ENVIRONMENTAL MANAGEMENT PLAN REPORT

of

Indesore Sweater Ltd.

Deger Chala, National University, Gazipur Sadar, Gazipur.

Conducted By

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ABBREVIATION

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
CO2	Carbon Dioxide
DOE	Department of Environment
ECA	Environment Conservation Act 1995
ECR	Environment Conservation Rules 1997
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMS	Environmental Management System
IEE	Initial Environmental Examination
IFC	International Finance Corporation
MoEF	Ministry of Environment and Forests
NEMAP	National Environmental Management Action Plan
NGO	Non-Government Organization
NOx	Oxides of Nitrogen
PM2.5	Particulate Matter < 2.5µm
PM10	Particulate Matter < 10µm
SOx	Oxides of Sulfur
SPM	Suspended Particulate Matter
TSS	Total Suspended Solids

LEXICON

Adverse impact: An impact that is considered undesirable.

Ambient air: Surrounding air.

Aquatic: Growing or living in or near water.

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

Bazar: Market.

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

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

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

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

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

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

Environmental impact assessment (EIA) / Environmental assessment: The systematic, reproducible and interdisciplinary identification, prediction and evaluation, mitigation and management of impacts from a proposed development and its reasonable alternatives, sometimes known as environmental assessment.

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

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

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

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

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

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

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

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

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

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

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

Initial Environmental Assessment / Evaluation: Preliminary analysis undertaken to ascertain whether there are sufficient likely significant adverse impacts to warrant a „full" EIA. In some countries, use of initial assessment forms a meaning of "screening" proposed projects.

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

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

Negative Impact: Negative change from the existing situation due to the project. Public involvement / Public consultation: A range of techniques that can be used to inform, consult or interact with stakeholders affected / to be affected by a proposal.

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

Taka: Unit of Bangladeshi currency.

Terrestrial: Living on land.

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

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

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

Zila: Bengali word of district.

EXECUTIVE SUMMARY

The tremendous success of readymade garment exports from Bangladesh over the last two decades has surpassed the most optimistic expectations. Today the readymade garment sector is a multi-billion-dollar manufacturing and export industry in the country. The overall impact of the readymade garment exports is certainly one of the most significant social and economic developments in contemporary Bangladesh. With over two million women workers employed in semi-skilled and skilled jobs producing clothing for exports, the development of the apparel export industry has had far-reaching implications for the society and economy of Bangladesh.

In terms of Bangladeshi garments about half of the firms are woven garments, while knitwear and sweaters together make up the other half of the industry. Like other industries of Bangladesh, Indesore Sweater Ltd. is a factory of 100% local investment and export oriented. As a part of complying all the required national and international guideline Indesore Sweater Ltd. is committed to find out it's all possible ways for sustainable development. Finding out its environmental impact is also a process for that sustainable development along with the requirement from Department of Environment (DoE) of Bangladesh Government. The Environmental Management Plan (EMP) study report has been prepared for this project based on baseline environmental quality data in the project area. Identification & prediction of significant environmental impacts due to existing factory along with Environmental Impact Statement followed by delineation of appropriate Environmental Management Plan are included in Report. Indesore Sweater Ltd. has retained INTERTEK to conduct Environmental Management Plan study for the existing factory.

For this study, the impact zone shall confine within a radius of 5 km from the center of the development site since the nature of the factory is such that most of the potential impacts are likely to occur within this area. However, a buffer area extending to 10 km radius from the site has also been studied for any likely impacts. The methodology for EMP is to establish the baseline environmental setting in the 10 km radius area, assess the potential impacts of the proposed project components on different environmental components, develop adequate and feasible mitigation measures (via revising working practices, adopting cleaner development mechanism or to mitigate where appropriate) so as to keep residual impacts within acceptable limits and develop monitoring and other measures as necessary to ensure successful implementation.

The Executive Summary summarizes the findings of the EMP study undertaken in accordance with the EMP guidelines on similar developed projects. The summary is intended to provide an overview of the prevailing baseline conditions, key environmental issues and their likely impacts and also list the major recommended mitigation measures to attenuate the impacts.

The report comprises 12 Sections. 1st Section of the report gives a background and objective of this study. The scope of work and methodology of the factory followed by EMP process and EMP Team members are also described in this section. Section 2 describes the different policy and legal requirements. In section 3 the factory is being described with a detail factory's description, project location and traffic zones. Production process, raw material, sources of raw materials & chemicals used

is described in section 4. The description of wastage including solid & liquid with consumption is described in section 5. Existing physical and biological conditions of the area where the factory is situated is described in section 6. It has been found that the air (in terms of SPM) & water (in terms of solid concentration) quality of that area is good like typical urban areas of Bangladesh. The meteorological condition of that area is tropical monsoon. Noise, air and water quality of this area is measured and showed in this section.

Prediction and evaluation of impacts are done in section 7. Simple checklists used to identify the impacts due to installation of the factory. Impact evaluation matrix also provided for easy understanding of impact in process wise & location wise in Indesore Sweater Ltd.

As the factories uses Diesel as fuel for its power generation, the pollutants of potential concern are Oxides of Nitrogen (NOx), Suspended Particulate Matter (PM 2.5 & 10), Carbon Dioxide (CO_2) and Carbon Monoxide (CO), Oxides of Sulfur (SO_2). Each of these pollutants is examined to ensure the Bangladesh emission limit standard, where appropriate, the required emission control techniques would be incorporated into the mitigation measures. Also this EMP has considered other standards requirements for all these pollutant content such as USEPA, IFC/World Bank and WHO.

Environmental Management Plan, Disaster Management Plan and Alternative Analysis are also presented in Section 8 elaborately.

Overview of the baseline environment:

The specific objectives of the baseline study were to gather information on the existing physical environment, biological-ecological environment, and socio-economic environment of the areas in and around the factory site to gather and assess peoples 'perception on different aspects of the factory. This factory is situated in a tropical, with monsoons, characterized by a change of four season's area. The ambient maximum average temperature of 35 degree Celsius was observed where average minimum temperature was 6.2 degree Celsius during the baseline study. Its annual rainfall is about 2000 mm and approximately 80% of it occurs during the monsoon. Average monthly rainfall during monsoon period varies between 300 mm to 450 mm. Maximum daily rainfalls during this period recorded 13 September 2004 is 341 mm. As would be expected, relative humidity during the wet season is significantly higher than those occurring at other period of the year. General soil types of this area are: non-calcareous grey floodplain soils, acid basin clays, non-calcareous dark grey floodplain soils, shallow red-brown terrace soils, deep red-brown terrace soils, brown mottled terrace soils, shallow grey terrace soils & deep grey terrace soils.

The ambient air quality in the factory area was found complying with the standard from Department of Environment and IFC/World Bank guideline. The ambient sound quality of the factory mostly found fulfilling the standards from national and international authorities. The factory is using the water from the ground water sources. The factory is in a mix industrial & rural setting with greenery. This includes homesteads, horticulture, roadside plantation, natural vegetation, and agricultural crops. Besides highland (elevated) forestation and homesteads, the remaining area is mostly lowland and generally interconnected with certain manmade barriers and kacha roads here and there. But no main river was

not in the adjacent area of the factory. Indesore Sweater Ltd. has total land area of 0.92 acre, located in 23.9630714 north latitudes and in 90.39626320000002 east longitudes. It is bounded by forest, residential area, low laying and crop land in all side of the facility.

Potential Environmental Impact:

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

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

All these aspects have been examined and the findings are as follows:

Atmospheric Emission and Air Quality: The factory produced its power from the generator that runs on Natural gas. Apart from generation of power and steam factory uses natural gas for its boiler machine. Emission of sulfur dioxide and particulates from the emission of the generator would be insignificant as the Bangladeshi indigenous natural gas is almost free of Sulphur and particles. Emission of NOx will also be very low as the air-fuel ratio is high. For NOx reduction, the gas engines will be equipped with low NOx combustion chambers. As per the emission dispersion modeling, the NOx emission from all the stacks would be within the WB/IFC standard. Apart from the air emission from Generator and boiler, factory also has the production process included knit compositing. In knit compositing production process there is huge potentiality of producing particulate matter like small yarn particles. Also that has been considered in Ambient Air quality assessment.

Liquid Discharge: The factory produce wastewater from washing section in the production. That waste water is treated by Effluent Treatment Plant. Apart from that domestic liquid wastes are produced from the factory by the use of worker.

Noise: The noise impact would be produced by power generator and boiler. The results will be used to specify noise abatement measurers. Appropriate noise controls have been installed to keep the neighborhood impact due to noise within the limit of DoE and international standards by using 10 inch thick wall surrounded by the generator room as it is the main source of noise. PPE for all sections of the factory has been advised accordingly.

Solid waste Generation: This factory has a small amount of production of solid waste. This solid waste is basically paper and food waste, chemical container etc. Apart from that food waste is being disposed according to the govt. legislations.

Apart from all these negative impact, there is a positive impact also for the establishment of this factory. As it has been evidenced that factory has been established on forest land that was less potential farm land. Also this land didn't have any residence before construction of this factory. So, establishing this

factory increased efficiency in term of economical scale of production as well as created employment opportunity for adjacent community.

It is obvious from noting that many environmental, safety and social requirements outlined in this report that a comprehensive documents is needed which incorporates these requirements, in order to guide and track the projects performance from factory operation. That is the essential purpose of this Environmental Management Plan (EMP) Report.

This EMP report finds that though there are certain adverse environmental impacts associated with the industrial unit under consideration, those are however manageable. Given the location, proponent's commitments, measures undertaken and commitment for further measures to be adopted in due course of time if needed, Indesore Sweater Ltd. is going to be a nationally important and environmentally compatible industrial venture.

Last but not least, we would like to express our special gratitude and heartfelt thanks to the factory personnel for giving us such attention and time maintaining their tight production schedules; we could not but mentioning the following name:

- Akter Ali (Assistant manager-HR & Compliance Officer)

The whole facility was observed, inspected & reviewed by the member of following Environmental Assessment Team of Intertek Bangladesh.

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Chapter One
Introduction

1.1 Background

Bangladesh is going to be an industrialized country. Once upon a time agriculture was the main sector of the country's economy and tea and jute were the main export items. Things have changed in the last 10-15 years and Bangladesh has switched to second gear from the agricultural sector to the manufacturing sector. Tea or jute is no more the main export; ready-made garments (RMG) have replaced them. About 3.0 million people are directly related while another 20 million people are indirectly involved in the RMG sector. Undoubtedly, the garment industry has a significant impact on the economy and image of Bangladesh. The garment industry is one of the two major foreign exchange generating sources, the other being remittance from expatriates. The garment industry is providing employment to a huge number of people especially women who account for 90 per cent of the work force in this industry. Due to conservative norms and values that exist in the country, women are not able to work in all kinds of industries. The RMG has provided an excellent opportunity for them to get employment, bringing a significant change in the demographics of the work force of the country. The success of RMG has given a positive image to Bangladesh worldwide. Many brand name apparel items are now 'Made in Bangladesh'. In shopping centers across the USA and Europe, clothes 'Made in Bangladesh' can be found. People leaving abroad identify Bangladesh as a place where their dresses come from.

Whatever industrial growth that has been achieved in the country, most of the portion has come from garment sector. Garment sector of Bangladesh is a booming sector and it is increasing day by day with higher percentages. Sweater industry is doing well. Total 730 industries are in operation now. The industry fetched $2.83 billion foreign currency in the fiscal 2014-15, out of total apparel export of $31 billion, meaning the sub-sector shares 9 percent of total RMG exports. The sweater industry has aimed at reaching $8.0 billion export milestone in the year 2020 to fulfill the target of fetching $50 billion from ready-made garment sector. But the industry people alone cannot make the dream come true. The nation as a whole should act together in meeting this target. Especially, the government should shoulder the leading role in taking the sector ahead through adopting a sustained policy and providing necessary logistic supports including infrastructure and utilities. On the other hand, most of the garment factories are running without considering environmental issues which are having an adverse impact on our country. Bangladesh is passing transition period to transform into an industrialized country. The government fully recognized that it is the high time to think about environmental issues. In the meantime, buyers and consumers are more conscious about environmental facts before past time. At present they all together are pushing onto more environmentally friendly products for which Environmental Management Plan report becomes mandatory for all the factories.

Indesore Sweater Ltd. is running sweater factory. Indesore Sweater Ltd. started its operation in 2014. The factory is located in Degerchala, National University, Gazipur Sadar, Gazipur. The Project falls under the "RED" category as per the Environmental Conservation Rules of 1997, which requires submission of an Environmental Management Plan (EMP) report. The factory has already got no objection certificate from the Local authority DoE. The EMP report will show the path of the impact of the project in an environmentally sound manner. In compliance with these requirements, INTERTEK has been assigned by the Indesore Sweater Ltd. to conduct the Environment Management Plan study and prepare the Report accordingly.

1.2 What is EMP?

The city of today is a major performer for the secondary sector of the economy. Manufacturing and processing facilities not only provide the city with the essential commodity inputs but also provide the means of living for the populace. Of late, ad-hoc decisions for industrial development have led to an adverse impact on the local environment at costs which are much higher than the benefits actually accrued. In view of the deteriorating environmental conditions in and around industrial townships, it has become necessary to account for the environment while planning for such areas.

An Environmental Management Plan is an implementation plan for mitigation, protection and/or enhancement measures. The EMP presents in detail how these measures should be operated, the resources required and the schedule for implementation. It is intended that in the EMP, the implementation status of protection measures will be elevated to a level suitable for incorporation in design phase of the proposed project. The project measures which require formulation of detailed implementation plan.

The EMP document should contain an implementation plan for each of the selected mitigation, protection and enhancement measures.

In the process of planning, every project should ensure that resources are used with minimum efficiency, waste generation is minimized, residuals are treated adequately and products are recovered and recycled to the maximum extent possible. This overall strategy will not only cut down pollution control costs but also result in savings in the cost of production.

The best strategy for minimizing waste generation at the source is to use minimum sources with maximum efficiency. For example, the volume of wastewater generated from an industry could be reduced by improving the efficiency of combustion process. Efforts should be made to conserve water and energy and to use renewable resources to the greatest extent possible.

Further reduction in waste generation could be achieved through the use of non-waste technologies. Several non-waste technology operations; such as alternative raw materials and production processes, equipment redesign, product reformation, by product recovery and recycle, etc. have been developed in the recent years and these should be used wherever applicable.

Focus must turn to pollution control only after adequate measures have been taken to minimize waste generation at the source. Here also, the stress should be on by product recovery and recycle rather than treatment per se. It must be realized that waste is a misplaced resource and its proper management could result in profitable propositions for the industry in the otherwise deemed non-productive activity of pollution control.

The total production cycle should be subjected to pollution audit for identification of the points where the pollutions could be best tackled. A suitable waste treatment scheme should accordingly be designed. In the operation phase, pollution audit should also involve testing of performance standards of equipment.

The ultimate objective of waste management is to meet the stipulated standards at the least cost. The project proponent should also formulate a suitable scheme for disposal of treated effluent, solid wastes, and toxic/hazardous material, if any.

The waste residuals subsequent to pollution control measures should be further attenuated by the development of a green belt around the industry. Green belts not only absorb air and water pollutants but also help in arresting noise and soil erosion and creating favorable aesthetic conditions. Thus, the EMP may consist of one or several implementation plans. Each of these should include the following:

1.3 Objective of EMP

The general objectives of this management plan are to study the existing environmental status of the facility area and to prescribe the steps to upgrade both industrial production and environmental stability. The specific objectives of the study are given below:

1. To find out how the existing activities may impact environmental factors
2. To study the air and water quality status at different points of industry
3. To study the arrangement of the industries in case an emergency takes place
4. To study the occupational health and safety of the workers
5. To compare the existing level of different environmental parameters and to compare them with local or international standards (whichever is available/feasible)

Based on the comparison, a set of recommendations will be listed for future planning of the environmental management of the area under study.

1.4 Purpose of this Report

The purpose of this report is to provide an environmental management plan to demonstrate that there is no insurmountable environmental problem associated with the Indesore Sweater Ltd.

Environmental Management Plan considered in this report includes:

• Air quality impact;

• Noise impact;

• Water quality impact;

• Sediment contamination;

• Sewerage and sewage treatment implications;

• Waste management implications;

• Land contamination impact;

• Hazard to life;

• Ecological impact;

• Fisheries impact;

• Heritage impact; and

• Landscape and visual impact

1.5 Methodology

Based on the scope of work as defined earlier, the following steps were followed during the EMP process:

- Undertaking a rapid field survey toward collection of existing Environmental information and data pertaining to the project area.
- Collection of Secondary data from different government and non-government organizations.
- Understanding the technical and environmental aspects of the existing facilities;
- Identification of potential environmental impacts (along with residual impacts and cumulative impacts, if any) and evaluation of socio impacts.

Multiple data collection techniques were adopted to collect primary as well as secondary information required the preparation of overall management plan. Detailed information about the project were gathered from published literature by BLPGL and from key individuals involved in the project. Several field visits was carried out by the EMP Team to gather firsthand information on the surrounding environment of the project site. During this field visit, formal and informal discussions were carried out with people in and around the project site. Climatic data of the project area was collected from the Department.
On the basis of collected relevant data, identification of possible impacts has been done using checklists method. This was followed by evaluation of likely impacts along with the impacts origin and extent. The possible impacts have been suggested during (EMP).

1.6 Acknowledgement

The EMP Report has been prepared basically with the support of Indesore Sweater Ltd. and also from various government agencies including Bangladesh Meteorological Department (BMD), Soil Resource Development Institute (SRDI), Bangladesh Bureau of Statistics (BBS), Bangladesh Water Development Board (BWDB), Department of Environment (DOE) and Department of Agriculture Extension (DAE), etc. We would like to say thanks to each organization and its employees for their contribution in conducting the study.

1.7 Report Structure

The issue and the Corresponding section of the report where it has been addressed is summarized in the following table.

Table 1.1: Structure of the report

Sl. No	EMP Review Issues	Sections where Addressed
01	Introduction	Chapter One
02	Policy and Legal Consideration	Chapter Two
03	Project Description	Chapter Three
04	Production-Process Description	Chapter Four
05	Waste Disposal	Chapter Five
06	Existing Environment: Physical	Chapter Six
07	Environmental Impacts and Mitigations	Chapter Seven
08	Description on Environmental Management Plan	Chapter Eight
09	Risk Assessment and Management	Chapter Nine
10	Conclusion	Chapter Ten

1.8 Summary

In a nut shell EMP is just an information gathering exercise carried out by the developer and other bodies which enables a Local Planning Authority to understand the environmental effects of a development before deciding whether or not it should go ahead. The really important thing about environmental assessments is the emphasis on using the best available sources of objective information and in carrying out a systematic and holistic process which should be bias free and allow the local authority and the whole community to properly understand the impact of the proposed development. EMP should lead to better standards of development and in some cases development not happening at all. Where developments do go ahead environmental assessments should help to propose proper mitigation measures. EMP is meant to be a systematic process which leads to a final product, the Environmental Statement (ES).

Chapter Two
Policy and Legal Consideration

2.1 Background

The emerging environmental scenario calls for attention on conservation and judicious use of natural resources. There is a need to integrate the environmental consequences of the development activities and for planning suitable measures in order to ensure sustainable development. The environmental considerations in any development process have become necessary for achieving sustainable development. To achieve such goals the basic principles to be adopted are:

- To enhance the quality of environment in and around the project area by adopting proper measures for conservation of natural resources;
- Prevention of adverse environmental and social impact to the maximum possible extent;
- To mitigate the possible adverse environmental and socio-economic impact on the project-affected areas.

2.2 Policies

2.2.1 Industrial Policy 1991

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

- To conserve ecological balance and prevent pollution during industrialization
- To take effective steps for pollution control and conservation of environment during industrialization

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

2.2.2 National Environmental Policy 1992

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

- Maintenance of the ecological balance and overall progress and development of the country through protection and improvement of the environment.
- Protection of the country against natural disasters
- Identification the regulation of all types of activities which pollute and degrade the environment
- Ensuring sustainable utilization of all natural resources
- Active association with all environmentally-related international initiatives

Environmental policy contains the following specific objectives with respect to the industrial sector:

- To adopt corrective measures in phases in industries that causes pollution.
- To conduct Environmental Impact Assessments for all new public & private industries.
- To ban the establishment of any industry that produces goods cause environmental pollution, closure of such existing industries in phases and discouragement of the use of such goods through the development and/or introduction of environmentally sound substitutes.
- To ensure sustainable use of raw materials in the industries to prevent their wastage.

