IMPACT OF THE JAMUNA FERTILIZER INDUSTRY ON THE SURROUNDING ENVIRONMENT

A PROJECT REPORT

BY

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DECLARATION

I do hereby declare that the project work reported herein has been performed by me and this work has neither been submitted nor is being concurrently submitted in candidature for any degree at any other university.

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ABSTRACT

Fertilizer is an important chemical compound. In Bangladesh yearly agricultural productions are much less than the actual demand. Nitrogenous fertilizer (mainly urea) is essential to increase the agricultural production. Hence Bangladesh is now promoting rapid industrial development in this sector. However this increases the pollution load on natural environment.

The study presented in this report has attempted to cover the identification of both positive and negative environmental impacts induced due to installation of the Jamuna Fertilizer Company Ltd (JFCL). For this purpose extensive field investigations and a questionnaire survey among residents in the area near the industry have been made. An evaluation of the impact of the industry on surrounding also has been made through observing plant species.

To identify the impact of the industry on river water, results of chemical analysis of the water samples collected from the river Jamuna before and after installation of the industry have been collected and analyzed. A laboratory test program was undertaken to monitor the water quality of the river Jamuna and also to verify collected data. The important parameters those have been taken under consideration are pH, conductivity, BOD_5, COD, SS, TS ammonia, urea sulphate, sulphide, heavy metals (Cu, Zn, Pb Mn) and turbidity.

It has been found that the concentration of these parameters occasionally exceed the respective permissible values. As a result fish population of the Jamuna river near the factory reduced to a great extent compared to that before installation of the industry.

The factory was found to cause some negative impact on open water fisheries, surface water, horticulture and air quality around a small area. On the other hand it induced great positive impact on socio-economic side e.g., income and employment generation, education, infrastructure etc. Although, the overall impact of the industry is positive, identified negative impacts should not be neglected. This study will enhance further research in this related field.

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CHAPTER-1

INTRODUCTION

1.1 Introduction

The Jamuna Fertilizer Company Ltd. Tarakandi, Sarishabari, Jamalpur is situated on the left bank of river Jamuna and is about 200 km north from the Dhaka city. It is one of the largest fertilizer industries in Bangladesh. The total area of 194 acres of land of which 75 acres used for industry 60 acres for residential purpose, 27 acre for heavy duty road, 20 acres for Jetty and water intake and 12 acres for railway siding. The yearly production capacity of the industry is 5,61,000 MT of urea and 3,55740 MT of ammonia.

The main raw materials used are natural gas, air and water (steam). The industry was designed and constructed by Mitsubishi Corporation of Japan and went on trial production in December 1991. The industry is equipped with its own power Generation plant, water treatment plant, inspection and quality control Laboratory with most modern and sophisticated equipment and devices. There are polyethene bag manufacturing plant, bagging, storage and dispatch system as well as various engineering shops to carry out normal maintenance of the industry to ensure steady operation of the plants. Additional provisions include export and import jetty, railway sidings and natural gas regulating and metering stations (NRMS) and telecommunications and wireless facilities.

1.2 Rationale

Fertilizer is one of the most important chemical ingredients to increase the agricultural production. In spite of fertilizer production and its import, the per hectare consumption of fertilizers in Bangladesh is still on the lower side i.e., 86 kg/ha. (BARC,1991) in comparison with 335.30 kg/ha. in South Korea, 163.90 kg/ha. in France and 265 kg/ha. in West Germany. These data amply justify the increased production of fertilizers in Bangladesh.

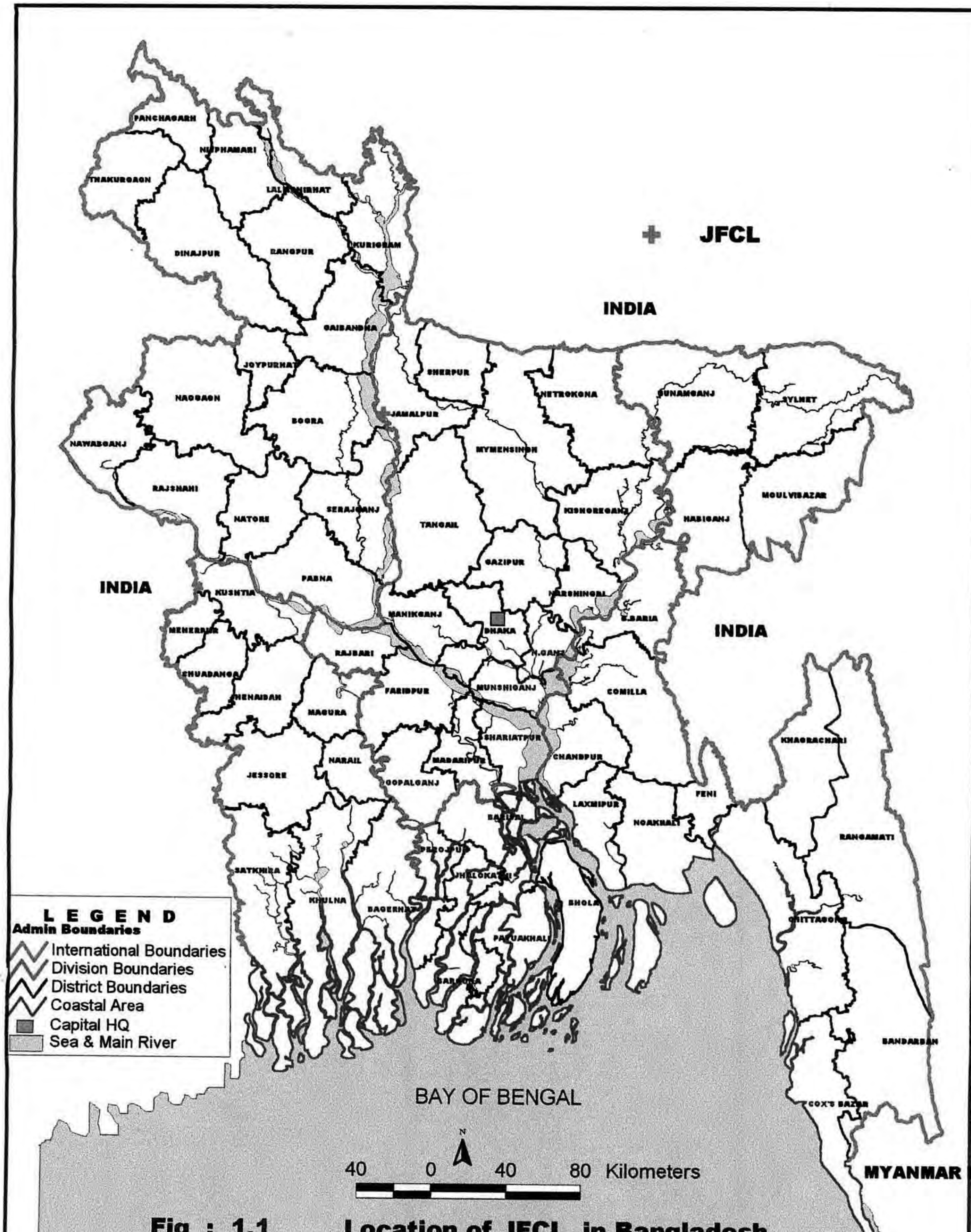


Fig : 1.1 Location of JFCL in Bangladesh

Urea fertilizer manufacturing process involves modern complex technology and deals with many chemicals, which are ultimately responsible for environmental pollution. Since ammonia is one of the raw materials for urea production, it is likely that due to the leakage from the system or due to some unforeseen reasons, which takes time to get rectified, the industrial effluent may get contaminated with ammonia. Also the water treatment system, the cooling water system and the carbon dioxide removal system etc. utilize a number of chemicals which are either toxic or may act as pollutants. So effluents from these systems which are discharged to the river, obviously become a source of pollution and are hazardous not only to the aquatic and marine lives but also to the industry itself using huge amount of water. Thus an environmental study of the industry was needed to evaluate the overall environmental condition surrounding the industry site and to suggest suiTable control measures for the abatement and mitigation of adverse impact on the environment.

1.3 Objectives

The following are the objectives of this study :

a. To identify any change of adjacent river water quality due to discharge of industrial effluent from JFCL in to the river Jamuna.

b. To identify and assess the possible significant impacts of the industrial activities on the surrounding environment.

c. To recommend suiTable mitigatory measures for any adverse impact on the environment.

1.4 Scope and Methodology:

To achieve the objectives some secondary data were collected from the department of environment (DOE) and JFCL. To compare with the secondary data water samples were collected from the project site for water quality test. The collected water samples were tested at the JFCL laboratory . Analyses were carried out with assistance from the JFCL laboratory staff. The water quality parameters analyzed were temperature, pH, color, ammonia, urea, chloride, turbidity, alkalinity, total solids, dissolved solids, suspended solids, chromium, DO, BOD and COD.

Several field visits were made to observe the changes occurred around the industry sites and wastewater discharge points. To visualize and elucidate the impact of JFCL on various environmental issues some photographs were taken during field visits. The photographs are given in Chapter – 4.

In order to assess the public awareness and their reaction of the environmental consequences of the project a questionnaire survey was conducted. After making several field investigations and discussing with some local people, a questionnaire was prepared, (given in Annexure – A).

1.5 Organisation of the study:

This study comprises five chapters, chapter one is for introduction, chapter two describes the reviewed literature, which covers the description of urea manufacturing process, quantity of different chemical used, sources of pollution and their probable effects and EIA methodologies. Chapter three deals with data collection and laboratory test program, which provide information about field survey, sources of collected data and test procedure of water quality parameter.

Results of field survey, detail analytical study of collected data, effects of JFCL effluent on river water are described in chapter four. This chapter covers impact identified on various environmental issues during field survey, comparison of Jamuna river water quality before and after construction of the industry, and comparison of water quality with the standard value of water for different uses.

Finally chapter five describes conclusions of the study, suiTable mitigatory measures and recommendations for further research.

CHAPTER-2

LITERATURE REVIEW

2.1 Introduction :

Urea fertilizer manufacturing process involves modern complex technology and deals with many chemicals, a part of which are disposed as a industrial effluent and are responsible for environmental pollution. This chapter deals with the description of urea manufacturing process adopted in Jamuna Fertilizer Company Ltd., quantity of different chemicals used, sources of environmental pollution, their quality and probabable effects on environment. Different EIA methodologies which are generally used in Environmental Impact Assessment are also briefly reviewed.

2.2 Description of urea manufacturing process.

There are several urea manufacturing process which are described bellow :

2.2.1 General Manufacturing Processes

Ammonia Processes: There are various ammonia processes offered by different eminent process lisensors like Chemico-Foster-Wheeler, ICI, Montecantiri, Kellogg, Topic, BASF etc. These processes differ from utilization of raw materials, N_2 separation system, CO_2 removal section and final purification system.

Urea Process: The synthesis of urea from ammonia and carbondioxide is done in two stages.

<u>1st step</u>

Formation of Ammonium Carbamate

$2NH_3 + CO_2 = NH_4COONH_2$

2nd step

Decomposition of Carbamate to Urea

$NH_4 COONH_2 = NH_2CONH_2 + H_2O$

Based on the mode of recycling of unrecalled carbonate, urea process can be classified as follows:

i) Partial recycle process
ii) Total recycle process
iii) Slurry recycle process
iv) Stripping process

The three-urea processes, which are most widely employed at the present time, are,

i) Sam (Snamprogetti) process
ii) Stami (Stamicarbon) process
iii) MT (Mitsui-Teatsu) process
iv) Advance cost and Energy Saving Method.

The process adopted by JFCL is the Snamprogetti.

2.2.2 Process Involved in Jamuna Fertilizer Company Ltd.

So far as manufacturing process is involved Jamuna Fertilizer Industry of Tarakandi broadly consists of the following two sections:

i) Ammonia synthesis section
ii) Urea section.

2.2.2.1 Description of the Ammonia Process

Synthesis Gas production process:

Natural gas is preheated and treated for sulfur removal. Desulfurzed gas and steam are then made to react (reformed) over a nickel catalyst in the primary reformer to produce a mixture of hydrogen, carbonmonoxide and carbondioxide plus unreacted methane and steam according to the following reactions

$CH_4 + H_2O = CO + 3H_2$

$CH_4 = 2H_2O = CO_2 + 4H_2$

$CO + H_2O = CO_2 + H_2$

Since reaction is endothermic, fuel is burned outside the tubes containing the catalyst to supply the heat of reaction at high temperature. The waste heat is recovered from the combustion gas by preheating gas and air and by raising steam for power and process use.

The normal operating temperature and pressure in primary reformers are 780°C and 39kg/cm respectively. The normal steam/ methane ratio is 3.5. Gas from the primary reformer with a residual methane level of 0.25% passes to the secondary reformer, a vessel filled with bulk nickel catalyst and air is added to supply heat for completing the steam methane reaction. The air also supplies the nitrogen needed for ammonia synthesis. However the amount of secondary reforming is limited by the amount of air that can normally be added to generate3:1 H_2 / N_2 ratio in final gas.

$CH_4 + 2H_20 = CO_2 + 4H_2$

$CH_4 = CO_2 = 2CO + 2H_2$

$CH_4 + H_2O = CO + 3H_2$

The gas is then cooled in a waste heat reboiler and passed into carbon monoxide converters (Shift Converters) where the following reaction occurs:

$CO + H_2O = CO_2 + H_2$

The conversion is carried out in two reactors, a high temperature converter and is followed by a low temperature converter. The gases emerging from the shift converters have 0.24% CO level.

The gas mixture then passes into an absorber where a solvent removes the carbondioxide. Here the following reaction occurs:

$K_2 CO_3$ (Benfield SOln) + $CO_2 + H_2 O = 2KHCO_3$ (absorption)

$KHCO_3 = CO_2 + K_2CO$ (regeneration)+H_2 o

Described CO_2 gas is used as the raw material for urea production.

Since the gas mixture still contains CO and CO_2 which may poison the ammonia catalyst it is passed over a micelle catalyst in the methanator to make the oxide of carbon react with hydrogen to from methane and water. The water is removed from the gas before it is passed through the catalyst .

$CO + 3H_2 = CH_4 + H_2O$

The gas mixture leaving the methanator is compressed to the synthesis pressure and mixed with recycled gas from an ammonia converter.

$N_2 + 3H_3 = 2NH_3$

Ammonia synthesis: The compressed gas enters the synthesis loop. Where it mixes with gases circulating through the synthesis catalyst and is then passed through condenser to remove the ammonia produced. The gases are removed around the synthesis loop by a compressor and a part of the mixture is purged to keep the content of inert gases at an accepTable level.

2.2.2.2 Description of the Urea Process

Urea plant consists of four Sections and utility system

- Synthesis section
- Purification Section
- Concentration and Granulation section
- Process condensate Treatment section

Synthesis Section

Urea is produced by synthesized from liquid ammonia (produced from natural gas) and gaseous carbondioxide. The reactions are as follows

$2NH_3+Co_2 \leftrightarrow NH_2CooNH_4$

$NH_2CooNH_4 \leftrightarrow NH_2CoNH_2 + H_2o$

Purification Section :

In this section the ammonium carbamate and excess ammonia are separated from the synthesized Urea Solution by pressure reduction and steam heating in two steps namely at 17 kg/cm^2, 3.5 kg/ cm^2 and The overhead gases are sent to respective absorbers in recovery section and purified aqueous urea solution of 71% wt. Urea concentration is sent to concentration and Granulation section.

Concentration and Granulation Section :

In the concentration section the urea solution is sent from the purification section is concentrated to make molten urea with water content of 4% wt. The urea solution is concentrated from 71% wt. To 83% wt. To 96.7 Temperature is 130^o C and the operating pressure are 0.3 Ata. The molten urea from strainer flows through acoustic granulates, by which the molten urea is sprayed into the prilling tower. Urea prills are formed while descending the prilling tower contacting with air and further cooled on fluidizing cooler at the base of prilling tower. All urea prills are sent to the storage as product.

The 96.7% urea solution is sent to the granulation section via centrifugel pump. Before entering in granulator formaldehyde is added to the urea solation as a process aid & anticaking agent.

Process condensate treatment Section :

The process water containing NH_3, Co_2 and urea, cowing from the vacuum system is sent to the PCT section in order to decompose the urea there contained and recover the NH_3 and Co_2, thus increasing plant efficiency and avoiding pollution problems.

2.3 Raw materials used in JFCL .

All raw materials used in JFCL for production of one ton of urea are given in tabular form bellow.

Table : 2.1 List of Raw materials and chemicals

Name of chemicals	Budgeted quantify	Actual quantify
1. Natural gas	800.00 SM^3	828.25 SM^3
2. Ammonia	0.580 MT	0.586 MT
3. Potassium carbonate	34.00 gm	64.33 gm
4. Potassium Nitrite	1.70 gm	2.99 gm
5. DI-ethyl amine	8.00 gm	6.12 gm
6. Vanadium pentaoxide	1.00 gm	0.72 gm
7. Chlorine	105.00 gm	93.60 gm
8. Corrosion inhibitors	30.00 gm	24.71 gm
9. Scale inhibitors	30.00 gm	27.93 gm
10. Ploy crane(A-496)	13.00 gm	8.62 gm
11. Polymer (A-322)	4.00 gm	3.62 gm
12. Alum	400.00 gm	305.26 gm
13. Sulphuric Acid	1100.00 gm	645.59 gm
14. Caustic soda	400.00 gm	169.35 gm
15. Hydrazine	0.80 gm	0.38 gm
16. Trisodium phosphate	0.40 gm	0.41 gm
17. Paraformaldchyd	7000.00 gm	7262.90 gm
18. Jute bag	20.02 Nos	20.03 Nos
19. Polyethene bag	20.02 Nos	20.03 Nos

Source : (JFCL Authority)

2.4 Pollutants from Jamuna Fertilizer industry

As discussed earlier JFCL has i) utility unit (water treatment unit, IG plant, Auxiliary boiler, cooling water and waste water treatment plant), ii) ammonia plant unit, iii) urea unit, iv) bagging and finishing unit, v) maintenance unit. These units discharge different types of pollutants containing ammonia, acid/alkali wash water, mud and aluminum hydroxide sludge, natural gas condensate, lubricating oil, urea condensate, diethanol amine potassium carbonate solution, vanadium oxides, urea dust etc.

