 kJ/kWh
NOx emission (dry at 15% O_2)	1850 mg/Nm3

Performance parameter	Data
Mean effective pressure	23.2/22.6 bar
Spec. lube oil consumption	0.50 g/kWh

3.5 POWER GENERATION DETAILS

93. The proposed power plant will use imported Heavy Fuel Oil for the generation of electricity. This supplied fuel will be burnt in internal combustion engine for complete combustion; the generated pressure as a result of combustion will operate the generator sets by some rotating mechanism and will produce electricity.

94. Manikganj 55 MW is a HFO plant. Fuel energy will be converted to electrical energy. However efficiency of engine will be 48% (so far highest in world). Rest thermal energy will be gone through exhaust gas. By utilizing exhaust gas temperature, steam will be produced with the help of HRSG. These saturated steams will be used to run turbine blade which will generate an additional electricity of 2.8 MW (co-generation). Generated hot water will be passed through a cooling tower which will discharge the waste heat to the atmosphere. The type of heat rejection in a cooling tower is termed "evaporative" which allows a small portion of the water being cooled to evaporate into a moving air stream to provide significant cooling to the rest of that water stream. The heat from the water stream transferred to the air stream raises the air's temperature and its relative humidity to 100%, and this air is discharged to the atmosphere. Evaporative heat rejection devices such as cooling towers are commonly used to provide significantly lower water temperatures than achievable with "air cooled" or "dry" heat rejection devices, like the radiator in a car, thereby achieving more cost-effective and energy efficient operation of systems in need of cooling. A general flow diagram for power generation and evacuation is provided in Figure 3.9(a) while a flow diagram of power generation and co-generation is shown in Figure 3.9(b)

95. The engines that will be used are of type 18V 48/60TS. Exhaust gas temperature of engine is 324 deg C and mass flow will be 128 ton/hour. This huge temperature will be used for producing steam. Some details of the engine are furnished below:

Project		Date	Revision
55 MW HFO Power Plant		27.08.15	Rev B
Subject			Author, department
Planning Data - Exhaust Gas Data			Development, Elahi

Engine configuration					
Engine type	18V 48/60TS				
Fuel type	HFO				
Cooling type	Radiator Cooling				
Glycol content cooling water	HT-circuit: 0% / LT-circuit: 0%				
Reference conditions		min	guarantee	derating	max
Air temperature at compressor inlet	°C	10	35	40	40
Wet bulb temperature	°C	28			
Relative Humidity	%	99	59	40	40
LT water temperature at charge air cooler inlet	°C	25	42	47	47
Air pressure / Site altitude	mbar/m	1010 / 25			
Engine output	%	100	100	100	100
	kW	18900	18900	18900	18900
Exhaust gas data					
Mass flow 1)	t/h	128,8	124,9	125,2	125,2
Temperature at turbine outlet 2)	°C	291	324	323	323
Permissible exhaust gas system back pressure after T/C (max.)	mbar	30			

Tolerances: 1) ± 5%

96. Each engine will have one HRSG, so there will be 03(three) HRSG. These are Alfa level Aalborg boiler. Steam flow rate of the boiler is 6204 kg/hr with a steam temperature of 270 deg. C.

97. The steam generated will be fed into a steam turbine which will generate an additional 2.8 MW of electricity. Data of the steam turbine is as follows:

Rated output	2.8 MW
Voltage	11 KV
Power factor	0.8
Excitation	Brush less
Insulation	Class F
Control type	Digital

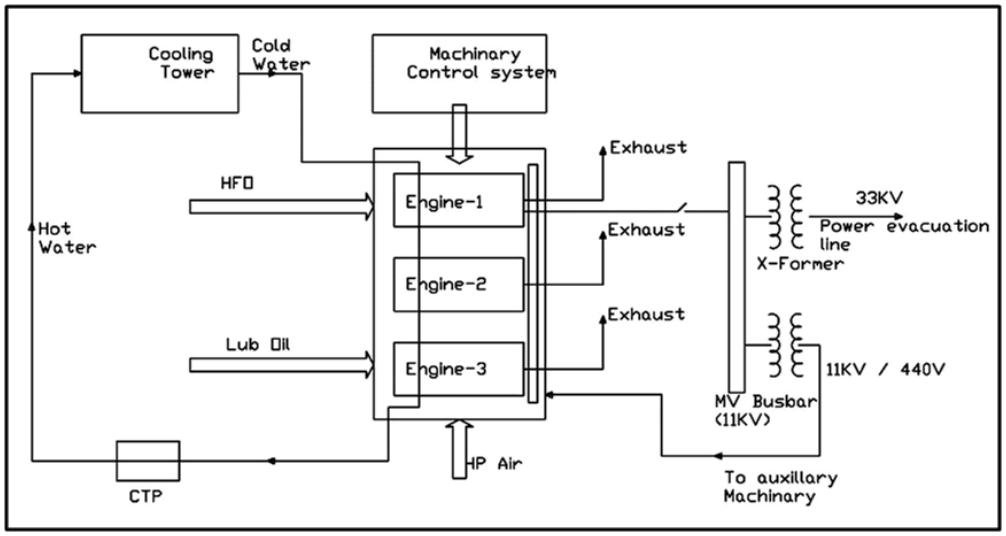


Figure 3.9(a): Flow Diagram of 55 MW Power Plant of DNPGL

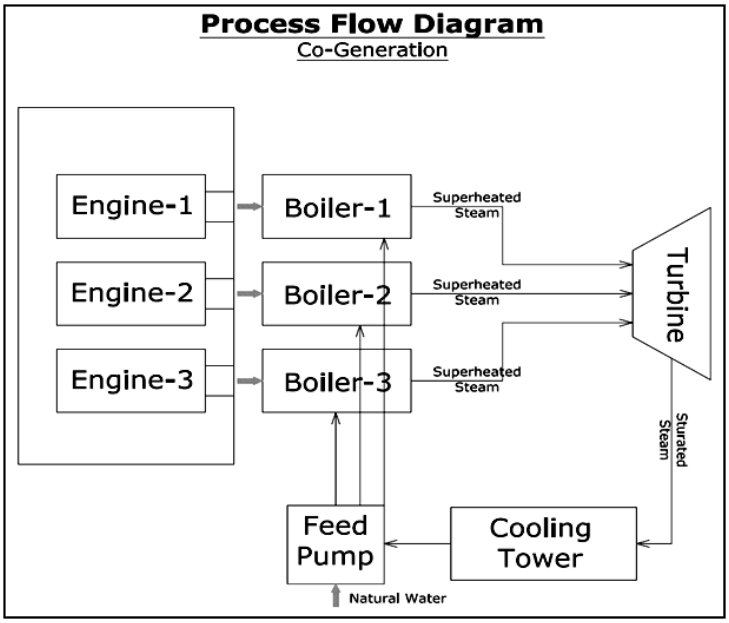


Figure 3.9(b): Flow Diagram of 55 MW Power Plant of DNPGL Power generation and cogeneration

98. Used lubricating oil from the engine sump will be stored in a dedicated used oil tank of 27 m^3 capacity. Each engine uses approximately 19 m^3 of lubricating oil, 50% of which is replaced at a time when the properties of the oil crosses certain threshold after continuous operation. The used lube oil from these engines has been found to be in high demand among the people working in the transportation, vehicle repair and other informal sectors. In order to ensure that the use lubricating oil do not end up in the informal sector and used lubeoil will be sold to DOE certified vendors who are expected to handle the used oil in environment friendly manner.

99. A small portion of the produced electricity will be consumed by all electrically operated machinery and for lighting of the plant. All the systems of the plant will be

installed as per the design, drawing and guide lines by the Original Equipment Manufacturer (OEM) and complying with the Standards as set by the OEM. The engines are started by High Pressure Air. The carefully designed forced ventilated Power House will contain the generating units and other auxiliary machinery. All MV and LV electrical controls will be from the Plant's Control Room through the MV and LV Switch Room.

100. The other supporting machineries are HP Air Compressors, Charge Air Filters, Engine Hall Ventilation Air Filters, Fuel Treatment Plant, Water Treatment Plant, Oily Water Treatment Plant, Auxiliary Boiler, Auxiliary Diesel Generator etc.

3.6 FUEL INFORMATION

3.6.1 Fuel Treatment

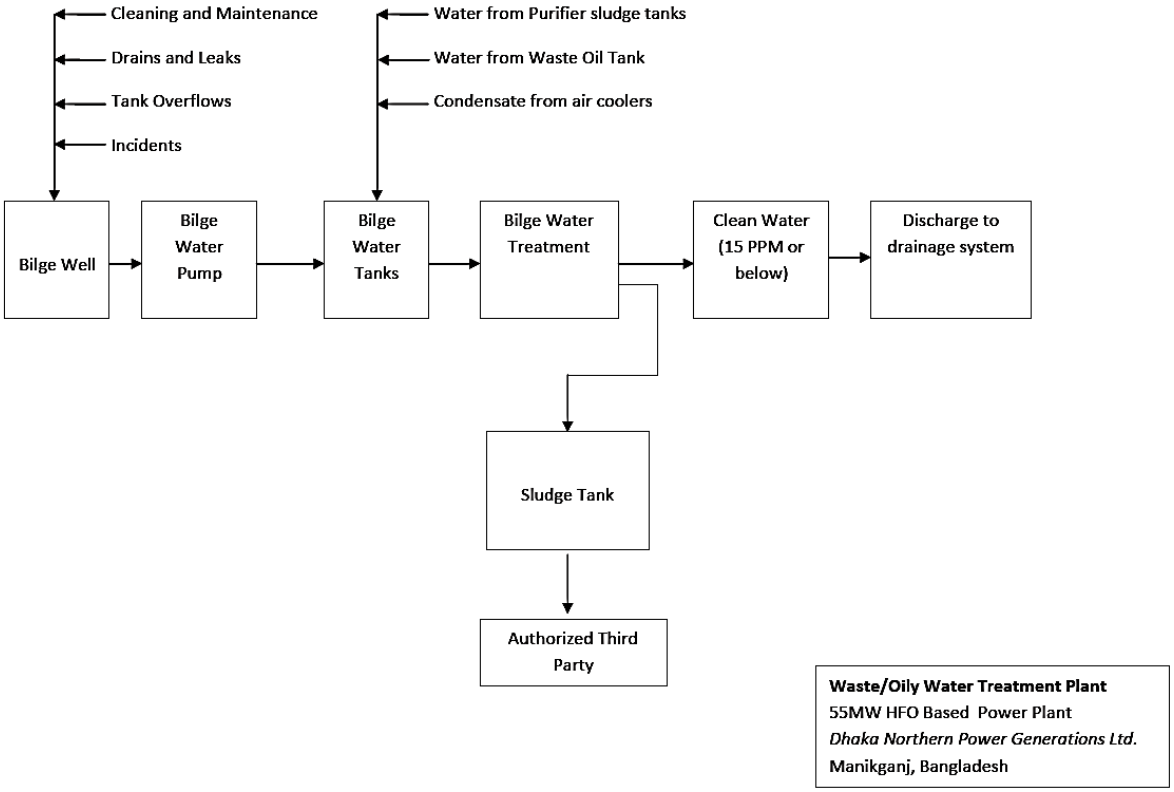
101. Liquid fuels vary substantially in hydrocarbon composition, physical properties and level of contaminants. Hence, treatment of the heavy fuel oil is mandatory. The imported heavy fuel oil would undergo proper treatment before feeding to the engines. The major functions of a heavy fuel forwarding system are: pumping, heating, fuel selection, filtration, and metering. Heating requirements will vary depending on the viscosity of the fuel. However, heavy fuel oils may require heating to 135-160°C to reduce viscosity to an acceptable level.

3.6.2 HFO Purifier

102. HFO Purifier will be used to separate sludge and water content from HFO. The separated water and sludge will be properly treated

3.6.3 Oily water Treatment

103. There will be an oily water separator which will trap waste oil from the oily water. The treated water (with oil and grease concentration <15 ppm) will be drained properly. The separated oil from the treatment will be given to approved third party who will re-use for other less quality-demanding use. The following line diagram shows the processes involved in the oily water treatment:



3.7 WATER PURIFICATION SYSTEM

104. There would be efficient water purification system for the proper treatment of water to be used in the cooling towers and the boilers. The required water would be the extracted from the groundwater by deep tube well. The raw water would be filtered through Multimedia filter and activated carbon filter after ozonation (to remove iron). Afterwards the water would go through softening process, special ultrafiltration reverse osmosis and electrodialysis to bring the electrical conductivity of water to below 1 µS/cm which is the requirement for EGB units.There will be closed loop cooling system in the power plant. The amount of make-up water for these cooling towers is about 28 ton per day which will be supplied from the filtered tank.

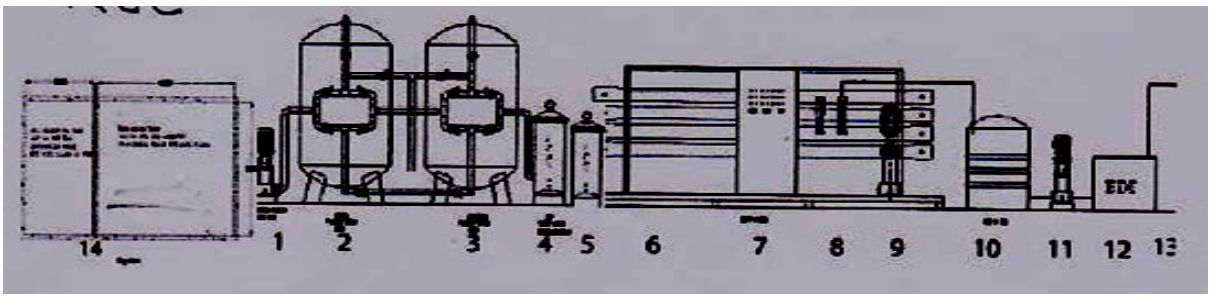


Figure 3.10: Block Diagram of the water purifier system of the proposed power plant by DNPGL. The diagram shows the sequence of processes that the water will undergo in order to achieve a high purity of < 2 µS/cm.

The explanation of the numbers: (1) LP feed pump (2) Multimedia filtration (3) Activated Carbon Filtration (4) Softener (5) Safety filter (6) Special ultrafiltration membrane (7) control panel (8) Special Reverse Osmosis System (9) High pressure pump (10) Middle tank (11) EDI feed pump (12) EDI module (13) Distribution line (14) Ozonation.

3.7 FLUE GAS DESULPHURIZATION

105. The FGD scrubbers are expected to remove approximately 90% of the sulphur dioxide (SO_2) present in the flue gases. The actual FGD unit to be used for the proposed plant has not been selected yet by DNPGL. A particular FGD unit by Yuxi Yushen Technologies Ltd is under consideration the specifications of which are provided in Annex J. This particular scrubber operates in a dual-alkali mode which uses a sodium-based alkali solution to remove $SO_2$from combustion gas. The dual-alkali process has reduced plugging and scaling problems in the absorber because sodium-scrubbing compounds are very soluble. The dual alkali system also has high SO_2 removal efficiency (~95%). The details of the process with relevant reactions are furnished in Annex J.

106. As SO_2 is removed from the flue gas, the gypsum solids concentration and that of other elements in the reaction tank increases. At a certain solids concentration set point (approximately 15%) a portion of the slurry is bled off and sent to a dewatering system to separate the water from the gypsum. This FGD wastewater, produced from dewatering may have significant calcium, magnesium, sodium and sulfates and cannot be used directly in other processes in the power plant without prior treatment. For the proposed 55 MW power plant, assuming a 90% efficiency of SO_2 removal and a 2408 tonnes/year of Sulphur emission, approximately 11700 tonnes of gypsum (or 9600 tonsof sodium sulphate) will be generated each year. Mechanically dewatered gypsum will have a moisture content of 5% and this gypsum can be used in cement industry, in agriculture (as soil amendments) and other industries. If no such suitable recycle option could be availed, If no recycle options could be availed, the gypsum will be dumped into the sanitary landfill of Aminbazar, Dhaka located approximately 8 km from the power plant site. Aminbazar landfill is one of the two major landfills receiving solid waste of Dhaka city and operated by the Dhaka city corporation. 58 decimal land is also under the process of purchase by DNPGL for temporary dumping Gypsum. In Bangladesh the use of residual gypsum from industrial processes is relatively uncommon and there is scope for DNPGL to think of some innovative ways to utilize this substance for useful purposes.

CHAPTER 4

BASELINE ENVIRONMENT

4.1 INTRODUCTION

107. As a part of the environmental assessment of the proposed project, an environmental baseline survey has been carried out in areas surrounding the proposed location of the 55MW power plant of DNPGL. The specific objectives of the baseline study were:

- To document the existing condition of physical and biological environment and prevailing socio-economic condition of the project areas;
- To identify the significant environmental and social aspects that are likely to be affected by the proposed project activities; and
- Setting of baseline parameters in order to identify possible adverse and beneficial impacts due to the proposed project activities.

This Chapter describes the baseline physical, biological and social environment of project areas based on the findings of the baseline surveys. The possible environmental impacts of the proposed project have been evaluated against these baseline environmental conditions.

4.2 PHYSICAL ENVIRONMENT

4.2.1 Physical Features of the Study Area

108. The site for the proposed Dhaka Northern Power Generations Ltd. (DNPGL) plant is situated in the Manikgonj district which located at the northern side of Dhaka the capital city of Bangladesh. The Manikgonj district is separated from Dhaka city by the Dhaleshwaririver. The selected site for DNPGL plant is located in Fordnagar Mouza, Dholla Village, Singair, Manikgonj. The total number of mouzas in Singair upazila is 138. The Fordnagar mouza is situated at the eastern periphery of Manikgonj district. (see Figures 3.1 to 3.3)

109. It is a 3.7 acre plot purchased by DNPGL, located only few hundred meters away from Dhaleshwaririver. It is situated at the northern side of Dhaka-Manikganj highway and the approximate distance from this highway is 0.8 km. This site is primarily an agricultural land and a residential house is situated at the North West corner of the proposed site. Although a few scattered residential houses (such as Mia bari and Munsi bari) are present around the plot, the area surrounding the plot is primarily agricultural land. The west side of the selected project site is mainly open agricultural field and several residential houses are situated along with these agricultural fields.

Figure 4.1: A Google image showing the existing physicalfeatures around the site of the proposed 55MW power plant of DNPGL.

110. The "Shahid Rafiq" bridge above the river Dhaleshwari is situated at the south east side of the proposed project. The bridge has eased the transportation system and connected Dhaka to Manikganj. The north side of the project area is known as Nurnagar, Khalpara where a number of factories namely Beautification Jackets Ltd, Bangle Group and significant numbers of Brick kilns are present. An ideal rural scenario prevails around the project site and the population density is very low in this area. South side of the Manikganj – Dhaka highway is known as char area, in this area population density, number of residential house and physical infrastructure are significantly low compared to the Northern side.

111. The existing scenario at the eastern side of the Dhaleshwari river is significantly different from the western side of this river. The eastern side of the Dhaleshwari river is known as Saver which is mainly a mixed area. A significant number of Mosques, temples, residential houses, commercial installations and various types of factories such

as Vertex wear Ltd, AKH Knitting and Dyeing Ltd, AJI group, Babylon Trems Ltd and Creative textile design are available in this area. Rashed Monjheel, a local residential house located in the Dhalla moddopara village, Singair is 1.5 km from the site. It was constructed arround three years ago. A water body, situated 700 meter away from project site,is used for seasonal fish farming purpose. Vaitor Rahaman Jame Mosjid was established in 1976 and is located 1.8 km away from proposed DNPGL site. Munsi bari is situated in the Dhalla moddopara village, Singair and its approximate distance from the DNPGL site is 1.7 km. Munsi bari has three houses and the total number of people live in this home are 18.

Figure 4.2: A view of a Residential House (Left) that is adjacent to the project site and a rural Residential Home (Right) namely Mia bari is located at the west side of the proposed site for DNPGL power plant.

Figure 4.3: A view of Rashed Monjeel (Left) and Water body (Right) which are located at the West side of proposed site for DNPGL power plant.

Figure 4.4: Vaitor Rahaman Jame Mosjid (Left) and Munsi bari (Right) located at the West side of the proposed DNPGL site.

Figure 4.5: A view of Dhalla Government Primary School (Left) and Dhalla Union Council High School (Right) situated at the west side of Proposed DNPGL site.

Figure 4.6: Mosjid Vaitussalat (Left) and a view of a Brick kiln (Right) situated on the Northern side of the proposed site for DNPGL.

112. Dhalla Government Primary School was founded by LGRD in 1925. It has a total number of 424 students and the ratio of number of boys to girls almost equal. It is around 2 km away from proposed DNPGL site. Dhalla Union Council High School was established in 1967 at the Dhalla bazar and is around 3.5 km away from DNPGL site. Mosjid Vaitussalat was established in 2008 at Nurnagar, Khalpara, Dhalla village and its approximate distance from the DNPGL site is 1.5 km. Several number of brick kilns are present at the North side of the proposed DNPGL power plant site which are adjacent to Dhaleshwari river. Beautiful Jackets Ltd, located at a distance of 1.8 km from the site, has around 1000 employees and it mainly makes different types of shirts. Bangle group, which produces different types of jute products such as carpet and papoosh, was established in 1980 at the portnagar and is around 4.5 km away from proposed DNPGL site. Al madrasatul atimkhana, a religious institution and orphanage established in 2010, has around 200 students and its approximate distance from DNPGL site is 2 km. The Rajfulbaria bazar jame mosjid was established in 1981 and is located very close to the DNPGL power plant site.Khalikhola mondir was constructed in 1992 and is approximately 1 km away from DNPGL site.

Figure 4.7: Beautiful Jackets Ltd (left) and Bangle group (Right) situated at the North side of the proposed DNPGL site.

Figure 4.8: A view of artificial tree garden (Left) and a religious institute (Right) namely Al madrasatul atimkhana located at the south side of the proposed site for DNPGL power plant and also Dhaka–Manikganj highway.

Figure 4.9: Vertex Wear Ltd (left) and Tatuljara Union Porishad (right) situated at the East side of the proposed DNPGL site and Dhaleshwari river.

Figure 4.10: A view of Rajfulbaria bazar jame mosjid (left) and Khalikhola mondir (right) situated at the East side of the DNPGL site.

Figure 4.11: AKH knitting and Dyeing Ltd (left) and AJI group industrial park situated at the East side of the proposed DNPGL site across the Dhaleshwaririver.

113. AKH knitting and Dyeing is a textile industry was established in 2004 and it has around 1200 employees. AJI group mainly makes several types of garments apparelsand has around 1500 employees. The approximate linear distance of both these

industriesfrom proposed DNPGL site is around 3.5 km and located across the Dhaleshwaririver. Babylon trems Ltd was established in 2009 and is located around 3 km from the site. It mainly makes various types of carton and polythene bags. Construction work of Tannery estate Dhaka (a Bangladesh Government project) is going on and all kinds of tannery and leather industries from the Hazaribagh area will be relocated here. A central effluent treatment plant will be setup for this Tannery estate. Besides these there are 67 brick kilns scattered around the project site within a 10-km radius from the plant. Table 4.1 is a list summary of the important physical structures mentioned above and their approximate distances from the site of the proposed DNPGL power plant site

Figure 4.12: A view of Babeylion Trems Ltd (left) and Tannery estate Dhaka (right) situated at the South – East side of the proposed DNPGL site.

Table 4.1: List of several significant places in and around the site of the proposed DNPGL along with their distance from the site.

Name of structure/feature	Type of Structure/facility	Distance from Proposed site
Private Residence	Residential area	90 meter West
Shahid Rafiq Bridge	Bridge	800 meter South - East
Creative Textile	Textile industry	700 meter East
Rashed Monjeel	Residential area	1.5 km West
Vaitor Rahaman Jame Mosjid	Mosque	1.7 km West
Munsi bari	Residential area	1.8 km West
Dhalla Government Primary School	Educational Institution	2.0 km West
Dhalla Union Council High School	Educational Institution	3.5 km West
Mosjid Vaitussalat	Mosque	1.5 km North
Brick Kiln	Brick making industry (total 67 no. within 10 km radius	Various distances
Beautiful Jackets Ltd	Textile industry	1.8 km North
Bangle group	Textile industry	4.5 km North
Artificial tree garden	Garden	2.2 km South
Al madrasatul atimkhana	Orphanage	2.0 km South
Vertex Wear Ltd	Textile industry	600 meter East
Tatuljara Union Porishad	Administrative institution	700 meter East
Rajfulbaria bazar jame mosjid	Mosque	600 meter East

Name of structure/feature	Type of Structure/facility	Distance from Proposed site
Khalikhola mondir	Temple	1.0 km East
AKH knitting and Dyeing Ltd	Textile industry	600 meter East
AJI group industrial park	Textile industry	3.5 km East
Babylon Trems Ltd	Textile industry	3.0 km South - East
Tannery estate Dhaka	Tannery industry	2.5 km South – East
Abedin Textile Mill Limited	Textile industry	2.0 km North
One way textile mill limited	Textile industry	2.0 km North
JK group	Textile industry	3.0 km North
Al muslim group	Textile industry	3.0 km North - East
Trendy Furniture and Dyeing Limited	Other industry	7.0 km East
Doel group of Industries Ltd.	Other industry	5.0 km North - East
Saver textile – Supasox and Surma garments	Textile industry	6.0 km North - East
Fashion Compact Accessories Ltd.	Textile industry	5.0 km North - East
Ping food Industry	Food industry	7.0 km East
Amin bazar 230 KV Grid Sub – Station	Electrical substation	7.0 km East
Hanif Refueling Station	Gas/CNG station	6.0 km East
NR CNG filling station	Gas/CNG station	5.0 km East
Green Power Electrical and Electronics	Other industry	2.0 km South - East

4.2.2Archaeological Sites

114. According to Department of Archaeology of Bangladesh three archaeological sites are present in the Manikgonj District and three archaeological sites are present at the bordering Savar thana in Dhaka district. No archaeological sites listed under the Department of Archaeology of Bangladesh for Manikgonj district were found in the immediate vicinity of the proposed project site; the closest site in Manikganj is almost 14 km away. The nearest site was found to be 6 km away which was in Savar, Dhaka. (Table 4.2)

Table 4.2: List of archeological sites around the site of the proposed DNPGL power plant site

Name of Archaeological Site	Location	Approximate Distance from the project site
Baliati Palace	Saturia (Manikgonj)	30 km North - West
Machain Shahi Jami Mosque	Harirampur (Manikgonj)	14 km South - West
Tomb of Josaph Paget	Sibaloy (Manikgonj)	20 km West
Building of Raja Harish Chandra	Savar (Dhaka)	Within 6 km East
Buruj of Raja Harish Chandra	Savar (Dhaka)	Within 6 km East
Rajashan	Savar (Dhaka)	Within 6 km East

4.2.3 Climate

115. Bangladesh is located at the central part within the Asiatic monsoon region where the climate is tropical. Relatively small size of the country and generally low-

lying area cause moderate spatial variation of temperature, precipitation, relative humidity, wind speeds and other climatic variables. However, the climate of Bangladesh exhibits pronounced temporal variability. This is because of the moisture-laden monsoon wind flowing predominantly from the southwest during summer and the comparatively dry and colder northwestern winds during winter.Three seasons are generally recognized: a hot, muggy summer from March to June; a hot, humid and rainy monsoon season from June to November during which more than 85% of the total annual rainfall occurs; and a moderately cold, dry winter from December to February. The beginning 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. Usually winter season is dry with occasional rains. The early summer season is considered from March-April. During summer the air becomes hot with very low humidity. Baishaki cyclone and rains also dominate the early summer.

116. The Bangladesh Meteorological Department monitors different climatic variables from 35 stations in Bangladesh. Among the station located at Agargaon, Dhaka is closest to the site and will best represent the meteorological condition of the site. Different meteorological data like rainfall, temperature, relative humidity, evaporation, and solar radiation measured in these stations during the period 2001 – 2013 are summarized in Table 4.3

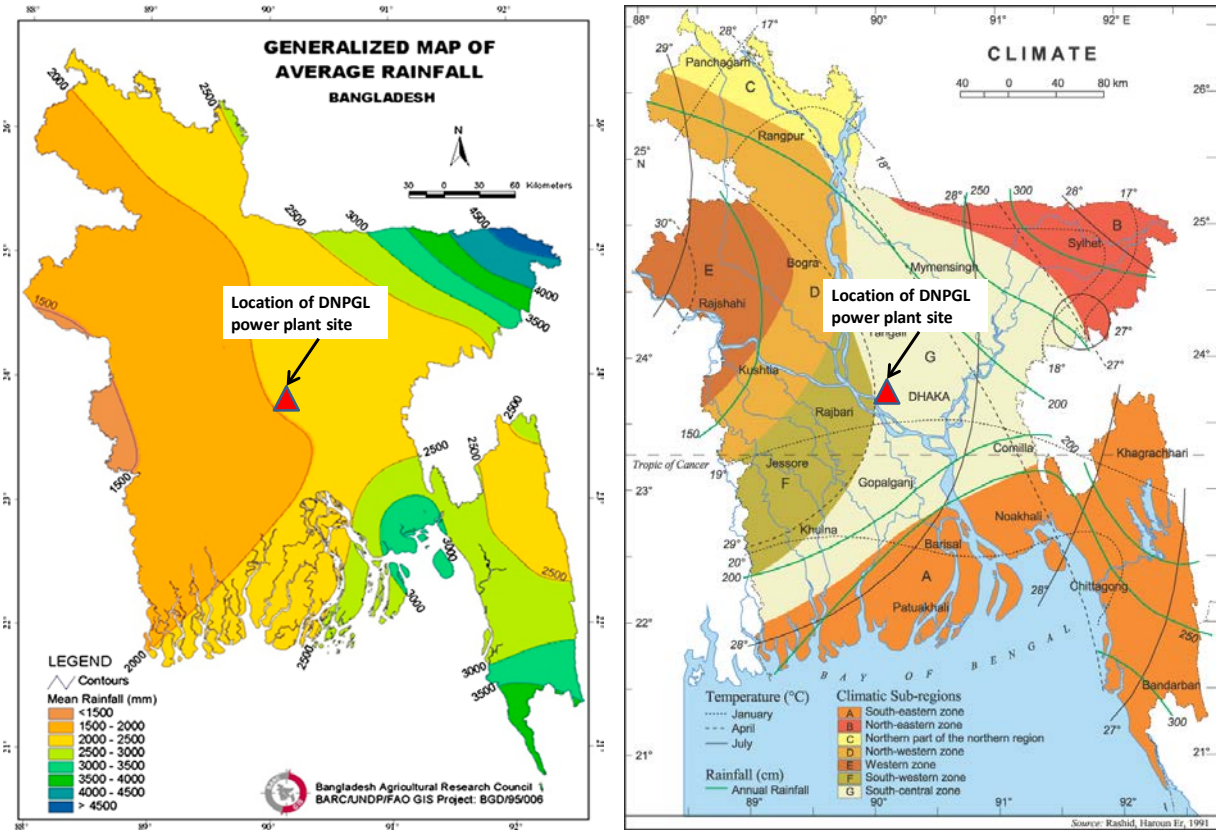


Figure 4.13a: The locations of the project study site on the mean annual rainfall map of Bangladesh. (map source: www.banglapedia.org)

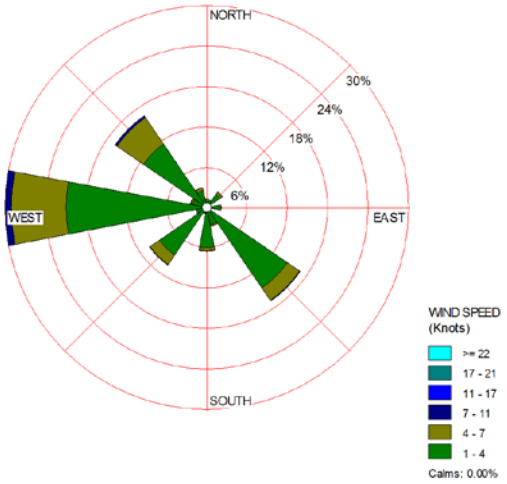


Figure 4.13b: Wind rose plot of from the 2008-2012 wind speed/ direction data gathered from Dhaka BMD station showing predominant directions and speeds of wind.

Precipitation

117. The general pattern of precipitation (which consists entirely of rain) follows the monsoon pattern with the cooler, drier months of November to March, increasing rains in April and May and highest rainfall in the summer months of June to September when the prevailing wind direction from the southwest brings moisture-laden air from the Bay of Bengal. The winter period (November to February) is dry with very little rainfall. Figure 4.13a shows the location of the site in Manikganj District on the rainfall map and climatic zone map of Bangladesh. Figure 4.13b shows the wind rose plot from the data of the last 5 years indicating the dominant directions and wind speed prevalence. A monthly wind rose plot for the year 2012 is shown in Annex B.

Table 4.3: Monthly averages of climatic variables at the Dhaka BMD Station, 2001-2013

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	5	14	29	111	212	326	350	290	316	155	19	11
Mean Temp (°C)	18.0	21.9	26.0	28.1	28.5	28.4	28.3	28.5	28.2	27.1	23.7	19.9
Max Temp (°C)	28.3	32.3	36.0	36.7	36.5	35.7	34.8	34.8	35.0	34.8	32.3	29.2
Min Temp (°C)	10.1	12.4	16.5	19.3	20.6	22.7	23.9	24.0	23.7	20.6	15.8	11.8
Humidity (%)	69	60	59	68	72	80	81	80	80	76	70	71
Sunshine (Hours)	5.7	7.3	7.5	7.7	6.8	3.4	4.0	4.5	4.2	5.7	6.8	5.8
Solar Radiation (Cal/cm2/min)	166	207	231	244	229	175	189	192	172	183	174	146
Evaporation (mm/d)	2.6	4.0	5.0	5.5	5.3	4.1	3.8	3.8	3.6	3.5	3.3	2.5

Source: Bangladesh Meteorological Department

Relative Humidity

118. The spatial and temporal variation of Relative Humidity throughout the year is very low in Bangladesh. The relative humidity varies from 59% to 86%.

Ambient Air Temperature

119. The temperature of the country is related to the period of rainfall. In general, cool seasons coincide with the period of lowest rainfall. Tables 4.2(a) – (c) shows the monthly average mean, maximum and minimum temperature in the three metropolitan cities. Maximum average temperature over the year is usually observed in May - September and minimum average temperature in January.

Solar Radiation and Evaporation

120. The average incident solar radiation is comparatively higher during the period between February – May than the other months of the year. Consequently the amount of evaporation is also higher during that period.

4.2.4 Geology, Soils and Seismicity

Geology

121. Geology of Bangladesh is generally dominated by poorly consolidated sediments deposit over the past 10,000 to 15,000 years (Holocene age). It is mostly characterized by the rapid subsidence and filling of a basin in which a huge thickness of deltaic sediments were deposited as a mega-delta out built and progressed towards the south. The delta building is still continuing into the present Bay of Bengal and a broad fluvial front of the Ganges-Brahmaputra-Meghna river system gradually follows it from behind.

Soil Characteristics

122. The soil formation in Bangladesh is remarkably homogeneous in appearance, both vertically and laterally. It comprises layer of unconsolidated clay, about 10m thick near Dhaka, but apparently thinner to the east and possibly much thicker in the west of the Rajshahi district. The sand mineralogy in this area is broadly similar to that of the tertiary hill sediments. Mineral contents of the soil are high in quartz, relatively low in feldspar and mica, and with zircon, tourmaline, kyanite, staurolite, sillimanite, and epidote dominating the heavy mineral fractions. The content of easily weatherable minerals ranges from 4 to 9%. The soil of Bangladesh can broadly be classified into seven tracts: (1) Madhupur Tract or Red Soil Tract, (2) Barind Tract, (3) Tista Silt, (4) Brahmaputra Alluvium, (5) Gangetic Alluvium, (6) Coastal Saline Tract, and (7) Hill Tracts. Figure 4.14 shows the position of the project site on the soil tract map of Bangladesh.

123. The soil formation of Manikganj district falls under the Brahmaputra Alluvium floodplain. The dominant soil texture is sandy loam. The soils are acidic in character and the pH ranges from 5.5 to 6.8. The soils are naturally fertile and are recharged every year by fresh deposition by the floodwaters.

124. To assess the heavy metal contents of the natural soil in the study area two soil samples were collected from (see Figure 4.15 for sampling locations) from about 0.15 m below the top of the original soil layer, using a split spoon. A total extraction of heavy

metal from soil samples following the USEPA guidelines has been performed to determine the selected heavy metal contents (see Table 4.4). The average concentrations of different heavy metals usually found in the natural soils along with their ranges are given in Table 4.5. Except Lead, most heavy metals tested have been found to be present in non-detectable levels in the soil samples.

Table 4.4: Heavy metal content of the soil samples collected from the study area

Sl. No.	Parameters	Unit	Concentration Present	
			Sample 1	Sample 2
1	Arsenic, As	mg/kg	<0.1	<0.1
2	Chromium, Cr	mg/kg	<0.1	<0.1
3	Lead, Pb	mg/kg	0.8	10
4	Mercury, Hg	mg/kg	<0.01	<0.01
5	Cadmium, Cd	mg/kg	<0.1	<0.1
6	Nickel, Ni	mg/kg	<0.7	<0.7
7	Copper, Cu	mg/kg	<1.4	<1.4

Table 4.5: Typical Heavy metal contents of natural soil

Sl. No.	Parameter	Unit	Range	Average
1	Cadmium, Cd	mg/kg	0.1 – 0.7	0.6
2	Chromium, Cr	mg/kg	1 – 1000	100
3	Lead, Pb	mg/kg	2 – 200	10
4	Copper, Cu	mg/kg	2 – 100	30
5	Zinc, Zn	mg/kg	100 – 300	50
6	Mercury, Hg	mg/kg	0.01 – 0.30	0.03

Source: USEPA Office of Solid Waste & Emergency Response, Hazardous WasteLand Treatment, SW-874 (April 1983, Page 273)

Seismicity

125. In the north and northeast of Bangladesh, there are areas of high seismic activity and some of the major earthquakes originating in these areas have affected the adjacent regions of the country. The whole of Bangladesh is divided into three seismic zones (Figure 4.19). The northern part of the country that includes the greater districts of Rangpur, Mymensingh, and Sylhet are in the Zone-I where earthquake shock of maximum intensity of IX of the Modified Mercalli Scale is possible. The Zone-II includes the greater districts of Dinajpur, Bogra, Dhaka and Chittagong and the shocks of intensity of VIII are possible. The southern part of the country, the least active region, where the maximum intensity is not likely to exceed VII, is in the Zone-III. The experts suggest not constructing normal buildings with more than 60m of height. Manikganj district is under zone II. Figure 4.14 shows the locations the project study area in the seismic map of Bangladesh.