2.2.3 National Conservation Strategy

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

- Industries based on nonrenewable resources should be made to adopt technology which conserves raw materials, and existing industries should be given incentives to install technical fixes to reduce wastage rate.
- All industries, especially those based on imported raw materials, should be subjected to EMP and adoption of pollution prevention/control technologies should be enforced.
- No hazardous or toxic materials/wastes should be imported for use as raw material.
- Import of appropriate and environmentally sound technology should be ensured.
- Complete dependence on imported technology & machinery for industrial development should gradually be reduced so that industrial development is sustainable with local skills and resources.

2.2.4 National Environnemental Management Action Plan (NEMAP), 1995

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

NEMAP has the broad objectives of:

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

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

- Pollution arising from various industrial processes and plants throughout the country causing varying degrees of degradation of the receiving environment (Air, Water, and Land).
- There is a general absence of pollution abatement in terms of waste minimization and treatment.
- Low level of environmental awareness amongst industrialists and entrepreneurs.
- Lack of technology, appropriate to efficient use of resources and waste minimization leading to unnecessary pollution loading in the environment.

- Economic constraints on pollution abatement and waste minimization such as the cost of new technology, the competitiveness of labor, and intensive production methods as compared to more modern methods.
- Concentration of industry and hence pollution in specific areas which exacerbate localized environmental degradation and exceed the carrying capacity of the receiving bodies.
- Unplanned industrial development has resulted in several industries located within or close to residential areas, which adversely affects human health and quality of human environment.
- Establishment of industries at the cost of good agricultural lands and in the residential areas.
- Lack of incentives to industrialists to incorporate emission/discharge treatment plant in their industries.

2.3 National Legislation

2.3.1 Environment Conservation Act 1995 (ECA 1995)

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

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

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

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

The main strategies of the act can be summarized as:

- Declaration of ecologically critical areas, and restriction on the operation and process, which can be carried, out or cannot be initiated in the ecologically critical areas.
- Regulation in respect of vehicles emitting smoke harmful for the environment.
- Environmental clearance
- Regulation of the industries and other development activities - discharge permit.
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes.

- Promulgation of standard limit for discharging and emitting waste.
- Formulation and declaration of environmental guidelines.

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

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

- The national Environmental Quality Standards (EQS) for ambient air, surface water, groundwater, drinking water, industrial effluents, emissions, noise and vehicular exhaust;
- Categorization of industries, development projects and other activities on the basis of pollution activities of the existing or proposed industries/development projects/activities.
- Procedure for obtaining environmental clearance;
- Requirement for undertaking & formulating EMP according to categories of industries/development projects/activities;
- Procedure for damage-claim by persons affected or likely to be affected due to polluting activities or activities causing hindrance to normal civic life.

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

Green: Industries/development projects/activities are considered relatively pollution-free and therefore no require of an environmental clearance certificate from the DOE and no environmental study.

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

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

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

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

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

2.4 Environmental Clearance

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

The first to obtain environmental clearance is for the project proponent to complete & submit an application form which may be obtained from the appropriate DoE regional offices as per the category. The application is accompanied by other supporting documents (i.e. project profile, lay-out plan, NOC from local authority, Government fees etc.) reviewed by the divisional and district offices of DOE who has the authority to request supporting documents as applicable. The divisional office has the power to take decision on Green and Amber-A & B category projects and the Red category projects are forwarded to head office for approval. The proposed projects receive an environmental site clearance at the beginning and the environmental clearance subject to the implementation of the project activities and all mitigation measures suggested in the EMP report or in the application. In case of Red category, the client needs to submit an EMP report for site clearance and EMP to obtain EMP approval and environmental clearance.

2.5 Environment court Act 2010

This Act was enacted to provide for the establishment of environment courts. These courts have the power to impose whatever actions/restrictions/penalties they deem necessary for compliance with the objectives of the ECA. Further, any offence under the Act is treated in accordance with the Criminal Procedure Code, and the environment courts would be deemed to be criminal courts. However, in cases relating to compensation, the courts would follow the Civil Procedure Code and consequently, be deemed as civil courts. The environment courts also have the ability to convert fines into compensation.

2.6 Bangladesh Energy Regulatory Commission Act, 2003 (Act No. 13 of 2003).

This is An Act to make provisions for the establishment of an independent and impartial regulatory commission for the energy sector. The Act consists of 14 Chapters divided into 66 sections. This Act provides for the establishment of the Bangladesh Energy Regulatory Commission to encourage private investment in the generation of electricity, and transmission, transportation and marketing of gas resources and petroleum products, etc. (Chapter 2). In chapters 3 and 4 deal with financial matters of the Commission and with its functions, powers and proceedings. The Government shall have the power to give policy directives for the development and overall planning in the energy sector (Chapter 5). Licenses shall be issued by the Commission for the following activities: power generation; energy transmission; distribution and marketing of energy; supply of energy; and, storage of energy (Chapter 6). Tariffs on power generation and on supply of energy shall be determined by the Commission in

consultation with the Government (Chapter 7). The remaining chapters deal with the following: flow of information; settlements and appeals; offences and penalties; and, provisions of miscellaneous nature.

2.7 National 3R Strategy for Waste Management

What is 3R?

The principle of reducing waste, reusing and recycling resources and products is often called the "3Rs."

- *Reducing* means choosing to use items with care to reduce the amount of waste generated.
- *Reusing* involves the repeated use of items or parts of items which still have usable aspects.
- *Recycling* means the use of waste itself as resources.

Waste minimization can be achieved in an efficient way by focusing primarily on the first of the 3Rs, "reduce," followed by "reuse" and then "recycle." The waste hierarchy refers to the "3Rs" i.e., reduce, reuse and recycle, which classify waste management strategies according to their desirability. The 3Rs are meant to be a hierarchy, in order of importance. The waste hierarchy has taken many forms over the past decade, but the basic concept has remained the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

2.8 Noise Pollution Rules 2006

As per the provision of the existing Environment Conservation Act 1995 which has set limit on noise pollution, the government has formulated the Noise Pollution (Control) Rules 2006. Under 229 these rules, it will be easier for the government to control noise pollution particularly the use of microphone and high level horn. The Ministry of Environment and Forest has fixed the target to reduce the level of sound pollution of Dhaka City form 90-110 decibel to 45-55 decibel by 2009-10.

Recently Dhaka Metropolitan Police (DMP) has prohibited the use of horns on several city streets to check sound pollution.

Whereas, the increasing ambient noise in public places from various sources, inter-alia, industrial activity, construction activity, generators sets, loud speakers, public address systems, vehicular horns and other mechanical devices have deleterious effect on human health and the psychological wellbeing of the people. It is considered necessary to regulate and control of noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise.

2.9 National Water Policy, 1999

As water is essential for human survival, socio-economic development of the country and preservation of its natural environment, it is the policy of the Government of Bangladesh that all necessary means and measures will be taken to manage the water resources of the country in a comprehensive, integrated and equitable manner. The policies enunciated herein are designed to ensure continued progress towards fulfilling the national goals of economic development, poverty alleviation, food security, public health and safety, decent standard of living for the people and protection of the natural environment.

The water policy of the government aims to provide direction to all agencies working with the water sector, and institutions that relate to the water sector in one form or another, for achievement of specified objectives. These objectives are broadly:

a. To address issues related to the harnessing and development of all forms of surface water and ground water and management of these resources in an efficient and equitable manner
b. To ensure the availability of water to all elements of the society including the poor and the underprivileged, and to take into account the particular needs of women and children
c. To accelerate the development of sustainable public and private water delivery systems with appropriate legal and financial measures and incentives, including delineation of water rights and water pricing
d. To bring institutional changes that will help decentralize the management of water resources and enhance the role of women in water management
e. To develop a legal and regulatory environment that will help the process of decentralization, sound environmental management, and improve the investment climate for the private sector in water development and management
f. To develop a state of knowledge and capability that will enable the country to design future water resources management plans by itself with economic efficiency, gender equity, social justice and environmental awareness to facilitate achievement of the water management objectives through broad public participation

Excessive water salinity in the southwest region is a major deterrent to industrial growth. Also, pollution of both surface and groundwater around various industrial centers of the country by untreated effluent discharge into water bodies is a critical water management issue. The policy of the Government in this regard is that:

a. Zoning regulations will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities.
b. Effluent disposal will be monitored by relevant Government agencies to prevent water pollution.
c. Standards of effluent disposal into common watercourses will be set by WARPO in consultation with DOE.
d. Industrial polluters will be required under law to pay for the cleanup of water- body polluted by them.

2.10 National Water Management Plan, 2001 (approved in 2004)

The central objectives of the National Water Management Plan are consistent with Policy aims and national goals. These objectives are:

- Rational management and wise-use of Bangladesh's water resources
- People's quality of life improved by the equitable, safe and reliable access to water for production, health and hygiene
- Clean water in sufficient and timely quantities for multi-purpose use and preservation of the aquatic and water dependent ecosystems.

The National Water Management Plan provides a framework within which all concerned with the development, management and use of water resources and water services in Bangladesh can plan and implement their own activities in a coordinated and integrated manner, confident that in doing so they are contributing to achievement of the national goals.

The Plan's conceptual framework is founded on an assessment of needs, opportunities and constraints throughout the sector. The assessments made during Plan preparation have highlighted the spatial and sub-sectoral diversity of the water sector. To facilitate a fully integrated approach, both the analyses undertaken and the presentation of the Plan are based on eight distinct and defined hydrological regions.

The planned activity program has been presented in the following eight sub-sectoral clusters:

- Industrial Development
- Enabling Environment
- Main Rivers
- Towns and Rural Areas
- Major Cities
- Disaster Management
- Agriculture and Water Management
- Environment and Aquatic Resources

2.11 Bangladesh Labor Act, 2006

An Act to amend and consolidate the laws relating to employment of workers, relations between workers and employers, determination of minimum rates of wages, payment of wages, compensation for injuries to workers during working hours, formation of trade unions, raising and settlement of industrial disputes, health, safety, welfare and working conditions and environment of workers and apprenticeship and matters ancillary thereto.

Chapter Three
Project Description

3.1 Introduction:

Indesore Sweater Ltd. is a 100% export oriented sweater factory situated in Degerchala, National University,Gazipur Sadar,Gazipur. Indesore Sweater Ltd. started its journey since 2014, present work force 3126, total land area of the facility is 40000 sq. feet where area covered by facility building 300000 sq. feet and 2000 sq. feet of land of the facility is covered by green trees & flowers.. Monthly production capacity is 300000 pieces. This Factory own founded industry. The name of the owner of the facility is- Mr. Mohammad Rokunzzaman, Chairman. Total investment in this facility is approximately 30000000 BDT only. In this chapter the location, type, materials and utilization and other facilities of the factory is described.

3.2 Location and access ways

Indesore Sweater Ltd. has total land area of 0.92 acre, located in 23.9630714 north latitudes and in 90.39626320000002 east longitudes. In east side of the facility Dhaka city bypass and in west side of the facility Matrix style ltd. is situated. In north side and south side of the facility low lying land is occupied.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>East Side of the Facility</td><td>West Side of the facility</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>North Side of the facility</td><td>South Side of the Facility</td></tr>
</table>

The 500 m radius satellite map, the 2 km radius satellite map, the 5 km radius satellite map and 10km radius satellite map of the factory as well as the Gazipur District and Gazipur Sadar Upazilla map are shown in figure 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6 respectively.

The access way of the factory is very simple. The convenient route of the factory is Dhaka city bypass which is situated in east side of the factory.

Indesore Sweater Ltd. is just 200 m from Matrix style ltd. & 2.2 km distance from Vogra bypass & and 12.93 km distance from Hazrat Shahjalal International Airport.

Sl. No.	Distance from Indesore Sweater Ltd.	Important Facilities, Markets & Places
01.	Within 0.5 km	Matrix Style Ltd., Iris Design Ltd. etc.
02.	Within 2 km	Deger Chala road, TNZ Apparels etc.
03.	Within 5 km	Bangladesh National University, Open University, Rumana fashion Ltd. etc.
04.	Within 10 km	Tongi Police station, East-West Medical College etc.

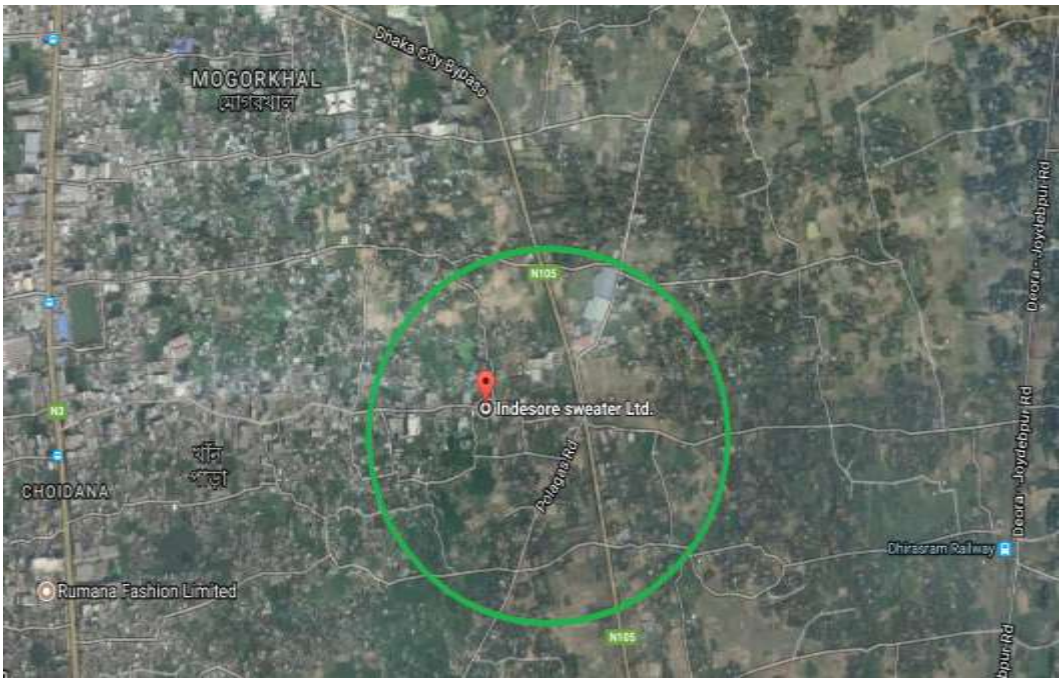


Figure 3.1: Satellite image of 0.5 km radius of the factory

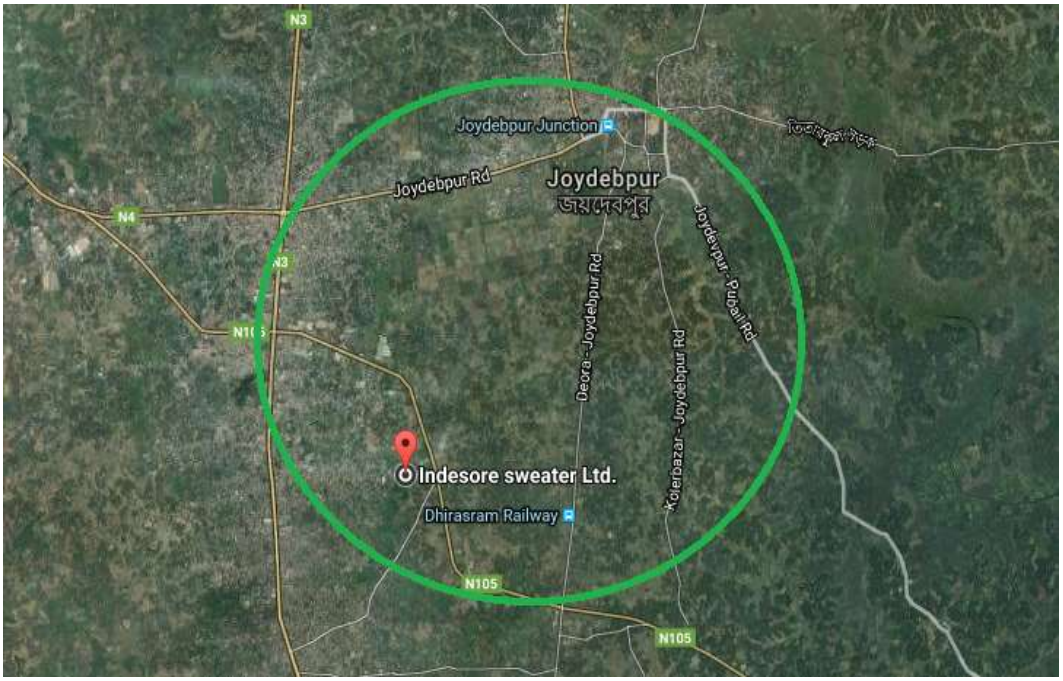


Figure 3.2: Satellite image of 2 km radius of the factory

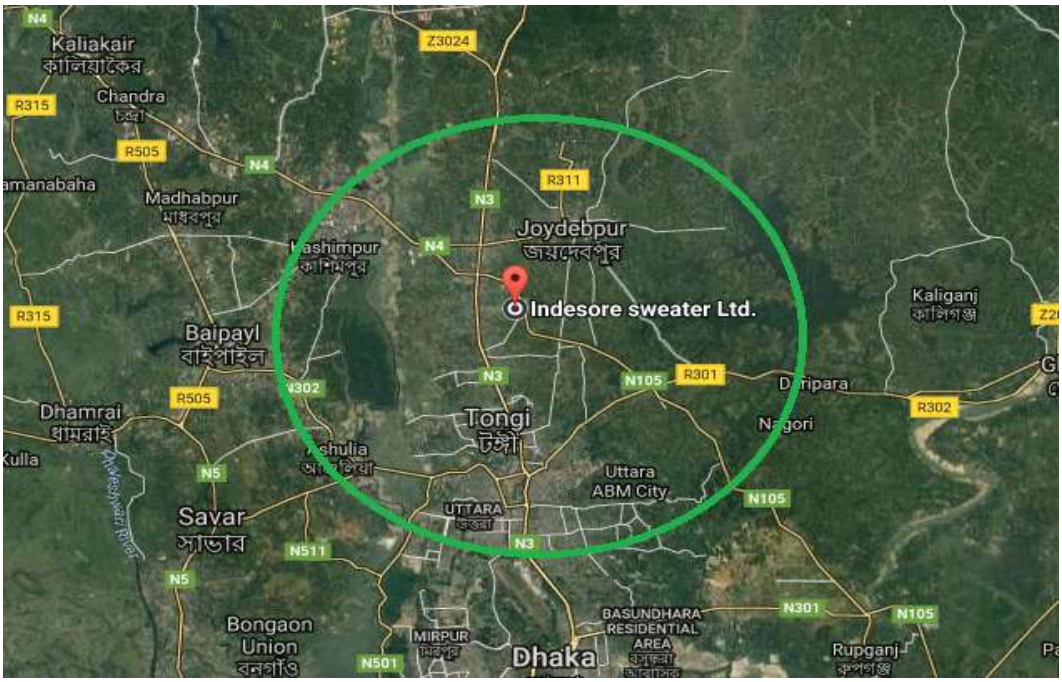


Figure 3.3: Satellite image of 5 km radius of the factory

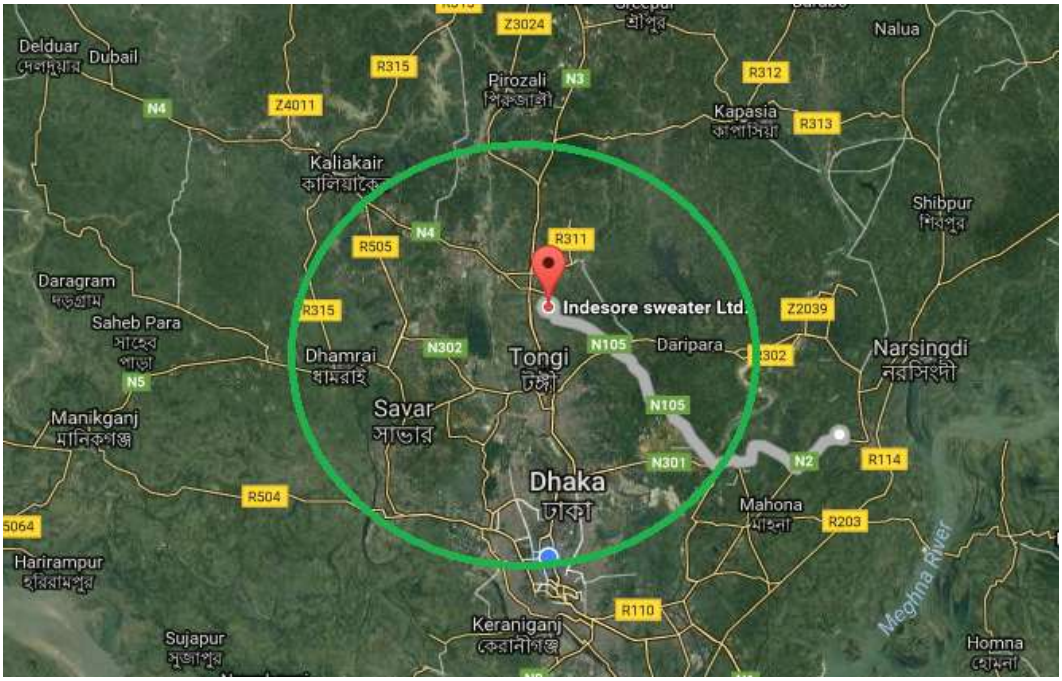


Figure 3.4: Satellite image of 10 km radius of the factory

Figure 3.5: Map of Gazipur District, Bangladesh

Figure 3.6: Map of Gazipur Sadar Upazila, Bangladesh.