Types of emissions and nature of pollution of the above effluents is explained in Table 2.1

Table 2.1 Emissions and Effluents of JFCL

Nature of Pollution	
Emissions	Fumes, Hydrogen sulphide
Air pollutants	Carbon monoxide, Carbon dioxide, Oxides of nitrogen, Hydrocarbons, Chlorine, Ammonia, urea dust, mainly from ammonia urea plant.
Effluents	Suspended solids, Hydrochloric acid Sulphuric acid, Sodium hydroxide, Ammonium hydroxide, Methanol, Urea and water pollution, NH_3 sol^n (ppm level), Hydrocarbons, Biocides, used Resins, Oil and Grease.

Source : Alam et al " Pollution effects of Zia Fertilizer factory on the river water Meghna" International symposium : water for the 21st Century, June Lahore.

2.3.1 Pollutants from urea plant

About 42 metric tons of condensate/hour is discharged from this unit which contain about 200-PPM urea and 50-PPM NH_4. Before discharging to the river water the condensate is treated by diluting with fresh water to bring the concentration of urea to the desired level of 30 ppm and NH_4 to 1 ppm (JFCL Authority)

2.4.2 Pollutants from Ammonia plant.

About 40 metric tons of condensate per hour is produced as pollutants from this unit, of which 25-30 metric tons of condensate is made free from dissolved ammonia by stripping process and re-used in the process. The rest 10-15 metric tons and is drained to the river water.

2.4.3 Pollutants from utility plants.

The utility plant comprises i) water treatment unit, ii) cooling Tower, iii) Nitrogen generation plant, iv) Ammonia storage and Bottling unit. Resin of demineralized plant is washed with acid and alkali and the waste is discharged to the river after some treatment. Blowdown cooling water to river contains phosphate-based chemicals, biocides, and Hexavalent chromium. Mud and Aluminum Hydroxide sludge from clarifier unit of water treatment plant are also discharged as Effluent. When vapor pressure of ammonia storage tower increases, ammonia is vent in atmosphere. Sometimes chlorine contaminates air through leakage of valve of chlorine cylinder.

2.4.4 Pollutants from bagging and finishing plant

The pollutants from this unit include a) Areadust from granular urea, b) free ammonia and carbondioxide, c) Formaldehyde, d) Dust from packing material Jute and polyethene bags.

2.4.5 Oil leakage

Lubricating oil from different pumps and compression machines and natural gas condensate leakage from condensate collecting points are generated about one MT daily as industry effluent.

It is clear from above that in comparison with other pollutants, the range of ammonia contamination of various effluent streams is a wider. At the same time, the possibility of effluent contamination by other hazardous pollutants (although small in quantity) can not be neglected.

2.5 Effects of various pollutants on environment

The salient effects of some pollutants in air water and soil of the surrounding area are briefly discussed as follows:

2.5.1 Ammonia

Among the pollutants, ammonia has the most severe effect on environment. Both liquid and gaseous ammonia has hazardous effects on the nose eyes and body of the workers when exposed to such an atmosphere. Mild irritation to the throat is experienced at a concentration of 35 mg/m^3, which is also harmful effect directly. When a ammonia (NH_3) molecule (from a fertilizer industry) is emitted in to the atmosphere, it is continuously deposited to the ground through dryfall and wetfall, thus contaminates surrounding air, water and soil (Ichevone, Herzfeld, 1986).

Ammonia in air: atmospheric deposition of gaseous ammonia gives a substantial contribution to the total deposition of nitrogenous air pollutants which is suspected to be a key factor in the disappearance of plant species in several ecosystems, forest declination and the transition of health land into grassland (eg Nihlgard 1985: Nilsson and Grennfelt, 1988). The tendency for sulferdioxide to be oxidized in the atmosphere to an ammoniumsulfate aerosol is deposited on the vegetation and impaction and/or possibly by active uptake.

Gmur et al. Subjected bean plants to ammoniumsulfate aerosol at concentrations of 26 mg/m^3. During a 3-week exposure period, foliage responded with chlorosis, necrosis and loss of turgor. The authors suggested that submicron aerosols enter abaxial stomata and affect internal cells before affecting leaf surface cells.

Ammonia in water: Michaelj Semmens (1978) reported that (1) ammonia exert an oxygen demand on receiving streams, (2) it contributes a source of nitrogen which may foster increased algal growth where nitrogen is a limiting nutrient (3) free ammonia is extremely toxic to aquatic life and finally (4) ammonia has been found to accelerate the corrosion of metals and materials used in construction. Ammonia is toxic to fish, the concentration of ammonia nitrogen (NH_3-N) in receiving waters should not exceed 0.02mg/l (Mc kee and Wolf 1963). Sawyer and Mc casty (1978) concluded that ammonia toxicity would not be problem in receiving waters with pH below 8 and NH_3-N concentration less than 1mg/1. The problems resulting from uncontrolled discharge of N-rich waste water can range from eutrophication in receiving waters to high nitrate concentration in drinking water, causing methamoglobinemia in infants and cardioc problems in adults.

Ammonia in the river water also harmful for industries using this water. Ammonia contaminated water decreases the efficiency of cat-ion exchange resins, accelerates slippage colloidal silica from raw water clarifire and ion exchange resin (R&D, UFFL, 1986).

Ammonia in soil: Emission of ammonia (NH_3) from a fertilizer industry ultimately deposits to the surrounding ground (through dryfall and wetfall) and the resulting input of ammonium (NH_4) in to the soil were the main reasons of nitrogen (N) cycle disturbance in forest ecosystem (Makarov and Kiselva 1995). NH_4 accumulation in soil and soil acidification are key process causing negative consequences of forest ecosystem pollution and saturation with N. NH_4 is accumulated in soil with low nitrification activity. High NH_4 uptake can lead to the imbalance in plant nutrition due to decreased potassium (K) and magnesium (Mg) uptake (Roelfs et al, 1985).
Berkvist, and Folkeson (1992) reported that soil acidification leads to an increased leaching of NO_3, Ca, Mg, Mn and A1. So the acidification also cause nutrient imbalance.

2.5.2 Oxides of nitrogen:

They contribute significantly towards the ambient air quality around the industry. Nitrogen oxides affect bronchial changes and also respiratory tract (Freeman et al 1966). Terminal bronchiolar epithelium is sensitive to NO_2, induced injury after brief exposure (Cooperand and Tebershaw, 1966). Significant increase in bronchitis resulting in mortality was reported among children exposed to elevated concentration of NO_2 in ambient air (Pearlman, 1971). Oxides of nitrogen can have biological and phytotoxic effects and they are ultimately involved in the formation of photochemical smog. The threshold limit value (TLV) for nitrogen dioxide is a concentration of $9mg/m^3$. Damage to vegetation has been reported following a one hour to $1mg/m^3$.

Nitrate (NO_3) is considered to be relatively non toxic to adults, as it is quickly exerted by kidneys. Concentration greater than 10mg NO_3 –N/L can be fatal to infants under six months of age. In infants NO_3 is reduced to NO_2 which combines with hemoglobin in the blood to form methemoglobin, and leads to a condition commonly known as "blue baby syndrome". The USEPA established an MCL of 10mg NO_3 –N and 3.2 mg/l nitrite when nitrates and nitrites are measured separately in drinking water. Increased nitrate concentration in ground water have caused the shutdown of wells and rendered aquifers unusable as water sources.

Like ammonia, emission of nitrogen oxides (NO) from a fertilizer industry and the resulting input of nitrates (NO_3) into the soil were the reasons of nitrogen (N) cycle disturbance in forest ecosystems.

2.5.3 Suspended solid:

Solids suspended in water may consist of inorganic or organic particles or of immiscible liquids. Organic suspended and dissolved solids undergo biodegradation and their pollution potentials are usually expressed in terms of BOD. The fixed or inorganic solids and heavier organic solids settle quickly and form a sludge blanket near the point of discharge. Colour may be partially imparted by the suspended solids but turbidity is wholly caused by suspended solids (Karim; 1992).

2.5.4 Acid and Alkali wash water:

An acidic wastes is corrosive to both metallic and concrete structures in the watercourse and is also toxic to aquatic life. Alkaline waste water on the other hand, when discharged into the water courses combine with free carbondioxide and further increase alkalinity of the water (Rao and Datta 1987).

2.5.5 Phosphate based chemicals and biocides:

They increase the growth of un-wanted plant and algal when decomposed they cause pollution of river water and ultimately cause the death of aquatic animals like fishes etc. (Alam and Rahman, 1997).

2.5.6 Chlorides:

Due to presence of higher than usual chloride concentrate in the body of water render it unfit for future use.

2.5.7 Arsenic:

Chronic effects can appear from its accumulation in the body at low intake levels. Carcinogenic properties also have been imputed to arsenic. The toxicity of arsenic compounds depends on the chemical and physical form of the compound, the route by which it inters the body, the dose and duration of exposure etc. Trivalent inorganic arsenic is more hazardous than the pentavalent form (Rahman, 1997).

2.5.8 Chromium:

Chromium being cancer sterilization and allergy inducing. Presence of chromium in water is detrimental to the health. The permissible level in drinking waters has been retracted to 0.10 mg/l.

2.5.9 Oil & grease:

Oil and floating materials are esthetically undesirable and interfere with the self-purification process of the stream.

2.5.10 Temperature:

Effluent of high temperature induce thermal load on receiving stream. Oxygen is less soluble in warm than in cold water, when significantly large quantities of heated water are discharged to natural receiving waters results in depletion of dissolved oxygen in stream and unfavorable condition for aquatic lives. (Meteaif and Eddy, 1991).

2.6 Theory of Environmental Impact Assessment (EIA)

There is no general and university accepted definition of Environmental Impact Assessment (EIA). Several authors and or organizations have put forward several definitions which provide a board indication of the objectives of EIA but illustrate differing concepts of EIA. Some of these definitions are given below :

1. The United Nations Environmental Programme (1978) defined EIA as a method "to identify predict to describe in appropriate terms the pros and cons (penalties and benefits) of a proposed development. To be useful, the assessment needs to be communicated to terms understandable by the community and decision makers and the pros and cons should be identified on the basis of criteria relevant to the countries affected."
2. Munn (1979) provided definition of EIA "as an activity designed to identify and predict the impact on biogeophysical environment and on man's health and well beings of legislative proposals, policies, programs, projects and operational procedures, and to interpret and communicate information about the impacts".
3. Clark (1979) defined EIA as "the systematic examination of the environmental, social and economic consequences of information about the impacts".

2.6.1 EIA Methodologies

Although a great diversification is apparent various definitions of EIA, Lohani and Halim (1983) suggest that the process of EIA essentially comprises of three sequential elements identification, prediction and evaluation. Most EIA methodologies are derived from a few existing general methodologies which are listed below and described hereafter :

1. Ad-Hoc
1. Checklist
2. Matrices

3. Network
4. Environmental Evaluation Systems (EES)
5. Overlay
6. Cost-Benefit Analyses
7. Adapted Environmental Assessment and Management (AEAM)

2.6.1.1. Ad-Hoc

This methodology gives a broad qualitative information of value in comparing alternative development sites or schemes. This information is stated in simple terms readily understandable by a lay decision-maker or member of the public without outlining the actual impacts on the specific parameters which will be affected. It is not exactly "Delphic" in nature, nor based on expert opinion. It is only a reasonable statement of the ad-hoc items of data for two or more alternatives, and can thus be prepared rapidly. For example, it may state the number of people likely to be affected adversely or favorably, the extent of area likely to be developed or affected etc.

The ad-hoc method has the following drawbacks ;

a) It gives no assurance that it encompasses a comprehensive set of all relevant impacts;
b) Possibility of selection of different criteria of different groups, causing lack of consistency in analysis.
c) It is intently inefficient as if requires a sizeable effort in identifying and assembling an appropriate panel for each assessment.

Because of the above drawbacks, it is not recommended as a method for impact analysis. It is as the name indicates, an ad-hoc method and it has utility only when other methods can not be used because of lack of expertise, resources etc.

2.6.1.2 Checklist

Checklist methodologies range form listings of environmental factors to highly structured approaches involving importance weighing for factor and the application of scaling techniques from the impacts of each alternative on each factor.

a) Simple Checklist :

This represents list of environmental factors which should be addressed. No information however, is provided on specific data needs, methods for measurement, or impact prediction and assessment. This method was extensively used in the initial year in the US (Described in Rahman and Hossain, 1993).

b) Descriptive Checklist :

This refers to a method which includes list of environmental factors along with information on measurement, impact prediction and assessment. These checklists are widely used in environmental impact studies of water resources projects, transpiration projects and land development projects in the US (Described in Rahman and Hossain, 1993).

At list of environmental factor related to ecological, physicochemical and human interest parameters is used for project evaluation. For each factor information is included on its definition and measurement, prediction of impacts and for data interpretation.

c) Scaling Checklist :

Scaling checklists refer to approaches in which numerical scales are assigned to the impact of each alternative being evaluated on each identified environmental factor. These type of checklists are useful for comparative evaluations of alternatives, thus providing a basis for selection of the preferred alternative.

d) Weighing -Scaling Checklist :

Weighing-scaling checklists refer to methodologies that embody the assignment of relative importance weights to environmental factors and impact scales for each alternative relative to each factor. An example of weighing scaling checklist methodology is the so called 'Environmental Evaluation System' (EES) deve,loped by Battelle Columbus Laboratories in the USA.

2.6.1.3. Matrices

Interaction matrices, as mentioned by Canter (Described in Rahman and Hossain 1993), were one of the earliest types of methodologies utilized. The simple matrix refers to a display of project actions or activities along one axis, with appropriate environmental factors listed along the other axis of the matrix. When a given action or activity is anticipated to cause a change in an environmental factor, this is noted at the intersection point in the matrix. A simple environmental matrix does not, however, provide information on the magnitude and importance of impact, nature of impact whether adverse or beneficial.

Leopold et al (Described in Rahman and Hossain 1993) have developed graded matrix system in which 'magnitude' and 'importance', of the impact in each cell of a matrix can be denoted by assigning numerical values. Assignment of numerical value for the magnitude of an interaction is based on an objective evaluation of facts while assignment of numerical value for importance is based on subjective judgement of the interdisciplinary team working on the environmental assessment study. This approach is used of gross screening technique for impact identification purposes. Summations of the number of row and columns designated as having interactions offer insight into impact assessment and interpretation.

Fischer and Davies (Described in Rahman and Hossain 1993) expanded the matrix concept further. The approach consists of a three--step procedure :

ii) "Environmental Compatibility Matrix" involves and overall assessment of impacts from proposed development activities. This requires the determination of index values to be placed in individual matrix which allows one to identify and evaluate.

Nature of impact	:	+ ve or - ve
Degree of impact	:	low (1) to high (5)
Duration of impact	:	short-term or long-term

iii) "Decision Matrix" which consists of list of the major impacts carried foreard from both steps one and two. This brings together all the necessary information in one format for making decision about environmental impact.

One of the main attributes of matrices is their highly visual nature. They can be equally useful in communication ideas to the public as well as to decision makers. In some cases when the number of interaction are too many, the Leopold matrix may be too cumbersome.

2.6.1.4. Networks

Networks are capable of identifying direct and indirect impacts, higher-order effects interactions between impacts and, hence, are able to identify and incorporate mitigation and management measures into the planning sages of a project. They are suitable for expressing ecological impacts but of lesser utility in considerations involving social, human and aesthetic aspects. This is because weighing and rating of impacts are not features of network analysis.

Networks generally consider only adverse impacts on the environment and hence decision-making in terms of the cost and benefit of a development project to a region is not amenable to network analysis. Temporal considerations are not properly accounted for and short-tem and long-term impacts are not differentiated to the extent required for easy understanding.

2.6.1.5 Environmental Evaluation Systems

The Environmental Evaluation System (EES) is used to evaluate the expected future conditions of the environmental quality, both 'with' and 'without' the project. A difference in Environmental Impact Units (EIU) between these two conditions constitutes either an adverse impact, which corresponds to a loss in EIU, or a beneficial impact, which corresponds to a gain in EIU.

Mathematically, this process may be represented as (Dee et al, 1972)

$$EI = \sum_{i=1}^{h} (V_i)_1 W_i - \sum_{i=1}^{h} (V_i)_2 W_i$$

Where EI = Environmental Impact

$(V_i)_1$ = value in environmental quality of parameter i with project

$(V_i)_2$ = value in environmental quality of parameter i without project

W_i = relative weight (importance) of parameter i

n = total number of parameters

To aid in transforming these parameter estimates into an environmental quality scale, value function graphs are used for each parameter. To determine value functions for an environmental parameter, Dee et al (1972) suggested a general approach as follows:

1. Collect information on the relationship between the parameter and the quality of the environment.
2. Order the parameter scale, which is normally the abscissa, so that the lowest value is zero.
3. Divided the environmental quality scale intervals ranging between 0 and 1 (or 0 and 10), and determine the appropriate value of the parameter for each interval. This process is to be continued until a reasonable curve may be drawn.
4. Steps 1 to 3 should be repeated various experts independently. The average values should produce the group curve. The above procedure should be conducted for all environmental parameters of interest or concern. The next step is the computation of environmental units (EIU) for the environmental components and categories.

2.6.1.6 Overlays

The overlays approach involves the use of superimposed transparencies to identify, evaluate, compare and communicate impacts in a geographic reference framework. The study area is divided into a number of environmental factors e.g., topography, vegetation distribution, ecologically sensitive areas, historical sites etc. Regional maps are prepared for common factors showing their areal extent and value. All the maps prepared in this way are made into transparent negatives, superimposed and photographed. The resulting maps show the simulation of all the values employed and thus the suitability of the area for a given activity. Similar maps are then prepared for the other development activities under consideration.

Although the method is flexible, efficient and very simple to conduct, preparation of maps may be costly and time consuming. The method does not specify cause-effect relationships and suffers by lumping physical, biological and social factors together. Although the method is primarily used for the comparison of impacts, e.g. selection of alternative highway routes, it is to be noted that it has no predictive capability whatsoever. Similar to overlays, but more sophisticated timesaving method that can handle mostly land reformation, is Geographic Information System (GIS).

A GIS described as an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently compute, store, update, manipulate ,analyze and display all forms of geographically referenced information. In short GIS can be defined as a computer system capable of holding and using data describing places on the earth's surface.

Geography (and the data describing it) is part of our everyday world; almost every decision we make is constrained influenced or dictated by some fact of geography, which (GIS) can easily handle.