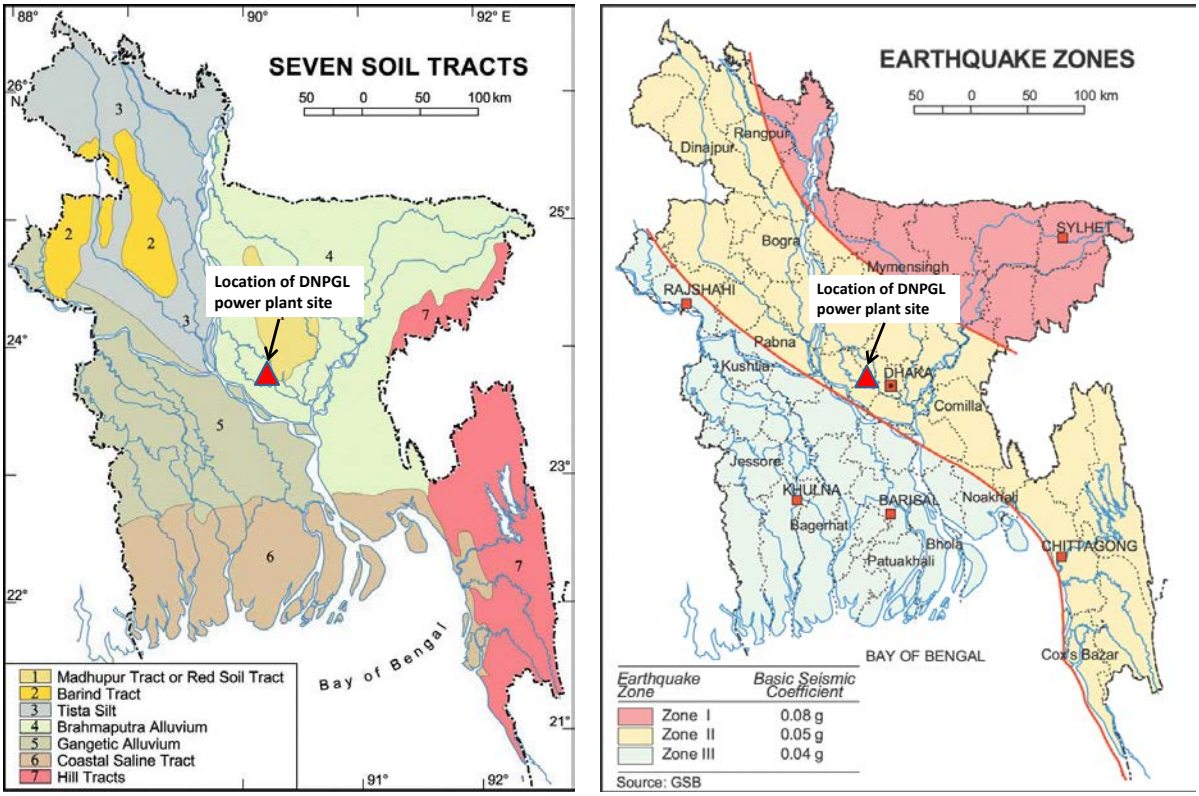


Figure 4.14: Map showing the proposed power plant site on the seven soil tracts of Bangladesh (left) and the seismic map of Bangladesh (right) (map source: www.banglapedia.org)

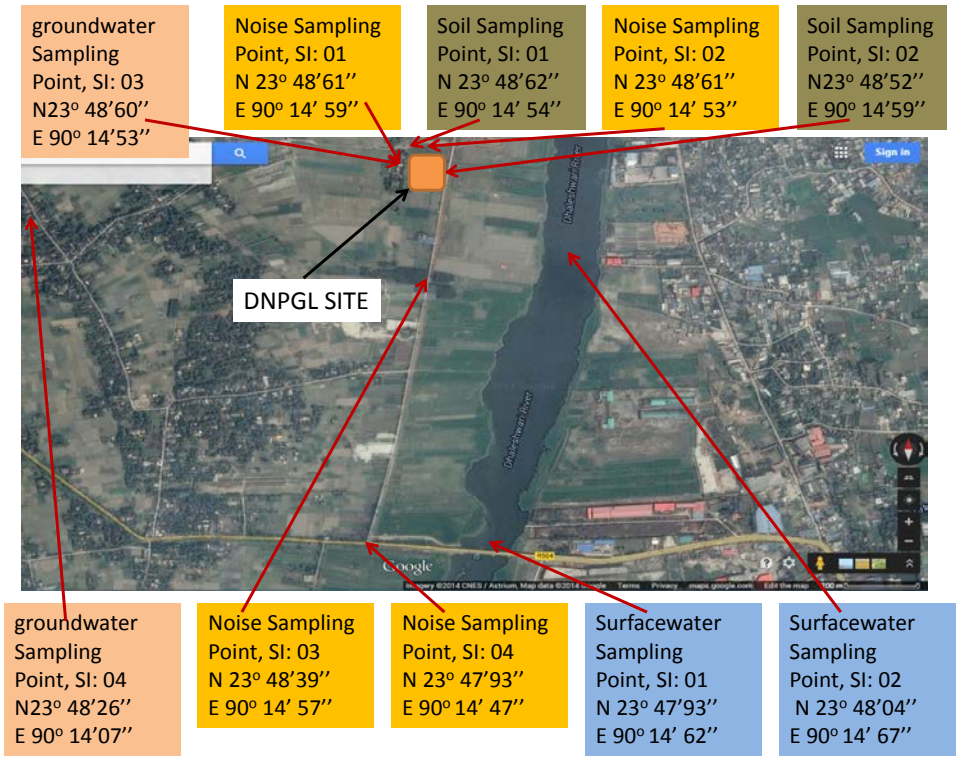


Figure 4.15: Soil, groundwater and surfacewater sample collection locations (with GPS coordinates) around the site for the proposed power plant of DNPGL

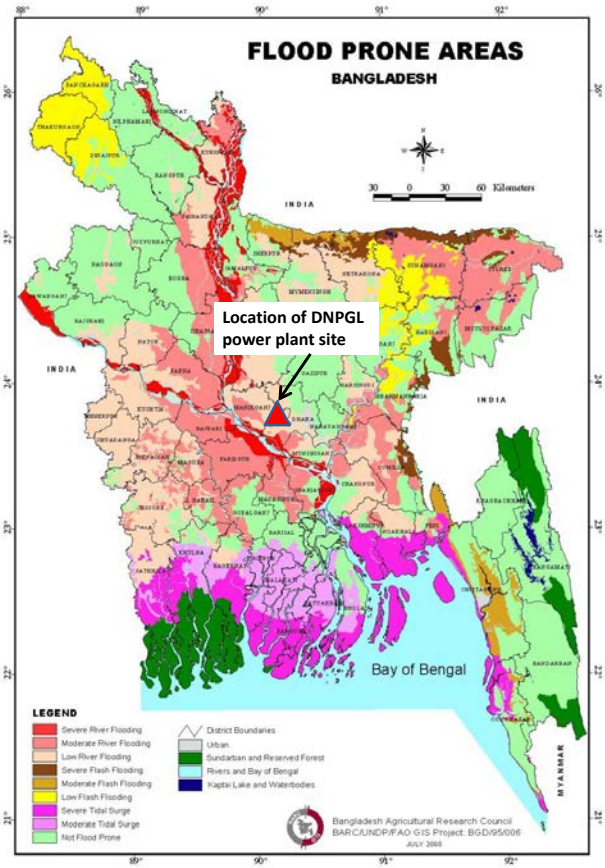


Figure 4.16: Locations of the power plant project site on the flood risk map of Bangladesh (map source: BARC)

4.2.5 Flood-prone Areas

126. Bangladesh is prone to flooding; the coastal flooding as well as the bursting of Bangladesh's riverbanks is common and severely affects the landscape of the country. 75% of Bangladesh is less than 10m above sea level and 80% is flood plain, therefore rendering Bangladesh a nation very much at risk of further widespread damage. Flooding normally occurs during the monsoon season from June to September during the monsoon. The convectional rainfall of the monsoon is added to by relief rainfall caused by the Himalayas. Melt-water from the Himalayas is also a significant input and flood every year. Figure 4.16 shows the positions of the project site over the flood risk map of Bangladesh. It can be observed that the project area is subject to low to moderate river flooding. The Dhaleshwari river flows very close to the project area.

4.2.6 Air Quality Assessment

127. The Clean Air and Sustainable Environment (CASE) Project, under the Ministry of Environment and Forest, Government of the People's Republic of Bangladesh, monitors different ambient air quality parameters from 11 fixed continuous air monitoring stations (CAMS) located in different parts of the country. Among these the data from the CAMS-3 station located in Darus Salam, Dhaka is the nearest CAMS station available (~12 km east of the project site, GPS N 23.78, E 90.36) and can represent the ambient air quality of the study site since. Different ambient air quality data like PM_{10}, $PM_{2.5}$, CO,

SO_2, NO_x, $O_3$are measured monthly and reported in the CASE Project website (http://www.case-moef.gov.bd/)

Table 4.6: Results of air quality parameter monitoring at the project site during November-December, 2014*

Air Quality parameters	SO_2 – 48hr	NO_X – 48hr	CO – 8hr	$PM_{2.5}$ – 48hr	PM_{10} – 48hr	SPM- 48hr
Unit	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³	µg/m³
Concentration present (Average of 4 measurements)	22±2.9	28±3.4	137±3.2	35±3.4	75±14.4	155±29
Measurement method	West-Geake	Jacob and Hochheiser	Indicator Tube	Gravimetric	Gravimetric	Gravimetric
Bangladesh Standards for Ambient Air Quality (Ref: GoB, 2005)	80 µg/m³ (Annual Avg.) 365 µg/m³ (24-hr Avg.)	100 µg/m³ (Annual Avg.)	10000 µg/m³ (8-hr Avg.) 40000 µg/m³ (1-hr Avg.)	15 µg/m³ (Annual Avg.) 65 µg/m³ (24-hr Avg.)	50 µg/m³ (Annual Avg.) 150 µg/m³ (24-hr Avg.)	200 µg/m³ (8-hr Avg.)
WHO Guidelines	50 µg/m³ (Annual Avg.) 125 µg/m³ (24-hr Avg.)	40 µg/m³ (Annual Avg.)	10000 µg/m³ (8-hr avg) 30000 µg/m³ (1-hr Avg.)	10 µg/m³ (Annual Avg.) 25 µg/m³ (24-hr Avg.)	20 µg/m³ (Annual Avg.) 50 µg/m³ (24-hr Avg.)	-

* Measurements were performed by Adroit Environmental Consultants Ltd. with supervision from BUET

128. Since air quality can vary significantly over various spatial scales, the data provided by the CAMS-3 might not be exactly representative of the project site at Manikganj. In order to assess the air quality of the project site, direct measurements of air quality parameters were made over a span of one month (Nov - Dec, 2014). 48-hour measurements of PM_{10}, $PM_{2.5}$, SO_2, and NO_x and 8-hour measurements of CO were done once per week during November, 2014 (i.e. total four measurements for each parameter). The average of the four measurements for each of the parameters is summarized in Table 4.6. The air quality monitoring data is compared with the Bangladesh Ambient Air Quality Standards, (as adopted in GoB, 2005) and WHO Ambient Air Quality Guidelines Global Update in 2005, for assessing the overall situation of the ambient air quality. By comparing with available standards, it can be seen that the air quality in the area is within acceptable limits.

129. By comparing the November-December, 2013 data from CAMS-3 with the measured data it can be seen that the CAMS-3 data overestimates all the air quality parameters to a certain degree. This may be due to a number of factors including landuse pattern, human and industrial activities, traffic movement etc. However, if we assume that the same normalization factor is valid between the observed data and CAMS-3 data, a temporal air quality profile of the project study site can be constructed as shown in Figure 4.17.

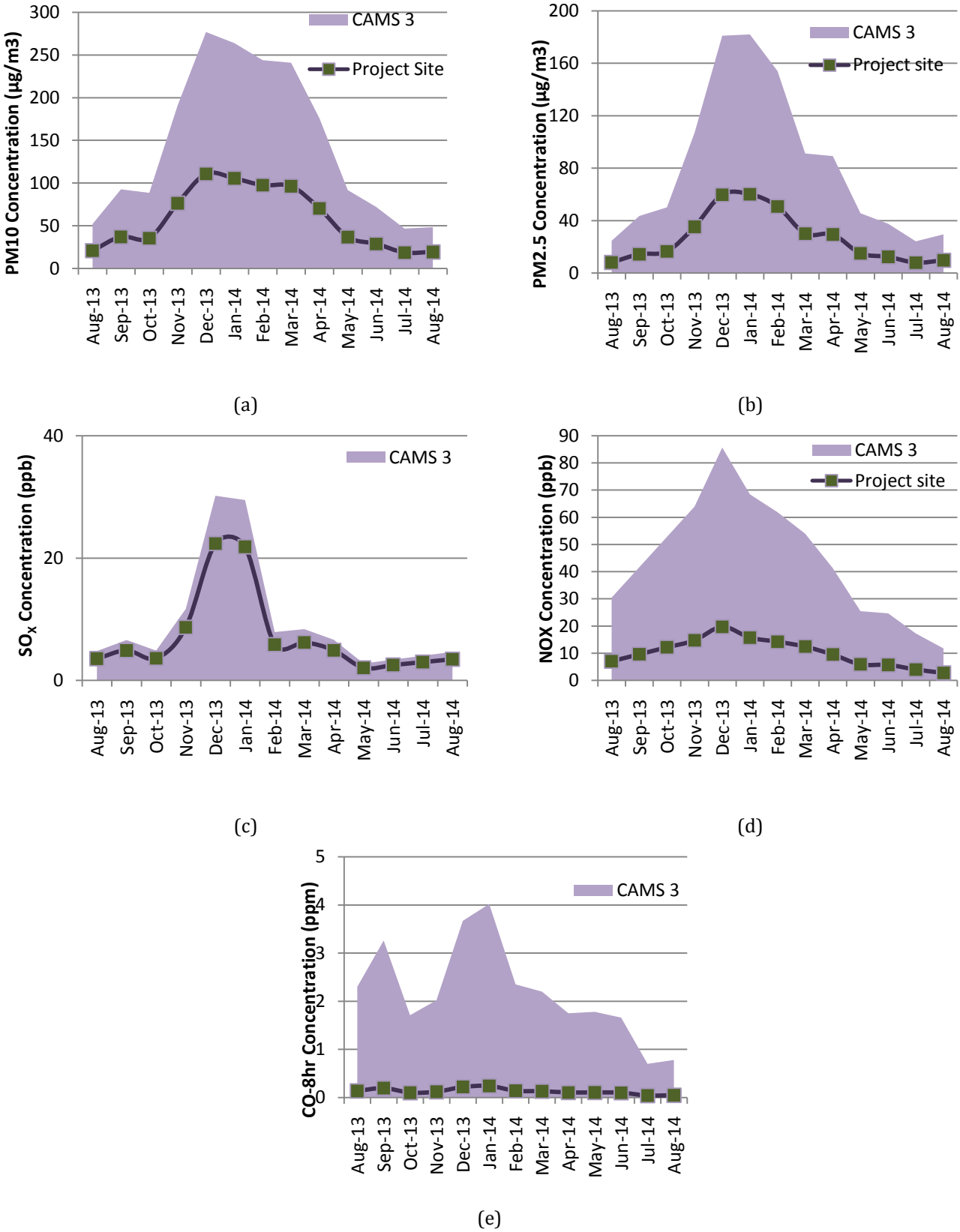


Figure 4.17: Monthly air quality monitoring data from the CAMS-3 located at Darus Salam, Dhaka for the time period of August 2013 to August 2014 along with the air quality data of the project study site. The parameters of the project site were obtained by normalizing the CAMS-3 data against the Nov-Dec 2014 observed data. The air quality parameters shown are (a) PM_{10}, (b) $PM_{2.5}$, (c) SO_2 (d) NO_x , and (e) CO.

Table 4.7: Normalized CAMS-3 monthly air quality data from August-2013 to July-2014 (representing the air quality of the project site)

Pollutant	Aug 2013	Sep 2013	Oct 2013	Nov 2013	Dec 2013	Jan 2014	Feb 2014	Mar 2014	Apr 2014	May 2014	Jun 2014	Jul 2014	Bangladesh Standards (GoB 2005)	WHO Guidelines	Averaging Time
CO (ppm)	0.14	0.20	0.10	0.12	0.22	0.24	0.14	0.13	0.11	0.11	0.10	0.04	10 mg/m^3 (9 ppm)	10 mg/m^3	8 hours
													40 mg/m^3 (35 ppm)	30 mg/m^3	1 hour
NO_x (ppb)	7.02	9.59	12.16	14.72	19.71	15.76	14.24	12.42	9.50	5.87	5.68	3.98	100 µg/m^3 (53 ppb)	40 µg/m^3	Annual
SO_2 (ppb)	3.55	4.89	3.61	8.66	22.35	21.83	5.85	6.21	4.91	2.05	2.52	2.99	80 µg/m^3 (30 ppb)	50 µg/m^3	Annual
													365 µg/m^3 (140 ppb)	125 µg/m^3	24 hours
$PM_{2.5}$ (µg/m^3)	8.12	14.36	16.53	35.31	59.73	60.06	50.82	30.10	29.44	15.05	12.41	7.99	15 µg/m^3	10 µg/m^3	Annual
													65 µg/m^3	25 µg/m^3	24 hours
PM_{10} (µg/m^3)	20.84	37.08	35.44	76.40	110.80	105.60	97.60	96.40	70.40	36.72	28.84	18.68	50 µg/m^3	20 µg/m^3	Annual
													150 µg/m^3	50 µg/m^3	24 hours

130. The annual average of PM_{10} and $PM_{2.5}$ of the study site are 58 µg/m^3 and 27 µg/m^3 respectively which marginally exceeded the national annual standards of these parameters (which are 50 µg/m^3 and 15 µg/m^3 respectively) although the measured quantities did not exceed the 24-hour average national limits. There is pronounced seasonal variation in particulate matter concentration and November – January (winter season) is the worst period considering the prevalence of particulate matter in the ambient air. The 67 brick kilns that are located within a 10-km radius area around the power plant are the likely cause of elevated ambient PM concentrations during the dry season. The reasons for lower levels of PM during the rainy seasonare (1) wet deposition (washing out) of PM due to precipitation and (2) the cease of operation of brick kilns during the rainy season.The 8-hr average CO concentration does not have any significant seasonal variation and the measured levels are well below national standards. The annual average of SO_2 and NO_X of the study site are 7 ppb and 10 ppb respectively which are within the national annual standards of these parameters (which are 30 ppm and 53 ppm respectively). Similar to particulate matter, there is pronounced seasonal variation in the concentrations of SO_2 and November – January (winter season) is the worst period in terms of air quality. The seasonal variation of NO_X is not as pronounced as SO_2.

4.2.7 Noise Level

131. As a part of the baseline study, noise level measurements were made at different locations around the proposed power plant site. Noise measurements were performed during both daytime and nighttime with a calibrated noise level meter (Extech HD-600). 5-minute continuous noise level measurements were carried out at the selected locations, and the equivalent noise levels (Leq) as well as the maximum noise levels (Lmax) were determined. Table 4.9 shows the summary of noise level measurements carried out in different locations in and around the study area. Table 4.10 and Table 4.11 shows the Bangladesh noise level standards and the World Health Organization noise level guidelines for community noise (Environmental, Health, and Safety General Guidelines, 2007), respectively, during daytime and nighttime for various types of areas. Table 4.12 and 4.13 shows the noise limits for various working environments according to Environmental, Health, and Safety General Guidelines and OSHA, respectively.

132. Table 4.8 shows that noise levels at the locations near the study area are generally low. The reason is that the area mostly agricultural land with limited activities being carried out; it is not heavily populated (most of the residents of the local people are far from the site, as previously mentioned). As expected, the Dhaka-Manikganj highway showed the highest noise levels mostly associated with vehicular movement and dense gathering of people.

Table 4.8: Noise level measurements during daytime at selected locations

Noise level measurement locations	GPS Co-ordinate	Equivalent Noise level (dBA),L_{eq}		Maximum Noise level (dBA),L_{max}	
		Day-time	Night-time	Day-time	Night-time
Project site	N 23° 48'61" E 90° 14' 59"	52.6	50.1	59	58.5
Adjacent Residential house to Project site	N 23° 48' 61" E 90° 14' 53"	45.3	53.6	51	59.3
Access road to Project site	N 23° 48' 39" E 90° 14' 57"	55.7	55.4	69.3	58
Dhaka - Manikganj high way	N 23° 47' 93" E 90° 14' 47"	74.8	67.9	92.1	81.9

[Note: The equivalent level is the level (L_{eq}) 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 represents the time average of the fluctuating sound pressure and is close to the maximum level observed during the measurement period. For the fluctuating noise scenario the equivalent noise level (L_{eq}) is generally used for more complete noise sample and is calculated as follows:

$$L_{eq} = 10\log_{10}\left[\sum_{i=1}^{n} P_i 10^{L_i/10}\right]$$

where P_i is the probability of the noise level lying in the i-the measurement interval and L_i is the mid-point of that interval.]

Table 4.9: Bangladesh standards for sound level (GoB, 2006)

Locations	Noise level (dBA) at day	Noise level (dBA) at night
Silent zone	50	40
Residential area	55	45
Mixed area	60	50
Commercial area	70	60
Industrial area	75	70

(Ref: Noise Pollution Control Rules, 2006)

Table 4.10: Noise Level Guidelines Measure Out of Doors. (Guidelines for Community Noise, WHO, 1999)

Receptor	One Hour L_{Aeq} (dBA)	
	Daytime 07:00 – 22:00	Nighttime 22:00 – 7:00
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999)

Table 4.11: Noise Limits for Various Working Environments.

Location/ activity	Equivalent Level L_{Aeq}, 8h	Maximum L_{Amax}, fast
Heavy Industry (no demand for oral communication)	85 dB(A)	110 dB(A)
Light Industry (decreasing demand for oral communication)	50 – 65 dB(A)	110 dB(A)
Open offices, control rooms, service counters or similar	45 – 50 dB(A)	--
Individual offices (no disturbing noises)	40 – 45 dB(A)	--
Classrooms, lecture halls	35 – 40 dB(A)	--
Hospitals	30 – 35 dB(A)	40 dB(A)

Note: For acceptable indoor noise levels for residential, institutional, and education settings refer to WHO (1999)

Table 4.12: OSHA Noise Exposure Limits for the Work Environment (Noise Exposure in dBA)

Noise Levels	Permissible Exposure (hours and minutes)
85	16 hrs
87	12 hrs 6 min.
90	8 hrs
93	5 hrs 18 min
96	3 hrs 30 min
99	2 hrs 13 min
102	1 hr 30 min
105	1 hr
108	40 min
111	26 min
114	17 min
115	15 min
118	10 min
121	6.6 min
124	4 min
127	3 min
130	1 min

Note: Exposure above or below the 90 dBA limit have been time weighted to give what OSHA believes are equivalent risks to a 90 dBA 8 hr. exposure (Marsh, 1991, p.322).

4.2.8 Water Quality

Groundwater quality

133. Groundwater samples were collected from two locations (the sample collection locations are shown in Figure 4.15) near the study site on November, 2014; one from a shallow tubewell (~70' depth) and one from a deep tubewell (~600 ft depth). Samples were tested for selected water quality parameters in BUET environmental engineering laboratory. Table 4.14 shows the characteristics of the groundwater at the different

locations tested. The 600 feet deep tubewell water has been found to be high in color probably due to high iron and manganese concentration. The manganese concentrations in both the tubewells have been found to exceed Bangladesh Standards for drinking water. (see Table 4.13). All other parameters tested have been found to be within acceptable range for that of drinking water. Hardness removal may be required if this water is to be used for generator cooling and boiler operations. In those cases, the extracted water has to be treated to the desired limits as prescribed in the engine/ boiler specifications.

Table 4.13: Summary of groundwater quality in the study area

Water Quality Parameters	Unit	70' deep tubewell	600' deep tubewell	WHO Guide line values 2004	Bangladesh Standard for Drinking Water (ECR'97)
pH	-	7.10	6.89	6.5 - 8.5	6.5 - 8.5
Turbidity	NTU	1.02	6.74	5	10
Color	Pt. Co Unit	11	23	15	15
Total Hardness as $CaCO_3$	mg/L	226	146	500	200 - 500
Iron, Fe	mg/L	0.15	0.58	0.3	0.3 - 1.0
Manganese, Mn	mg/L	1.22	0.51	0.5	0.1
Arsenic, As	µg/L	<1	<1	10	50
Chloride, Cl^-	mg/L	7	11	250	150 - 600
Fluoride, F	mg/L	0.25	0.23	1.5	1
Nitrate-Nitrogen (NO_3-N)	mg/L	0.6	0.5	50	10
Nitrite-Nitrogen (NO_2-N)	mg/L	0.027	0.0056	3	<1
Orthophosphate (PO_4)	mg/L	0.167	0.089	--	6
Ammonia-Nitrogen (NH_3-N)	mg/L	0.724	0.13	1.5	0.5
Total Dissolved Solids, TDS	mg/L	318	264	1000	1000
Total Coliform, TC	# / 100 ml	0	0	00 TC / 100 ml	00 TC / 100 ml
Fecal Coliform, FC	# / 100 ml	0	0	00 FC / 100 ml	00 FC / 100 ml

Surface water quality

134. The main surface water body in the study area is the Dhaleshwari river which serves the purpose natural drainage of storm water. Several factories are present on the bank of the river which receives their wastestreams. The Dhaleshwari river is also the intended recipient of the treated effluent of the CETP of the tannery estate which is under construction. In order to assess any domestic or industrial pollution in nearby areas, surface water can be a good indicator. Two water samples were collected from different stretches (see figure 4.15 for the location of sampling) of the river on November, 2014 and were analyzed in the laboratory for selected parameters. The results of the laboratory analysis are presented in Table 4.14. The results indicate that there is no significant organic pollution in any of the surface water resources as the

BOD, COD, Ammonia values are relatively low.. Some treatment may be required if this water is to be used for generator cooling and boiler operations. In those cases, the extracted water has to be treated to the desired limits as prescribed in the engine/ boiler specifications.

Table 4.14: Analysis of surfacewater samples collected at different locations in the study areas

	Water Quality Parameter	Unit	Concentration present		Inland Water Quality Standard (ECR' 97)
			Sample 1 (Adjacent to study site)	Sample 2 (Adjacent to Shahid Rafiq bridge)	
1	pH	-	7.37	7.76	6.5-8.5
2	Color (True)	Pt-Co	26	28	--
3	Turbidity	NTU	6.82	10.2	--
4	Total Dissolved Solids (TDS)	mg/L	222	190	--
5	Electrical Conductivity (EC) at 25°C	µS/cm	353	325	--
6	Dissolved Oxygen (DO)	mg/L	3.94	5.06	≥ 5[b, d, e, f], ≥ 6[a, c]
7	Ammonia (NH_3-N)	mg/L	0.357	0.491	--
8	Phosphate (PO_4)	mg/L	0.692	0.496	--
9	Sulfate (SO_4)	mg/L	31.2	26.2	--
10	Total Suspended Solids (TSS)	mg/L	16	18	--
11	Chloride (Cl)	mg/L	21	18	--
12	Silica (SiO_2)	mg/L	23	20.2	--
13	Sulfide (S^{2-})	mg/L	9	6	--
14	Chemical Oxygen Demand (COD)	mg/L	9	13	--
15	Biochemical Oxygen Demand (BOD_5)	mg/L	2.4	2.6	≤ 2[a], ≤ 3[b], ≤ 6[c, d], ≤ 10[e, f]

a: to be usable as a source of water supply only after disinfection; b: to be usable for recreational activity
c: to be usable as a source of water supply after conventional treatment; d: to be usable for fisheries
e: to be usable for various process and cooling industries; f: to be usable for irrigation

4.2.9 Surface Water and Ground Water Resources

River Network

135. Dhaleshwari River, a distributary of the Jamuna, takes off in the northwestern part of Tangail district. It is a meandering river having two branches. The main stream flows north of Manikganj and joins the other branch, the Kaliganga, south of Manikganj. The Kaliganga again joins with the Dhaleshwari. The Buriganga was once a distributary of the Dhaleshwari and used to discharge its flow again into the Dhaleshwari. It meets the Shitalakshya river near Narayanganj and flows south to meet the Meghna near Shaitnol and then loses its separate identity. Total length of the river is about 160 km.

River Water Level

136. Water level data of the Dhaleshwari river from the Savar station for the period 1994-2012 (collected by Bangladesh Water Development Board (BWDB)) is given in Table 4.16. The maximum and minimum water levels were found to be 11.44 m and 0.65 m in 2002 and 2007 respectively . It must be noted here that BWDB does not take either discharge or water level measurements during the dry season, only the data during the wet season is collected for flood monitoring. Therefore the data shown in table 4.15 is not representative of the whole year.

Table 4.15: Yearwise water level data of Dhaleshwari River from Savar Station (Station ID SW69)

Year	Maximum level (m PWD)	Minimum level (m PWD)
1994	5.83	1.23
1995	7.29	1.18
1996	6.48	1.25
1997	6.14	0.95
1998	8.63	0.88
1999	6.45	0.97
2000	6.48	1.00
2001	5.91	1.20
2002	11.44	1.24
2003	7.92	1.39
2004	5.96	0.88
2005	5.80	1.26
2006	5.05	0.78
2007	7.30	0.65
2008	4.10	0.97
2009	5.71	0.99
2010	6.15	1.36
2011	6.47	1.68
2012	6.16	1.69

Source: Bangladesh Water Development Board

From the available data the maximum yearly water level for floods with a 50-year return period may be calculated to be 10.57 mPWD[2]. The Finished ground level of the power plant is 11.38 m and the Engine floor level is 11.98 mPWD. Therefore, sufficient freeboard is available for extreme flood events.

River Discharge

137. The historic discharge data of Dhaleshwari river collected by BWDB at SW 68.5 gauging station during the wet seasons of 1994 - 2012 indicate that the maximum discharge of 86.88 m^3/sec occurred on September 1998, coincident with the 1998 flood

[2]Assuming an EV-1 Gumbel Distribution, the maximum flood level x_T with a specific return period T cand be calculated using: $x_T = u + \alpha y_T = \bar{x} - \frac{\sqrt{6}}{\pi}\left\{0.5772 + \ln\left[\ln\left(\frac{T}{T-1}\right)\right]\right\}s$ where $\bar{x}$ and s are the average and standard deviation of the annual maxima of the available length of water level record.

of that year. The water data collected from BWDB for the period from 1994 to 2012 is shown in Table 4.16.

Table 4.16: Yearwise wet season discharge data of Dhaleshwari River as recorded by BWDB (Station ID Dhaleshwari SW 68.5)

Year	Maximum Wet Season Discharge (m^3/s)
1994	53.9
1995	51.43
1996	NA
1997	34.6
1998	86.88
1999	51.67
2000	71.76
2001	NA
2002	34.54
2003	47.52
2004	65.23
2005	34.71
2006	23
2007	NA
2008	56
2009	21.72
2010	9.49
2011	11.59
2012	26.51

Source: Bangladesh Water Development Board NA = Not available

Groundwater

138. Water aquifers are present beneath the vast majority of Bangladesh, which are being recharged by the major river systems and by infiltration of rainwater. The groundwater level fluctuates seasonally, approaching the ground surface at some places of the country during the months July to September. However, the deep aquifer which is used for supplying water within and around Dhaka lies at a much greater depth (up to about 200m).Strong declining trends (0.5–1 metre/year) in dry-period groundwater levels are observed in the central part of the country surrounding the Dhaka city. Excess extraction has caused the groundwater level to decline at a rate of more than 2.0 m inside the city of Dhaka and more than 1.0 m near Buriganga river. Groundwater is replenished each year during the monsoon season when rain and flood water finds its way into the aquifer slowly percolating down through overlying soils and sediments. The rate of recharge varies depending on the property of soil and geology of the area. Figure 4.18 shows the location of the DNPGL project site on the groundwater zoning map of Bangladesh. It can be seen from the map that groundwater is available at the project site around 7.8 – 9.8 m below the ground surface.

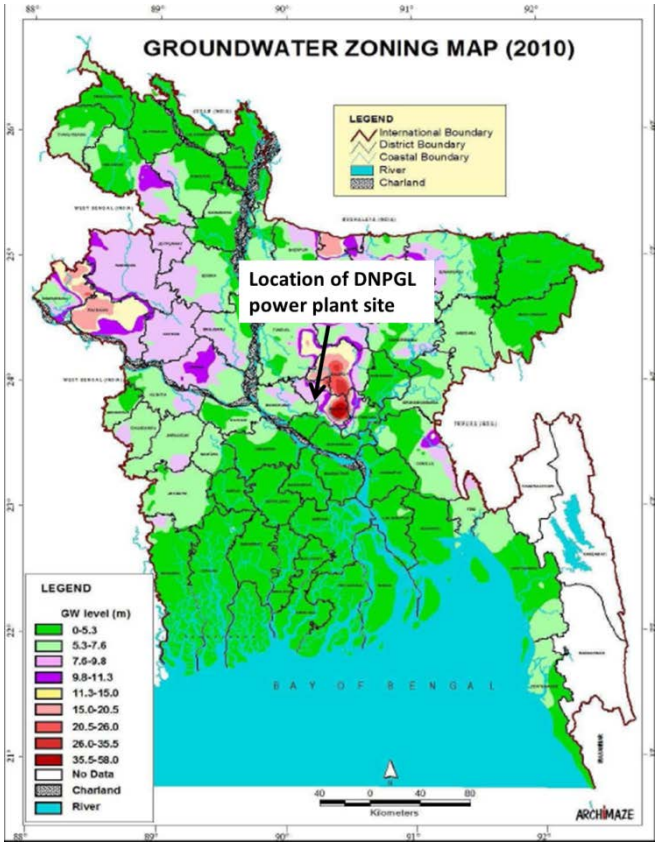


Figure 4.18: Location of the DNPGL project site on the Groundwater Zoning Map 2010 of Bangladesh (map source: Bangladesh Agricultural Development Corporation)

4.3 BIOLOGICALENVIRONMENT

139. The baseline ecological survey sought to determine the status, diversity and distribution of the flora and fauna including fish, and the extent to which that may be impacted due to the proposed project activities. As noted earlier, the power plant will be constructed near a piece of land beside the Dhaleshwari River, and its potential activities (during construction and operation phase) will be based on both land and river; hence, potential impact of various activities on terrestrial and aquatic environment (within and surrounding areas) is of particular interest for this environmental assessment. A team led by the ecologist of the ESIA team visited the proposed project site in between October and November 2014 to collect first hand data on floral and faunal diversity. The study has been conducted primarily in the day time, and to some extends at night. Aural and visual searching is the main method for ornithological survey. Herpeto-faunal and mammalian surveys have been done through visual search and also through discussion with local people and literature review. Information on fisheries has been collected through interviewing fishermen as well as survey of local fish market. Rapid visual field survey and discussion with local people are the main methods for floral survey. All collected data has been cross-checked through literature review. This baseline information has been used in the relevant section of this report to identify and assess impact of the proposed project on the

present existing ecological resources, and finally, to suggest mitigation measures to offset those potential impacts.

4.3.1 Ecological Perspective of the Proposed Project Study Area

140. Bio-ecologically the proposed project site remains under the Young Brahmaputra-Jamuna Floodplain. Agro-ecologically, it remains under Low Ganges River Floodplain. By analysis of available GIS data, the land use pattern of the proposed power plant study area is shown in Table 4.17.

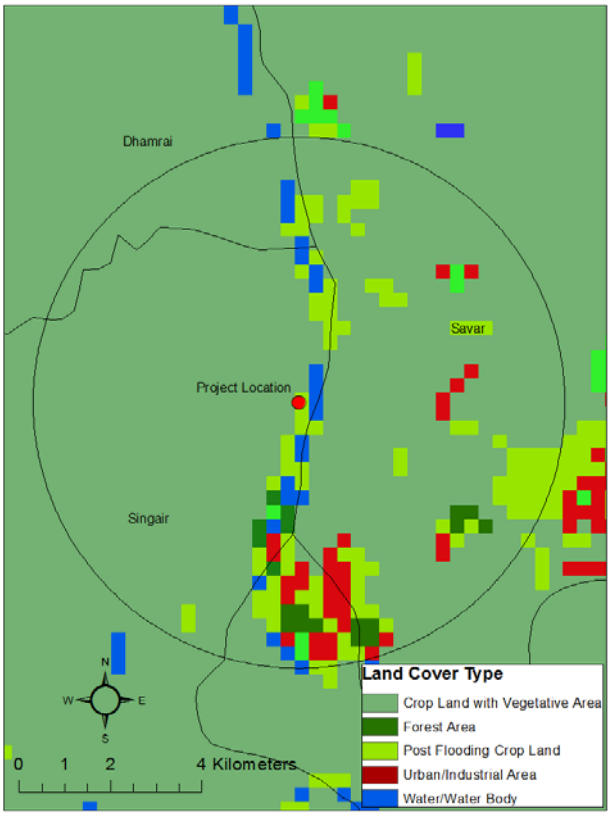


Fig. 4.19: Land use pattern of the proposed power plant project study areas.

Table 4.17: Land Use pattern within 5 km radius area of the proposed power plant project site

Land Use Type	Percent Area within 5 km radius
Crop Land With Vegetative Area	87.79
Post-Flooding Crop Land	7.06
Urban/Industrial Area	3.35
Forest Area	0.30
Water/Water bodies	1.50
Total	100.00

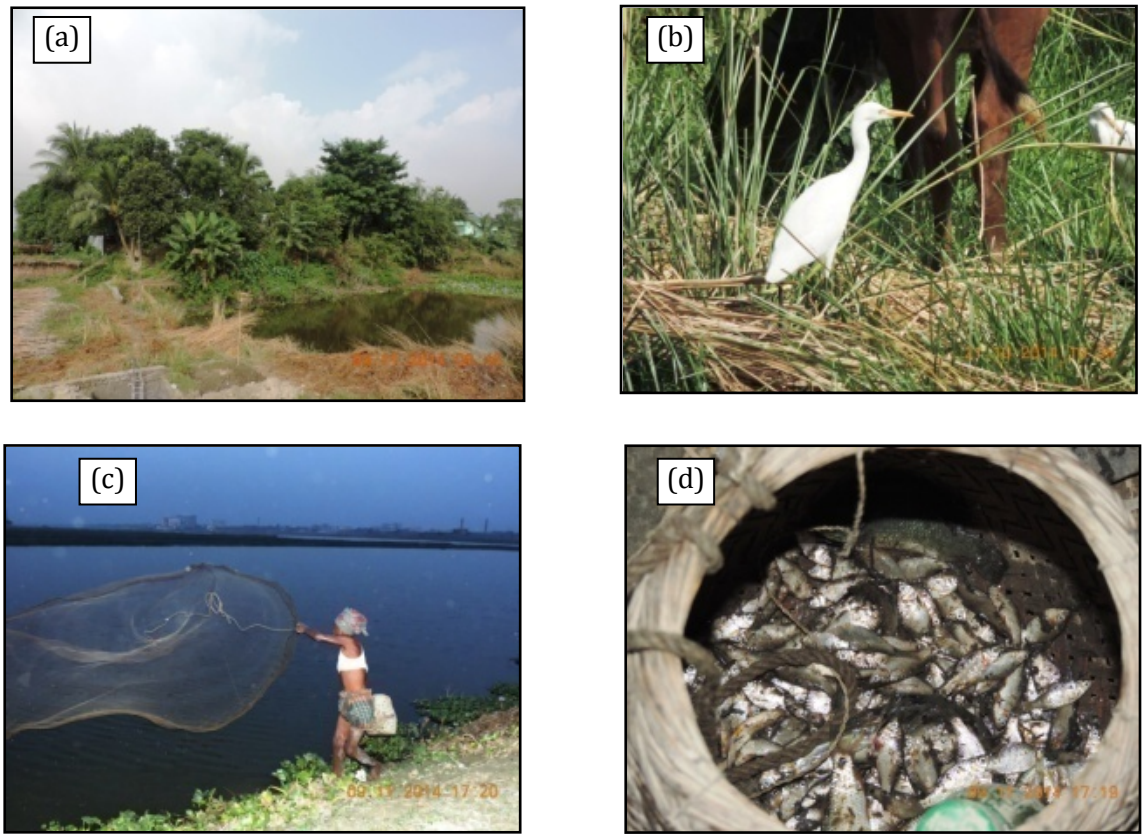


Figure 4.20: Floral, Faunal and Fish Diversity observed adjacent to the proposed project site: (a) A typical village with mixed floral diversity that supports certain types of faunal species, and the nearby pond supports native fish species. (b) Little Egret – a common fauna observed in a fallow land. (c) Evening fishing practice by a local fisherman in the Dhaleshwari River, and (d) Diversified native fish catches by a fisherman from the Dhaleshwari River.

141. The present ecological study has been confined within a part of Singair and Savar Thana near the proposed power plant (10 km radius from the center point of proposed project site). The ecological characteristics of both areas differ from each other (Fig. 4.20). The Singair study site has rural environment with rich ecological features, and the Savar site has urban industrial environment with low ecological features. The first one has several old and new villages, seasonal wetlands, fallow lands and agricultural lands that support diversified floral and faunal species. Most of the trees were planted and have economic importance to the human society. The high lands are used for agricultural practice (paddy, maize, mustard oil, vegetables etc). The low land areas are inundated seasonally, and act as a seasonal wetlands during rainy season up to 4 months. Throughout the year, the area provide habitat for aquatic and terrestrial flora and fauna including numerous freshwater native fish species. The surrounding wetland serves as the grazing ground for fish and other aquatic animals in rainy season. The changes in the physical characteristics of land (project site and its surrounding areas)

may have direct impacts on its dependent flora and fauna. On the other hand, natural ecological features under Savar site have already changed by the previous development works (e.g., road construction, other industrial infrastructure development, etc). Some land filling activities have been observed in Savar which is an example of gradual alteration of existing ecological features. Apart from anthropogenic influence, the ecological features generally fluctuate seasonally due to the environmental reasons (cyclone, drought, flood etc), and a new ecosystem has evolved there to support local adaptive biodiversity.

Figure 4.21: Diversified aquatic fauna observed in the project study areas: (a) Juvenile Common Teal, a migratory bird, searching food from an aquatic habitat. (b) Pond Heron waiting to catch fish from an aquatic habitat, (c) Bull frog resting in a ditch, (d) Skipper Frog at shallow water, (e) White-breasted Kingfisher waiting to catch fish from the Dhaleshwari River and (f)Cattle Egret standing beside an aquatic habitat.

142. As mentioned earlier, both rural and urban ecological features exist in the project study areas. For the purpose of this study, the macro ecological features of the study area are considered that primarily consists of rural and urban floral and faunal diversity. Description of these ecological features is presented below.

4.3.2 Faunal Diversity

143. Various assemblages of animal communities exist in the project study area. Some species use the area as permanent habitats while others as temporary / migratory habitats. On the basis of habitats, the faunal species found in the project study area have been divided into two major categories viz. (a) aquatic fauna, and (b) terrestrial fauna.

Aquatic fauna

144. Some species of amphibian, reptile, bird, mammal and freshwater fish are the main components of the aquatic fauna (Figure 4.21). The reproduction, breeding and multiplication of aquatic fauna is finely tuned and adjusted to the rhythm and amplitude of monsoon flooding. A total of 38 aquatic faunal species have so far been identified and relative abundance of these species is provided in Fig. 4.22. Except fish, the figure indicates that the area is abundant with aquatic birds followed by aquatic reptiles. A complete list of aquatic faunal species is given in Table 4.18.

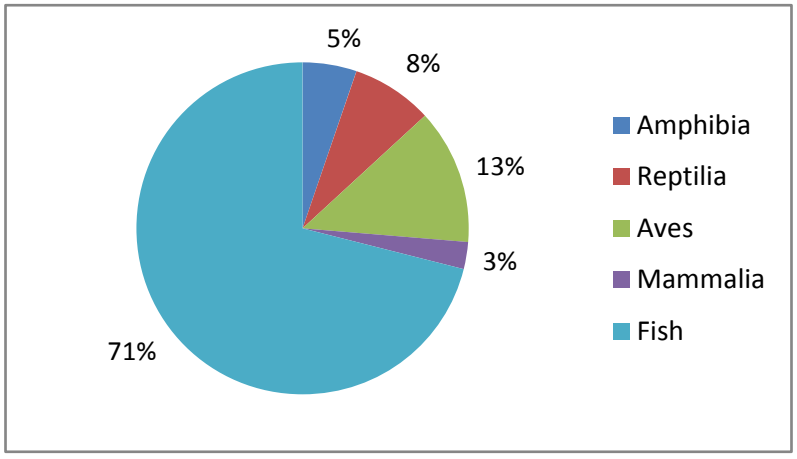


Figure4.22: Distrubution of aquatic fauna in the project study area

Table 4.18: Identified aquatic fauna in and around the DNPGL project study site.