3.3 Type

According to the Environmental conservation rules 1997 the industries of Bangladesh are divided in three types:

Green: Industries/development projects/activities are considered relatively pollution-free and therefore no require of an environmental clearance certificate from the DOE and no environmental study.

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

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

According to the criteria of the DoE, Indesore Sweater Ltd. falls in **RED** Category. For this reason, process flow diagram and schematic diagrams of waste treatment facilities as well as environmental management plan along with their application to DOE for obtaining environmental clearance is necessary.

3.4 Layout of the factory:

As Indesore Sweater Ltd. is a sweater factory, maximum equipments are related to make sweater. Unit wise production layout given below:

Floor name	Floor number	Floor area (sq. feet)
Administration/Office	5th Floor	15000 Sqft (Approx)
Production unit	Ground,1st,2nd,3rd, 4th, 5th ,6th ,7th ,	278000 Sqft (Approx)
Storage of raw materials	Ground Floor	5000 Sqft (Approx)
Storage of Chemical substances	Ground Floor	400 Sqft (Approx)
Rest room/ Day care	Ground Floor	300 Sqft (Approx)
Toilet facility	Ground,1st,2nd,3rd, 4th, 5th ,6th ,7th, 8th	300000 Sqft (Approx)
Generator	Basement	700 Sqft (Approx)
Boiler	Ground	600 Sqft (Approx)

Sewing, packing, finishing, trimming and mending section are common in 1st and 3rd floor. Manual knitting section are common in 4th and 6th floor. In 5th and 7th floor Jacquard section are common. Office area is also in the 5th floor. Second floor is occupied with winding, linking and sample section.

Treatment related infrastructure	Area (sq. feet)
Waste treatment plant	1500 (Approx)
Water treatment plant	500 (Approx)
Hazardous waste storage	450 (Approx)

Solid waste & sludge storage	350(Approx)

Production areas:

	
Sewing section	**Manual knitting section**
	
Jacquard section	**Trimming & Mending section**
	
Winding section	**Linking section**

	
Washing section	**Finishing section**

Land

Indesore Sweater Ltd. has total land area 0.92 acre, located in located in 23.9630714 north latitudes and in 90.39626320000002 east longitudes. Total 0.92 acre land area & Industries building won by Indesore Sweater Ltd. authority.

3.5 Transport requirements and their modes for incoming and outgoing materials

Indesore Sweater Ltd. is used their own vehicle for the incoming of the raw materials and the outgoing of the finishing product. The mode of the transportation use by the factory is small covered van. As the factory is situated not so far from the highway, for that reason the route for transportation is easy and convenient.

Table-3.1: List of Transport

Sl. No.	Transport Name	Quantity
1	Micro Bus	3
2	Car	13
3	Cover Van	01
4	Refrigerator VAN	0
5	Pickup	0

3.6 Labor force during operational phase

Operating time of the facility is average 9.30 hours per day and maximum 10 hours per day. Total 3126 employees engaged in the operation & production, 240 nos. employees engaged in administration & 2880 nos. employees engaged in production process.

Table-3.2: Work Force of the Facility

Sl. No.	Work force	No. of Employee
1	Administration	240
2	Production	2880
3	Environmental management	6
Total		**3126**

Chapter Four
Production- Process Description

4.1 Production Capacity

Facility has different production section like Sewing, Packing, Trimming, Mending, Winding, Linking, Manual knitting, Jacquard, Finishing and Packing. In general, working hour of the facility is average 9.30 hours/day & 6 days/week. In total about 3126 nos. of workers are working at present in production section, 240 nos. of employees are engaged in administrative section & 2880 nos. of people are engaged in production section. Total numbers of machines used in production processes of the facility are given in the following:

Table 4.1: List of the equipment of the factory

SL No.	Name of equipment	Amount
1.	Winding Machine	08 Spindle
2.	Hand Flat Knitting Machine	1370
3.	Computerized Flat Knitting Machine	536
4.	Knitting Auto Transformer	675
5.	Semi Auto Knitting Machine	10
6.	Auto Placket Machine	17
7.	Dial Linking Machine	746
8.	Overlock Machine	24
9.	Button Hole Machine	18
10.	Button Stitch	14
11.	Bartek Machine	20
12.	Flat lock Machine	3
13.	Plain Machine	102
14.	Washing Machine	8
15.	Hydro Extractor	7
16.	Auto Gas Dryer	5
17.	Auto Winding Machine	2

4.2 Raw materials:

The raw materials & chemicals used in the factory for the purpose of making sweater. All the raw materials are bought from various factories. The raw materials are listed in the table below-

Table 4.2: List of raw materials and chemicals used in production process

SL No.	Raw Material Description	Suppliers	Amount (Daily)
1	Yarn	Ring Shine Textile Ltd.	8000 LBS
2	Button	Royel Label & Accessories Ltd.	20000 Pcs
3	Zipper	Fabian Industries Ltd.	1200 Pcs
4	Sewing Thread	Etafil Bangladesh Ltd.	70 Cone
5	Labels	SML Group	10000 Pcs

Table 4.3: List of chemicals used in the factory

SL No.	Chemicals (Non-hazardous)
1.	Silicon
2.	Softener
3.	Detergent
4.	F-808
5.	TM-50
6.	Wash sol-ft-20

4.3 Generator & Compressor Specification

Total two generators and two boilers used in Indesore sweater Ltd. The specification of the total two generators and two boilers are listed in the table below.

Generator room

Boiler room

Table 4.4: Generator & Boiler Specification of the factory

SL No.	Description of the Generator	Technical Data
1	**Generator no.**	01
	Generator, Brand	F.G. WILSON
	Capacity	660 KVA
	Model	P660-1
	Origin	UK
	Fuel	Diesel
2	**Generator no.**	02
	Compressor Brand	F.G. WILSON
	Capacity	660 KVA
	Model	P660-1
	Origin	UK
	Fuel	Diesel
3	**Boiler no.**	01
	Capacity	01 ton
	Model	107936
	Origin	USA

	Boiler no.	02
4	**Boiler no.**	02
	Capacity	01 ton
	Model	107937
	Origin	USA

4.4 Processes and operations involved in the manufacture

The processes of the operation of the factory are very easy. The process flow diagram along with environmental aspect & impact analysis is provided below:

Production Flow Chart of Packaging Unit

Environmental Aspect				**Environmental Impact**
Dust, Use of electricity	⇔	**Winding**	⇨	Air, GHG emission
		⇩		
Yarn Dust, Waste generation and making noise	⇔	**Manual knitting**	⇨	Climate Change, pollution of atmosphere
		⇩		
Use of electricity, Dust	⇔	**Linking**	⇨	Air, GHG emission
		⇩		
Solid waste generation, Dust	⇔	**Trimming**	⇨	Air
		⇩		
Solid waste generation, Dust	⇔	**Mending**	⇨	Air
		⇩		
Use of Electricity and Making Noise, Fabric dust	⇔	**Sewing**	⇨	Climate Change, pollution of atmosphere, Contamination of air & Soil
		⇩		
Liquid wastes, Use of electricity	⇔	**Washing**	⇨	Water, Air & Soil
		⇩		
Electricity Consumption	⇔	**Iron**	⇨	GHG emission
		⇩		
Use of Electricity, Dust	⇔	**Finishing/PQC**	⇨	Not so much significant

		environmental impact
	⇩	
Use of Electricity, Dust ⇔	**Packing**	⇨ Not so much significant environmental impact

Environmental Issue: Electrical Substation

Aspect		Impact
Power Consumption	**Electricity Generation by Diesel**	Air Pollution, Noise Pollution

Environmental Issue: Chemical Store, Wastage Go-down, Finished Goods Store, Raw material Store

Aspect		Impact
Chemical Spillage, Disposal from raw material & finished goods	**Chemical Store, Wastage Go-down, Finished Goods Store, Raw material Store**	Soil contamination, water contamination etc.

Chapter Five
Wastage Disposal

5.1Generation of wastes

As the factory has washing process, so the scope of the generation of liquid waste is high and gaseous waste generated from process and generator, boiler and production machines like jacquard is also significantly considerable. In the factory also solid waste is generated. The greater portion of the composition of the solid waste of the factory is chemical container and other rejected accessories.

5.2 Liquid Waste

Waste water generated from the following sections-

Sources	Daily amount (Liter)	Nature of pollutant	
		Poisonous	Normal
Production process	0	0	0
Washing/Cleaning	98000 liter	0	98000 liter
Domestic sewerage	131000 liter	0	131000 liter
Total	229000 liter		

5.3 Effluent Treatment Plant

Liquid waste treated through an effluent treatment plant (ETP) whose capacity is described below-

The capacity of the ETP	100 m^3/day	**The area of the existing ETP**	512 sq. meter
The Units of the ETP			
Metal	Screening	Equalization	Greet Removal
	Oil-water separator	Sedimentation	Others
Chemical	**Adsorption-√**	**Disinfection-√**	**Neutralization Process (if necessary)**
	Flocculation-√	**Chemical Oxidation-√**	Others
Biological	.Sequencing Batch Reactor	Activated sludge	Aerated lagoon
	Biological contactor	Trickling Filter	Aeration tank
	Stabilization Pond	Anaerobic tank	Others
Sludge Treatment	Thickening	Dry with heat	Fried in the Brick field
	Digestion	De-watering	Others
Others	Ion exchange	Membrane filtration	Reverse Osmosis
	Activated carbon Adsorption	Septic Tank & Soak oil	

a. Chemical used in ETP

Sl. #	Name of Chemicals	Daily Use (kg)
1.	Pharous Sulphate	800 gm
2.	Polyelectrolyte	1200 gm
3.	Caustic	500 gm

b. Required electricity demand for Existing ETP

Running time of ETP	10 Hours/ day	Amount of treated liquid waste	100 m^3/day

Electricity cost for ETP/month (11700 BDT) in 2016												
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Unit (KWh)	**1820**	**1830**	**1850**	**1780**	**1820**	**1890**	**1898**	**1920**	**1851**	**1750**	**1728**	**1750**

ETP Inlet

ETP- Section

Sludge

ETP Outlet

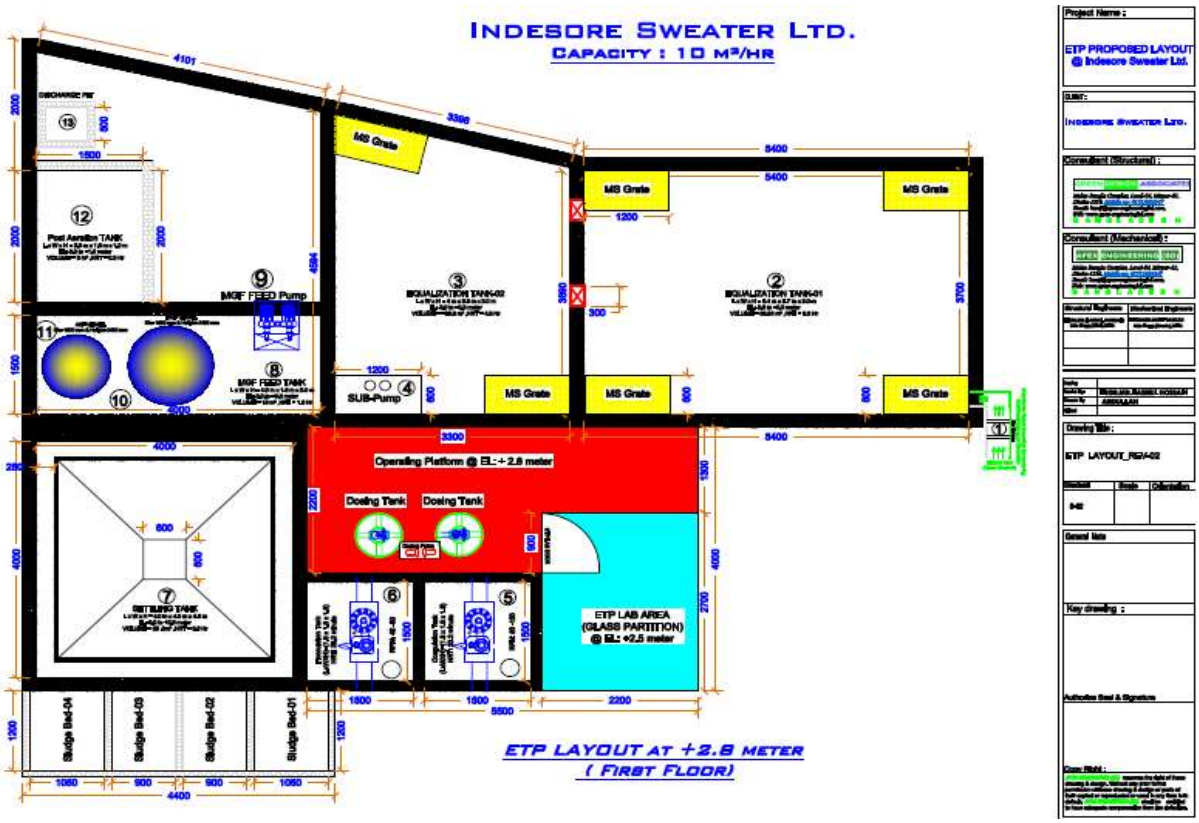


Figure 5.1: Layout plan for liquid discharge in the facility

Chapter Six
Existing Environment: Physical

6.1 Introduction

As part of the Environmental Management Plan (EMP) of Indesore sweater Ltd., an environmental baseline study was carried out in areas surrounding the project site. The specific objectives of the baseline study were to gather information on the existing physical environment, biological-ecological environment, and socio-economic environment of the areas in and around the project site. The data and information gathered during the baseline study provide a detailed description of the existing conditions of physical, biological as well as socio-economic environment in and around the project area.

This Chapter describes the existing physical environment of areas in and around the factory, based on the baseline survey and other studies (e.g., water quality, air and noise level measurements) carried out as a part of the present study. Relevant information on climate, topography and drainage, geology and soils, hydrology and water resources, air quality, noise level, and water quality have been described in this Chapter. The possible environmental impacts of the project activities will be evaluated against these baseline environmental conditions.

6.2 Climate

The climate of this region is tropical, with monsoons, characterized by a change of four seasons: pre-monsoon (March to May), monsoon (June to September), post-monsoon (October to November) and dry season (December to February). High air temperature is observed all throughout the year; daily air temperature variations are insignificant; air humidity is high with abounding rains. Typical parameters of the weather elements, as recorded for the period of last few years of observations (2012-2016) at Gazipur (Facility area), from the world weather online website are presented in table below.

6.2.1 Ambient Air Temperature

The temperature of the country has the relationship with the period of rainfall. In general cool seasons coincide with the period of lowest rainfall. Table 4.6 - Table 4.10 respectively shows the monthly average maximum and minimum temperature at Gazipur area for the period 2012 -2016. During this period maximum average temperature of 37.6 degree Celsius was observed in April, 2014 where average minimum temperature was 17.06 degree Celsius in January, 2013. Rainfall pattern in the project area likely to be more or less similar that of Gazipur.

Table 6.1: Monthly ambient temperature of the factory area in 2012

MONTH	Max. Temp(◦C)	Min. Temp(◦C)	Mean Temp(◦C)
Jan	26.32	17.81	22.06
Feb	30.79	20.43	25.61
Mar	32.74	23.45	28.10
Apr	33.67	25.97	29.82
May	35.13	28.06	31.60
Jun	34.03	28.53	31.28
Jul	31.68	27.16	29.42
Aug	31.00	26.71	28.85
Sep	31.40	26.50	28.95
Oct	32.00	23.68	27.84
Nov	29.23	20.77	25.00
Dec	27.58	18.00	22.79

(Source: http://www.worldweatheronline.com)

Table 6.2: Monthly ambient temperature of the factory area in 2013

MONTH	Max. Temp(◦C)	Min. Temp(◦C)	Mean Temp(◦C)
Jan	27.19	17.06	22.13
Feb	31.00	20.29	25.64
Mar	34.42	23.48	28.95
Apr	35.10	26.20	30.65
May	31.65	27.29	29.47
Jun	32.53	27.23	29.88
Jul	31.77	27.23	29.50
Aug	31.90	26.87	29.39
Sep	33.70	26.57	30.13
Oct	32.10	24.55	28.32
Nov	31.77	20.43	26.10
Dec	29.58	19.65	24.61

(Source: http://www.worldweatheronline.com)

Table 6.3: Monthly ambient temperature of the factory area in 2014

MONTH	Max. Temp(◦C)	Min. Temp(◦C)	Mean Temp(◦C)
Jan	29.35	18.06	23.71
Feb	31.21	20.25	25.73
Mar	34.87	23.61	29.24
Apr	37.60	26.90	32.25
May	36.32	28.45	32.39
Jun	35.57	28.70	32.13
Jul	33.39	27.94	30.66
Aug	32.84	27.13	29.98
Sep	33.43	26.63	30.03

Oct	34.26	24.45	29.35
Nov	33.20	22.13	27.67
Dec	30.00	19.10	24.55

(Source: http://www.worldweatheronline.com)

Table 6.4: Monthly ambient temperature of the factory area in 2015

MONTH	Max. Temp(◦C)	Min. Temp(◦C)	Mean Temp(◦C)
Jan	29.10	19.26	24.18
Feb	31.04	21.21	26.13
Mar	35.71	24.94	30.32
Apr	35.77	26.73	31.25
May	37.00	28.39	32.69
Jun	35.67	28.37	32.02
Jul	33.87	27.00	30.44
Aug	34.55	27.71	31.13
Sep	35.50	27.53	31.52
Oct	34.81	25.29	30.05
Nov	32.87	22.63	27.75
Dec	29.52	20.16	24.84

(Source: http://www.worldweatheronline.com)

Table 6.5: Monthly ambient temperature of the factory area in 2016

MONTH	Max Temp(◦C)	Min Temp(◦C)	Mean Temp(◦C)
Jan	29.13	19.48	24.31
Feb	32.57	22.89	27.73
Mar	36.45	25.74	31.10
Apr	36.17	27.53	31.85
May	36.55	28.10	32.32
Jun	35.20	27.57	31.38
Jul	34.55	27.06	30.81
Aug	34.55	27.00	30.77
Sep	34.73	27.27	31.00
Oct	34.90	25.45	30.18
Nov	32.63	21.93	27.28
Dec	31.71	20.26	25.98

(Source: http://www.worldweatheronline.com)

6.2.2 Rainfall

Its annual rainfall is about 2000mm and approximately 80% of it occurs during the monsoon. Average monthly rainfall during monsoon period varies between 300mm to 450mm. Maximum daily rainfalls during this period recorded 13 May 2016 is 209 mm & maximum monthly rainfalls recorded May 2016 is 745 mm.

The rainfall follows the general climate pattern with the highest rainfall in the summer month of June to September and minimum rainfall in the cooler and drier months of November to March. Table presents average monthly rainfall for Dhaka & Gazipur, average number of rainy days per month and average number of days per month when rainfall is greater than 10 mm. It is evident that extreme rainfall events occurred during the monsoon (April-September) in Gazipur. On May to September, 2016 almost every day of the month it is raining in Gazipur District.