2.6.1.7 Cost-Benefit Analysis

This method strives to evaluate effects in monetary terms and to express conclusion in an economic, cost-benefit format. The UNEP Test Model (ESCAP Publication, 1985) based on cost-benefit approach has developed a framework in the following six part format:

- Essential project description which set the physical and economic parameters for the analysis.
- itemizing the resources used in the project, indirectly affected, and residues created.
- Itemizing the resources exhausted, depleted or deteriorated.
- Itemizing the resource enhanced.
- Listing of the required additional project components.
- Summary of the conclusions and the formulations of the integrated cost-benefit presentation.

The major advantage of cost-b benefit analysis is that the nature of expense and benefit accruable form a project are provided in monetary terms as in traditional cost-benefit analysis and hence enable easy understanding, and aids in decision making.

The disadvantages is, of course, that impacts have to be transformed and stated in explicit monetary terms and this is not always possible, specially for intangibles like the monetary value of the damages to health. This type of approach is not useful for small scale development projects, but is better suited for the analyses and evaluation of a regional development plan.

2.6.1.8 Adaptive Environmental Assessment and Management (AEAM)

The AEAM approach uses small interdisciplinary teams interacting through modelling workshops over a relatively short time to predict impacts and evaluate alternatives including management measures. The adaptive assessment process can be divided into three types of workshops :

- Initial workshop
- Second-phase workshop
- Transfer workshop

The AEAM technique largely overcomes the short comings of most other methods in that other methods assume unchanging conditions or project impacts in a single time frame with statically - descried environmental conditions.

It also overcomes a built-in bias towards compartmentalization and fragmentation of the relationship between project actions, environmental characteristics which are likely impacts, while the reality may be that the actual impacts may alter the scale and direction of charge within environmental and social system. The AEAM technique enables the assessment of development projects in light of the reality of such change.

The AEAM technique can handle higher-order impacts and interactions between impacts. But it depends on a small group of experts and has no avenue for public participation. this aspect is of particular significance for large-scale development, where the opinions of interest groups are important. Simulation models are usually expensive, time consuming and only used when budgets and manpower are not constraints. The models will be only as accurate and comprehensive as the data available.

Various methodologies for Environmental Impact Assessment of development projects have been discussed. As already pointed out earlier, there is no single methodology which can be adopted for all projects under any circumstance. Selection of EIA methodology is therefore, an important consideration. Canter (1983) suggested some desirable characteristics for the selection of an EIA methodology.

- An EIA methodology should be comprehensive in that it addresses appropriate environmental factors and impacts related to the project type being evaluated. Attention should be given to both beneficial as well as detrimental impacts.
- The methodology should stress the objective, quantitative analysis rather that purely subjective, qualitative approaches. It is however, recognized that even with quantitative approaches there is the necessity for subjective evaluation of objective information.
- Finally the selected methodology should be implement Table in terms of manpower, funding, and data and time requirements.

CHAPTER-3

DATA COLLECTION AND LABORATORY TEST PROGRAM.

3.1 Introduction

Environmental impact assessment (EIA) of a project such as JFCL requires pre and post project data. But most of the industries in Bangladesh have no pre-project environmental data. On the other hand, post project data generation requires a long-term monitoring and large amount of cost involvement. Since this is out of the scope of present study, this chapter focused only on the environmental impacts based on extensive field investigation and public opinion survey. A detailed discussion on field survey has been made in the next chapter.

3.2 Data collection

In order to assess the impact of JFCL on the waste water receiving stream, the river Jamuna, it was necessary to have sufficient data on water quality during both pre-construction and post construction period of the industry. A comprehensive data collection program was undertaken for both the pre-construction and post construction period of the industry. Various organizations such as Department of Environment (DOE), JFCL (Laboratory) were contacted to collect data. Significant amount of data were collected from these organizations for post construction period i.e., year 1992 to 1997. However sufficient data for pre construction period were not found. Data for only two months, July and August in 1991 were obtained from DOE. The water quality data for the Jamuna river was subsequently analyzed and discussed in the next chapter.

3.3 Laboratory Test program:

Although data for pre and post construction period of the industry had been collected from various organizations. A laboratory test program was under taken to monitor the water quality of the wastewater receiving stream, the river Jamuna. An effort was made to verify these data and also to assess possible impacts of the Jamuna fertilizer industry. Details of the laboratory test program is depicted in this chapter.

The whole operation of this program may be broadly classified into three categories;

(i) Selection of sampling locations (2) Collection of river water sample and (3) Detailed analysis of samples in the laboratory to evaluate the quality of the river water,

3.3.1 Selection of sampling Locations:

In locating sampling stations or points on a river it is necessary to determine a suiTable point on the longitudinal section, taking into consideration the distance form the riverbank and the depth, usually measured from the water sample.

The following three criteria, being basic practical consideration, should be considered when locating sampling stations.

- The sampling points must be located at points where the measured parameters show a distinct gradient.

- It is not the water quality at the sampling point, which is of interest, but that of the total water body. Sampling points should, therefore, be representative, as far as possible, of a whole water body.
- Some practical constraints must be considered, for example, river traffic condition or the access to the sampling station.

For this study only one sampling point S_1 was selected on the Jamuna river at a location of 100 m from the discharge point (s1) shown in Fig 3.1. Since JFCL laboratory always collects the river water sample from that point, the same point was selected in this study.

3.3.2 Collection of samples:

The frequency of sampling depends on the objective of the measurement program and on the type of parameters to be measured. Common frequency range from yearly, monthly, weekly or daily measurements to continuous monitoring.

A frequency of one or two samples per year can be used for long-term observations of the water quality standards of a particular water body. For statistical evaluations as well as for the analysis of physical, chemical and biological process, more frequent measurements are necessary.

Purposes of this study is for comparison of tested data with the base line data to assess the impact of the fertilizers industry, samples only for continuos 3 days were used for the above mentioned river, During only dry period samples were collected and tested in the laboratory.

Water samples were collected in a plastic container with stopper , from the middle of the river and in about 2 feet below the top surface of water. There are three main methods of sampling viz. grab sampling, composite sampling and continuous monitoring sampling. However sampling for ordinary chemical analysis requires no specific methods and precautions other than collecting it in a clear glass container of good quality having glass stopper. Samples for bacterial analysis must be collected in a sterilized bottle with stopper. Samples of wastewater collected form different sources should fairly represent the body of the waste from which they were collected. For this study grab sampling method was employed.

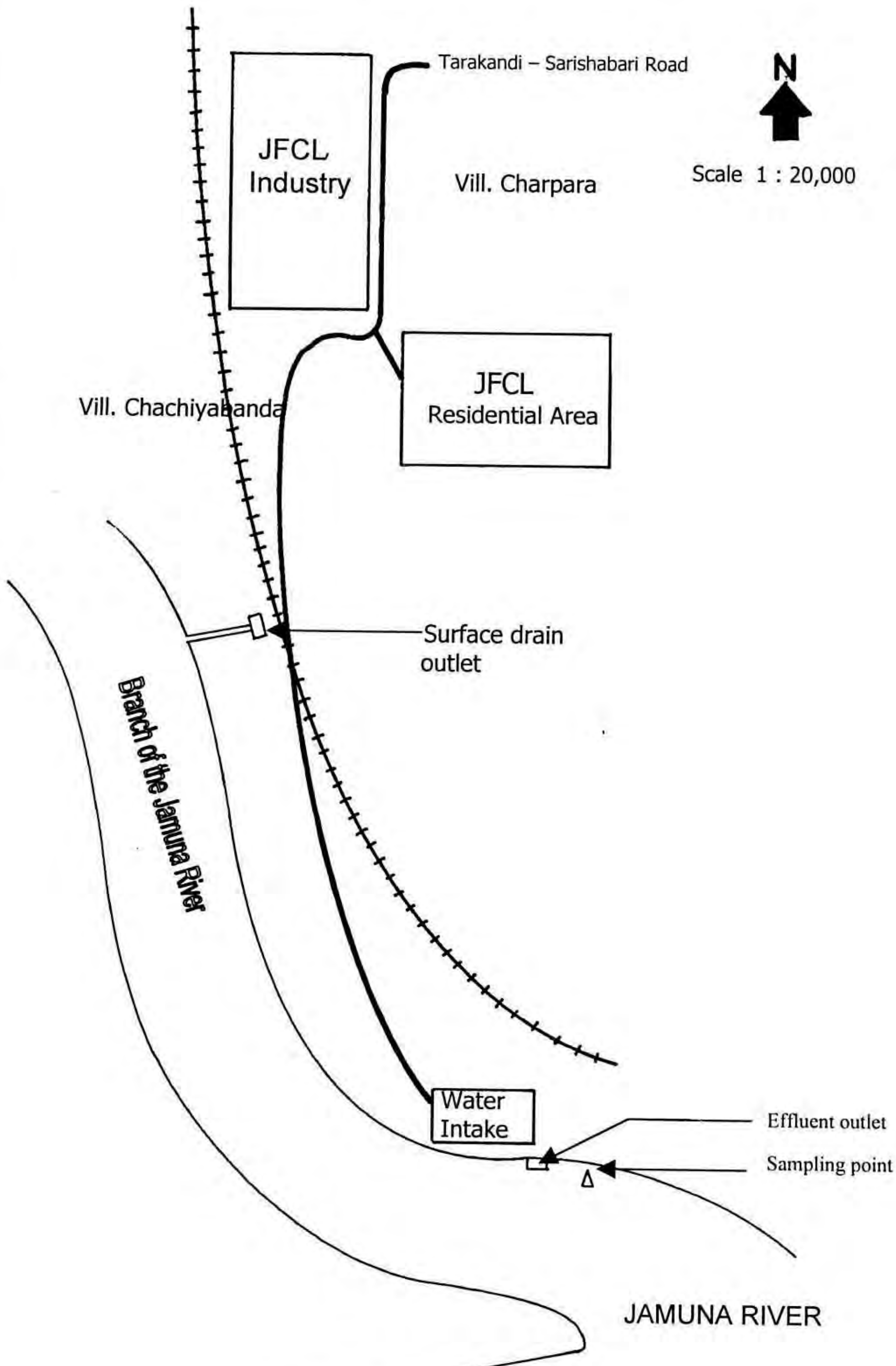


Fig. 3.1: Location of Sampling point

3.3.3 Analysis of the Samples

Parameters Analyzed

To assess the effect of water and wastewater quality on various environmental aspects such as aquatic lives, human health etc. various water and wastewater quality parameters are to be monitored. The parameters required to be monitored for this purpose are temperature, p^H, color, turbidity, alkalinity, electrical conductivity (EC), chloride, solid content, dissolved oxygen, BOD, COD, ammonia, chromium arsenic.

Experimental procedure

The physical, chemical and biological qualities of the waste waters were assessed through laboratory analysis. The different tests performed were color, turbidity, total solids, dissolved solid and suspended solids for ascertaining physical qualities, pH, chloride, ammonia, chromium and COD for chemical qualities and BOD for biological quality. The experimental procedure of each parameter is described in a nutshell in this section.

(i) **pH:** pH, determined by ASTM D1293-84 (ASTM, 1988) is carried out by electrometric measurement using the glass electrode as the sensor. pH determined by colorometrically by choosing indicators with colors that are highly pH dependent in HACH DR-EL/4 Photospectrometer (HACH, 1984) In this study pH was determined colorometrically.

(ii) **Solid Content:** Solids may be classified as total solid, dissolved solid and suspended solid. Total solids refer to the matter that remains as residue upon evaporation and during at 103 – 105°C (ASTM, 1988). The particles having size less than or equal to 0.001 micrometer when present in the waste, they are known as dissolved solids. Total solids were determined by standard Method 209A (APHA, AWWA, WPCF, 1985).

(iii) **Dissolved oxygen (DO):** Dissolved oxygen is measured by HACH Standard Method (APHA, AWWA, WPCF, 1985) using HACH Digital Titrator.

(iv) **Biochemical Oxygen Demand (BOD):** BOD test was performed according to the recommended winkler procedure described in Methods 507 (APHA, AWWA, WPCF, 1985).

(v) **Chemical Oxygen Demand (COD):** In the determination of COD, equal volumes (10 ml) of diluted sulfuric acid and potassium permanganate are added to 100 ml of sample and heated in a water bath for 30 minutes. 10 ml of standard ammonia oxalate is added to the boiled sample. The standard potassium permanganate is then added to the mixture until first permanent pink color is obtained from the additional volume of standard potassium permanganate added to the sample.

(vi) **Chloride:** Chloride in the form of chloride (Cl^-) ion is one of the major inorganic anions in water and wastewater. The chloride concentration is higher in wastewater than in raw water because NaC1 is a common article of diet and passes unchanged through the digestive system. A high chloride content may harmful to metallic pipes and structures as well as growing plants. It was determined by standard Titration Method 407A (ASTM, 1988, P. 286-287) and ASTM D512 B, 81 9ASTM, 1988, P. 316) using electromechanical titration.

(vii) **Turbidity:** Turbidity is measured by the deflection of light caused by variety of suspended matter, which ranges in size from colloid coarse dispersions, depending upon the degree of turbulence. Turbidity was measured by Nephelometric method with turbidimeter 9Model 168000, Plate 5.3) using highly diluted sample.

(viii) **Color:** Color caused by colloidal form of impurities is called true color and that caused by suspended matter is called apparent color. Color was determined by HACH DR-EL/4 (Plate 5.1) apparatus using highly diluted sample (APHA, AWWA, WPCF, 1985).

(ix) **Chromium:** chromium was measured by Standard Method 303A, 303B and 304 (APHA, AWWA, WPCF, 1985) using Atomic Absorption/Flame Emission Spectrophotometer of Model AA 680 Plate 4.1.

(x) **Ammonia:** Ammonia was measured by HACH standard Method using Photospectrometer DR-EL/4.

CHAPTER-4

RESULTS AND DISCUSSION

4.1 Introduction

In order to assess the impact of Jamuna Fertilizer Company Ltd. on the river water Jamuna and surroundings, a field survey and a questionnaire survey were undertaken. To qualify and elucidate this impact, water quality data of Jamuna river near the industry were collected from DOE and JFCL laboratory and presented in Table B-4 and B-5 of Annexure-B.

Water samples from Jamuna river near the industry were collected and tested. The sampling locations are illustrated in Fig. 3.1. Test result for Jamuna river is presented in Table B-8.

The results of these laboratory test programs as well as field survey have been discussed in this chapter.

4.1 Field Survey and Environmental Impact Assessment.

To make assessment of JFCL on various environmental issues, several field visits have been made to the industry sites to observe the changes occurred around the industry during December 1996 to November 1997 both dry and wet seasons. Trees and plants have used as bioindicator to signify the environmental pollution. During field visits some photographs have been taken and local people have been interviewed regarding the environmental consequences.

4.1.1 Agriculture

The JFCL plant is situated on an area of 194 acres of land which was previously being used for agriculture. Agricultural production would they sustain an annual loss of about 60 tons of paddy, worth of Tk. 4,90,000/-. Now there is no significant agricultural land in the vicinity of the plant and therefore production of crops with due favorable pollination is not being affected due to urea dust. However the crops grown on lands adjacent to the surface drain outlet (shown in plate- A) has been subjected to ill effects of ammonia occasionally when the process condensate of urea plant (highly contaminated with ammonia) disposed off that lands, ammonia causes burning of leaves of crops, inhibits their growth, ultimately hampered the production. So impact of the industry on Agriculture is negative. Since the affected area is small, it has been taken as –1 on the scaling check list of Table 4.3. On the other hand the industry provides great benefit to the Agricultural sector of the country through the production of 0.55 million ton of urea per year. Considering this national benefit impact on agriculture has been taken as + 5 also.

Plate – A Surface Drain Outlet of JFCL .

4.1.2 Horticulture:

There are no real fruit orchard near the industrial area. But plants like mango, kathal, and coconut exist in every homestead which are susceptible to the emission and discharges form the industry. It has been observed in some cases that ammonia has caused temporary burning or even shedding and discoloration of leaves of plants mentioned above. During field visit it has been observed that several coconut trees (shown in plate-B) adjacent to the west site of industry affected seriously, ammonia and other gaseous emissions caused the burning of leaves inhibition of growth and also reduction of fruit yield. Local people opined that yield of plants like coconut, mango, kathal, and grout also in that area reduced about 50% compared to that before installation of the industry. Similar affects on fruit plant due to gaseous emission was reported by Kawamuta (1976), Przytocka (1976). Such effect on fruit plants due to the industry is not far extended, only about ¼ th - ½ km around the industry. Hence degree of impact has been considered has – 2 on Table 4.3 .

Plate – B Affected Coconut Trees of Pogaldiga High School Exist North –West Corner of JFCL.

4.1.3 Live Stock:

Both draft and nondraft animals comprise the total livestock of this area. Buffaloes, bulls, and cows are the main draft animals, while the non draft animals like goat, sheep etc. are mainly used for meat and milk production.

The usual concentration of air pollution e.g., ammonia has a very little possibility to create any negative impact on the existing livestock. But effluent outlet and surface drain outlet (shown in plate – C & D) also are hazardous for livestock. Outlets are easily accessed and has no barriers to prevent cattles from grazing around them. Occasionally highly polluted water when discharging through the surface drain creates problem on above respect. It was learned from interviewing local people that from beginning of the industry to December 1997, two cows and six goats of neighboring villagers were succumbed to death due to grazing around the surface drain outlet. Toxic effect of ammonia (as described in Sec. 2.4.1) is responsible to the death of these animals. Therefore impact of the industry on live stock is considered negative. Since it occurs rarely degree of impact on live stock has been taken as – 1 in Table 4.3.

Plate – C Effluent Outlet of JFCL.

Plate – D Surface Drain Outlet of JFCL.

4.1.4 Fisheries:

Culture Fishery:

There are some ponds and other surface water bodies at the immediate vicinity of the industry which were found to be affected by the JFCL discharge and spillage during rainy season. It was observed that industry ground level is about 4. m higher than the adjacent water bodies, and rain water (contaminated by ammonia) accumulates within the industry. Ultimately this water finds its way to these water bodies seep through the ground. That's why always water of these pools and ponds are contaminated by ammonia and not favorable for fish survival. Due to this local negative impact on limited area degree of impact on culture fishery has been considered as – 2 in Table 4.3.