CLASS	FAMILY	ENGLISH NAME	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
Amphibia	Ranidae	Asian Bull Frog	*Hoplobatrachus tigerinus*		✓	✓
		Skipper Frog	*Euphlyctis cyanophlyctis*		✓	✓
Reptilia	Bataguridae	Indian Roofed Turtle	*Kachuga tecta*		✓	
	Natricidae	Checkered Keelback	*Xenochrophis piscator*		✓	
	Homalopsidae	Com Smooth Water Snake	*Enhydris enhydris*		✓	
Aves	Ardeidae	Pond Heron	*Ardeola Grayii*		✓	

CLASS	FAMILY	ENGLISH NAME	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
		Cattle Egret	*Bubulcus ibis*		✓	
	Alcedinidae	White breasted Kingfisher	*Halcyon smyrnensis*		✓	
	Anatidae	Common Teal	*Anas Crecca*		✓	
	Dendrocygnidae	White-breasted Waterhen	*Amaurornis phoenicurus*		✓	
Mammalia	Platanistidae	Ganges River Dolphin	*Platanista gangetica*		✓	
Fresh water Fish / Osteichthyes	Anabantidae	Climbing Perch	*Anabas testudineus*		✓	✓
	Pangasidae	Pungus (cultured)	*Pangasius pangasius*		✓	
	Claridae	Walking Catfish/ Magur	*Clarius batrachus*		✓	
	Heteropneustidae	Stinging Catfish	*Heteropneustes fossilis*		✓	
	Notopteridae	Grey Featerback	*Notopterus notopterus*		✓	✓
	Synbranchidae	Gangetic Mudeel	*Monopterus cuchia*		✓	✓
	Cyprnidae	Indian Carplet	*Ambhypharyngodon microlepis*		✓	✓
	GoBiidae	Tank GoBy	*GlossoGoBius giuris*		✓	✓
		Bumblebee GoBy	*BrachyGoBius nunas*		✓	✓
	Clupeidae	Indian River Shad	*Gudusia chapra*		✓	✓
	Nanidae	Mottled Nandus	*Nandus nandus*		✓	
	Polynemidae	Indian Threadfish	*Polydactylus indicus*		✓	
	Belontiidae	Sunset Gourami	*Colisa sota*		✓	
	Ariidae	Gagora Catfish	*Arius gagora*		✓	
		Soldier Catfish	*Osteogeneiosus militaris*		✓	
	Channidae	Asiatic Snakehead	*Channa orientalis*		✓	✓
		Spotted Snakehead	*Channa punctatus*		✓	✓
	Polynemidae	Indian Threadfish	*Polydactylus indicus*		✓	
	Cyprinidae	Catla	*Catla catla*		✓	✓
		Rohu	*Labeo rohita*		✓	✓
		Mrigal	*Cirrhinus mrigala*		✓	✓
		Ticto / Firefin Barb	*Puntius ticto*		✓	✓
		Swamp/ Chola Barb	*Puntius chola*		✓	
	Mastacembelidae	Tire-trak Spinyeel	*Mastacembelus armatus*		✓	
		One-stripe Spinyeel	*Macrognathus aculeatus*		✓	
	Bagridae	Tengra Mystus	*Mystus tengara*		✓	✓
		Long-whiskered Catfish	*Aorichthys aor*		✓	

[*Note: 1 = Proposed DNPGL Project Site at Singair, 2 = Surrounding rural areas of proposed project site under Singair Thana, and 3 = Surrounding urban industrial areas of proposed project site under Savar Thana]

Terrestrial fauna

145. Several species of amphibians, reptiles, birds and mammals are the main components of terrestrial fauna (Figure 4.22). The project area has agricultural dry land, seasonal wetland, homestead land, fallow land, roadside low land, as well as rivers, canals, ditches, which provide good environment for terrestrial habitat. A total of 56 terrestrial faunal species have so far been identified and a relative abundance of these species is provided in Fig. 4.23. The figure indicates that the area is abundant with terrestrial birds followed by terrestrial mammals. A complete list of aquatic faunal species is given in Table 4.19.

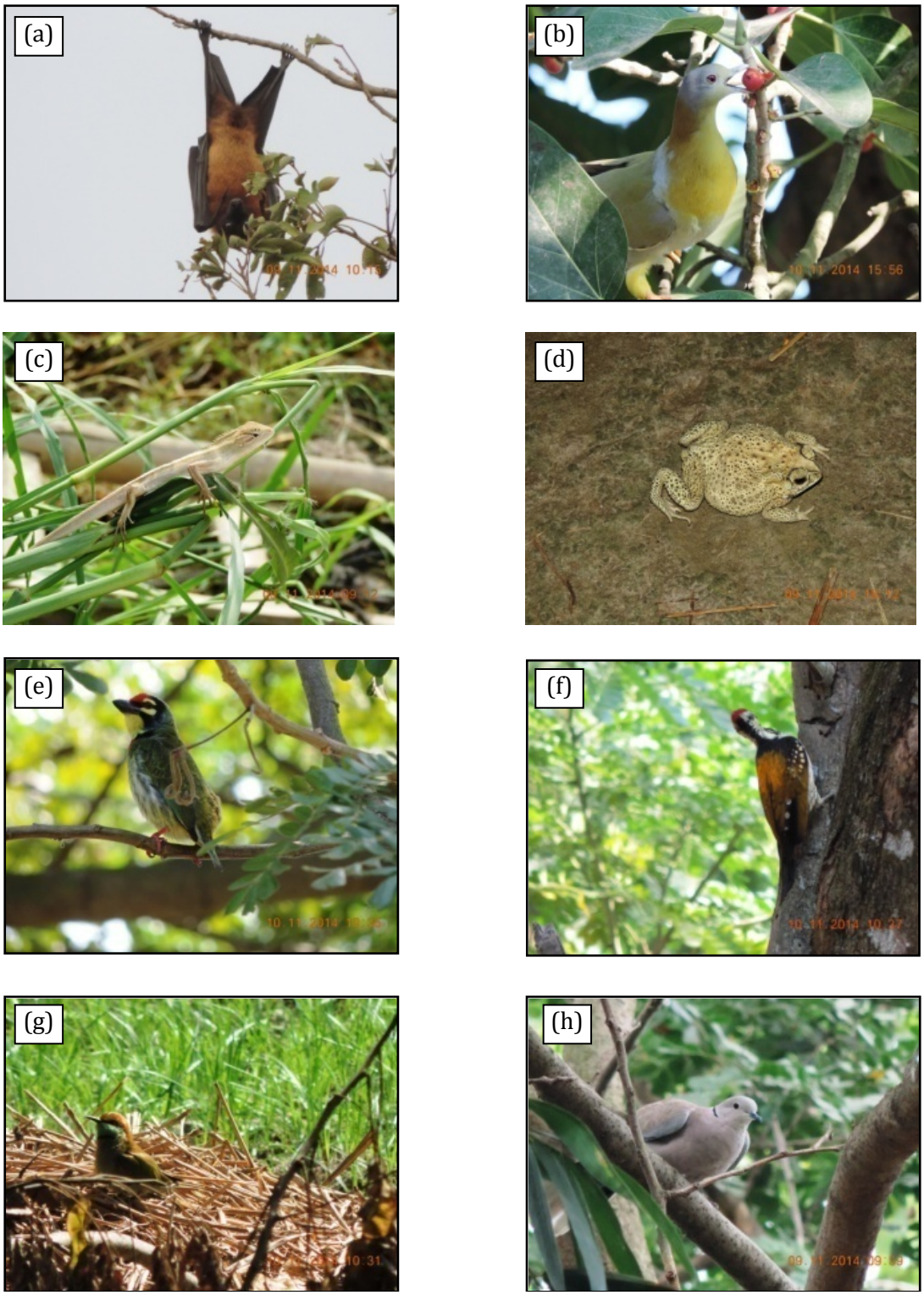


Figure 4.22: Diverse terrestrial fauna observed in the project study areas: (a) Flying fox - a mammal, roost in a large tree. (b) Yellow legged Green Pigeon eating a fruit from a large tree. (c) Common Garden Lizard on a herb, (d) Common Toad crossing a muddy road in the evening, (e) Coppersmith Barbet taking rest on a tree branch, (f) Black-rumped Flamback searching food (insect) from a tree trunk. (g) Green Bee Eater taking rest, and (h) Ring Dove taking rest on a branch of a tree trunk.

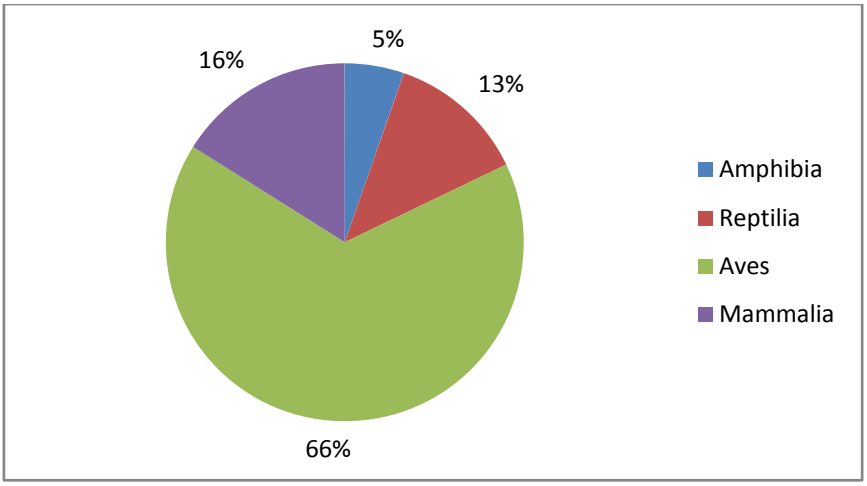


Figure4.23 : Distribution of terrestrial fauna in the project areas

Table 4.19: Identified terrestrial fauna at three major sampling areas for the DNPGL project site

CLASS	FAMILY	ENGLISH NAME	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
Amphibia	Bufonidae	Common Toad	*Bufo melanostictus*	✓	✓	✓
	Rhacophoridae	Maculated Tree frog	*Polypedates maculatus*		✓	✓
	Ranidae	Cricket frog	*Limnonectes limnocharis*	✓	✓	✓
Reptilia	Agamidae	Common Garden Lizard	*Calotes versicolor*	✓	✓	✓
	Gekkonidae	Common House Lizard	*Hemidactylus flaviviridis*		✓	✓
		Common House Lizard	*Hemidactylus brooki*		✓	✓
	Scincidae	Common Skink	*Mabuya carinata*		✓	
	Varanidae	Grey Monitor Lizard	*Varanus bengalensis*		✓	
	Dipsadidae	Common Wolf Snake	*Lycodon aulicus*		✓	
	Colubridae	Rat Snake	*Coluber mucosus*		✓	
Aves	Megalaimidae	Coppersmith Barbet	*Megalaima haemacephala*		✓	
	Picidae	Black-rumped Flamback	*Dinopium benghalense*		✓	
	Scolopacidae	Fantail Snipe	*Gallinago gallinago*		✓	
	Laniidae	Brown Shrike	*Lanius cristatus*	✓	✓	✓
	Dicruridae	Black Drongo	*Dicrurus macrocercus*	✓	✓	✓
	Alcedinidae	Common Kingfisher	*Alcedo atthis*		✓	
		White-throated Kingfisher	*Halcyon smyrnensis*		✓	
	Meropidae	Green Bee Eater	*Merops orientalis*		✓	
	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer*		✓	✓
	Apodidae	Asian Palm Swift	*Cypsiurus balasiensis*		✓	✓
	Psittacidae	Rose ringed Parakeet	*Psittacula krameri*		✓	
	Nectariniidae	Purple Sunbird	*Nectarinia asiatica*		✓	
	Muscicapidae	Oriental Magpie Robin	*Copsychus saularis*		✓	✓
		White-throated Fantail	*Rhipidura albicollis*		✓	

CLASS	FAMILY	ENGLISH NAME	SCIENTIFIC NAME	SURVEY AREAS*		
				1	2	3
	Motacillidae	White-browed Wagtail	*Motacilla alba*		✓	
	Irenidae	Common Iora	*Aegithina tiphia*		✓	
	Ardeidae	Indian Pond heron	*Ardeola grayii*		✓	
		Cattle Egret	*Bubulcus ibis*		✓	
		Little Egret	*Egretta garzetta*		✓	
	Centropodidae	Indian Cuckoo	*Cuculus micropterus*		✓	
	Columbidae	Ring Dove	*Streptopelia decaocto*		✓	✓
		Rock Pigeon	*Columba livia*		✓	✓
		Yellowlegged Green Pigeon	*Treron phoenicoptera*			
	Laridae	Common Tern	*Sterna hirunda*		✓	
	Rostratulidae	Greater Painted-Snipe	*Rostratula bengalensis*		✓	
	Accipitridae	Brahminy Kite	*Haliastur Indus*		✓	
	Passeridae	House Sparrow	*Passer domisticus*		✓	✓
		Baya Weaver	*Ploceus philippinus*		✓	
		Paddy field Pipit	*Anthus rufulus*		✓	
	Sulviidae	Striated Grassbird	*Megaurus palustris*		✓	✓
		Common Tailorbird	*Orthotomus sutorius*		✓	✓
		Common Babbler	*Turdoides caudatus*		✓	✓
	Oriolidae	Black-headed Oriole	*Oriolus xanthornus*		✓	
	Corvidae	House crow	*Corvus splendens*			✓
		Rufous Tree Pie	*Dendrocitta vagabunda*		✓	
	Sturnidae	Asian Pied Starling	*Sturnus contra*			✓
		Common Myna	*Acridotheres tristis*		✓	✓
Mammalia	Pteropodidae	Flying Fox	*Pteropus gigantius*		✓	
	Vespertilionidae	Indian Pipistrelle	*Pipistrellus coromandra*		✓	✓
	Herpestidae	Small Indian Mongoose	*Hervested auropunctatus*		✓	✓
	Soricidae	Grey Musk Shrew	*Suncus murinus*		✓	✓
	Muridae	Indian Field Mouse	*Mus booduga*		✓	
		House Mouse	*Mus musculus*		✓	✓
		Common House Rat	*Rattus rattus*		✓	✓
		Bandicoot Rat	*Bandicota indica*		✓	
		Indian Mole Rat	*Bendicota bengalensis*		✓	

[*Note: 1 = Proposed DNPGL Project Site at Singair, 2 = Surrounding rural areas of proposed project site under Singair Thana, and 3 = Surrounding urban industrial areas of proposed project site under Savar Thana]

4.3.3Floral Diversity

146. Wild plant species that grows in a habitat for a particular period is known as flora. It plays a vital socio-economic and ecological role in a particular habitat or ecosystem. Some flora develops adaptive features to survive in particular types of habitats. Some plants are habituated with soil, some are with water and some are with both soil and water for their normal growth and development. On the basis of habitats, the floral species found in the project study areas have been divided into two major categories viz. (a) aquatic flora, and (b) terrestrial flora.

Aquatic flora

147. Except Dhaleshwari River bank, the project study areas have few low land / seasonal wetlands with some varieties of aquatic flora. The aquatic flora is divided into three major types, viz. tree, shrub and herb. These floral species grow in ponds, canals, ditches, river, seasonal wetland and low lying agricultural lands in submerged, free-floating, or rooted floating states (Fig. 4.24). The common aquatic floral species in the project area include Kalmi - *Ipomoea aquatica* , Kachuripana - *Eichhornia crassipes,* Khudipana - *Lemna perpusilla*, Helencha- *Enhydra flactuans,* etc. A total of 21 aqautic foral specises have been identified of which 2 are trees and rest are herbs. No aquatiic shrubs were identified from the project study areas. Figure 4.25 shows their relative abundance and Table 4.20 provides a complete list of floral species.

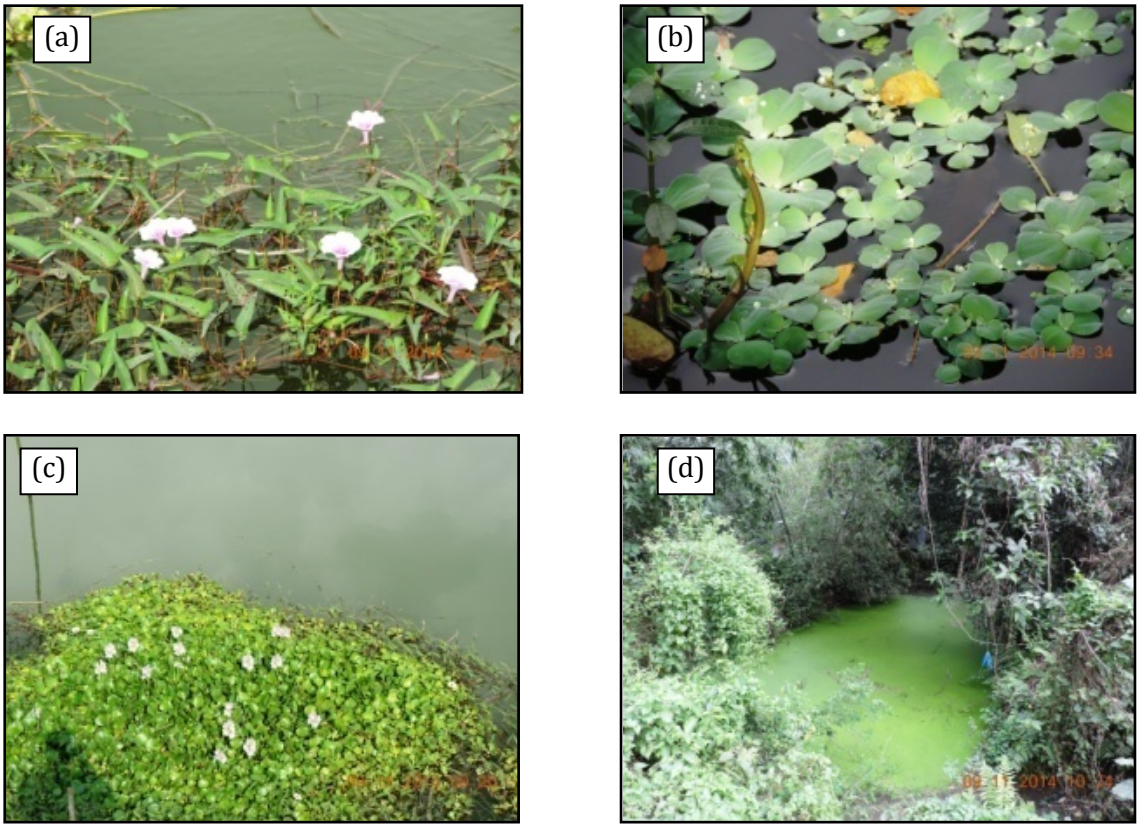


Figure 4.24 Diversified aquatic flora observed in the project study areas: (a) Flower of Kolmi, (b) Topapana, (c) Flower of water hyacinth, and (d) Khudipana in their aquatic habitats

Table 4.20: Identified terrestrial flora at three major sampling areas for the DNPGL project.

NAME			HABIT	STUDY AREAS*		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Clynogyne dichotoma	Marantaceae	Sitalpati	Herb		✓	
Vallisneria spiralis	Hydrocharitaceae	Patajhangi	Herb		✓	
Utricularia aurea	Utriculariaceae	Jhangi	Herb		✓	

NAME			HABIT	STUDY AREAS*		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Ceratophyllum dumersum	Ceratophyttaceae	Jhanjhi	Herb		✓	
Nymphaea nouchali	Nymphaeaceae	Sada shapla	Herb		✓	
Lemna perpusilla	Limnaceae	Khudipana	Herb		✓	✓
Eichhornia crassipes	Pontederiaceae	Kachuripana	Herb		✓	✓
Pistia strateotes	Araceae	Topapana	Herb		✓	✓
Salvinia cuculata	Salviniaceae	Indurkanipana	Herb		✓	
Hygroryza aristata	Gramineae	Phutki janglidhan	Herb		✓	
Ipomoea aquatica	Convolvulaceae	Kalmi	Herb		✓	
Hydrilla verticillata	Hydrocharitaceae	Janjhi, Kurcli	Herb		✓	
Enhydra fluctuans	Compositae	Helencha	Herb		✓	
Alternanthera philoxeroides	Amaranthaceae	Helencha	Herb		✓	✓
Aponogeton natans	Aponogetonaceae	Ghenchu	Herb		✓	✓
Scirpus articulatus	Cyperaceae	Chechra	Herb		✓	
Barringtonia acutangula	Lecythidaceae	Hijal	Tree		✓	
Crataeva nurvala	Capparidaceae	Barun, banny	Tree		✓	
Colocasia esculenta	Araceae	Katchu	Herb	✓	✓	✓
Monochoria vaginalis	Pontederiaceae	Sarkachu	Herb		✓	✓
Calamus sp	Palmae	Bet	Herb		✓	

[*Note: 1 = Proposed DNPGL Project Site at Singair, 2 = Surrounding rural areas of proposed project site under Singair Thana, and 3 = Surrounding urban industrial areas of proposed project site under Savar Thana]

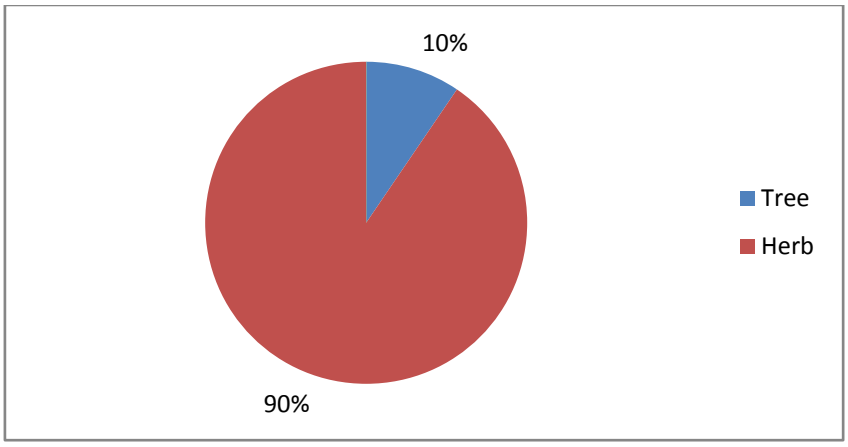


Figure 4.25: Distribution of aquatic floral habit in the project study areas

Terrestrial flora

148. Several villages exists in the project study areas; these villages have planted terrestrial flora that have economic value to the community. The terrestrial plant species make a complex ecosystem in which wildlife has direct relationship through their ecological niche. Commercial flower garden and vegetable plantation were observed. Common terrestrial flora are Mehagini - *Swietenia mahagoni,* Bot - *Ficus benghalensis,* Betelnut - *Areca catechu*, Coconut - *Cocos nucifera*, Mango - *Mangifera indica*, Rain tree - *Samanea saman,* etc. Scattered terrestrial flora were observed in the Savar industrial area portion. Three types of terrestrial plant habit e.g. trees, shrubs and herbs exist in the project areas (Fig.4.26). Except herbs and shrubs, few natural trees

(naturally originated) exist in the project area. Most of the plants particularly the trees and shrubs are planted and cultivated. A total of 61 floral species have so far been identified in the project study areas of which 31 are tree species, 20 are herb species and the rest are shrubs. Figure 4.27 shows their relative abundance and Table 4.21 provides a complete list of floral species.

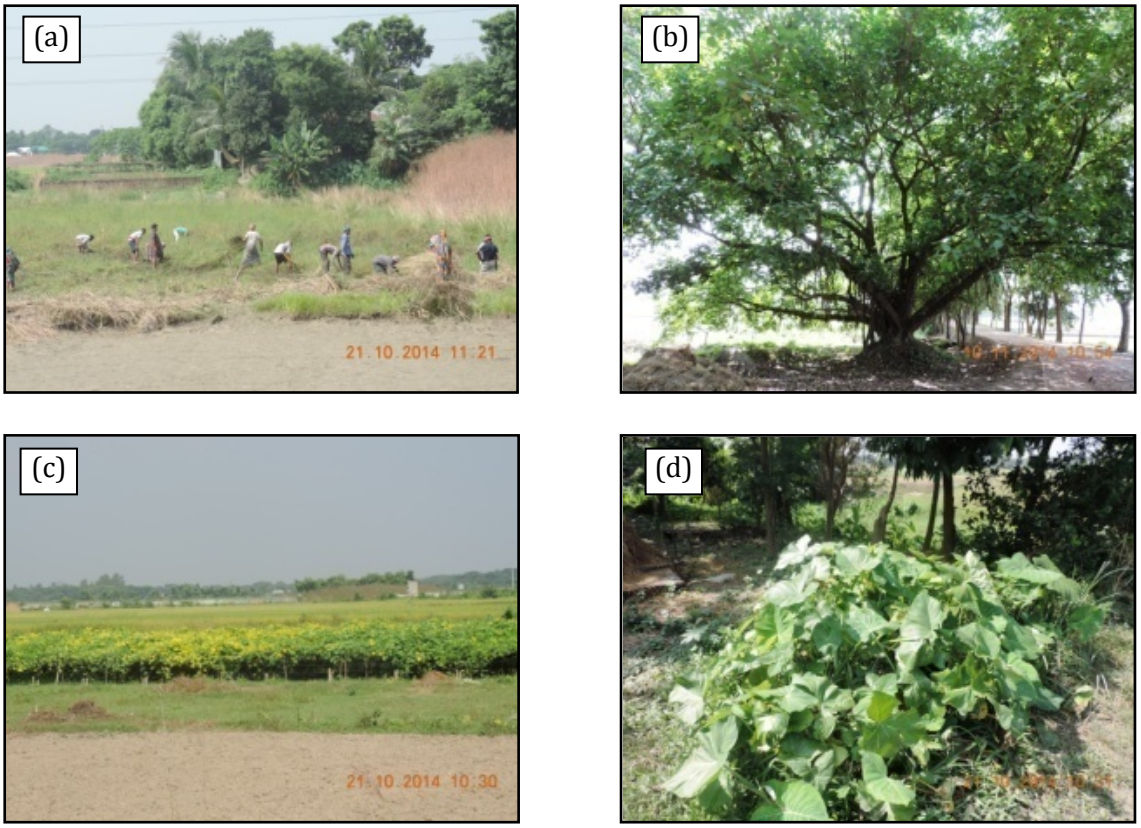


Figure 4.25 Diversified terrestrial floral observed in the project study areas: (a) Varieties of terrestrial flora in a village, (b) Large matured fig tree beside a road, (c) Terrestrial flora (vegetable) planted in a cultivable land, and (d) Terrestrial flora (herb) grown in a fallow land.

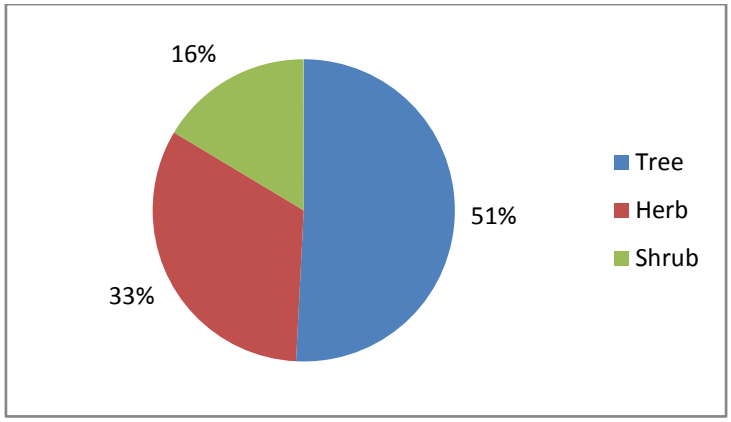


Figure 4.26: Distribution of terrestrial floral habit in the project areas

Table 4.21: Identified terrestrial flora at three major sampling areas for the DNPGL project site.

NAME			HABIT	STUDY AREAS		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Saccharum spontaneum	Graminace	Kash	Herb	✓	✓	✓
Clerodendrum viscosum	Verbinaceae	Vat	Herb	✓	✓	✓
Pteris vittatai	Pteridophyte	Dhekishak	Pteridophytes	✓	✓	✓
Solanum indicum	Solanaceae	Titbegun	Shrub	✓	✓	✓
Mikania cordata	Compositae	Assamlata	Herb	✓	✓	✓
Coccinia indica	Cucurbitaceae	Telakucha	Herb	✓	✓	✓
Chrysopogon aciculate	Gramineae	Chore Kanta	Herb	✓	✓	✓
Carica papaya	Caricaceae	Pape	Shrub		✓	✓
Polygonum hydropiper	Polygonaceae	Bishkatali	Herb	✓	✓	✓
Ipomoea fistulosa	Convolvulaceae	Dholkalmi	Herb		✓	✓
Lindernia procumbens	Scrophulariaceae	Bakpuspa	Herb		✓	✓
Alternanthera sesilis	Amaranthaceae	Haicha	Herb		✓	✓
Zizyphus mauritiana	Rhamnaceae	Boroi, Kul	Tree	✓	✓	✓
Datura metol	Solanaceae	Dhutra	Herb		✓	✓
Azadirachta indica	Meliaceae	Neem	Tree		✓	
Heliotropium indicum	Boraginaceae	Hatisur	Herb	✓	✓	
Centolla asiatica	Hydrocotyleace	Than kuni	Herb		✓	✓
Ocimum sanctum	Labiatae	Tulsi	Herb		✓	
Hyptis suaveolens	Labiatae	Tokma	Herb		✓	
Molocanna bambusoides	Gramineae	Muli bansh	Shrub		✓	
Litchi chinensis	Sopindaceae	Lichee	Tree		✓	
Calotropis gigantean	Asclepiadaceae	Akonda	Tree		✓	
Averrhoa carambala	Averhoaceae	Kamranga	Tree		✓	✓
Basella rubra	Basellaceae	Pui Shak	Shrub		✓	
Acacia auriculiformis	Leguminosae	Akashmoni	Tree		✓	✓
Acacia mangium	Leguminosae	Mangium	Tree		✓	
Erythrina variegata	Leguminosae	Mandar	Tree		✓	
Tamarindus indica	Leguminosae	Tetul	Tree		✓	
Ficus glomoreta	Moraceae	Jagadumur	Shrub		✓	
Eucalyptus citriodora	Myrtaceae	Eucalyptus	Tree		✓	✓
Albizia procera	Leguminosae	Koroi	Tree		✓	✓
Anthocephalus chinensis	Rubiaceae	Kadam	Tree		✓	✓
Dalbergia sissoo	Leguminosae	Sisu	Tree		✓	✓
Musa spp	Musaceae	Kala	Herb		✓	✓
Barringtonia acutangula	Lecythidaceae	Hijal	Tree		✓	
Aegle marmelos	Rutaceae	Bel	Tree		✓	✓
Blumea lacera	Compositae	Sheyalmutra	Herb		✓	✓
Areca catechu	Plamae	Supari	Tree		✓	✓
Leonurus sibiricus	Libiatae	Raktadrone	Herb		✓	✓
Samanea saman	Leguminosae	Rendi	Tree		✓	✓
Bombix cliba	Bombacaceae	Simul	Tree		✓	
Cynodon dactylon	Gramineae	Durbaghas	Herb		✓	✓
Solanum nigrum	Solanaceae	Phutibegun	Herb		✓	✓
Acacia nilotica	Leguminosae	Babla	Tree		✓	✓
Bambusa spp	Gramineae	Bansh	Tree		✓	
Mangifera indica	Anacardiaceae	Am	Tree		✓	✓
Ricinus communis	Euphorbiaceae	Reri, venna	Shrub		✓	✓
Alstonia scholaris	Apocynaceae	Chatim	Tree		✓	
Delomix regia	Leguminosae	Krishnachura	Tree		✓	✓
Swietenia mahagoni	Meliaceae	Mehagini	Tree		✓	✓

NAME			HABIT	STUDY AREAS		
SCIENTIFIC	FAMILY	NATIVE		1	2	3
Ficus benghalensis	Moraceae	Bot	Tree		✓	✓
Clematis gouriana	Ranunculaceae	Chagalbati	Herb		✓	
Coccos nucifera	Palmae	Narikel	Tree		✓	✓
Lagerstroemia speciosa	Lythidaceae	Jarul	Tree		✓	
Phoenix sylvestris	Palmae	Khejur	Tree		✓	✓
Phyllanthus reticulates	Euphorbiaceae	Chitki	Shrub		✓	✓
Ficus hispida	Moraceae	Kakdumur	Shrub		✓	✓
Artocarpus heterophyllus	Moraceae	Kathal	Tree		✓	✓
Casuarinas equisetifolie	Casuarinaceae	Jhau	Tree		✓	✓
Borassus fiabellifer	Palmae	Tal	Tree		✓	✓

[*Note: 1 = Proposed DNPGL Project Site at Singair, 2 = Surrounding rural areas of proposed project site under Singair Thana, and 3 = Surrounding urban industrial areas of proposed project site under Savar Thana]

Threatened Flora and Fauna

149. Some specific scientific criteria are followed to declare a species as threatened (critically endangered, endangered etc.). It is generally declared by the World Conservation Union (IUCN) for each country. Floral or faunal species including fish that exist in threatened condition are generally known as threatened species. Currently 147 wildlife and 54 freshwater fish species are threatened in Bangladesh; 40 plant species are also threatened in Bangladesh. No threatened floral species have been identified in the project area. However, some threatened wildlife and fish species have been identified in the project areas (Table 4.22) which are considered threatened throughout the country as well. Ganges river dolphin is an endangered mammalian species in Bangladesh. It was described as an endangered species for entire Bangladesh including Dhaleshwari River. No authentic data has so far been available on its population number and trend, species composition, food habit, feeding behavior, and other ecological aspects of this species in the Dholeshwari River except its existence in the river. It could be seen during wet season when the clean water is plenty in the river; but, in winter, it may not be seen due to the degraded water quality of the river. Ganges river dolphins generally use Dholeshwari River as their habitat due to the availability of clean water, food and other ecological component. It is an integral part of Dhaleshwari river ecosystem and plays vital role to balance the existing river ecosystem.Water pollution, inadequate water (in dry season), frequent vessel movement in the Dholeshari River is the prime threats for Ganges river dolphin. Ganges river dolphin is sometimes caught and killed by the fishermen for commercial use. It is also killed by other people for preparing traditional medicine.

Table 4.22: List of Critically Endangered, Endangered and Vulnerable wildlife and fish fauna in the study area

Biological Class	English name	Scientific name	O	L	CE	E	V	CT
Reptilia	Grey Monitor Lizard	*Varanus bengalensis*	√				√	
	Common Wolf Snake	*Lycodon aulicus*		√			√	

Mammalia	Ganges River Dolphin	*Platanista gangetica*		√		√		
Osteichthyes	Mottled Nandus	*Nandus nandus*		√			√	√
	Asiatic Snakehead	*Channa orientalis*	√				√	√
	Ticto / Firefin Barb	*Puntius ticto*		√			√	√
	Tire-trak Spinyeel	*Mastacembelus armatus*		√		√		√
	One-stripe Spinyeel	*Macrognathus aculeatus*		√			√	√
	Long-whiskered Catfish	*Aorichthys aor*	√				√	√
	Grey Featerback (V)	*Notopterus notopterus*	√	√			√	√
	Gangetic mudeel (V)	*Monopterus cuchia*		√			√	√

[Legend: O = Observed, L = Local Info. CE = Critically Endangered, E = Endangered, V = Vulnerable, CT = Commercially Threatened].

4.3.4ECA, Protected Area, National Park, Game Reserve & Wildlife Sanctuary

Ecologically Critical Area (ECA)

150. It is an environmental protection zone, defined by the Government of Bangladesh under the Bangladesh Environment Conservation Act, 1995, where ecosystem is considered to be threatened. The declaration states restrictions on hunting, fishing, all activities that could result in the destruction of floral or faunal habitats, activities that could destroy natural characteristics of water and soil, activities detrimental to fishery, installation of polluting industrial units, and discharge of domestic/ industrial liquid waste into any water bodies / river. No ECA exists at or near the project study areas

Protected area (PA)

151. An area of land and/or ocean especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means is referred to as "Protected Area (PA)". Such an area is predominantly a natural area established and managed in perpetuity, through legal or customary regimes, primarily to conserve their natural resources. No PA exists at or near the proposed project site.

National Park (NP)

152. A National Park (NP) is a reserve land, usually declared and owned by a national government, protected from most human development activities and pollution. No NP exists at or near the proposed project site.

Game reserve (GR)

153. A Game Reserve (GR) is an area of land set aside for maintenance of wildlife for tourism or hunting purposes. No GR exists at or near the proposed project site.

Wildlife Sanctuary (WS)

154. A Wildlife Sanctuary (WS) is an area that assures the natural conditions necessary to protect nationally significant species, groups of species, biotic communities, or physical features of the environment where these require specific

human manipulation for their perpetuation. No WS exists at or near the proposed project site.

4.4 SOCIO-ECONOMICENVIRONMENT

155. As a part of ESIA, a social baseline study was carried out, which includes baseline socio-economic information and findings of Focus Group Discussions (FGDs) & meetings. The specific objectives of the social baseline were to gather information on the existing social environment surrounding the proposed project site. The social study primarily focused on identifying the status of important economic and social attributes of the project study areas. Possible impacts of the proposed project activities have to be evaluated against these baseline socio-economic attributes, and later, mitigation measures have to be suggested to reduce / eliminate the significant adverse impacts. This section describes the baseline socio-economic aspects / attributes of the project study areas based on the field study as well as secondary information. Findings of the FGDs and meetings have been presented in Chapter 6 of this report.

4.4.1 Approach and Methodology

156. As a part of the ESIA, an assessment of baseline socio-economic attributes of the proposed project study areas were made. The social assessment covered an area of about 5 km radius surrounding the power plant project site which includes a small portion of two upazila under two districts (viz. Singair, Manikganj and Savar, Dhaka). The districts are separated by Dhaleshwari River. Efforts were made to identify the socio-economic attributes that may be impacted due to the proposed project activities. Some basic features of the social environment of project study areas are available in the Population and Housing Census 2011 of Bangladesh Bureau of Statistics (BBS, 2012) of GoB. To collect more information on socio-economic attributes, the members of the survey team visited the project study areas in between October–November 2014, conducted field study / observation, meetings (both formal and informal) and focus group discussions (FGDs). More than 100 people have been directly interacted during the study; 62 people participated in a couple of FGDs, and others participated in the formal/informal meetings. Some socio-economic attributes of the project study areas are shown in Fig. 4.27 - 4.30

4.4.2 Socio-economic perspective of the study areas

157. As noted earlier, this socio-economic study covers a couple of Upazila under two districts viz. Singair Upazila of Manikganj district and Savar Upazila of Dhaka district. The basic socio-economic features of both Upazila are summarized below (BBS, 2012):

158. Singair Upazila is situated at 23.8167°N 90.1500°E. Total area is about 217.38 sq. km. It has 236 villages under 11 Unions and 1 Municipal. A total of 287,451 people live in this area of which around 49% male and 51% female. Population density is 1,321 per sq. km. Most of the people live in the rural environment. Total number of households (HH) is 65,068 and average HH size is 4.4. Most of the HH structure (84%) is not strong

enough (i.e. Katcha / non concrete structure). Average literacy rate is 46% where male are 48% and female are 44%. About 96% HH have tube well from where they get water for their various purposes. The toilet facility varied. Among them 24% sanitary (water sealed), 58% Sanitary (non-water sealed), 16% non-sanitary and 2% have no such facility. Almost 57% HH have electricity. No pipe supplied natural gas line available. About 94% population is Muslim followed by Hindus. Around 35,898 male and 1,327 female are employed.

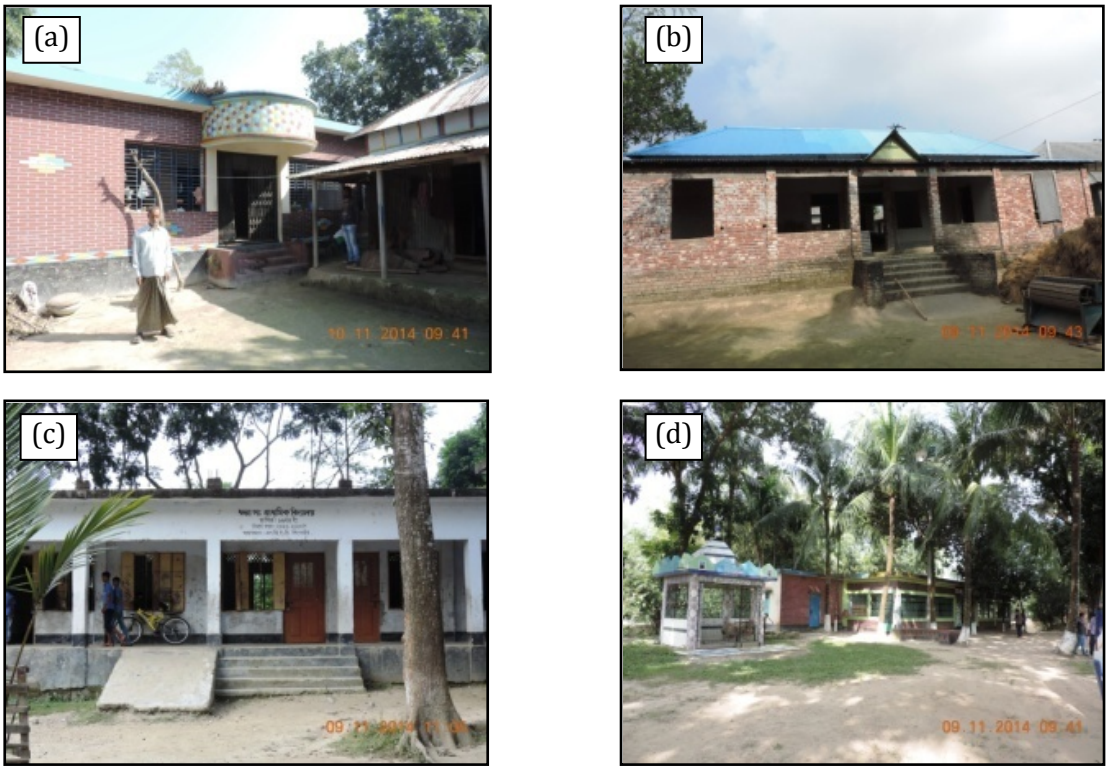


Figure 4.27: Various type of socio-economic attributes of the project study areas: (a) a newly built firm structure – symbol of local economic growth, (b) A new house is under construction also indicate the growth of local economy, (c) A Government school for local student, and (d) A mosque in the project study areas.