Table 6.6: Rainfall statistics in Dhaka in between 2011 to 2015

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total
In millimeter													
2011	0	0	20	123	235	314	356	409	207	112	0	0	1776
2012	10	1	37	269	137	175	226	282	81	38	68	5	1329
2013	0	8	26	32	378	325	302	212	172	131	0	4	1590
2014	0	12	10	80	147	342	212	391	156	49	0	0	1399
2015	3	17	4	166	185	375	623	395	346	51	0	1	2166

(Source: BMD)

Table 6.7: Rainfall Statistics in Gazipur in 2016

Month	Rainfall(mm)	Total No. of rain days/month
Jan	0.7	1
Feb	14.5	8
Mar	50.1	11
Apr	202.9	22
May	744.7	31
Jun	183	28
Jul	230.3	31
Aug	174.7	30
Sep	239.5	30
Oct	91.4	20
Nov	43.2	8
Dec	0	0
Annual	1975	220

(Source: http://www.worldweatheronline.com)

6.2.3 Wind Speed

Table 6.8: Monthly Prevailing Wind Speed of Gazipur for the period of 2012-2016

Year	Month	Speed (mph)
2012	Jan	6.63
	Feb	5.21
	March	7.90
	April	10.80

	May	9.52
	June	11.70
	July	12.32
	Aug	10.06
	Sep	8.43
	Oct	5.68
	Nov	5.90
	Dec	6.32
2013	Jan	6.65
	Feb	7.32
	March	7.52
	April	10.17
	May	13.68
	June	10.03
	July	11.19
	Aug	9.68
	Sep	6.83
	Oct	5.32
	Nov	6.43
	Dec	5.42
2014	Jan	6.10
	Feb	5.75
	March	6.84
	April	9.03
	May	10.97
	June	9.80
	July	12.00
	Aug	10.19
	Sep	8.50
	Oct	5.00
	Nov	4.13
	Dec	5.84
2015	Jan	6.32
	Feb	6.32
	March	7.48
	April	10.63
	May	12.32
	June	14.03
	July	12.45
	Aug	11.48
	Sep	8.27
	Oct	5.19
	Nov	5.10
	Dec	5.45
2016	Jan	5.77
	Feb	6.43

	March	8.45
	April	15.57
	May	11.29
	June	10.77
	July	12.03
	Aug	11.61
	Sep	8.30
	Oct	6.13
	Nov	5.07
	Dec	5.39

(Source: http://www.worldweatheronline.com)

6.2.4 Relative Humidity

As would be expected, relative humidity during the wet season is significantly higher than those occurring at other period of the year. This is well depicted by the data as shown in the Table - 4.8 for relative humidity of Dhaka during the period 2012 – 2016.

Table 6.9: Average Monthly Relative Humidity of the Project Area in last 5 years

Humidity in %	Monthly Mean Humidity												
Year	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
2012	58	45	66	74	73	76	80	83	82	80	69	57	70
2013	47	40	58	67	81	80	80	81	80	83	73	62	69
2014	53	53	53	62	70	74	79	81	80	77	67	59	67
2015	55	52	44	67	71	71	79	77	75	74	67	59	66
2016	53	57	58	72	73	77	78	79	78	77	74	62	70

(Source: http://www.worldweatheronline.com)

6.3 Geology and Soil

6.3.1 Soil

Most of the area of Bangladesh is a vast, low-lying alluvial plain, sloping gently to the south and southeast. According to Bangladesh Agricultural research council's Agro-Ecological Zoning map of Bangladesh, The project area occupies on northern side of Gazipur district and standing right side of Dhaka-Tangail highway road.

General soil types of this area are: non-calcareous grey floodplain soils, acid basin clays, non-calcareous dark grey floodplain soils, shallow red-brown terrace soils, deep red-brown terrace soils, brown mottled terrace soils, shallow grey terrace soils & deep grey terrace soils.

According to Soil Resource Development Institute (SRDI), govt. republic of Bangladesh, Soil description of the project area is described below:

The project area represents soil series like: Tejgaon, Belabo, Gerua, Bhatpara, Salna, Noadda, Chandra, Chiata occupying on terrace area & Chalna, Khilgao, Demra and karaill on Baid area/valley.

Tejgaon, Belabo & Gerua is moderately deep to deep red clay soil occurring on almost level terrace developed on Madhupur clay. Soil reaction is generally moderately acid to acidic (PH value lies between 4.5 to 5.5 having drainage condition moderately well drained to well drained.

Its cropping pattern generally varied from double to triple; Rabi vegetables is followed by kharif vegetables; fruit trees, pine apple, guava, forest trees etc.

Bhatpara, Salna and Noaddais generally light yellowish to brown clayey soil; slightly acidic to acidic, moderately well drained compact soil. Its cropping pattern is generally fruit trees, forest trees, forest planted rice in kharif-2 season, and crop suitability is comparatively poor.

Chandra, Chiata: Yowlish brown/strong brown clayey, moderately well drained soil and soil reaction is slightly acidic to moderately acidic (PH value lies between 4.5 to 5.5).

Chalna, Khilgao, derma & karail is occupied on poorly drained grey clay soil on baid area. Cropping pattern is generally is single cropped. Suitability of transplanted rice crop is in kharif-2 season.

Soil properties of Gazipur Sadar Upazilla thana:

This area represents another type of soil which is named as “Old Bemhaputra alluvium”. This soilseries comprises Nokla, sherpur, sonatola, silmondi, lokdeo, tarakanda occupying on ridge and ghatail, ghereargao, belna and mohanganj of basin area. Sonatola, sherpur&nokla is generally mixed brown and grey, silt loam, friable soil. Silmondi, lokdeo & tarakanda is mixed brown and grey, silty clay loam to silty clay, slightly acidic to neutral (PH value lies between 5.6 to 6.5).

Ghatail, glorargao and mohanganj occur on basin area, shallowly flooded to moderately deep flooding, poorly drained, silty clay to clay soils.

Cropping Pattern: Overall ridge soils is double crop to triple cropped; lands, rabi crops followed by kharif-1 & 2 crops; Mastered, khesari, mosur, followed by kharif vegetables; transplanted rice crops.Basins area is double cropped land; mainly boro followed transplanted rice crops.

The analytical figures for these nutrients in these soils are below the standard of the Bangladesh average.

The total cultivated land at Gazipur is 88%, where 38% is high land(HL), 18% is medium high land(MHL), 14% is medium low land(MLL), 12 % is low land(LL), 6% is very low land(VLL) and rest of 12 % is used as miscellaneous land. Total 46162.71 acres of land occupied as forest according to the data of department of forest, 2013. But the total cultivated land at Gazipur Sadar upazilla is 41,633 hector, where HL is 20,406 hector, MHL is 6652 hector, MLL is 1,197 hector, LL is 7,229 hector & VLL is 1,827 hector. (Source: SRDI)

Drainage classes of this Sadar upazilla are stated below:

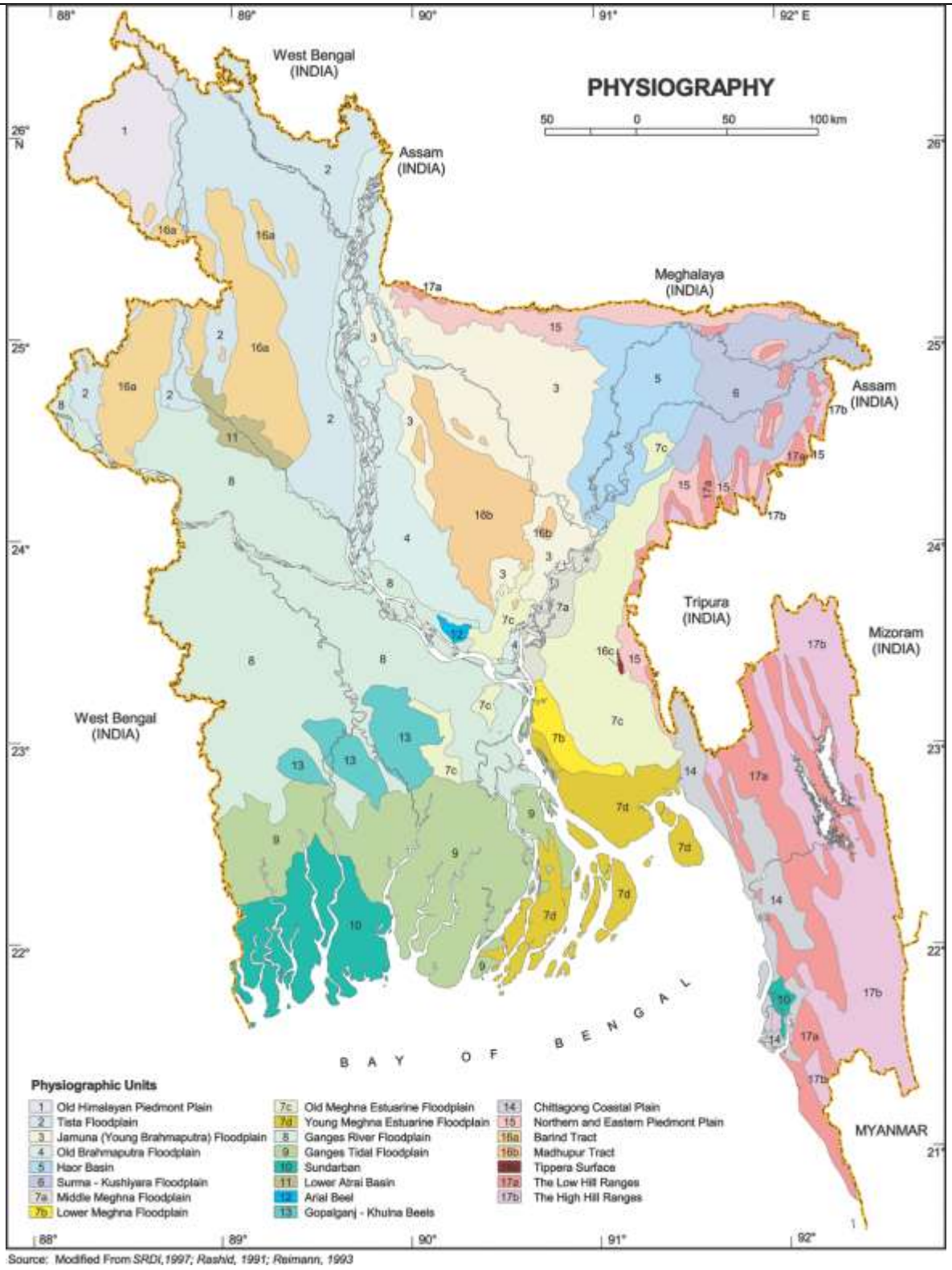
Well drained	Moderately well drained	Imperfectly drained	Poorly drained	Very poorly drained	Miscellaneous	Total
Hector (Ha)						
3234	8151	10322	10427	5177	4322	41633

Source: SRDI

Textural classes of the soil of the Gazipur Sadar Upazila are described below:

Sand	Sandyloam	Loam	Clay Loam	Clay	Miscellaneous	Total
Hector (Ha)						
29	242	8355	16741	11944	4322	41633

Source: SRDI



Source: Modified From *SRDI,1997; Rashid, 1991; Reimann, 1993*

Figure 6.1: Physiographic Map of Bangladesh

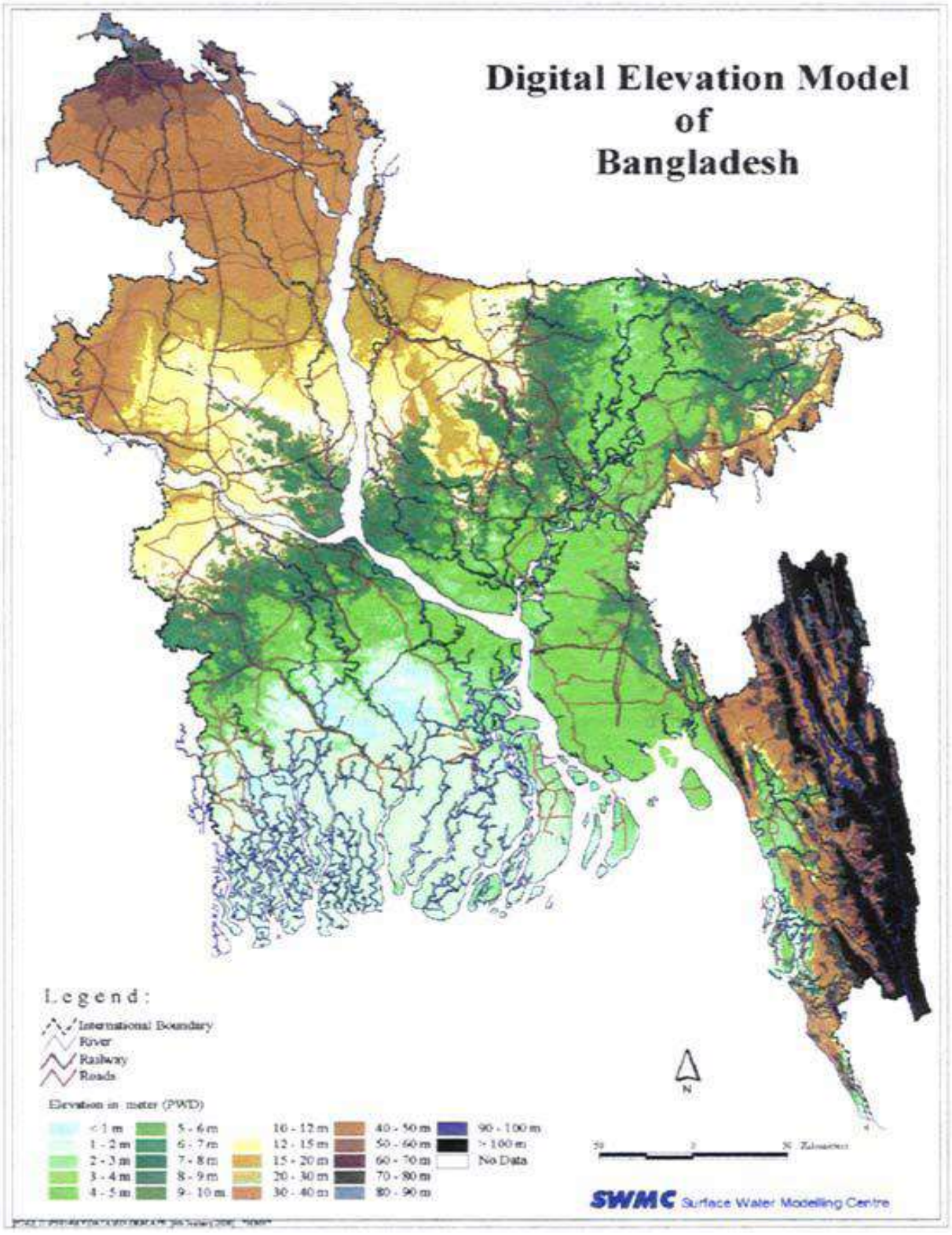


Figure 6.2: Digital Elevation Model of Bangladesh

6.3.2 Seismicity

Bangladesh, a densely populated country in South Asia, is located in the north-eastern part of the Indian sub-continent at the head of the Bay of Bengal. Tectonically, Bangladesh lies in the north-eastern Indian plate near the edge of the Indian carton and at the junction of three tectonic plates – the Indian plate, the Eurasian plate and the Burmese micro plate. These form two boundaries where plates converge– the India-Eurasia plate boundary to the north forming the Himalaya Arc and the India-Burma plate boundary to the east forming the Burma Arc.

Active faults of regional scale capable of generating moderate to great earthquakes are present in and around Bangladesh. These include the Dauki fault, about 300km long trending east-west and located along the southern edge of Shillong Plateau (Meghalaya- Bangladesh border), the 150km long Madhupur fault trending north-south situated between Madhupur Tract and Jamuna flood plain, Assam-Sylhet fault, about 300km long trending north east southwest located in the southern Surma basin and the Chittagong-Myanmar plate boundary fault, about 800km long runs parallel to Chittagong-Myanmar coast.

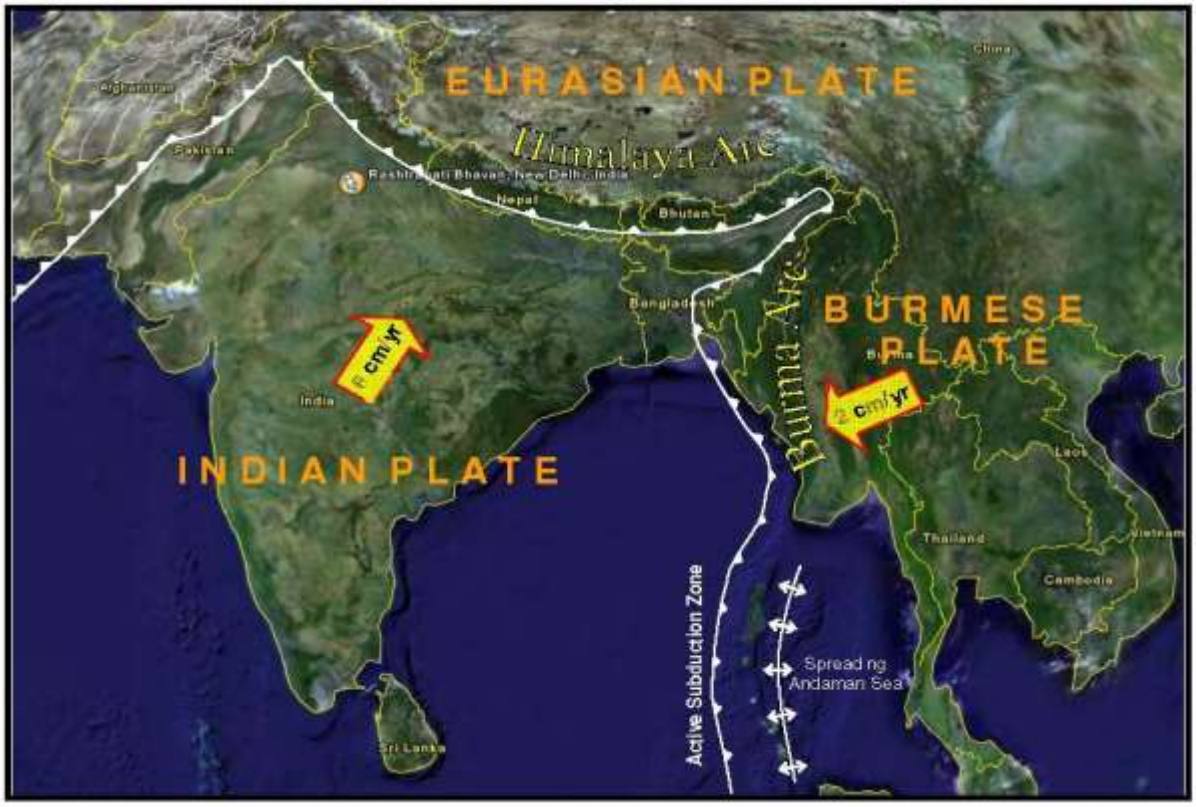


Figure 6.3: Regional tectonic setup of Bangladesh with respect to plate configuration

The Chittagong- Myanmar plate boundary continues south to Sumatra where it ruptured in the disastrous 26 December 2004 Mw 9.3 earthquake (Sticklers et al．（2008)). These faults are the surface expression of fault systems that underlie the northern and eastern parts of Bangladesh. Another

tectonic element, the Himalayan Arc' is characterized by three well defined fault systems (HFT, MBT and MCT) that are 2500 km long stretching from northwest syntaxial bend in Pakistan in the west to northeast syntaxial bend in Assam in the east. It poses a great threat to Bangladesh as significant damaging historical earthquakes have occurred in this seismic belt (Bilham et al., 2001; Mukhopadhyay et al., 2004 and Mullick et.al 2009). The tectonic set-up and the plate motions together place Bangladesh potentially vulnerable to earthquake. Dhaka is situated in the central part of the country on the bank of the Buriganga River and at the southern tip of the Madhupur Tract dating back to the Pleistocene age. The Madhupur Tract is an area of recent uplift within the delta and the surface of the tract is in general higher on the west, sloping very gently eastward to disappear beneath younger sediments (Fergusson, 1863; Morgan and McIntire, .(1956Dhaka is surrounded by the old Brahmaputra floodplain in the north and east, by the Ganges-Meghna flood plain in the south and by the Jamuna flood plain in the west. Dhaka is slightly elevated above the surrounding floodplains and represents mostly flat land with minor undulations. Topographically Dhaka is of low relief with many low depressions. According to Alam ((1988, the Madhupur Tract is structurally controlled. The Pleistocene sediments of Madhupur Tract have been affected by numerous episodes of faulting. These faults are probably the branch out surface faults from the low dipping western extension of Burma Arc detachment fault. Dhaka lies within 50to 500km distances from the seismogenic faults and sits on the Burma Arc detachment fault.