Capture fishery:

The river Jamuna flows near the industry is the main source of capture fishery. The water quality analysis data of this river presented in annexure –B shows that DO of the river water has (6 to 9.1) always been within the permissible limit for fishery water. However concentration of ammonia in the river water found from trace amount to 6.0 mg/l, much more than the tolerable limit, where Mc kee and walf (1963) reported that "because of its toxicity to fish, the concentration of NH_3 –N in receiving waters should not exceed 0.02 mg/l". Department of Environment (DOE), Bangladesh (1991) selected 0.075 mg/l of NH_3 is the max ^{m} allowable limit for fishing water. Local fisherman (responded) opined during the time of field investigation that fish population of the Jamuna river now reduced to great extends compared to that before installation of the industry. They also informed that when a polluted water released suddenly from the industry, discharged to the river Jamuna, observed dead fishes into the river. Obviously it-is a direct effect of ammonia. Similar fish destruction due to discharge of fertilizer plant effluent was reported by (Jothikumar & Krishnamoorthi, 1983). Capture fishery is an important environmental parameter in Bangladesh due to identified negative impact, degree of impact has been considered as –3 in Table 4.3.

4.1.5 Water quality

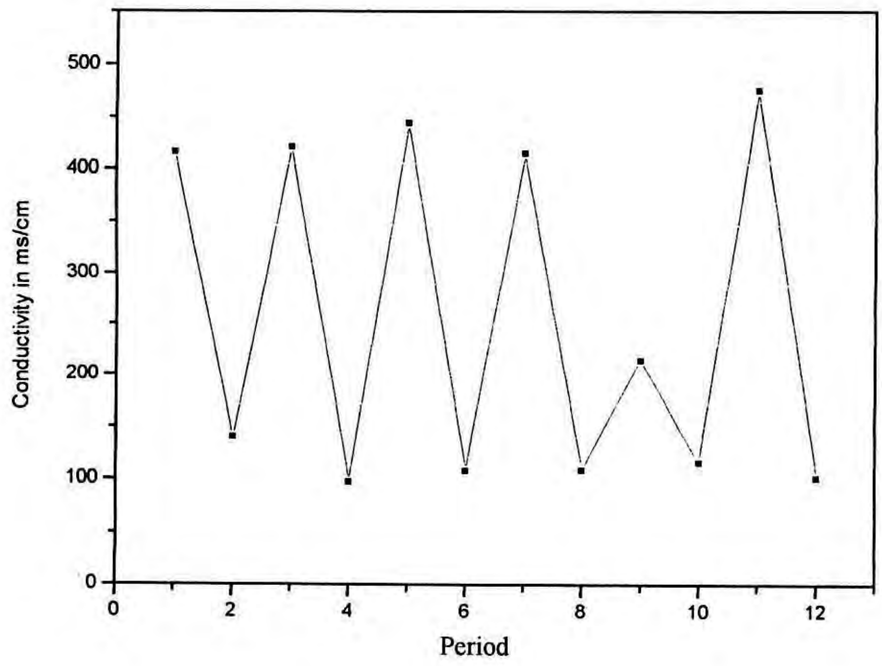
Ground water:

Ground water quality report around the project area has presented in Table B-7 Annexure-B It is seen that all the parameters are within the limits specified by WHO, WASA, and DOE. During field visit, water from 3 shallow Tube well of a neighboring village e.g. Charpara were tested for taste & odour and local people were interviewed about water quality. However no objectionable report was found. Therefore it may be consider safe for drinking purpose.

Surface water (based on collected data):

The main source of surface water in the vicinity of the industry is the river Jamuna, exist at a distance of about 1km from the industry main gate and receive the wastewater of it. Water quality data of the river Jamuna before and after confluence were presented in Table B-4 and B-5 (a, b, c) respectively in Annexure - B.

Graphical representation of various parameters have been presented in Fig. 4.1(a,b,..j). Where abrupt change of concentration of some parameters e.g., total iron, ammonia phosphate, nitrite have been observed, but real cause of its were not understood. A comparison of Table B-4 and B-5 is shown in Table 4.1. Parameters listed in Table 4.1 showed that there were variations in the water quality of the Jamuna river before and after confluence with effluent of the industry.



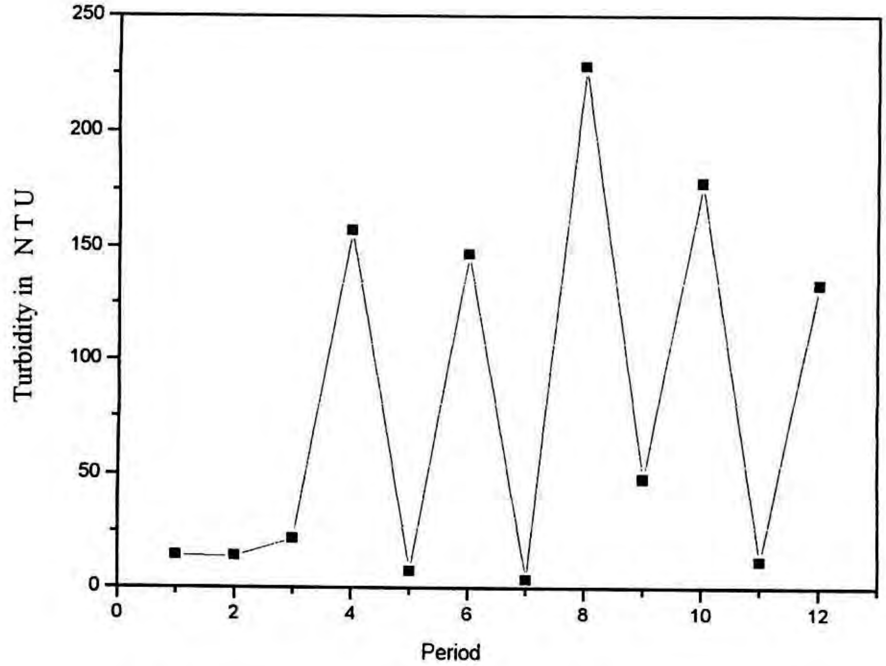
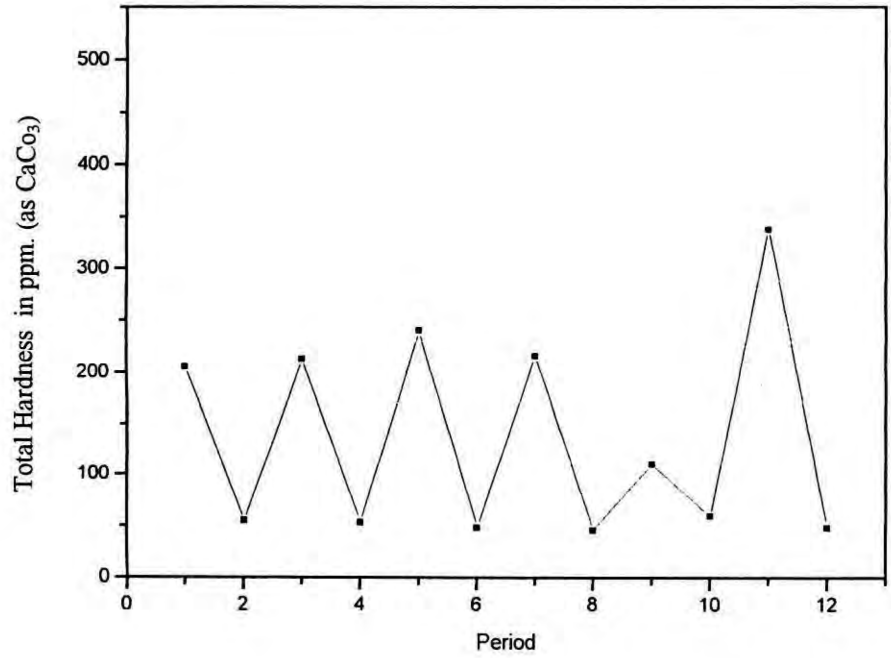


Fig.4.1 Graphical representation of Parameters
(Conductivity& Turbidity) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet.
Period, 93 dry period, to 97 wet period respectivity.



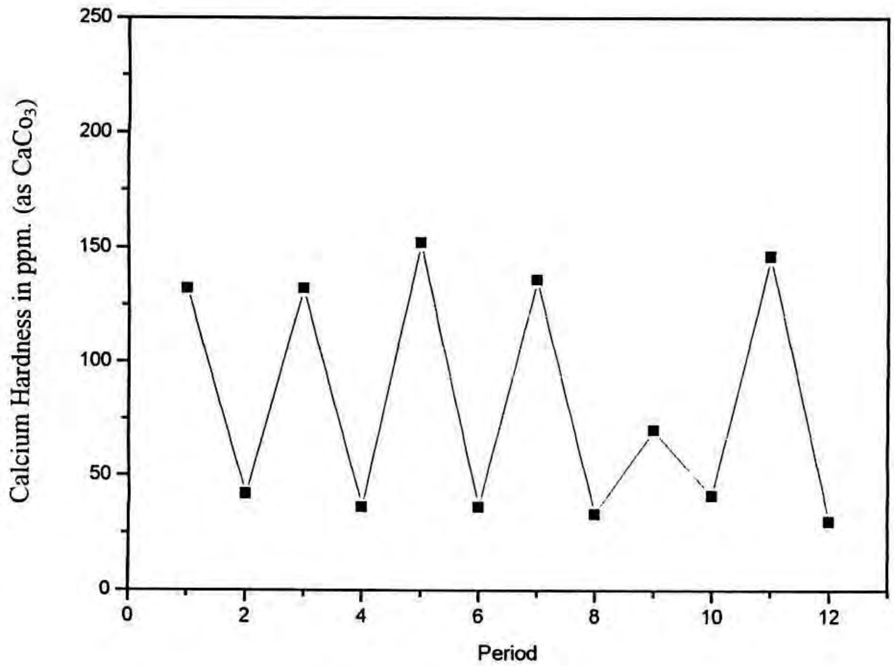
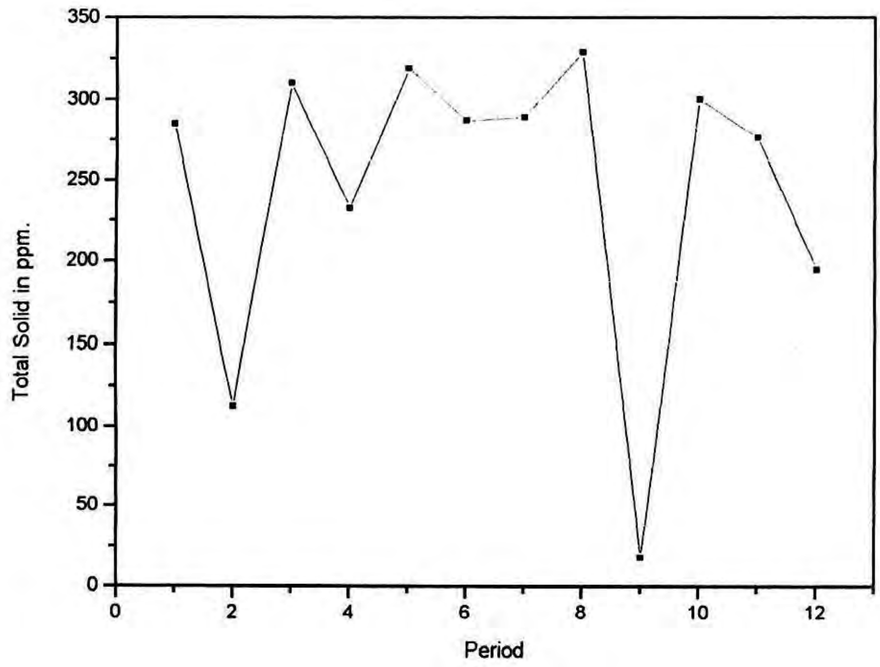


Fig.4.1a. Graphical representation of parameters
(Hardness & Culcium) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet.
Period, 93 dry period, to 97 wet periodrespectivily.



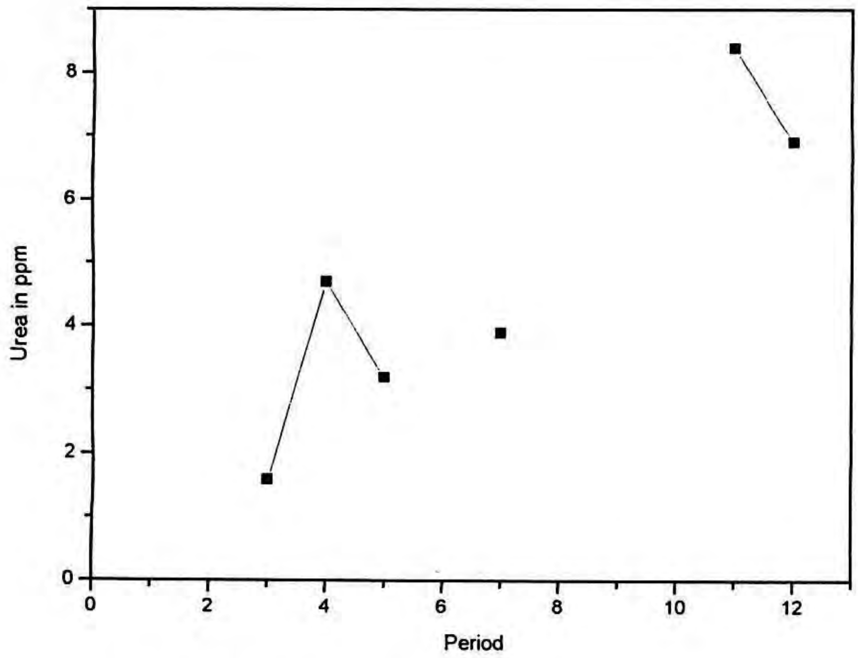
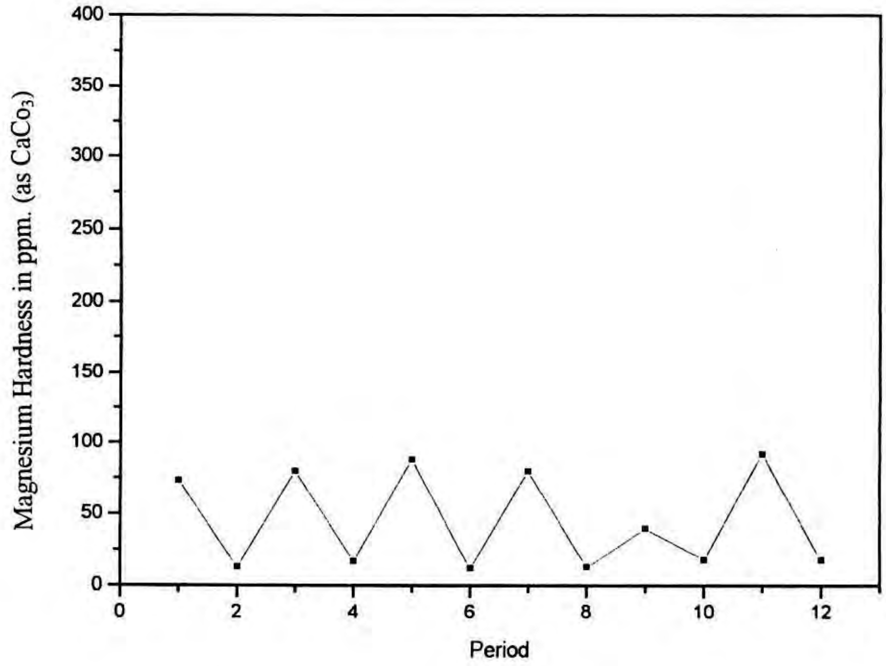


Fig.4.1b. Graphical representation of parameters
(Total Solid & Urea) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet.
Period, 93 dry period, to 97 wet periodrespectivily.



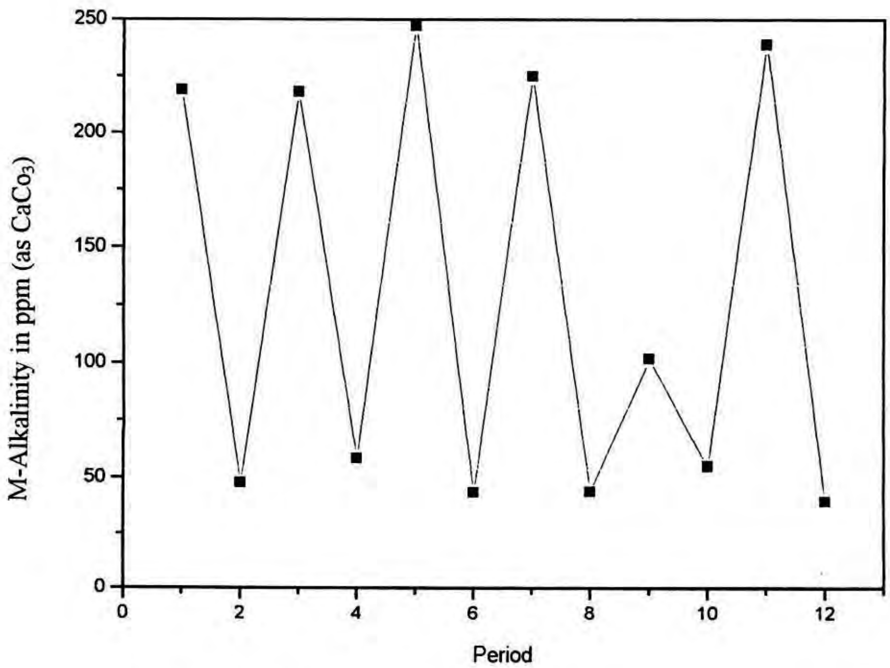
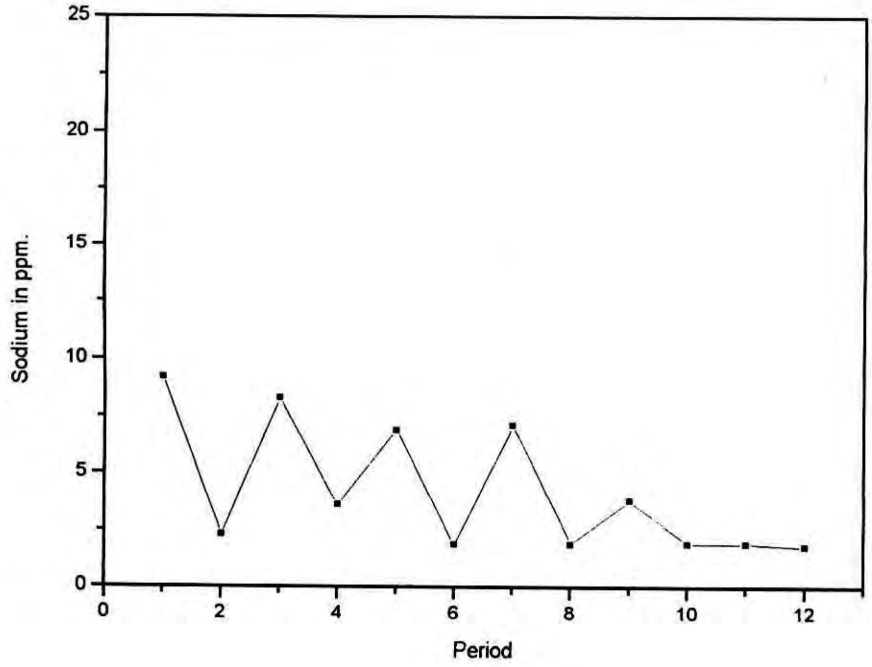


Fig.4.1c. Graphical representation of parameters (Mahnesium Hardness & M-Alkalinity) of river water Jamuna Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet. Period, 93 dry period, to 97 wet period respectivily.