159. This portion of study area under Savar upazila have semi urban industrial environment. Garment industry dominates this area and thousands of people worked there. It is mainly inhabited by people of middle and low-income groups. High income group people live nearby Dhaka City though they come here for day to day work. Utility services including piped water, sanitation, waste damping issues seems to be scanty. Market, small shops, rickshaws, three wheeler CNG taxi, truck etc.are also available here that play an import economic role among the people of present society. School, college, religious institution, bank etc. also available here and play a vital socio-economic role to the local community. Few local fishermen also catch fishes from the Dheleswari River.

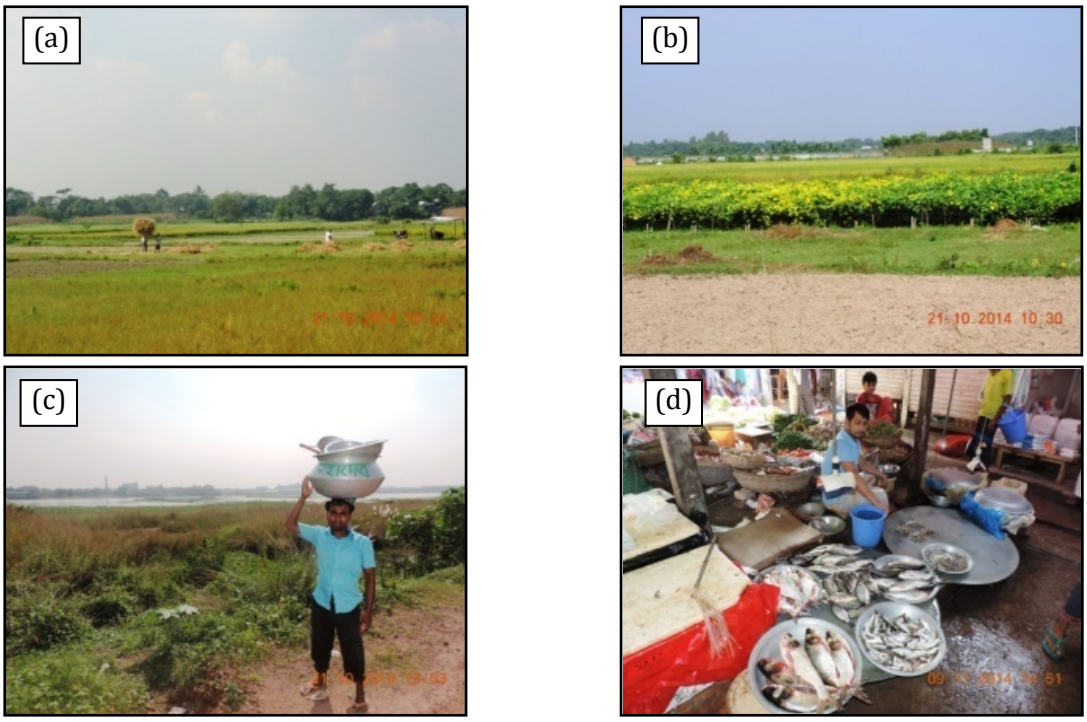


Figure 4.28: Various type of socio-economic attributes observed in the project study areas. (a) A typical paddy field with paddy collection by farmers, (b) Winter vegetable garden, (c) Local fisherman returning home after selling fish from a local market, and (d) Local fish market with local and outside fish.

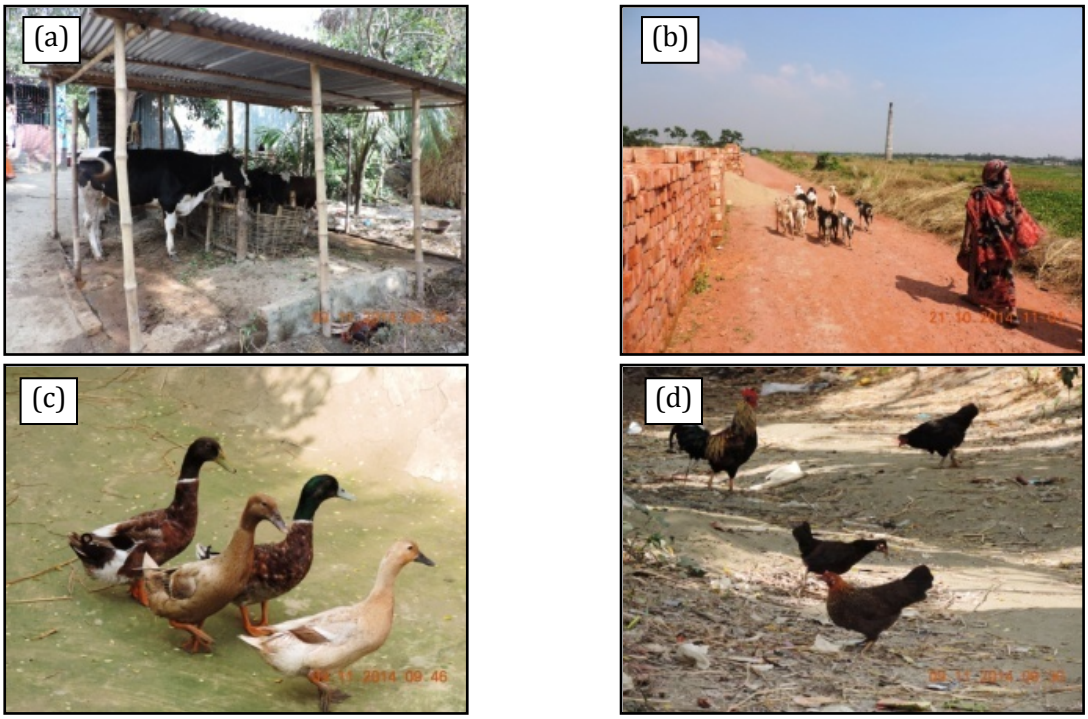


Figure 4.29: Various type of socio-economic attributes observed in the project study areas: (a) Milk producing cow resting in a shed, (b) Women are engaged in rearing goats, (c) Duck rearing in a village, and (d) Poultry in a village.

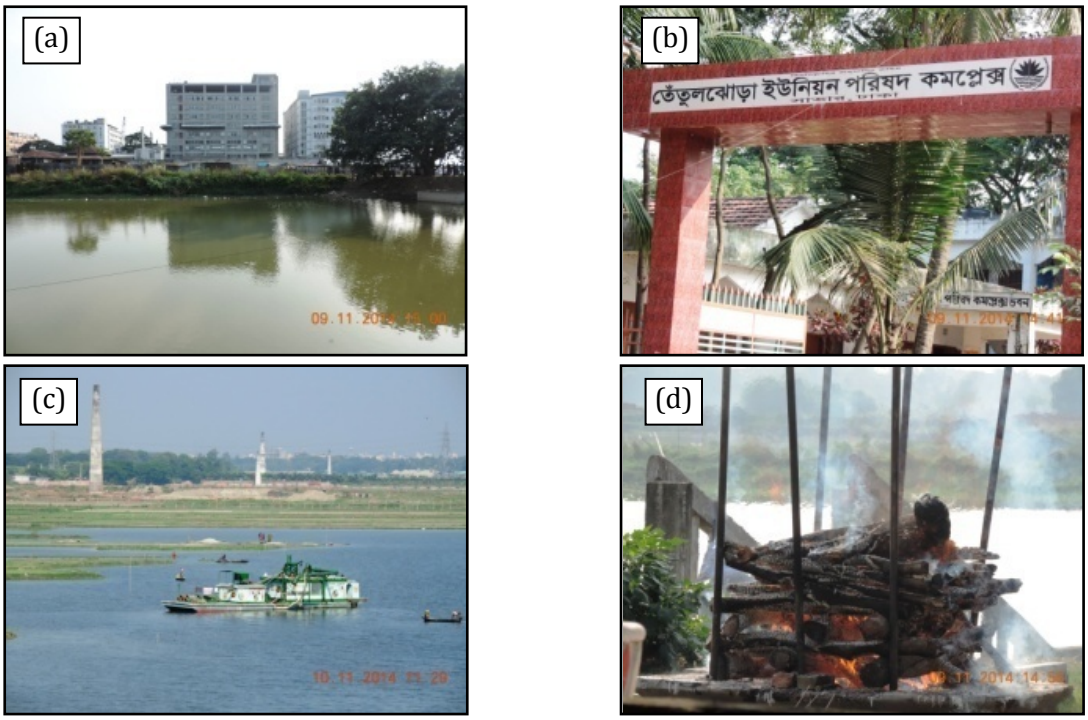


Figure 4.30: Various type of socio-economic activities observed in the project study areas. (a) garment industries exist just opposite side of the proposed power plant project, (b) Tetuljhora Union Parishad office engaged for public service, (c) Some brick kilns observed beside the Dhaleshwari River, and (d) Hindu religious ceremony – burning of a dead female human body beside Dhaleshwari River .

CHAPTER 5

EVALUATION OF IMPACTS

5.1 INTRODUCTION

160. As a part of the Environmental and Social Impact Assessment (ESIA), environmental impacts of the specific project activities on different ecological, physico-chemical and human interest related parameters, both during the construction phase and the operation phase, have been identified and assessed. The proposed project involves construction of a 55 MW HFO-based power plant in Singair, Manikganj. Detailed description of the project has been provided in Chapter 3 of this report. The baseline environment of areas within the surrounding the project site has been presented in Chapter 4. This Chapter presents an assessment of the potential significant impact of the proposed project on the surrounding baseline environment during both construction and operational phases.

5.2 ENVIRONMENTAL IMPACT DURING CONSTRUCTION PHASE

161. The major activities during the construction phase of the proposed 55 MW HFO power plant may be broadly classified into the following: (i) mobilization of equipment, materials and personnel; (ii) site preparation; and (iii) civil construction and electromechanical installation/erection. Some of these project activities would likely to have some adverse impacts on certain environmental parameters, while some other would have beneficial effects. In this study, the effects of the project activities on physico-chemical, ecological and socio-economic (i.e., human interest related) parameters have been assessed separately.

5.2.1 Ecological Impacts

162. The proposed project activities (viz. construction and operation of power plant) have some potential impacts (direct and indirect) on the existing ecological environment. Important project activities include land clearing and alteration, movement of people and vehicle through road and river, material transport and placement, excavation, construction work, accident (e.g. HFO spills) etc. During construction phase, land related activities are likely to have some adverse impact on its existing environment. During operational phase, ecological impacts may result from improper handling of HFO, which is likely to have some adverse impact on flora, fauna and fish. For the proposed project, potential ecological impacts could be divided into two broad category viz. (a) direct impact and (b) indirect impact. This Section describes

both impacts on flora, fauna and fish diversity of the proposed power plant project study areas.

Impact on Flora

163. Activities related to construction of power plant and associated HFO transmission line have some potential impacts (direct and indirect; positive or negative) on the existing floral environment. Magnitude or intensity of these impacts may differ; some could easily be identified while others require long-term study / monitoring. Potential impacts of the proposed project on flora are described below.

Potential Impact on Aquatic Flora

164. Seasonal native aquatic freshwater flora exists in and around the proposed project site. Adjacent aquatic habitat support more than 21 aquatic floral species; however, none of them are threatened in Bangladesh. Due to proposed project activities (e.g. conversion of low land to high land), some aquatic flora may have to face potential adverse impacts. If project activities run over an aquatic floral habitat, partial or entire aquatic flora may be damaged or destroyed. People, vehicle and material movement over the aquatic floral habitat may cause damage or uproot them from the ground.

Potential Impact on Terrestrial Flora

165. Little undergrowth (no tree) with less terrestrial floral diversity exists in the proposed project site. This undergrowth should be removed for project completion. Terrestrial undergrowth has great contribution to the existing ecosystem, and clearing or removal of the undergrowth would also have some adverse impacts. On the other hand, the project study areashave moderate number of terrestrial habitat to support at least 61 terrestrial floral species, though none of them are threatened in Bangladesh. Most of the floral species are planted by the local Govt. (roadside plantation) and local people (private plantation) for their livelihood, and these are common throughout the project study areas, and seem not to be impacted by this project.

Potential Impact on Fauna including Fish

166. Construction activities related to the proposed power plant project could have potential impacts (direct and indirect) on the existing aquatic and terrestrial fauna due to their highly sensitive and reactive behavior in response to disturbance that may occur at or near their habitat. Faunal species that are sensitive to direct (human activity and traffic) or indirect disturbance (noise) would be impacted most. Habitat disturbance would reduce habitat availability and effectiveness for a certain period for mammals, reptiles, amphibians, birds and their predators. There are also some possibilities of direct mortality and displacement of amphibians, reptiles, birds and mammals from the use of vehicle or machineries over terrestrial or aquatic faunal habitats. Quantification of these losses is difficult; however, the impact is expected to be low and short-term in nature.

167. Various type of project activities near fish habitats (e.g. Dhaleswari River) may also have some potential impact on fish e.g. mortality, disturbance of fish passage during monsoon, deposition of excavated soil on fish habitat (e.g. river bank), contamination of water, destruction of shallow fish habitat or saturated ground by movement of project vehicles, etc. The jetty/pontoon construction in the bank of the Dhaleshwari river will cause short-term, localized disturbance to their habitat. It is likely that the habitat will be restored after construction is completed. Vessel movement during operation phase of the project will not affect these species as they reside underwater. The Gangetic Dolphin, which often shows up at the water surface may collide with the fast-moving water vessels and may get injured.

Potential Impact on Amphibians

168. Five aquatic and terrestrial amphibian species have identified from the project study areas and none of them area threatened in Bangladesh. However, a couple of amphibian species observed in the proposed power plant site. Amphibians are more sensitive to the environmental changes due to their permeable skin and other biological features. Amphibians use both aquatic and terrestrial habitat for their survival and changes in characteristics of habitat have a great impacts for their survival. Some of the project activities could have some impacts on existing amphibians such as (i) undergrowth or vegetation may be cleared for construction works, affecting amphibian habitat, (ii) project vehicle and materials may enter into the shallow freshwater bodies or saturated ground affecting habitat, (iii) increased sediment load or contamination of water due to various project activities, also affecting habitat. These activities may cause temporary or permanent disturbance of amphibian habitat. Impacts on amphibian population could be evaluated by monitoring the changes of species composition and richness and their relative abundance.

Potential Impact on Reptiles

169. Ten aquatic and terrestrial reptiles were identified at or near the project sites, and a couple of them are nationally threatened. These are Grey Monitor Lizard (Varanusbengalensis) and Common Wolf Snake (Lycodonaulicus). Reptiles are sensitive animal and sometimes used as indicative species for bio-environmental assessment. Burrowing reptiles are sensitive and respond quickly to any man-made or natural activities/calamities. Special care should be taken before conducting any activity in and around the habitats of these animals. If the project activities are conducted during pre or post breeding season of the burrowing reptiles, the entire community could be affected seriously or their life cycle could be jeopardized. To evaluate impacts on reptilian species, relative abundance and changes in species composition could be used as indicators.

Potential Impact on Birds

170. Forty two avian species (terrestrial and aquatic) are available in the proposed power plant project study areas, and none of them are threatened in Bangladesh.

Potential impacts of project activities on birds include disturbance due to project related actions and excessive human presence during bird's foraging, resting and nesting time that might result in reproductive disturbance / failure. Removal of floral (tree, herb and shrub) species for the proposed project would affect some bird habitat from where they collect food (insects), take rest and also build nests. Potential impacts for those bird species include: (i) habitat destruction, (ii) temporary displacement due to increased human disturbance and vehicle movement, and (iii) nest abandonment and/or reproductive failure caused by project related disturbance.

Potential Impact on Mammals

171. Ten mammalian species (terrestrial and aquatic) are available in the project study areas and none of them are observed in the proposed power plant site. The Dhaleshwari River provides habitat for one nationally threatened aquatic mammalian species which is the Ganges River Dolphin -Platanistagangetica. However, some mammalian species may be disturbed and displaced from their habitat for some hours, days or months due to the power plant project activities. They are likely to return to their habitat soon after the disturbance has ceased. Some mammalian species also utilize village vegetation throughout the year or seasonally as permanent or temporary habitat. Project activities, e.g., movement of vehicle, vessels and also people could displace some prey species for some mammal within the project areas. However, disturbances associated with the proposed project works are too small to have any measurable effect on the prey for mammals. Effects are expected to be temporary, incidental and minimal.

Potential Impact on Fish

172. Twenty seven freshwater native fish species are available in the project study areas, of which eight are nationally threatened. These fishes are commercially important to the local community. In order to prevent habitat destruction, measures are needed for protection of water quantity, quality and fish passage/access to habitat during flow periods. Freshwater native fish may encounter some potential impacts due to project activities, such as mortality, disturbance of fish passage, sediment deposition on fish habitat, contamination of water, destruction of shallow fish habitat due to intrusion of project vehicles, dewatering of water bodies, etc. The proposed power plant will carry materials, oil etc via Dholeshwari River. Accidental oil spill in the river water is a major concern during transportation that may create adverse impact to the habitat of Ganges River Dolphins. Frequent movement of project related vessels in the river may disturb the dolphin habitat and its prey as well as cause collision with it. Proposed power plant wastes dumping, if any, may create water pollution of Dholeshwari River that will ultimately degrade the existing dolphin habitat.

Table 5.1: Consequence (Impact) Severity Ranking (Project Site Level)

Environmental effects				
Low	Minor	Moderate	Major	Critical
No lasting effect. Low-level impacts on biological environment. Limited damage to minimal area of low significance	Minor effects on biological environment. Minor short-medium term damage to small area of limited significance	Moderate effects on biological environment but not affecting ecosystem function. Moderate short-medium term widespread impacts (e.g. oil spill)	Serious environmental effects with some impairment of ecosystem function (e.g. displacement of species). Relative widespread medium –long term impacts.	Very serious environmental effects with impairment of ecosystem function. Long-term, widespread effects on significant environment (e.g. unique habitat, national park)

Risk Assessment of Ecological Impacts

173. A typical environmental risk assessment matrix has been developed for flora, fauna and fish species within the power plant project areas. A similar format is widely used in oil and gas industries. Table 5.1 shows the consequence severity ranking (from low to critical); Table 5.2 shows the likelihood ranking (from "almost certain" to "rare"), along with frequency level for each ranking. Table 5.3 shows the risk assessment matrix, which is based on consequence severity and likelihood/frequency of occurrence of an event; risk has been classified from "low" to "extreme".

Table 5.2: Likelihood ranking table

Likelihood	Description	Frequency Description
Almost certain	Consequence expected to occur in most circumstances	High frequency of occurrence – occur more than once per month
Likely	Consequence will probably occur in most circumstances	Regular frequency. Event likely to occur at least once per year
Possible	Consequence should occur at some time	Occurs once every 1 – 10 years
Unlikely	Consequence could occur at some time	Unlikely to occur during life of operations – occurs once every 10 – 100 years
Rare	Consequence may occur under exceptional circumstances	Highly unlikely to occur during life of the operation. Occurs less than once every 100 years.

Table 5.3: Risk assessment matrix

Likelihood / Frequency	Consequence Severity				
	Low	Minor	Moderate	Major	Critical
Almost certain	High	High	Extreme	Extreme	Extreme
Likely	Moderate	High	High	Extreme	Extreme
Possible	Low	Moderate	High	Extreme	Extreme
Unlikely	Low	Low	Moderate	High	Extreme
Rare	Low	Low	Moderate	High	High

174. In Table 5.4, the potential impacts of the project activities on the flora, fauna and fish species have been ranked on the basis of consequence severity ranking (Table 5.1), likelihood/frequency ranking (Table 5.2), and risk rating (Table 5.3). Both the "consequence severity" and "risk" of the possible impacts have been categorized as "low", while likelihood/frequency" has been categorized as "possible". Thus, the proposed project is not likely to have any significant adverse impact on the existing ecological environment, if appropriate mitigation measures are adopted and described in relevant Chapter of this report.

Table 5.4: Summary of Environmental Risk Assessment Matrix

Ecological Aspects	Potential Impact (Consequence)	Consequence severity ranking	Impact likelihood rating	Risk rating
Flora	Minor impact to flora may occur during the installation of HFO transmission pipeline (vessel to power plant).Construction of power plant may displace or remove terrestrial / aquatic undergrowth /floral species; Such type of undergrowth is available in the proposed project adjacent areas. As these are grows naturally and seasonality, no plantation programme required; hence no major effects are expected.	Low	Possible	Low
Fauna	Minor impacts (temporary displacement) to all types of fauna may occur during installation of HFO transmission pipeline (vessel to power plant). Construction of power plant has negative impacts (e.g., habitat loss). Since the activities are temporary in nature, no major or long-term effects are anticipated, except loss of some habitat.	Low	Possible	Low
Fish	Low impact to fish community may occur due to frequent movement of vessel in the Dhaleswari river; Moderate impact may also occur due to oil spill (as an accidental case). Therefore, nearby fish communities could potentially be impacted from soil deposition in aquatic habitat, noise, water pollution, etc. The majority of impacts would be temporary in nature; fish may avoid the impacted areas during construction period, but return when it ceases.	Low	Possible	Low

5.2.2 Socio-economic Impacts

175. Major social parameters considered for assessment of social impacts of the proposed power plant project include loss of land and income, traffic congestion and safety, employment and commercial activities. The effects of the project activities on these parameters have been assessed.

Loss of Land

176. Land acquisition has significant adverse social impacts, and therefore, special care needs to be taken to minimize land acquisition with proper compensation as per Government rules and regulations and World Bank policies. No land acquisition will be required for this power plant project since it is being implemented on DNPGL-owned land. To use river bank land and embankment /walkway for installation of HFO pipeline (vessel to power plant), only permission needs to be taken from appropriate governmental authority.

Loss of Income

177. Loss of income may result from inability to use a particular piece of land/ establishment (e.g., agricultural land; road-side shops) during the construction phase for income generation activities. Since the power plant project is being implemented on DNPGL-owned land and there would be no direct loss of income as the project area is not being used for any income-generating activities of the local people. But there may be minor inconveniences of the people to carry out their income-generating activities around the project area. Efforts should be made to keep such disturbance to a minimum (e.g., scheduling construction keeping in mind agricultural/fishing practices in the area) and provide proper compensation for any unforeseen loss of income (if any).

Crossing of Roads and Water bodies

178. Road and river will be used to carry the power plant machineries and materials. Temporary disruption of river and road traffic and commutation is anticipated. Possible traffic congestion resulting from movement of vehicles / vessels carrying material and equipment should be addressed with proper traffic management, and avoiding stockpiling of materials in a way that could hamper traffic movement. Traffic safety issues also should be given utmost importance.

Public Safety Issues

179. Safety (including occupational safety) is an important issue during construction of power plant and its HFO transmission line (vessel to power plant). Construction activities near villages and along the narrow river side embankment road could increase risks to pedestrian and vehicular movement. Scheduling of construction works and delivery of construction material and proper management of traffic are very important to minimize such impacts. Safety issues (particularly occupational health and safety) are also important for general construction activities, which should be addressed as part of

occupational health and safety plan. Accident during construction phase is also an important issue. Proper measures including regular maintenance of equipment and use of protective gear are needed to reduce the risk of such accidents during the construction phase.

Employment

180. Some job opportunities will be created for labors as well as skilled manpower (including engineers) for construction of the proposed project. Installation of power plant will require relatively small number of skilled personnel and laborers; as such installation is highly automated.

Impact on Indigenous/tribal people

181. No indigenous or tribal people were observed in the project area and therefore World Bank OP 4.10 will not be triggered.

5.2.3 Physico-chemical Impacts

182. Major physico-chemical parameters considered for assessment of environmental impacts of project activities include drainage congestion, air and noise pollution, sanitation and solid waste, water pollution. The effects of the project activities during construction phase on these parameters have been assessed.

Water Quality

183. The power plant is located beside the Dhaleshwari river which may be susceptible to pollution from construction related activities, e.g., accidental spills of chemicals (e.g. oil/grease), materials and contamination by discharge of wastes from workforce (e.g. from labor sheds) during the construction phase. Care should be taken to avoid such contamination, especially because many of these water bodies are important for fisheries, which could be adversely affected by water pollution. Besides this, an oil pipeline is to be constructed from the river bank to the power plant in order to convey the HFO from the river vessels to the plant. During construction of this pipeline, the navigation in the river might be hindered to some extent, but this effect is very much localized and confined to the bank area only. Construction activities will increase turbidity of the river water. This would reduce light penetration, thereby interfering with the photosynthetic process; this may in turn adversely affect the aquatic ecosystem, including fisheries resources. However, since pipeline construction will cover a relatively small area of the river, these effects are not likely to be significant.

Noise and Air Pollution

184. Some noise and air pollution could result from excavation and other construction activities. Noise generated by construction activities will typically be for a short duration with minor adverse impact. During the construction phase of the proposed power plant project, the important sources of emissions would include those from the

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 (aggregate) crushers is used at the site, this may result in significant emission of particulate matter during its operation. Since construction of the proposed power plant project would most likely involve significant earthworks, increase in particulate matter in the air from wind-blown dust is also a concern, especially considering the close proximity to the nearby residential area.

Sanitation and Solid Waste

185. Problems related to sanitation and solid waste may result from improper/inappropriate facilities at the labor sheds. Lack of proper sanitation facilities for project people, including the labor/construction worker and absence of proper solid waste (e.g., food waste, construction debris) disposal facilities may create an unhealthy environment within and around the project sites. Use of un-sanitary latrines and improper disposal of human waste would create environmental pollution and adversely affect health and well-being of the people at the construction site by increasing the risk of disease transmission. Construction debris and wastes to be generated during the construction phase would include scrap iron, steel, wooden frames, piping, and other solid wastes. Most of it will be generated toward the end of the construction phase during carrying out of the finishing works, while the site will be cleared of waste materials. The volume of such construction wastes is likely to be significant. Indiscriminate storage and disposal of these construction debris and wastes could create local water logging and ponding by blocking drainage lines and would be aesthetically displeasing.

Drainage Congestion

186. Since the construction phase involves significant earthwork, there are chances of stagnation and ponding of storm water if care is not taken for proper drainage of storm water.

Impact on Historical and Cultural Resources

187. The field surveys found no archaeological or historical sites that would be affected by the construction of the power plant. Buildings and properties of historical importance are very far away from the proposed site will not be directly impacted. Should the proposed construction inadvertently encounter buried cultural deposits, World Bank Operational Policy for Physical Cultural Resources (OP 4.11) will be triggered. In that case DNPGL and its contractor will halt construction in that vicinity and immediately follow the protocols suggested in Annex E.

5.3 ENVIRONMENTAL IMPACT DURING OPERATION PHASE

188. During operation of the 55 MW combined cycle power plant, certain environmental parameters will experience some adverse impacts while some others

will enjoy beneficial effects. In this study, the effects of the project activities on ecological, physico-chemical, and socio-economic parameters have been assessed. Since there will be no thermal discharge (or other forms of liquid emissions from the power plant) in the Dhaleshwari river, the operation of the power plant will not affect the water quality or the aquatic ecosystem of the river. The physico-chemical environmental parameters that have been assessed include noise level, water quality, and air quality. The impact of the power plant project at its operation phase on socio-economic parameters will be mostly beneficial. Increased power supply will promote well-being of the people suffering from lack of power supply or serious load shedding; it is also likely to have positive impact on industrial activities and employment. The impacts of project activities on socio-economic parameters are also described in this Section.

Noise Impact

189. Prolonged exposure to high level of noise may cause significant damage to human hearing organ and may cause neurological damage. OSHA noise exposure limits for the work environment provides a guideline for the time of noise exposure at the work environment which may be adopted to prepare an environmental management plan (see section 4.2.7).

190. Noise assessment during the operational phase of different units of a power plant is essential to adopt adequate management and mitigation measures. With this objective the cumulative noise levels at three major units of the 55MW HFO-fired power plant during their operation have been performed. The details of the noise simulation is described in Annex C (noise pollution modelling for operation phase of the power plant). The major noise generating units are the engine room, exhaust stacks and air inlets . Two scenarios have been modeled which include a worst-case scenario (no noise attenuation measures, case-1) and a measure with all attenuation features (case-2).

191. Since the power plant surrounding area is mostly agricultural land with no major residential areas, the only case of concern for the time being was the effect of the single residential plot located approximately 90 meters away from the power plant boundary. The baseline noise in this area varies from 50 to 60 dBA depending on the time of the day. As per Bangladesh Standards and WHO guidelines, the maximum permissible noise in a residential/mixed area is 55-60 dBA. From noise modeling simulation results it can be seen that the predicted excess noiselevel from all noise generating units due to proposed power plant at this house (within 90 meter radius distance) will be 95.5 dBA, and 55.6 dBA for case 1 and case 2 respectively. It is clear that the scenarios in the first case would not create an acceptable noise environment for the inhabitants in the residential house and it only becomes acceptable if attenuation measures are applied. The engine room must be constructed with standard noise attenuation features and the

inlet/outlet stacks should have properly designed silencers so that the noise emission complies with applicable standards and guidelines. The power plant authorities will acoustically design the engine room so that noise emission from the power plant comply with the applicable guidelines and does not pose any health hazard.

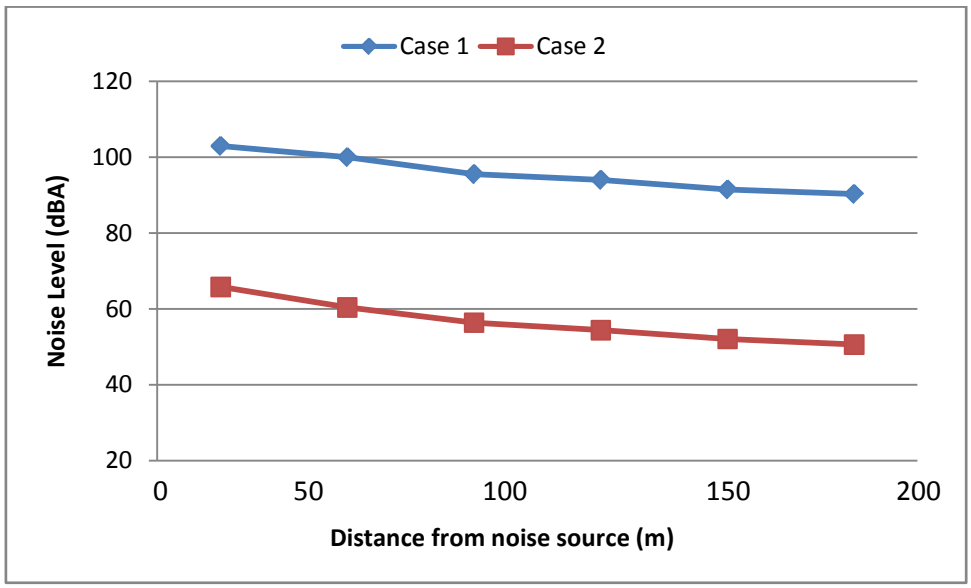


Figure 5.1: Simulated noise profiles for case 1 (no attenuation measures) and case 2 (with attenuation measures) [Details and assumptions of the modeling are in Annex-C]

Air Quality Impact

192. The primary emissions to air from the combustion of HFO are sulfur dioxide (SO_2), Nitrogen oxides (NO_X),particulate matter (PM), carbon monoxide (CO). The amount and nature of air emissions depends on factors such as the type and design of the combustion unit (e.g., reciprocating engines, combustion turbines, or boilers), operating practices, emission control measures (e.g., primary combustion control, secondary flue gas treatment), and the overall system efficiency.

193. In order to assess the air quality impact of the proposed 55MW HFO-fired power plant, the emissions data was collected from equipment specifications and discussions with power plant technical persons. The SO_2 emission was calculated from the yearly fuel consumption and the % of Sulfur in the HFO data. Emissions of NO_2, CO and PM were calculated based on stack emission rate and exhaust concentration of those specific pollutants from the equipment specifications. A screening air quality model SCREEN3 was used to generate the worst-case scenario of ambient air quality and the results are plotted in Figures 5.2 - 5.5. The details and assumptions of the air quality modeling exercise is explained in Annex D (Air pollution modelling for operation phase of the power plant).

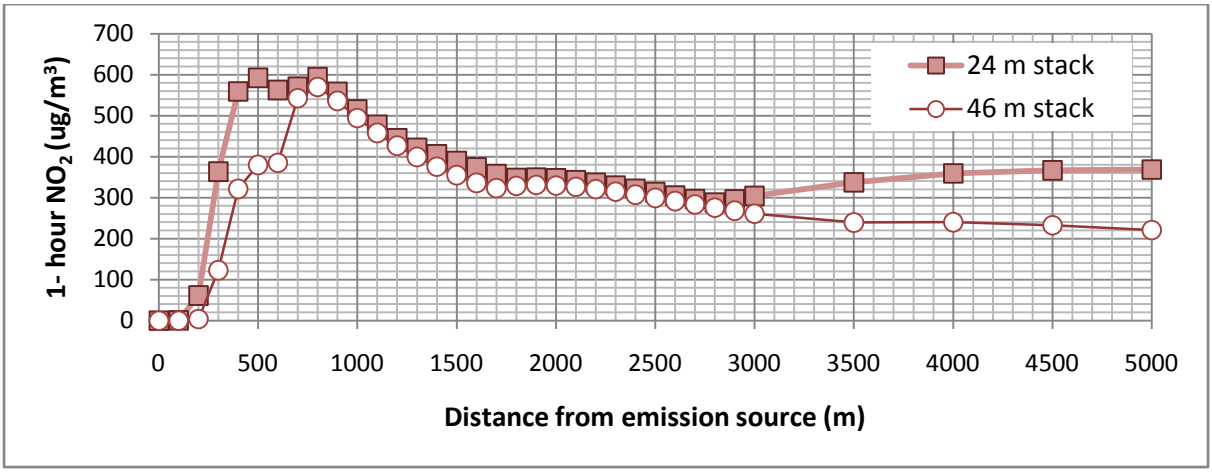


Figure 5.2: Excess ground-level 1-hr NO_2 concentration as a function of the distance from the source for the worst case scenario.

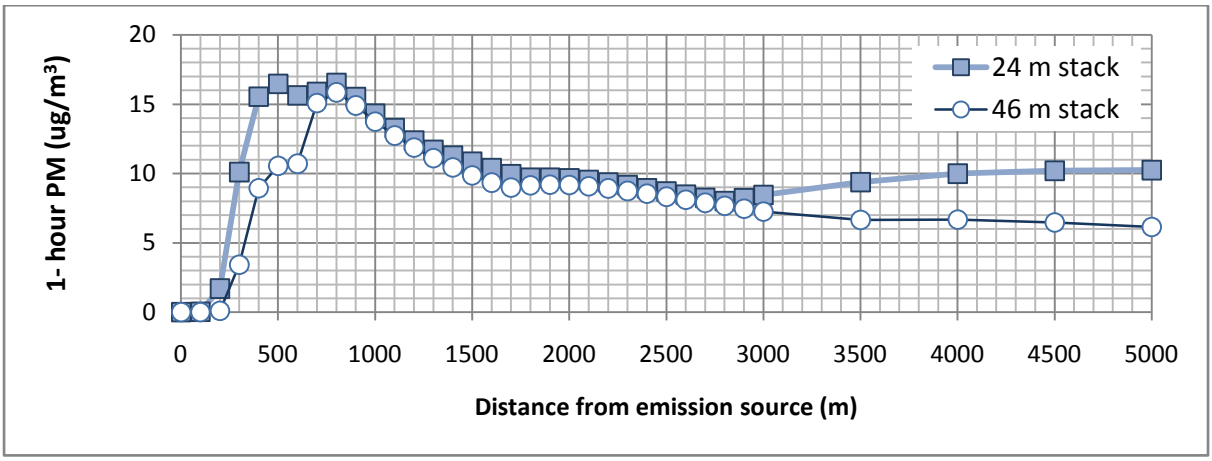


Figure 5.3: Excess ground-level 1-hr PM concentration as a function of the distance from the source for the worst case scenario.

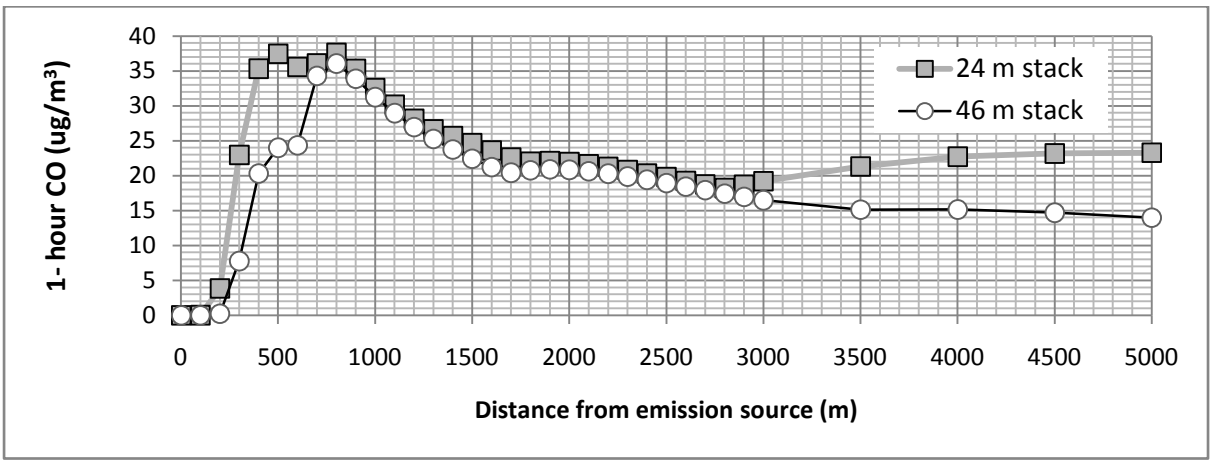


Figure 5.4: Ground-level 1-hr CO concentration as a function of the distance from the source for the worst case scenario

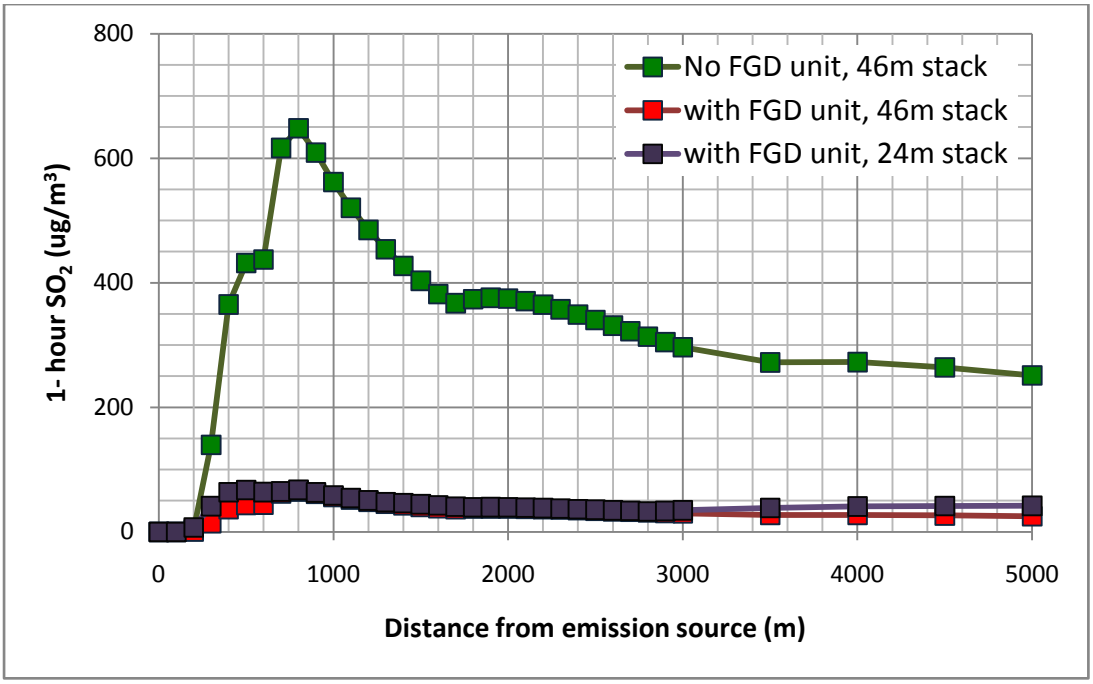


Figure 5.5: Excess ground-level 1-hr SO_2 concentration as a function of the distance from the source for the worst case scenario for various emission configurations.