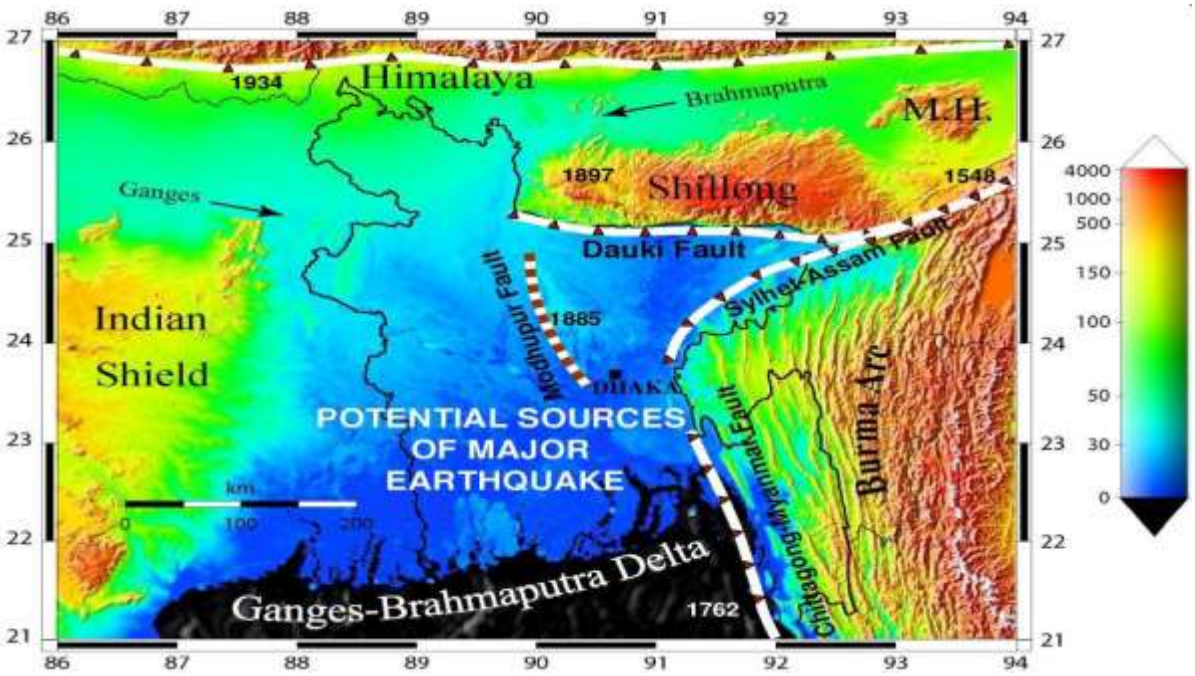


Figure 6.4: Digital Elevation Model (DEM) of Bangladesh and surroundings showing geological faults – potential sources of major earthquakes in Bangladesh

On the basis of distribution of earthquake epicenters and morph tectonic behavior of different tectonic blocks Bangladesh has been divided into three generalized seismic zones (figure 6.7). Zone-II comprising the central part of Bangladesh represents the regions of recent uplifted Pleistocene blocks of the Barind

and Madhupur Tracts, and the western extension of the folded belt. The zone II consists of the regions of recent uplifted Pleistocene blocks of the Barind and Madhupur and the western extension of the folded belt and the Bask coefficient for this zone is 0.05. Narshingdi area within the vicinity of Dhaka falls in seismic zone II of the seismic zoning map of Bangladesh.

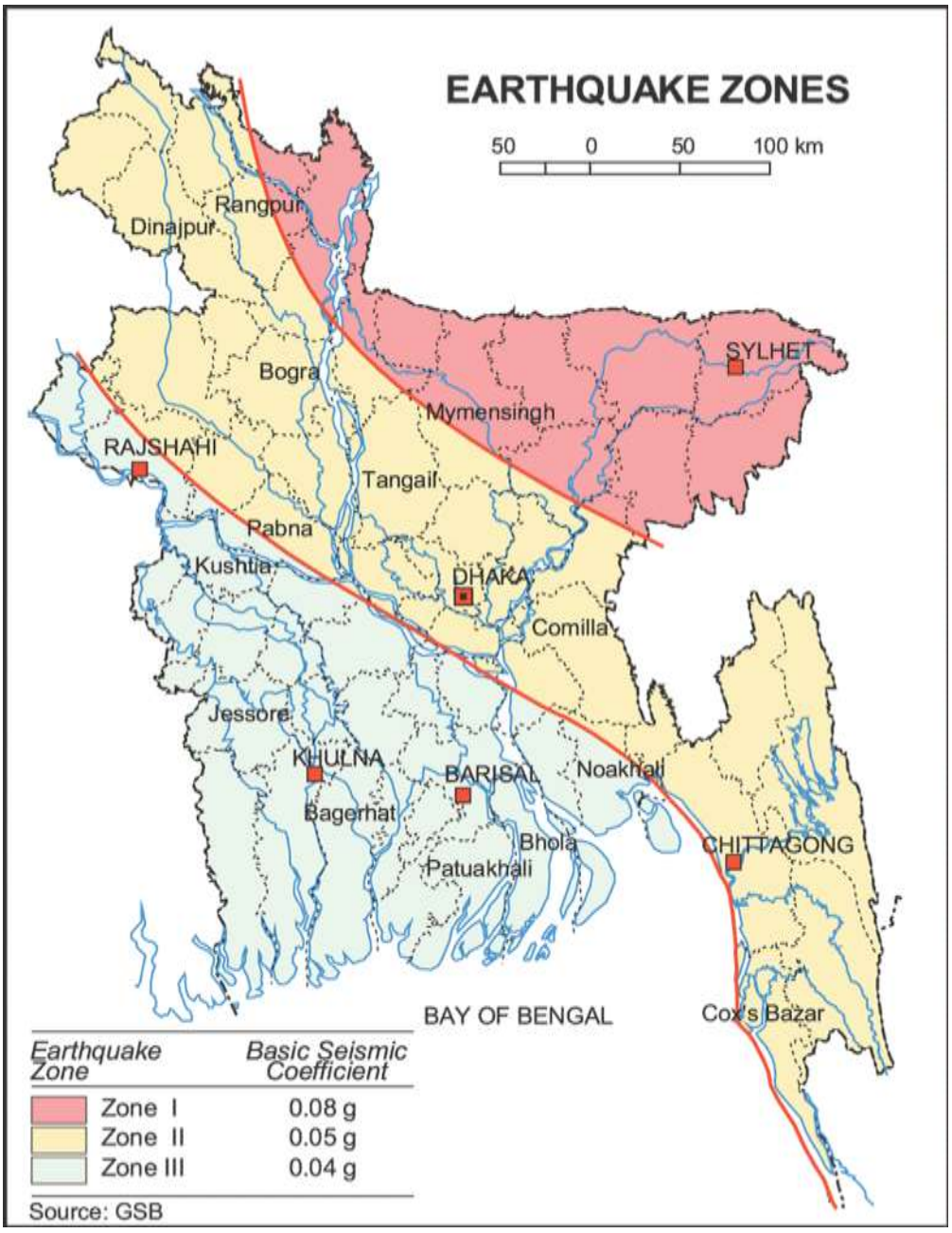


Figure 6.5: Earthquake Zoning Map of Bangladesh

Table 6.10: Seismic Zone of Bangladesh

Zoning	Area Mercalli Scale	Modified
I	North and eastern regions of Bangladesh (Seismically most active)	IX
II	Lalmai, Barind, Madhupur Tracts, Dhaka, Comilla, Noakhali and western part of Chittagong Folded belt.	VIII

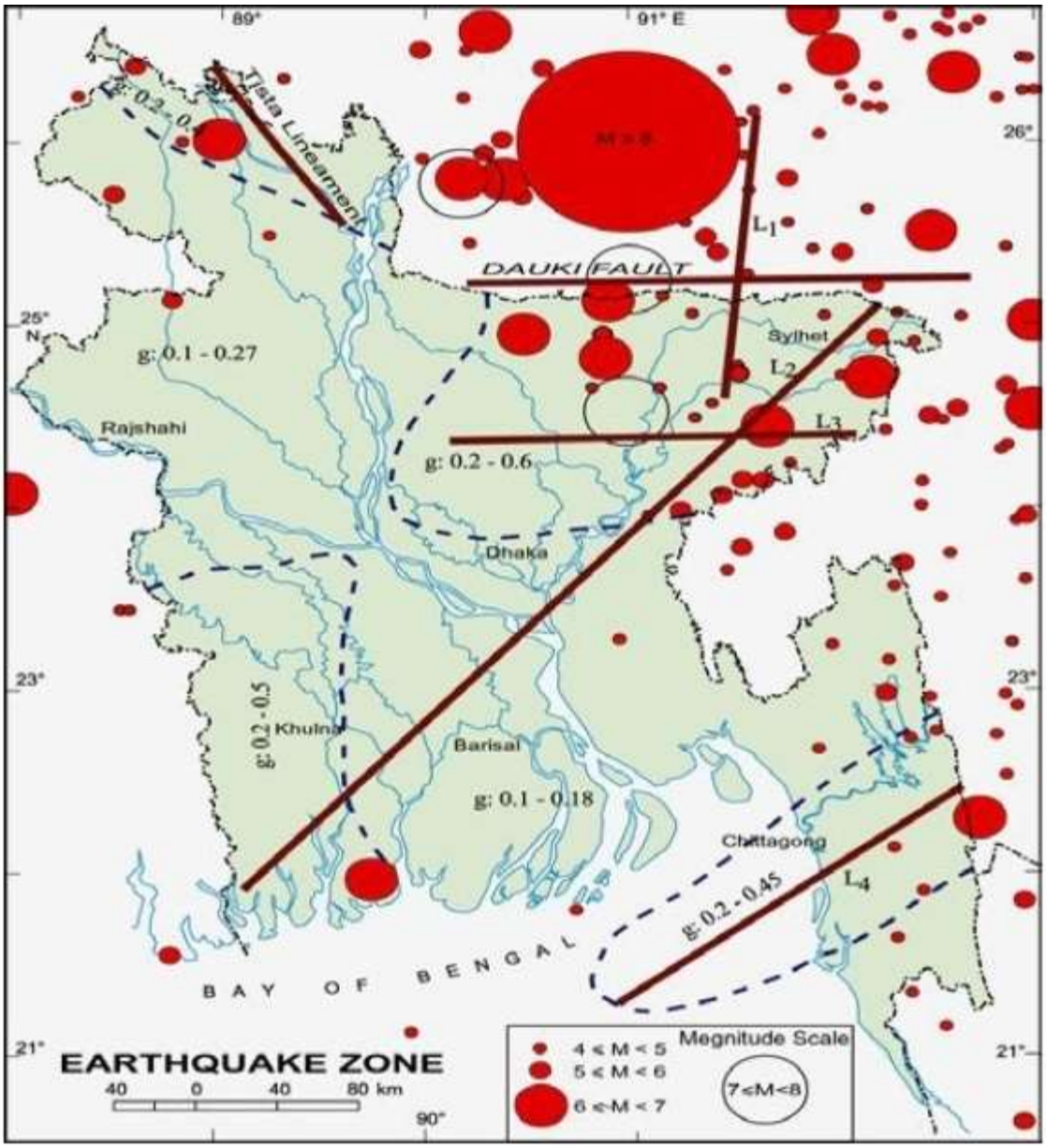


Figure 6.6: Seismic Activity of Bangladesh

Dhaka suffered ground shaking of the order III to VIII on the Modified Marcella (MM) scale from both tele seismic (distant) and local earthquakes during historic and recent times. Among all the earthquakes that Dhaka has suffered from, the earthquakes of 1762, 1812, 1865, 1885 and 1897 were the most

severe earthquakes in recent recorded history. The following descriptions summarize the earthquake history that affected Dhaka.

Major earthquake affect in Dhaka Division:

1548 Earthquake – Assam

The first known earthquake in Bangladesh was a ―terrible one‖ and destroyed both Sylhet and Chittagong in 1548 (Rizvi, 1970; Iyengar, et al., 1999; Banglapedia , 2003), The details of the earthquake and the damage are not available but it opened numerous ground fissures and caused liquefaction in Assam, Sylhet, Tripura and in the Meghna floodplains. It is assumed from the descriptions in the reports that the 1548 earthquake epicenter was somewhere in Assam or Nagaland. Though no reports were made on the effect of this earthquake in Dhaka, it can nevertheless be well imagined that the intensity was V to VI in Dhaka.

1642 Earthquake – Assam

This earthquake was more severe than the 1548 earthquake (Rizvi, 1970). It probably occurred in the Assam-Sylhet region, but might have shaken Dhaka with moderate intensity.

1762 Earthquake – Chittagong

The earthquake of 1762 was very destructive and violent. It was felt all over Bengal and Arakan and it originated somewhere along the Chittagong-Myanmar coast on 2 April. It damaged vast areas of Dhaka, Chittagong and Myanmar (Oldham, 1883: Rizvi, 1969: Martin and Szeliga, 2010). Rizvi (1969) writes: ―The earthquake on April 2, 1762 proved very violent at Dhaka and along the eastern bank of Meghna as far as Chittagong. At Dhaka the rivers and jhils were agitated, and raised high above their usual levels, leaving, when they receded, their banks were strewn with dead fish. The shocks were accompanied by subterranean hollow noises and were so severe that a number of houses were thrown down by which 500 persons, it is said, lost their lives‖. Based on the degree of damage of the ground surface, its aerial extent and comparing with the 2004 Sumatra earthquake, the magnitude of the 1762 earthquake was 8.5+ on the Richter scale. The intensity of this earthquake in Dhaka was MM VI.

1775 Earthquake

Very little is known about this earthquake. This earthquake was severe in Dhaka with no loss of life (Rizvi, 1969, Banglapedia, 2003).

1787 Earthquake – Sirajganj

The earthquake of 1787 changed the course of the rivers and the ground shaking at the epicentral region was probably MM X. No report was available of the effect of this earthquake in Dhaka. However, from the level of physiographic changes at Sirajganj and Dhaka being 100 km away to the southeast, it may be said that the ground shaking intensity in Dhaka was MM VI to VII.

1812 Earthquake – Dhaka

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

1822 Earthquake – Kishoreganj

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

1842 Earthquake – Rajshahi

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

1845 Earthquake – Sirajganj

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

1846 Earthquake – Mymensingh

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

1865 Earthquake – Chittagong

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

1885 Earthquake – Bengal

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

1897 Earthquake – Great Indian

This earthquake is known as the Great Indian Earthquake and was triggered on 12 June 1897 at 17:11 BST. It is one of the most powerful and destructive earthquakes in recorded history. The quake was located in the western part of the Shillong Plateau about 200 km north of Dhaka. It probably originated from the reactivation of Dauki fault, (Szeliga et al., 2010), although Bilham and England (2001) place it on the Oldham fault on the north side of the Shillong Plateau. The magnitude is estimated from its surface effects and their spatial distribution suggests it was 8.7 on the Richter scale. The shock was preceded by a rumbling underground noise which lasted for about 3 minutes (Johnson, 1988). The actual earthquake lasted about two and a half minutes in Shillong. This noise was compared with the tremendous rumbling noise like a thousand ships' engines thumping away in the midst of a storm at sea. The shocks were so severe and prolonged that most buildings were leveled to the ground (Moore,

1910). The earthquake left an area of 3, 90,000 sq.km. In ruins and was felt over 6, 50,000 sq.km. From the Myanmar to Delhi, A large number of ground fissures and vents were observed. The epicentral area, including parts of Bangladesh, witnessed many secondary effects like ejection of water and sand, rotation of pillars, rise in river height, and liquefaction of soils and sinking of houses. Hundreds of aftershocks—some very heavy and some light—were felt in Dhaka over a period of two months. At Browder tea estate, a week after the great shock, the surface of a glass of water standing on a table was in a constant state of tremor. At Tura, a hanging lamp was kept constantly on the swing for three days. At least 1,626 people were killed. Extensive damage from shaking and liquefaction occurred in Assam, Meghalaya and Bangladesh (Oldham, 1899; Ambrose's and Balham, 2003). The great earthquake of 1897 did much damage in Dhaka city, but luckily it caused comparatively little loss of life. Ground fissures and sand veins were also occurred at many places in the city. The earthquake intensity at Dhaka was VIII+ on MM scale. Sheehan Medical Hall, a temple known as Nazir's Math, Shahbagh, and the house occupied by Mrs. Sainsbury – all collapsed and five persons were killed, including two foreigners, beneath the ruins, while nine other houses, including the residences of the Commissioner, the Collector, the Judge, and the Civil Surgeon, were rendered uninhabitable. The amount of damage to buildings published in the print media was different from the government statement.

1918 Earthquake – Srimangal

Often referred to as the Srimangal earthquake, this massive quake was centered 70 km southeast of Mymensingh and 100 km northeast of Dhaka near Kishorganj. It was preceded by a series of light to moderate foreshocks. The earthquake occurred at 4:22:07 pm local time and had a magnitude 7.6 on the Richter scale. Its depth of focus was 14 km. The earthquake was strongly felt throughout Bangladesh and the degree of ground shaking in Dhaka was MM VII. The earthquake caused considerable damage to buildings in Dhaka.

1923 Earthquake – Meghalaya

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

1930 Earthquake – Dubri

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

1934 Earthquake – Bihar-Nepal

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

1935 Earthquake – Pabna

An earthquake of magnitude 5.9 on the Richter scale occurred on 21 March 1935 shook Dhaka moderately. The epicenter was centered in Pabna, 130 km west-northwest of Dhaka. It was widely felt in Bangladesh with MM intensity VI in Dhaka.

1943 Earthquake – Assam

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

1950 Earthquake – Assam

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

1954 Earthquake – Monipur-Myanmar Border

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

1977 Earthquake – Bangladesh-Myanmar Border

A moderate earthquake occurred on 12May 1977 at 18:20:00 BST with magnitude of 5.7 on the Richter scale that jolted Dhaka with MM intensity III. The epicenter of the quake was located 340 km southeast

of Dhaka near Bangladesh-Myanmar border with focal depth of 40 km. It was strongly felt at Bandarban where people attending a political rally rushed outdoors in panic. Many buildings in Chittagong developed cracks and numerous people were injured, some after jumping from buildings.

1988 Earthquake – Bihar-Nepal

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

2001 Earthquake – Dhaka

The residents of Dhaka city experienced two consecutive shocks in a second. The first shock was due to the arrival of P-wave followed by the arrival of S-wave as second shock. This was an earthquake triggered at the southern periphery of the city. The earthquake occurred on 19 December 2001 at 1:54:07 pm local time. The epicenter was centred 11 km south of Curzon Hall across the Burigonga River at Kalakandi. The earthquake had magnitude estimated 4.5 on the Richter scale and had hypocentral depth of about 10 km. The duration of shaking was 21 seconds. The earthquake was felt at Narayanganj, Munshiganj, Chittagong, Comilla, Dhaka, Laxmipur, Rajshahi and as far as Rangpur. Strong tremors were felt (MM V-VI) in Dhaka city, and many people rushed out of their homes and offices in panic.

2003 Earthquake – Borkol

It is known as the Borkol earthquake, occurred in the early morning of 27 July 2003 at 5:18:17 am local time. This quake killed three people, injured 25 people and damaged about 500 buildings in Chittagong and the Chittagong Hill Tracts. Power supply to some areas was cut as a transformer exploded at the Modunaghat Grid Sub-station in Hathazari, Chittagong. The epicenter was situated 217 km southeast of Dhaka at the eastern bank of Kaptai reservoir. It had a magnitude measured Mw 5.7. Dhaka shook with MM intensity IV. Many people were awakened, especially residents of upper floors of high rise buildings.

2004 Earthquake – Sumatra

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

2008 Earthquake – Manikganj

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

2008 Earthquake – Mymensingh

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

2008 Earthquake – Chandpur

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

2009 Earthquake – Bhutan

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

2009 Earthquake – Bay of Bengal

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

6.4 Ambient Air Quality

Air quality in Gazipur (Dhaka Division) and adjacent industrial areas is worsening day by day. Basically effects from the manmade occurrence along with some natural calamities are causing this condition of air quality. As a process of development, activities like burning fuel, industrial production process, construction work, transportation facility are causing this damage to air quality. Though still the air quality of the rural area of Bangladesh still comparatively good, but expanding industrial areas in rural areas will not let this situation to stay long. It is assumed that accepting the small areas near the urban growth center air quality in the most of the area would be far below the Environmental Quality Standards of Bangladesh. Recent air quality data collected from the site is given in Table 4.10. It shows that the ambient air quality in terms of major three ambient air quality indicators SPM, NOx and SOx, is considered to quite good and still has reasonable buffer/assimilation capacity to absorb air pollutants to a certain extent. These are within the prescribed limit of the National Air quality Standards.