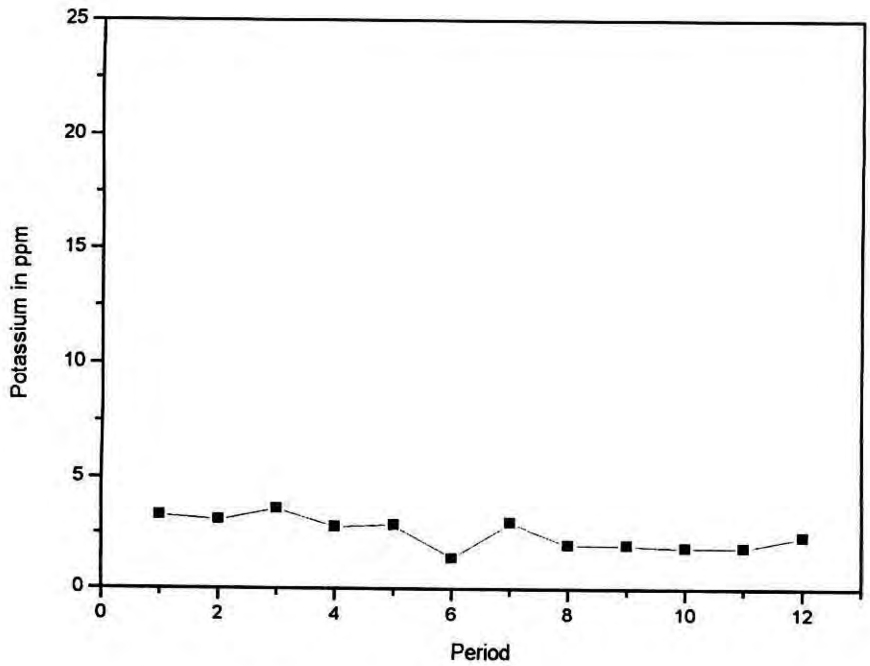
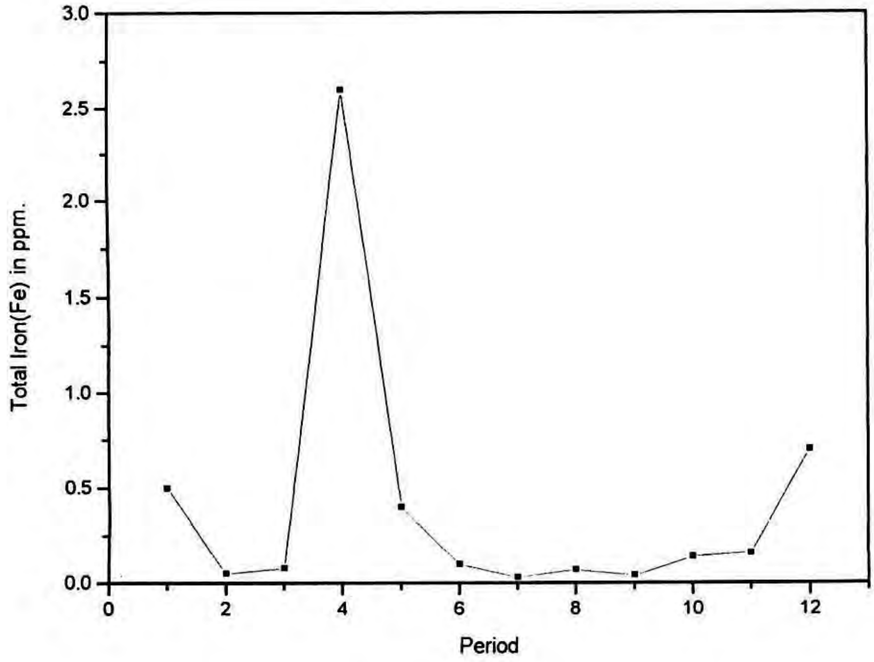


Fig.4.1d. Graphical representation of parameters
(Sodium & Potassium) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet.
Period, 93 dry period, to 97 wet period respectivily.



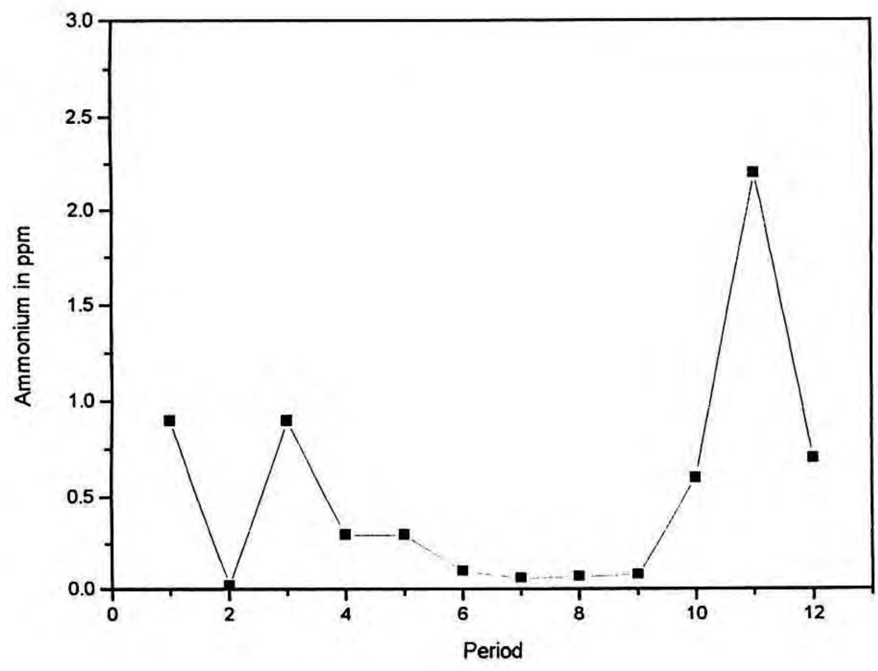
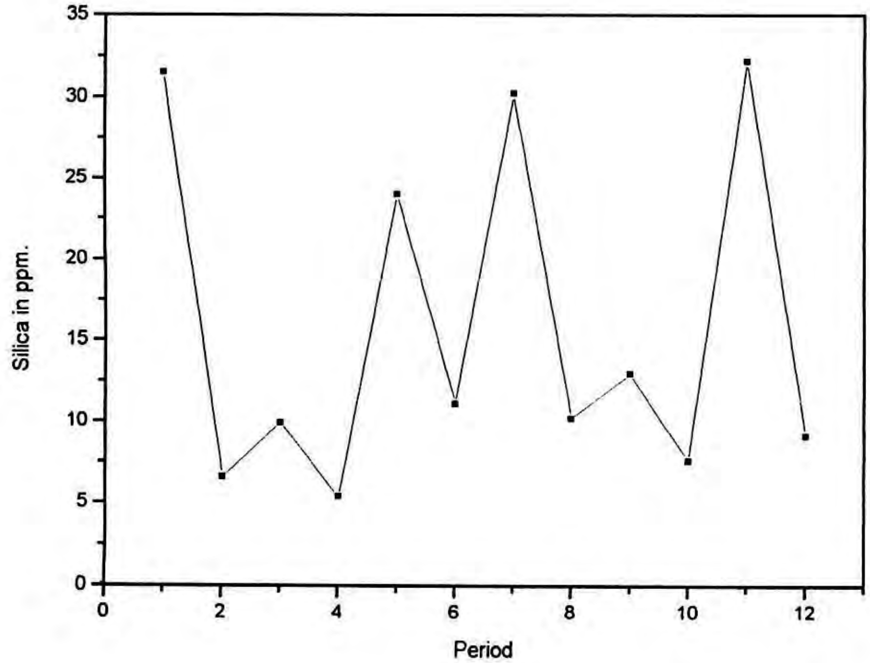


Fig.4.1e. Graphical representation of parameters (Total Iron & Ammonium) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet. Period, 93 dry period, to 97 wet period respectivily.



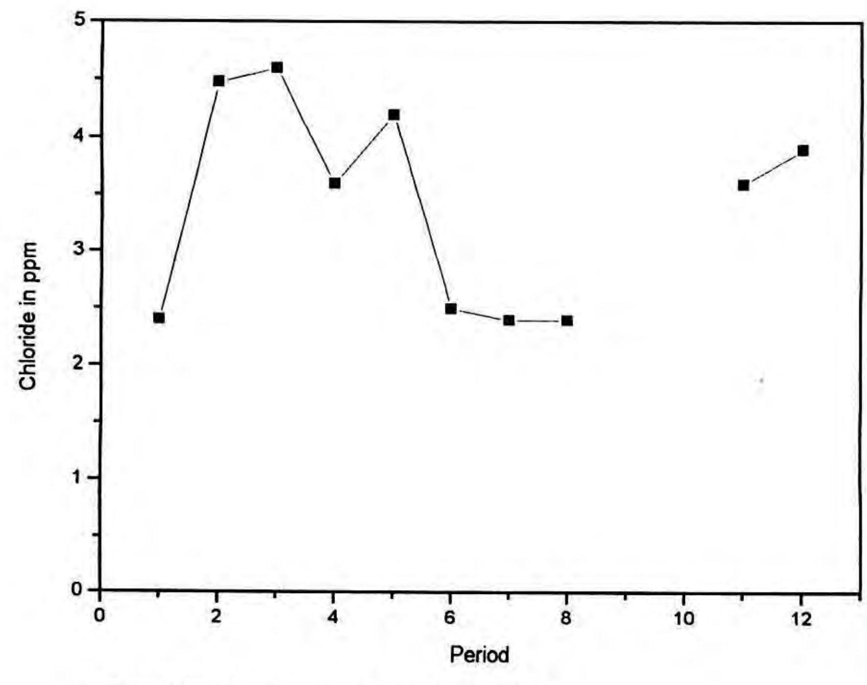
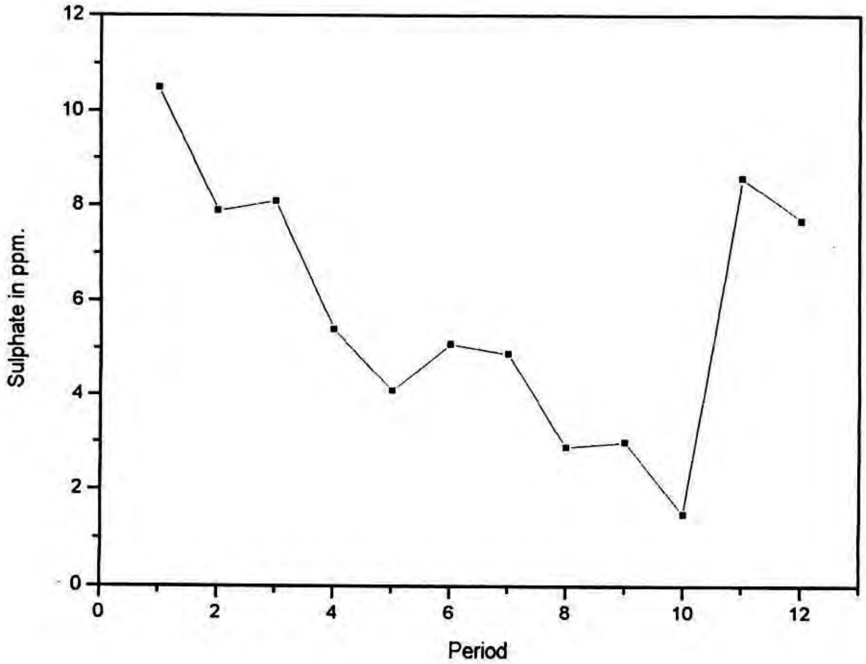


Fig.4.1f. Graphical representation of parameters
(Silica & Choloride) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet.
Period, 93 dry period, to 97 wet period respectivily.



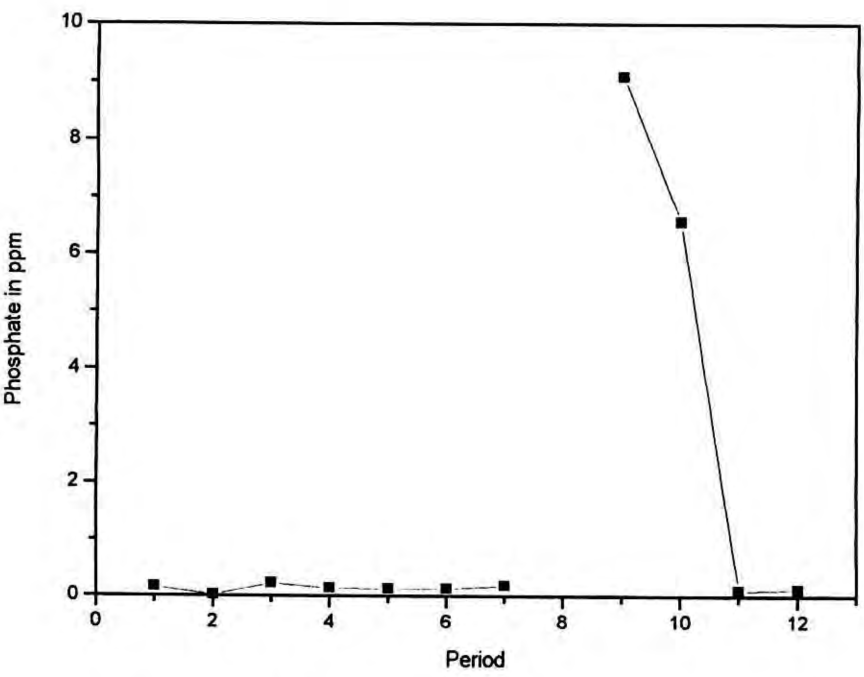
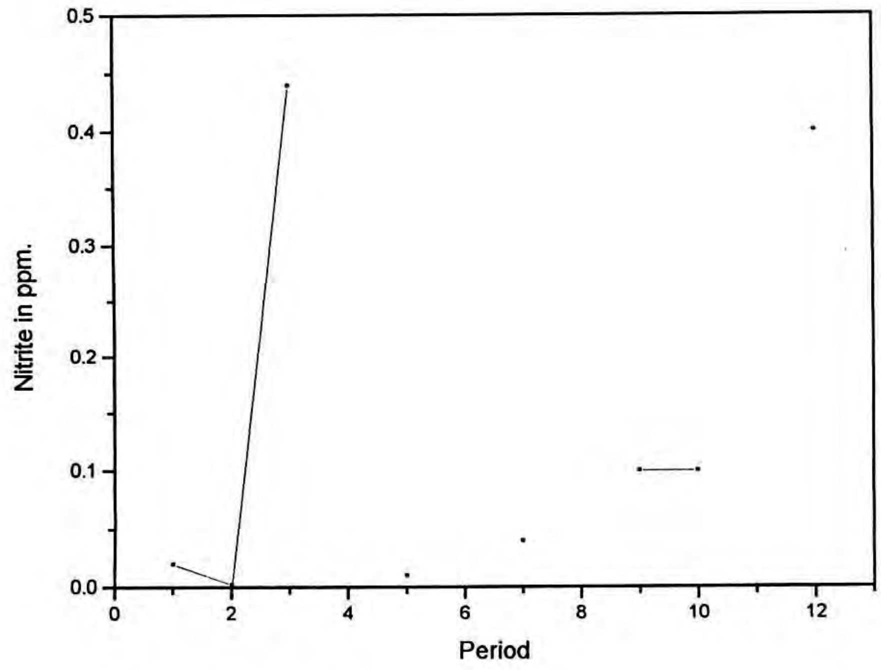


Fig.4.1g. Graphical representation of parameters (Sulphate & Phosphate) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet. Period, 93 dry period, to 97 wet period respectivily.