194. Maximum (peak) 1-hr ground level concentrations of PM, NO2 and CO and SO2 have been predicted to be 16.6 µg/m^3, 597 µg/m3, 37.7 µg/m^{3}and 650 µg/m^3, respectively, at a distance of 772 m from the stack. It is worth noting that SCREEN3 is only able to estimate 1-hr pollutant concentrations (except for complex terrain, where 24 hr average is calculated). For the purpose of compliance, it is recommended that these 1 hr-average values be multiplied by a certain factor to estimate long-term averages (24-hr or annual). For "points" and "flares," the U.S. EPA multiplying factors shown in Table 5.5 is used to convert 1-hour concentration estimates from SCREEN3 to other averaging periods.

Table 5.5:"POINT" source multiplying factors to convert 1-hour average concentration estimates from the SCREEN3 model to longer averaging periods.[3]

Averaging period	EPA Multiplying factor for point sources
3-hr	0.9
8-hr	0.7
24-hr	0.4
Annual	0.08

195. In interpreting the effect of stack emissions on ambient air quality, background concentration of the pollutants reported in Chapter 4 have been considered. Comparing these with the measured background concentrations of the study site (see Table 4.6 4.7), it can be seen that the addition of CO and PM to the existing air environment is very

[3]"Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised," EPA-454/R-92-019, page 4-16).

much insignificant. Although the background PM concentration exceeds the national standards during certain parts of the year, since the PM emission from the power plant is very low it is not likely to affect the ambient PM concentration significantly in the vicinity of the project site. In order to assess the compliance with existing standards for NO_2 and SO_2, the maximum groundlevel concentrations of the pollutants were multiplied with the factors stated in Table 5.5 and the summary of the observations are presented in Table 5.6

Table 5.6: The simulated maximum ground level air pollutant concentration compliance assessment for DNPGL 55MW power plant[4]

Pollutant	**1-hr average Maximum ground level concentration (µg/m³)**	**Normalized Maximum ground level concentration (µg/m³)**	**Bangladesh Standard for ambient air quality**	**WHO Guidelines for ambient air quality**
NO_2	625	50 (Annual)	100 (Annual)	40 (Annual)
SO_2 (with FGD)	87	7 (Annual) 35 (24 hr avg)	80 (Annual) 365 (24 hr avg)	50 (Annual) 125 (24-hr avg)

196. The background concentrations of NO_2 and SO_2 at the study site (from Tables 4.6 - 4.7) have been found to be very low. As can be seen from Table 5.6, the operation of the power plant would result in an ambient air quality below the national standards. Therefore the incremental addition of the NO_2 and SO_2 due to the operation of the power plant is not likely to deteriorate the ambient air quality in this respect. The Table also shows that although the simulated ambient NOx concentration satisfy the National Standards, there is marginal exceedance of WHO guidelines. However, this marginal exceedance is predicted at a distance of 600m – 1000 m from the plant (as per SCREEN3 simulation). There are no sensitive receptors within this strip in the direction of predominant wind (from West and Northwest in Winter, from southeast in Rainy season) in the area around the power plant that could be affected by this level of NOx. This is because most lands around the plant within a 1 km-radius is primarily agricultural land. The nearest residential plot which is 100m from the plant is outside this zone of NOx exceedance. The other residential areas around the plant are at a distance 1.5 km or higher. It must be noted that the above screening model simulation (SCREEN3) has used the worst possible scenario to estimate the ambient air quality. For example, the simulation has been performed for the driest of months (winter season) with the most stable atmospheric conditions (F class). Also the effect of local meteorology was ignored (i.e. wet deposition due to rainfall not considered). It is certain that taking these factors into consideration would generate a scenario with a

[4] The simulated maximum ground level concentrations include the ambient background concentrations of the relevant pollutants

more improved ambient air quality. However, since the worst case scenario showed compliance with the existing standards, it was not deemed necessary to carry out detailed simulations with more sophisticated air quality models.

Water Quality and Quantity Impact

197. The HFO-fired power plant will not generate any thermal effluent. This is because the cooling towers will dissipate the waste heat into the ambient air rather than the surface water body. The wastewater streams from the power plant include wet FGD system discharges; material storage runoff, metal cleaning wastewater and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from water purification units. Although the amount of liquid emission may be small and the quantity variable, it needs to be treated before discharging into the environment. Sewage and other wastewater generated from washrooms etc., are similar to domestic wastewater. Theeffluent discharges would comply with the discharge criteria of National Standards as well as the World Bank guidelines (see Annex G).

198. The plant water requirement for cooling and other purposes will be met by groundwater. It is estimated that groundwater will be abstracted at a rate of 25 m^3/hour. This requirement of groundwater is insignificant to have any kind of impact on the groundwater table.

Solid Waste/ FGD Residuals

199. Sources of solid wastes are the ash residues and dust removed from exhaust gases and sludges from FGD plants. It is roughly estimated that the power plant FGD scrubber will generate 11700 tonnes of gypsum (after dewatering) per year which needs to be disposed. Instead of disposal in a landfill, this gypsum may have further utilities in the cement industry, agriculture (as soil amendment) or other industries. But the use of power plant residual gypsum in these industries in Bangladesh is not yet developed and therefore disposal in a landfill is probably the most viable option.

200. The gypsum itself is not hazardous or toxic, however it may also contain some heavy metals collected from exhaust gases which must be screened before disposal in a landfill. If they are disposed on open ground, it may cause soil pollution or groundwater contamination (by leaching).

Used Lubricating oil from Engines

201. Oil The used lubricating oil from engines, if disposed to the environment, will pose threat to human health by soil and water pollution. If this oil enters the water environment, it will cause significant damage to the aquatic flora and fauna. The layer of oil above water will retard the light penetration in the water column and affect photosynthetic activities. Fish and other aquatic species will be affected through lack of

food, organ damage eventually leading to their death. Used lubricating oils cannot be disposed into the environment.

Health Hazard and Occupational Safety

202. Hazardous materials stored and used at combustion facilities in power plants include solid, liquid, and gaseous waste-based fuels; air, water, and wastewater treatment chemicals; and equipment and facility maintenance chemicals (e.g., paint certain types of lubricants, and cleaners). Handling and storage of these chemicals, accidental leakage and spilling would pose health and safety concerns for the persons involved. Besides there would be other hazards related to non-ionizing radiation, heat, noise inside the workplace, electrical hazards and fire and explosion hazards. A comprehensive health and safety guideline should be followed in order to reduce health hazard.

Beneficial Impacts, Employment and Commercial Activities

203. The major beneficial impact of this power plant project would certainly be on public access to additional electricity and indirectly on the national economy. The project will contribute to resolve the electric problem in project area via BREB as well in the Dhaka city through national gridline. Some beneficial impact at local level would come in the form of employment. This in turn would induce some positive impacts on some other parameters including commercial activities in the project area.

5.4 EVALUATION OF IMPACTS

204. A simple semi-quantitative descriptive checklist method has been applied to evaluate the potential environmental impacts. Firstly, the activities during construction and operation were identified and listed in the impact table. Then the corresponding impacts on the specific ecological components (terrestrial and aquatic flora and fauna, fish), socio-economic parameters and physic-chemical environment attributes were evaluated based on the baseline scenario and an assessment of the typical interactions with power plant project activities. Assessments were made as to whether the impacts were positive (beneficial) or negative (harmful), short-term (short recovery time) or long-term (extended recovery time); and of high or low/moderate intensity. The results of the assessment are summarized in Tables 5.7 – 5.9.

205.

Table 5.7: Evaluation of ecological impacts resulting from different project activities

Source of Potential Impacts	Ecological Issues										
	Flora		Fish	Fauna							
				Amphibia		Reptile		Bird		Mammal	
	AQ	TR		AQ	TR	AQ	TR	AQ	TR	AQ	TR
During construction											
Camp setting	0	-1S	0	0	-1S	0	-1S	0	-1S	0	-1S
Access road	-1S	-1S	0	0	-1S	0	-1S	0	0	0	-1S

Source of Potential Impacts	Ecological Issues										
	Flora		Fish	Fauna							
				Amphibia		Reptile		Bird		Mammal	
	AQ	TR		AQ	TR	AQ	TR	AQ	TR	AQ	TR
construction for camp											
Land clearing	-1S	-1S	0	-1S	-1S	-1S	-1S	0	-1S	0	-1S
Soil excavation	-1S	-1S	-1S	-1S	-1S	0	-1S	0	0	0	-1S
Generation of Noise	0	0	-1S	-1S	-1S	-1S	-1S	-1S	-1S	-1S	-1S
Deterioration of water quality	0	0	-1S	-1S	-1S	-1S	0	-1S	0	-1S	0
Sewage discharge on soil / water	-1S	0	-1S	0	-1S	0	0	0	0	0	0
HFO transmission line construction (vessel to power plant)	-1S	0	-1S	-1S	-1S	-1S	0	-1S	0	-1S	0
During Operation											
Spills (oil / Chemical), lubricating oil disposal on land/water	-2S	-1S	-2S	-2S	-1S	-2S	-1S	-1S	-1S	-2S	-1S
Waste/sludge disposal	-1S	-1S	-1S	-1S	-1S	-1S	-1S	-1S	-1S	-1S	-1S

[Legend:AQ = Aquatic; TR = Terrestrial; 0 = No impact (negligible impact), 3 = High impact, 2 = moderate impact, 1 = Low impact, S = Short term impact, L = Longterm impact, +/- = positive/negative impact]

Table 5.8:Socio-economic impacts from activities associated with the construction and operation of 55MW power plant

Project Activities		Socio-Economic Impacts				
		Loss of Land and income	Traffic (road and river navigation)	Impact on indigenous/ tribal people	Public Health and safety	Employment and commercial activities
During Construction	Construction noise	**0**	**0**	**0**	**-1S**	**0**
	Labor camp setting	**0**	**0**	**0**	**0**	**+2S**
	Land clearing	**0**	**0**	**0**	**0**	**+2S**
	Soil excavation	**0**	**0**	**0**	**-1S**	**+2S**
	Piling work	**0**	**0**	**0**	**-1S**	**+2S**
	Concreting work	**0**	**0**	**0**	**-1S**	**+2S**
	HFO transmission line	**0**	**-1S**	**0**	**-1S**	**+2S**

Project Activities		Socio-Economic Impacts				
		Loss of Land and income	Traffic (road and river navigation)	Impact on indigenous/ tribal people	Public Health and safety	Employment and commercial activities
	construction (vessel to power plant)					
	Local road use	**0**	**-1S**	**0**	**-1S**	**+1S**
	Provision for safe water and sanitation facilities for workers	**0**	**0**	**0**	**+2S**	**0**
During Operation	Accidental HFO/chemical oil leaks, spills, lubricating oil disposal on land/ water, handling of chemicals	**0**	**0**	**0**	**-1S**	**0**
	Solid /hazardous waste and wastewater generation	**0**	**0**	**0**	**-1S**	**0**
	Access to additional electric supply	**0**	**0**	**0**	**+3L**	**+3L**
	Noise and Air emission from power plant	**0**	**0**	**0**	**-2L**	**0**

[+3 = High Positive Impact, +2 = Moderate positive impact, +1 = Low Positive Impact, 0 = No impact, -1 = Low Negative Impact, -2 = Moderate Negative Impact, -3 = High Negative Impact S = Short term impact, L = Long term impact]

Table 5.9: Physico-chemical impacts from activities associated with the construction and operation of 55MW power plant

Project Activities		Physico – chemical Impacts						
		Drainage congestion	Noise level	Air quality	Surface Water quality	Groundwater quality	Physical cultural	Soil quality
During Construction	Labour camp setting and its operation	**0**	**0**	**0**	**-1S**	**-1S**	**0**	**0**
	Access road construction	**-1S**	**-1S**	**-1S**	**-1S**	**0**	**0**	**0**
	Land clearing	**-1S**	**0**	**0**	**0**	**0**	**0**	**0**
	Soil excavation	**-2S**	**-2S**	**-2S**	**-1S**	**0**	**-1S**	**-1S**
	Piling work	**0**	**-2S**	**-1S**	**-1S**	**-1S**	**-1S**	**0**
	Concreting work	**0**	**-2S**	**-1S**	**0**	**0**	**0**	**0**
	HFO transmission line construction (vessel to power plant)	**-1S**	**-1S**	**-1S**	**-2S**	**0**	**-1S**	**0**
	Provision for safe water and sanitation facilities for workers	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Project Activities		Physico – chemical Impacts						
		Drainage congestion	Noise level	Air quality	Surface Water quality	Groundwater quality	Physical cultural	Soil quality
During Operation	Solid /hazardous waste/ FGD residuals and wastewater generation	**0**	**0**	**0**	**-1L**	**-2L**	**0**	**-2L**
	Noise and air emission from power plant operation	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Accidental chemical oil leaks, spills, lubricating oil disposal on land/ water	**0**	**0**	**0**	**-2S**	**-1S**	**0**	**-1S**

[+3 = High Positive Impact, +2 = Moderate positive impact, +1 = Low Positive Impact, 0 = No impact, -1 = Low Negative Impact, -2 = Moderate Negative Impact, -3 = High Negative Impact S = Short term impact, L = Long term impact]

5.5CUMULATIVE IMPACT ANALYSIS

206. From Tables 5.7 – 5.9 it can be seen that the proposed 55MW HFO-fired power plant will not have any lasting adverse environmental impacts on the project area during the construction phase. Implementation of the proposed project would have a limited amount of, short-term, local impacts on flora and fauna, noise level, water resources, air quality, navigation and traffic movement. It is not expected, however, that any of the above effects would persist over an extended period beyond the installation phase of this project.

207. During the operation phase, there is a possibility of a number of adverse impacts. Analysis shows that if proper noise mitigation measures are not taken, the noise emission from the engines and exhausts will generate an unacceptably high noise levels in the surrounding environment. The study area currently has an urban setting with baseline noise levels to be very low. The power plant will have indirect effects of generating employment opportunities, small businesses and it is likely that the noise environment in future will have the characteristics of a mixed (residential and commercial) area.

208. In order to assess the cumulative impact of the power plant on the air environment of the area, the industries located within a 10-km radius of the power plant were considered. As can be seen from Table 4.1, the industries within the 10-km radius of the power plant include textile factories, dyeing plants and brick kilns. There are no other power plants within this area. The textile and dyeing industries do not emit

pollutants in the air (the emission from their gas generators is considered negligible). The 67 brick kilns that are located within this area are the major air polluters. To estimate their combined contribution to the air pollution, emission factors calculated by Guttikunda et al (2012) were used. For the base year 2010, based on fuel consumption and fuel characteristics data, the emission factors (in grams per brick produced) of coal-based brick kilns were estimated as 6.8 for $PM_{2.5}$,9.7forPM_{10},4.6forSO_2,4.7forNO_X, 90.0 for CO. Assuming that each brick kiln produces on an average 10,000 bricks per day (typical value 10,000 – 40,000 during manufacturing season as per Guttikunda et al 2012)[5], the yearly emission of gaseous pollutants and particulate matter are calculated and are shown in Table 5.10. The corresponding emissions for the power plant are computed from Table D-1 in Annex D. It can be seen from the table that the PM and CO contribution from the power plant is very negligible (2.11% and 0.9% respectively). It was observed that the ambient air quality with respect to PM in the study area usually exceeds the national standards and WHO guidelines in specific seasons. But the incremental addition to the ambient PM is likely to be very low because of its low emission share as stated above.

209. However the contribution of SO_2 and NO_X from the power plant in the total emission inventory appears to be dominant. This is because the emission potential from brick kilns with respect to SO_2 and NO_X is not as high as the power plant and also there are no significant sources of emission for SO_2 and NO_X in the surrounding area. It needs to be mentioned that the emission of SO_2 is based on the % of S in fuel (2.5%) and the yearly fuel consumption rate of the power plant and the emission of PM and NO_X are based on the PM and NO_X concentration guarantee (50 mg/Nm^3 and 1850 mg/Nm^3 respectively) and a gas emission rate of 129 ton/hr which were derived from the engine specifications (see Annex J). The emission parameter values from the specifications of the engine conform to the WBguidelines for a non-degraded airshed (see Table 5.11). Currently the ambient air quality with respect to SO_2 and NO_X are acceptable with respect to the national standards and WHO guidelines. Modeling results considering the worst-case scenario show that (Annex-D) the air environment will not become degraded with respect to SO_2 and NO_X as a result of the operation of the power plant. Also since the power plant is installing an FGD unit, the SO_2 emission will be consequently reduced (its cumulative share will be reduced to 23.5%).

[5]Ref: Guttikunda, S.K., Begum, B.A. and Wadud, Z. (2012) Particulate pollution from brick kiln clusters in the Greater Dhaka region, Bangladesh, Air Qual Atmos Health. DOI: 10.1007/s11869-012-0187-2

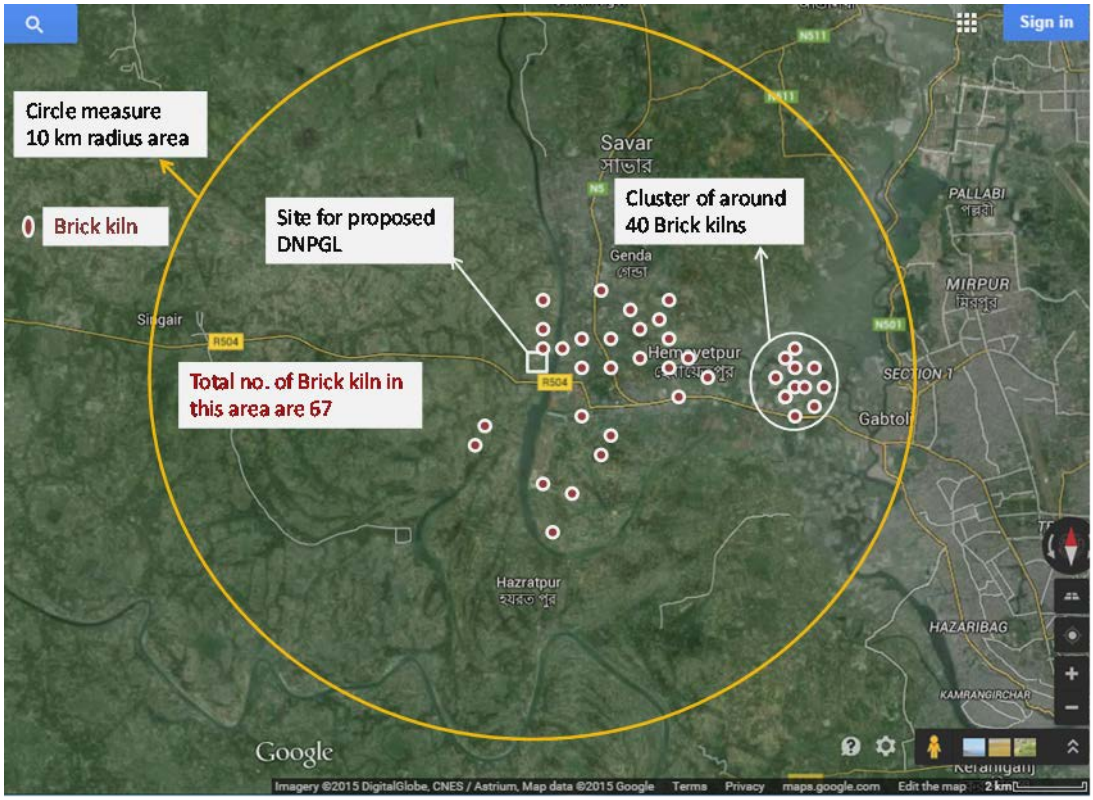


Figure 5.6: Location of brick kiln clusters within the 10-km radius of area from the proposed 55MW HFO power plant by DNPGL

Table 5.10: Yearly cumulative emission scenario from the power plant and brick kilns

Air Emission parameter	Yearly emission from brick kilns within the 10 km radius area from the power plant (ton/yr)	Estimated yearly emission from the power plant (ton/year)	Contribution from the power plant relative to the total emission (%)
PM_{10}	1662	84	2.11%
$PM_{2.5}$	2372		
SO_2	1124	3468 (without FGD) 347 (with FGD)	75% (without FGD) 23.5% (with FGD)
NO_X	1149	3053	73%
CO	22009	193	0.9%

Table 5.11: Liquid fuel based Power plant emission standards and guidelines

Emission parameter	WBGguideline values for non-degraded airshed
PM	50 mg/Nm^3
SO_2	1170 mg/Nm^3 or use of 2% or less S fuel
NO_X	1850 mg/Nm^3

210. Positive impacts of the project include public access to additional electricity, which may trigger direct and indirect positive effect on national economy, industrial

development and productivity etc. Movement of river vessels (for fuel transport) will slightly increase the river traffic. Road traffic might also increase as an indirect effect of the power plant due to the increase of commercial activities in the area.

5.6 PROJECT ALTERNATIVES AND NO PROJECT SCENARIO

211. Several alternative scenarios can be analyzed to see why the current project may be the best possible venture by DNPGL. These alternatives can be alternative sites, alternative electricity generation technology and alternative mode of fuel transportation.

212. The project is being implemented on a DNPGL-owned land in Singair, Manikganj, therefore no land acquisition is involved. It is located near the bank of the Dhaleshwari river which makes fuel transportation by river very much suitable. The area surrounding the power plant is mostly agricultural land and relatively less populated which renders the immediate human impact due to construction activities to be minimal. Therefore the current site for the power plant is an ideal one.

213. The Government of Bangladesh is encouraging a fuel diversification policy and the basic idea of this policy is to explore fuels other than natural gas for the generation of electricity. In this regard, other sources of energy could be coal, HFO, nuclear power, hydropower, geothermal, wind power, hydropower and solar power which are used worldwide. Bangladesh has a flat terrain and has only very limited potential for hydro-electricity. Bangladesh does not have any geothermal sites and the prospects of renewable energy (solar and windpower) are yet to be proven cost effective and to become attractive for private entrepreneurs. This leaves the two conventional sources of energy which are coal and fuel. Although Bangladesh has a huge reserve of bituminous coal, the extraction of this coal is not easy and local demand for coal is mostly met from the coal imported from India. Coal-fired plants are also considered less environment-friendly due to its high PM and SOx emission. In this regard, HFO-fired power plant generates less environmental burden compared to coal-fired plants. This initiative is also in line with the fuel diversification policy of the Government of Bangladesh.

214. Alternate mode of HFO fuel transport from Chittagong to Singair, Manikganj that can be considered in this context is by road using trucks. However, this has several distinct disadvantages. Firstly, a truck is able to convey only 5 tonnes of fuel as opposed 1000 tonnes by inland water barges in a single trip. The probability of accidents and pilferage of fuel in road transport is also higher than that of water transport. This is why water transport of fuel is the only viable alternative.

215. The No Action Alternative would have no negative impacts on the existing environmental and social resources but the positive socio-economic and beneficial commercial impacts would also not be realized as well. No additional megawatts of electricity would be added to the national grid and the associated benefits of increased electricity availability will not be realized. Considering the country's national goals related to Vision 2021 and power systems masterplan 2010, halting this project would mean a step in the backward direction.

CHAPTER 6

PUBLIC CONSULTATION

6.1 INTRODUCTION

216. A couple of Focus Group Discussions (FGDs) and some public consultations were carried out for documenting the existing socio-economic condition in the project study areas and for assessment of social impact of project activities. The FGDs were conducted involving major stakeholders. The public consultations were carried out in public places within the project study areas for documenting views, opinions and concerns of the local people. This Chapter presents the major findings from the FGDs and public consultations.

6.2 METHODOLOGY

217. Two FGDs were organized and conducted at a couple of important places within the project study areas in November, 2014. The locations were Jaigeer Primary School and Dhalla Govt. Primary School both located in Singair, Manikganj. More than 60 people participated in the FGDs (see Table 6.1 for details) (Annex -F). The participants' sex ratio is shown in Fig. 6.1.

218.

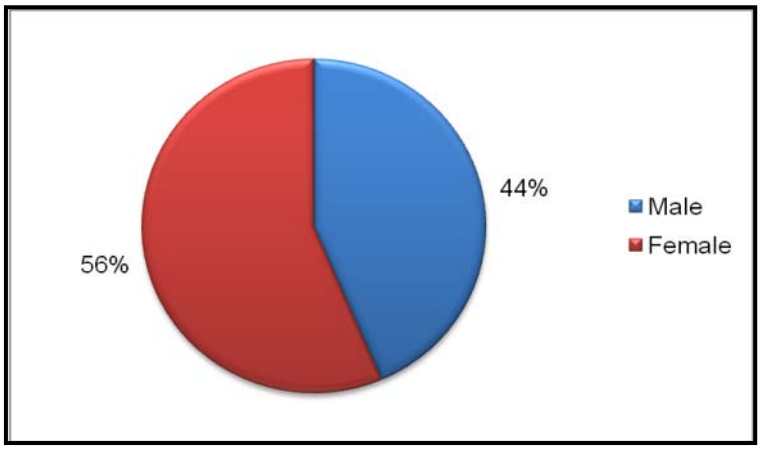


Figure 6.1: FGD Participants' sex ratio for the proposed 55MW Power Plant construction project at Singair, Manikganj, Dhaka.

219. These locations were selected to represent the viewpoints of the general people residing near the proposed power plant (FGD -1 within 0.5 km and FGD -2 within 4 km of the project site). In the FGDs, an effort was made to invite a wide range of stakeholders including farmers, businessmen, land owners, house owners, laborers, teachers, students etc (see Fig. 6.2 and Fig. 6.3). In addition to the FGDs, a number of

formal/informal meetings with stakeholders were carried out in the project study areas; the study team interacted with more than 40 people during these meetings.

Table 6.1: Details of Focus Group Discussion (FGD) for the proposed 55 MW Power Plant Project at Singair, Manikganj, Dhaka.

Date	Venue	Time	Number of Participants
13-11-2014	Jaigeer Primary School, Jaigeer, Singair, Manikganj, Dhaka.	10.30 am – 11.30 am	27
13-11-2014	Dhalla Govt. Primary School, Dhalla, Singair, Manikganj, Dhaka.	02.30 pm – 03.30 pm	35
Total			62

Figure 6.2: First Focus Group Discussion (FGD) at Jaigeer Primary School. (a) Headmaster & Asstt. Headmaster of Jaigeer Primary School, and Deputy Manager of Dhaka Northern Power Generations Limited (DNPGL) attended in the first FGD. (b-d) People from various professions participated in the discussion and provided their opinions and concerns.

6.3 KEY FINDINGS FROM FGDS AND PUBLIC CONSULTATIONS

220. Utmost efforts were made in both FGDs to get feedback from participants on the nature of environmental impacts, and their suggestions about ways to mitigate the

adverse impacts and enhance beneficial impacts. People who participated in the public consultations were found enthusiastic in sharing their views. The participants expressed their opinions regarding different issues including their knowledge about the proposed power project, socio-economic condition of people in their localities, possible impact of the proposed power project on the existing environment and in their localities, and mitigation measures to address adverse impacts. The major findings of both FGDs and public consultation are summarized below.

Figure 6.3: Second Focus Group Discussion (FGD) at Dhalla Govt. Primary School (a) Headmistress & Asstt. Headmaster of Dhalla Govt. Primary School and Deputy Manager of Dhaka Northern Power Generations Limited (DNPGL) attended in the second FGD. (b-d) People from various groups participated in the discussion and provide their opinions and concerns

General Opinion regarding the project

- Most participants have not heard about the proposed construction of 55MW power plant project at their locality. This indicates that news/information about the proposed project has not been widely circulated in mass media or in the localities.
- After hearing about the project details, most participants expressed their support for this power plant project in their locality with minor reservations . However, they opined that more public consultations are needed to make people aware of the project and its activities.

- Some participant expressed their concerns regarding the safety and security of the proposed project (construction and operation phase)
- Construction of pollution free power plant will be supported by the local community.
- All participants expressed their demand for new electric supply from DNPGL to be given to the Bangladesh Rural Electric Board (BREB) as the first subscriber before giving it to the national electric gridline so that the rural areas are benefited first.

General opinion regarding possible impacts of the project

- Some participants have no knowledge about the power plant and its activities; or its impact on the existing environment. However, most participants believe that somehow they will get benefit by this initiative.
- Some participant expects both benefit and harmful impact for the proposed initiative, though it is difficult to judge at present which impact - positive or negative would come.
- Some participants expressed their concern regarding the environmental effects of current development activities on their livelihoods. For example, the operation of the existing brick fields were already damaging agro-products (coconut, rice, vegetable) in their localities.
- Some participants believed that existing flora (fruits e.g. guava) and fauna (bird) may be negatively impacted by this initiative. For example, industrialization occurring beside Dhaleswari River (opposite side of proposed power plant), according to them, have reduced the biodiversity of the surrounding ecosystem.
- Participants believe that this initiative might reduce the land suitable for vegetable gardening. Quantification of agro-product damage by previous industrial activities should be investigated and later, this type of venture should be allowed. Some thought that although a small amount of land will be damaged for the time being but eventually some unforeseen and associated impacts of the industrialization could damage more land in future. The participants probably have come to such an understanding due to the harmful effects of the brick kilns in the areas surrounding the project site.
- The project should ensure that no harmful effects should come to Dhaleswari River and its surrounding environment; otherwise, river fish may be reduced.
- Agro-products may be impacted due to the proposed project; so initiative should be taken to assess it.
- Some participants suggested that local contractors should be given priority to supply construction materials.
- Some participants hoped that overall economy of the local area will be benefited due to generation of employment opportunities during construction phase of the project and later on, getting more electricity during the operation phase.

- Local roads are not in good condition; therefore the people thought that the current initiative may help to improve those roads for better connection to Dhaka, the capital city.
- Local community may face some problems due to influx of outside workers. The society might face increase of crimes and proper actions must be taken in this regard.
- Local demand for electricity should be fulfilled first to reduce huge electric load-shedding. Only 3 hours of electricity is available for each day. Participants demanded a cheap rate of electricity as it is increasing day by day. Harassment should be reduced to get new electric connections. Also damaged transformers should be replaced by REB

Expectation of people from the Project

- Proposed project will ensure supply of 55MW electricity to fulfill the local and national demand.
- Efforts will be made by DNPGL to supply electricity round the clock;
- Executing agency will give preference to engage qualified contractor to ensure quality of works as well as timely completion of work;
- Local people (male and female) will be employed by the contractor during construction work;
- Pollution free environment will be ensured. All pollution including air, water, sound etc should be controlled in proper way.
- Adequate safety and security measures will be taken during construction work;
- People whose livelihood have been affected (if any) will be given required assistance (e.g., in the form of cash compensation);
- Local people appreciate the initiative of the DNPGL and will cooperate with the executing agency during project implementation.

CHAPTER 7

MITIGATION MEASURES AND ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

7.1 INTRODUCTION

221. The proposed project involves construction of a 55MW HFO-fired power plant and ancillary facilities in Singair, Manikganj. It also involves construction of HFO transmission pipe from the bank of Dhaleshwari River to storage area and access road to the plant from Dhaka-Manikganj highway. The significant environmental impacts of project activities during construction and operational phases have been presented in Chapter 5.As discussed in Chapter 5,there would be some short-term and long-term adverse effects due to project activities during the construction and operation phases. This chapter summarizes the mitigation and abatement measures in order to minimize or eliminate these impacts. It also presents an environment and social management plan (ESMP), including a monitoring program and the resources and institutional setup for implementation of the ESMP. Since no adverse social impacts (loss of land and associated income, harmful effects on social structure or tribal people etc.) are anticipated in this project, a RAP and TPP will not be necessary. Since the other social impacts (e.g. traffic, public safety, impact of outside workers etc) are minor, they have been discussed as a part of the ESMP and a separate social management plan (SMP) was not deemed necessary. Finally this chapter discusses occupational health and safety and risk management issues in the power plant and proposes separate plans for each of them.

7.2 MITIGATION MEASURES DURING CONSTRUCTION PHASE

222. Table 7.1 shows the mitigation measures corresponding to specific adverse impacts during construction phase, along with assignment of responsibilities for their implementation. The measures presented in Table 7.1 are aimed at minimizing the effects of the possible adverse impacts and enhancing the positive impacts. The table shows that most of the adverse impacts could be minimized or even removed if appropriate mitigation measures are taken. However, a post-project monitoring program needs to be put in place to ascertain that the potential impacts have been predicted adequately and that suggested mitigation measures are effective in minimizing adverse impacts on the environment.

Table 7.1 Potentially significant environmental impact during construction phase and mitigation measures

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Influx of workers	• Generation of sewage and solid waste	• Construction of sanitary latrine and septic tank system (one latrine for 20 persons) • Erecting "no litter" sign, provision of waste bins/cans, where appropriate • Waste minimization, recycle and reuse • Proper disposal of solid waste (in designated waste bins)	Contractor (Monitoring by DNPGL)
	• Possible spread of disease from workers	• Clean bill of health a condition for employment • Regular medical monitoring of workers	
Transportation of equipment, materials and personnel; storage of materials	• Increased traffic/navigation • Generation of noise from vehicles, especially affecting the nearby residential area	• Establishment of minimally intrusive and well-designed traffic and river navigation patterns for onsite construction activities	Contractor (Monitoring by DNPGL)
	• Deterioration of air quality from increased vehicular movement and construction equipment movement, affecting people in the surrounding areas	• Keeping vehicles under good condition, with regular checking of vehicle condition to ensure compliance with national standards • Limiting GHG emission by using modern construction equipment and by prohibiting excessive idling of equipment when not in use.	
	• Wind-blown dust from material (e.g., fine aggregate) storage areas	• Watering unpaved/dusty roads (at least twice a day; cost estimate provided) • Sprinkling and covering stockpiles • Maintain adequate moisture content of soil during transportation, compaction and handling • Covering top of trucks carrying materials to the site and carrying construction debris away from the site	
	• Damage/ reduction of native flora, displacement of wildlife, birds etc., impact on vulnerable species such as the Gangetic Dolphin	• Provide proper compensation if there is any destruction of trees outside the project boundary. • Control intensive movement of heavy construction vehicles. • Temporary stockpiling of materials should be done on non-vegetative surfaces • Revegetation, if required, should be done using native, non-invasive species and by preventing the	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		introduction of noxious weeds • Keep noise level (e.g., from equipment) to a minimum level, as certain fauna may be very sensitive to loud noise. • If native fauna is encountered during construction or land clearing activities, the workers should be advised not to injure or kill it, rather allow it to pass by or displace itself in its own will. (Same for any threatened/vulnerable species). • If the construction crew in the vessels encounters the Gangetic Dolphin, they should reduce the speed of their vessels and wait for it to move away and disappear. No attempt should be made to approach the dolphin or catch it.	
Construction activities, including operation of construction equipment	• Generation of noise from construction activities (general plant and access road construction),	• Use of noise suppressors and mufflers in heavy equipment • Avoiding, as much as possible, construction equipment producing excessive noise at night • Avoiding prolonged exposure to noise (produced by equipment) by workers • Creating a buffer zone between the residential area and construction site to reduce disturbance • Regulate use of horns and avoiding use of hydraulic horns in project vehicles.	Contractor (Monitoring by DNPGL)
	• Deterioration of air quality from wind-blown dust and possible use of equipment, such as stone (aggregate crushers)	• Not using equipment such as stone crushers at site, which produce significant amount of particulate matter • Keeping construction equipment and generators in good operating condition • Using equipment, especially generators with high levels of emission control (e.g., TIER-4). • Immediate use of construction spoils as filling materials • Immediate disposal/sale of excavated materials • Continuous watering of bare areas	
	• Generation of construction waste	• Hauling of construction debris away from the site and their appropriate disposal in a sanitary landfill	
	• Accidents	• Regular inspection and maintenance of equipment • Environmental health and safety briefing	

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Provision of protective gear	
	• Spills and leaks leading to soil and water contamination with hydrocarbon and PAHs	• Good house keeping • Proper handling of lubricating oil and fuel • Collection, proper treatment, and disposal of spills • A spill prevention, containment, and countermeasure plan would be prepared. This plan would detail the measures required of all construction, operation, and maintenance personnel for transport, storage, use, spill response/ containment, and disposal of hazardous materials, waste, and debris.	
	• Employment of work/labor force	• Local people should be employed in the project activities as much as possible. • Promote supply from local suppliers	
	• If cultural resources are found during excavation	• Follow the "Chance Find Procedure" World Bank Operational guidelines OP 4.11 (See Annex F)	
	• Drainage congestion during construction activities	• Provide adequate diversion channel, if required • Provide facilities for pumping of congested water, if needed • Ensure adequate monitoring of drainage effects, especially if construction works are carried out during the wet season.	Contractor (Monitoring by DNPGL)
Construction of HFO transmission pipeline from bank of Dhaleshwari river to storage space, construction of service jetty	• Water pollution due to sediment suspension (increase in suspended solids) or washing away of slurry to the water bodies, temporary, localized disruption of fish habitat	• Use directional boring technique for minimally intrusive pipeline construction • Ensuring that no seepage occurs through the borehole (if directional boring is used). After completion of the borehole, all slurry should be removed from the construction site and disposed in an approved site.	
	• Noise and air pollution	• As applicable, adopt similar noise and air pollution mitigation measures stated above for trenching operation, concreting work, mobilization of vehicles and equipment.	
	• Disruption of river navigation	• Design minimally intrusive vessel movement patterns for mobilization of construction equipment	
General Construction activities	• Worker health and safety	• Provide the workers with personal protective equipment for protection against noise.	Contractor (Monitoring by DNPGL)

Activity/Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
		• Contractors should comply with the relevant WBguidelines of occupational health and safety	

7.3 MITIGATION MEASURES DURING OPERATION PHASE

223. At the operational phase, DNPGL will be responsible for the operation and maintenance of the power plant and its ancillary facilities. The project will add 55MW electricity to the nation's power inventory and the beneficial effects of additional electricity and the flourishing local commerce will be realized. Efforts should be made to enhance these beneficial impacts, which may include incentives for proper growth of industries in the area. However, operation of the power plant needs special considerations for the issues regarding (a) Emission from the power plant; (b) Generation of noise; (c) Waste generation at the plant, which if left unmitigated, may cause detrimental effects to the environment. Table 7.2 summarizes the potentially significant environmental impacts during operation phase, the measures needed to eliminate or offset adverse impacts and enhance positive impacts.

Table 7.2: Environmental impact during operation phase and mitigation measures

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
Power Generation	• SO_2 and NO_2Emission from the power plant	• Using stack as per specifications • Using low nitrogen oxide burners/ selective catalytic converters or any other proven technologies available to reduce the NOx emission • Use of Flue Gas Desulfurization (FGD) units to reduce the SOx emission from the power plant • Installation of stack emission monitoring equipment for major pollutants	DNPGL
	• Generation of noise from operation of turbines, engines, air inlet/outlet	• Provision of appropriate silencers forair inlets and exhaust stacks • Adopt of proper acoustic design of engine/ turbine rooms • Planting of trees around the project site • Regular plant maintenance • Regular noise monitoring, especially at the residential area located near the power plant • Use of ear-muffs and ear-plugs by plant personnel working in the generator and turbine facilities of the plant	
	• Crews engaged in the transportation of HFO in water vessels may encounter endangered	• If the crew in the vessels encounters the Gangetic Dolphin, they should reduce the speed of their vessels and wait for it to move away and disappear. No attempt	

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
	species in Dhaleshwari river such as the Gangetic Dolphin	should be made to approach the dolphin or catch it.	
Waste generation	• Inappropriate disposal of sewage causing environmental pollution • Generation of solid waste including sludge from demineralizer. • Generation of FGD gypsum • Possible water pollution from wastewater generated from cooling tower blowdown; wet FGD system discharges; material storage runoff; metal cleaning wastewater; and low-volume wastewater, such as air heater and precipitator wash water, boiler blowdown, boiler chemical cleaning waste, floor and yard drains and sumps, laboratory wastes, and backflush from water purification units. • Indiscriminate disposal of used lubricating oils can cause environmental degradation	• Good housekeeping • Proper construction and maintenance of domestic wastewater disposal system for the plant premises (septic tank, sewage treatment plant etc.) • Ensuring proper storage, treatment, and disposal of all solid waste • Provision of a treatment plant designed to remove contaminants from plant-generated wastewater to applicable standards. • If the effluent wastestream is a slurry (e.g. FGD waste from scrubber) appropriate dewatering unit has to be constructed to separate/ thicken the solid fraction of the slurry from the liquid wastewater. • Monitoring of effluent quality from treatment plant (monitoring requirement and cost estimate provided) • Monitoring of river water quality (monitoring requirement and cost estimate provided) • Devise innovative ways to utilize FGD residual gypsum in a sustainable manner (e.g. cement industry, agriculture). If no such options can be availed, DNPGL should take necessary steps to convey the accumulated gypsum to the nearest sanitary landfill (in case the Aminbazar landfill operated by the Dhaka City Corporation) after verifying that the generated waste is not hazardous with respect to metal leaching characteristics. In this respect, DNPGL is to take necessary permissions to dispose the gypsum from DCC. If the generated waste has heavy metal leaching characteristics above the USEPA standard limit[6], DNPGL should dispose them in lined pits within their premises. • Used lubricating oil cannot be disposed with the liquid wastestream. The power plant must ensure that certified vendors are there to purchase the used lubricating oil from them.	DNPGL

[6] USEPA."Land Disposal Restriction." 2012.http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol28/xml/CFR-2012-title40-vol28-sec268-40.xml

Activity/ Issues	Potentially Significant Impacts	Proposed Mitigation and Enhancement Measures	Responsible Parties
General Power Plant Operation	• Worker health and safety	• Provide the workers with personal protective equipment for protection against noise. • Contractors should comply with the relevant WBguidelines of health and safety for thermal power plants in addition to general occupational health and safety guidelines	DNPGL

7.4 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

7.4.1 Scope of ESMP

224. The primary objective of the environmental management and monitoring is to record environmental impacts resulting from the project activities and to ensure implementation of the "mitigation measures" identified earlier in order to reduce adverse impacts and enhance positive impacts from specific project activities. Besides, it would also address any unexpected or unforeseen environmental impacts that may arise during construction and operation phases of the project. The ESMP should clearly lay out: (a) the measures to be taken during both construction and operation phases of the project to eliminate or offset adverse environmental impacts, or reduce them to acceptable levels; (b) the actions needed to implement these measures; and (c) a monitoring plan to assess the effectiveness of the mitigation measures employed. Environmental management and monitoring activities for the proposed power plant project could be divided into management and monitoring: (a) during construction phase, and (b) during operation phase.