Test Result:

Table 6.11: Ambient Air Quality

Description	Ambient Air Pollution Concentration Limit (µg/m³)						
	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)	CO (µg/m³)	Temperature (°C)	Humidity (%)
Concentration present in North Side near boundary area	57	43	38	00	1230	32.2	74.0
Concentration present in South Side near boundary area	55	45	31	00	4930	33.0	70.8
Concentration present in East Side near boundary area	53	40	52	00	3700	32.9	72.7
Concentration present in West Side near boundary area	44	34	49	00	4930	33.8	67.3

Standard Requirement:

Description	Ambient Air Pollution Concentration Limit (µg/m³)						
	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)	CO (µg/m³)	Temperature (°C)	Humidity (%)
Air Quality Standard, (Bangladesh Gazette from the department of Environment & Forest, 2005)	150	65	365	100	10000	NF	NF
IFC/World Bank Standard	50	25	150	NF	NF	NF	NF
World Health Organization (WHO)	150	75	500	200	NF	NF	NF
EPA Standard	150	35	100	100	10000	NF	NF

Abbreviation **:** SPM (Suspended Particulate Matter), PM10 (Respirable Dust Content), PM2.5 (Fine Particulate Matter), SO2 (Sulphur-Di-Oxide), NO_x (Oxides of Nitrogen), CO (Carbon Monoxide), DoE (Department of Environment), WB (World Bank), NF (Not Found).

Main building

Recent indoor air quality data collected from the main building of the factory and the data given in Table 6.11 which shows that the indoor air quality. In terms of air quality parameter it is considered to quite good in every section of the factory.

Test Result:

Table 6.12: Indoor Air Quality

Description	Indoor Air Pollution Concentration Limit (µg/m³)						
	$PM_{2.5}$ (µg/m³)	PM_{10} (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)	CO (µg/m³)	Temperature (°C)	Humidity (%)
Sewing section (1st floor)	36	49	10	13	2470	32.7	65.0
Packing section (1st floor)	37	51	14	09	3015	32.8	64.1
Trimming & Mending section (1st floor)	34	45	17	07	3920	32.5	65.6
Iron section (1st floor)	36	50	13	11	4110	33.1	65.6
Finishing section (1st floor)	35	51	15	08	3075	32.6	62.9

Sample section (2nd floor)	29	42	11	16	2804	33.2	63.9
Winding section (2nd floor)	35	60	19	13	3170	32.4	62.6
Linking section (2nd floor)	32	40	21	14	4286	32.4	64.2
Sewing section (3rd floor)	37	61	14	13	2938	32.2	64.0
Packing section (3rd floor)	34	46	16	10	2810	31.7	67.1
Trimming & Mending section (3rd floor)	36	48	11	07	3659	31.4	64.5
Iron section (3rd floor)	41	59	19	11	3795	32.6	68.3
Finishing section (3rd floor)	32	47	13	08	3355	31.8	66.4
Manual Knitting section (4th floor)	32	44	21	14	4270	30.6	72.7
Office room (5th floor)	25	47	14	00	2451	29.2	53.4
Jacquard section (5th floor)	27	54	11	06	2980	30.0	58.5
Manual Knitting section (6th floor)	40	54	14	00	00	29.7	69.6
Jacquard section (7th floor)	26	46	22	00	2230	29.7	57.9
Ground floor							
Washing section	32	43	16	20	4208	33.5	63.4
ETP section	41	53	09	05	2870	30.7	70.5
Boiler room	32	44	12	15	3286	33.7	60.6
Generator room	53	105	15	13	4689	32.0	65.7
Fabric store	35	48	13	10	2658	32.8	63.6
Chemical store	36	47	14	11	2640	33.8	61.1
Medical room	24	31	00	00	2017	30.9	50.3

Standard Requirement:

Description	Indoor Air Pollution Concentration Limit (µg/m³)						
	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)	SO_2 (µg/m³)	NO_x (µg/m³)	CO (µg/m³)	Temperature (°C)	Humidity (%)
Air Quality Standard, (Bangladesh Gazette from the department of Environment & Forest, 2005)	150	65	365	100	10000	NF	NF

IFC/World Bank Standard	50	25	150	NF	NF	NF	NF
World Health Organization (WHO)	150	75	500	200	NF	NF	NF
EPA Standard	150	35	100	100	10000	NF	NF

Abbreviation **:** SPM (Suspended Particulate Matter), PM_{10} (Respirable Dust Content), $PM_{2.5}$ (Fine Particulate Matter), NO_x (Oxides of Nitrogen), DoE (Department of Environment), WB (World Bank), NF (Not Found).

6.5 Noise

Noise is an important part of the environment. The World Bank and Bangladesh has different recommended value for noise standard.

Table 6.13: The test result for noise level assessment

Sl. No.	Sample Location	Concentration Present (LA_{eq}) dBA
1.	Sewing section (1st floor)	71.2
2.	Packing section (1st floor)	66.9
3.	Trimming & Mending section (1st floor)	63.5
4.	Iron section (1st floor)	66.3
5.	Finishing section (1st floor)	65.0
6.	Sample section (2nd floor)	68.7
7.	Winding section (2nd floor)	64.7
8.	Linking section (2nd floor)	67.6
9.	Sewing section (3rd floor)	69.4
10.	Packing section (3rd floor)	61.5
11.	Trimming & Mending section (3rd floor)	62.4
12.	Iron section (3rd floor)	64.6
13.	Finishing section (3rd floor)	62.3
14.	Manual Knitting section (4th floor)	67.5
15.	Office room (5th floor)	54.2
16.	Jacquard section (5th floor)	70.1
17.	Manual Knitting section (6th floor)	68.8
18.	Jacquard section (7th floor)	69.2
19.	Washing section	71.0
20.	ETP section	72.8
21.	Boiler room	84.9
22.	Generator room	**102.55**

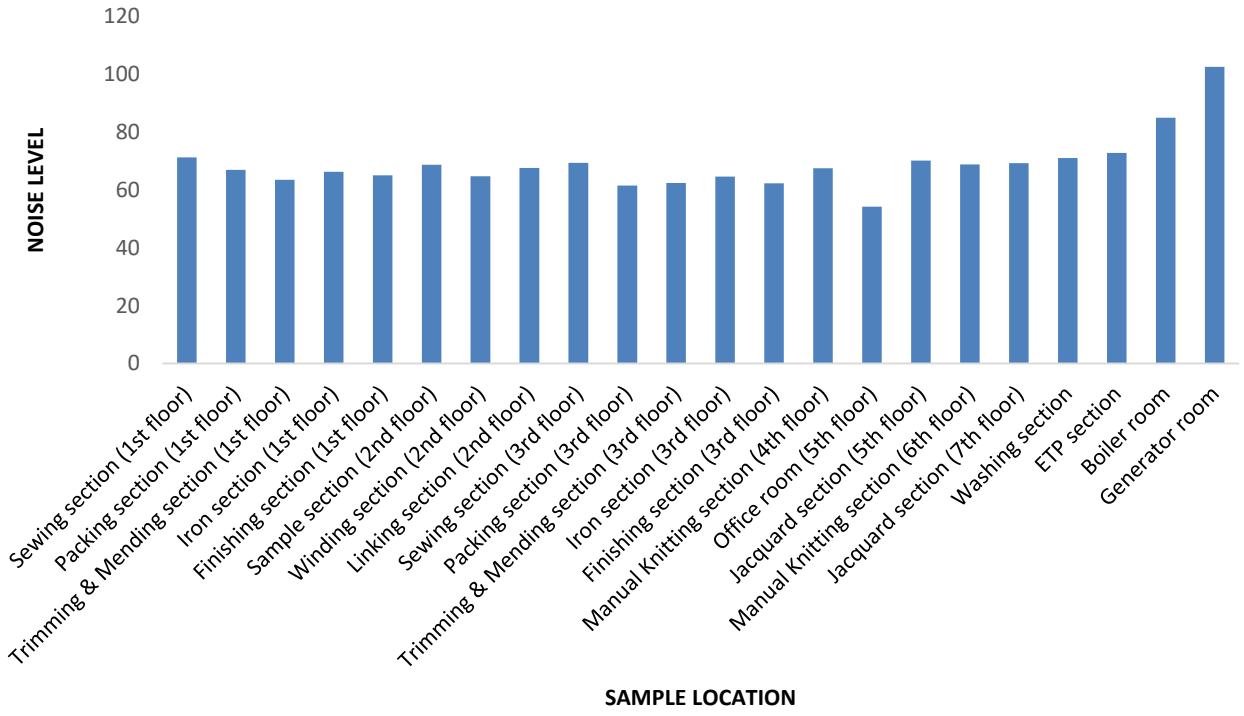


Figure 6.7: Noise level at different areas of the factory

Standard Requirement:

According to the Environment Conservation Rules 1997 in industrial area noise level should be 75 dBA at day time and 70 dBA at night time. World Health Organization (WHO) standard is 85 dBA for indoor workplace area.

World Bank Reported value (dBA) for 8 hours exposure = 85 dBA (Day & Night) DoE recommended value (dBA) for 8 hours exposure= 75 dBA (Day) and 70 dBA (Night).

6.6 Water Quality

As Indesore sweater Ltd. basically a sweater factory therefore it uses water mainly for washing purpose. For this purpose water is collected from the ground water. Indesore sweater Ltd. use ground water sources for this purpose. Ground water level exists at a moderate (Generally below 8.0 m) depth, which is being recharged mainly by infiltration of rainwater. According to Bangladesh Water Development Board the ground water level of Dhaka is about 35.5 m. The ground water zoning map is shown in Figure 6.9. Ground water is the source of water for domestic use in this area. Water from underground source, which is assumed to be available as because most of the period of the year the area remains under water and there is a canal passing by the side of the site. That means the recharge capacity of the ground water level seems to be adequate.

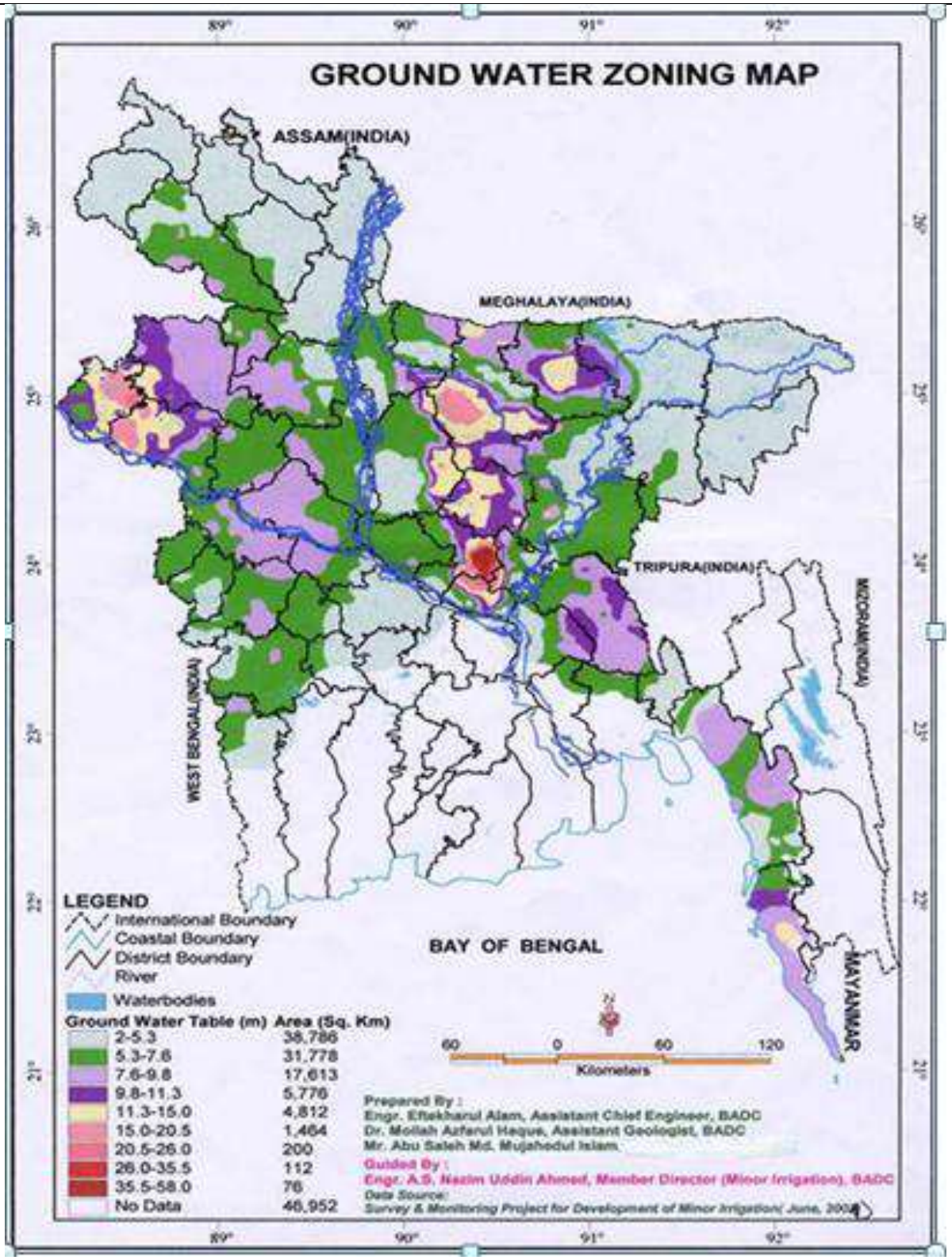


Figure 6.8: Ground Water Zoning Map of Bangladesh

Chapter Seven
Environmental Impacts and Mitigations

7.1 Land acquisition

Indesore sweater Ltd. has total land area 0.92 acre, located in 23.9630714 north latitudes and in 90.39626320000002 east longitudes. Total 0.92 acre land area & Industries building won by Indesore sweater Ltd. authority.

7.2 Traffic

The access way of the factory is very simple. The convenient route of the factory is Dhaka city bypass which is situated in east side of the factory. Indesore sweater Ltd. is just 12.93 km distance from Dhaka International Airport.

Hence, no new road has been required for the factory and per day a huge amount of traffic moves by the highway, so the transport of the factory has no significant impact on traffic.

7.3 Drinking Water and Sanitation

As the factory is an export oriented sweater factory, water is used mainly in the washing and domestic purposes. The water is collected from the underground. And the waste water is treated by ETP before discharged. So, there is no scope of ground water pollution by the factory. Water is tested by the factory in regular interval and the test report is found satisfactory. Sanitation system is well equipped and monitored by the administration. All the human waste are stored in the septic tank and treated there.

Mitigation measures

For the generation of waste water the factory has installed an Effluent treatment Plant and the design for treating the waste water has been set according to the regulation of ECR' 97. The waste water has been tested regularly from different laboratories and found satisfactory. But these measures should be maintained continuously. If any deviation found from the accepted value, the design and treatment process should be revised.

7.4 Accidents or Occupational Health Hazard

Impact Origin

Under controlled situation, accident is not expected. However, occasionally it occurs during operational works. Accident may occur during chemical use, manual knitting, finishing works and many others machineries works. The protection of head, eye, ear, and hand, foot of the workers, laborers and office personnel could be affected if proper and adequate arrangement is not ensured.

Mitigation Measures

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

7.5 Impact due to Solid Waste

Impact Origin

Factory is producing a small amount of solid waste like plastic barrel, plastic drum, plastic jar, metallic, plastic, light, paper waste, medical waste, sludge and many more. Waste is stored in organized way in the store.

Mitigation Measures

Some solid Waste like plastic wastes has tremendous secondary demand and sold to the secondary dealers. Other solid wastes are disposed to the safe places carefully.

7.6 Impact on Air quality

Impact Origin

Emission from the generator and other production processes stack may affect the ambient air quality. The situation aggravates when gas contains high percentage of impurities like sulfur, hydrocarbon, etc. The combustion of fossil fuels for power Generation inevitably results in emission of gaseous pollutants to the atmosphere. Each of these pollutants is examined below to ensure the Bangladesh emission limit, where appropriate, the required emission control techniques would be incorporated into the mitigation measures.

Sulphur di-Oxide (SO2) Emissions from the power plant

The emissions of SO2 are dependent on the sulfur content of the gas. As the Bangladeshi indigenous natural gas is almost free from Sulphur and particles so there would be no emission of Sulphur di-Oxide from the generator. Moreover from the test report of the air emission from the generator stack it shows that the amount of Sulphur Di-oxide (SO_2) is less than the acceptable limit.

Nitrogen Oxides (NOx) Emissions from the Factory

In the generator, electricity is produced using lean burn mixture of air and gas in the cylinder i.e. more air will be present in the cylinder than required for complete combustion. From the test report of the air emission from the generator stack it shows that the amount of Nitrogen oxide is less than the maximum allowable limit by World Bank. So in this case there will be no significant harm on the ambient air quality.

Carbon monoxide and carbon dioxide Emissions from the Generator

Carbon monoxide is generated when incomplete combustion takes place. The emission of carbon dioxide depends on the fuel burn and the carbon content in the fuel. The Generator of the factory is a gas fires modern design with optimum designed cycle efficiency in order to maximize the MW output and less consumption of natural gas and water, CO & CO2 emission per unit of fuel burnt will be smaller amount compare to other old generator.

In the table, the stack source air emission quality test result is shown

Description	Stack Air Emission Concentration Limit								
	SPM (µg/ m^3)	SO_2 (µg/ m^3)	NO (µg/m ^{3})	CO (µg/ m^3)	NO_2 (µg/m ^{3})	CO_2 (%)	O_2 (%)	Ambient Temperature (°C)	Flue Gas Temperature (°C)
Diesel Generator-1 660 kVA Model:	227	182	26020	3922	00	1.69	18.29	36.1	314

P660-1 Brand: FG Wilson									
Diesel Generator-2 660 kVA Model: P660-1	214	165	22660	4176	00	1.74	18.23	34.8	250
Gas Boiler-1 Model: 107936 Capacity: 1 ton Origin: USA	126	00	14830	6464	00	9.38	2.07	33.8	328
Gas Boiler-2 Model: 107937 Capacity: 1 ton Origin: USA	118	00	16650	5130	00	8.40	2.11	33.3	298

Standard Requirement :

Description	Stack Air Pollution Concentration Limit (µg/m³)								
	SPM (µg/m³)	SO_2 (µg/m³)	NO (µg/m³)	CO (µg/m³)	NO_2 (µg/m³)	CO_2 (%)	O_2 (%)	Ambient Temperature (°C)	Flue Gas Temperature (°C)
Department of Environment (DoE)/Environment Conservation Rules, 1997	350	NF	NF	NF	NF	NF	NF	NF	NF

1. Suspended Particulate Matter (SPM), PM2.5, PM10

The most common pollutant involved in fugitive emissions is dust or particulate matter (PM). This is released during certain operations, such as transport and open storage of solid materials, and from exposed soil surfaces, including unpaved roads.

Particulate matter," also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. USEPA, EHO and DoE are concerned about particles that are 10 micrometers in diameter or smaller because those are the

particles that generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects. Particle pollution has been grouped into two categories:

"Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.

"Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

2. Oxygen (O_2)

Many major classes of organic molecules in living organisms, such as proteins, nucleic acids, carbohydrates, and fats, contain oxygen, as do the major inorganic compounds that are constituents of animal shells, teeth, and bone. Most of the mass of living organisms is oxygen as it is a part of water, the major constituent of life forms (for example, about two-thirds of human body mass). Elemental oxygen is produced by cyanobacteria, algae and plants, and is used in cellular respiration for all complex life.

Oxygen is an important part of the atmosphere, and is necessary to sustain most terrestrial life as it is used in respiration. However, it is too chemically reactive to remain a free element in Earth's atmosphere without being continuously replenished by the photosynthetic action of living organisms, which use the energy of sunlight to produce elemental oxygen from water.

The combustion of a carbon-based fuel consumes oxygen. The 21% oxygen content present in the combustion air that is fed to a furnace will be depleted to some lower level in the exhaust gas. The interpretation clause of IPPC licenses typically require emission data to be reported at reference oxygen conditions that are defined according the fuel type, for example:

- Gas and liquid fuels 3% ref O2
- Solid fuels 6% ref O2
- Waste incineration 11% ref O2
- Other fuels (e.g. fume thermal oxidizer):- The application of reference oxygen conditions will be determined on a case-by-case basis.
- Emissions from all sources: Temperature 273.15K, Pressure 101.325kPa (no correction for oxygen or water content). May apply to the wood panel industry, which have combustion plants as an integral part of the drying process and necessarily dilute with ambient air to affect control of the drying process.

3. Carbon Monoxide (CO)

Nature and Sources of the Pollutant

Carbon monoxide is a colorless, odorless, poisonous gas formed when carbon in fuels is not burned completely. It is a byproduct of highway vehicle exhaust, which contributes about 60 percent of all CO emissions nationwide. In cities, automobile exhaust can cause as much as 95 percent of all CO emissions.

These emissions can result in high concentrations of CO, particularly in local areas with heavy traffic congestion. Other sources of CO emissions include industrial processes and fuel combustion in sources such as Boiler/Generator s and incinerators. Despite an overall downward trend in concentrations and emissions of CO, some metropolitan areas still experience high levels of CO.