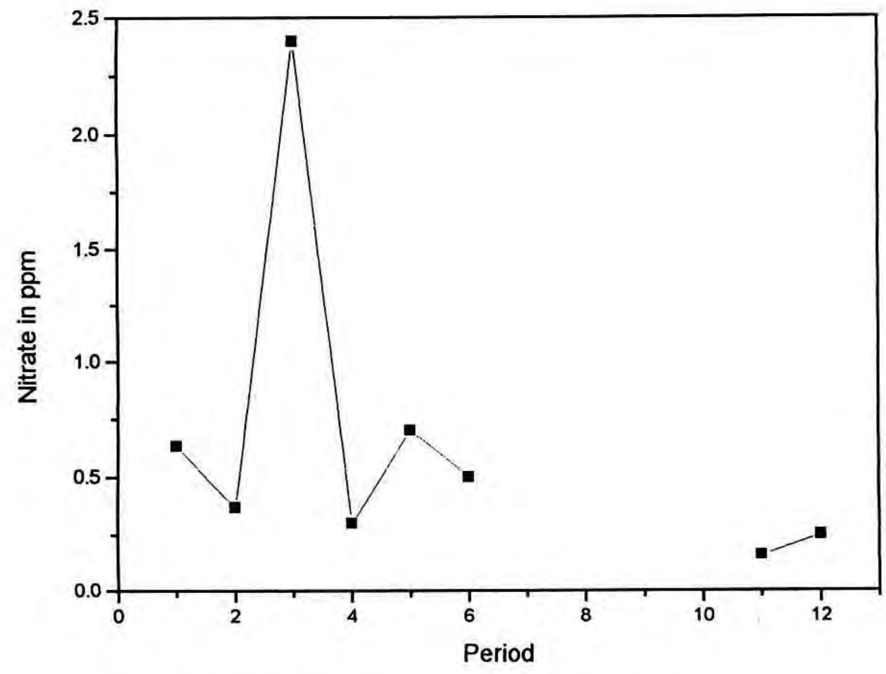
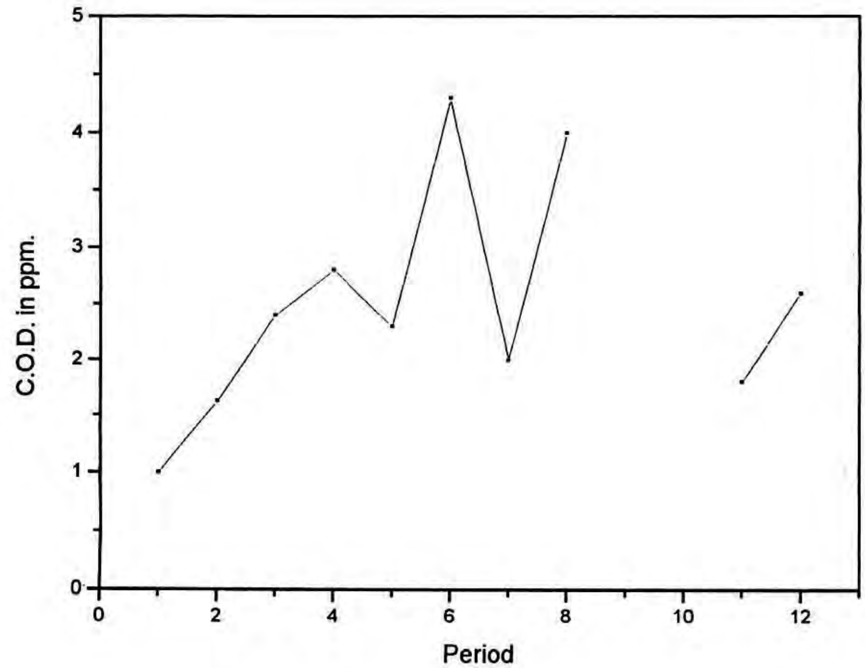


Fig.4.1h. Graphical representation of parameters (Nitrite & Nitrate) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet. Period, 93 dry period, to 97 wet period respectivily.



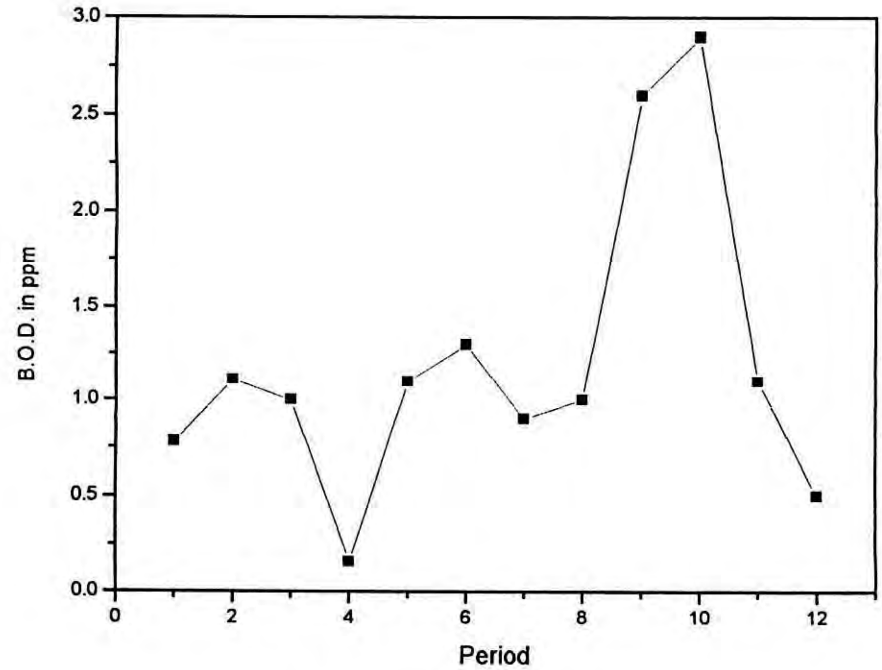
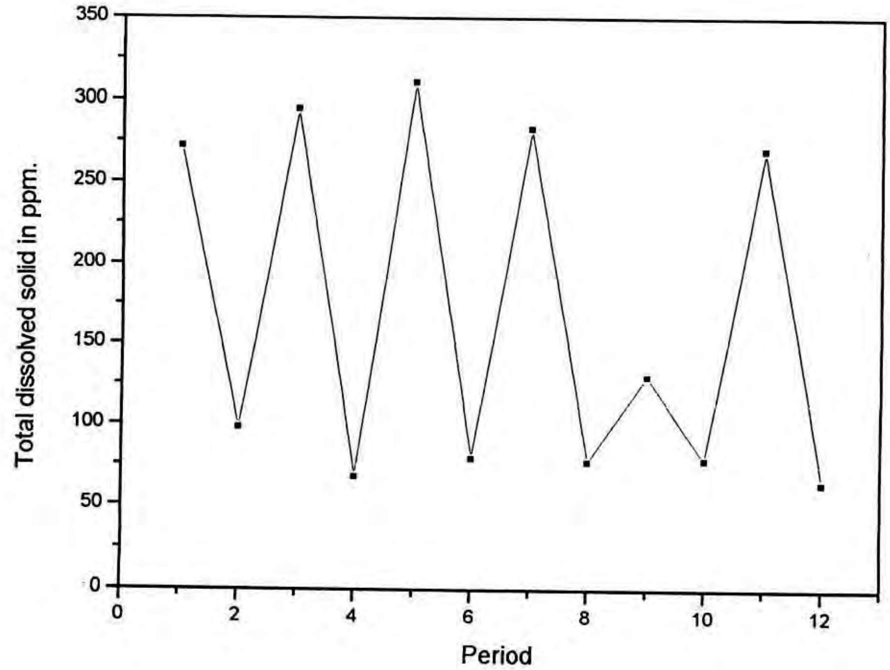


Fig.4.1i. Graphical representation of parameters (C.O.D. & B.O.D) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet. Period, 93 dry period, to 97 wet period respectivily.



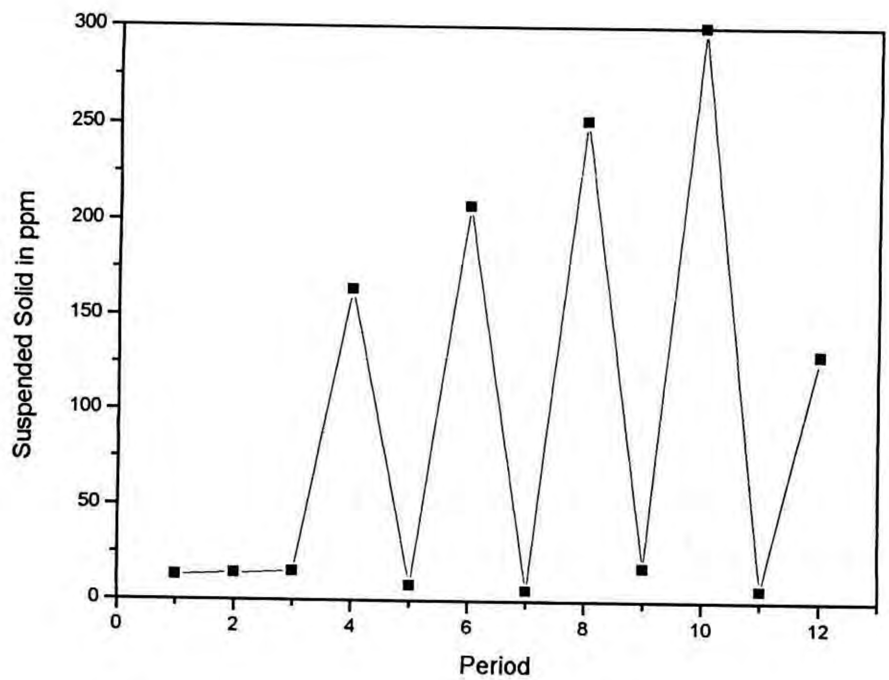


Fig.4.1j. Graphical representation of parameters
(Total dissolved solid & suspended solid) of the river water Jamuna
Note: Period 1,2,3 to 12. Represent 92 dry period, 92 wet.
Period, 93 dry period, to 97 wet period respectivily.

The Jamuna river water quality before confluence with industry effluent (I e before installation of the industry) showed normal values of the water quality parameters due to low level of organic and inorganic load. After confluence the pH and concentration of ammoniacal nitrogen ($N\text{-}NH_4$) of the river water increased, because of mixing with industry effluent of high pH and ammonia ($N\text{-}NH_3$). An observation on the pH value of this effluent (Table-B-6) showed high range 8.5 to 9.5 and concentration of ammoniacal nitrogen from 0.46 to 53.85 mg/l.

Study further revealed that high biochemical oxygen demand and chemical oxygen demand in the fertilizer plant effluent caused increased in BOD and COD load of the stream. However the DO was observed fairly high upto 7.35 mg/1, probably due to high reaeration rate of bottom vegetation as the water level was low. The increase of pH, $N\text{-}NH_4$, BOD and COD due to fertilizer industry effluent was also reported by Bergkvist & Folkeson (1992), Makarov & Kiseleva (1995).

Analysis further revealed that the presence of alkalinity, chloride calcium, magnesium, sodium, potassium in the effluent caused remarkable increase in values in all these parameters in the river water. Similar alteration in water quality due to addition of industrial effluent was also reported by Verma et al (1978), Dakhini and soni (1979) Panday et al (1986), Baruah et al (1996).

So it can be concluded that water quality of the Jamuna river appears to be improved with respect to DO, calcium and magnesium hardness, but with respect to ammonia, pH, E-conductivity, T-alkalinity, Total solid content has appeared to deteriorate the river water quality after the construction of the industry. A comparison of these Table is shown in Table 4.1. below.

Table 4.1 comparison of the Jamuna river water quality (collected data) after construction of the industry to that of before construction of the industry.

Parameter	unit	Pre-construction Rainy season (Collected data)	Post-construction rainy season (Collected data)	Comments	Test Result (This study)
pH		7.2	7.5-8.3	Increased significantly	8 - 8.1
Conductivity	Mohs/cm	95-115	98-212.8	,,	430 – 590
DO	Mg/l	5.5	6-7.35	Increas slightly	---
BOD	,,	4-1.6	1.6-2.7	,,	---
Ammonia	,,	0.15-0.29	Trace-0.6	Max^{m}valu increased.	0.41 – 6.0
Chloride	,,	2.0-3.0	1.4-4.48	,,	4.3 – 6.37
T-Hardness	,,	30.29-31.68	9.0-18.0	Decreased	230 – 240
Calcium hardness	,,	44-48	30-44	,,	---
Turbidity	,,	310-400	14.2-402	,,	20 – 102
M-Alkalinity	,,	5.2-5.6	39.5-58.2	Increased ignifacantly	233.7– 235.6
S S	,,	62-65	14.5-670	,,	54 – 65
Dissove solid	,,	78-83	54.6-200	,,	346 – 390
Total solid	,,	140-148	112.5-744.3	,,	407- 455

Further a comparison of water quality both dry and rainy period after starting the industry i.e. Table, B-7 with standard value of water for different uses Table B-1 revealed that standard value of pH is 6.5 to 8.5 for drinking water, 6.0 to 9.5 for recreational water, 6.5 to 8.5 for fishing water, 6.0 to 9.5 for industrial water, (DOE, 1991), from Table B-7 it is seen that during dry period pH value of the Jamuna river water varies from 7.6 to 8.8.

According to pH consideration, this water is not suiTable for drinking, irrigation, and fishing purposes but it can be used in recreational, industrial, and livestock purpose.

DO of this river water varies from 6.0 to 9.1, minimum DO require for water use in drinking is 6.0 , recreational 4.0 to 6.0 (DOE, 1991). According to DO consideration this water can be used for all the purposes described above. The BOD of the river water is varied from 0.7 to 2.7 where the recommended limits of BOD are 0.2 for drinking water, 10 for both industrial and irrigation water. Therefore the river water is not suiTable for drinking purpose but suiTable for all other purposes. A summary of this comparison shown in Table 4.2.

Table 4.2 Comparison of the Jamuna river water (after construction of JFCL) to standard values of water for different uses.

Parameters	Drinking water	Recreational water	Fishing water	Industrial water	Irrigation water	Live stock water
PH	NS	S	NS	S	NS	S
DO	S	S	S	S	S	S
BOD_5	NS	S	S	S	S	S
COD	NS	NS	-	S	-	-
Chloride	S	S	S	S	S	S
E-Conductivity	-	S	S	-	S	-
Turbidity	NS	NS	NS	NS	NS	-
Ammonia	NS	NS	NS	-	S	-
S S	NS	NS	NS	NS	-	-
TDS	S	-	-	S	S	S

Note: S means suitable, NS means not suitable.

From the analysis to data collected from various organization it can be seen that some changes (mainly with respect to pH, hardness, alkalinity, E-conductivity ammonia and solid content) do occur in the water quality of the Jamuna river during Post-construction period, compared to that of pre-construction period.

Surface water quality (based on test result)

As described in Art, 4.1.4 occasionally a highly polluted effluent discharged from the industry spread bad small of ammonia in the surrounding area and also be the cause of fish destruction of the receiving stream. Once on Feb.-4/1998 observed that case and both effluent and river water sample were collected and tested in laboratory. River water sample also for 5&6 Feb.-/1998 has been tested in the laboratory and are presented in Table B-8 of Annexure-B.

The result of the analysis of the JFCL effluent for Feb.-4/1998 showed significantly high value of parameters like ammonia, urea, pH, conductivity, nitrate and total solid content that compared to effluent generates in normal operation period of the industry. The reason of such high values was detected through conversation with industry employees. According to their opinion process condensate of urea plant when posses a high concentration on ammonia due to leakage or some other means. Condensate treatment section (utility section) then fails to treat it, so drain out as a industry effluent. For that reason river water quality for that day showed significantly high values of parameters, e.g. ammonia of 6.0 mg/1, conductivity 590 ms/cm, urea 3.1 mg/1, and phosphate 1.1 mg/l, where in normal operation period ammonia varies from trace amount to 0.6 mg/1, urea from trace amount to 1.2 mg/1, conductivity from 98 to 495 ms/cm , phosphate from 0.021 to 0.34 mg/1. All other parameters e g temp., pH, T-hardness, M-alkalinity, chloride, nitrate, nitrite, silica, are found almost within range of collected data in Table –B-7 of annexure-B.

Local people informed that such phenomena were occurred several times from beginning of the industry to till now, probably due to their business secrecy, authority did not give data of that severe cases.

Above test results and collected data also evident that the Jamuna river water quality near the industry deteriorated large extend due to installation of JFCL. Hence the degree of impact on surface water due to the industry has been taken as – 3 in Table 4.3.

4.1.6 Air Quality

The air quality inside the industry and surrounding of JFCL have deteriorated due to the emission of ammonia, methane and particulate matters. People during movement to the Sharishabari-Tarakandi road which passes on to the East of the industry, always feel bad smell of ammonia. Coverage of this polluted air is normally not far extend about one-fourth kilometer all around the industry, it increases toward wind direction about 2-3 km due to wind velocity and any abnormality in industry. Concentration of ammonia and other pollutants in air were not possible to measure due to lack of instrument. However plants have been used as bioindicators for air pollution. Many plant species are susceptible to increased level of NH_3, NO_2, and NO, show typical symptoms e.g burning of leaf, defoliation and stunted growth, (Kawamata. 1976) are the evidence of polluted air. During field visit it has been observed, above mentioned symptoms on several coconut trees exist on the north-west corner of the industry (shown in plate- B). Obviously it is a negative impact of the industry. Since the affected area is not so large, degree of impact has been considered as – 1 in Table 4.3.

4.1.7 Socio-Economic condition

Resettlement

Total 194 acres of land have been acquired for the industrial development of the industry. It is gathered that proper land compensations have been paid to the land owners. Displaced farm owners have been compensation in respect of cost for loss but reportedly they were not resettled to proper places at the initiative of the industry authority. Though little in amount but it is a negative impact. Hence degree of impact has been considered as – 1 in Table 4.3.

Income & Employment:

Implementation of the Jamuna Fertilizer Company Ltd. results in meeting the increasing demand of urea fertilizer in the country from local production which would otherwise shall have to be met through import of 0.55 million metric ton of urea per year. Implementation of the industry therefore, results in foreign exchange savings approximately Taka 3000 million per year.

It creates an employment opportunity for 860 personnel, including 259 officers 247 staff and 354 workers, (Annual report-1994) and about 700 casual workers. Two market developed adjacent to the industry also have created a source of income of about 300 family. Through installation of temporary and permanent shops. During construction period most of the agriculture labour of the surrounding areas worked in the industry as casual worker. Apart from these major impacts other beneficial impacts include benefit to local transport business, 240 number of trucks are engaged to carry fertilizer from the industry. In spite of earning benefit to owners, each truck made a source of income for at least three persons. The industry also employed 800 number of dealers i.e. source of income has been created for 800 families. Such a number of benefits in income and employment side have been achieved by the industry, hence degree impact has been considered as + 5 in Table 4.3.

Education

The industry have an indirect impact on education status of the surrounding areas. The people who changed there profession to industry workers from farmers, now would like to send their children in the school. A study has been conducted on two villages- Charpara and Chachiyabanda adjacent to the industry and another village Degreeband about 4 km away form the industry. The result of the study has shown in Table B-9. It was found that current literacy rate of village of Charpara is 56%, Chachiyabanda is 60% and the village Degreeband is 32%. From 1991 census it was found that literacy rate of these villages were 27.5%, 48.5% and 21.5% respectively. Since the literacy of the adjacent villages has increased too much than the far village. It indicates that the industry induced a positive impact on education. Since the influencing area is medium in volume degree of impact has been considered as +3 in Table 4.3.