7.4.2 Work Plans and Schedules

Construction Phase

225. The environmental management program should be carried out as an integrated part of the project planning and execution. It must not be seen merely as an activity limited to monitoring and regulating activities against a pre-determined checklist of required actions. Rather it must interact dynamically as project implementation proceeds, dealing flexibly with environmental impacts, both expected and unexpected.

226. For this purpose, it is recommended that the Project Coordinator for this specific project should take the overall responsibility of environmental management and monitoring. The Project coordinator will form a team or project management unit (PMU) with required manpower and expertise to ensure proper environmental monitoring, as specified in the following sub-section, and to take appropriate measures to mitigate any adverse impact and to enhance beneficial impacts, resulting from the project activities. For this purpose, he will engage an environmental and social specialist in the PMU who will assist him these activities. The Project Coordinator through its team will make sure that the Contractor undertake and implement appropriate

measures as stipulated in the contract document, or as directed by the Project Coordinator to ensure proper environmental management of the project activities. It should be emphasized that local communities should be involved in the management of activities that have potential impacts on them (e.g., traffic congestion in the surrounding areas). They should be properly consulted before taking any management decision that may affect them. Environmental management is likely to be most successful if such decisions are taken in consultation with the local community. The environmental management during the construction phase should primarily be focused on addressing the possible negative impacts arising from:

(a) Generation and disposal of sewage, solid waste and construction waste
(b) Increased traffic
(c) Generation of dust (particulate matter)
(d) Generation of noise
(e) Water Pollution
(f) Drainage congestion

227. The environmental management should also focus on enhancing the possible beneficial impacts arising from employment of local workforce for construction works. In addition, the PMU should set up a procedure to address complaints and grievances (e.g., receiving formal complaints/ grievances, arrange hearing involving all stakeholders and keeping records of such hearings, device and implement mitigation measures). However, the complaints and grievances redress procedure will not preempt age aggrieved person's/ group's right to seek redress in the courts of law. Table 7.1 summarizes the potentially significant environmental impacts during construction phase, the measures needed to eliminate or offset adverse impacts and enhance positive impacts. The monitoring plan and monitoring schedule has been presented in the subsequent sections.

Operation Phase

228. Most of the environmental parameters will experience beneficial effects during the operation phase of the power plant project. Efforts should be made to enhance these beneficial impacts, which may include incentives for proper growth of industries in the area. The plant management authority (DNPGL) should be responsible for overall environmental management during operation phase of the project. The environmental management during the operation phase should primarily be focused on addressing the following issues: (a) Emission from the power plant; (b) Generation of noise; (c) Solid/Liquid waste generation at the plant

229. In addition, the procedure to address complaints and grievances (noted above) should also be in place during operational phase. Table 7.2 summarizes the potentially significant environmental impacts during operation phase, the measures needed to eliminate or offset adverse impacts and enhance positive impacts. The monitoring plan and monitoring schedule has been presented in subsequent sections. Resources

required for implementation of mitigation and enhancement measures and monitoring during construction will be borne by the Contractor. Most of the mitigation and enhancement measures identified for operation phase (see Table 7.2), e.g., use of tall stack, using low NO_x burners, selective catalytic converters, using silencers for generators and turbines, will have to be addressed during the design phase and resources required will be within the estimated cost of the plant construction.

Implementation Schedule

230. An implementation schedule for environmental management and monitoring during the construction phase will be prepared by the Contractor as part of construction contract following recommended mitigation measures of potentially significant impacts given in Table 7.1.Table 7.3 shows a tentative plan for environmental reporting. These reports should be shared with IPFF PIU and the World Bank from time to time.

Table 7.3 Environmental monitoring reporting schedule

Stage or Topic	Frequency/ Stage
Initial review	Before start of work
Routine Progress Report	Quarterly
Specific Problems and Solutions	As required
Mid-term Review: • review of activities • possible modification to procedure and/or overall plan	Approximate mid-way through the project
Final Review	Toward the end of the project

7.4.3 Environmental Monitoring During Construction Phase

231. Monitoring plan should also include regular reviews of the impacts that cannot be adequately assessed before the start of the works, or which arise unexpectedly, along with appropriate measures to mitigate any negative impacts and/or enhancing beneficial impacts. This section outlines the main environmental parameters to be monitored, timing of the monitoring work and the recommended frequency of monitoring during the construction phase of the project. Specific monitoring requirements for the environmental issues during construction phase listed in Table 7.4 are presented in Table 7.5.

Table 7.4: Monitoring issues/ requirements during construction phase of the project

Environmental Issue	Monitoring requirements/issues
Air pollution	•Construction materials should be properly covered while hauled and stored, roads properly cleaned and water sprayed in order to minimize concentration of dust in air. •Use of equipment like stone crushers (for concreting work), which produce excessive noise as well as generate particulate matter, must not be

Environmental Issue	Monitoring requirements/issues
	used close to human settlement. • During trench construction activities, the topsoil removed should be placed in a location that ensures little or no fugitive dust formation from stockpile • Concentration of particulate matter within and around the project site should be measured, at least once every three months, and air quality management plan should be revised, if needed. • The adjacent residential plot should be given high importance
Noise pollution	• Equipment producing excessive noise should not be operated after dark. • Use of equipment like stone crushers (for concreting work), which produce excessive noise as well as particulate matter, must not be used at the site. • Vehicle movement to and from the site should be properly managed in order to ensure that this causes minimum disturbance to the people living in the surrounding areas. • Noise levels along the perimeters of the project area should be monitored during the construction period and any defective equipment or vehicle removed from activities immediately. • The adjacent residential plot should be given high importance
Traffic congestion	• Hauling of materials and equipment to and from project sites should preferably be done after the regular working hours, so that it causes minimum disturbances to the regular traffic in and around the project site. • Contractor should take responsibility of proper traffic flow and management within the immediate vicinity of the project site.
River navigation	• See that the river navigation is not disturbed due to construction of HFO pipeline and service jetty.
Drainage congestion	• Appropriate measures should be taken to avoid temporary drainage congestion during construction activities
Impacts to Water Resources	• During excavation activities, the topsoil removed should be placed in a location that ensures no turbidity impacts to nearby water resources and the flora and fauna • Should the contractor vacate the area leaving stockpiled material a suitable penalty (fine and removal cost) should be levied to remedy the situation.

232. Table 7.5 shows monitoring plan for during construction phase of the project. The monitoring plan includes the parameters to be monitored, the time location and frequency of monitoring and the assignment of responsibilities. As can be seen from Table 7.4, monitoring is primarily the responsibility of the Contractor. The Contractor will perform these monitoring activities as prescribed in Table 7.4 and will directly report the results to the Project Coordinator. The Project Coordinator will examine the performance of the contractor in carrying out these activities.

Table 7.5: Monitoring of water quality, air quality and noise during construction phase

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Noise Level	Baseline One set of measurements at property boundaries of selected	Equivalent Noise level (L_{eq}) with GPS location, wind speed	Spot checking in a monthly basis; Contractor's	Noise level meter, GPS;

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
	critical locations (the nearby residential plot, other residential areas, highways etc.) prior to commencing activities One set of measurements at the same locations during construction activities	and direction	Responsibility	
Air Quality (dust particles/ particulate matter)	Baseline Only at selected critical locations downwind of site activities (prior to commencement of work) and in close proximity to human receptors (specially the nearby residential plot) Only at selected critical locations downwind of site activities (during construction activities) and in close proximity to human receptors	SPM, PM_{10} with GPS location, wind speed and direction	Once in three months or as deemed by the Project Coordinator; Contractor's Responsibility	PM sampling device*, GPS Wind speed/direction data to be collected from local BMD station
Surface Water Quality	Baseline: One measurement from a location downstream of the project site of Dhaleshwari River One measurement from the same location during construction activities	Turbidity, Total Suspended Solids, Dissolved Oxygen, oil and grease	Monthly and as directed by the Project team leader; Contractor's Responsibility	Laboratory facilities for water/ wastewater analysis
Ground water quality	Chemical Analysis of Tubewell water used as drinking water source for the workers	Routine drinking water parameters	Once in six months; Contractor's Responsibility	Laboratory facilities for water/ wastewater analysis
Soil Quality	Sample randomly selected at one or two locations within the project site	Selected heavy metals (Pb, Cr, Cd)	Once in six months; Contractor's Responsibility	Laboratory facilities for soil sample analysis
Threatened Flora and fauna	At the construction site, in Dhaleshwari river	Visual observation of threatened flora, fauna and fish species listed in Table 4.22	Once in six months; Contractor's Responsibility	Record of observation in the progress report.
General site condition	Baseline: Visual survey (once) of proposed site before commencement of work	General site condition, traffic condition, pedestrian	Weekly and as directed by the Project team	Digital camera

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
	Visual survey of the power plant site during the entire period of construction	movement, vegetation clearance etc. by visual survey (photographs)	leader; Contractor's Responsibility	
House-keeping activities, Safety measures during construction	Visual survey of the power plant site during the entire period of construction	Construction debris management, road traffic/ river traffic management, management of flammable materials (if any), use of Personal Protective Equipment by workers etc.	Weekly and as directed by the Project team leader; Contractor's Responsibility	Digital camera

Note: * PM-sampling has to be done with USEPA-approved FRM-based or equivalent PM sampling device. The Project Coordinator will decide actual monitoring time and location.

233. The measured noise levels should conform to the national noise level standards (see Table 4.10) as well as the WBGguidelines (Table 4.12) for different areas (residential, silent zone etc.) as applicable. Noise level during construction activities should be within the limits of exposure prescribed in the OSHA guidelines (Table 4.13). The measured air quality should be within the limits of the national ambient air quality standards (Table 4.7) as well as those mentioned in the WBGguidelines (Table 4.8) for particulate matters in the air. The surface water quality parameters measured should be within the limits of Bangladesh Standards for inland water quality (Table 4.16). The drinking water quality parameters should be within Bangladesh drinking water quality standards (Table 4.15)

7.4.4 Environmental and Social Monitoring During Operation Phase

234. Environmental monitoring during operation phase must address the concerns of air and noise pollution as well as solid/liquid waste generated from the power plant facility. This would be mainly the responsibility of DNPGL. Specific monitoring requirements for the environmental issues during operationphase listed in Table 7.6 are presented in Table 7.7.

Table 7.6: Monitoring issues/ requirements during operation phase of the project

Environmental Issue	Monitoring requirements/issues
Air pollution	• Continuous monitoring of emissions of SO_x, CO, NO_x, PM_{10}, $PM_{2.5}$, and temperature of flue gases should be carried out and should be checked against the manufacturer's specifications and effectiveness of abatement measures. Stack emission measuring device should be installed by the

Environmental Issue	Monitoring requirements/issues
	power plant. • Ambient air quality should be monitored at different locations within and around the power plant site within a 5-km radius • The adjacent residential plot should be given high importance
Noise pollution	• Noise measurements in the surrounding environment should be to determine the effectiveness of noise attenuation measures from the power plant • Indoor noise environment should also be assessed as a part of the occupational health and safety plan • The adjacent residential plot should be given high importance
River navigation	• See that the river traffic is not hampered during off-loading of HFO in the service jetty
Solid waste disposal	• Amount of solid waste generated from the facility should be documented. • The hazardous nature of the waste should be assessed before final disposal at a landfill
Wastewater treatment	• liquid waste generated from the facility should be treated (for separation of oil/grease and harmful constituents) before discharging into the environment. The efficiency of the effluent treatment plant should be monitored from time to time.
Ground water	• The groundwater level along with the selected drinking water quality parameters (e.g., pH, Color, Turbidity, TDS, Ammonia, Nitrate, Phosphate, As, Fe, Mn and Coliforms) may be monitored since the groundwater would still be used for drinking purpose for the power plant officials.
Threatened fauna	• The HFO transmission crew might encounter the Gangetic Dolphin in its travel route. Record of observation is required.
River water	• Although the proposed plant is not expected to be a contributor to the deterioration of water quality of the Dhaleshwari river due to organic pollution, there is some concern regarding accidental leaks and spills of HFO while transporting the fuel from the service jetty to the plant via the transmission pipeline. Therefore oil and grease of the river water along with a few basic parameters should be monitored regularly.

Table 7.7: Monitoring of water quality, air quality and noise during operation phase

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Noise Environment	<u>Baseline</u> One set of measurements at property boundaries of selected critical locations (residential area adjacent to the site, other residential areas, highways etc.) prior to commencing activities	Equivalent Noise level (L_{eq}) with GPS location	Spot checking in a monthly basis; Responsibility of DNPGL	Noise level meter, GPS;
	One set of measurements at the same locations during plant operation			
Ambient Air Quality (particulate matter and	<u>Baseline</u> Only at selected critical locations within and downwind of site activities (prior to plant	Various priority pollutants: $PM_{2.5}$, PM_{10}, SO_2, NOx, CO with GPS	Once in three months using passive samplers for critical points	Particulate matter and gaseous constituent

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
gaseous components)	commission) and in close proximity to human receptors within a 5-km radius of the plant (adjacent residential area, other residential areas) At the same locations during plant operation	location, wind speed and direction	outside the plant premises; continuous air quality monitoring at least one location within the plant premises; Responsibility of DNPGL	sampling device*, Continuous air quality monitoring device*, GPS, Wind speed/direction data to be collected from local BMD station
Air emission from stacks	Emission from all three stacks should be continuously monitored	Various priority pollutants: $PM_{2.5}$, PM_{10}, SO_2, NOx	Continuous monitoring throughout the life-cycle of the power plant; Responsibility of DNPGL	Continuous emission measuring device
Surface Water Quality	<u>Baseline:</u> One measurement from a location downstream of the project site of Dhaleshwari River One measurement from the same location during construction activities	Dissolved Oxygen, oil and grease	Once in six months; Responsibility of DNPGL	Laboratory facilities for water/ wastewater analysis
Ground water quality	Chemical Analysis of Tubewell supplying drinking water to plant officials and workers	Routine drinking water parameters	Once in six months; Responsibility of DNPGL	Laboratory facilities for water/ wastewater analysis
Threatened Flora and fauna	Gangetic Dolphin in the Dhaleshwari river	Visual observation by the vessel crew transporting HFO	Responsibility of DNPGL	Record of observation and measures adopted (if any) by the crew
Solid Waste	Determine the hazardous nature of solid waste/ sludge generated from plant operation / FGD residual gypsum	TCLP tests for selected heavy metals (Pb, Cr, Cd, As)	Once a year; Responsibility of DNPGL	Laboratory facilities for soil/sludge sample analysis

Monitoring	Period/Location	Parameters to be monitored	Monitoring Frequency and responsibilities	Resources Required
Liquid Wastewater	From the effluent treatment plant, FGD unit wastewater prior to disposal	pH, TSS, TDS, Oil and Grease, Total Chromium, Copper (Cu), Iron (Fe), Zinc (Zn), Lead (Pb), Cadmium (Cd), Mercury (Hg), Arsenic (As), Sulphate	Once a month; Responsibility of DNPGL	Laboratory facilities for water/ wastewater analysis
Occupational health and safety (worker health, working environment)	surveillance of workplace environment	Noise, air quality, worker health status check	Monthly, Responsibility of DNPGL	Noise and air quality: see above. Certified medical professional for worker health status check
Volatile organic compound monitoring in workplaces	Workplace having lube oil, fuel, diesel storage containers	Total Volatile Organic Content in ambient air	Monthly, Responsibility of DNPGL	Ambient air quality monitoring device

* PM-sampling has to be done with USEPA-approved FRM-based or equivalent PM sampling device. The Project Coordinator will decide actual monitoring time and location.

7.4.5Estimation of Cost of ESMP

235. Many of the activities to be carried out as a part of ESMP would not involve any additional direct cost e.g., employing local work force, where appropriate; keeping sub-project vehicles in good operating condition; scheduling deliveries of materials/ goods in off-peak hours; good housekeeping, avoiding spills; etc. Medical examination can be performed by in-house medical doctors. On the other hand, a number of activities would require additional cost. Environmental monitoring during construction phase would involve direct cost. At the same time, a number mitigation measures (including health and safety measures) would require additional cost; these include medical examination, water sprinkling on surfaces, protective gear etc. Table 7.8 provides method of estimation of costs of different items of ESMP. It is advised that the power plant authorities develop in-house capacity of monitoring some of these environmental parameters such as installation of stack emission measuring equipment, laboratory facilities for analyzing water/wastewater samples etc.

Table 7.8: Method/ basis of estimation of cost of Monitoring

Item	Basis of cost/Estimated cost
Monitoring:	
Noise level	Prevailing rate (~ Tk. 5,000/- per

Item	Basis of cost/Estimated cost
	measurement per day)
Ambient Air Quality (SPM, $PM_{2.5}$, PM_{10}, CO, NOx, SO_2, TVOC)	Prevailing rate (~ Tk. 16,000/- per measurement)
Continuous Stack Emission monitoring ($PM_{2.5}$, PM_{10}, CO, NOx, SO_2)	Continuous monitoring equipment to be installed by DNPGL. Price: *as quoted by the manufacturer* (must include the price for periodic maintenance/ calibration of equipment)
Continuous Ambient Air quality monitoring($PM_{2.5}$, PM_{10}, CO, NOx, SO_2)	Continuous monitoring equipment to be installed by DNPGL. Price: *as quoted by the manufacturer* (must include the price for periodic maintenance/ calibration of equipment)
Routine Drinking water quality parameters	Prevailing rate (~ Tk. 8,500/- per sample)
River Water quality (Turbidity, Total Suspended Solids, Total Solids, Dissolved Oxygen, Oil and grease)	Prevailing rate (~ Tk. 3,000/- per sample)
Liquid Effluent (pH, TSS, TDS, Oil and Grease, Total residual Chlorine, Total Chromium, Copper (Cu), Iron (Fe), Zinc (Zn), Lead (Pb), Cadmium (Cd),Mercury (Hg), Arsenic (As), Sulphate	Prevailing rate (~ Tk. 19,000/- per sample)
Soil Quality (Heavy metals Pb, Cr, Cd, As)	Prevailing rate (~ Tk. 7,000/- per sample)
Water sprinkling on aggregate	Latest PWD/LGED rate (if available)/A fixed rate per cubic meter of aggregate per day
Protective gear	Contractor to quote rate of different items of works considering the provision of adequate protective gear for workers, in accordance to the conditions of contract, specified in the Tender Document

7.5 OCCUPATIONAL HEALTH AND SAFETY PLAN

236. Occupational health and safety means preventing accidents and work related ill health. Improved health and safety management can bring significant benefits to the business. It reduces individual and human costs of accidents and ill health, direct and indirect cost to the business, improves customer perception and company profile and workers' morale. Under occupational health hazards, one can group several categories of working conditions impairing the health conditions of workers, though this impairment is slow. Safety relates more to health hazards that results from accidents and can cause instantaneous impairment of the workers' health.

7.5.1 General Requirements

237. 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. The salient features of the general requirements for the workers' health and safety stated in this law is presented in Table 7.9.

7.5.2 Workplace Environmental Quality

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

Health Hazards

239. 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.

Table 7.9 General requirements for workers' health and safety

Issues	Requirements
Health and Hygiene	• Cleanliness • Ventilation and temperature • Dust and fumes • Disposal of wastes and effluents • Overcrowding • Illumination • Latrines and urinals • Spittoons and dustbins
Safety	• Safety for building and equipment • Precautions in case of fire • Fencing of machinery • Floor, stair and passage way • Work on or near machinery in motion • Carrying of excessive weights
Compensation for accidents at work	• Owner's responsibility for compensation • Amount of compensation • Report on fatal accident and treatment • Compensation on contract and contract registration • Appeal
Dust and Fumes	• Any dust or fumes or other impurities likely to be injurious to the workers, effective measures shall be taken to prevent its accumulation and its inhalation by workers

Issues	Requirements
Overcrowding	• No work room in any factory shall be overcrowded • At least five hundred cubic feet of space shall be provided for every worker employed in a work room
Latrines and urinals	• Sufficient latrines and urinals shall be provided • Shall be maintained in clean and sanitary condition • Shall be adequately lighted and ventilated
Precautions in case of fire	• Shall be provided with means of escape in case of fire • Effective measures shall be taken to ensure that all the workers are familiar with the means of escape • Fire fighting apparatus should be provide and maintained
First aid	• Provided and maintained first aid facility • One for every one hundred and fifty workers • Shall be kept with a responsible trained person who shall be available during the working hours • In every facility where five hundred or more workers are employed, a dispensary shall be provided and maintained
Disposal of wastes and effluents	• Provide with proper disposal system for solid waste and effluents. • In case of a factory where no public sewerage system exists, prior approval of the arrangements should be made for the disposal of wastes and effluents
Occupational and poisoning diseases	• 16 occupational diseases notifiable to the Chief Inspector of Factories: 1. lead poisoning 2. lead tetraethyl poisoning 3.phosphorous poisoning 4. mercury poisoning 5. manganese poisoning 6. arsenic poisoning 7. poisoning by nitrous fume 8. carbon di sulfide poisoning 9. benzene poisoning 10. chrome ulceration 11. Anthrax 12.silicosis 13. poisoning by halogens 14. primary epitheliomatous cancer of the skin 15. toxic anemia 16. pathological manifestation due to radium or x-rays
Compensation	• If personal injury is caused to workmen by accident arising in the course of employment, employer shall be liable to pay compensation • 36 occupational diseases for compensation payable • Monthly payment as compensation for temporary disablement are 1. Compensation should be paid for the period of disablement or for one year whichever period is shorter 2. Such compensation shall be paid at the rate of full monthly wages for the first two months 3. Two thirds of the monthly wages for the next two months

Issues	Requirements
	and at the rate of the half of the monthly wages for the subsequent months 4. In case of chronic occupational diseases , half of the monthly wages during the period of disablement for a maximum period of two years shall be paid

240. A quantification of the measure of severity in health hazards is not well defined. They are slow acting and cumulative, their effects may not be visible for years. During plant installation and commissioning phase, use of chemicals (paints, solvents, thinners etc) batteries, welding materials, lubricants etc. may contribute to health hazards to the workers. These substances may be carcinogenic or detrimental in other ways. Use of industrial solvents can cause anemia, liver and kidney damage, cardiovascular diseases and neurological disorder.

Remedial measures

241. 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 sullage 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

Safety

242. 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, and discipline amongst workers, maintenance of machineries

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

243. 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.

7.5.3 Work in Confined Spaces

244. 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.

245. 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. Adequate care should be taken to minimize stress and ergonomic design should be improved to minimize health hazards. First aid facilities should be available and evacuation plans for emergency situations should be in place with adequate drills, instructions and signs. Adequate fire-fighting arrangements should be installed and maintained on a regular basis.

246. Where appropriate strict work procedure and guidelines are to be defined for different jobs and be informed to the relevant staff. Regular medical examination should be arranged for the staff exposed to occupational health hazards. Areas where people may be exposed to excessive noise should be sign posted as "Hearing Protection Areas" and their boundaries should be clearly defined. No person should enter this area unless wearing personal hearing protectors.

7.5.4 Hazardous Material Handling and Storage

247. 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.

248. Used lead acid batteries contain lead, sulfuric acid and several kinds of plastics which are hazardous to human health. Therefore the ideal place to store used lead acid batteries is inside an acid resistant sealed container to minimize the risk of an accidental spillage. However this is not often the case and 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

249. It is recommended that where dangerous goods are stored and handled, that premises should be provided with fire protection and firefighting equipment. These equipment 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.

250. Laborers handling offensive toxic chemicals should be provided with and forced to use protective clothing. Works with volatile toxic chemicals should be undertaken in a well-ventilated place. Arrangements should be made for sufficient and suitable lighting.

251. Safe access within and to and from the premises should be ensured. Unauthorized access and activity on the premises should be prevented. These measures will reduce the chances of accidents and facilitate a safe environment for the workers, the staff and the plant.

7.5.5 Training

252. 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. The following issues should be addressed in training of the managers, staff and workers:

- Workers should be trained to use the engineering controls where installed
- Arrange workplace consultation on noise control
- Workers should participate in training and contribute to the noise management strategy
- 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 firefighting 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.

7.5.6 Record Keeping and Reporting

253. 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.

Plant Construction

254. 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.

Plant Operation

255. 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.

Noise

256. Audiometric test records of employees should be kept during the employee's period of employment and longer as necessary, as they may provide a useful reference for workers' compensation. The records should be kept in a safe, secure place and held as confidential documents.

Hazardous Substances

257. Assessment reports which indicate a need for monitoring and/or health surveillance together with the results of monitoring and/or health surveillance shall be kept as records in a suitable form for at least 30 years from the date of the last entry made. Retention for a period of at least 30 years is necessary because some health effects, such as cancers, may take a long time to become evident. The information kept will be valuable in epidemiological studies and for developing effective control strategies.

258. 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.

7.6 POWER PLANT RISK ASSESSMENT

259. The process of electricity generation from HFO is by no means risk free because of high temperature 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 HFO-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 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

260. Several strategic areas within the power plant can be identified as places of potential risks during plant operation:

Areas prone to explosion are:

- Boiler area
- Turbine hall

Premises prone to fire and electrocution are:

- Electrical rooms
- Transformer area
- Cable tunnel

Premises where people can be exposed to toxic chemicals:

- Storage facilities for chemicals

261. 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.

7.7 MANAGING THE RISKS

262. 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:

- The power plant should be located on a reasonably large plot of land giving ample space to locate all units whilst maintaining safe distances between them.
- The plant layout should provide roads of adequate width and service corridors so that no undue problems arise in the event of fires or other hazards.
- HFO 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, CO_2 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.

263. In order to achieve the objective of minimizing risks at the DNPGL-owned power plant, in addition to Environmental Management Unit for the complex, a disaster management unit with adequate manpower and facilities for each plant within the complex must be in place. 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.

7.8 EMERGENCY RESPONSE PLAN

264.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.

7.8.1 Emergency Response Cell

265.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 complex 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 communication system
- Mobilizing all units in the complex within a very short time to address any emergency

7.8.2 Emergency Preparedness

266. The ERC headed by an Emergency Manager (Incident Commander), who would be the focal point of emergency management, should establish an Emergency Control Room with links to all plant control rooms and all other services. The ERC shall work as a team of the following officials:

- Emergency Manager (Incident Commander),
- Fire Officer,
- Safety Officer,
- Chief Security Officer,
- Chief Medical Officer,
- Rescue Officer, and
- Public Relations Officer

267. The Environmental Specialist of the proposed PMU of the DNPGL-owned power plant will act as the Emergency Manager of ERC. The Emergency Manager shall have the prerogative of shutting down the relevant units or the complete plant, which are affected or may further deteriorate damages, in case of an emergency. The EM however,

shall have to report to the Chief Engineer of the power plant of such an event without any delay.

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

269. 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.

270. 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.

7.8.3 Fire Fighting Services

- The Fire Officer will be the commanding officer of the firefighting services. The FO will head a fire fighting team of trained officers and workers. The size of the team should be determined by the DNPGL considering requirement of all existing and proposed power plants within the complex.
- Adequate firefighting equipment e.g. fire extinguishers of different types appropriate for different strategic locations must be planned according to requirements of existing and future plants in the complex.
- Depending on the scale of emergency, the firefighting team will work in close association with security and maintenance personnel of the complex. Additional assistance may also be sought from outside fire stations when required.
- Preparedness is extremely important for efficient and effective firefighting services at the time of emergency. In order to achieve this fire drills should be conducted 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 complex, and utilizing all firefighting gears. Records of the fire drills should be kept in terms of date and time of drill, signature of the officers conducting the drill, comments on satisfactoriness of the drill and photographic evidence of the drill.

7.8.4 Emergency 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 complex and affected by any accident within the plant complex.
- The existing Medical Center of the power plant must be equipped with adequate medical personnel and equipment for providing emergency services in addition to normal Medicare services to population of the complex.

- 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 Center. The number of officers may be determined considering the total number of staff and their family members in the complex. Special attention must be given to child injury treatment.

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

- First aid services for attending patients on the spot. The Medical Center 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 for transport of casualties from spot to Medical Center of the plant, and from Medical Center 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 emergency/ accidents in the plant complex must have an information chart including contact phone numbers of relevant services.

7.8.5 Rescue Services

271. 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 firefighting 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. Important functions include:

- Cut-off electricity, fuel or water supply to accident spots
- Rescue people from debris of collapsed structures
- Demolish damaged structures that may endanger human lives
- Rescue people from fire areas with adequate protection
- Assist other services promptly to save human lives
- Salvage equipment from debris
- Isolate damaged equipment or machineries that may endanger human lives
- Provide repair services as appropriate to restore operations

7.8.6 Security Services

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

273. The Chief Security Officer shall communicate with local police and other law enforcing agencies and seek assistance as may be needed during an emergency. In particular they will ensure that all roads are unobstructed during emergencies.

7.8.7 Public Relations Services

274. The Public Relations Officer (PRO) of the Power Plant will be responsible for communicating emergency related information to concerned officials within the complex. 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 complex 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.

7.9 CONTRACTOR REQUIRMENT

275. Apart from the provisions under "General Specification" and "Particular Specification" for different sub-project components, the following special environmental clauses (SECs) shall be included in the Tender Document under General/Particular Specification. These clauses are aimed at ensuring that the Contractor carries out his responsibility of implementing the ESMP and other environmental and safety measures.

276. **Environmental and Social Management Plan (ESMP):** The Contractor shall carry out all mitigation and enhancement measures (including those related to mitigation of air/noise/water pollution; drainage/traffic congestion) as specified in the Environmental and Social Management Plan (ESMP), annexed to his Contract. This includes Table 7.1 (mitigation measures during construction) and 7.5 (Environmental monitoring plan during construction phase)

277. **Temporary Works:** The Contractor shall make sure that all equipment and safeguards required for the construction work such as temporary stair, ladder, ramp, scaffold, hoist, run away, barricade, chute, lift, etc. are substantially constructed and erected, so as not to create any unsafe situation for the workmen using them or the workmen and general public passing under, on or near them.

278. **Occupational Health and Safety:**

- The Contractor shall observe and maintain standards of Health and Safety towards all of his employees not less than those laid down by the national standards or statutory regulations.
- The Contractor shall provide all appropriate protective clothing and equipment for the work to be done and ensure its proper use. Where required, safety nets, the contractor shall provide belts, harnesses and lines. The "safety directives for work equipment" and "safety directives for protective gears", as specified in the Occupational Health and Safety Guidelines shall be followed.
- The Contractor shall provide and maintain in prominent and well-marked positions all necessary first-aid equipment, medical supplies and other related facilities. A sufficient number of trained personnel will be required to be available at all times to render first aid.

- The Contractor must provide or ensure that appropriate safety and/or health signs are in place at their work sites where hazards cannot be avoided or reduced.
- The Contractor shall report to the Engineer promptly and in writing particulars of any accident or unusual or unforeseen occurrences on the site, whether these are likely to affect progress of the work or not.

279. **Disposal and Pollution:**

- The Contractor shall not dispose any waste, rubbish or offensive matter in any place not approved by the Engineer or Statutory Authority having jurisdiction. The Contractor shall not discharge into any watercourse oil, solids, noxious or floating materials.
- The Contractor shall take all reasonable precautions to keep public or private roads clean of any spillage or droppings from his vehicles or equipment. Any spillage or droppings, which accrue, shall be cleaned without delay to the satisfaction of the Engineer.
- The Contractor shall provide waste bins/ cans for collection of solid waste at appropriate locations (as directed by the Engineer), and ensure proper transfer/ disposal of solid waste.

7.10 GRIEVANCE REDRESS

280. A Grievance Redress Mechanism (GRM) has been proposed which will allow people to voice concerns regarding environmental and social impacts of the proposed project if they are affected. DNPGL should be the first-line recipient of any such grievance. The project-affected persons can register their grievances at the complaint cell of the PMU (available online at the http://doreenpower.com/contacts/) either in writing or online. DNPGL would duly address their grievances within fifteen days of the receipt of the complaint. A Grievance Redress Committee (GRC) will be considered in outstanding cases that cannot be resolved directly and require mediation by a third party.

281. A GRC will be formed for each sub-project, headed by a local Govt. representative of relevant area (a Thana Nirbahi Officer (TNO)). Members will be taken to represent the communities and other stakeholders, which may include representatives from local administration, school teachers, local NGOs, and women. The local Govt. representative will nominate members of the GRC. The local Govt. representative will form the GRC and forward the composition to the PMU of the sub-project. Table 7.10 shows a possible composition of the GRC. The GRC will ensure proper presentation of complaints and grievances, as well as impartial hearings and transparent decisions. If required, the GRCs will meet periodically to discuss the merit of outstanding cases and fix a date for hearing and notify the PAP to submit necessary documents in proof of her/his claim/case. DNPGL will try to address the grievances on their own as a first-line recipient, however, if a GRC formation becomes necessary in certain cases, DNPGL will have the responsibility of carrying out necessary expenditure related to the formation

of the committee. If a GRC is formed, it will have a commitment to resolve grievances within one month of receipt of complaint.

Table 7.10: Structure of Grievance Redress Committee (GRC)

Chairman	Local Govt. Representative (Thana Nirbahi Officer or his representative)
Member-Secretary	Project Coordinator of the Power Plant Project or any member of PMU appointed by him
Member*	Representative from local administration
	Teacher from a local educational institution
	Representative of a local NGO
	Village representative (e.g. chairman)
	Female ward councilor (relevant area)
	Representative of religious society (e.g., Imam)
	Representative of DNPGL
	Any other representative deemed suitable by DNPGL

*Total number of members will be selected to make the operation of the GRC feasible and acceptable to the PAPs.

The following figure summarizes the proposed grievance redress mechanism.

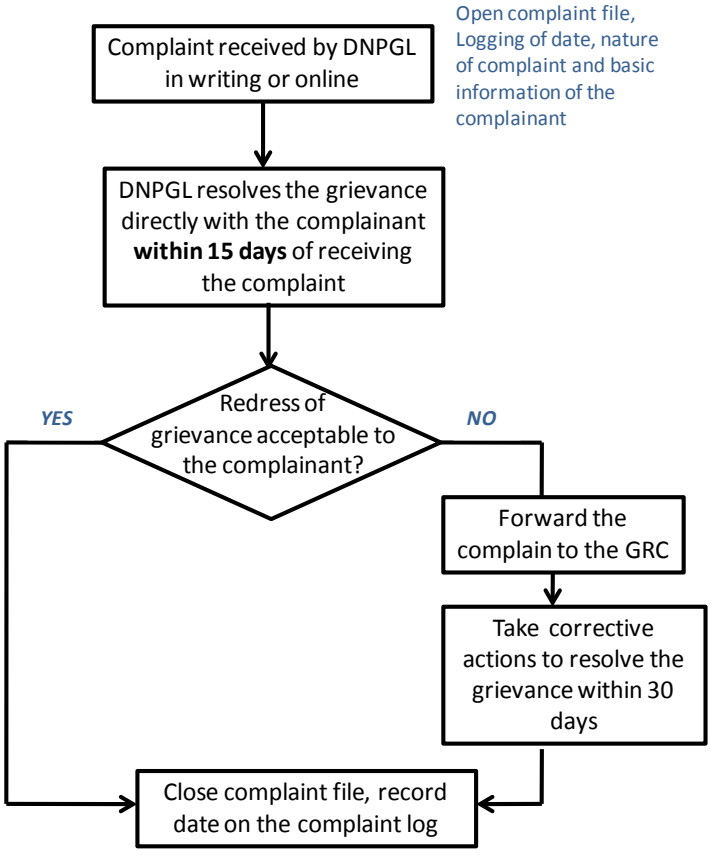


Figure 7.1: Proposed grievance redress mechanism

282. DNPGL will maintain a database of complaints which will contain all information on complaints or grievances received from the community. This would include the type of complaint, location, times of complaints and complaint resolution, description of actions taken to resolve the complaint, method of resolution (one-to-one resolution with the complainant or through a GRC), information on the GRC members present etc. It needs to be mentioned that the procedures followed in the GRM will not pre-empt a person's right to go to the courts of law.

7.11 SUMMARY OF ROLES AND RESPONSIBILITIES IN ENVIRONMENTAL MANAGEMENT

Table 7.11 presents a summary of the roles and responsibilities of different units, cells and committees to be formed by DNPGL in order to successfully implement the environmental management plan, occupational health and safety plan, emergency response plan and grievance redress

Table 7.11 Roles and responsibilities of different units/cells/ committees involved in the overall environmental management of the proposed 55MW power plant project by DNPGL

Issue	Units/Cells/ Committees	Roles / Responsibilities
Environmental and Social Management Plan	PMU of DNPGL (headed by the Project Coordinator)	• Project Coordinator has overall responsibility and will be the focal person of environmental management and ESMP implementation. PMU will be staffed by environmental and social management specialist(s) • Oversee the contractor implementing the ESMP during construction phase, ensure compliance of mitigation measures by the contractors • Prepare monitoring progress reports and share them with Bangladesh Bank IPFF PIU/ World Bank • Implementation of ESMP during operation phase, responsible for monitoring of environmental compliance during operation phase, keep records of environmental monitoring • May engage independent organization to carry out environmental monitoring during project implementation, review the monitoring reports • Ensure the inclusion of ESMP in the contractor bidding documents • Ensure that all the project activities are carried out in environmentally sound manner. • Mitigation of unforeseen impacts (if any) during construction and operation • Arrange for training of staffs in environmental management if necessary(capacity building) • Maintaining database for environmental management

Issue	Units/Cells/ Committees	Roles / Responsibilities
Emergency Response Plan	ERC of DNPGL (headed by an Emergency Manager who is also the Environmental Specialist of the PMU)	• The ERC is in charge of implementing the Emergency Response Plan with a group of officers whose roles and functions are outlined in section 7.8 • ERC and PMU will develop site-specific Emergency and Risk management plan following international guidelines and protocols (IEC HAZOP Guide, IChemE HAZOP guide)
Occupational Health and Safety plan	PMU of DNPGL (headed by the Project Coordinator)	• PMU must ensure that Occupational health and safety is addressed at all stages of power plant construction and operation • Ensuring that the contractor submits his occupational health and safety plan before commencement of construction and they are appropriately reflected in the bidding documents. • Ensure that the OHS plan is implemented by the contractor during construction phase through their proposed monitoring scheme and duly reflected in their progress reports. • Develop a plant-specific checklist for OHS monitoring and conduct the OHS monitoring during operation phase • Modify/update the operation-phase OHS monitoring protocol, if necessary, to suit the plant-specific requirements • Maintain and preserve records of OHS monitoring as suggested in the OHS plan
Grievance Redress	DNPGL, GRC (Project Coordinator of PMU is the member-secretary)	• Project Coordinator of the PMU will directly try to resolve the grievance with the complainant at first; the GRC will be engaged if a resolution could not be achieved in the first attempt. • As member-secretary of the GRC, the Project Coordinator has the responsibility of contacting the GRC members and making arrangements for the hearing/meeting with the complainant. • DNPGL through the PMU is to maintain all records of grievance redress.

7.12 DISCLOSURE REQUIREMENTS

283. As per World Bank's policy on access to information, DNPGL will make the ESIA document available to the public by publishing it in their websites. In addition, hard copies of these documents in English (including an executive summary in Bengali and English) will be made available in publicly accessible locations in the project site as well as in the head office of DNPGL. Any public notices (or any other means of communication) posted ahead of the construction work at a certain location should also contain the information as to where the ESIA documents would be available.

7.13 CONCLUDING REMARKS

284. 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 PMU and the Emergency Response Cell shall develop their own site-specific emergency plans, hazard and risk management plans following international guidelines and protocols when the pertinent data and information are available. A detailed, site-specific Quantitative Risk Assessment (QRA) will be prepared in accordance with the International Electrotechnical Commission (IEC) International Standard 61822 Hazard and Operability Studies (HAZOP) Application guide ('the IEC HAZOP Guide') and with reference to applicable guidance on the Institution of Chemical Engineers (IChemE) HAZOP Guide to Best Practice, 2nd Edition, April 2008 ('the IChemE HAZOP Guide'). The HAZOP guides are available in the following links:
http://webstore.iec.ch/webstore/webstore.nsf/artnum/026991!opendocument
http://www.icheme.org/shop/books/safety/hazop%20guide%20to%20best%20practice.aspx

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1 INTRODUCTION

285. There is no alternative but to add more power generating units to the existing power system of Bangladesh within a shortest possible time frame. This is due not only to meet the increase in demand, but also due to aging of the existing power generating units, many of which will near their life cycle very shortly.