Health and Environmental Effects

Carbon monoxide enters the bloodstream and reduces oxygen delivery to the body's organs and tissues. The health threat from exposure to CO is most serious for those who suffer from cardiovascular disease. Healthy individuals are also affected, but only at higher levels of exposure. Exposure to elevated CO levels is associated with visual impairment, reduced work capacity, and reduced manual dexterity, poor learning ability, and difficulty in performing complex tasks. EPA's health-based national air quality standard for CO is 9 parts per million (ppm) measured as an annual second-maximum 8-hour average concentration.

4. Nitrogen Dioxide (NO_2)

Nature and Sources of the Pollutant

Nitrogen dioxide belongs to a family of highly reactive gases called nitrogen oxides (NOx). These gases form when fuel is burned at high temperatures, and come principally from motor vehicle exhaust and stationary sources such as electric utilities and industrial Boiler/Generator s. A suffocating, brownish gas, nitrogen dioxide is a strong oxidizing agent that reacts in the air to form corrosive nitric acid, as well as toxic organic nitrates. It also plays a major role in the atmospheric reactions that produce ground-level ozone (or smog).

Health and Environmental Effects

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza. The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. EPA's health-based national air quality standard for NO_2 is 0.053 ppm (measured as an annual arithmetic mean concentration). Nitrogen oxides contribute to ozone formation and can have adverse effects on both terrestrial and aquatic ecosystems. Nitrogen oxides in the air can significantly contribute to a number of environmental effects such as acid rain and eutrophication in coastal waters like the Chesapeake Bay. Eutrophication occurs when a body of water suffers an increase in nutrients that leads to a reduction in the amount of oxygen in the water, producing an environment that is destructive to fish and other animal life.

5. Carbon Dioxide (CO_2)

Nature and source of pollutant

Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities. In 2012, CO_2 accounted for about 82% of all U.S. greenhouse gas emissions from human activities. Carbon dioxide is naturally present in the atmosphere as part of the Earth's carbon cycle (the natural circulation of carbon among the atmosphere, oceans, soil, plants, and animals). Human activities are altering the carbon cycle—both by adding more CO_2 to the atmosphere and by influencing the ability of natural sinks, like

forests, to remove CO_2 from the atmosphere. While CO_2 emissions come from a variety of natural sources, human-related emissions are responsible for the increase that has occurred in the atmosphere since the industrial revolution.

The main human activity that emits CO2 is the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportation, although certain industrial processes and land-use changes also emit CO_2.

Health and Environmental Effects

Since the industrial revolution in 1850 began, human processes have been causing emissions of greenhouse gasses, such as CFC's and carbon dioxide. This has caused an environmental problem: the amounts of greenhouse gasses grew so extensively, that the earth's climate is changing because the temperatures are rising. This unnatural addition to the greenhouse effect is known as global warming. It is suspected that global warming may cause increases in storm activity, melting of ice caps on the poles, which will cause flooding of the inhabited continents, and other environmental problems.

Together with hydrogen, carbon dioxide is the main greenhouse gas. However, hydrogen is not emitted during industrial processes. Humans do not contribute to the hydrogen amount in the air, this is only changing naturally during the hydrological cycle, and as a result it is not a cause of global warming.

Increasing carbon dioxide emissions cause about 50-60% of the global warming. Carbon dioxide emissions have risen from 280 ppm in 1850 to 364 ppm in the 1990s.

6. Nitric Oxide (NO)

Nitric oxide, or nitrogen oxide, also known as nitrogen monoxide, is a molecule with chemical formula NO. It is a free radical and is an important intermediate in the chemical industry. Nitric oxide is a by-product of combustion of substances in the air, as in automobile engines, fossil fuel power plants, and is produced naturally during the electrical discharges of lightning in thunderstorms.

Nitric oxide in the air may convert to nitric acid, which has been implicated in acid rain. However, it is an important source of nutrition for plant life in the form of nitrates. Furthermore, both NO and NO2 participate in ozone layer depletion. Nitric oxide is a small highly diffusible gas and a ubiquitous bioactive molecule.

7. Nitrogen Oxides (NO_x)

Nature and Source of pollutant

NOx is a generic term for the mono-nitrogen oxides NO and NO2 (nitric oxide and nitrogen dioxide). They are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. In areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere as air pollution can be significant. NOx gases are formed whenever combustion occurs in the presence of nitrogen – as in an air-breathing engine; they also are produced naturally by lightning. In atmospheric chemistry, the term means the total concentration of

NO and NO2. NOx gases react to form smog and acid rain as well as being central to the formation of tropospheric ozone.

Health and Environmental Effects

NOx reacts with ammonia, moisture, and other compounds to form nitric acid vapor and related particles. Small particles can penetrate deeply into sensitive lung tissue and damage it, causing premature death in extreme cases. Inhalation of such particles may cause or worsen respiratory diseases, such as emphysema or bronchitis, or may also aggravate existing heart disease.

NOx reacts with volatile organic compounds in the presence of sunlight to form ozone. Ozone can cause adverse effects such as damage to lung tissue and reduction in lung function mostly in susceptible populations (children, elderly and asthmatics). Ozone can be transported by wind currents and cause health impacts far from the original sources.

NOx destroys ozone in the stratosphere. Ozone in the stratosphere absorbs ultraviolet light, which is potentially damaging to life on earth. NOx from combustion sources does not reach the stratosphere; instead, NOx is formed in the stratosphere from photolysis of nitrous oxide.

NOx also readily reacts with common organic chemicals, and even ozone, to form a wide variety of toxic products: nitroarenes, nitrosamines and also the nitrate radical some of which may cause biological mutations. Recently another pathway, via NOx, to ozone has been found that predominantly occurs in coastal areas via formation of nitric chloride when NOx comes into contact with salt mist.

8. Sulfur Dioxides (SO_2)

Nature and Sources of the Pollutant

Sulfur dioxide belongs to the family of gases called sulfur oxides (SOx). These gases are formed when fuel containing sulfur (mainly coal and oil) is burned, and during metal smelting and other industrial processes.

Health and Environmental Effects

The major health concerns associated with exposure to high concentrations of SO_2 include effects on breathing, respiratory illness, alterations in pulmonary defenses, and aggravation of existing cardiovascular disease. Children, the elderly, and people with asthma, cardiovascular disease or chronic lung disease (such as bronchitis or emphysema), are most susceptible to adverse health effects associated with exposure to SO_2. EPA's health-based national air quality standard for SO_2 is 0.03 ppm (measured on an annual arithmetic mean concentration) and 0.14 ppm (measured over 24 hours). SO_2 is a precursor to sulfates, which are associated with acidification of lakes and streams, accelerated corrosion of buildings and monuments, reduced visibility, and adverse health effects.

Discussion and Recommendation

Indesore sweater Ltd. has two generators and two boilers in running condition. INTERTEK has tested all required air quality parameter according to the Department of Environment (DoE), EPA and World Health Organization (WHO). According to the test result the findings are given below:

1. Suspended Particulate Matter (SPM), PM2.5, and PM10 present in the stack found within the acceptable limit for Generator and boiler.
2. The amount of Oxygen, CO, CO_2, NO_2, NO, SO_2 for indoor air quality and ambient air quality found within the acceptable limit according to the DoE and other international standards.
3. Noise level in different location of the facility and different production processes found within acceptable limit. Only in generator and boiler room noise level was found in high concentration.

For obtaining above result the recommendation are given below:

1. Factory has to maintain proper Stack Height.
2. Factory has to check Air emission quality regularly.
3. Facility should ensure ear muff for the boiler and generator operator.

Factory is suggested to assess the Air emission Quality every six month interval at least if all other set up are constant.

Mitigation measures

From the air emission test report it is clearly shown that the effect from the generator, production machines and others of Indesore sweater Ltd. is significant in context of air pollution. Most of the parameter for all emitted gases is under the maximum allowable limit from Department of Environment Bangladesh and International and World Bank except CO & NO. Factory has to check the quality of the emitted gasses after regular interval, to monitor the performance of generator. If in any case the result found that the emitted air doesn't comply with the any standard mitigation measures has to be taken according to the situation.

Residual Impact

It is clear from above study that the factory already meets the most of the national standards. Adoption of measures set out above is not expected to provide total mitigation, because no machine works at 100% efficiency. After adopting proper mitigation measures while it will be deviated from national/international standards, Indesore sweater Ltd. will emit some residual pollutants, which can affect the environment in the long run. On the other hand, if other industries located in the area, emits air meeting the national requirement as Indesore sweater Ltd. the cumulative residual pollutants will create an adverse situation in the ambient air quality. So, this situation can be overcome by determining the exact level of treatment and maintaining it by following the management plan properly, which is required to maintain the normal ambient air quality of the area.

7.7 Impact due to Liquid Discharge

Indesore sweater Ltd. use water for different purposes. So the waste water discharge from washing process, and for domestic purposes which has some significant impact for this factory. This wash water contain significant amount of pollution, which may impact the surface water quality. Therefore, this will have to be treated by effluent treatment plant.

Test result from BUREAU VERITAS Laboratory

Sample Location	Date	pH	TSS (mg/L)	BOD (mg/L)	COD (mg/L)
Outlet of ETP	14.05.2017	7.3	7.0	27	76
Bangladesh Standard for Waste Water From industrial units, discharge to inland surface water as per ECR 1997		6.5-9.0	NF	≤50	≤200.0

Note: - BOD_5 temperature at 20^0c.

Biochemical Oxygen demand (BOD)

The strength of the wastewater is often determined by measuring the amount of oxygen consumed by microorganism like bacteria in biodegrading the organic matter. The measurement is known as the Biochemical Oxygen Demand (BOD). Microorganisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, cellulose components, manure, sewage, organic waste like dyes, fats and oils, or even food waste is present in a water supply, the bacteria will begin the process of breaking down this waste. When this happens, bacteria in aerobic process, robbing other aquatic organisms of the oxygen they need to live, consume much of the available dissolved oxygen.

If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) so the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.

Nitrogen and phosphates in a body of water can also contribute to high BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level. The temperature of the water can also contribute to high BOD levels. For example, warmer water usually will have a higher BOD level than colder water. As water temperature increases, the rate of photosynthesis by algae and other plant life in the water also increases. When this happens, plants grow faster and also die faster. When the plants die, they fall to the bottom where they are decomposed by bacteria. The bacteria require oxygen for this process so the BOD is high at this location. Therefore, increased water temperatures will speed up bacterial decomposition and result in higher BOD levels.

When BOD levels are high, dissolved oxygen (DO) levels decrease because the bacteria are consuming the oxygen that is available in the water. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. Textile mill wastewater possesses a very high BOD like 400 – 600 mg/l. It is necessary to reduce this BOD value up to a level less than 30 mg/l before discharging them into the environment like canals or rivers. If a water body of high BOD is discharged into the sea or very large river then off course the concentration of BOD decreases due to dilution and has little or no harmful effect on the aquatic life or environment. Therefore if it is possible to discharge a highly toxic effluent in sea or large river no treatment is necessary.

Though it was not mentioned, the dissolved oxygen (DO) is a highly significant parameter to define the BOD or COD of a wastewater. The amount of oxygen present in a certain amount of water in dissolved state is known as DO. It is normally expressed as mg/l. Water may contain DO ranging from 0 to 18 mg/l but in most cases of normal waters, DO lies between 7-9 mg/l. Aquatic lives require certain level of DO to survive in the water. In case of wastewater the microorganisms require oxygen to consume the organic wastes. As a result the DO of water decreases tremendously and becomes a threat to the life of aquatic species. Textile effluents possess very low DO, which is unsuitable for discharging to the environment. During treatment of wastewater air is blown through the effluent when oxygen is dissolved in the effluent as a result DO level raises and as the DO increases the BOD/COD decreases.

Chemical Oxygen Demand (COD)

This is a means of measuring the ability of wastewater to sustain aquatic life, essential for the preservation of the environment. It also enables proper assessment of treatment plant performance. Aquatic organisms and animals require dissolved oxygen to flourish. The Chemical Oxygen Demand (COD) test gives an indication of the impact of discharge waters on aquatic life by measuring the oxygen depleting nature of the discharge water.

COD is based on the fact that nearly all-organic compounds can be fully oxidized to carbon dioxide with a strong oxidizing agent under acidic condition. COD is another common measure of water-borne organic substances — the process of measuring COD causes the conversion of all organic matter into carbon dioxide. For this reason, one limitation of COD is that it cannot differentiate between biologically active and those which biologically inactive. One major advantage of COD over BOD is that COD can be measured in just three hours whereas BOD measurement takes at least five days. The value of COD is always higher than BOD, this is because BOD accounts for only biodegradable organic compounds while COD accounts for all organic compounds e.g. biodegradable as well as no biodegradable but chemically ox disable.

Sludge

The settable solids separated from the liquid during sedimentation (clarification). The sludge is very toxic in nature and needs to be dealt with very carefully. Under no circumstances it should be mix with the environment again.

Mitigation Measures

The domestic liquid waste is disposed through a septic tank with a soak pit. The factory has a planned drainage system to discharge the surface runoff. The surface drainage network is connected with an interceptor prior to discharge through natural water. The interceptor traps all oily matter present in the water. Apart from that the waste water from production floor has to be treated through Effluent Treatment Plant.

Residual Impact

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

7.8 Noise and Vibration Impacts

Impact Origin

Noise level must has to be less than 85 dBA because working under a condition more than 85 dBA is harmful for health in short and long term. Mainly personnel working at the Generator and Compressor section is at high risk because the noise level found higher than the acceptable limit of both Department of Environment Bangladesh (DoE) and World Health Organization. So the following recommendations are suggested to reduce the adverse effect:

Mitigation measures

To reduce the noise from generator& boiler, Indesore sweater Ltd. has built separate room for generator which has been constructed with 150mm thick wall which will reduce the noise level 60 dBA. So, the noise level will be reduced to 60 dBA. So it will be within the standard limit of World Bank and DoE. Moreover INTERTEK team also measured the noise level of the outside of generator room in different distance. The test result was found high in the generator and boiler room. Therefore, facility should aware the operators to wear ear muff in running condition.

Residual Impact

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

Table 7.1: Evaluation matrix showing various impacts from the facility

PROBABILITY	SEVERITY		
	1x1=1	1x2=2	1x3=3
	2x1=2	2x2=4	2x3=6
	3x1=3	3x2=6	3x3=9

Impact Level *Based on Impact Priority Number (IPN)* *Minor= A* *1 - 3*

IPN=PxS

Moderate= B	4 - 6
Major= C	8- 9

Process/ Location	Environmental Aspect	Environmental Impact	Probability (P)	Severity (S)	IPN (PxS)	Impact Level	Existing Mitigation Measures	Responsible Person for Implementing Control Measures
Raw Materials from Supply	• Yarn • Use of Chemicals	• Water pollution • Air pollution	1	2	2	A	Careful planning & design	Store Supervisor

Chemical store & wastage go-down	• Chemical Spillage	• Water pollution • Soil contamination	2	3	6	B	Proper health & safety management system & Proper emergency management system,	Chemical Store Supervisor/ Compliance dept.
Knitting Section	• Waste generation • Making Noise	• Climate Change • Atmospheric pollution	2	2	4	B	Mandatory ear Protection, Proper maintenance of machineries	Knitting machine operator/ Compliance dept.
Washing Section	• Electricity consumption • Making Noise • Liquid wastes	• Climate Change • Contamination of Air, Soil& Water	2	3	6	B	Proper Design of ETP and Septic Tank	Washing machine operator/ Compliance dept.
Finished Fabrics Store	• Electricity consumption • Dust particles	• No significant impact	1	1	1	A	Ensure proper Solid waste management facility	Store Supervisor

Sewing section	• Electricity consumption • Fabric dust • Making noise	• Contamination of air & Soil	2	2	4	B	Mandatory ear Protection, Proper maintenance of machineries	Sewing machine operator/ Compliance dept.
Finishing section	• Electricity consumption • Dust particles	• No significant impact	1	2	2	A	Ensure proper Solid waste management facility	Finishing store Supervisor/ Compliance dept.
Packing	• Electricity consumption • Dust particles	• No significant impact	1	2	2	A	Ensure proper Solid waste management facility	Packing store Supervisor/ Compliance dept.
Gaseous Emissions	• Dust particles • Making high noise	• Atmospheric pollution	2	3	6	B	Mandatory ear Protection, Proper maintenance of machineries	Generator and Boiler operator/ Compliance dept.

Chapter Eight
Environmental Management Plan

8.1 Introduction

In the context of a project, Environmental Management Plan (EMP) is concerned with the implementation of the measures necessary to minimize or offset adverse impacts and to enhance beneficial impacts. All the measures are said to be successful when they comply with the Environmental Quality Standard (EQS) of the host country in this case Bangladesh. Thus the objectives of EMP for the present project would be.

- Propose Mitigation measures to reduce or eliminate negative impacts
- Propose Enhancement measures to maximize positive impacts
- Define Monitoring requirement and Monitoring indicators
- Propose budgeting and allocation of funds for environmental management system

The EMP 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 Indesore sweater Ltd. could be divided into management and monitoring: (a) during construction phase, and (b) during operation phase. As the factory is now on operation phase only management and monitoring during operation phase will be discussed here.

8.2 Management in operation phase

Most of the environmental parameters will experience beneficial effects during the operation phase. Efforts should be made to enhance these beneficial impacts, which may include incentives for proper growth of industries in the area. The factory authority should be responsible for overall environmental management during operation phase of the factory. The environmental management during the operation phase should primarily be focused on addressing the following issues:

(a) Air quality

(b) Generation of noise

(c) Waste generation at the factory

Table 8.1 summarizes the potentially significant environmental impacts during operation phase, the measures needed to eliminate or offset adverse impacts and enhance positive impacts. Most of the mitigation and enhancement measures identified for operation phase.

Table 8.1: Potentially significant environmental impact during operation phase and mitigation measures for Indesore sweater Ltd.

Potential impacts	Risk Label			Proposed Mitigation and Enhancement Measures
	H	M	L	
On Neighbor & surrounding people			√	• Install adequate buffer zone. • Ensure adequate plantation in the buffer zone.
Ai pollution from dust & stack emission quality (Ref.: DoE,1997 & Environmental Court Act-2010)			√	• Proper stack height has to be maintained for generator. • Factory has to check air quality parameter regularly. • Ensure wearing of mask at printing, color mixing, finishing, generator etc.
Generation of noise (Ref.: Bangladesh Noise Pollution, 2006)			√	• Provision of silencers for generators • Planting of trees around the factory site • Regular maintenance • Regular noise monitoring • Use of ear-muffs and ear-plugs by factory personnel working in the generator facilities of the factory. • Built 150mm thick wall to separate generator room to reduce the impact of noise. • Provide proper PPE for the worker adjacent to Noise creating machine.
Waste Generation-Liquid & Solid (Ref.:National-3R Strategy for Waste Management & DoE,1997)			√	• Good housekeeping • Ensuring proper storage with separation, treatment, and disposal of all solid waste • Monitoring of waste management system periodically. • Train employees for proper waste management. • Lead acid battery should be back to the dealer. • Ensure proper dumpsite or sanitary landfill to dispose solid wastage. • Test the waste water from outlet and inlet of ETP regularly and maintain an inventory.
Odor (Ref.: DoE,1997)			√	• Ensure sealed container in the chemical store. • Wear proper mask, where necessary.
Traffic congestion			√	• Avoid carrying of materials in peak hour of road traffic
Employment (Ref.: Bangladesh Labor Law-2006 &			√	• Employ local people wherever possible to mitigate the diverse effect on their livelihood for using their land.

Rules-2015)				
Impact on health and Safety (Ref.: Bangladesh Labor Law-2006 & Rules 2015)			√	• Set up warning signs, signals and provide helmets for workers in accordance with relevant accident prevention and work safety procedure • Supply good quality drinking water to the workers • Provide well-planned sanitary facilities • Provide regular health inspection among workers • Promote health education campaign among workers
Impact on surface water quality (Ref.: ECR,1997)			√	• Dispose all domestic waste water through septic tank • Surface drainage should be disposed through an interceptor.