Infrastructure

The industry locates (Tarakandi) at a distance of 10 km from Sarishabari thana head Quarter and there were no metaled road communication except Railway. After construction of industry a bituminous pavement road JFCL (Tarakandi) to Bhuapur, Tangail has been constructed by R & H Department and another bituminous pavement road Tarakandi to Jamalpur has been constructed by LGED, which are the indirect benefits to inhabittants provided by the industry. Other beneficial impact in this field includes supply of electricity to surrounding villages which were out of electrification before installation of the industry. Due to these beneficial effects on infrastructure degree of impact has been considered as +5 in Table 4.3.

Public Health

During construction of the Sarishabari-Tarakandi road near the industry area have cut adjacent low lands leading to the formation of stagnant ponds shown in plate - C, which could have become the breeding ground for disease vectors. Further during rainy season, occasionally contaminated rain water from the industry enter these pond seeping through the ground, and make its highly polluted, by both chemical and pathogens poisoning. Which is obviously a negative impact.

Plate -E Stagnent Ponds Adjacent to JFCL.

On the other and the industry induced a great positive impact, (indirectly) with respect to sanitation coverage. Study have been conducted over two adjacent villages Charpara and Chechiabunda and another village Degreband 4 kilometer away from the industry. Result of the study have been presented in Table B-10, B-11, B-12 figures 4.3, 4.4 and 4.5. It is seen that in the village Degreeband population per sanitary latrine is 88 where in Charpara is 30 and Chachiabunda is 20 only, up to December 1997.

Which indicate that people of adjacent villages are more conscious about health and sanitation. Thus, it is believed that the industry has a positive impact on public health. The influencing area is medium volume hence degree of impact on public health has been considered as ± 3 in Table 4.3.

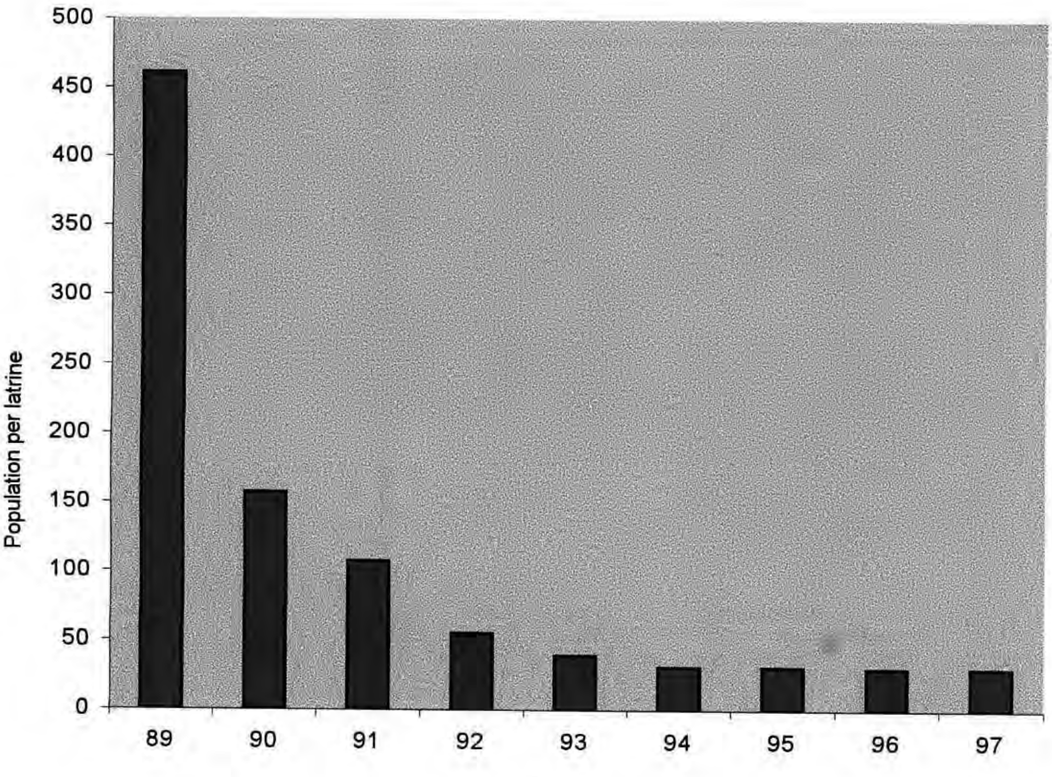


Fig. 4.3. Status of Sanitary Latrine used in village Charpara

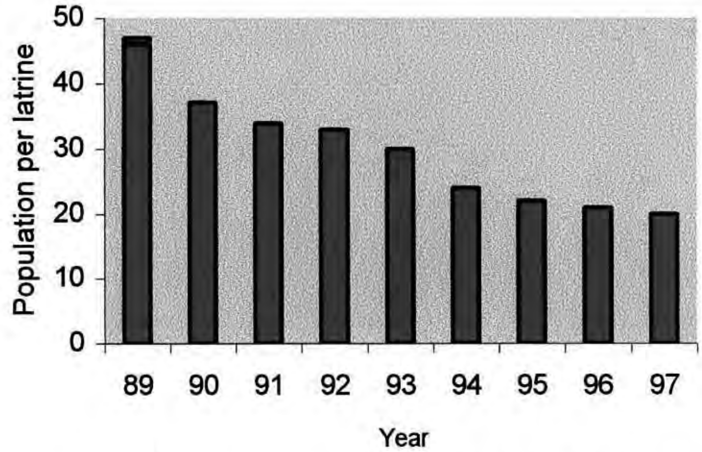


Fig. 4.3 Staus of sanitary latrine used in village Chachiyabanda

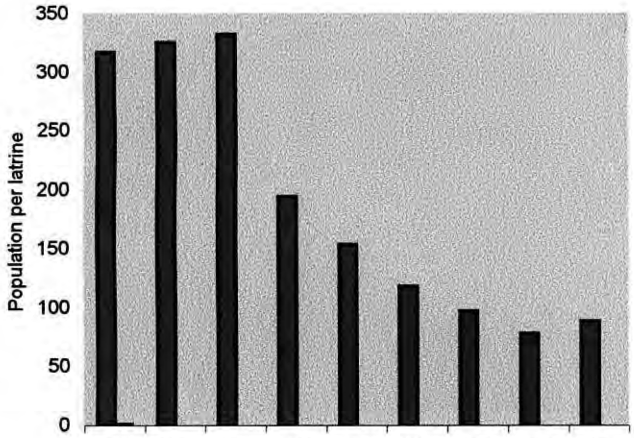


Fig. 4.4 Status of sanitary latrine used in village Degreeband

4.2 Summary of Field Survey:

Based on field investigation and public opinion survey, an initial environmental impact assessment has been made and presented through checklist form in Table 4.3 According to usual practice the degree of environmental impacts of a project varies within the range –5 to + 5, – 5 representing an extremely negative impact and +5 representing an extremely positive impact and higher the number, higher the degree of the impact. Again the impacts are classified as short-term (S) and long-term (L) impact. Short-term impact is associated with the immediate implementation of the project while long-term impact arises as a result of change in environment long after the project.

Table 4.3 Environmental Impact Checklist of JFCL

Environmental Parameter	Degree of Impact	Nature of Impact	Environmental comments
1. Agriculture	-1 +5	S L	Negative impact in the sense due to permanent loss of agricultural land Positive impact in the sense due to the industry has earned a national benefit on agriculture sector
2. Horticulture	-2	L	Reduces fuirt yield
3. Livestock	-1	S	Occasional highly polluted effluent at outlet point may cause harmful effect.
4. Fisheries: I) Capture fisheries ii) Culture fisheries	 -3 -2	 L L	River water fisheries have declined due to polluted effluent, fish cultivation in adjacent water bodies was hampered.
5. Surface water	-3	L	Deteriorate some parameter.
6. Ground water	X	X	Further study is necessary in this field.
7. Air quality	-1	L	Deteriorate Air quality adjacent small area through contamination with ammonia.
8. Socio Economic:			
i) Resettlement	-1	S	Landowners of the project area were not properly settled.
ii) Income & Employment	+5	L	The industry provided large scale of employment opportunity.
iii) Education	+3	L	Increased literacy rate.
iv) Infrastructure	+5	L	Existence of the industry largely improved road communication facility.
v) Public health	±3	L	Positive in the sense peoples surrounding the industry award about health & Sanitation; negative in the sense that the adjacent low lands were polluted by spillage from the industry and became permanent breeding place of mosquito.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The main focus of the present study was to assess impact of Jamuna Fertilizer industry on the various environmental issues (mainly on river water Jamuna). This was done by (a) Collection data from different organizations. (b) Testing river water on the laboratory, (c) observing trees and plants exist on the surrounding area. The environmental impacts of the industry were also addressed through extensive field investigation and questionnaire survey among 500 residents in the surrounding area.

Following are major conclusion drawn from the study :

1. Water quality of the Jamuna river has deteriorated with respect to pH, alkalinity, solid content and ammonia, for that reason fish population reduces significantly. This water is now not suitable for drinking, fishing and irrigation purpose.
2. Air quality of surrounding area (about ¼ km around the industry) has deteriorated due to emitted ammonia, that's why except the bad muisance of ammonia, yield of several fruit plants has reduced some extend.
3. Surface drain outlet and effluent water discharge outlet are hazardous to live stock during dry period, since no protection exists there.
4. The industry was found to have positive impacts on agriculture and socioeconomic sectors. It has contribution on increased crop production of adjacent several districts, e.g. Jamalpur, Sherpur, Tangail, Mymensings and Sirajgonj. The industry brings a major positive change in income and employment, road communication, education and public health. Apparently no conclusion could be drawn on ground water quality. However, from the users perspective, the ground water is suitable for irrigation and for drinking purpose.

The present study shows that the activities of the Jamuna fertilizer industry have some adverse effects on the surrounding environment. However no industrial development can be expected without any adverse impact on environment. The beneficial impacts on the nation as well as human beings would only be possible if the adverse effects are minimized through strict maintenance and control measures as proposed and recommended for this project.

5.2 Recommendation for Environmental pollution control.

1. For the greater interest of the industry as well for the environmental pollution it is necessary to control ammonia contamination of river water up to the allowable limit. For that purpose occasionally released urea plant process condensate instead of direct discharged in to the surface drain should be store in a lagoon or pond. Where ammonia will partially evaporate and partially converted to nitrate by bacteria. After a certain period water from that lagoon will be discharged to the river by pumping.
2. Tall tree species in the outer rows and heavily branched with thick leafed of small to medium height trees in the inner rows are suggested for green belt, which will act as a buffer zone and will minimize air pollution.
3. Leakage from pipe line, valves or ammonia storage tank should be prevent through regular maintenance.
4. It is observed that pH of waste water lies within the range of 7.5 – 8.8 indicate that waste water is alkaline in nature. It should be make neutral before discharge in to the river water. For that purpose a required dose of Alum or sulphiuric acid need to be added at the final pH adjustment basin of the existing waste water treatment system.
5. To reduce fine dust generated during transfer of hot fertilizer from drying channel to the cooler channel, a blower can be install in this section to trop the dust. The outlet of this blower would be dipped in a water reservoir where the dust o fertilizer would be dissolved and deposited at there bottom of the tank.
6. Public awareness should be built up about the health hazard that may be cause due to industry activities.

6.3 Recommendation for future study:

The present study, by no means can be considered as a comprehensive one covering all aspects of environmental impacts due to the construction of the fertilizer industry. However, within its limitations and scope this study has certainly provided a basis and has focussed on various important environmental issues which should be considered for detailed study in the future.

The following recommendations are made for further study in this relevant field:

1. A further study of the water quality of Jamuna river may be perform to identify how extend the water quality have affected by the industry.
2. A detail study and investigation may be carried out over the whole year upon the flucturation of the quality and the quantity of JFCL effluent with time.
3. A study regarding the pollution of air due to JFCL activities may be considered to identify affected area and degree of pollution.
4. A detail study about ground water quality of the surrounding area of Jamuna Fertilizer Company Ltd. may be under taken to identify impact of industrial pollution on ground water.

References

1. American Public Health Association, American Water Works Association, Water Pollution Control Federation, (APHA, AWWA, WPCF) [1985]; "Standard Methods for the Examination of water and Waste Water", 16th edition.

2. American Society for Testing and Materials (ASTM) [1988] "Annual Book of ASTM Standard ", D1293-84, Vol. 11.01 Water-(1) part-I ,

3. Alam, M.K., Rahman M.L. and Ali M.A [1997]; "Pollution Effects of Zia Fertilizer Factory on the river water of Meghna", International Symposium: Water for the 21st Century. June, Lahore.

4. Baruah, B.K. Baruah, D. and Das, M. [1996]; " Study on the effect of paper mill effluent on the water quality of Receiving wetland", Pollution Research 15 (4) p.p 389 -393.

5. Chevone, B. I. Harzfeld, D.E., Krupa, S.V. and Charpperlka, A.H. [1986]; " Direct Effects of Atmospheric Sulfate Deposition on Vegation" Journal of the Air Pollution and Control Association 36 p.p 813- 815.

6. Department of Environment (DOE) [1991]; " Environmental Quality standards for Bangladesh", Govt. of the people's Republic of Bangladesh.

7. Government of the people's Republic of Bangladesh (GOB), [1997]; "Bangladesh Gazette"; Additional copy, 28 August.

8. Kumer, J. N. and Krishnamoothi, K.P. [1983]; " Evaluation of Toxicity of Ammoniacal fertilizer effluents", Environmental pollution (Series A) 30 p.p 77- 86.

9. Kapoor, A. and Viraraghavan, T. [1997]; "Nitrate Removal from drinking water Review" Journal of environmental Engg. 123 (4).

10. Kamal, M. M. [1996]; " Assessment of impact of pollutants in the River Buriganga using a water quality model", M.Sc. Engg. Thesis Department of Civil Engineering, BUET, Dhaka.

11. Karim, M.A [1992]; " Impact of greater Dhaka City flood protection works on the environment with specific reference to industrial waste disposal", M.Sc Engg. Thesis, Department of Civil Engineering, BUET, Dhaka.

12. Khondaker. M.A.M., [1995]; "An environmental impact evaluation of the coastalk embankment on surge flooding in Chittagong City", M.Sc Engg. Thesis, Department of Civil Engineering, BUET, Dhaka.

13. Makarov, M.I and Kiselaeva, V.V. [1995]; " Acidification and Nutrient Imbalance in forest soils subject to Nitrogen Deposition", Water, Air and Soil pollution, 85 pp 1137-1142.

14. Panndy, G.N. and Carney, G.C. [1989]; " Environmental engineering, Tata McGraw-Hill publishing Company Ltd. New Delhi.

15. Panda, . and Dash, T. [1996]; " Ambient Air Quality around a pulp and paper mill", pollution research 15(4) p.p. 399 - 402.

16. R & D Department, UFFL, [1986]; " A Brief on Environmental Pollution Control measures in Urea fertilizer Factory Ltd. Ghorassal, Narasingdhi"

17. Rahman, M.M. and Hossain , M.D. [1993] "EIA Methodology-I and EIA Methodology-II " Instructors Menual, and Environmental Management Training Project, Organized by Dan Educ Consulting and Association with Pathmark associates Limited.

18. Semmens, J.M. Booth, A. and Taure, G.W. [1978]; Clinptilolite column Ammonia removal model" ASCE, April 1978 p p 231-244, 104 (EE2).

19. Shin, H.K. and Chongrak, P. [1988]; " Ammonia Nitrogen Removal in Attached Growth Ponds" Journal of Environmental Engg. 114(4).

20. Salam, M.A. and Soja, G. [1996]; "Investigation of the Air pollutant effects on common agricultural crops and grass plants and ethylene Di urea (Edu) antitoxident", Bangladesh J. Environ, Sci. Vol. 2, p.p. 79 -94.

Annexure - A

Questionnaire

Name (respondent) : ....

Address : ....

....

Date : ....

Interview taken by ....

How many members in your family ?

How many literate person in your family ?

Do you use sanitary latrine ? Yes/No.

If yes, when has it been constructed ?

Has yield of agricultural land been reduced due to the industry's activities ?

Has yield of fruit plants been changed due to emissions of the industry?

Have any problem on cattle been occurred due to the industry?

Has the industry induced any affect on open water fisheries?

Do you feel any change of air quality after installation of the industry?

প্রশ্ন পত্র

নাম : ....

ঠিকানা : ....

....

তারিখ : ....

সাক্ষাতকার গ্রহনকারী : ....

আপনার পরিবারের লোক সংখ্যা কত ?

আপনার পরিবারে কতজন লেখাপড়া জানে ?

আপনারা কি স্বাস্থ্য সম্মত পায়খানা ব্যবহার করেন ? হ্যাঁ / না

করে থাকলে উহা কখন স্থাপন করা হয়েছে ?

সারকারখানার জন্য কি এখানে কৃষি জমির ফলন কম হচ্ছে ?

এখানে ফলের গাছের ফলনের কোন পরিবর্তন হয়েছে কি ?

কারখানার কারনে কখনও গরু,ছাগলের কোন সমস্যা হয়েছে কি ?

কারখানার জন্য নদীর মাছের উপর কোন প্রভাব লক্ষ্য করেছেন কি ?

কারখানা তৈরীর পরে এখানে বায়ুর মধ্যে (গন্ধ ইত্যাদির) কোন পরিবর্তন লক্ষ্য করেছেন কি ?

Annexure - B

Table B.1 Standard values for water use

Parameters	Drinking water	Recreational water	Fishing water	Industrial water	Irrigation water	Livestock water
PH	6.5 - 8.5	6.0 - 9.0	6.5 - 8.5	6.0 - 9.5	6.0 - 8.5	5.5 - 9.0
DO, mg/l	6	-	-	5	5	
BOD, mg/l	0.2	3	6	10	10	
COD, mg/l	4.0	4	-			
Chloride, mg/l	150 - 600	600	600		600	2000
EC, mohs/cm	-	500	800 - 1000		750	
Turbidity	10	10		50		
Ammonia	0.5	2	0.075		3	
Chromium, mg/l	0.05	0.05				
Total coliform	2	200			1000	100
TDS, mg/l	1000			1500	2000	5000
SS, mg/l	10	20	25	75	-	-

Source : Department of Environment (DOE), [1991]; Bangladesh.