286. An Environmental Impact Assessment (ESIA) of the proposed 55 MW Combined Cycle Power Plant at Singair, Manikganj has been carried out, which included development of an Environmental and Social Management Plan (ESMP), covering both the construction and operational phases of the project.The detailed ESIA of the proposed power plant was conducted following the guideline (GoB, 1997) of the Department of Environment (DoE) of GoB and the relevant operational policies (e.g., OP 4.01) of the World Bank.

287. 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 quality and noise level.

288. The study suggests that most of the adverse impacts on the physico-chemical environment could be offset or minimized if the mitigation measures are adequately implemented. Noise level has been identified as a significant potential impact of the proposed power plant during both the construction and operation phases. The noise generated from power plant operation might become a source of annoyance at the residential area located close to the project site if noise attenuation measures are not taken. Mitigation measures, including installing proper silencers and acoustically designed engine rooms have been suggested in order to reduce noise exposure. Noise modelling has been done to confirm these findings. High level of noise is expected to be generated within the confines of the turbine and generator installations. Prolonged exposure to such high level of noise may cause permanent hearing loss. Therefore, proper protective measures should be adopted during the operation and inspection of this equipment. The project workers should not be exposed to the noise produced by the construction equipment for a prolonged period to prevent permanent hearing loss. A rotational work plan is advised for the workers and operators of this equipment.

289. Some adverse impact during the operation phase of the plant will come from NO_x and SO_x emission from the power plant. Modeling study of the worst case scenario suggests that the effect of increased NO_x and SO_xin the ambient air above the background levels due to emission from the power plants will be very significant. By adopting certain technological options such as low NOx burners, Flue Gas Desulfurization (FGD), the levels of NO_x and SO_x in the ambient air can be brought down to acceptable levels.

290. The management of FGD residuals can become an issue during operation phase. As per the EMP, the solid waste generated from the FGD unit has to be tested for heavy metals before sending it for disposal to landfill or selling it to other users. If the solid waste generated from FGD has leaching characteristics exceeding USEPA limit, special containment measures (such as in a lined pit) need to be adopted by DNPGL to safely dispose the waste.

291. The proposed plant will be constructed within the DNPGL-owned 3.7 acre land. So there is no need for land acquisition. Additionally, this area is not used for income-generating activities. Therefore, no population will be displaced and no resettlement will be required for the construction of the power plant, and no loss of income is associated with the proposed project.

292. During operation phase, no significant negative impact is anticipated on socio-economic environmental parameters. Significant positive impacts are expected due to improvement in power supply. This will reduce load shedding in Dhaka city and contribute to the national economy. Well-being of the surrounding population, especially Dhaka city, will be significantly improved due to generation of electricity during peak hours.

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

8.2 RECOMMENDATIONS

294. The environmental assessment carried out for the proposed HFO-fired power plant at Singair, Manikganj suggests low to moderate scale of adverse impacts, which can be reduced to acceptable level through recommended mitigation measures as mentioned in the ESMP. It is therefore recommended that the proposed 55 MW Power Plant may be installed in Singair, Manikganj, 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.

295. Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation activities, the HFO- fired 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.

296. It will be the obligation of the contractor to submit their Environmental Management Action Plan (EMAP) before commencement of work. The EMAP should specify all affected environmental values, all potential impacts on environmental values, mitigation strategies, relevant monitoring together with appropriate indicators and performance criteria, reporting requirements and, if an undesirable impact or unforeseen level of impact occurs, the appropriate corrective actions available.

ANNEX A
SITE CLEARANCE LETTER FROM THE DEPARTMENT OF ENVIRONMENT

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর
মানিকগঞ্জ জেলা কার্যালয়
৪২(নতুন), বেউথা সড়ক, মানিকগঞ্জ।
www.doe-bd.org

স্মারক নং-৩০.৫৬.৮২.৪.২৪.২৩০৬১৪/ছাড়- ০৪

তারিখ: ২৪/০৫/১৪২১ বঙ্গাব্দ।
০৮/৯/২০১৪ খৃষ্টাব্দ।

বিষয়ঃ **অবস্থানগত ছাড়পত্র।**

সূত্রঃ আপনার ২৪/৬/২০১৪ তারিখের আবেদন পত্র।

উপর্যুক্ত বিষয় ও সূত্রের প্রেক্ষিতে আপনার আবেদনপত্র ও সংশ্লিষ্ট কাগজপত্র পর্যালোচনান্তে এবং পরিবেশ অধিদপ্তর, সদর দপ্তর, ঢাকার "লাল" শ্রেণীভূক্ত কারখানার পরিবেশগত ছাড়পত্র বিষয়ক কমিটির ৩৭৮ তম সভার সিদ্ধান্ত {(চ-১(১)} মোতাবেক সাং- ফোর্ডনগর, ডাকঘরঃ ধল্লা, উপজেলা-সিংগাইর, জেলা-মানিকগঞ্জ-এ প্রস্তাবিত **"ঢাকা নর্দান পাওয়ার জেনারেশনস লিমিটেড"** নামক ফার্নেস ওয়েল থেকে ৫৫ মেগাওয়াট বিদ্যুৎ উৎপাদনকারী প্রকল্পের অনুকূলে নিম্নবর্ণিত শর্তে **অবস্থানগত ছাড়পত্র** প্রদান করা হলো।

শর্তাবলীঃ

১) অবকাঠামো উন্নয়নের আওতায় অন্যান্য বিষয়ের মধ্যে আইইই প্রতিবেদনে বর্ণিত সকল মিটিগেশন মেজার্স যথাযথভাবে বাস্তবায়ন করতে হবে।

২) অনুমোদিত TOR এর ভিত্তিতে ইআইএ প্রতিবেদন প্রণয়ন করতে হবে এবং উক্ত ইআইএ প্রতিবেদন পরিবেশ অধিদপ্তরে অনুমোদনের নিমিত্তে দাখিল করতে হবে।

৩) ইআইএ প্রতিবেদনে প্রকল্প সৃষ্ট গ্যাসীয় পদার্থের নিঃসরণ এবং বস্তুকণার (Particulate Matters) নির্গমন বাংলাদেশ পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭-এ উল্লিখিত মানমাত্রার মধ্যে রাখা, কুলিং ওয়াটার পুনঃব্যবহারের ব্যবস্থা এবং তরল বর্জ্য পরিশোধনের ক্ষেত্রে প্রতিটি রিভাকশন ষ্টেজের ক্ষেত্রে বিস্তারিত ও বাস্তবসম্মত বর্ণনা, স্থাপিতব্য ইটিপি-এর ডিজাইন(ক্যালকুলেশনসহ) এবং ১০০% ওয়াটার রিসাইক্লিং-এর বিষয় অন্তর্ভূক্ত করতে হবে। প্রতিবেদনে অন্যান্যের মধ্যে Spent lubricating oil, oil Filter এবং Sludge ব্যবস্থাপনার বিবরণী ও ড্রেনেজ প্লান অন্তর্ভূক্ত থাকতে হবে।

৪) ইআইএ প্রতিবেদনে নিজস্ব লোকবল ও ইকুইপমেন্ট-এর সমন্বয়ে ইন-হাউজ এনভায়রনমেন্টাল মনিটরিং সিস্টেম গড়ে তুলার বিষয়ে প্রয়োজনীয় কারিগরী ও আর্থিক প্রস্তাবনা অন্তর্ভূক্ত করতে হবে।

৫) ইআইএ অনুমোদিত না হলে আমদানীতব্য যন্ত্রপাতির L/C খোলা যাবে না।

৬) প্রকল্প চত্বরের ন্যূনতম ৩৩% জায়গা উপযুক্ত প্রজাতির ফলজ ও বনজ গাছ লাগিয়ে সবুজায়ন করতে হবে।

৭) প্রকল্পে কর্মরত শ্রমিক/কর্মচারীদের পেশাগত স্বাস্থ্য রক্ষার্থে সকল ব্যবস্থা যেমনঃ হার্ড হেলমেট, নোজ মাস্ক, বুট, চশমা ইত্যাদির ব্যবস্থা রাখতে হবে।

৮) উপরোক্ত অনুচ্ছেদ '১' হতে '৭' সিদ্ধান্ত/শর্ত বাস্তবায়ন পূর্বক পরিবেশগত ছাড়পত্রের জন্য আবেদন করতে হবে।

৯) পরিবেশগত ছাড়পত্র গ্রহণ ব্যতিরেকে প্রকল্প চালু করা যাবে না।

১০) প্রকল্পের পাশে সরকারী জমি থাকলে তা অননুমোদিতভাবে ব্যবহার করা যাবে না।

১১) এ ছাড়পত্র ইস্যুর তারিখ হতে পরবর্তী ১(এক) বৎসরের জন্য বহাল থাকবে এবং মেয়াদ শেষ হবার অন্তত ৩০(ত্রিশ) দিন পূর্বে নবায়নের জন্য আবেদন করতে হবে।

১২) ছাড়পত্রের মূলকপি প্রতিষ্ঠানে সংরক্ষণ করতে হবে। পরিবেশ অধিদপ্তরের এনফোর্সমেন্ট টীম বা কোন কর্মকর্তা প্রকল্প পরিদর্শনে গেলে তাদেরকে ছাড়পত্র প্রদর্শন ও প্রকল্পের কার্যক্রমের বিষয়ে অবগত করানোসহ সর্বাত্মক সহযোগিতা প্রদান করতে হবে।

১৩) এ পর্যায়ে প্রাপ্ত ও পরিবেশিত তথ্যের ভিত্তিতে এ ছাড়পত্র প্রদান করা হলো। পরবর্তীতে কোন তথ্য অসম্পূর্ণ, ত্রুটিপূর্ণ, অসত্য কিংবা গোপন করা হয়েছে মর্মে প্রমাণিত হলে এ ছাড়পত্র বাতিল করা হবে।

১৪) এ ছাড়পত্রের ১ নং অনুচ্ছেদ হতে ১৩ নং অনুচ্ছেদে বর্ণিত শর্তের যে কোন শর্ত ভঙ্গ করা হলে এ ছাড়পত্র বাতিল বলে গণ্য হবে এবং আপনার প্রতিষ্ঠানের বিরুদ্ধে বাংলাদেশ পরিবেশ সংরক্ষণ আইন, ১৯৯৫ (সংশোধিত ২০১০) ও পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ (সংশোধিত ২০০২) অনুসারে আইনগত ব্যবস্থা গ্রহণ করা হবে।

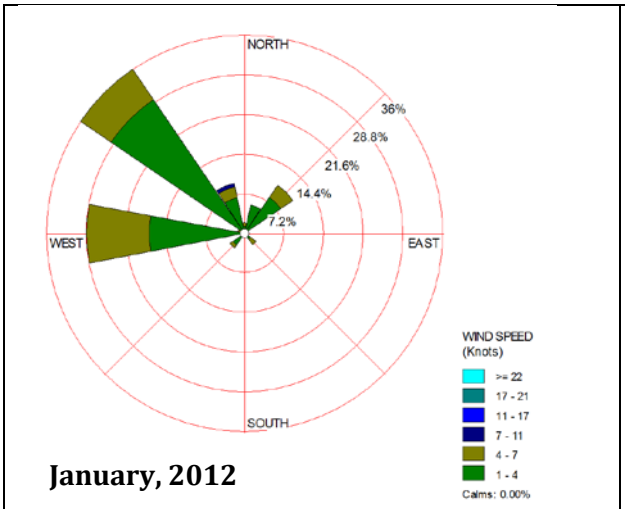
০৮/০৯/২০১৪
(মুহাম্মদ আব্দুল্লাহ আল মামুন)
সিনিয়র কেমিষ্ট
ফোনঃ ০২-৭৭১১০৫৭

জনাব তাহজীব আলম সিদ্দিকী
ব্যবস্থাপনা পরিচালক
ঢাকা নর্দান পাওয়ার জেনারেশনস লিমিটেড
বাড়ি নং-৪২৬, ফ্লাট নং-ডি, রোড নং-৩০
ডিওএইচএস, মহাখালী, ঢাকা।

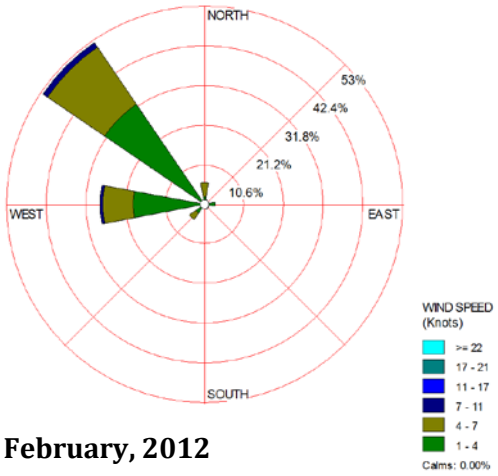
অনুলিপি ঃ
১। পরিচালক, পরিবেশ অধিদপ্তর, ঢাকা আঞ্চলিক কার্যালয়, ঢাকা।

ANNEX B

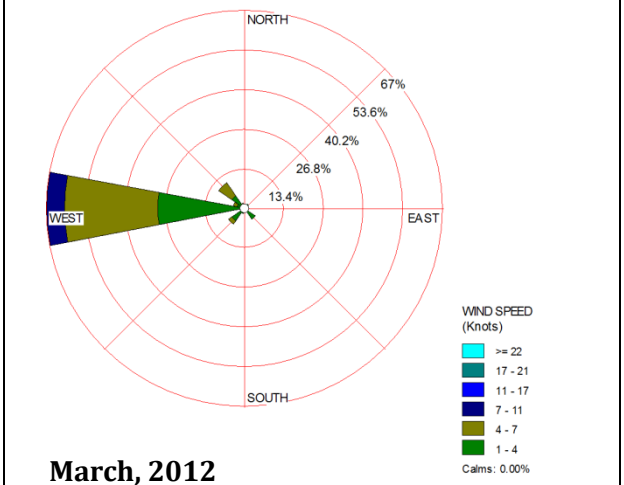
MONTHLY WIND ROSE DIAGRAMS OF THE PROJECT SITE FOR THE YEAR 2012



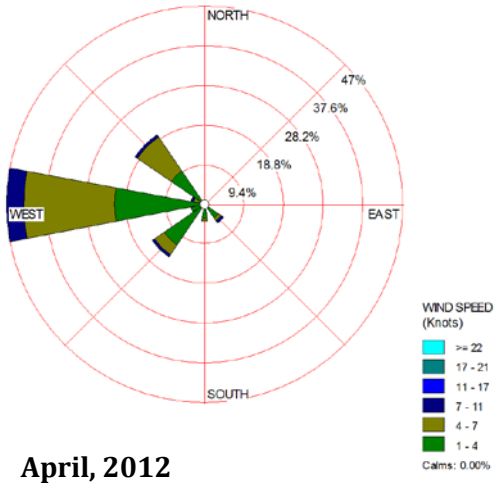
January, 2012



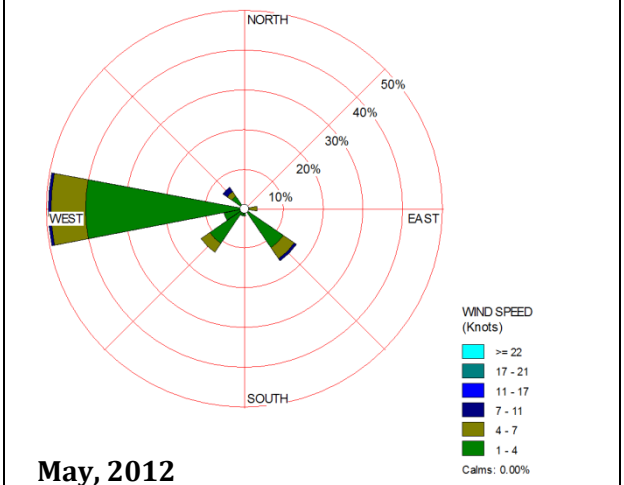
February, 2012



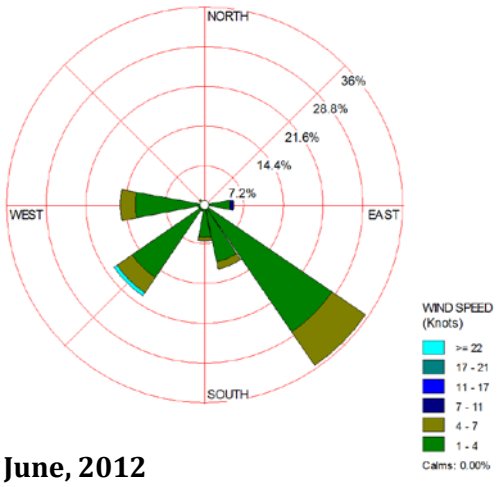
March, 2012



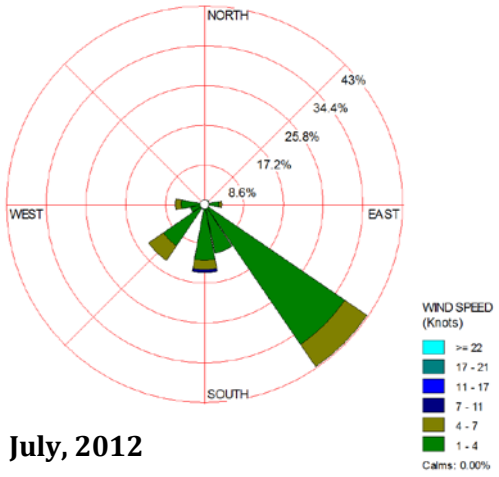
April, 2012



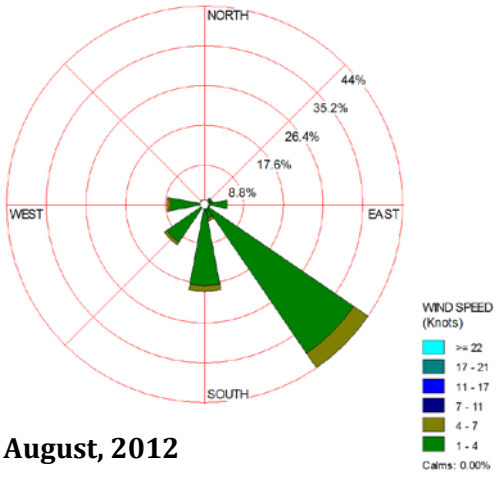
May, 2012



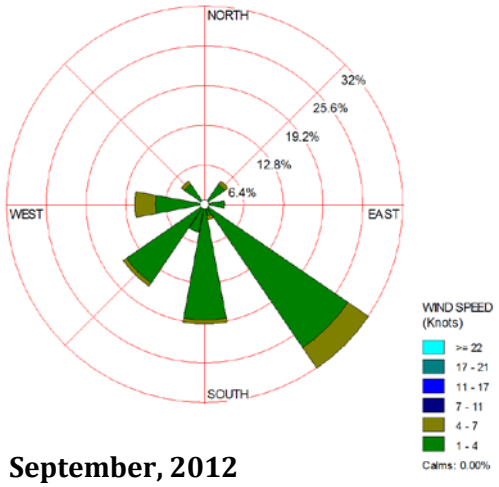
June, 2012



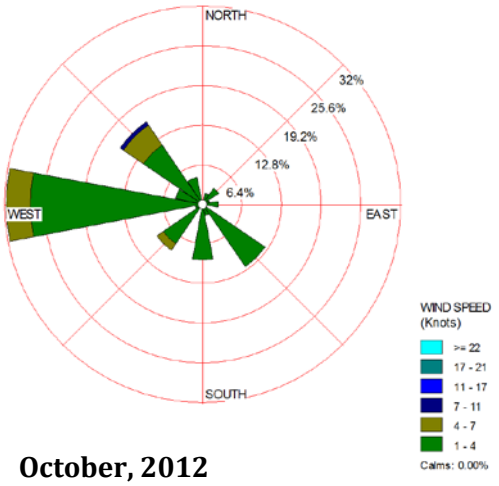
July, 2012



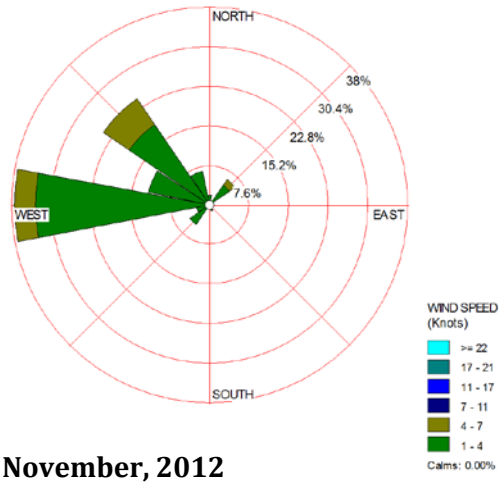
August, 2012



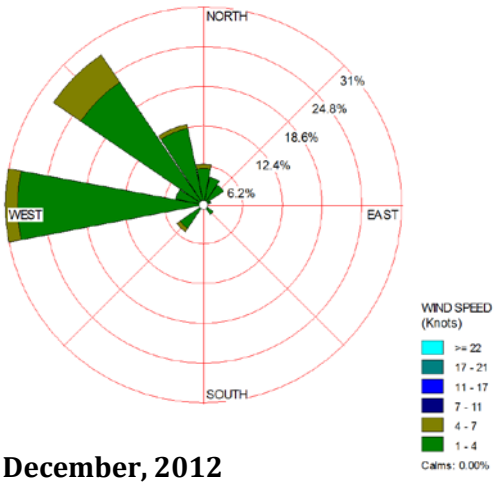
September, 2012



October, 2012



November, 2012



December, 2012

ANNEX C
NOISE POLLUTION MODELLING FOR OPERATION PHASE OF POWER PLANT

The sources of noise during the operations of the power plant are Engine generator, Steam Turbine, Chimney outlets for exhaust gas and Intake air openings. Dhaka Northern Power Generations Ltd (DNPGL) will have 3 units of ultra-efficient MAN 18V48/60 HFO Generator sets with combined capacity of 55MW. Each unit includes engine generator, steam turbine, chimney outlets for exhaust gas and intake air openings. Generally engine generator is considered as a main source of noise in power plant.

Internal noise emission: According to MAN DIESEL & TURBO SE – PETE report on sound emission summary, generator room will have 3 engine generators and 3 steam turbines. The generator room will have a combined noise effect from the 3 engines & turbines of around 112 dBA. (The internal noise level at 1m distance from each reciprocating engine is 107 dBA and the steam turbine noise is 90 dBA, the combined noise effect of which is 112 dBA by applying the formula of ($\Sigma L = 10.\ Log_{10}\ (10^{L1/10} + 10^{L2/10})$). The noise emission from engine room to the outside environment will be minimized by sophisticated acoustic power house building design so as to minimize the noise emission up to standard level. Although DNPGL is yet to confirm which type of material they will use to acoustically design the engine generator room for noise modeling purpose we considered that they will may use 15 mm thick Styrofoam filler sheet in between 150 mm thick brick walls. According to the CUSTIC noise modelling user's manual, the Styrofoam sheet and brick wall will absorb noise as follows:

Material	Thickness	Approximated noise absorption capacity (dBA)
Styrofoam (Acrylic – Poly – Methyl – Meta – Acrylate (PMMA)	15 mm	32 dBA
Brick wall	150 mm	40 dBA
Combined noise effect		40.6 dBA

It is estimated that the noise attenuation of the acoustically designed power house building will be 40.6 dBA for engine room. The maximum engine room noise level is around 112 dBA and noise level further from the engine room will be determined by modeling.

External noise emission: Generally Chimney outlets for exhaust gas and Intake air openings in power plant are located outside the acoustically designed engine room. So we can consider Chimney outlets for exhaust gas and Intake air openings as an external noise emission source for the purpose of noise modelling. According to MAN DIESEL

&TURBO SE – PETE report on sound emission summary, the noise emission level from Chimney outlets for exhaust gas and Intake air openings are 117 dBA and 113 dBA respectively but noise emission will be minimized down to 92 dBA and 73 dBA by using silencer (25 dBA attenuation for Chimney outlets and 40 dBA attenuation for Intake air openings). The combined noise emission from 3 Chimney outlets and 3 Intake air openings can be calculated by applying the formula of noise source addition((ΣL = 10. Log_{10} ($10^{L1/10} + 10^{L2/10}$)) which is 97 dBA. The spatial distribution of propagated noise from 3 Chimney outlets and 3 Intake air openings will be calculated by the noise model.

Noise Modeling input data:

Internal point source

Equivalent Noise: 112 dBA from engine room
Total External surface area: 1632 sq. m
Noise Attenuation/insulation: 40.6 dBA

External point source

Equivalent noise power: 123 dBA from 3 Chimney outlets and 3 Intake air openings without silencer and 97 dBA after providing silencer.
Terrain: Flat terrain without sound attenuation
Height of noise calculation: ground level
Calculation Model: ISO 9613 model

Noise Modeling

Canarina CUSTIC 3.2 software for noise pollution modeling is used for the assessment of the noise pollution propagation of this power plant project. The CUSTIC Software allows us to create robust and useful numeric simulations that fully make use of the graphical user interface.

Two cases were considered in noise modeling to account for all possible scenarios:

Case 1: Considering there is no barrier and no noise attenuation (walls/ noise absorbing materials in the engine house, silencers for exhausts etc) for noise emission from internal and external sources. This is the worst case scenario.

Case 2: Noise simulation for Internal and external sources considering the noise attenuation provided by the silencers (for outside sources) and acoustic design of the generator/engine room (using brick walls and/or styrofoams). Since the actual design of the acoustic properties of the engine room is not yet known, this case can be used to simulate the most ideal scenario.

Figures C-1 to C-4 provides the results of the noise simulation for both cases mentioned above in the form of noise isolines.

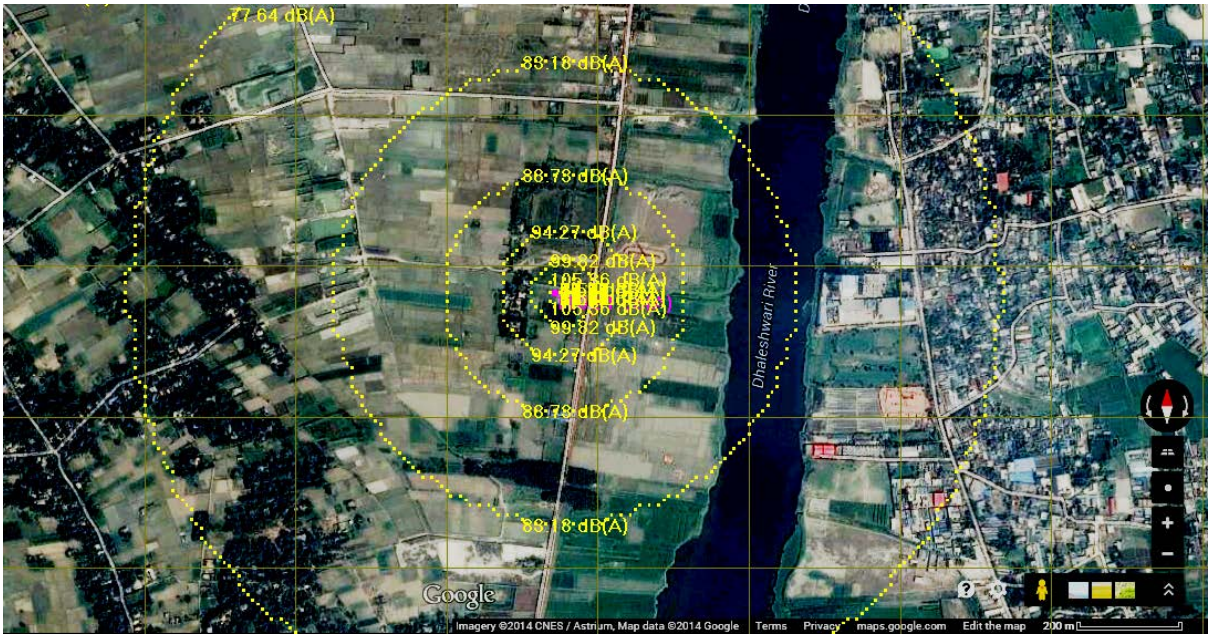


Figure C-1: Noise emission simulation for Internal Source for case 1 scenario

Figure C-2: Noise emission simulation for External Source for case 1 scenario

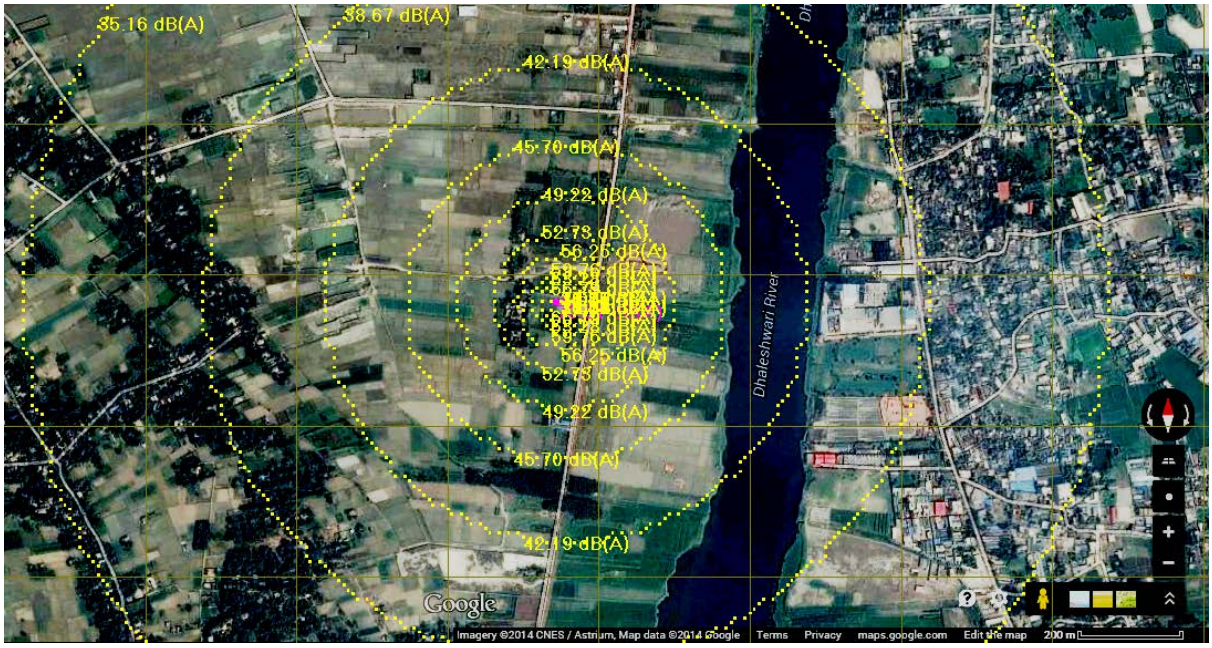


Figure C-3: Noise emission simulation for Internal Source for case 2 scenario (with noise attenuation measures)

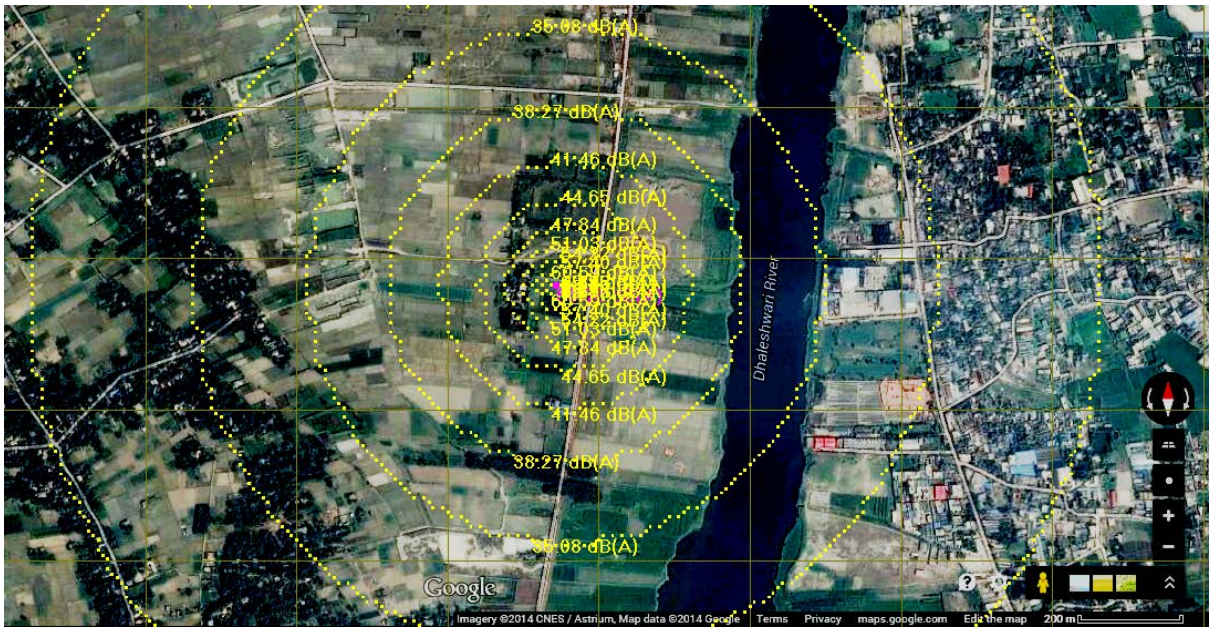


Figure C-4: Noise emission simulation for external Source for case 2 scenario (with noise attenuation measures)

Noise Modeling Results:

Case 1 (No boundary wall + no attenuation measures, worst case scenario)

Distance from noise source (m)	30	60	90	120	150	180
Simulated noise (dBA) for internal source	103	100	95.5	94	91.5	90.3
Simulated noise (dBA) for external source	82.5	78.5	74.4	72.8	70.4	69
Combined Equivalent Noise (dBA)	**103**	**100**	**95.5**	**94**	**91.5**	**90.3**

Case 2 (attenuation measures considered)

Distance from noise source (m)	30	60	90	120	150	180
Simulated noise (dBA) for internal source	63	59.5	55.1	53.5	51	49.5
Simulated noise (dBA) for internal source	62.5	53	50.5	46.9	45.6	44.5
Combined Equivalent Noise (dBA)	**65.8**	**60.4**	**56.4**	**54.4**	**52.1**	**50.6**

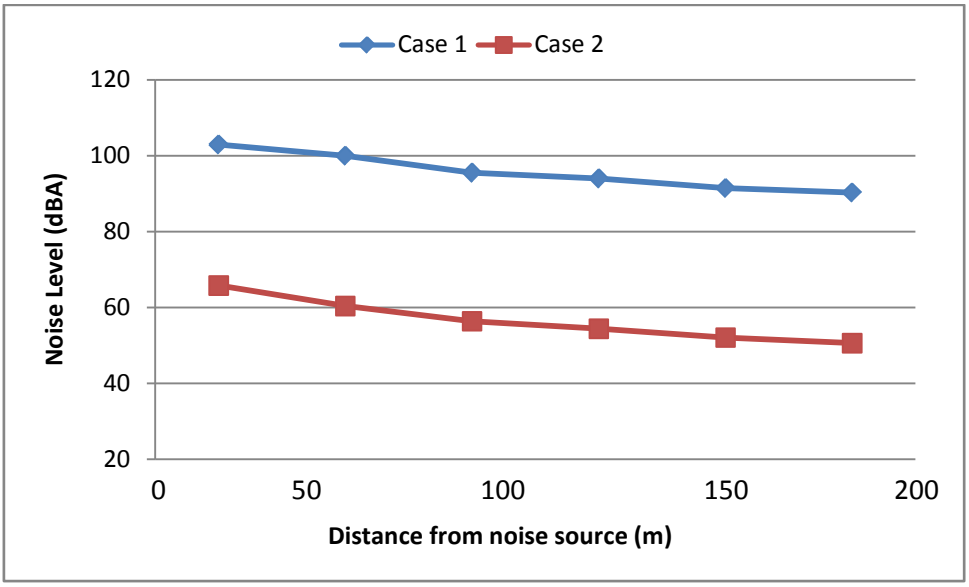


Figure C-5: Simulated noise profiles for case 1 (no attenuation measures) and case 2 (with attenuation measures)

As per layout of the proposed plant, around 20 to 25 meter away from engine room a 3 meter high brick wall will be constructed as a boundary wall. This boundary wall has not been considered as a barrier in this simulation in order to get a conservative estimate. A residential house is situated at the west side (approximately 90 meter from the source of noise) of the proposed power plant. From noise modeling simulation results it can be seen that the predicted combined equivalent noise level due to proposed power plant at this house (within 90 meter radius distance) will be 95.5 dBA, and 56.4 dBA for case 1 and case 2respectively. It is clear that the scenario in the first case would not create an acceptable noise environment for the inhabitants in the residential house and it only becomes acceptable if attenuation measures are applied. It is advised that the power plant authorities employ any reasonable means necessary to acoustically design the engine room so that noise emission from the power plant comply with the applicable guidelines and does not pose any health hazard. A noise monitoring scheme during the operation phase of the power plant is proposed in the ESMP this issue is adequately addressed.

ANNEX D
AIR POLLUTION MODELLING FOR OPERATION PHASE OF POWER PLANT

As part of the ESIA, the effect of stack emissions on ambient air quality has been assessed. Effect of stack emission from the 55MW HFO-based power plant during operational phase on ambient air quality has been assessed using USEPA SCREEN 3 model. SCREEN3 is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources, as well as concentrations in the cavity zone, and concentrations due to inversion break-up and shoreline fumigation.

The model was used to estimate the maximum possible ground level concentrations of PM, CO, NO_2 and SO_2 due to emission from the power generation unit. In all cases, ground level concentration along the center-line of the plume has been estimated using the model. The required information regarding power plant parameters was obtained from manufacturer's specification and from discussion with power plant officials. Table D-1 shows the main input parameters used in the SCREEN 3 model. It needs to be mentioned that some design parameters of the power plant (i.e. stack height) have not been finalized yet; in those cases the latest available data from the power plant officials have been used in the simulation.

As described in Chapter 4, during November to February the predominant wind directions in the project area are from north to northeast, while from March to October it is from south to southeast. Based on wind speed data presented in Chapter 3, a wind speed of 3 m/sec may be used for air quality modeling (which corresponds to approximately the average wind speed). However, all the meteorological combinations between stability classes and their associated wind speeds are considered in this exercise to identify the "worst case" meteorological conditions, that is, the combination of wind speed and stability that results in the maximum ground level concentrations. The wind speed and stability class combinations used by the SCREEN model are given in the following table:

Pasquill-GiffordStability Class	10-Meter Wind Speed (m/s)												
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	8.0	10.0	15.0	20.0
A	*	*	*	*	*								
B	*	*	*	*	*	*	*	*	*				
C	*	*	*	*	*	*	*	*	*	*	*		
D	*	*	*	*	*	*	*	*	*	*	*	*	*
E	*	*	*	*	*	*	*	*	*				
F	*	*	*	*	*	*	*						

The Pasquill-Gifford stability classes represent six levels of atmospheric stability. Atmospheric stability is important as it influences the rate of dispersal of pollutants. Increased amounts of turbulence will cause pollutants to disperse more

rapidly than with more stable atmospheric conditions. The Pasquill-Gifford stability classes range from A to F (1.0 to 6.0) and describe the ambient atmospheric stability as shown in the table below:

Class	Value	Description
A	1.0	Very unstable
B	2.0	Unstable
C	3.0	Slightly unstable
D	4.0	Neutral
E	5.0	Slightly stable
F	6.0	Stable

Stability classes A, B and C are considered unstable conditions and are associated with enhanced turbulence. Stability class D is referred to as neutral conditions and is associated with mechanically generated turbulence or overcast conditions. Stability classes E and F are considered stable conditions are associated with suppressed turbulence.

Ambient temperature was assumed to be 20°C, which corresponds to approximately the average temperature during the dry months (see Chapter 3), during which air quality becomes worse.

The SCREEN 3 model was run for estimating ground level concentration of PM, CO, NO_2 and SO_2along the centerline of the plume with the option of exploring all possible stability classes and wind speeds. Simple (flat) terrain and a rural environment was assumed in the model runs.

Table D-1: Input values used in SCREEN3 air quality model

Parameter	Value	Basis
Exhaust flow rate	17.17m^3/sec	calculated based on the FGD design data in Annex J
Stack Height	46 m/ 24 m	Email correspondence with the power plant technical person (value might change), with FGD the stack height might be 24 m
Stack diameter	1.6 m	Email correspondence with the power plant technical person (value might change)

Parameter	Value	Basis
Estimated Emission Rate and Other Data		
PM Emission[7]	2.57 gm/sec	See footnote below
SO_2 Emission[8]	110 gm/sec (11 gm/sec if FGD is used)	See footnote below
NO_2 Emission[9]	95 gm/sec	See footnote below
CO Emission[10]	5.84 gm/sec	See footnote below
Ambient Temperature	20 °C (293 K)	Average temperature of the study area in the dry season
Wind speed and stability class	All stability classes and associated wind speeds are explored to obtain the worst case scenario	

Tables D-2 and D-3 show the worst case scenario of predicted 1-hr ground level concentration of PM, NO_2 and CO and SO_2, as a function of distance downwind (up to 5 km) as a result of emission from the power generation. The effect of incorporating a Flue Gas Desulfurization (FGD) are explored in Table D-3.