8.3 Environmental Monitoring Plan

8.3.1 Overview of Impacts and Mitigation Measures:

Indesore sweater Ltd. invariably has potential for environmental impacts during the operation of the factory. The following impacts are normally of most significant:

- Impacts on air quality;
- Impact on Water body
- Noise and vibration impacts
- Socio-economic impacts;

Over viewing of mitigation measures due to impacts arises from the operation of Indesore sweater Ltd. is atmospheric pollutant emissions, which are being controlled at source by the following mitigation measures:

- Sulfur dioxide- Very low concentration of sulfur in the gas fuel will ensure that the Bangladesh emission limits will be met.
- Nitrogen dioxide & Nitric oxide- Significant impact according to the National air quality limits.
- Carbon mono oxide-Significant impact according to the National air quality limits.
- A septic tank will be provided to ensure that waste water from domestic uses is treated properly.
- Environmental noise from generator, boiler will be controlled through separate room with thick wall and noise from a specific machine will be controlled by using PPE.
- Generated solid waste will be supplied to recycler and rest will be disposed properly.
- Generated Liquid waste will be treated by effluent treatment plant.

Table 8.2: Monitoring plan during operational phase of the factory

Issue	Monitoring Place	Monitoring Parameters	Monitoring Frequency	Responsibility
Solid Wastes	Production processes-Finishing, store, wastage go-down, chemical go-down etc.	Finishing material, weight etc.	Daily.	Process owners, EHS Team, Admin.
Meteorological measurements	All the corners of the facility area, inside production area	Wind direction and speed, temperature, humidity and precipitation.	Yearly	EHS Team, admin, external.
Ambient air in the work place	All the production processes.	Quality CO, NOx, PM10, PM2.5, SO2,	Quarterly	EHS Team, Admin., External
Groundwater	From underground source	pH, Color, Turbidity, TDS, Ammonia, Nitrate, Phosphate, As, Fe , Mn and Coli forms;	Yearly	EHS Team, Admin. External
Industrial Waste water	Production processes-Printing, Washing etc.	pH, BOD, COD, TDS, TSS, DO	Quarterly	EHS Team, Admin., External
Noise level	Working place	Noise at different locations	Quarterly	EHS Team, Admin., External
Occupational health and safety	Production processes, maintenance work, chemical process,	Health status and safety	Yearly.	EHS Team, Admin.

8.3.2 Atmospheric Emission Management

The combustion of fossil fuels for power generation of the factory inevitably results in emission of gaseous pollutants to the atmosphere. As the power generator of the factory is fired with Diesel, the pollutants of potential concern are only oxides of nitrogen (NO & NO_2) and carbon dioxide (CO_2). The exhaust gas extraction and analysis facilities as well as the data acquisition and processing facilities is designed in accordance with the requirements of Bangladesh Legislation. When the generator starts operation, gaseous emissions are released to the atmosphere through the stacks. The proponent will take necessary step to minimize the emission level to meet the national standards of Bangladesh-

a) Indesore sweater Ltd. should take appropriate measure to mitigate the impact by maintaining proper stack height, for generator this could be determined applying the thumb rule that, the stack height is

taken as height of the building where generator is installed plus 0.2 times of square root value of generator capacity in kVA. **(H=h+0.2√kVA).**

b) Ensure BERC license are updated & kept in place in the facility.
c) Develop renewable energy source to reduce GHG emission.
d) Long term Plan: Verify efficiency level for generator by conducting energy efficiency audit as per the guideline of BERC.
e) Long term plan: Install renewable energy of 10% of the total electricity consumption of the facility may introduce for using power for emergency lighting system as per guide line of energy regulatory commission.(Ref.: BERC, 2006)

8.3.3 Management of Solid Wastes

The Indesore sweater Ltd. authority will have their solid waste collection and disposal system in place to abate the pollution from the solid waste. The solid waste which has secondary demand will be sold to the local traders after inspection and other waste will be properly managed and disposed of off-site. Therefore, no significant ecological impacts arising from solid waste management are anticipated.

a. Indesore sweater Ltd. should take an effective care to mitigate significant impact from chemical warehouse. (ECR 1997).

b. Indesore sweater Ltd. should take appropriate measure in segregation & disposal of wastes and conducting agreement with third party.

c. Contractor assigned in disposal activities must bear license from the concern authority for handling all wastages of Medical, Battery, Plastic container, printing wastages etc.
d. Indesore sweater Ltd. should monitor activities of the third party while performing disposal activities. (National 3R Strategy Clause 2.2 & 2.3).

e. Long term Plan- Indesore sweater Ltd. should consider recycling of wastage by installing recycle plant to meet National 3R strategy, 2006.

8.3.4 Liquid Waste Management

All domestic sewage will be treated in a septic tank. The treated water will be discharged through soak pit. Other than, all waste water from production process has to be treated through Effluent treatment plant and the parameters of the inlet and outlet of ETP has to be checked in a periodical basis.

a. Indesore sweater Ltd. need to check industrial waste water at inlet & outlet quarterly.

b. The operators those are involved in the operations of effluent treatment plant need to be certified, trained.

c. Indesore sweater Ltd. should recycle outlet water of the ETP to reduce ground water depletion.

d. The sludge generated from the effluent treatment plant should be accumulated/ exposed/ discharged properly.

8.3.5 Noise and Vibration Level Management

Adequate measures have been proposed for the control of noise and vibration from the power generator and other production related machine. Noise level monitoring would be performed periodically and the workers exposed to noise would have adequate protective device. Vibration protecting pad (shoe) would be provided under the generator to protect the vibration during operation. An inlet silencer shall be incorporated to reduce the noise level to the specified level. The silencer shall consist of individual noise absorbing exchangeable elements filled with mineral wool. Significant impact of noise found in generator and compressor room. Therefore, Indesore sweater Ltd. should ensure wearing proper PPE for assigned person in this section and monitor noise level quarterly. (Ref.: Bangladesh Labor Rules 2015, Chapter-5.)

8.3.6 Greening Program

A green belt development program with different kinds of trees has been undertaken. The vegetation would purify the air, reduce noise level, maintain ecological balance and generally contribute to the scenic beauty of the air. Soil in and around the plan site is fertile and plenty of water is available. Hence, the green belt as an environmentally sound and friendly project with a buffer zone surrounding the plant area may be created in a short time and therefore green area will be increased and reduce the environmental impacts.

8.3.7 Monitoring requirement

The environmental monitoring program includes a schedule of monitoring and institutional arrangements. The environmental monitoring program will show the path for taking precautions during and after the construction of the transmission line and substations so that necessary steps can be taken to rectify defects or deficiencies. The prime objectives of monitoring are-

- To check on whether mitigation and benefit enhancement measures are actually being adopted and are providing effective in practice
- To provide a means whereby impacts which were subject to uncertainty at the time of preparation of EMP, or which were unforeseen, can be identified, and steps to be taken to adopt appropriate control measures.
- To provide information on the actual nature and extent of key impacts and the effectiveness of the mitigation measures which, through a feedback mechanism, can be taken into account in the planning and execution of similar projects in future

There are two basic forms of monitoring:

- Visual observation or checking, coupled with inquiries

- Physical measurement of selected parameters In the case of industrial projects in general, monitoring is done by physical measurement of some selected parameters like air, water, noise etc. It should be mentioned here that the monitoring program should be such so that it can ensure compliance with national environmental standards. The importance of this monitoring program is also for ensuring that the factory does not create adverse environmental changes in the area and providing a database of operations and maintenance, which can be utilized if unwarranted complaints are made.

Environmental monitoring requires a set of indicators that could be conveniently measured, assessed and evaluated periodically to establish trends of impacts. The indicators may be independent or may be functionally related. The physic-chemical, ecological and human interest including socio-economic indicators should be well understood. The monitoring program, in view of the possible impacts as assessed earlier, should consider the indicators for the impact assessment related to following issues is presented in Table.

It is desirable that the mitigation measures for the negative impacts and environmental enhancement for positive impacts are implemented according to the suggestions presented in this report. There are two types of environmental monitoring activities associated with the project, during construction and during operation of the project. Each of the components is to be dealt with according to the requirement of suggested measures.

Monitoring indicators is limited to a number of impact parameters to see the actual performance of the factory. Environmental monitoring requires set of indicators that could be conveniently measured, assessed and evaluated periodically to observe the trends of change in base line environmental quality.

The factory management authority of Indesore sweater Ltd. should be responsible for overall environmental monitoring of the factory. The environment monitoring of the factory should primarily be focused on addressing the following issues:

(a) Emission from the power generator

(b) Generation of noise

(c) Waste generation at the factory

8.3.8 Monitoring Parameters for Operational Phase

Meteorological measurements: Meteorological monitoring should be conducted to monitor the wind direction and speed, temperature& humidity.

Ambient air quality monitoring: Continuous and/or periodic measurement of the air quality indicators e.g., SOx, CO, NOx, PM10, PM2.5, and temperature needs to be carried out.

Groundwater monitoring: The groundwater level along with the selected drinking water quality parameters (e.g., pH, Color, Turbidity, TDS, Ammonia, Nitrate, Phosphate, As, Fe, Mn and Coli forms) may be monitored.

Noise level monitoring: Indoor noise levels in the generator facilities along with the outdoor need to be monitored regularly.

8.4 Occupational Health and Safety

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.

8.4.1 General Requirements

In Bangladesh the main law related to occupational health and safety is Labor Law 2006 and its updated specific revision in 2015. 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 8.3.

Table 8.3: General requirements for workers' health and safety

Issues	Precautionary measures	Action taken after incident
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 • Firefighting apparatus should be provide and maintained • Storage water source • Fire hydrant • Emergency light/PA System • Organize regular fire drill.	• Emergency evacuation of the employee • Provide medical services to a safe place. • Call fire brigades, hospital, and civil defense for emergency.
Precautions in case of Explosion	• Inspect equipment regularly. • Install automatic emergency controls in the equipment. • Develop emergency SOPs & organize training	• Shut down all the operations • Evacuate all the employees in a safe place. • Provide first aid in a safe place. • Contact with the hospitals/ civil

	• Fix rescue area • Ensure first aid	defense.
Health and Hygiene with emergency accidental case	● Cleanliness ● Ventilation and temperature ● Disposal of wastes and effluents ● Latrines and urinals ● Spittoons and dustbins	• Provide medical services to a safe place. • Call hospital, civil defense for emergency. Owner's responsibility for compensation ● Amount of compensation ● Report on fatal accident and treatment ● Compensation on contract and contract registration ● Appeal
Other Safety	● Safety for building and equipment ● Floor, stair and passage way ● Work on or near machinery in motion ● Carrying of excessive weights	
Latrines and urinals	● Sufficient latrines and urinals shall be provided ● Shall be maintained in clean and sanitary condition ● Shall be adequately lighted and ventilated	
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.	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 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

8.4.2 Remedial measures

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

- Employees should be informed of the potential health impacts they are facing
- 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 silage 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

8.5 Safety Mitigation Plan

8.5.1 Safety Management System

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

Visitors to the worksite may also face legal action if they knowingly disobey safety rules. In addition, the company may face legal action and fines for violations of regulatory requirements. Those individuals who do not fulfill their safety responsibilities will become accountable for any problems their negligence creates and may be liable under the law. Everyone employed by a company is responsible for maintaining the safety program. Managers and supervisors are responsible for identifying safety needs, communicating safety hazards, investigating hazardous conditions and accidents, providing training, supply or wearing appropriate safety and personal protective equipment, and ensuring all equipment is properly maintained and meets legislated safety standards. Their role is supported by input from all employees.

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

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

8.5.2 Company Safety Policy

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

8.5.3 Safety Responsibilities

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

8.5.4 Management Communication

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

8.5.5 Inspections

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

8.5.6 Personnel Protective Equipment (PPE)

The work site should be assessed to determine what personal protective and safety equipment is needed and the equipment must be available. A maintenance schedule must be developed for PPE and records for maintenance retained on file. Employees must be trained in fitting, care, maintenance and use of PPE. Detailed rules and procedures identifying company and legislative requirements and expectations must be communicated to all employees and contractors. They serve as a reference and describe the minimum standard by which business is conducted. Most important rules and procedures ensure consistency in the performance of tasks by all employees. The current rules should be reviewed and assessed as to whether they are appropriate for the operation/facility/employees. The formulated rules must be communicated to the workers effectively, and workers must ensure that they understand the rules and have no difficulty to comply with the rules.

8.5.7 Standard Work Procedure

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

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

8.5.8 Emergency Procedures

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

Subcontractor employees will also be trained in first aid. The following are the important events that need emergency procedures.

- Fire
- Injury/death
- Electrical injuries
- Natural disasters

8.5.9 Safety

Safety implies the reduction of risk of accidents at the work site. Accident prevention is more valuable than any mediatory 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.

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
- 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.
- Factory 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 work is being undertaken.

8.5.10 Training

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

8.5.11 Record Keeping and Reporting

Record keeping and reporting is one of the requirements of any QA/QC system and essentially of a good management tool. Properly maintained records of construction, installation, training, equipment maintenance, operation, fault detection and remedy can help in reducing risks of accidents, legal costs and thereby overall cost of operation of a plant. Records also help in identifying causes of any accident and elimination of the same accident in future. Records may be maintained for the proposed plant as follows.

Noise

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

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.

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.

8.6 Environmental Management Systems (EMS)

An EMS is a tool designed to enable organizations to target, achieve and demonstrate continuous improvement in environmental performance. It is one integrated management process with a number of stages, which includes an environmental audit. There are a number of standards (e.g. the British Standard BS7750 (BS11992), the European Eco-Management and Audit Scheme for Industry (CEC, 1993)). These consist of most or all of the following elements depending on the standard, to:

1. Adopt an environmental policy to confirm and promote commitment to continual improvement in environmental performance;

2. Undertake an environmental review to identify significant environmental issues and effects;

3. Setup environmental programs of objectives, targets and actions;

4. Establish an environmental management system to ensure the implementation of the necessary actions to achieve these objectives;

5. Undertake periodic environmental audits to assess the performance of such components;

6. Prepare an environmental statement on environmental performance; and

7. Obtain independent verification of the environmental statement.

Also there is ISO 14001 which is a voluntary international standard for environmental management systems ("EMS"). ISO 14001:2015 provides the requirements for an EMS and ISO 14004:2015 gives general EMS guidelines. An EMS meeting the requirements of ISO 14001:2015 is a management tool enabling an organization of any size or type to:

(1) Identify and control the environmental impact of its activities, products or services;

(2) Improve its environmental performance continually, and

(3) Implement a systematic approach to setting environmental objectives and targets, to achieving these and to demonstrating that they have been achieved.

Chapter Nine
Risk Assessment and Management

9.1 Introduction

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

The risk assessment should constitute an organization's best effort to employ advanced scientific and technical methods to predict accurately the sizes of the risks. Once the relevant risks are estimated accurately and objectively through the risk assessment process, it can then be decided how best that risks could be addressed in the risk management phase.

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

- Hazard identification: determining what kinds of adverse health effects a substance, product or activity can cause
- Dose – response assessment: predicting the degree of adverse effects at a given exposure level
- Exposure assessment: estimating the amount of exposure, and
- Risk characterization: combining the foregoing into a numerical range of predicted deaths or injuries associated with actual exposure event

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

9.2 Factory Risks Assessment

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation, the factory put human beings and the environment inside and outside of the factory 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 garment factory leading to disasters or emergency situations may occur during following events:

- Risks during emergency
- Fire
- Explosion

- Electrocution
- Risks due to natural disasters
- Cyclone
- Earthquake
- Storm
- Lightning
- Risks due to external threats
- Sabotage
- War situation
- Water/food poisoning

Several strategic areas within the factory can be identified as places of potential risks during factory operation:

Areas prone to explosion are:

- Generator area
- Chemical store

Premises prone to fire and electrocution are:

- Electrical rooms
- Transformer area
- Cable tunnel

In garment factory accidents can occur at two different levels. First, these may occur due to fires, explosions. In such events, operators working inside the factory and at various strategic hazard locations will be affected.

Second, risks are also associated with external threats of sabotage.

9.3 Managing the Risks

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

- The factory layout should provide roads of adequate width and service corridors so that no undue problems arise in the event of fires or other hazards (Chapter six, Bangladesh Labor Rules 2015).

- With respect to factory operation, safe operating procedures should be laid down and followed to ensure safety, optimum operation and economy.
- A firefighting 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, control rooms.
- Regular checks on safe operating practices should be performed.

In order to achieve the objective of minimizing risks at the Indesore sweater Ltd., 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 (Chapter six, Bangladesh Labor Rules 2015).

9.4 Emergency Response Plan

Emergency response plans are developed to address a range of plausible risk scenarios and emphasize the tasks required to respond to a physical event. The emergency response plan (ERP) for the proposed factory has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster. The primary objective of the plan is to keep the loss of life, material, machinery/equipment damage, and impacts on the environment to minimum.

9.4.1 Emergency Response Cell

It is highly recommended that an Emergency Response Cell (ERC) adequately equipped with highly trained manpower and appropriate gears is established within the factory 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

9.4.2 Emergency Preparedness

The ERC headed by a trained Manager should establish an Emergency Control Room with links to all plant control rooms and all other services. The ERC shall work as a team of the following officials:

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

The Senior Environmental Specialist of the proposed Environmental Management Unit for the Indesore sweater Ltd. with adequate skills of facing emergency situation can 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 complex of such an event without any delay.

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

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

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

9.4.3 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.
- Adequate firefighting equipment e.g. fire extinguishers of different types appropriate for different strategic locations must be planned according to requirements of existing factory.
- 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. This can be better achieved by organizing fire drills at regular intervals, e.g. once every two weeks during dry summer months and once every two months during wet months involving all team members, all other service groups, all staff of the factory complex, and utilizing all firefighting gears.

9.4.4 Emergency Medical Services

- The Chief Medical Officer will be responsible for providing medical services within the Indesore sweater Ltd. 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 Indesore sweater Ltd. 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 factory 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 factory.

- 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, 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 factory 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.

9.4.5 Rescue Services

Without going for additional manpower, the rescue team can be formed with potential staffs of the Factory, 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, gas 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
- Isolate damaged equipment or machineries that may endanger human lives
- Provide repair services as appropriate to restore operations

9.4.6 Security Services

The Indesore sweater Ltd. will have a strong independent security team headed by the Chief Security Officer and will be responsible for the overall security of the factory, 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.

The Chief Security Officer shall communicate with local police and other law enforcing agencies and seek assistance as may be needed during an emergency. The security team will also regulate vehicular traffic inside the complex. In particular they will ensure that all roads are unobstructed during emergencies.

9.4.7 Public Relations Services

- The Public Relations Officer (PRO) of the factory 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 factory against potential fire hazards, or other emergencies.
- 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 peoples.

9.5 Conclusion

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

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

Chapter Ten
Conclusion

Bangladesh's export earnings are mostly determined by the export of readymade garments (RMG) to North American and European countries with 75% of total export earning coming from this sector. So with the improvement of the sector, the business became huge and industries started to set up in large scale. As an obvious result of that the effect of these industries on environment increased day by day. In some cases the situation became worse. For a sustainable development a lot of initiative has been taken by the regulatory bodies, buyers of the garments and manufacturing industries. As a process of protecting environment it is essential to know the impact on the environment by any specific industry. So being one of the leading companies in sweater making track, Indesore sweater Ltd. found the necessity of an Environmental Management Plan (EMP) study for their company. The EMP report has been prepared through identifying the potential impacts, assessing them and recommendation possible mitigating and enhancing measures for negative and positive impacts, respectively.

From the EMP report it was found that the effect of the factory on environment is minimal. The reason of being the effect so negligible is because the facility uses ETP for waste water treatment and air pollution is from the power generator and the noise level found satisfactory in most of the places.
So the potential impacts from the factory can be divided into three major sections:

1. Atmospheric emissions and Air quality
2. Water pollution and waste water discharge
3. Noise

All these aspects have been examined and the findings are as follows:

Atmospheric Emission and Air Quality

The factory power generator is operated on diesel. Emission of sulfur dioxide and particulates would be insignificant as the Bangladeshi indigenous natural gas is almost free of Sulphur and particles. Emission of NOx will also be very low as the air-fuel ratio is high. From the test report we found the emission of NOx is within the limit of DoE, IFC/World Bank and other Bangladesh national regulation.

Liquid Discharge

The factory will produce wastewater from production process since it has mainly process in the production. That waste water will be treated by Effluent Treatment Plant. Apart from that domestic liquid wastes will be produced from the factory by the use of worker in the factory. This liquid waste would be disposed through septic tank.

Noise

The noise impact generated by operation of the power generator is the main source of noise pollution. Appropriate noise controls will be installed to keep the neighborhood impact due to noise emissions within the limit of DoE and international standards. In that case personal protection has to be taken for the worker working adjacent to the machine.

Having reviewed all the potential environmental impacts, and following our proposed mitigation measures the factory is expected to proceed without having unacceptable environment.

However no development can be expected without any adverse impact on the environment. The beneficial impacts on the nation as well as human beings would only be meaningful and sustainable development would only be possible if adverse impacts are minimized through strict maintenance and control measures as mentioned for this factory. All this would need vigilant care and cost money, and the factory authority should take these into consideration.

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