Table B.2 ISI tolerance limits for the industrial effluents and that of inland surface water [Rao and Datta; 1987]

Characteristics	Unit	Tolerance Limits		
		Discharge into inland surface water	Discharge into public sewer	Discharge into inland surface water, when used as raw water for public water supplies and bathing ghats.
BOD5 AT 200C	mg/l	30	500	3
COD	mg/l	250	-	-
pH	-	5.5 - 9.0	5.5 - 9.0	6.0 - 9.0
Total Suspended Solids	mg/l	100	600	-
Temperature	0C	40	45	-
Oil and Greas	mg/l	10	100	0.1
Phenolic Compounds	mg/l	1.0	5	0.005
Sulphides	mg/l	2.0	-	-
Total residual cholorine	mg/l	2.0	-	1.5
Arsenic (As)	mg/l	zero	-	zero
Cadmimum (as Cd)	mg/l	2.0	-	0.2
Chromium Hexavalent (as Cr)	mg/l	0.1	2.0	0.05 (total chromimum)
Copper	mg/l	3.0	3.0	-
Lead	mg/l	0.1	1.0	0.1
Mercury	mg/l	0.01	-	-
Chloride (as Cl)	mg/l	-	600	600
Sulphates	mg/l	-	-	1000
Ammoniacal Nitrogen	mg/l	-	50	50
Nitrates (as NO3)	mg/l	-	-	50
Dissolved Oxygen	mg/l	-	-	40% of the saturation value, or 3 mg/l which ever is higher

Table B 3 Standards for nitrogenous Fertilizer liquid effluent

Parameters	Not to exceed, mg/l (except pH
Ammoniacla Nitrogen, as N	50 (New) 100 (Old)
Total kjeldahl nitrogen as N	100 (new) 250 (Old)
PH	6.5 - 8.0
Chropmium as Cr in the outlet of the chromoate removal .... total ...... hexavalent	- - 0.5 0.1
S S	100
Oil and greage	10
Waste water discharge	$10m^3$/ton of urea

Source : Bangladesh gazette August 28, 1997, [GOB; 1997)

Table B-4 Water quality of the Jamuna river before installation of JFCL

Year		1991	
Parameters	Unit	July	August
pH	-	7.2	7.2
T-Alkalinity	mg/l	5.6	5.2
Total solid	mg/l	148	140
Total dissolve solid	mg/l	83	78
Suspended solid	mg/l	5	62
DO	mg/l	5.5	5.5
BOD1	mg/l	1.6	0.4
Magnesium Hardness	mg/l	31.68	30.29
Calcium Hardness	mg/l	48	44
Chloride	mg/l	3	2
Ammonia	mg/l	0.29	0.15
Bicarbonate	mg/l	68.32	63.74
De Hardness	mg/l	180	170
Turbidity	jtu	400	310
E. conductivity	mohs/cm	115	95

Source : Department of Environment (DOE), Bangladesh.

Table B-5 (a) Water Quality of the Jamuna River Near JFCL

Parameter	Year	1991	1992						1993				
	Month	Dec.	Jan	Feb	Jun	July	Aug	Dec	Jan	Feb	Jun	July	Aug
	Unit	Dry period/92			Wet. Period/92			Dry period/93			Wet period/93		
Temperature	°C	24.0	-	18.5	30.0	22.6	30.0	22.0	20.0	-	-	29.0	-
pH		7.9	7.7	7.8	7.8	7.8	7.9	7.7	7.7	7.9	7.8	7.5	7.9
Conductivity	Sm/cm	425.0	416.0	495.0	118.3	140.8	107.2	376.0	421.0	408.0	100.2	98.0	106.0
Turbidity	ppm	103.2	14.5	4.1	53.4	14.2	142.6	9.3	22.0	7.0	212.8	157.6	147.3
Total Hardness	Ppm	224.97	205.4	224.0	50.0	55.0	50.0	200.5	212.5	222.0	45.0	53.0	53.0
Calcium Hardness	Ppm	150.0	132.2	144.0	34.0	42.0	38.0	128.3	132.3	140.0	32.0	36.0	41.0
Magnesium Hardness	Ppm	74.97	73.2	80.0	16.0	13.0	12.0	72.2	80.2	82.0	13.0	17.0	12.0
M-Alkalinity	Ppm	228.0	218.9	241.2	48.5	47.9	45.2	199.0	218.0	224.9	40.5	58.2	50.0
Sodium	Ppm	7.32	9.2	11.7	3.0	2.3	2.1	3.9	8.3	9.7	2.7	3.6	2.3
Potassium	Ppm	3.3	3.3	4.3	1.8	3.1	2.4	2.5	3.6	3.1	2.0	2.8	2.3
Total Iron	Ppm	0.93	0.50	0.51	1.9	0.05	0.70	0.25	0.08	0.13	3.6	2.6	1.2
Ammonium	Ppm	0.23	0.90	0.10	Trace	0.02	0.48	0.60	0.90	0.60	Trace	0.3	0.14
Silica	Ppm	30.46	31.5	32.0	7.74	6.62	8.5	20.23	9.9	24.5	6.9	5.4	6.12
Chloride	Ppm	1.5	2.4	2.9	1.45	4.48	2.13	4.0	4.6	5.6	2.4	3.6	3.7
Sulphate	Ppm	15.0	10.5	8.0	8.4	7.9	7.8	6.4	8.1	8.0	9.5	5.4	5.5
Phosphate	Ppm	0.05	0.17	0.22	0.34	0.021	0.08	0.28	0.23	0.15	0.22	0.15	0.23
Nitrite	Ppm	-	Trace	0.02	0.13	0.002	0.03	0.20	0.44	1.2	0.01	Trace	Trace
Nitrate	Ppm	-	0.63	-	1.3	0.37	0.68	1.50	2.4	6.8	0.24	0.30	0.32
C.O.D.	Ppm	2.45	-	1.0	2.42	1.62	4.85	1.50	2.4	1.2	0.94	2.80	2.30
B.O.D.	Ppm	-	-	0.78	-	-	1.11	0.80	1.0	-	0.67	0.16	0.8
Total dissolved solid	Ppm	295.0	272.0	342.6	83.0	98.0	75.0	263.2	294.7	285.6	70.1	68.0	168.0
Suspended Solid	Ppm	586.0	13.0	3.4	147.0	14.5	150.0	7.6	15.2	3.5	249.3	164.0	74.2
Total Solid	Ppm	881.0	285.0	346.0	230.0	112.5	225.0	270.8	309.9	289.1	319.0	232.0	242.2
Urea	Ppm	-	-	-	-	Trace	2.1	Trace	1.6	5.24	-	4.7	2.12
Do	ppm	-	-	-	-			7.48	-	-	-	-	-

Table B-5 (b) Water Quality of the Jamuna River Near JFCL

Parameter	Year	1993	1994						1995				
	Month	Dec.	Jan	Feb	Jun	July	Aug	Dec	Jan	Feb	Jun	July	Aug
	Unit	Dry period/92			Wet. Period/92			Dry period/93			Wet period/93		
Temperature	°C	25.0	23.0	23.0	27.0	29.0	30.0	25.5	20.0	24.0	27.0	28.0	27.0
pH		7.8	7.7	7.9	7.9	8.0	7.9	7.6	8.0	8.2	7.6	7.7	8.0
Conductivity	Ms/cm	316.0	444.0	428.0	102.0	108.0	125.8	435.0	415.0	440.0	120.5	109.0	108.4
Turbidity	ppm	17.3	7.6	7.8	402.0	147.0	511.4	9.6	3.7	3.8	153.5	228.0	243.4
Total Hardness	Ppm	180.0	240.0	229.0	45.0	48.0	47.0	210.0	216.0	226.0	49.0	46.0	47.0
Calcium Hardness	Ppm	114.0	152.0	143.0	34.0	36.0	36.0	135.0	136.0	91.0	36.0	33.0	34.0
Magnesium Hardness	Ppm	66.0	88.0	86.0	11.0	12.0	11.0	75.0	80.0	135.0	13.0	13.0	13.0
M-Alkalinity	Ppm	157.9	247.1	237.0	42.9	43.5	47.0	214.0	225.0	228.0	46.8	44.0	46.2
Sodium	Ppm	3.2	6.9	7.0	1.8	1.9	2.1	7.3	7.1	7.2	2.2	1.9	2.1
Potassium	Ppm	2.1	2.9	3.2	1.3	1.4	1.7	2.9	3.0	2.5	1.9	2.0	1.7
Total Iron	Ppm	1.98	0.4	0.14	2.0	0.1	0.22	0.28	0.03	0.04	0.2	0.07	0.1
Ammonium	Ppm	0.63	0.3	0.58	Trace	Trace	Trace	0.34	0.06	0.80	Trace	Trace	Trace
Silica	Ppm	14.2	24.0	28.6	6.8	11.1	9.84	22.6	30.2	36.3	8.7	10.2	15.8
Chloride	Ppm	3.2	4.2	4.6	3.0	2.5	2.2	6.2	2.4	6.0	2.5	2.4	2.5
Sulphate	Ppm	11.1	4.1	4.4	3.7	5.1	1.82	4.8	4.9	8.5	4.5	2.9	4.0
Phosphate	Ppm	Trace	0.13	Trace	0.13	0.13	Trace	0.31	0.19	Trace	Trace	-	Trace
Nitrite	Ppm	0.05	0.01	Trace	Trace	Trace	Trace	Trace	0.04	Trace	Trace	Trace	Trace
Nitrate	Ppm	0.88	0.70	0.60	1.4	0.50	Trace	0.98	Trace	Trace	Trace	Trace	Trace
C.O.D.	Ppm	2.73	2.3	3.5	4.8	4.3	4.8	2.40	2.0	2.1	4.7	4.0	3.8
B.O.D.	Ppm	1.02	1.1	2.0	1.6	1.3	2.7	1.3	0.9	1.2	1.0	1.0	0.6
Total dissolved solid	Ppm	221.2	310.8	292.6	74.9	79.0	90.0	304.0	283.0	259.0	72.0	77.0	76.0
Suspended Solid	Ppm	30.0	8.2	7.6	670.0	208.0	233.0	15.8	5.8	1.6	248.0	252.0	198.0
Total Solid	Ppm	251.2	319.0	300.2	744.9	287.0	323.0	319.8	288.8	260.6	320.0	329.0	274.0
Urea	Ppm	-	3.2	Trace	Trace	Trace	Trace	Trace	3.9	Trace	2.5	Trace	Trace
Do	ppm	-	-	-	6.0	6.3	6.8	7.5	8.4	8.3	7.2	6.6	7.0

Table B-5 (c) Water Quality of the Jamuna River Near JFCL

Parameter	Year	1995	1996						1997				
	Month	Dec.	Jan	Feb	Jun	July	Aug	Dec	Jan	Feb	Jun	July	Aug
	Unit	Dry period/92			Wet. Period/92			Dry period/93			Wet period/93		
Temperature	°C	22.0	22.0	20.0	27.0	27.0	28.0	22.0	21.0	21.0	29.0	30.0	
pH		8.0	8.6	8.8	8.2	8.1	7.8	7.9	7.7	8.0	8.3	7.8	
Conductivity	Ms/Cm	206.0	214.0	193.7	118.0	115.3	135.7	422.0	475.0	480.0	112.8	101.2	
Turbidity	Ppm	58.0	48.0	43.3	176.5	-	178.0	35.0	12.0	4.3	148.2	133.1	
Total Hardness	Ppm	93.0	110.0	104.0	50.5	59.0	57.0	196.0	338.0	228.0	50.0	48.0	
Calcium Hardness	Ppm	66.0	70.0	72.0	34.0	41.0	44.0	126.0	146.0	142.0	33.0	30.0	
Magnesium Hardness	Ppm	27.0	40.0	32.0	16.5	18.0	13.0	70.0	92.0	86.0	17.0	18.0	
M-Alkalinity	Ppm	94.4	102.0	103.8	46.0	55.0	56.0	198.8	239.0	236.0	42.3	39.5	
Sodium	Ppm	4.01	3.8	4.4	2.27	1.92	2.08	-	-	-	-	1.8	
Potassium	Ppm	1.71	2.0	1.8	1.49	1.89	2.20	-	-	-	-	2.4	
Total Iron	Ppm	0.03	0.04	0.08	0.15	0.14	2.07	1.0	0.16	0.2	1.8	0.7	
Ammonium	Ppm	0.14	0.08	0.8	Trace	0.60	0.22	0.3	2.2	1.0	0.1	Trace	
Silica	Ppm	13.80	12.96	12.6	13.5	7.60	9.54	16.0	32.2	42.0	4.9	9.1	
Chloride	Ppm	2.50	3.0	3.0	1.6	1.50	3.92	1.8	3.6	4.0	1.4	3.9	
Sulphate	Ppm	5.10	9.1	6.4	7.9	6.58	3.88	6.6	8.6	4.0	8.0	7.7	
Phosphate	Ppm	Trace	0.1	Trace	0.25	0.10	0.12	0.19	0.1	0.07	0.08	0.12	
Nitrite	Ppm	Trace	Trace	Trace	0.07	Trace	Trace	Trace	Trace	Trace	0.007	0.40	
Nitrate	Ppm	Trace	-	-	-	-	-	0.14	0.16	0.8	Trace	0.25	
C.O.D.	Ppm	1.20	2.6	2.0	2.0	2.90	2.80	2.3	1.8	1.1	1.2	2.6	
B.O.D.	Ppm	0.70	0.9	0.8	0.35	1.08	0.60	1.7	1.1	0.8	Trace	0.5	
Total dissolved solid	Ppm	123.0	130.0	131.0	200.0	78.0	69.0	240.0	270.0	300.0	54.6	64.0	
Suspended Solid	Ppm	29.4	18.0	16.40	400.0	300.0	220.0	101.0	6.4	6.8	129.5	130.0	
Total Solid	Ppm	152.4	148.0	147.4	600.0	378.0	289.0	341.0	276.0	306.8	183.5	194.0	
Urea	Ppm	Trace	Trace	Trace	Trace	Trace	Trace	Trace	4.2	8.0	2.7	3.6	
Do	Ppm	8.03	8.3	6.4	7.35	6.68	7.02	7.8	8.4	9.1	7.2	6.9	

Table B - 6 : Effluent quality of JFCL

		Year 1995			Year 1995					Year 1997	
Months		Jan.		July		Jan.		July		Jan.	
Parameters	Units	min	max	min	max	min	max	min	max	min	max
pH		8.5	9.3	8.2	9.4	7.1	9.2	7.8	8.3	8.9	9.5
Temperature	^0C	24	27	26	32	22	24	29	29	21	26
Ammoniacal nitorgen (as n)	mg/l	19.8	72	16.3	64.3	0.09	56.6	0.31	.062	39.7	65.3
Urea (as n)		14.05	44.5	2.8	160.1	9.8	24.9	-	-	7.91	480.2
Phosphate		0.17	0.3	0.2	0.6	0.09	0.7	0.04	0.05	0.09	0.2
BOD		7.8	16.4	4.7	10.4	1.4	11.4	3.2	3.6	9.8	11.61
S S		8.4	40.8	175	283	3.3	9	90	716	5.8	200
TKN		43.2	124.2	35.5	225.7	16	83				

Source : JFCL Laboratory

Table. B-7 : Parameter showing significant seasonal variation of the river water Jamuna for period 1992-97

Parameters		dry season (Dec. to Feb)		Rainy season June to Aug.	
	Unit	Min	Max	Min	Max
Temperature		18.5	25	22.6	30
pH		7.6	8.8	7.5	8.3
Conductivity		193.7	495	98	212.8
Turbidity		3.7	103.2	14.2	402
DO		7.48	9.1	6	7.35
BOD		0.7	2	0.16	2.7
COD		1.1	2.73	1.2	4.8
Ammonia		0.06	2.2		0.6
Nitrite (NO2)		Trace	0.44		0.4
Nitrate		Trace	6.8		1.4
Phosphate		Trace	0.31		0.25
Sulphate		4	11.1	1.82	9.5
Silica		9.9	42	4.9	15.8
Chloride		1.5	6.2	1.4	4.48
Calcium Hardness		66	152	30	44
Magnisium Hardness				11	18
Total Hardness		93	338	45	228
M-Alkalinity		94.4	247	39.5	58.2
Dissolved solids		123	342	54.6	200
Suspended solid		1.6	586	14.5	670
Total solid		147.4	881	112.5	744.3
Urea		Trace	8	Trace	4.7

Source : JFCL Laboratory

Table B – 8 Water quality of the Jamuna river of Sampling point S_1 (test result).

Parameter	Unit	Sampling date		
		4-2-98	5-2-98	6-2-98
Temp.	°C	23	24	23.7
pH		8.0	8.1	8.0
Conductivity	Ms/cm	590	468	430
NH_4	Mg/L	6.0	1.72	0.41
Urea	,,	3.1	0.65	0.23
T-Hardness	,,	234	240	230
M-Alkalinity	,,	233.7	235.6	234
Chloride	,,	4.6	6.37	4.3
No_2	,,	1.6	0.42	0.52
No_3	,,	7.0	2.37	2.21
Total phosphate	,,	1.1	0.256	0.26
Silica (so_2)	,,	4.01	32.87	32.00
Turbidity	,,	20	31.23	102
COD	,,	3.2	3.5	2.6
Suspended solid	,,	61	65	54
T.D.S	,,	346	390	370
T.S	,,	407	455	424

Table B-9 : Literacy rate of experimental villages

Name of Village	No of families	Total population	No of literate person	Literacy rate
Charpara	215	1103	617	56%
Chachiyabanda	120	641	384	60%
Degreeband	350	1522	533	35%

Table B-10 Status of sanitary latrine used in village Charpara

Year	Population	No of existing Sanitary latrine	Population per latrine
89	920	2	460
90	941	6	157
91	963	9	107
92	985	18	55
93	1008	26	39
94	1031	33	31
95	1054	34	31
96	1078	36	30
97	1103	37	30

Table B-11 Status of sanitary latrine used in village Chachiyabanda

Year	Population	No. of existing sanitary latrine	Population per latrine
89	506	11	46
90	521	14	37
91	537	16	34
92	553	17	33
93	570	19	30
94	587	24	24
95	604	28	22
96	622	30	21
97	641	32	20

Table B-12 Status of sanitary latrine used in village Degreeband

Year	Population	No of latrine	Population per latrine
89	1270	4	317
90	1299	4	325
91	1329	4	332
92	1359	7	194
93	1391	9	154
94	1422	12	118
95	1455	15	97
96	1488	19	78
97	1522	19	88