Table D-2:SCREEN3 Simulations of PM, NO_2 and CO concentrations as a function of distance from the source (24 m stack)

Distance from source (m)	1-hour PM concentration (µg/m³)	1-hour NO_2 concentration (µg/m³)	1-hour CO concentration (µg/m³)
1	0	0	0
100	1.72E-02	0.6191	3.91E-02
200	1.7	61.17	3.868
300	10.1	363.4	22.98

[7] From specifications, PM concentration at the exhaust is 50 mg/m³. This is multiplied by 3 for emission from three exhausts to give a total emission rate of 2.57 gm/sec

[8] Emission of SO_2 is calculated from fuel sulphur content and fuel consumption specifications. From specifications, Fuel consumption = 68800 tons/year, Maximum Sulphur content in the fuel = 2.5 % Therefore, emission = 1720 tons/year of Sulphur = 3440 tons/year as SO_2= 110 gm/sec as SO_2 from all three exhausts

[9] From MAN engine specifications, NO_2concentration guarantee at operation mode 1 = 1850 mg/m³. This is multiplied by 3 for emission from three exhausts to give a total emission rate of 95 gm/sec

[10]From specifications, CO concentration at the exhaust is 0.01 %(v/v) = 114 mg/m³. This is multiplied by 3 for emission from three exhausts to give a total emission of 5.85 gm/sec

Distance from source (m)	1-hour PM concentration (µg/m³)	1-hour NO_2 concentration (µg/m³)	1-hour CO concentration (µg/m³)
400	15.53	559	35.34
500	16.46	592.4	37.45
600	15.63	562.6	35.57
700	15.87	571.1	36.1
800	16.52	594.4	37.58
900	15.51	558.2	35.29
1000	14.32	515.2	32.57
1100	13.27	477.5	30.19
1200	12.37	445.1	28.14
1300	11.71	421.3	26.64
1400	11.28	406	25.67
1500	10.84	389.9	24.65
1600	10.38	373.7	23.62
1700	9.938	357.6	22.61
1800	9.683	348.4	22.03
1900	9.703	349.2	22.08
2000	9.643	347	21.94
2100	9.522	342.6	21.66
2200	9.355	336.6	21.28
2300	9.156	329.5	20.83
2400	8.937	321.6	20.33
2500	8.708	313.4	19.81
2600	8.474	304.9	19.28
2700	8.241	296.6	18.75

Distance from source (m)	1-hour PM concentration (µg/m³)	1-hour NO_2 concentration (µg/m³)	1-hour CO concentration (µg/m³)
2800	8.013	288.3	18.23
2900	8.22	295.8	18.7
3000	8.449	304	19.22
3500	9.377	337.4	21.33
4000	9.986	359.4	22.72
4500	10.19	366.6	23.18
5000	10.24	368.6	23.31

Table D-3:SCREEN3 Simulations of SO_2 for various configurations of outlet stack as a function of distance from the source.

Distance from source (m)	1-hour SO_2 concentration (µg/m³) No FGD	1-hour SO_2 concentration (µg/m³) with FGD and stack height 46 m	1-hour SO_2 concentration (µg/m³) with FGD and stack height 24 m
1	0	0	0
100	6.03E-06	6.03E-07	7.04E-02
200	4.123	0.4123	6.952
300	139.8	13.98	41.3
400	365.2	36.52	63.52
500	431.6	43.16	67.32
600	437.5	43.75	63.93
700	616.5	61.65	64.89
800	648.1	64.81	67.55
900	609.2	60.92	63.43
1000	561.9	56.19	58.54
1100	520.5	52.05	54.26
1200	484.9	48.49	50.58

Distance from source (m)	1-hour SO_2 concentration ($\mu g/m^3$) No FGD	1-hour SO_2 concentration ($\mu g/m^3$) with FGD and stack height 46 m	1-hour SO_2 concentration ($\mu g/m^3$) with FGD and stack height 24 m
1300	454	45.4	47.88
1400	427	42.7	46.14
1500	403.2	40.32	44.31
1600	382	38.2	42.46
1700	367.2	36.72	40.64
1800	373.7	37.37	39.59
1900	375.9	37.59	39.68
2000	374.7	37.47	39.43
2100	370.7	37.07	38.94
2200	364.8	36.48	38.25
2300	357.4	35.74	37.44
2400	349.1	34.91	36.55
2500	340.3	34.03	35.61
2600	331.3	33.13	34.65
2700	322.3	32.23	33.7
2800	313.4	31.34	32.77
2900	304.8	30.48	33.61
3000	296.4	29.64	34.55
3500	272.1	27.21	38.34
4000	272.7	27.27	40.84
4500	264.3	26.43	41.66
5000	251.3	25.13	41.89

Maximum (peak) 1-hr ground level concentrations of PM, NO_2 and CO and SO_2have been predicted to be 16.6 $\mu g/m^3$, 597 $\mu g/m^3$, 37.7 $\mu g/m^3$and 650 $\mu g/m^3$, respectively, at a distance of 772 m from the stack. It is worth noting that SCREEN3 is only able to estimate 1-hr pollutant concentrations (except for complex terrain, where 24 hr average is calculated). For the purpose of compliance, it is recommended that these 1 hr-average

values be multiplied by a certain factor to estimate long-term averages (24-hr or annual). For "points" and "flares," the U.S. EPA multiplying factors shown in the following table is used to convert 1-hour concentration estimates from SCREEN3 to other averaging periods.

Table D-4:"POINT" source multiplying factors to convert 1-hour average concentration estimates from the SCREEN3 model to longer averaging periods.[11]

Averaging period	EPA Multiplying factor for point sources
3-hr	0.9
8-hr	0.7
24-hr	0.4
Annual	0.08

In interpreting the effect of stack emissions on ambient air quality, background concentration of the pollutants reported in Chapter 4 have been considered. Comparing these with the measured background concentrations of the study site (see Table 4.6 4.7), it can be seen that the addition of CO and PM to the existing air environment is very much insignificant. Although the background PM concentration exceeds the national standards during certain parts of the year, since the PM emission from the power plant is very low it is not likely to affect the ambient PMconcentration significantly in the vicinity of the project site.

In order to assess the compliance with existing standards for NO_2 and SO_2, the maximum groundlevel concentrations of the pollutants were multiplied with the factors stated in Table D-4 and the summary of the observations are presented in Table D-5

Table D-5: The simulatedmaximum ground level air pollutant concentration compliance assessment for DNPGL 55MW power plant[12]

Pollutant	1-hr average Maximum ground level concentration ($\mu g/m^3$)	Normalized Maximum ground level concentration ($\mu g/m^3$)	Bangladesh Standard for ambient air quality	WHO Guidelines for ambient air quality
NO_2	625	50 (Annual)	100 (Annual)	40 (Annual)
SO_2 (with FGD)	87	7 (Annual) 35 (24 hr avg)	80 (Annual) 365 (24 hr avg)	50 (Annual) 125 (24-hr avg)

[11]"Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised," EPA-454/R-92-019, page 4-16).
[12] Maximum groundlevel concentration of pollutants include the background level of respected pollutants

The background concentrations of NO_2 and SO_2 at the study site (from Tables 4.6 - 4.7) have been found to be very low. As can be seen from Table D-5, the operation of the power plant would result in an ambient air quality below the national standards. Therefore the incremental addition of the NO_2 and SO_2 due to the operation of the power plant is not likely to deteriorate the ambient air quality in this respect. The Table also shows that although the simulated ambient NOx concentration satisfy the National Standards, there is marginal exceedance of WHO guidelines. However, this marginal exceedance is predicted at a distance of 600m – 1000 m from the plant (as per SCREEN3 simulation). There are no sensitive receptors within this strip in the direction of predominant wind (from West and Northwest in Winter, from southeast in Rainy season) in the area around the power plant that could be affected by this level of NOx. This is because most lands around the plant within a 1 km-radius is primarily agricultural land. The nearest residential plot which is 100m from the plant is outside this zone of NOx exceedance. The other residential areas around the plant are at a distance 1.5 km or higher. It must be noted that the above screening model simulation (SCREEN3) has used the worst possible scenario to estimate the ambient air quality. For example, the simulation has been performed for the driest of months (winter season) with the most stable atmospheric conditions (F class). Also the effect of local meteorology was ignored (i.e. wet deposition due to rainfall not considered). The operation of the FGD would also have some effect on reducing the NO_2. It is certain that taking these factors into consideration would generate a scenario with a more improved ambient air quality. However, since the worst case scenario showed compliance with the existing standards, it was not deemed necessary to carry out detailed simulations with more sophisticated air quality models.

ANNEX E
CHANCE FIND PROCEDURES FOR PROTECTION OF CULTURAL PROPERTY

Works could impact sites of social, sacred, religious, or heritage value. “Chance find” procedures would apply when those sites are identified during the design phase or during the actual construction period and the related activity will not be eligible for financing under the project.

1. Cultural property include monuments, structures, works of art, or sites of significanc eoints of view, and are defined as sites and structures having archaeological, historical, architectural, or religious significance, and natural sites with cultural values. This includes cemeteries, graveyards and graves.

2. The list of negative subproject attributes, which would make a subproject ineligible for support, includes any activity that would adversely impact cultural property.

3. In the event of finding of finding properties of cultural value during construction, the following procedures for identification, protection from theft, and treatment of discover ed artifacts should be followed and included in standard bidding documents.

(a) Stop the construction activities in the area of the chance find;
(b) Delineate the discovered site or area;
(c) Secure the site to prevent any damage or loss of removable objects;
(d)Notify the supervisory Engineer who in turn will notify the local authorities (city corporations) and the Department of Archaeology, Bangladesh. The Department of Archaeology of Bangladesh is mandated to protect archaeological relics and antiquities in the country as per the Antiquities Act 1968. The contacts for the Department can be found in: http://www.archaeology.gov.bd/contact-us.php
(e)The Department of Archaeology, Bangladesh would be in charge of protecting and preserving the site before deciding on subsequent appropriate procedures.
(f)Decisions on how to handle the finding shallbe taken by the Department of Archaeology, Bangladesh.Thiscould includechanges in the layout (such as when finding an irremovable remain of cultural or archeological importance), conservation, restoration and salvage.
(g)Implementation for the authority decision concerning the management of thefinding shallbe communicated in writing by the Department of Archaeology, Bangladesh.
(h)Construction work could resume only after permission is given from theDepartment ofArchaeology, Bangladesh concerning safeguard of the heritage.

4. These procedures must be referred to as standard provisions in the construction contracts. During project supervision, the Site Engineer shall monitor the above regulations relating to the treatment of any chance find encountered are observed.

Relevant findings will be recorded in World Bank Supervision Reports andImplementati onCompletion Reports will assess the overall effectiveness of the project's cultural property mitigation, management, and activities, as appropriate.

ANNEX F
PARTICIPANTS OF THE FOCUS GROUP DISCUSSIONS

Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)
Attendant List- FGD

FGD # 1 **Venue #** JAIGEER PRIMARY SCHOOL **Date #** 13.11.2014 **Time #** 10.30 am-11.30 am

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
1	মোঃ আনছুর আলী	জায়গীর	৩৫	M	[illegible]	01719118409	আনছুর
2	মাহমুদুন নবী চৌধুরী	জায়গীর	৬২	M	শিক্ষকতা	01920648162	[illegible]
3	হাজী তারা মোল্লা	জায়গীর	৮০	M	অবসর	—	তারা
4	মোঃ আইয়ুব আলী	জায়গীর	৫০	M	ইমাম	01824170507	আইয়ুব আলী
5	শামীম আহমেদ	জায়গীর	২৩	M	শিক্ষকতা	01675505002	শামীম
6	মোঃ আবুল খায়ের	জায়গীর	১২	M	ছাত্র	01710811584	আবুল খায়ের
7	মোঃ শরীফ হোসেন	জায়গীর	১২	M	ছাত্র	01714337469	শরীফ
8	ফারহানা হক	~~জায়গীর~~ সিংগাইর সোনা পাড়া	৩০	F	শিক্ষক	01762649694	ফারহানা
9	মুর্শেদা পারভীন	জুমদক্ষিণ	২৪	F	শিক্ষক	01981009011	Parvin
10	রাশেদা আক্তার	মেদুলিয়া	২৮	F	শিক্ষক	01682812248	রাশেদা

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Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)
Attendant List- FGD

FGD # 1 **Venue #** JAIGEER PRIMARY SCHOOL **Date #** 13.11.2014 **Time #** 10.30 am - 11.30 am

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
11	তহমিনা রহমান	জায়গীর	80	F	গৃহিনী	01715724005	তহমিনা
12	সাজেদা খাতুন	জায়গীর	28	F	গৃহিনী	01815432659	সাজেদা
13	মালেকা খাতুন	মেদুলিয়া	২৬	F	গৃহিনী	01726485054	মালেকা
14	সেলিনা আক্তার	জায়গীর	৩০	F	গৃহিনী	0828301910	সেলিনা আক্তার
15	খালেদা আক্তার	জায়গীর	২৬	F	গৃহিনী	0181919924 17	খালেদা
16	সাহিমা	জায়গীর	৬৩	F	গৃহিনী	—	সাহিমা
17	সেলিনা খানম	আটালিয়া	৩২	F	গৃহিনী	01736353579	সেলিনা খানম
18	জীবননাহার	আটালিয়া	২৫	F	গৃহিনী	01671679196	জীবননাহার
19	আয়েশা আশরাফ	নয়াপাড়া	১০	F	ছাত্রী	01813074555	আয়েশা
20	মোঃ আনোয়ার হোসেন	আটালিয়া	৩৭	M	[illegible]	01683766316	[illegible]

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Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)

Attendant List- FGD

FGD # 1 **Venue #** JAIGEER PRIMARY SCHOOL **Date #** 13.11.2019 **Time #** 10.30am - 11.30 am

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
21	মো: [illegible]	[illegible]	86	M	[illegible]	01722311455	[illegible]
22	Md Lekajuddin Mollah	gaygire	62	M	Bis	01719779516	Lekajuddin
23	মো: লুৎফর রহমান	নয়া পাড়া	৫৭	M	ব্যবসায়ী	01913961781	[illegible]
24	মো: আতাউর রহমান	[illegible]	৫২	M	কৃষক	0173261374 56	[illegible]
25	মো: আজাদ হোসেন	[illegible]	২৯	M	শিক্ষক	01726-485054	[illegible]
26	মো: [illegible] হোসেন	[illegible]	৪০	M	শিক্ষক	01715459121	[illegible]
27	IKRAM HUSSAIN	MOHAKHALI DOHS	31	M	Engineer	01914034210	[illegible]
28							
29							
30							

Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)

Attendant List- FGD

FGD # 2 **Venue #** DHALLA GOV'T. PRIMARY SCHOOL **Date #** 13.11.2019 **Time #** 2.30 pm - 3.30 pm

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
1	SUMON	Dhalla	29	M	Live Abroad	07935843739	[illegible]
2	ANOWAR	Dhalla	34	M	Live Abroad	01867746512	[illegible]
3	সোহেল রানা	ধল্লা	12	M	Student	01862709265	সোহেল
4	নাজমুল হাসান খান	ধল্লা	12	M	Student	01828647446	নাজমুল
5	[illegible]	ধল্লা	60	M	কৃষক	01752724017	[illegible]
6	মো: [illegible]	ধল্লা	22	M	ইলেকট্রিশিয়ান	0177123526	[illegible]
7	আব্দুল কুদ্দুস	[illegible]	80	M	কৃষক	01817-608451	মো: কুদ্দুস
8	এম, এ, কাইয়ুম	ধল্লা	60	M	অবসরপ্রাপ্ত চাকুরী	01812-661841	[illegible]
9	হাজী আব্দুর রহমান খান	ধল্লা [illegible]	65	"	কৃষি	01760568072	হাজী আব্দুর রহমান
10	[illegible] খান	ধল্লা	80	"	কৃষি		[illegible]

Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)

Attendant List- FGD

FGD # 2 **Venue #** DHALLA GOVT. PRIMARY SCHOOL **Date #** 13.11.2014 **Time #** 2:30pm - 3:30 Pm.

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
11	[illegible]	[illegible]	৬২	M	[illegible]	[illegible]	[illegible]
12	মো: নুরুল আবেদীন	ধল্লা [illegible]	60	M.	কৃষি	01732197413	[illegible]
13	মোঃ হালিম মিয়া	গ্রাম ধল্লা	৪৫	M	ব্যাবসা	017355151 394	হালিম
14	মি: আ: সালাম	গ্রাম লেবু বাড়ী	৬২	M	ইমাম	01720634705	আ: Salam
15	মো: আনিসুর রহমান	ধল্লা	৫৭	M	শিক্ষক	01821171990	[illegible]
16	রোকেয়া বেগম	সারারিয়া, জামশা	৪৭	F	শিক্ষক	01718164058	[illegible]
17	আ: হান্নান	গ্রাম- ধল্লা সিংগাইর মানিকগঞ্জ	৪৬	M	কৃষক	01813117600	[illegible]
18	মো: আজাদ	গ্রাম ভুরুন্দিয়া	26	M	চাকরি	01823474617	[illegible]
19	মো: জহিরুল ইসলাম	গ্রাম ধল্লা, সিংগাইর, মানিকগঞ্জ	26	M	ছাত্র	01836185386	Jahorul
20	সালমা	ধল্লা দক্ষিণ	26	F	গৃহিনী	01	salma

Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)

Attendant List- FGD

FGD # 2 **Venue #** DHALLA GOVT. PRIMARY SCHOOL **Date #** 13.11.2014 **Time #** 2:30pm - 3:30pm

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
21	রুবিনা	ধল্লা	25	F	গৃহিনী	01840248450	রুবিনা
22	নাজমা	ধল্লা [illegible]	৩০	F	গৃহিনী	01822206677	নাজমা
23	ইয়াসমিন	ধল্লা [illegible] পাড়া	25	F	গৃহিনী	01733499649	ইয়াসমিন
24	লাইলি আক্তার	ধল্লা [illegible] পাড়া	৩০	F	গৃহিনী	01	লাইলী আক্তার
25	নাদিরা পারভীন	মেদুলিয়া, ধল্লা	26	F	শিক্ষক	01762393016	Nadeni
26	রেনু আক্তার	ধল্লা [illegible] পাড়া	২৫	F	গৃহিনী	01826682004	রেনু আক্তার
27	রোজিনা বেগম	ধল্লা [illegible] পাড়া	৩০	F	গৃহিনী	. —	রজিনা
28	পেয়ারা বেগম	ধল্লা	২৮	F	গৃহিনী	01822692859	[illegible]
29	[illegible] খানম	ধল্লা	২৭	F	শিক্ষক	01819.508278	[illegible]
30	মাকসুদা আক্তার	ধল্লা	১০	F	ছাত্রী	01835505755	[illegible]

Environmental Impact Assessment (EIA)
Section: Focus Group Discussion (FGD) for
Construction of 55 MW Power Plant at Singair, Manikganj (Proposed)

Attendant List- FGD

FGD # 2 **Venue #** DHALLA GOVT. PRIMARY SCHOOL **Date #** 13.11.2019 **Time #** 2.30pm - 3.30pm.

Sl	Name	Address	Age	Sex	Profession	Mobile No	Signature
31	সুকায়াত জেসমিন কাশেদা	ধল্লা নাজিরপুর	17	F	Student	01835505755	কাশেদা আক্তার
32	লিমা জাহান নাজনীন	ধল্লা নাজিরপুর	11	F	Student	01713571979	লিমা আক্তার
33	বাবুল	ধল্লা বাজার	৩৫	F	গৃহিণী	-	বাবুল
34	নিরব হোসেন	ধল্লা	১৭	M	ছাত্র	০১৪৫১৫২৩১০৫	নিরব
35	রওশন আরা	ধল্লা নাজিরপুর	৩০	F	গৃহিণী	-	রোশনা
36							
37							
38							
39							
40							

ANNEX G
STANDARDS AND GUIDELINES FOR EFFLUENT DISCHARGE

Bangladesh Standards for Waste Discharge

(Schedule 10, Rule 13, Environment Conservation Rules 1997)

Parameters	Unit	Places for determination of standards		
		Inland Surface Water	Public Sewerage system connected to treatment at second stage	Irrigated land
Ammonia-nitrogen (as elementary N)	mg/l	50	75	75
Ammonia (as free ammonia)	mg/l	5	5	5
Arsenic (as As)	mg/l	0.2	0.05	0.2
BOD_5 at 20°C	mg/l	50	250	100
Boron	mg/l	2	2	2
Cadmium (as Cd)	mg/l	0.5	0.05	0.05
Chloride	mg/l	600	600	600
Chromium (as total Cr)	mg/l	0.5	1.0	1.0
COD	mg/l	200	400	400
Chromium (as hexavalent Cr)	mg/l	0.1	1.0	1.0
Copper (as Cu)	mg/l	0.5	3.0	3.0
Dissolved oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8
Electro-conductivity (EC)	µSiemens/cm	1200	1200	1200
Total dissolved solids	mg/l	2100	2100	2100
Fluoride (as F)	mg/l	2	15	10
Sulfide (as S)	mg/l	1	2	2
Iron (as Fe)	mg/l	2	2	2
Total kjeldahl nitrogen (as N)	mg/l	100	100	100
Lead (as Pb)	mg/l	0.1	1.0	0.1
Manganese (as Mn)	mg/l	5	5	5
Mercury (as Hg)	mg/l	0.01	0.01	0.01
Nickel (as Ni)	mg/l	1.0	2.0	1.0
Nitrate (as elementary N)	mg/l	10.0	Not fixed	10.0
Oil and grease	mg/l	10	20	10
Phenolic compounds (as C_6H_5OH)	mg/l	1.0	5.0	1.0

Parameters	Unit	Places for determination of standards		
		Inland Surface Water	Public Sewerage system connected to treatment at second stage	Irrigated land
Dissolved phosphorus (as P)	mg/l	8	8	15
pH		6-9	6-9	6-9
Selenium (as Se)	mg/l	0.05	0.05	0.05
Zinc (as Zn)	mg/l	5	10	10
Total dissolved solids	mg/l	2100	2100	2100
Temperature (thermal effluent)	˚C (summer) ˚C (winter)	40 45	40 45	40 45
Suspended solids	mg/l	150	500	200
Cyanide	mg/l	0.1	2.0	0.2

Notes:

(1) These standards shall be applicable to all industries or projectsother than those specified under the heading “Standards for sectorwiseindustrial effluent or emission.”
(2) Compliance with these standards shall be ensured from the momentan industrial unit starts trial production, and in other cases, from themoment a project starts operation.
(3) These standards shall be inviolable even in case of any samplecollected instantly at any point of time. These standards may beenforced in a more stringent manner if considered necessary inview of the environmental conditions of a particular situation.
(4) Inland Surface Water means drains/ponds/tanks/water bodies/ditches, canals, rivers, springs and estuaries.
(5) Public sewerage system means treatment facilities of the first andsecond stage and also the combined and complete treatmentfacilities.
(6) Irrigable land means such land area which is sufficiently irrigatedby waste water taking into consideration the quantity and quality ofsuch water for cultivation of selected crops on that land.
(7) Inland Surface Water Standards shall apply to any discharge to apublic sewerage system or to land if the discharge does not meet therequirements of the definitions in notes 5 and 6 above.

WBGEffluent Guidelines

(Ref: WBG Environmental, Health and Safety Guidelines for Thermal Power Plants)

Parameters	Unit	Concentration
pH	--	6-9
TSS	mg/l	50
Oil and Grease	mg/l	10
Total residual Chlorine	mg/l	0.2
Total Chromium	mg/l	0.5
Copper (Cu)	mg/l	0.5
Iron (Fe)	mg/l	1.0
Zinc (Zn)	mg/l	1.0
Lead (Pb)	mg/l	0.5
Cadmium (Cd)	mg/l	0.1
Mercury (Hg)	mg/l	0.005
Arsenic (As)	mg/l	0.5
Temperature increase by thermal discharge from cooling system	--	Site specific requirement to be established by the EA Elevated temperature areas due to discharge of once-through cooling water (e.g. 1 Celsius above, 2 Celsius above, 3 Celsius above ambient water temperature) should be minimized by adjusting intake and outfall design through the project specific EA depending on the sensitive aquatic ecosystems around the discharge point

Note: Applicability of heavy metals should be determined in the EA. Guideline limits in the Table are from various references of effluent performance by thermal power plants

ANNEX H
AIR QUALITY MEASUREMENT EQUIPMENT AND METHODS

Methodology of Determining Air Quality Parameters

Ambient air sample is collected from the site using Respirable Dust Sampler Envirotech APM–460BL for PM_{10} (Ref: http://www.envirotechindia.com/apm-460bl.html) and Fine Particulate Sampler Envirotech APM-550 for $PM_{2.5}$. (Ref: http://www.envirotechindia.com/apm-550.html) with an attachment APM 411TE to measure ambient gaseous compounds (SO_2, NO_2)

The APM 550 system is a manual method for sampling fine particles (PM2.5 fraction) and is based on impactor designs standardized by USEPA for ambient air quality monitoring. Ambient air enters the APM 550 series samplers system through an omni-directional inlet designed to provide a clean aerodynamic cut-point for particles greater than 10 microns. Particles in the air stream finer than 10 microns proceed to a second impactor that has an aerodynamic cut-point at 2.5 microns. The air sample and fine particulates exiting from the PM 2.5 impactor are passed through a 47 mm diameter Teflon filter membrane that retains the fine particulate matter. The sampling rate of the system is held constant at 1 m^3/hr by a suitable critical orifice. The standard system is supplied with a Dry Gas Meter to provide a direct measure of the total air volume sampled.The APM 460 sampler uses an improved cyclone with sharper cutoff (D50 at 10 microns) to separate the coarser particulates from the air stream before filtering it on the glass microfibre filter. By using the APM 460, measurement of Respirable Particulate Matter can be done accurately and TSPM can also be assessed by collection of dust retained in the cyclone cup.The APM 411TE is designed as an attachment to operate with Envirotech's Respirable Dust or High Volume Samplers and PM 2.5 samplers. When paired with an appropriate dust sampler, the APM 411 TE allows the user to collect gaseous pollutant samples (for monitoring SO2, NOx, NH3, Ozone, etc) as well as dust samples simultaneously.

All samples are collected from the site according to the standard sample collection method. The sampling machines consist of blowers which blow air through standard filters e.g. glass fiber filters. There are different kinds of filters for different parameters. Dusts are trapped in filters. The collected samples are analyzed as per standard procedure to determine all parameters in the laboratory of our own.

Procedures of Determining Air Quality Parameters

PM2.5 and PM10: (Gravimetric Method)

Gravimetry measures the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature- and relative humidity-controlled environment. To minimize particle volatilization and aerosol liquid water bias, PM2.5

reference methods require that filters be equilibrated for 24 hours at a constant (within ±5%) relative humidity between 30% and 40% and at a constant (within ±2 °C) temperature between 20 °C and 23 °C, which is a more stringent requirement than for PM10 filter equilibration. PM10 filters are required to be equilibrated at 20% to 45% relative humidity (±5%) and 15 °C to 30 °C temperature (±3 °C). These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species. Nominal values of 30% RH and 20 °C best conserve the particle deposits during sample weighing. Accurate gravimetric analyses require the use of filters with low dielectric constants, high filter integrity, and inertness with respect to absorbing water vapor and other gases. Equilibration at low temperatures and relative humidities effectively removes liquid water associated with the particle deposit, but some particles may volatilize if they are exposed to ambient air for more than a day or two (Witz et al., 1988, 1990). Gravimetric analysis of the filters needs to be performed with a microbalance (Feeney et al., 1984). The sensitivity and reliability of the electrobalance is about ±0.001 mg or ±1 Fg, though tolerances on re-weights of Teflon-membrane filters are typically ±0.010 mg. These sensitive balances require isolation from vibration and air currents. Balances placed in laminar flow hoods with filtered air minimize contamination of filters from particles and gases in laboratory air. Ammonia produced by human breathing and cleaning solvents can neutralize acidic species that might have been captured on the filters. The main interference in gravimetric analysis of filters results from electrostatic effects. Engelbrecht et al. (1980) found that residual charge on a filter could produce an electrostatic discharge between the filter on the pan and the metal casing of the electrobalance, which induces non-gravimetric forces. This charge can be removed from most filter media by exposing the filter to a low-level radioactive source (500 picocuries of polonium210) prior to and during sample weighing. Balance calibrations should be established before and after each weighing session using Class M and Class S standards traceable to National Institute of Standards and Technology (NIST, formerly National Bureau of Standards) mass standards, and they should be verified with a standard mass every ten filters. Approximately one out of ten filters should be re-weighed by a different person at a later time. These re-weights should be used to calculate the precision of the measurement as outlined by Watson et al. (1995a).

SPM (Suspended Particulate Matter)

Gravimetric Method:

Sampling:

*Filter Preparation –Expose each filter to the light source and inspect for pinholes, particles and other imperfection. Filters with visible imperfection s hall not are used.A small brush is useful for removing particles.

Equlibrate the filters in the filter conditioning environment for 24 hours. Weigh the filters to the nearest milligram; record tare and filter identification number. Do not bend or fold the filter before collection of the sample .

*Sample Collection: Open the shelter. Loosen the wing nuts, and remove the face plate from the filter holder. Install the numbered, pre-weighed, glass-fiber filter in position(rough side up). Replace the face plate without disturbing the filter and fasten securely under tightening will allow air leakage. Over tightening will damage the sponge-rubber face plate gasket. A very light application of talcum powder may be used on the sponge-rubber face-plate gasket to prevent the filter from sticking. During inclement weather the sampler may be removed to a protected area for filter change.

*Close the roof of the shelter run the sampler for about 5 minutes, connect the rotameter to the nipple on the lock of the sampler and lead the rotameter ball with rotameter in the vertical position. Estimate to the nearest whole number. If the ball is fluctuating rapidly, tap the rotameter and slowly straighten it until the ball gives a constant reading. Disconnect the rotameter from the nipple; record the initial rotameter reading and the starting time and date on the filter holder.

Note – The rotameter should never be connected to the sampler except when the flow is being measured.

*Collect the sample for 24 hours and take a final rotameter reading .Record the final rotameter reading and ending time and date on the filter holder. Remove the face-plate as described above and carefully remove the filter from the holder, touching only the outer edges. Fold the filter lengthways so that only surfaces with collected particulate are in contact and place in special folder. Record on the folder the filter number. Location and any other factors, such as meteorological conditions or razing of nearby buildings, that might affect the results.

Sulfur Dioixide (SO_2):

Principle of west-geake method : When air containing SO_2 is bubbled through potassium tetrachloromercurate solution (absorbent) taken in the impinge,SO_2 forms a stable dichlorosulphitomercurate complex (DCSM).This complex is not oxidized by the oxygen of air of that remains dissolved in the absorbent containing DCSM is then treated with pararosaniline and formaldehyde to form an intense red-violet color . The intensity of this occurence is directly related to the amount of SO_2 absorbed and is measured colorimetrically by spectrophotometer .The quantity of SO_2 is then obtained from a calibration curve prepared earlier. The absorbed are relatively stable. Losses of SO_2 from the sample may occurat a rate of one percent per day at 22°C. No measurable loss is found to occur when stored at 5°C for 30 days.

Notrogen Dioixide (NO_2):

Measurement of Nitrogen Dioxide in Ambient Air:

Principle:

NO_2 is absorbed in an alkaline solution (NaOH-sodium arsenite solution) where in it forms sodium nitrite which is quite stable. The solution is then freed of possible SO_2 interference, by treatment with H_2O_2 and acidified. The nitrite ion reacts with sulphnilamide phosphoric acid solution to form a diazonium salt which couples with NEDA to form a deep colored azo dye. Absorbance due to this color is measured in spectrophotometer against a blank.

Analysis Procedure:

- At the end of the stipulated sampling period note the flowmeter reading and switch off the air pump.
- Make up the exposed absorbent volume to 20 ml with distilled water to compensate for any loss of water due to evaporation during sampling .
- Transfer by pipetting 10 ml of the exposed absorbent into a test tube.Add 1.0 ml of H_2O_2 solution, 10.0 of sulphanilamide solution and 1.4 ml of NEDA with through mixing after the addition of each reagent A 10ml unexposed absorbent taken in another test tube and treated similarly serves as the reagent blank for colorimetry.
- After 10 min color development period, the absorbance/transmittance of the exposed sample is measured with a spectrophotometer at 540nm against the reagent blank, microgram of NO_2 per ml is read from the calibration curve.

Carbon Monoxide (CO):

Indicator Tube Method:

Principle: Carbon monoxide reduces yellow silicomolybdate to lower oxides. The color changes from yellowish green and finally deep blue depending on the extent of reduction which again under identical conditions depends on concentration of carbon monoxide in air.

Procedure:

- Draw 300 ml of the sample at the prescribed rate (40-60 ml/min) through the tube by the aspirator provided.
- Compare the color produced with the standard colors provided and calculate the concentrations.

ANNEX I
ENGINE SPECIFICATIONS FROM THE MANUFACTURER

18V48/60TS Technical Data

Engine type:	**18V48/60TS**
Engine cycle:	four-stroke
Turbocharging system:	2-stage, constant pressure
▪ Low pressure TC type:	MAN TCA88
▪ High pressure TC type:	MAN TCA77
Number of cylinders:	18
Bore:	480 mm
Stroke:	600 mm
Swept volume per cyl.:	108.6 dm³
Engine speed 50/60Hz:	500/514 rpm
Mean piston speed:	10.0/10.3 m/s
Nom. generator efficiency:	97.5%
Cooling:	
Cylinder cooling:	HT cooling water
LP-TC charge air cooler:	2-stage HT and LT cooling water
HP-TC charge air cooler:	2-stage HT and LT cooling water
Starting method:	compressed air with blower for low part load operation up to 25% load

General definition of diesel engine ratings according to ISO 3046-1: 2002

ISO Reference conditions:

- Air temperature: +25°C (77F)
- Air pressure: 1000 mbar
- Cooling water temperature upstream of charge air cooler: +25°C (77F)
- Relative air humidity: 30%

Figures are given with a tolerance of 5%, except for the lubrication oil consumption, which is given with a tolerance of 20%.

Abbreviations:

TC	Turbocharger
HP	High pressure
LP	Low pressure
HT	High temperature
LT	Low temperature

18V48/60TS engine

		Operation mode			
Performance data	**Unit**	**1**	**2**	**3**	**4**
Power per cylinder	kW	1050	1100	1150	1200
Tot. engine power	kW	18,900	19,800	20,700	21,600
Tot. el. genset power	kW	18,428	19,305	20,183	21,060
Spec. fuel oil consumption acc. to ISO 3046, without pumps, mech. Power output, +5% tolerance	g/kWh	171	172	174	177
Heat Rate acc. to ISO 3046, without pumps, mech. Power output, +5% tolerance	kJ/kWh	7,305	7,350	7,430	7,560
NO_x emissions (dry at 15% O2)	mg/Nm³	1850	1740	1580	1480
Mean effective pressure	bar	23.2/22.6	24.3/23.7	25.4/24.7	26.5/25.8
Spec. lube oil consumption	g/kWh	0,60	0,60	0,60	0,60

	A	**B**	**C**	**H**	**W**
Dimensions (mm)	9625	5410	24510	9023	4694
Dry mass (t)	407	407	407	407	407

1.2.4 Exhaust gas emissions

The exhaust gas emissions[3] at continuous power as per section 1.2.1 and at above defined guarantee conditions will not exceed the following values:

Nitrogen oxide (NO_x) **2,000 mg/Nm³**

at 15% O_2 in dry exhaust gas. Measuring after the engine.

The nitrogen oxide (NO_x) value is calculated as NO_2 contingent and based on the heavy fuel oil as defined in section 9.1.6.

Sulfur dioxide (SO_2) **2,000 mg/Nm³**

at 15% O_2 in dry exhaust gas.

The sulfur dioxide (SO_2) content in the exhaust gas will not be measured but calculated upon sulfur content in the fuel oil. The above stated value based on the heavy fuel oil as defined in section 9.1.6 containing ≤ 3.5%-wt. sulfur.

Particulate matters (PM) **50 mg/Nm³**

at 15% O_2 in dry exhaust gas.

Measuring after the engine. Particulate matter emission limit based on the heavy fuel oil as defined in section 9.1.6.

The above-mentioned values are valid for non-degraded air shed.

Applicable standards for exhaust gas emissions: Pollution Prevention and Abatement Handbook, Part III, The World Bank Group, 1998.
O_2 and NO_x measurements as per ISO-8178, PM according to VDI 2066 or US EPA method 17.

3 *Reference conditions to a normal cubic meter (Nm³): pressure = 1,013 mbar, temperature = 0°C.*

ANNEX J

SPECIFICATIONS OF FGD UNIT

2. Design Basis

Description	Unit	Data
Ambient Temperature	℃	35
Humidity	%	90
Engine		MAN
Flue Gas Flow for each Engine	T/h	129
Quantity	Set	3
EGB outlet temperature	℃	180
Initial SO_2 Content	mg/m3	2000
Power supply	v	400 AC 50HZ
Design Code		China

3. Main Performance and Specification

3.1 Main Performance

DESCRIPTION	UNIT	DATA
Flue gas flow	t/h	129±15%
Initial SO_2 Content	mg/m3	2000
Final So_2 Content	mg/m3	300
Draught Loss	Pa	1700
Liquid gas ratio	L/Nm3	1.2 ~ 1.8

Efficiency	%	＞85
Final SO2 content	mg/Nm3	≤300
Outlet temperature	℃	＞85
Consumption for each Engine		
Lime（80%CaO）	kg/h	85
Caustic Soda（NaOH）	kg/h	4
Water	m3/h	10

3.2 Main Specification

ABSORPTION TOWER		
Quantity		2 for Each engine
Design Pressure	Pa	±5000
Flue gas velocity	m/s	3
Diameter	mm	Φ2700
Height	mm	15000
Wall thickness	mm	δ=12
Wall Material		Q235-A
Anticorrosion		Glass Flake
FAN		
Flow	Cu.m	100,000
Head	mmWC	200
Motor Rate	kW	132

Quantity		1 for each engine
Material		SS304

3.3 Control

PLC control panel is provided for the plant monitoring and control.

- Flue gas pneumatic damper auto control
- Absorbent circulating pump control
- Backwash Water (ME) Pump control

NaOH and $Ca(OH)_2$ dosing plant is manual control.

4. Write up of Dual Alkali Desulphurization

Dual- or double-alkali scrubbing is a third throwaway FGD process that uses a sodium-based alkali solution to remove SO2 from combustion exhaust gas. The sodium alkali solution absorbs SO2, and the spent absorbing liquor is regenerated with lime. Using both sodium- and calcium-based compounds is where the name dual or double-alkali comes from. Calcium sulfites and sulfates are precipitated and discarded as sludge. The regenerated sodium scrubbing solution is returned to the absorber loop. The dual-alkali process has reduced plugging and scaling problems in the absorber because sodium scrubbing compounds are very soluble. Dual-alkali systems are capable of 95% SO2 reduction.

4.1 Process Chemistry

The sodium alkali solution is usually a mixture of the following compounds:

1 Sodium hydroxide (NaOH), also called caustic

2 Sodium carbonate (Na2CO3), also called soda ash

3 Sodium sulfite (Na2SO3)

The SO2 reacts with the alkaline components to primarily form sodium sulfite and sodium bisulfite (NaHSO3). The following are the main absorption reactions :

$2\ NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$

$NaOH + SO_2 \rightarrow NaHSO_3$

$Na_2CO_3 + SO_2 + H_2O \rightarrow 2NaHSO_3$

$Na_2CO_3 + SO_2 \rightarrow Na_2SO_3 + CO_2$

$Na_2SO_3 + SO_2 + H_2O \rightarrow 2NaHSO_3$

In addition to the above reactions, some of the SO3 present may react with alkaline components to produce sodium sulfate. For example,

$2NaOH + SO_3 \rightarrow Na_2SO_4 + H_2O$

Throughout the system, some sodium sulfite is oxidized to sulfate by:

$2Na2SO3 + O2 \rightarrow 2Na2SO4$

After reaction in the absorber, spent scrubbing liquor is bled to a reactor tank for regeneration. Sodium bisulfite and sodium sulfate are inactive salts and do not absorb any SO2. Actually, it is the hydroxide ion (OH^-), sulfite ion (SO_3^{2-}), and carbonate ion (CO_3^{2-}) that absorb SO2 gas. Sodium bisulfite and sodium sulfate are reacted with lime or limestone to produce a calcium sludge and a regenerated sodium solution.

$2NaHSO_3 + Ca(OH)_2 \rightarrow Na2SO + CaSO_3 \bullet 1/2\ H\ 2O\downarrow + 3/2\ H2O$

$Na2SO_3 + Ca(OH)_2 + 1/\ 2\ H2O \rightarrow 2NaOH + CaSO_3 \bullet 1/2\ H2O$

$Na2SO_4 + Ca(OH)_2 \rightarrow 2NaOH + CaSO_4 \downarrow$

At the present time, lime regeneration is the only process that has been used on commercial dual-alkali installations.

4.2 System Description

The dual-alkali process uses two loops - absorption and regeneration. In the absorption loop, the sodium solution contacts the flue gas in the absorber to remove SO2. the scrubbing liquor from the bottom of the absorber is mixed with regenerated solution and sprayed in at the top of the absorber. A bleed stream from the recirculating liquid is sent to the reactor tank in the regeneration loop. The bleed stream is mixed with a lime slurry in a reactor

tank, where insoluble calcium salts are formed and the absorbent is regenerated. The sludge from the reactor is then sent to a clarifier, or thickener, where the calcium sludge is drawn off the bottom, filtered, and washed with water. From the filter, the sodium solution is recycled to the clarifier, and the sludge is discarded. From the clarifier, the regenerated sodium solution is sent to a mixing tank where the sodium compounds and makeup water are added.

Some sodium sulfate solution is un-reacted in the regeneration step. Additional sodium to makeup for that lost in the sludge is added to the regenerated solution in the form of soda ash or caustic soda. This regenerated absorbent is now ready to be used again.

ANNEX K

UNDERTAKING OF WILLING BUYER-WILLING SELLER AND DEEDS OF LANDPURCHASE